Nature News

周二, 07 11月 2017

Nature News

[周二, 07 11月 2017]

- **Nature News**

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Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

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Lab mice's ancestral 'Eve' gets her genome sequenced

Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.

13 November 2017

Anne Chadwick Williams/Sacramento Bee/ZUMA Press/Alamy

The genomes of lab mice can shift in subtle and unpredictable ways over generations of breeding.

Adam and Eve, a pair of black mice, lived for less than two years and never left their home at the Jackson Laboratory (JAX) in Bar Harbor, Maine. But since they were bred in 2005, their progeny have spread around the globe: the

pair's living descendants, which likely number in the hundreds of thousands. They are members of the most popular strain of mice used in biomedical research, which was created nearly a century ago.

Now, researchers at JAX are reconstructing Eve's genome in the hopes of better understanding — and compensating for — the natural mutations that occur in lab mice over the course of generations. These genetic changes can cause unanticipated physiological effects that can confound experiments. Related substrains of lab mice can differ in their taste for alcohol or their sensitivity to insulin, for example, and researchers suspect that such differences between supposedly identical mice lines have hampered some areas of research.

The scientists who founded JAX created Adam and Eve's breed, which is called C57BL/6, in 1921. To keep the mice as genetically similar as possible, researchers have repeatedly bred brothers with sisters for nearly a century — and sold the resulting offspring to customers around the world. But this strategy created a genetic bottleneck: every generation, between 10 and 30 new mutations pop up and are passed down to offspring. This 'genetic drift' quickly accumulates over the years, says Laura Reinholdt, a geneticist at JAX. The genomes of the C57BL/6 mice that the lab sells today have thousands of genetic differences from the mouse reference genome, which was created in 2002 from three mice from the substrain C57BL/6J. The genome is used as a template for researchers developing genetically modified mice.

Other suppliers have inadvertently created divergent substrains of C57BL/6 mice when they've bought rodents from JAX and bred them over several generations. Although most mutations go unnoticed, some occur in genes that affect a mouse's appearance or physiology. In 2016, mouse supplier Envigo in Somerset, New Jersey, found that C57BL/6 mice at 6 of its 19 breeding facilities around the world had acquired a mutation in a gene related to the immune system. The company notified the researchers that bought these mice, and asked customers to specify which location they preferred to source mice from in the future, given that the company's stocks were no longer identical.

Hidden changes

And although it is easy to spot a mutation that changes fur from black to white, for instance, some changes are discovered only if researchers are investigating a particular trait. A substrain of C57BL/6 mice that the US National Institutes of Health bred for 50 generations are uninterested in alcohol, whereas those bred at JAX's facility display a preference for alcoholic beverages.

In 2005, a team at JAX decided to reset the genetic clock by selling only C57BL/6J mice descended from two chosen mice: Adam and Eve. The researchers froze hundreds of embryos of the duo's grandchildren, enough to last for 25-30 years. Every five generations, the company thaws some of these embryos and raises them to adulthood as new breeding pairs.

"In some ways, the changes that are acquired are insidious and unstoppable," says Michael Wiles, the lab's senior director of technology evaluation and development, who led the project. "We've not stopped general drift, but we've slowed it considerably." Once the stockpiled embryos run out, however, JAX will have to start over with new breeding pairs from a much later generation.

Yet Eve's genome is very different from the 2002 mouse reference genome. In a presentation last month at the American Society for Human Genetics' meeting in Orlando, Florida, JAX computational scientist Anuj Srivastava spoke about the company's effort to reconstruct Eve's genome in high detail, using three different sequencing methods. Wiles says that the genome will be finished by the end of November, and that JAX plans to publish it early in 2018.

Mouse trap

Other mouse breeders have started their own efforts to account for genetic drift. Taconic Biosciences, a mouse distributor in Hudson, New York, restarts its C57BL/6 line every ten generations from its stash of frozen embryos.

Because Taconic has bred its line separately from the JAX line for decades, the Eve genome won't necessarily reflect the genetic make-up of Taconic's mice any more than the current mouse reference genome does.

Ana Perez, Taconic's global director of genetic sciences and compliance, says that the company plans to publish the genome of its own Eve. "From my perspective, each particular breeder should have their own reference genome to follow," she says. Buying mice from different breeders and expecting them to be the same is a fallacy, she adds.

But most researchers don't think about the differences between the various substrains of C57BL/6 mice and how those disparities can affect reproducibility in research, says Cory Brayton, a pathobiologist at Johns Hopkins University in Baltimore, Maryland. "The vendors are pretty good about making the information available, but the awareness is still pretty low," she says. It is impossible to quantify how often experiments or entire research programmes are wasted when researchers realize that their supposedly identical mice have genetically diverged from the ancestor they bought from a vendor, but Brayton suspects it is common.

The Eve genome will be a useful addition for researchers who use animals from JAX, says Brayton, although it won't solve all the reproducibility problems inherent to inbred mouse lines. "If you use [inbred mice] wisely, they can be highly informative," she says. "If you use them stupidly, they may really confound your studies."

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Comments

Comments

There are currently no comments.

High-jumping beetle inspires agile robots

Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.

13 November 2017

Brian L. Stauffer

Click beetles have a hinged body that can propel them to great heights.

A beetle that can launch itself spectacularly into the air after falling on its back — flipping right side up without having to use its legs — could inspire a new generation of smart robots.

Imagine a rescue robot vaulting its way through a disaster zone riddled with obstacles, or a planetary robot extricating itself from an unexpected tumble on Mars. Each might use a trick or two learnt from the click beetles, a family of insects with the unique ability to catapult themselves out of trouble.

“A lot of robots out there jump using their legs,” says Aimy Wissa, a mechanical engineer at the University of Illinois in Urbana-Champaign. “What’s unique about this is if something breaks, you can still jump without legs and get out of the situation.”

Wissa and her Illinois colleagues, led by mechanical-engineering graduate student Ophelia Bolmin, described the mechanics of jumping click beetles on 7 November at a meeting of the Entomological Society of America in Denver, Colorado. They published early results in the proceedings of a bio-inspired robotics conference in July[1].

So far, the scientists have studied how click beetles manage to store and hold the energy needed to launch themselves into the air. They hope to soon start building prototype machines designed after the beetles.

Snap to it

There are about 10,000 species of click beetles around the world. The insect’s head and body are connected by a hinge that the beetle can slowly arch and then suddenly snap in the opposite direction, jack-knifing its body and sending it into the air with an audible ‘click’. Earlier work has shown that the beetles launch nearly vertically before somersaulting through the air[2].

Ophelia Bolmin/University of Illinois at Urbana-Champaign

Click beetles can launch themselves up with surprising force.

If the beetle lands on its back, it just does the same manoeuvre again. Compare that to an upended ladybird — also known as a ladybug — which has to wiggle around on its back until it manages to roll over far enough and get traction with its legs to flip itself over.

The Illinois team wanted to analyse how the click beetles pull off their acrobatic feat. “We thought we could look at, how do they really jump, how is that energy being released?” says Marianne Alleyne, an entomologist on the team.

Students measured the dimensions of dozens of beetles of four species (*Alaus oculatus*, *Ampedus nigricollis*, *Ampedus linteus* and *Melanotus* spp.), videotaped their jumps with high-speed cameras and analysed the energy required for the beetles to pull the hinge back and then release it. Muscles alone are not enough, because they contract relatively slowly, and so other body parts such as tendons must also be involved, the team says.

How high?

The researchers also measured the force drop as the hinge snapped shut, confirming that it corresponded to the click as the beetle begin to soar skyward. They are now analysing the energies involved as beetles of different sizes make the jump. Click beetles can range from just a few millimetres to a few centimetres long; early results suggest that the bigger the beetle, the higher it can jump, Wissa says.

Other engineers have developed a range of agile robots that can jump using their legs — including one inspired by the Senegal bushbaby (*Galago senegalensis*), which has the highest vertical jumping ability of any animal[3]. Compared with crawling, jumping is a fast and efficient way for small robots to get around obstacles, says Mark Cutkosky, a mechanical engineer at Stanford University in California.

The advantage of the beetle approach is that something could go wrong with the robot's legs, and it could still get out of its predicament, Wissa says. "It simplifies the design a lot."

Any robots inspired by the click beetle would probably have to be quite small — perhaps a few tens of grams, says Gal Ribak, a biomechanics specialist at Tel Aviv University who has studied the beetles' jumps[4]. "Otherwise, the jumping mechanism will require too much energy to lift the body into the air, and the repeated impacts at take-off and landing would result in mechanical damage," he says.

But those constraints might not apply to robots exploring planets other than Earth. On worlds with lower gravity, beetle-like robots could fly high.

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Comments

Comments

There are currently no comments.

Archaeologists say human-evolution study used stolen bone

Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.

13 November 2017 Updated:

1. 13 November 2017

Marc Steinmetz

The Untermassfeld site in Germany has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago.

Serious concerns have surfaced about three research papers claiming evidence for one of the earliest human occupations of Europe.

In an extraordinary letter posted to the bioRxiv.org preprint server on 31 October[1], archaeologists allege that the papers, published in 2013, 2016 and 2017, included material of questionable provenance, and that results reported in the 2016 paper were based on at least one stolen bone. Editors at the journals concerned have now published expressions of concern about the papers.

There is no suggestion that the authors of those papers were involved in theft, but the researchers behind the letter say they are concerned that appropriate questions regarding the provenance of the material appear not to have been asked. They also reject the authors' conclusion that a German site known for animal remains was also home to hominins, ancient relatives of humans, 1 million years ago. The authors have denied the allegations and say they stand by their conclusion.

The letter was initiated by archaeologist Wil Roebroeks at Leiden University in the Netherlands, and Ralf-Dietrich Kahlke, a palaeontologist and head of the Senckenberg Research Station of Quaternary Palaeontology in Weimar, Germany, who leads excavations at Untermassfeld, a fossil site about 150 kilometres northeast of Frankfurt. Their preprint describes repeated disappearances of bones from Untermassfeld, as well as fossils delivered in anonymous packages. The authors of the disputed papers insist, however, that they analysed independent collections of bones and stones, and reject the suggestion that any of it was stolen.

Untermassfeld, which has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago, holds the most complete record of northern European wildlife from this time period. But since yearly excavations began in the late 1970s, no hominin bones or signs of occupation have been found, says Kahlke. Hominins first settled in southern Europe around 800,000 to 1 million years ago, most archaeologists agree, and expanded farther north only sporadically until around 500,000 years ago.

Uncertain origins

One of the first claims that hominins lived near Untermassfeld more than 1 million years ago appeared in a 2013 paper in the journal *Quaternary International*, which contended that rocks from the site resembled stone tools[2]. In a 2016 *Journal of Human Evolution* paper[3], two of the original paper's authors, Günter Landeck at the North Hessian Society of Prehistory and Archeology of the Medieval in Bad Hersfeld, Germany, and Joan Garcia Garriga at the Universitat Oberta de Catalunya in Barcelona, concluded that marks on animal bones from Untermassfeld were made by humans. In 2017, Landeck and Garcia Garriga published further analysis of the bones in another *Quaternary International* paper[4].

There is no suggestion that the other co-authors of the 2013 paper had any connection with the material from Untermassfeld. And after this article was published, Garcia Garriga contacted *Nature* to say that he, also, did not have connections with the material; he said that Landeck had done the analysis, while he himself helped in discussing data and writing up its archaeological implications.

In their papers, Landeck and Garcia Garriga attributed the material, along with hundreds of rock fragments of limestone and chert, to “the Schleusingen collection”, which they stated was recovered by a biology teacher in the late 1970s and early 1980s.

Kahlke says he is personally unaware of a Schleusingen collection and questions whether the material was collected at this time. Rocks like those described in the papers can be found in the vicinity of the site, but he says that animal fossils are concentrated in a small area that has been under excavation since 1978. No other research teams had permission to excavate the site during that time, Kahlke says. But he says that material was routinely stolen from the site — which he reported to the police, most recently in 2012 — until the site and fossil bed were better secured. There is no suggestion that Landeck and Garcia Garriga were involved in these thefts.

Ralf-Dietrich Kahlke

Researchers excavating at Untermassfeld allege that part of a deer bone protruding from the sediment on 28 May 2009 (in box, left) had disappeared several days later.

One fossil that Kahlke considers suspicious is a right limb-bone fragment from an extinct species of fallow deer, described in Landeck and Garcia Garriga's 2016 *Journal of Human Evolution* paper. Kahlke says that the bone in the paper seems to match a piece of deer bone that thieves broke from a larger chunk of sediment at Untermassfeld, leaving part of the bone behind. The bone fragment is present in a photograph taken on 28 May 2009, and missing in a photograph taken several days later. A rhinoceros limb fragment that disappeared from the site in 2012 also closely resembles a fossil described in the 2016 paper, Kahlke says.

Case unsolved

Deepening the mystery, a deer bone fragment was among a jumble of bones and rocks in two packages sent anonymously to a museum near Untermassfeld in March 2014. Ralf Werneburg, a palaeontologist and director of the Natural History Museum Schloss Bertholdsburg in Schleusingen, Germany, recognized the material as originating from Untermassfeld and contacted Kahlke.

Ralf-Dietrich Kahlke

An anonymous package sent to a museum in Schleusingen contained a deer bone fragment (lower bone), which appears to match a fragment left behind (upper bone) after a theft from the Untermassfeld site in 2009. (The fragments are shown pieced together in the view on the far-right).

In Kahlke's opinion, the returned deer bone fragment is the one described in the 2016 paper, and matches up with the piece left behind after the 2009 theft**.** He says that the sixty-three other bone fragments in the packages also closely resemble some of the fossils described in the 2016 paper (the rhinoceros limb bone was not among them), and 11 rock fragments resemble

artefacts in the 2013 *Quaternary International* paper.

Roebroeks and Kahlke's team analysed the material in the returned packages, and concluded that it does not support a hominin occupation at Untermassfeld. They argue that the claimed cut-marks on the animal bones, including the deer bone, were probably caused by rodents or other natural wear, they say, and the rock fragments lack telltale marks typical of hominin tools. They say that it wasn't possible to analyse other material from Landeck and Garcia Garriga's paper because its location is unclear.

Nature exchanged multiple e-mails with Landeck and Garcia Garriga about this mystery and asking for comment on the contents of this article. The researchers responded that most of the material they examined, including the deer bone fragment, was from two private collections amassed in the 1970s and early 1980s, and that much of it came from the same geological layer as Untermassfeld, but not within the site itself. They said that they presumed that some of this material was returned to the Natural History Museum Schloss Bertholdsburg in 2014 by the individual who had loaned it to them. They would not name the individual, but insisted: "We have nothing to do with a stolen bone". They added that they are planning to publish a detailed response to Roebroeks and Kahlke's allegations.

The regional prosecutor's office in Meiningen that investigated the 2009 theft told *Nature* the case had been closed unsolved later that year. A 5-year statute of limitation prevents it from being reopened. The case involving the 2012 theft of the rhinoceros bone was reopened early this year after the *Journal of Human Evolution* paper was published. The prosecutor's office said that an individual, whom it declined to name because of data protection laws, had been found guilty and fined.

Ongoing inquiry

Expressions of concern published on each of the three papers note that the location of the Untermassfeld material "was not stated accurately in the publication", and that the authors have been unable to adequately clarify where it is now. Landeck and Garcia Garriga declined to comment to *Nature*

on the specific details of the notes but said that they plan to publish a response.

Sarah Elton, an anthropologist at the University of Durham, UK, and an editor at the *Journal of Human Evolution*, says that an investigation into the accusations is ongoing. She adds that, as a result of the case, the journal now asks prospective authors to supply complete information about the location of material included in a study, as well as how it was accessed.

Other experts have been shocked by the revelations. “This paper should be retracted, of course,” says Jean-Jacques Hublin, an anthropologist and a director at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, about the 2016 paper. But the concerns go beyond questions of provenance. Hublin says that, like Roebroeks and Kahlke, he does not accept the claim that Untermassfeld contains signs of hominin presence, and he worries that its appearance in prominent journals will cause others to accept the idea, despite the lack of evidence for it.

The debate around Untermassfeld, Roebroeks and his colleagues say, underscores the importance of providing accurate descriptions of the provenance of published material, which is needed to verify claims. The desire to set the record straight about the arrival of hominins to Europe was the primary motivation for the team’s letter, he says. Based on his analysis, Roebroeks argues: “These bones and stones are not indicative of hominin presence.”

With additional reporting by Alison Abbott

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Updates

Updated:

This article was updated on 13 November to note that expressions of concern have been published on all three papers, and to include a statement made after publication by Garcia Garriga: that he was not involved in analysing the material from Untermassfeld.

Comments

Commenting is currently unavailable.

World’s carbon emissions set to spike by 2% in 2017

Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.

13 November 2017

Kevin Frayer/Getty

China, the world’s largest emitter of greenhouse gases, is trying to reduce its reliance on coal.

Humanity’s carbon emissions are likely to surge by 2% in 2017, driven mainly by increased coal consumption in China, scientists reported on 13 November[1–3]. The unexpected rise would end a three-year period in which

emissions remained flat despite a growing global economy.

Researchers with the Global Carbon Project, an international research consortium, presented their findings at the United Nations climate talks in Bonn, Germany. Countries there are ironing out details of how to implement the 2015 Paris climate accord, which calls for limiting global warming to 1.5–2 °C. The projected jump in the world's greenhouse-gas output underlines the challenges ahead; if the latest analysis proves correct, global carbon dioxide emissions will reach a record-breaking 41 billion tonnes in 2017.

"We were not particularly surprised that emissions are up again, but we were surprised at the size of the growth," says Corinne Le Quéré, a climate scientist at the University of East Anglia, UK, and co-author of the work, which was published in the journals *Nature Climate Change*, *Environmental Research Letters* and *Earth System Science Data Discussions*. To Le Quéré, the question now is whether 2017 is a temporary blip or a return to business as usual. "If 2018 is as big is 2017, then I will be very discouraged," she says.

Several factors caused the world's CO_2 emissions to level out from 2014 to 2016, including the economic slowdown in China, the world's largest emitter; a shift from coal to gas in the United States; and global growth in the use of renewable energies such as solar and wind. Many climate scientists and policymakers had hoped that the pause in emissions growth represented a shift in energy use that would eventually cause global greenhouse-gas emissions to peak — and then decline.

The latest analysis projects that CO_2 emissions in the United States and the European Union will continue to decline — by 0.4% and 0.2%, respectively, in 2017 — although at a slower pace than in recent years. And emissions growth in India is set to slow, rising by just 2% this year, compared with an average of 6% per year over the past decade.

But the picture is very different in China, which produces nearly 26% of the world's output of CO_2. This year, the country's emissions of the greenhouse gas are expected to surge by 3.5%, to 10.5 billion tonnes. The main causes are increased activity at the country's factories and reduced hydroelectric-

energy production, the Global Carbon Project analysis finds.

The effort highlights nagging uncertainties about greenhouse-gas emissions trends, particularly in China, India and other countries with economies that are rapidly growing and changing, says David Victor, a political scientist at the University of California, San Diego. He is not convinced that government actions — at the national or international level — drove the recent levelling of emissions. And although emissions are projected to grow this year, Victor says that China is still on a trajectory that would see its emissions peak well before its 2030 target.

Taken together, the projections for 2017 reinforce the notion that the world has far to go before it solves the climate problem, says Glen Peters, a climate-policy researcher at the CICERO Center for International Climate Research in Oslo and a co-author of the Global Carbon Project's 2017 analysis.

"This is basically saying that we are not safe yet," Peters says. "We can't be complacent."

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Comments

Comments

There are currently no comments.

South Africa tackles crime at sea with ship-spotting satellites

Automated vessel-tracking system aims to spy poachers and smugglers.

10 November 2017

Leeman/Getty

South Africa has started to combine data from satellites, vessel transponders and radar to monitor ships in its waters in real time.

In October last year, a fishing boat set out from Velddrif, a small town on South Africa’s west coast. It sailed northwest for about 25 nautical miles (46 kilometres), then turned sharply and headed back the way it had come. Staying clear of coastal settlements, it entered the West Coast National Park

marine protected area — a strictly no-fishing zone — where it slowed down and began to sail in a zigzag pattern.

“It was obvious what they were doing,” says Niel Malan, a marine biologist who works in South Africa’s Department of Environmental Affairs in Cape Town. “They were poaching.”

On any other day, the transgression would probably have passed undetected. But Malan and his colleagues were testing a new vessel-tracking system that — when fully operational — will send out alerts when ships are acting suspiciously anywhere in South African waters.

A test version of the Integrated Vessel Tracking Decision Support Tool was launched on 7 November by the South African Oceans and Coastal Information Management System (OCIMS), at its annual meeting in Cape Town. The tracking system, which has taken US$1 million and 5 years to develop, combines data from satellites, vessel transponders and radar to monitor ships in real time and spot any that might be engaged in criminal activities, such as illegal fishing or smuggling.

Similar remote-sensing systems have been developed over the last decade or so by countries including the United States, Australia and India. But South Africa is a particularly crucial area for maritime crime-fighting, because of its geographical location at the joining of three oceans — the Atlantic, Indian and Southern — and because of the sheer extent of its waters. The country’s Exclusive Economic Zone, which extends 200 miles off the coastline and includes an additional 400-mile-diameter circle around the Prince Edward Islands, exceeds its land area by 25%. “Because of the vastness of our EEZ, we see this as a critical technology,” says Waldo Kleynhans, the system’s lead developer based in Pretoria.

South Africa's coast is also a busy shipping lane and an area rich in natural resources. Cold, nutrient-rich waters sustain extensive commercial fishing on South Africa's west coast and to the south, while every year billions of sardines migrate down the east coast, attracting flocks of birds, as well as dolphins, sharks and whales.

South Africa has a well-documented problem with coastal poaching of high-

value species such as abalone and rock lobster, whereas the extent of illegal fishing in its open oceans is largely unknown. The area around the Prince Edward Islands — home to the prized Patagonian toothfish (*Dissostichus eleginoides*) — is particularly vulnerable, says Timothy Walker, a researcher focusing on maritime and water security at the Institute for Security Studies in Pretoria. South African authorities are also concerned about human trafficking and the smuggling of drugs or banned wildlife items, such as rhino horn and ivory.

Yet the navy has scant physical resources to monitor illegal activities, says Mark Blaine, a captain in the South African Navy and a part-time researcher in nautical science at Stellenbosch University — four frigates, three submarines and a handful of patrol vessels and aircraft — which he describes as equivalent to "a country the size of Algeria using around six police cars to patrol the entire country".

Satellite spotting

The satellite data used by the new system includes information from automated identification system (AIS) trackers, which all ships above a certain size are required to carry. South Africa currently buys this data from third-party suppliers, but plans to launch its own constellation of AIS nano-satellites in 2018 to collect the information. Meanwhile, satellites using synthetic-aperture radar, which can spot vessels in the dark or through thick cloud, will help to detect 'dark targets' that are not carrying trackers or that have turned them off.

Malan says that the tracking system can be set to flag up different suspicious behaviours. Users such as the fisheries department or the South African navy might create a digital fence around a marine reserve or other sensitive area, for example, and ask to receive alerts when ships enter it. Or they could request to be alerted if two ships meet in the open ocean for an extended time.

Ultimately, Malan says, the system's success will depend on the end-users, who will have to monitor incoming data, set up appropriate alerts and decide

how to respond. Enforcement will also be a challenge. Malan says that details of the suspicious boat he spotted in October 2016 were relayed to the fisheries department. “But we're not sure if they finished the investigation,” he says.

He hopes that once a few miscreants have been caught using the tracking system, however, its existence will act as a deterrent: “I think once we start prosecuting a few people, then the word will spread quickly — and we hope that will lead to better behaviour.”

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Comments

Commenting is currently unavailable.

Resurrected malaria strategy saves thousands of lives in Africa

Pre-emptively treating kids for malaria is working, despite logistical challenges.

10 November 2017

Amy Maxmen

A healthworker in Mali prepares a dose of malaria chemoprevention.

In a sea of high-tech malaria fixes — everything from drug-delivery by drone to gene-edited mosquitoes — an old-fashioned approach is saving thousands of children in West Africa, according to studies presented this week at the American Society of Tropical Medicine and Hygiene (ASTMH) meeting in

Baltimore, Maryland.

The measure, called seasonal malaria chemoprevention, involves giving children a dose of antimalarial drugs once each month in the rainy season to prevent the disease in hard-hit regions. Researchers have previously demonstrated this strategy in large clinical trials but they had feared that their positive results wouldn't be replicated in the messy, real world, because chemoprevention requires thousands of local health workers to deliver drugs to children in villages far from hospitals, pharmacies and paved roads.

"People were doubtful this intervention would work, because it's so demanding," says Brian Greenwood, an infectious disease specialist at the London School of Hygiene and Tropical Medicine who helped to conduct trials that showed reductions in malaria prevalence up to 84%[1]. As a result of those studies, more than 6.4 million children in nine countries in sub-Saharan Africa (Burkina Faso, Cameroon, Chad, Gambia, Guinea, Mali, Niger, Nigeria, Senegal) received the drugs in 2016.

It seems to be working, according to data presented at the ASTMH meeting. "They are seeing the same level of efficacy against malaria that we saw in clinical trials and reducing hospital admissions," says Greenwood. "I am very happy." But researchers are also finding signs that this approach may not work for long.

Data driven

Malaria researchers deployed chemoprevention in the 1950s, but it fell out of favour when the widespread use of malaria drugs led to drug resistance. Yet by 2000, more than 830,000 people were dying of the disease each year — mainly children in Africa — and there were no blockbuster vaccines on the horizon. So malariologists revisited the approach. Between 2002 and 2012, clinical trials conducted in West Africa suggested that combinations of older malaria drugs had the power to prevent 8.8 million cases and 80,000 deaths every year if implemented solely during the rainy season, when the disease spikes.

Amy Maxmen

Children in Mali receive a dose of malaria drugs, to reduce their risk of becoming infected with the disease.

In 2012, the World Health Organization recommended the strategy with three old drugs — sulphadoxine, pyrimethamine and amodiaquine — so that the only sure-fire cure for malaria, artemisinin, would remain effective. Alassane Dicko, a malariologist at the University of Bamako in Mali, says that he did not take the intervention for granted when it launched in Mali in 2013, because he knew that funds were limited and drug resistance inevitable. “Research is essential,” he says. His lab began assessing chemoprevention’s efficacy, cost and effects on drug resistance.

In August, Dicko and his colleagues reported[2] that malaria prevalence was reduced by 65% in children under age 5 who were treated with chemoprevention in the Malian district of Kita, compared to a similar number of children in a neighbouring district that lacked the funds to roll out the intervention.

Race against resistance

On the basis of results such as these, malaria researchers at the meeting estimate that chemoprevention has averted roughly 6 million cases and 40,000 deaths in 2015 and 2016 in the countries where it is practised. “This intervention has been extremely well documented over three or four years,” says Erin Eckert, an epidemiologist at the US Agency for International Development’s President’s Malaria Initiative, based in Washington DC. As a result, the agency plans to help fund chemoprevention in eight countries next year.

Also at the ASTMH meeting, Dicko reported a 80-person trial showing that adding another old malaria drug, primaquine, to the regimen combo blocks the transfer of the malaria parasite, *Plasmodium falciparum*, from humans into mosquitoes. This would further reduce the amount of the parasite in circulation. Dicko aims to hit the disease hard and fast — with multiple drugs, as soon as possible — because he and his colleagues are already detecting genetic signs of drug resistance in parasites[3].

New chemoprevention drugs in the pipeline might not be ready before existing drugs fail because of resistance, Greenwood says. This year, he helped to launch a trial combining chemoprevention and a less effective malaria vaccine in Burkina Faso and Mali. The vaccine was previously shown to reduce the number of malaria cases by less than 36% in children[4], but Greenwood hopes the combined tools, together with bed nets, can suppress malaria enough to stop it from bouncing back once today’s drugs fail. By that time, he says, genetically engineered mosquitoes might be ready to fly.

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Comments

Comments

There are currently no comments.

Physicists shrink plans for next major collider

Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.

09 November 2017

CERN/SPL

The Large Hadron Collider (pictured) collides protons, whereas the proposed linear accelerator would smash together electrons and positrons.

Limited funding and a dearth of newly discovered particles are forcing physicists to cut back plans for their next major accelerator project: a multibillion-dollar facility known as the International Linear Collider (ILC)

in Japan.

On 7 November, the International Committee for Future Accelerators (ICFA), which oversees work on the ILC, endorsed halving the machine's planned energy from 500 to 250 gigaelectronvolts (GeV), and shortening its proposed 33.5-kilometre-long tunnel by as much as 13 kilometres. The scaled-down version would have to forego some of its planned research such as studies of the 'top' flavour of quark, which is produced only at higher energies.

Instead, the collider would focus on studying the particle that endows all others with mass — the Higgs boson, which was detected in 2012 by the Large Hadron Collider (LHC) at CERN, Europe's particle-physics lab near Geneva, Switzerland.

Leading particle physicists nevertheless remain upbeat. A 250-GeV machine still has "a convincing physics case", says Hugh Montgomery at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia. He says that it could be upgraded to higher energies in future.

High-energy physicists have been planning a future linear collider for 25 years, but the ILC is now unlikely to see the light of day until at least 2030. They viewed the linear collider as complementary to the LHC, allowing physicists to scrutinize in detail any particles discovered at CERN.

Linear design

The circular LHC smashes together protons, which allows it to reach very high energies (13 teraelectronvolts). But, as composite particles (made of quarks), protons create messy collisions with clouds of debris.

By contrast, the ILC would collide electrons and positrons head on after accelerating them in thousands of superconducting cavities joined end to end. Although yielding lower energies, its collisions — between fundamental particles — would be cleaner and more precise than those in a proton–proton machine.

The international physics community had hoped that Japan would foot much of the estimated US$10 billion needed to realize the original design, after researchers there put forward a proposal to host the facility in October 2012, just after the Higgs discovery. But the Japanese government — deterred by the project's huge price tag, according to Tatsuya Nakada, a physicist at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland — has not yet made any offer of funding.

That fact, coupled with an absence of any other new particle discoveries at the LHC beyond the Higgs, led the Japan Association of High Energy Physicists in July to propose capping the ILC's energy at 250 GeV.

Aiming for a higher energy, the association explained, made less sense after data collected by the LHC in 2015 and 2016 showed that any particles outside physicists' standard model are unlikely to weigh less than 1,000 GeV, and therefore would be out of reach even for a full-scale version of the ILC. However, 250 GeV is high enough to produce large numbers of Higgs bosons, which, the association said, could yield indirect signs of new physics through measurements of their interactions with other known particles.

Energy debate

This proposed 'Higgs factory' has also been endorsed by an international working group responsible for formulating the ILC's science case, in a paper uploaded to the preprint server arXiv last month[1]. The ICFA then gave the pared-down collider its thumbs up at a meeting held in Ottawa, Canada, this week.

Not all physicists are enthusiastic, however. John Ellis, a theorist at King's College London and CERN, maintains that only when operating at around 1,000 GeV will a linear collider provide "a more complete picture of the Higgs". He acknowledges that costs need to be reined in, but says that in limiting the ILC to 250 GeV, "you are making significant scientific compromises".

A report uploaded to arXiv last week[2] describes three possible layouts for the

250 GeV model (a technical design for the higher-energy ILC was published in 2013). Each requires halving the length of the superconducting electron–positron accelerators, but two of the options retain extra tunnel space to accommodate future upgrades.

Taking into account projected savings from ongoing research into accelerators, the report estimates that the collider's core construction cost could be reduced by as much as 40% — bringing it down to around $5 billion in 2012 prices. Manpower and detectors would then raise the total to about $7 billion, according to Lyn Evans, an accelerator physicist at CERN who is directing research on the ILC.

Michael Peskin, a theoretical partical physicist at the SLAC National Accelerator Laboratory in Menlo Park, California, and a member of the ILC working group, has no doubt about the value of a Higgs factory. He says that theoretical studies of the Higgs boson and the weak nuclear force — one of the four known fundamental forces — done over the past year have strengthened the case for experimental probes of the Higgs' interaction strength (the Higgs is required to give the carriers of the weak force finite mass). "The 250-GeV stage is actually more interesting scientifically than we thought," he says.

The ILC decision now rests with Japan. Evans describes the Japanese government's ongoing assessment of the linear-collider project as "very long and very frustrating". But other countries won't commit money until the host country makes its plans known, he says. "The rest of the world is waiting for the Japanese government to decide," he says.

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Comments

3 comments

1. *Pentcho Valev* • 2017-11-11 04:23 PM

   Peter Woit: "I think the worst thing that has happened to theoretical physics over the past 25 years is this descent into ideology, something that has accelerated with the multiverse mania of the last 10-15 years." http://www.math.columbia.edu/~woit/wordpress/?p=9375 Correct, except for the number 25 - it should be replaced by 112: Peter Hayes: "This paper investigates an alternative possibility: that the critics were right and that the success of Einstein's theory in overcoming them was due to its strengths as an ideology rather than as a science. The clock paradox illustrates how relativity theory does indeed contain inconsistencies that make it scientifically problematic. These same inconsistencies, however, make the theory ideologically powerful. [...] The gatekeepers of professional physics in the universities and research institutes are disinclined to support or employ anyone who raises problems over the elementary inconsistencies of relativity. A winnowing out process has made it very difficult for critics of Einstein to achieve or maintain professional status. Relativists are then able to use the argument of authority to discredit these critics. Were relativists to admit that Einstein may have made a series of elementary logical errors, they would be faced with the embarrassing question of why this had not been noticed earlier. Under these circumstances the marginalisation of antirelativists, unjustified on scientific grounds, is eminently justifiable on grounds of realpolitik. Supporters of relativity theory have protected both the theory and their own reputations by shutting their opponents out of professional discourse. [...] The triumph of relativity theory represents the triumph of ideology not only in the profession of physics bur also in the philosophy of science." The Ideology of Relativity: The Case of the Clock Paradox http://www.informaworld.com/smpp/content~content=a909857880 Joao Magueijo: "Lee [Smolin] and I discussed these paradoxes at great length for many months, starting in January 2001. We would meet in cafés in South Kensington or Holland Park to mull over the problem. THE ROOT OF ALL THE EVIL WAS CLEARLY SPECIAL RELATIVITY. All these paradoxes resulted from well known effects such as length contraction, time dilation, or E=mc^2,

all basic predictions of special relativity. And all denied the possibility of establishing a well-defined border, common to all observers, capable of containing new quantum gravitational effects." Faster Than the Speed of Light, p. 250 http://www.amazon.com/Faster-Than-Speed-Light-Speculation/dp/0738205257 Pentcho Valev

2. *Pentcho Valev* • 2017-11-11 07:32 AM

   Dead (schizophrenic) science - colliders are not necessary: "...Lorenzo Maccone, of the University of Pavia in Italy, Seth Lloyd at MIT in Cambridge, USA, and Vittorio Giovannetti at the Scuola Normale Superiore in Pisa, Italy. [...] They hope their strategy may make it possible to solve one of the biggest problems in physics: the apparent incompatibility of quantum mechanics, which governs the physics of the very small, and general relativity, which describes the motion of stars and planets. [...] In general relativity, space and time are woven together into a pliable thing called spacetime, but quantum mechanics runs on quaintly separate, classical notions of space and time. And when physicists try to apply the equations of general relativity to the realm of quantum mechanics, those equations spit out nonsense." http://fqxi.org/community/articles/display/224 Big Brother replaced 2+2=4 with 2+2=5: "In the end the Party would announce that two and two made five, and you would have to believe it. It was inevitable that they should make that claim sooner or later: the logic of their position demanded it. Not merely the validity of experience, but the very existence of external reality, was tacitly denied by their philosophy. The heresy of heresies was common sense. And what was terrifying was not that they would kill you for thinking otherwise, but that they might be right. For, after all, how do we know that two and two make four? Or that the force of gravity works? Or that the past is unchangeable? If both the past and the external world exist only in the mind, and if the mind itself is controllable what then?" https://ebooks.adelaide.edu.au/o/orwell/george/o79n/chapter1.7.htm Einstein replaced Newton's absolute time with spacetime: "Special relativity is based on the observation that the speed of light is always the same, independently of who measures it, or how fast the

source of the light is moving with respect to the observer. Einstein demonstrated that as an immediate consequence, space and time can no longer be independent, but should rather be considered a new joint entity called "spacetime." http://community.bowdoin.edu/news/2015/04/professor-baumgarte-describes-100-years-of-gravity/ Scientists in Big Brother's world are trying to reconcile 2+2=4 and 2+2=5. Scientists in Einstein's schizophrenic world are trying to reconcile Newton's absolute time and Einstein's spacetime: Natalie Wolchover: "The effort to unify quantum mechanics and general relativity means reconciling totally different notions of time. In quantum mechanics, time is universal and absolute; its steady ticks dictate the evolving entanglements between particles. But in general relativity (Albert Einstein's theory of gravity), time is relative and dynamical, a dimension that's inextricably interwoven with directions X, Y and Z into a four-dimensional "space-time" fabric." https://www.quantamagazine.org/20161201-quantum-gravitys-time-problem/ Perimeter Institute: "Quantum mechanics has one thing, time, which is absolute. But general relativity tells us that space and time are both dynamical so there is a big contradiction there. So the question is, can quantum gravity be formulated in a context where quantum mechanics still has absolute time?" https://www.perimeterinstitute.ca/research/conferences/convergence discussion-questions/what-are-lessons-quantum http://negrjp.fotoblog.uol.com.br/images/photo20150819051851.jpg Pentcho Valev

3. *Pentcho Valev* • 2017-11-09 08:59 PM

   Nowadays the conclusion "Physics is dead" is getting more and more explicit - it has even entered popular culture: Leonard: "I know I said physics is dead, but it is the opposite of dead. If anything, it is undead, like a zombie." https://www.youtube.com/watch?v=GDNP9KOEdh0 The problem is theoretical - experimentalists are just misguided: "The Large Hadron Collider is a particle accelerator currently under construction in the research centre CERN. From the point of view of relativity theory, it has several points of interest: First of all, the protons it accelerates will reach higher energies than ever, allowing

new tests of the relativistic quantum field theories that are at the core of modern particle physics. Secondly, at such high energies, there should be first traces of an as-yet unproven symmetry of nature called supersymmetry, which plays an important role in string theory, one of the candidates for a theory of quantum gravity (the quantum theory version of Einstein's general relativity). Finally, the high energies are interesting because they give information about the very early high temperature universe, and about the physics that should be included in the big bang models of relativistic cosmology." http://www.einstein-online.info/dictionary/large-hadron-collider There is a tenet which, if false, does convert modern physics into a zombie, and this is Einstein's constant-speed-of-light postulate. Here is the original formulation: Albert Einstein, ON THE ELECTRODYNAMICS OF MOVING BODIES, 1905: "...light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body." http://www.fourmilab.ch/etexts/einstein/specrel/www/ If interpreted correctly, the Doppler effect directly refutes the postulated independence from "the state of motion of the emitting body". Here is an incorrect interpretation - the postulate is saved by wrongly assuming that the light pulses bunch up in front of the moving source: Albert Einstein Institute: "We will start with a very simple set-up, which you can see in the following animation. On the right-hand side, drawn in green, there is a sender that emits pulses in regular succession. On the left-hand side there is a receiver, drawn in blue. The pulses themselves are drawn in red, and they all travel at the same speed from right to left. Everytime the sender emits a new pulse, a yellow indicator light flashes once. Likewise, a flashing light indicates when a pulse has reached the receiver: http://www.einstein-online.info/images/spotlights/doppler/doppler_static.gif Next, let us look at a slightly different situation, where the source is moving towards the detector. We assume that the motion of the sender does not influence the speed at which the pulses travel, and that the pulses are sent with the same frequency as before. Still, as we can see in the following animation, the motion influences the pulse

pattern: http://www.einstein-online.info/images/spotlights/doppler/doppler_source_blue.gif The distance between successive pulses is now smaller than when both sender and receiver were at rest. Consequently, the pulses arrive at the receiver in quicker succession. If we compare the rates at which the indicator lights at the receiver and at the sender are flashing, we find that the indicator light at the receiver is flashing faster." [END OF QUOTATION] http://www.einstein-online.info/spotlights/doppler Einsteinians make the following assumption above, which is essentially identical to Einstein's 1905 constant-speed-of-light postulate: Assumption 1: "The motion of the sender does not influence the speed at which the pulses travel." Assumption 1 goes hand in hand with another assumption: Assumption 2: "The distance between successive pulses is now smaller than when both sender and receiver were at rest." Assumption 2 is false - the pulses do not bunch up when the source (sender) is moving. If they did, by measuring the (variable) distance between the pulses, an observer associated with the source would know whether he is moving or at rest, which contradicts the principle of relativity. Since Assumption 2 is false, Assumption 1 is false as well. If the speed of the moving source is v, the speed of the light relative to the receiver is c'=c+v, in violation of Einstein's relativity. The following quotations suggest that, if the speed of light is variable, modern physics is dead: "The speaker Joao Magueijo, is a Reader in Theoretical Physics at Imperial College, London and author of Faster Than the Speed of Light: The Story of a Scientific Speculation. He opened by explaining how Einstein's theory of relativity is the foundation of every other theory in modern physics and that the assumption that the speed of light is constant is the foundation of that theory. Thus a constant speed of light is embedded in all of modern physics and to propose a varying speed of light (VSL) is worse than swearing! It is like proposing a language without vowels." http://www.thegreatdebate.org.uk/VSLRevPrnt.html "But the researchers said they spent a lot of time working on a theory that wouldn't destabilise our understanding of physics. "The whole of physics is predicated on the constancy of the speed of light," Joao

Magueijo told Motherboard. "So we had to find ways to change the speed of light without wrecking the whole thing too much." http://www.telegraph.co.uk/technology/2016/12/06/speed-light-discovered/ Pentcho Valev

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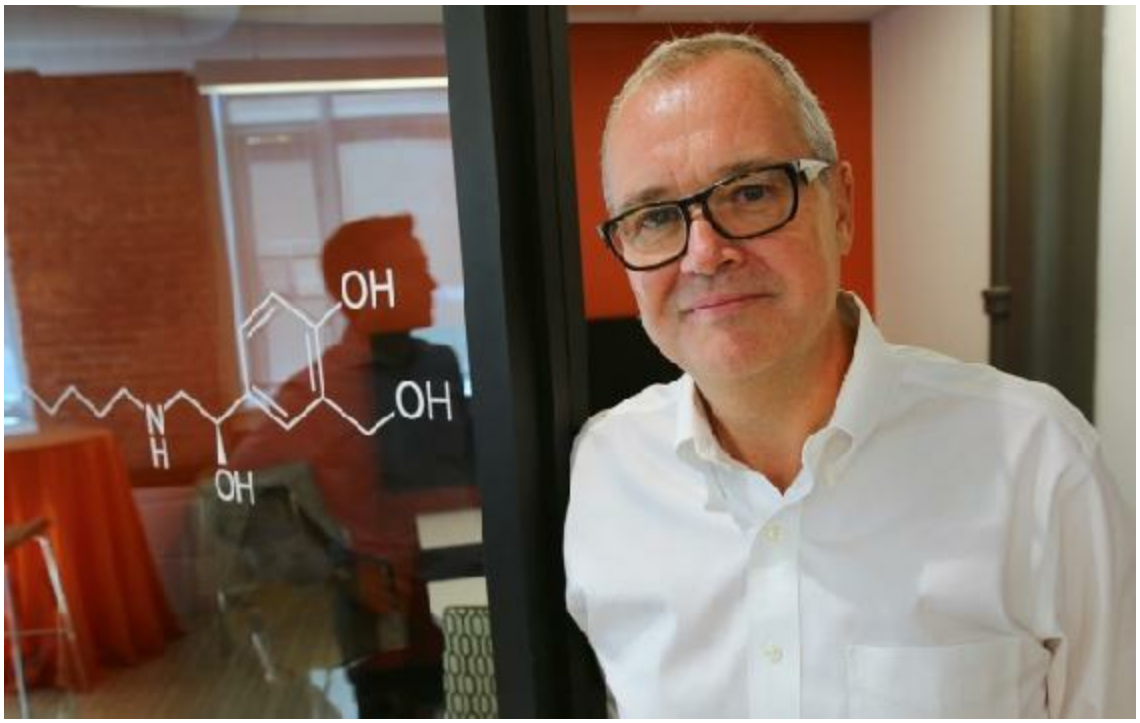
UK government appoints next chief scientific adviser

A former pharmaceutical boss will help navigate the UK's exit from the European Union.

08 November 2017



Pat Greenhouse/Boston Globe/Getty

Patrick Vallance is the third successive biomedial scientist to be appointed chief scientific adviser.

Patrick Vallance, president of research and development at the pharmaceutical giant GlaxoSmithKline, has been appointed as chief scientific adviser, the UK government announced on 8 November.

Vallance, a clinical pharmacologist who previously led the medical division at University College London, will replace Mark Walport in April 2018. Walport has left the government to become head of a powerful new funding body called UK Research and Innovation.

As chief scientific adviser, Vallance will advise the prime minister and her cabinet, the government's most senior decision-making body. He will also lead the Government Office for Science, which promotes the use of scientific evidence in policymaking across government.

A major part of his role will be to ensure that high-quality advice is available across government departments as they deal with the legal and regulatory consequences of the UK's decision to leave the European Union, says Graeme Reid, a science-policy researcher at University College London. The United Kingdom needs to manage the impact of Brexit on the regulation of the nuclear industry and the UK's role in fusion research, as well as on environment policy and other science-related issues. "Patrick Vallance's experience in both business and universities will be of huge value," says Reid.

Brexit is likely to boost the day-to-day importance of chief scientific advisor's role, but Vallance will also have to reinvent other, more informal aspects of the position, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School. The creation of UK Research and Innovation, intended to increase the power of UK research-funding bodies, means Walport will continue to wield great influence over science in government. The chief scientific adviser has traditionally been the voice of science in government, Flanagan says.

The relationship between Vallance and Walport will be an interesting dynamic to watch, says James Wilsdon, a research-policy specialist based at the University of Sheffield, UK. He says he hopes that Vallance will act as a bridge between the science community and policymakers, and will be open to a wide range of people and perspectives. The network of chief scientific advisers is not yet operating at full strength, he says, "so re-energising the collegiality and connectivity of that network though Whitehall is a really important thing".

The role is less well-paid than Vallance's present position. His base salary at GlaxoSmithKline is £780,000 (US$1.02 million), but the science-adviser job was advertised in the salary range of £160,000–£180,000.

Vallance will be the third successive chief scientific adviser to come from the biomedical sciences. He follows Walport, who is a former director of the Wellcome Trust, and John Beddington, a population biologist now at the Oxford Martin School and the University of Oxford, UK.

In a separate announcement, GlaxoSmithKline announced that it had appointed Hal Barron, current president of research and development at Alphabet-funded California Life Sciences, to replace Vallance.

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Comments

Commenting is currently unavailable.

Skin regeneration with insights

A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.

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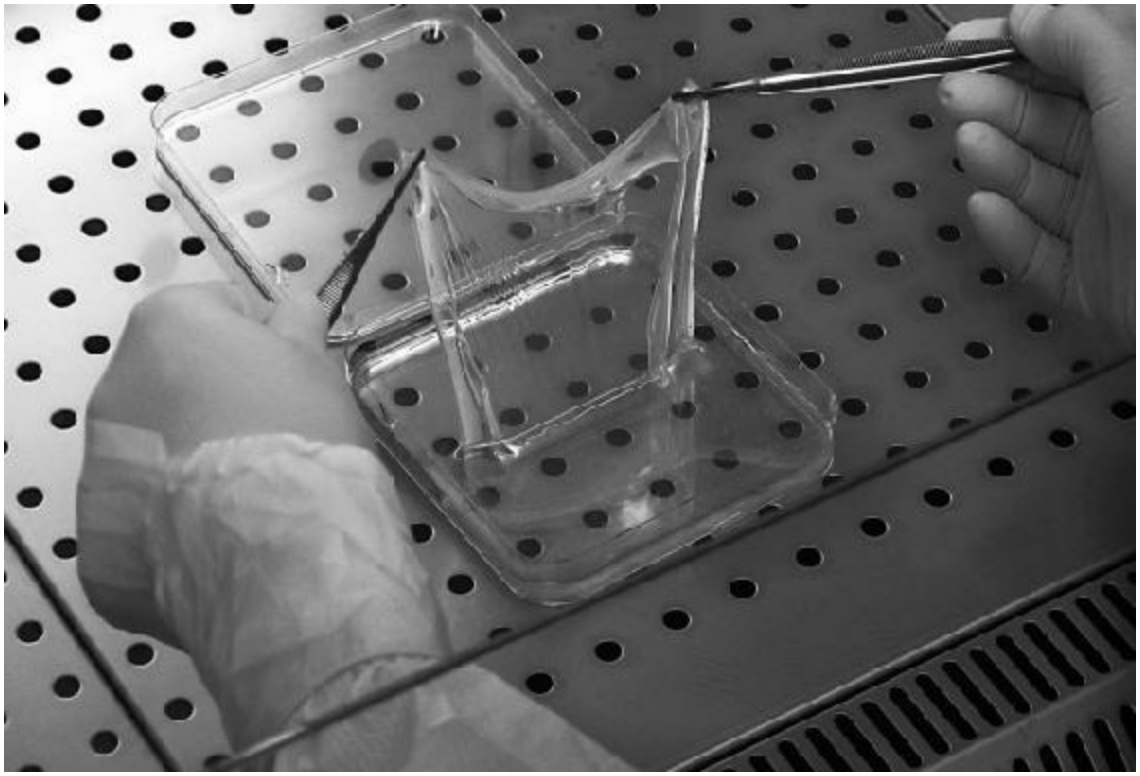

A sheet of skin cells grown in culture.

Somewhere in Germany’s Ruhr valley, a nine-year-old boy is doing what children do: playing football, joking around with friends and going to school. Two years ago, he was confined to a hospital bed, dying of a rare and cruel genetic skin disease. In a landmark paper online in *Nature* this week, scientists and clinicians present the details of his astonishing recovery (T. Hirsch *et al.* *Nature* http://dx.doi.org/10.1038/nature24487; 2017).

The boy had junctional epidermolysis bullosa, or JEB. He, like other people with the disease, carried a mutation in a gene that controls the integrity of the skin. Doctors could only try to ease his suffering as some 80% of his skin simply fell away.

A team of Italian researchers came to his aid by combining stem-cell techniques with gene therapy. As a young scientist at Harvard Medical School in Boston, Massachusetts, in the 1980s, Michele De Luca — the lead author of the new study — watched pioneers in skin regeneration learn to grow small sheets of skin from cells taken from burns patients, and to use them in grafts. He extended the work in Italy, applying new genetic and stem-cell technologies. He developed ways to generate stem cells from human skin, replace disease-causing genes in them and grow sheets of healthy skin on scaffolds in the lab.

He chose JEB for his first clinical trial, which he registered with the Italian Medicines Agency in 2002. Four years later, he reported his first success, in which he created healthy skin patches from biopsies to replace small areas of sloughed-off skin on the legs of a patient with a form of JEB (F. Mavilio *et al. Nature Med.* **12,** 1397–1402; 2006). New European Commission regulations introduced in 2007 required him to pause the project while he created facilities adhering to ‘good manufacturing practices’ (GMPs) and a spin-off company to meet the demands for strengthened oversight of cell-based therapies.

Having a company refocused his team’s attention on a different type of stem-cell therapy, one likely to yield a product for the market faster. Holoclar, a treatment that replaces the eye’s cornea in a form of blindness, became the world’s first commercial stem-cell therapy in 2015.

A few months later, at the University of Modena, De Luca got a call out of the blue from doctors in Germany who were trying to treat the little boy. Because the therapy had been in a clinical trial, albeit one on hold at the time, and because De Luca could provide GMP services, German regulatory authorities quickly approved the one-off compassionate use of the JEB therapy. Surgeons in Germany sent a skin biopsy to Modena, and two major skin transplants followed. Six months after the initial biopsy, the boy returned to school. During the many months since, he has not had so much as a blister,

and loves to show off his ‘new skin’.

This major clinical development was based on decades of basic research. The clinical data gathered during 21 months of follow-up after the boy’s treatment have also led to major insights into human skin biology, as discussed in an accompanying News & Views (M. Aragona and C. Blanpain *Nature* http://dx.doi.org/10.1038/nature24753; 2017). For example, normal regeneration of the epidermis is directed by only a few stem-cell clones that can self-renew.

By their nature, highly personalized treatments using gene therapies and products derived from an individual’s stem cells are likely to be applicable to only a subset of patients. Although the report presents the treatment of one patient, it is a classic case of researchers standing on the shoulders of others. This project, for example, relied on long-term follow-up of a patient treated in 2006, as well as parallel studies that underpinned the development of tools for *ex vivo* gene therapy and for growing transplantable sheets of epidermis *in vitro*.

The work is both a technical achievement and an example of how translational medicine should be conducted. It involves research informing the clinic and the clinic informing research, with seamless collaboration between doctors, scientists, regulators and technicians at many levels — a particularly important aspect in areas such as stem-cell biology. It requires the highest standards of scientific and ethical diligence. Similar treatments are starting to be rolled out in other labs for other diseases. *Nature* is glad to celebrate and support such an enterprise.

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Too many academics study the same people

Researchers should recognize communities that feel over-researched and under-rewarded.

08 November 2017

Susanna D'Aliesio/SOPA Images/LightRocket/Getty

Two women in Lebanon’s Shatila camp.

In southern Beirut, a temporary shelter has become a permanent home. The Shatila refugee camp was established to house displaced Palestinians in 1949 and now has thousands of families within its walls. Residents have learnt to contend with overcrowding, pollution — and a steady stream of well-funded

foreign researchers who come to study them.

Drawn by its unusual story and convenient position close to the airport, researchers flock to Shatila to track the effects of prolonged refugee status and cultural isolation on the community. Well-meaning researchers are so common in Shatila that locals have learnt how to spot them.

Before she became a social anthropologist at King's College London, Mayssoun Sukarieh did voluntary work in Shatila. Residents who saw her reach for her notebook would ask if she was a social researcher: "They come for a tiny bit, and then they leave," the locals explained.

Sukarieh realized that scholars' repeated visits were affecting the community. Academics were among the few contacts that people in Shatila had with the wider world. Again and again, the outsiders would fly out with what they wanted and offer little or nothing in return. The community started to view the visitors with amusement, then resentment.

Some people in Shatila, Sukarieh feared, were being 'over-researched' — an anecdotal concern that social scientists and biomedical researchers increasingly encounter at 'high-traffic' research sites around the world. Sometimes, it is a point raised by ethical-review committees. Occasionally, the community under study makes its own frustrations heard loud and clear.

How big is the problem? Ironically, the issue of over-research has not been researched much. In a study published last month, scientists in South Africa analysed concerns about over-research at two sites of HIV-prevention studies (J. Koen, D. Wassenaar and N. Mamotte *Soc. Sci. Med.* **194,** 1–9; 2017).

They found that the term 'over-research' is poorly defined and encompasses a range of concerns. For example, some use it to describe how other communities are being neglected in favour of one with a pre-established research structure or proximity to a university. This can lead to skewed data, and misconceptions about a particular phenomenon or place.

Alternatively, the term could be used to describe a local community that bears the burden of research participation without sufficient reward, creating a sense of frustration that leads to dwindling participation. In biomedical

studies, researchers sometimes worry that involvement in multiple clinical trials — and exposure to multiple medications — can increase the risk to participants and cloud results.

Repeated studies can certainly exaggerate the frustration that local people feel when their cooperation produces only data, publications and further research. In the South African study, many locals argued that the research should be more closely linked to developing their communities. Some projects, including certain grants from UNAIDS, a global United Nations effort to tackle HIV/AIDS, do require researchers to invest in infrastructure and education. More funders should look at this model. However, several HIV-prevention studies have done such a good job that their results are inconclusive: too few participants contracted the disease for the data to be statistically meaningful.

It is crucial that efforts to reward research participation are developed in consultation with the community being studied. Sukarieh describes well-intentioned educational courses aimed at Shatila-research participants that were impractically long — one consisted of 20 hourly sessions — and discussed issues irrelevant to the people's needs.

Over-research can bring benefits, though: a heavily studied community can become savvy in making its needs known to researchers and in influencing how a study is done. In Hackney, an ethnically diverse borough of London that underwent a period of rapid gentrification, a sociologist who came to study participants in a creative-writing group, for example, was told that, to do so, she had to join the group and write pieces like everyone else. The researcher reported how this strengthened her involvement and built stronger links to the community that helped the project to succeed (S. Neal *et al. Qual. Res.* **16,** 491–507; 2016).

Forging deep links with a community takes time, and time requires funding. Funders should recognize the need to build resources for such efforts into their grants; institutions should recognize and reward this time and effort, and acknowledge that it can eat into a researcher's publication record. It is not good enough to come in for a tiny bit, and then leave.

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Comments

There are currently no comments.

Grant recipients can still give objective advice

The US environment agency should not ban researchers it funds from its advisory boards.

08 November 2017

KEENPRESS/Getty

Melting ice caps are raising sea levels.

Scott Pruitt, administrator of the US Environmental Protection Agency (EPA), levelled a damning accusation against scientists on 31 October. In the interests of restoring scientific “integrity”, Pruitt signed a directive stating that the EPA would no longer allow researchers with active grants from the

agency to serve on the EPA's scientific advisory boards. By his tally, an unspecified number of scientists in voluntary positions on those boards had received US$77 million in EPA grants over the past three years — more than enough, Pruitt declared, to raise questions about their ability to provide independent scientific advice.

It was a cynical move — and entirely unnecessary. After all, it is ultimately up to Pruitt and his team to make the appointments to the boards, which advise the agency on everything from basic research programmes to contentious regulatory decisions. If Pruitt wanted to increase the geographical diversity, or include more people from local, state and tribal agencies, as claimed, he could have done so without raising a fuss. Instead, he opted for a public proclamation that singles out active academic scientists as a unique source of bias. He is wrong, on multiple counts.

Scientific enquiry requires money. That's a fact of life. But receiving a research grant is very different from being on the payroll of an institution, advocacy group or company. Those are all very real conflicts of interest that were ignored in Pruitt's directive.

Moreover, winning competitive research grants does not imply fealty to the granting institution. What drives EPA-funded researchers above all is the desire to deliver a public good: discovery and understanding.

Of course, scientific conflicts of interest do exist. So there are established procedures that require scientists to excuse themselves when their own work is under consideration by the boards. These same procedures apply to industry scientists — who are also rightfully represented on the advisory boards — when deliberations involve issues that could affect their companies' bottom lines.

What Pruitt either fails to understand, or has chosen to ignore, is that his advisory boards are designed to focus on science, not policy. Understanding the latest research requires perspectives from the leading scientists. And when it comes to environmental and human-health issues, it is only to be expected that many of those people will have research grants from the EPA.

In the end, Pruitt's directive seems crafted to incite US President Donald

Trump’s political base, and it’s yet another example of researchers being dragged into the political and cultural wars rending the country.

Happily, it is harder to argue with data. This might explain why the first volume of a comprehensive — and congressionally mandated — assessment of climate science released on 3 November (see page 152) sailed through reviews from officials at the EPA and other federal agencies.

That report, which integrates the latest climate research, found that greenhouse-gas emissions caused by human activity are altering the planet in fundamental ways. It lays out what we know about the threat of global warming — from deep in the ocean to the highest mountain peaks. And it stands in direct opposition to the climate scepticism voiced by Pruitt and Trump.

Some scientists had feared political interference, but senior officials at federal agencies gave the report the green light, without major changes. This is as it should be: scientists can assess what’s known and probe what is not. And it is up to policymakers to decide what to do with that information. This should be a lesson for Pruitt: the current administration has the right to create its own priorities, but it should not and cannot override what science reveals.

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Rohingya refugees, Bulgarian protests and a prize for negative results

The week in science: 3–9 November 2017.

08 November 2017

Events | Research | Policy | Climate | People | Publishing | Trend watch

EVENTS

Ice crack to close Antarctic base again For the second time in two years, the British Antarctic Survey (BAS) will close its Halley VI research station for the winter season because of an enormous crack in the floating ice shelf on which it rests. In March, operators finished moving the transportable station 23 kilometres inland from its initial 2012 location because of an ice chasm nearby. Now, another crack in the Brunt Ice Shelf, this one 50 kilometres long, is threatening the station from the other side. Halley VI will close between March and November 2018, the BAS said on 31 October, because it is too difficult to evacuate personnel quickly in winter if the crack develops further.

Michal Krzysztofowicz/BAS

Money for nothing A data organization has launched what it says is the world's first prize for publishing negative scientific results. The European College of Neuropsychopharmacology's Preclinical Data Forum says that the aim of the €10,000 (US$11,600) prize is to encourage researchers to publish data that don't confirm the hypothesis being tested. Such negative studies are much less likely to be published than positive results, meaning that other scientists may waste time trying to repeat the work. The call for entries — initially just for neuroscience research — opened on 8 November.

Bulgarian protest Hundreds of Bulgarian researchers took to the streets of Sofia on 1 November to demand higher wages and an increase in science funding marked out in the government's 2018 budget. Bulgaria has one of the lowest levels of research investment in the European Union. The demonstrators are threatening further protests when Bulgaria takes over the rotating EU presidency next January.

Rohingya refugees A survey of Rohingya refugees in Bangladesh suggests

that 7.5% of the children have life-threatening malnutrition. The United Nations children's charity UNICEF reported the figure on 3 November. More than 2,700 children are being treated for acute malnutrition in refugee camps, where conditions are expected to worsen because of poor sanitation and crowding. Since late August, more than 600,000 Rohingya people have fled from Myanmar to Bangladesh, following attacks by Myanmar's police.

RESEARCH

Weather forecasts Improving forecasts of severe weather is important, but meteorologists should also listen to social scientists to help save lives during storms, says a 1 November report from the US National Academies of Sciences, Engineering, and Medicine. It recommends that federal agencies do more to incorporate social- and behavioural-sciences research into their preparation for weather hazards. These changes might include researching people's processes for deciding how to respond to threats such as tornado or hurricane warnings, and evaluating how weather forecasters communicate with media and emergency-management officials to convey messages more effectively.

POLICY

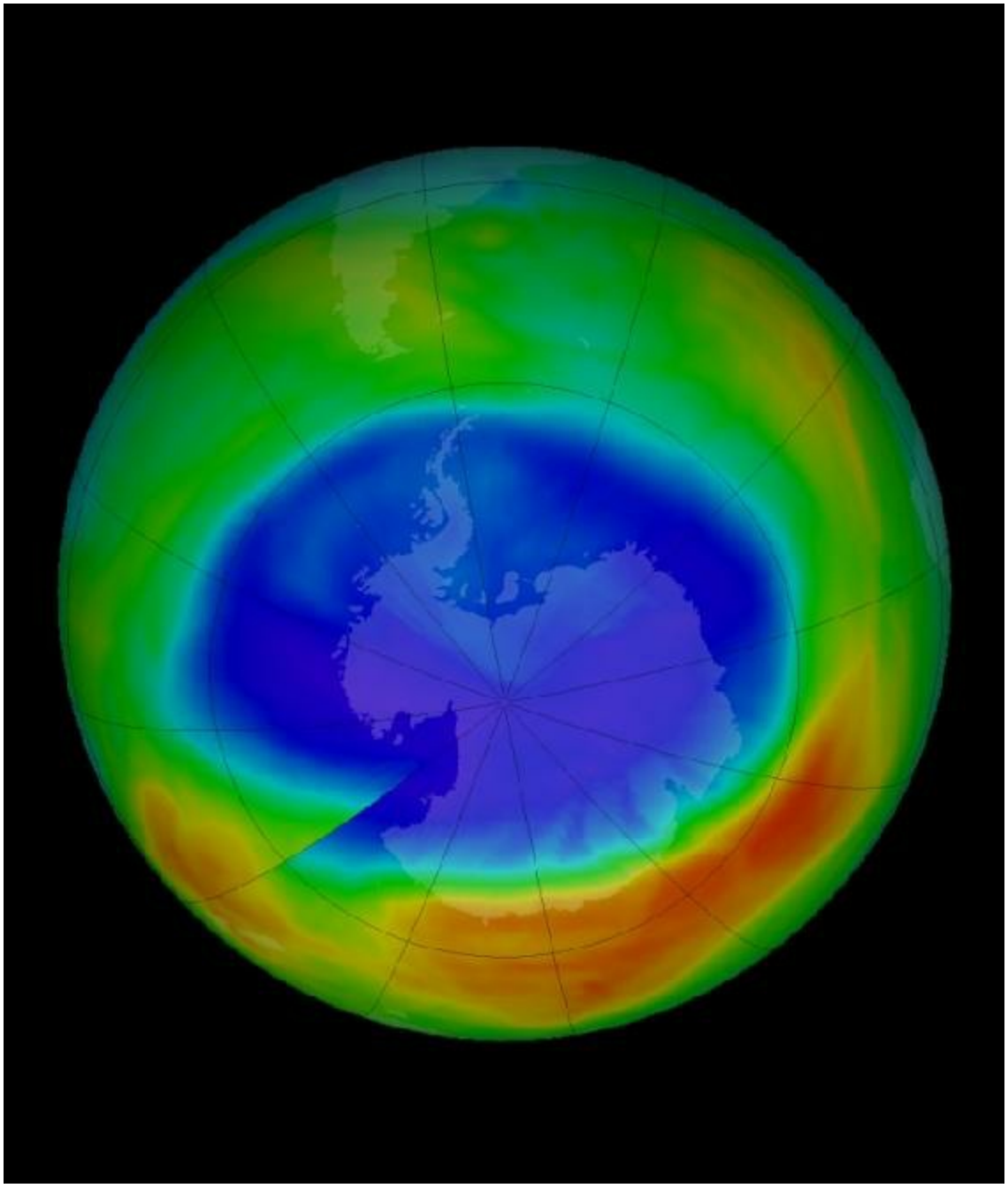
Antibiotic advice The World Health Organization (WHO) has recommended that animal-food industries curb the routine use of antibiotics for growth promotion and disease prevention. Healthy animals should receive the drugs only if others in the same flock or herdare diagnosed with communicable infections, the agency said in guidance published on 7 November. The recommendations were informed by a review of 179 studies; it found that the prevalence of multidrug-resistant bacteria in farmed animals dropped by up to 32% in places that had cut back on antibiotic use (K. L. Tang *et al. Lancet Planet. Health* http://doi.org/cfxh; 2017). The evidence connecting antibiotic restrictions in farm animals to drug resistance in humans was less robust, but hinted at a similar correlation.

Genetic-test rules The US Food and Drug Administration (FDA) is seeking

to loosen its regulation of genetic tests that are marketed directly to consumers, its commissioner, Scott Gottlieb, announced on 6 November. The FDA has proposed a policy that would allow genetic-testing companies to submit a product to the agency for a one-time review; if approved, the company would be allowed to market more tests without further review. The proposal is open for public comment until January. The agency also said that it has decided to exempt from review tests that are used to determine whether potential parents carry disease-causing genetic mutations that could cause an inherited disorder in their children.

CLIMATE

Small ozone hole This year's hole in the ozone layer was the smallest since 1988, NASA said on 2 November. The hole above Antarctica, which opens each September, was unusually small, owing to warm weather in the Southern Hemisphere. At its peak, the area of the hole was almost 2 billion hectares, or roughly two and a half times the size of the contiguous United States. Scientists attribute the shrinkage to natural variation, and not to rapid healing because of human intervention, NASA said. This year, warm air above Antarctica depleted cloud cover, which is where ozone-destroying chemical reactions occur. The hole has been shrinking since the introduction in 1987 of the Montreal Protocol to phase out ozone-depleting chemicals.



Katy Mersmann/NASA Ozone Watch/NASA

PUBLISHING

Censorship in China Springer Nature, one of the world's largest academic

publishers, has stopped readers in China from accessing some of its content. *The Financial Times* reported on 1 November that the publisher had blocked access to more than 1,000 articles from the websites of two of its journals, *The Journal of Chinese Political Science* and*International Politics*. The publishing house, which also owns *Nature*, said that the articles accounted for less than 1% of its content and had been blocked to comply with local Chinese laws. (*Nature*'s news team is editorially independent of its publisher.) The articles included politically sensitive terms such as Tibet, Taiwan and Cultural Revolution. Some in the academic community criticized the decision, which comes two-and-a-half months after UK firm Cambridge University Press blocked access to some articles in China and then swiftly reversed its decision.

Copyright battle The scholarly social network ResearchGate has over the past month disabled public access to 1.7 million papers on its site, according to five scientific publishers who have been tracking its activities. Early last month, the publishers formed a coalition to get ResearchGate to take down papers that breach copyright; two publishers have also filed a lawsuit against the site. The coalition says that the site has since disabled access to around 93% of its copyrighted material, although academics have re-uploaded some papers for public view. The publishers have now sent an undisclosed number of take-down notices to order the removal of remaining infringing content. ResearchGate, which is based in Berlin, declined to comment.

Piracy-site lawsuit The American Chemical Society (ACS) has won a lawsuit against the pirate site Sci-Hub over the website's illicit dissemination of copyrighted research articles. On 3 November, a US court granted the ACS US$4.8 million in damages for copyright infringement and trademark violation. The court also issued an injunction ordering Internet services that are "in active concert or participation" with Sci-Hub, including providers and search engines, to stop facilitating access to the site. Representatives of Sci-Hub, which was launched in 2011, did not appear in court to present their case.

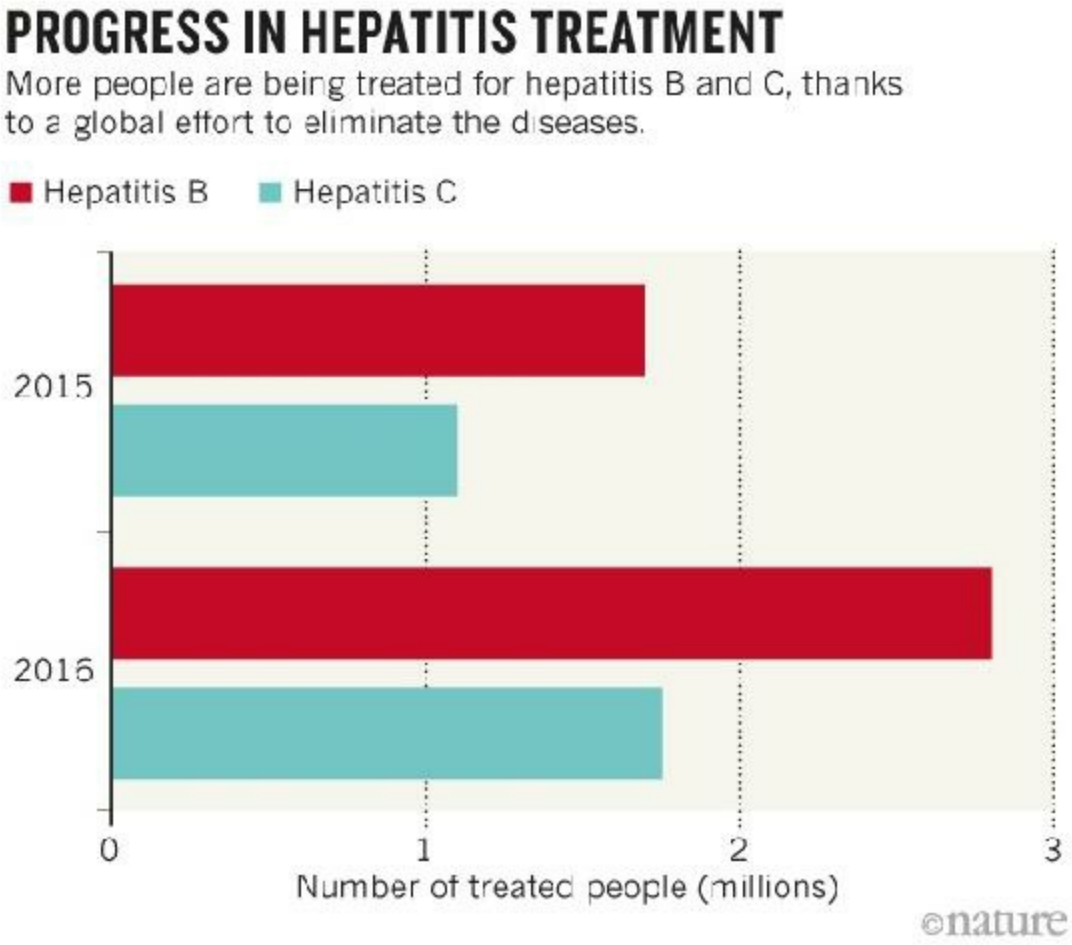
PEOPLE

Nominee withdraws Sam Clovis, the controversial nominee for the post of chief scientist at the US Department of Agriculture, withdrew from consideration on 2 November. The announcement came shortly after Clovis's name surfaced in the ongoing investigation into links between US President Donald Trump's election campaign and Russia. Clovis, a former conservative talk-show host and economics professor, was already a controversial pick for the chief-scientist position, which, by law, must be filled by a distinguished scientist.

Science chair to quit Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, said on 2 November that he will retire when his term expires late next year. The Texas Republican has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. The House of Representatives limits committee chairs to six years in the role, so Smith would have been forced to relinquish his post on the science panel in 2019.

TREND WATCH

The number of people who were able to access treatment for viral hepatitis C grew by some 1.7 million in 2016, a 60% increase over 2015, the World Health Organization (WHO) said on 31 October. A further 2.8 million people were given lifelong treatment for hepatitis B in 2016, a 65% jump over 2015. The WHO estimates that there were between 6 million and 10 million new cases of viral hepatitis B and C in 2015. The agency wants 80% of people diagnosed to be receiving treatment by 2030.



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Dark-matter hunt fails to find the elusive particles

Physicists begin to embrace alternative explanations for the missing material.

08 November 2017

XENON Collab.

Scientists working on the XENON1T experiment are searching for signs of dark matter.

Physicists are growing ever more frustrated in their hunt for dark matter — the massive but hard-to-detect substance that is thought to comprise 85% of the material Universe. Teams working with the world's most sensitive dark-matter detectors report that they have failed to find the

particles, and that the ongoing drought has challenged theorists' prevailing views.

The latest results from an experiment called XENON1T at the Gran Sasso National Laboratory in Italy, published on 30 October[1], continue a dry spell stretching back 30 years in the quest to nab dark-matter particles. An attempt by a Chinese team to detect the elusive stuff, the results of which were published on the same day[2], also came up empty-handed. Ongoing attempts by space-based telescopes, as well as at CERN, the European particle-physics laboratory near Geneva, Switzerland, have also not spotted any hints of dark-matter particles.

The findings have left researchers struggling for answers. "We do not understand how the Universe works at a deeper and more profound level than most of us care to admit," says Stacy McGaugh, an astrophysicist at Case Western Reserve University in Cleveland, Ohio.

Physicists have widely accepted the existence of dark matter since the 1980s as an explanation for why galaxies remain intact rather than flying apart, which would be expected given the amount of observable mass they contain and how fast they rotate. Researchers surmised that halos of invisible dark matter surround galaxies and stabilize them. Physicists grew more confident when dark-matter models successfully predicted the fluctuations detected in an observable echo of the Big Bang, known as the cosmic microwave background.

These observations became the most dramatic evidence for a proposal in the 1980s that dark matter might be formed of weakly interacting massive particles, known as WIMPs. The existence of such particles fits with how physicists think that the Universe evolved, and with the relative abundance of matter. Moreover, the properties of WIMPs would match those predicted by a branch of particle physics called supersymmetry.

The latest round of results seems to rule out the simplest and most elegant supersymmetry theories, casting doubt on the idea that the still-undetected particles are the missing dark matter. If simple supersymmetry theories are no longer viable, scientists say, any WIMP particle has to interact with matter much more feebly than physicists once thought. "It's not a wholesale retreat

from the WIMP paradigm, but it is definitely a change in emphasis," says Dan Hooper, a physicist at the Fermi National Accelerator Laboratory in Batavia, Illinois.

Attitudes are shifting, and physicists are increasingly embracing other possible explanations for dark matter, says David Spergel, a theoretical astrophysicist at Princeton University in New Jersey, who was an early proponent of WIMP models. "These experiments haven't completely closed the window. However, we also need to be thinking about other types of dark matter and new experiments," he says.

Dedicated detectors

It has taken decades to build experiments capable of detecting the minuscule rate at which WIMPs were thought to interact with matter. Only in the past ten years have experiments, carried out at about a dozen laboratories, reached the level of sensitivity needed to detect them. The most sensitive detector in the world is Gran Sasso's XENON1T, which looks for flashes of light created when dark matter interacts with atoms in its 3.5-tonne tank of extremely pure liquid xenon. But the team reported no dark matter from its first run. Neither was there any signal in data collected over two years during the second iteration of China's PandaX experiment, based in Jinping in Sichuan province. Hunts in space have also failed to find WIMPs, and hopes are fading that a once-promising γ-ray signal detected by NASA's Fermi telescope from the centre of the Milky Way was due to dark matter — more-conventional sources seem to explain the observation. There has been only one major report[3] of a dark-matter detection, made by the DAMA collaboration at Gran Sasso, but no group has succeeded in replicating that highly controversial result; renewed attempts to match it are under way.

Future generations of detectors based on the same principle as XENON1T are already in the works, and will be needed if physicists are to finally close the window on WIMPs. But the particles' continuing no-show is making theorists more open-minded and has allowed other theories to gain prominence, says Hooper. Perhaps dark matter consists of exotic axion particles, which are akin to strange, massive photons. Theorists are also

looking at whether dark matter might not interact with known particles at all, but exist in a “hidden sector”, he says.

The looming rejection of the WIMP hypothesis is encouraging for the few physicists who claim that dark matter itself is a red herring. “I hope people will become even more open-minded,” says McGaugh, who has studied modified versions of gravity that negate the need for dark matter. However, Hooper stresses that the fading support for WIMPs does not weaken the case for dark matter, which he thinks will eventually be found. “I’m not worried about the never possibility, but it could be very, very difficult,” he says.

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The bitter battle over the world's most popular insecticides

As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.

08 November 2017

Lucy Hulmes/CEH

Researchers have monitored the health of the red mason bee (*Osmia bicornis-rufa*), which nests in hollow cavities.

Maj Rundlöf remembers the moment she changed her mind about neonicotinoids. In December 2013, in her office at Lund University in Sweden, she and postdoc Georg Andersson were peering at data from their

latest study. It was designed to test what would happen to bees if they fed on crops treated with neonicotinoids — the world's most widely used insecticides. “I didn't expect to see any effect at all, to be honest,” says Rundlöf.

Hives of honeybees (*Apis mellifera*) weren't greatly affected by the chemicals in their pollen and nectar, the study suggested[1]. But the data on bumblebees (*Bombus terrestris*) told a different story. Bumblebee colonies that hadn't fed on the treated crops looked normal: they were packing on weight to survive the winter. But in the colonies exposed to neonicotinoids, the growth chart was a flat line.

When the Swedish study was published in April 2015, it made headlines around the world. It was the first to show that neonicotinoid chemicals — known as neonics — could harm bees in a real-world farming situation.

Bee populations are declining in many parts of the globe, a worrying sign for the crops and wild plants that rely on these pollinators for their survival. Parasites, disease and shrinking food resources are all prime suspects. But a link to neonics has become a major flashpoint.

Even before Rundlöf's results were revealed, the European Union had placed heavy restrictions on the three most widely used neonics in flowering crops — plants that might be attractive to bees — amid rising concerns that the chemicals might harm pollinators. The restricted neonics were imidacloprid and clothianidin, made by agrochemical giant Bayer, and thiamethoxam, made by Syngenta. But farmers, the agrochemical industry and some scientists pointed out that the moratorium was precautionary and based on limited evidence, gathered mostly from lab tests.

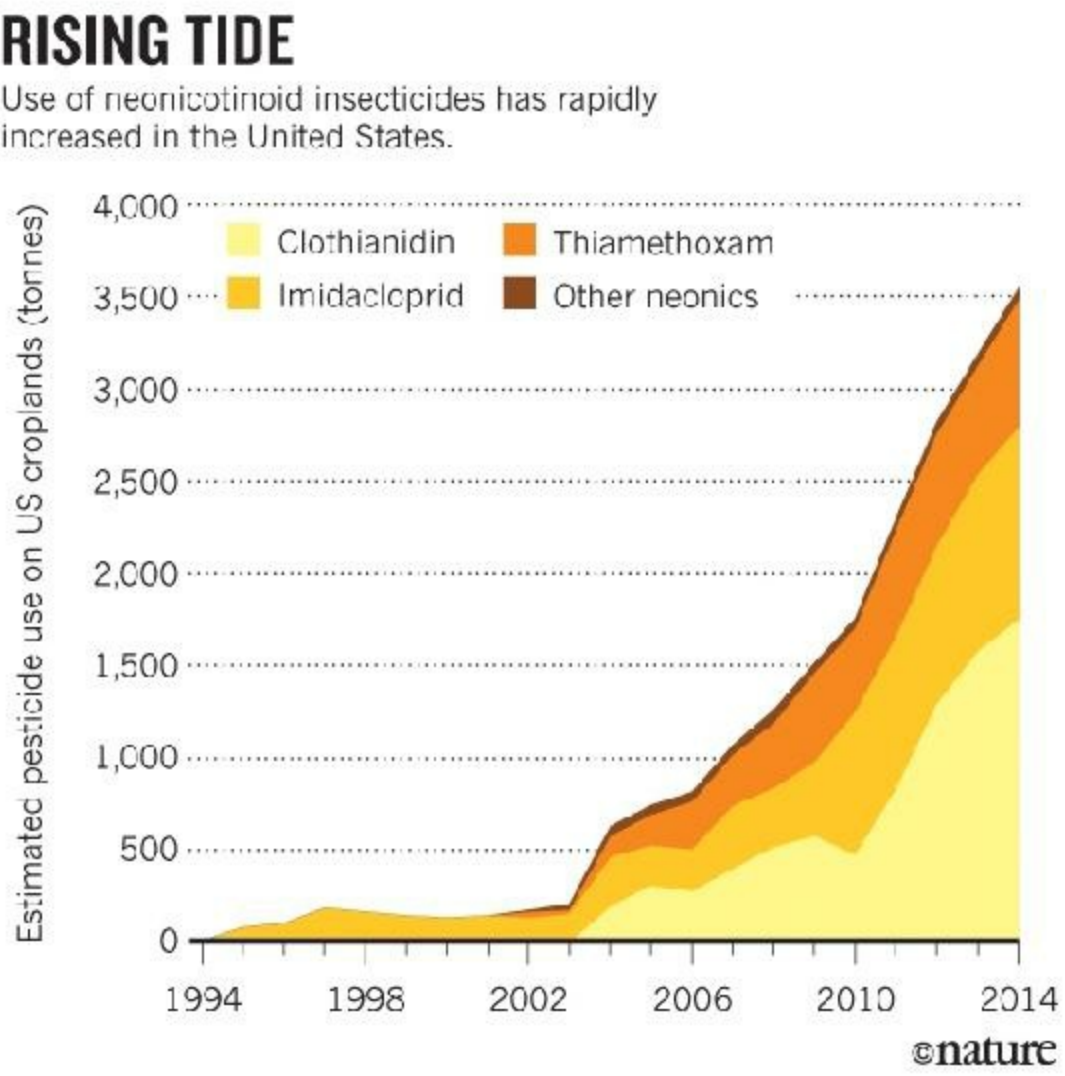
Since Rundlöf's paper, studies showing real-world evidence of harm from pesticides in the field have been mounting — and environmental organizations have demanded wide-ranging bans. Regulatory agencies will soon decide what to do about neonics, which have a global market worth more than US$1.5 billion per year. This month, the EU's European Food Safety Authority is due to complete a re-evaluation of evidence for restricting neonics; the EU will then need to decide what action to take. The US Environmental Protection Agency is expected to complete its own review of

the insecticides next year. France's parliament has passed a law that would ban neonics in 2018, although some exemptions will be allowed.

But industry groups and some scientists say the evidence still isn't conclusive. The picture is complicated: some studies show harm to some bees in some circumstances, whereas others find no harm. The results seem to be affected by many factors, including the species of bee and the kinds of crops involved. Scientists working on the question say the subject has become toxic: any new study is instantly and furiously picked at by entrenched advocates on both sides. Even the results of the largest study on the matter, funded by the agrochemical industry, failed to produce a consensus. Published this year[2], it launched another round of recriminations — including complaints from funders who criticized the paper that they had paid for. Ultimately, it's likely that political or regulatory decisions will settle the matter before opposing parties agree, says Sainath Suryanarayanan, an entomologist and sociologist at the University of Wisconsin–Madison who has studied the bee-health issue. “It is a common pattern for highly contentious and polarized debates,” he says.

The world's favourite insecticide

In the early 1980s, scientists at Nihon Tokushu Noyaku Seizo in Tokyo, an arm of Bayer, started to play around with nithiazine, an insecticide created in California a decade earlier. They discovered a new compound that was more than 100 times as effective at killing crop pests, such as aphids. Named imidacloprid, the chemical was launched onto the market in the 1990s, and it quickly became one of the most widely used insecticides in the world. By the mid-2000s, imidacloprid and similar compounds made up one-quarter of all insecticides (see 'Rising tide'). The compounds damage insects' nervous systems by causing the nerves to fire continually until they fail, eventually leading to death. Many neonics are applied directly to seeds, and are taken up by growing plants. If the plant flowers, the chemicals find their way into pollen and nectar.



Source: USGS/CalPIP

In France, where sunflower seeds coated with imidacloprid came on the market in 1994, beekeepers raised the alarm. They said that their honeybees were failing to make it home after foraging flights, and they pinned the blame on the sunflowers. The concerns triggered a 1999 French ban on imidacloprid-coated sunflower seeds, which continues to this day — although it was based on the precautionary principle, rather than formal proofs of harm, says Axel Decourtye, a researcher at the Institute for Bees in Avignon, France.

Scientists hurried to find those proofs — or evidence that the concern was overblown. Researchers quickly discovered that honeybees fed high doses of neonicotinoids died. And even sub-lethal doses triggered unusual behaviour: exposed honeybees changed their dining habits, foraging less often but for longer periods[3]. Other research showed[4] that neonics act on parts of a bee's brain associated with memory and learning. Honeybees trained to respond to particular scents by sticking out their tongues, for example, performed worse — or failed to learn the task at all — when dosed with a neonic.

At every stage, critics raised new queries about how realistic the experiments were, says Decourtye. “How do we know if the neonicotinoid doses are realistic? Does the effect on the individual have any effect on the colony?”

Out in the field

As work continued in the laboratory, researchers also began to turn to the fields. In 2012, Decourtye and his colleagues published a paper[5] showing that what they called “thiamethoxam intoxication” seemed to interfere with the ability of honeybees to return to their hives after looking for food in a realistic, outdoor setting. Yet that study still dosed bees' food with neonics, rather than allowing them to feed on treated crops.

Around the same time, a UK team found[6] that it was not just honeybees that could be at risk. They reported that colonies of bumblebees exposed to “field-realistic” levels of imidacloprid in the lab and then left to grow in field conditions grew slower than controls. They also produced 85% fewer new queens to carry on their line. That work was led by Dave Goulson, a bee researcher now at the University of Sussex in Brighton, UK. In 2006, Goulson had started a charity dedicated to conserving bumblebees, and people began telling him their concerns about neonics. “To start with, I was pretty dubious,” he says. But by 2014, the Task Force on Systemic Pesticides (TFSP) — a group of 30 scientists, including Goulson — announced that it had analysed 800 peer-reviewed studies on neonics and bees, and found “clear evidence of harm sufficient to trigger regulatory action”[8].

Rundlöf's study set out to be the most realistic yet. Her team sowed eight

Swedish fields with oilseed-rape seeds coated in clothianidin, and eight with untreated seeds. They found[1] not only that bumblebee colonies in treated fields grew less well than the controls, but also that the numbers of wild bees in the treated fields fell. Industry spokespeople noted that honeybee colonies weren't affected, and also quibbled with the study — arguing, for example, that the researchers had only placed a small number of wild bees into fields, so findings might not be statistically robust. Rundlöf, however, points out that the researchers also surveyed wild bees flying around, and had the bumblebee-colony data to draw on. “I know we have robust evidence,” she says.

Maj Rundlöf

Researchers examine the health of honeybees during a field study led by Maj Rundlöf in Sweden.

In mid-2017, the largest field study yet — funded with some $3 million from

industry — reported its long-awaited results[2]. Scientists from the Centre for Ecology and Hydrology (CEH) near Wallingford, UK, had put honeybees, mason bees (*Osmia bicornis*) and bumblebees in 33 oilseed-rape fields in the United Kingdom, Germany and Hungary. This time, the seeds, sown in winter, had been coated with either clothianidin or thiamethoxam, or with a neonicotinoid-free pesticide treatment.

The researchers, led by CEH entomologist Ben Woodcock, found that bumblebees and mason bees fared less well the more neonics they were exposed to. The honeybee picture was more complicated: in some cases, neonics seemed to affect bee health, but in others, they didn't. In the United Kingdom and Hungary, neonic compounds seemed to reduce worker-bee numbers in honeybee hives; in Hungary, researchers also saw fewer egg cells in these hives, an indication of reduced reproductive success. In Germany, however, the honeybee hives exposed to neonics had more egg cells — a puzzling result. Overall, the CEH study concluded that neonicotinoids reduced bees' ability to establish new colonies after winter. The journal editor's summary of the paper came under the headline: “Damage confirmed”.

The agrochemical firms that funded the study don't agree. At a press conference in June, when CEH scientists presented their results — without Woodcock, who was overseas — spokespeople from Syngenta and Bayer told reporters that both the study's analysis and its conclusions were questionable. They noted that Woodcock's team had analysed more than 200 pieces of information about honeybees; 9 showed a negative effect from neonicotinoids, whereas 7 were positive. “The one-line simplistic summary conclusion published does not reflect the data presented in this paper,” argued Peter Campbell, an environmental specialist at Syngenta in Reading, UK, in a separate statement released to the media.

Woodcock was incensed by the criticism. In an interview with environmental group Greenpeace, he said that industry had accused him of being a liar. Now, he says, he regrets that choice of words, but he still thinks industry took a blinkered view of the results. “I do feel that the sentiment of what I implied, while inappropriate, was not an unreasonable reaction,” he says. The negative effects were in key areas related to bee health, he says, adding that for

industrial firms to deny that neonics are having an effect on bees is “probably naive”.

Many of the academics *Nature* talked to agree. “I think the majority of researchers highlight that the weakening of bee populations caused by neonicotinoids is proved,” says Decourtye. But not everyone is so certain. “The question of whether the damage to bees is translated to an effect in fields on whole populations of bees is much harder to show,” says Linda Field, head of the department of Biointeractions and Crop Protection at Rothamsted Research in Harpenden, UK. Mature colonies may survive even if individual bees are impaired, because other worker bees compensate, notes Nigel Raine, a biologist at the University of Guelph in Canada. But solitary bees, such as wild bees and queen bumblebees emerging from hibernation, might be at greater risk.

Campbell thinks that many academics are “neutral” on the matter, but are not vocal about it. Studies showing harm to bees tend to garner media attention, and are published in widely read journals, whereas those showing no impact are relegated to less highly cited publications, he says. But Goulson and Woodcock say some of the studies that industry cites as showing no harm are statistically dubious, and more flawed than the headline-garnering trials that show harm.

Christian Maus, global lead scientist for bee care at Bayer in Monheim am Rhein, Germany, picks his words carefully. “I think it is clear and undebated that neonicotinoids do have some intrinsic toxicity to bees,” he says. “But under realistic conditions, as prevailing in the field and agricultural practice, we have not seen any evidence that they would be harming honeybee colonies, for instance, when they are correctly applied.”

Combinatorial effects

Researchers are looking beyond simple relationships between a single pesticide and bee harm. In a 2012 paper[8], Raine and his colleagues showed that exposing bumblebees to a neonicotinoid in combination with a pesticide called a pyrethroid hampered their ability to collect pollen. Colonies exposed

to both compounds experienced higher losses of worker bees than did controls, or colonies dosed with only one. The study was the first to show combinatorial effects, Raine says — which is important, because bees will be exposed to multiple compounds in the wild. And this year, in a paper[9] published alongside Woodcock's, a Canadian team studying honeybee colonies near maize (corn) plants found that the presence of the fungicide boscalid halved the dose of neonics needed to cause death.

That work also suggested that neonic chemicals can migrate away from the plants that they are supposed to protect: by identifying the sources of pollen grains in the hives, the researchers showed that bees were exposed to neonics mainly through pollen from untreated plants. Neonicotinoids are water-soluble — which is how they move from seeds into growing plant tissues. “But that also means they can be washed off the seed, into the soil, and maybe into other plants,” says Christian Krupke, an entomologist at Purdue University in West Lafayette, Indiana.

In one study[10], Krupke found that just 1.34% of clothianidin applied as seed treatment to maize ended up in the crop’s tissues. Neonics that get into the wider environment might cause other, more indirect problems. A 2014 study[11] in the Netherlands, for instance, reported a fall in populations of insect-eating birds in areas with high concentrations of neonicotinoids in the water. It suggested that the chemicals might have depleted the birds’ food resource.

Some researchers are now questioning whether there is any benefit to using neonicotinoids at all. In another study[12], Krupke’s group found no benefits on maize yield from the use of neonicotinoids in Indiana. In this crop, he says, the prophylactic use of neonicotinoids — which are often part of a bundle of pesticides sold pre-applied to seeds — is foolish.

“The way they’re used doesn’t make any sense,” he says. “It only makes sense from one motive. That is the profit motive for the manufacturer.”

Campbell insists that neonicotinoids do provide yield increases, but much of the evidence is proprietary and unpublished. Since the EU neonicotinoid restrictions, Maus says, research suggests there has been a 4% decline in

oilseed-rape yield. Whether or not the restrictions have had any effect, farmers have furiously protested against losing the ability to use neonics. Anecdotal reports suggest many are attempting to compensate by applying increasing amounts of pyrethroids, which are sprayed over crops, rather than applied to seeds; these chemicals may bring their own health risks if used in large quantities, because they are toxic to fish and aquatic insects.

The B word

Regulators in some countries will soon decide whether to take further action to restrict neonics — and here, researchers are split. Some campaign groups, such as Greenpeace and the Pesticide Action Network, have argued for a ban on the use of neonics on all outdoor crops, not just those that might be attractive to bees, such as the bright-yellow flowers of oilseed rape.

“A lot of farmers do fundamentally rely on neonicotinoids,” says Woodcock. And clamping down severely on one chemical might mean that greater amounts of other damaging substances are used. “If people can't use neonicotinoids and they go to other insecticides, is that any better? There are lots of knock-on effects,” says Field.

That concern points to wider doubts about the regulatory systems that allowed agrichemicals such as neonics onto the market in the first place, says Goulson. Many researchers are hesitant to advocate outright bans. Some, such as Rundlöf, say it isn't their job to make policy recommendations. But Goulson says his view has changed as the evidence has mounted. In 2014 — at the time of the TFSP's first synthesis report — he thought that there might be certain situations in which neonics were the best option. But since then, he says, there's been even stronger evidence of collapsing insect populations — and it is hard to regulate partial bans. “I think now I'd vote for a complete ban,” he says.

Whatever regulators do, Goulson says, he is growing increasingly downbeat about the chances of any consensus forming between industry and academia on the issue. “I'm starting to come to the conclusion there will never be a game-changer,” he says. “There is nothing I think any scientist could do at

this point to make people all sit down and have any answer.”

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Four ethical priorities for neurotechnologies and AI

08 November 2017

Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

BSIP/UIG/Getty

A man with a spinal-cord injury (right) prepares for a virtual cycle race in which competitors steer avatars using brain signals.

Consider the following scenario. A paralysed man participates in a clinical

trial of a brain–computer interface (BCI). A computer connected to a chip in his brain is trained to interpret the neural activity resulting from his mental rehearsals of an action. The computer generates commands that move a robotic arm. One day, the man feels frustrated with the experimental team. Later, his robotic hand crushes a cup after taking it from one of the research assistants, and hurts the assistant. Apologizing for what he says must have been a malfunction of the device, he wonders whether his frustration with the team played a part.

This scenario is hypothetical. But it illustrates some of the challenges that society might be heading towards.

Current BCI technology is mainly focused on therapeutic outcomes, such as helping people with spinal-cord injuries. It already enables users to perform relatively simple motor tasks — moving a computer cursor or controlling a motorized wheelchair, for example. Moreover, researchers can already interpret a person's neural activity from functional magnetic resonance imaging scans at a rudimentary level[1] — that the individual is thinking of a person, say, rather than a car.

It might take years or even decades until BCI and other neurotechnologies are part of our daily lives. But technological developments mean that we are on a path to a world in which it will be possible to decode people's mental processes and directly manipulate the brain mechanisms underlying their intentions, emotions and decisions; where individuals could communicate with others simply by thinking; and where powerful computational systems linked directly to people's brains aid their interactions with the world such that their mental and physical abilities are greatly enhanced.

Such advances could revolutionize the treatment of many conditions, from brain injury and paralysis to epilepsy and schizophrenia, and transform human experience for the better. But the technology could also exacerbate social inequalities and offer corporations, hackers, governments or anyone else new ways to exploit and manipulate people. And it could profoundly alter some core human characteristics: private mental life, individual agency and an understanding of individuals as entities bound by their bodies.

It is crucial to consider the possible ramifications now.

The Morningside Group comprises neuroscientists, neurotechnologists, clinicians, ethicists and machine-intelligence engineers. It includes representatives from Google and Kernel (a neurotechnology start-up in Los Angeles, California); from international brain projects; and from academic and research institutions in the United States, Canada, Europe, Israel, China, Japan and Australia. We gathered at a workshop sponsored by the US National Science Foundation at Columbia University, New York, in May 2017 to discuss the ethics of neurotechnologies and machine intelligence.

We believe that existing ethics guidelines are insufficient for this realm[2]. These include the Declaration of Helsinki, a statement of ethical principles first established in 1964 for medical research involving human subjects (go.nature.com/2z262ag); the Belmont Report, a 1979 statement crafted by the US National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research (go.nature.com/2hrezmb); and the Asilomar artificial intelligence (AI) statement of cautionary principles, published early this year and signed by business leaders and AI researchers, among others (go.nature.com/2ihnqac).

To begin to address this deficit, here we lay out recommendations relating to four areas of concern: privacy and consent; agency and identity; augmentation; and bias. Different nations and people of varying religions, ethnicities and socio-economic backgrounds will have differing needs and outlooks. As such, governments must create their own deliberative bodies to mediate open debate involving representatives from all sectors of society, and to determine how to translate these guidelines into policy, including specific laws and regulations.

Intelligent investments

Some of the world's wealthiest investors are betting on the interplay between neuroscience and AI. More than a dozen companies worldwide, including Kernel and Elon Musk's start-up firm Neuralink, which launched this year, are investing in the creation of devices that can both 'read' human brain activity and 'write' neural information into the brain. We estimate that current spending on neurotechnology by for-profit industry is already US$100

million per year, and growing fast.

BSIP/UIG/Getty

After having electrodes implanted in the brain to stimulate neural activity, some people have reported feeling an altered sense of identity.

Investment from other sectors is also considerable. Since 2013, more than $500 million in federal funds has gone towards the development of neurotechnology under the US BRAIN initiative alone.

Current capabilities are already impressive. A neuroscientist paralysed by amyotrophic lateral sclerosis (ALS; also known as Lou Gehrig's or motor neuron disease) has used a BCI to run his laboratory, write grant applications and send e-mails[3]. Meanwhile, researchers at Duke University in Durham, North Carolina, have shown that three monkeys with electrode implants can operate as a 'brain net' to move an avatar arm collaboratively[4]. These devices can work across thousands of kilometres if the signal is transmitted wirelessly by the Internet.

Soon such coarse devices, which can stimulate and read the activity of a few dozen neurons at most, will be surpassed. Earlier this year, the US Defense Advanced Research Projects Agency (DARPA) launched a project called Neural Engineering System Design. It aims to win approval from the US Food and Drug Administration within 4 years for a wireless human brain device that can monitor brain activity using 1 million electrodes simultaneously and selectively stimulate up to 100,000 neurons.

Meanwhile, Google, IBM, Microsoft, Facebook, Apple and numerous start-ups are building ever-more-sophisticated artificial neural networks that can already outperform humans on tasks with well-defined inputs and outputs.

Last year, for example, researchers at the University of Washington in Seattle demonstrated that Google's FaceNet system could recognize one face from a million others. Another Google system with similar neural-network architecture far outperforms well-travelled humans at guessing where in the world a street scene has been photographed, demonstrating the generality of the technique. In August, Microsoft announced that, in certain metrics, its neural network for recognizing conversational speech has matched the abilities of even trained professionals, who have the option of repeatedly rewinding and listening to words used in context. And using electroencephalogram (EEG) data, researchers at the University of Freiburg in Germany showed in July how neural networks can be used to decode planning-related brain activity and so control robots[5].

Future neural networks derived from a better understanding of how real ones work will almost certainly be much more powerful even than these examples. The artificial networks in current use have been inspired by models of brain circuits that are more than 50 years old, which are based on recording the activity of individual neurons in anaesthetized animals[6]. In today's neuroscience labs, researchers can monitor and manipulate the activity of thousands of neurons in awake, behaving animals, owing to advances in optical methods, computing, molecular engineering and microelectronics.

We are already intimately connected to our machines. Researchers at Google calculated this year that the average user touches their phone nearly one million times annually (unpublished data). The human brain controls auditory

and visual systems to decipher sounds and images, and commands limbs to hold and manipulate our gadgets. Yet the convergence of developments in neurotechnologies and AI would offer something qualitatively different — the direct linking of people's brains to machine intelligence, and the bypassing of the normal sensorimotor functions of brains and bodies.

Four concerns

For neurotechnologies to take off in general consumer markets, the devices would have to be non-invasive, of minimal risk, and require much less expense to deploy than current neurosurgical procedures. Nonetheless, even now, companies that are developing devices must be held accountable for their products, and be guided by certain standards, best practices and ethical norms.

We highlight four areas of concern that call for immediate action. Although we raise these issues in the context of neurotechnology, they also apply to AI.

Privacy and consent. An extraordinary level of personal information can already be obtained from people's data trails. Researchers at the Massachusetts Institute of Technology in Cambridge, for example, discovered in 2015 that fine-grained analysis of people's motor behaviour, revealed through their keyboard typing patterns on personal devices, could enable earlier diagnosis of Parkinson's disease[7]. A 2017 study suggests that measures of mobility patterns, such as those obtained from people carrying smartphones during their normal daily activities, can be used to diagnose early signs of cognitive impairment resulting from Alzheimer's disease[8].

Algorithms that are used to target advertising, calculate insurance premiums or match potential partners will be considerably more powerful if they draw on neural information — for instance, activity patterns from neurons associated with certain states of attention. And neural devices connected to the Internet open up the possibility of individuals or organizations (hackers, corporations or government agencies) tracking or even manipulating an individual's mental experience.

We believe that citizens should have the ability — and right — to keep their neural data private (see also 'Agency and identity'). We propose the following steps to ensure this.

For all neural data, the ability to opt out of sharing should be the default choice, and assiduously protected. People readily give up their privacy rights to commercial providers of services, such as Internet browsing, social media or entertainment, without fully understanding what they are surrendering. A default of opting out would mean that neural data are treated in the same way that organs or tissues are in most countries. Individuals would need to explicitly opt in to share neural data from any device. This would involve a safe and secure process, including a consent procedure that clearly specifies who will use the data, for what purposes and for how long.

Even with this approach, neural data from many willing sharers, combined with massive amounts of non-neural data — from Internet searches, fitness monitors and so on — could be used to draw 'good enough' conclusions about individuals who choose not to share. To limit this problem, we propose that the sale, commercial transfer and use of neural data be strictly regulated. Such regulations — which would also limit the possibility of people giving up their neural data or having neural activity written directly into their brains for financial reward — may be analogous to legislation that prohibits the sale of human organs, such as the 1984 US National Organ Transplant Act.

Another safeguard is to restrict the centralized processing of neural data. We advocate that computational techniques, such as differential privacy or 'federated learning', be deployed to protect user privacy (see 'Protecting privacy'). The use of other technologies specifically designed to protect people's data would help, too. Blockchain-based techniques, for instance, allow data to be tracked and audited, and 'smart contracts' can give transparent control over how data are used, without the need for a centralized authority. Lastly, open-data formats and open-source code would allow for greater transparency about what stays private and what is transmitted.

Protecting privacy: Federated learning

When technology companies use machine learning to improve their software, they typically gather user information on their servers to analyse how a particular service is being used and then train new algorithms on the aggregated data. Researchers at Google are experimenting with an alternative method of artificial-intelligence training called federated learning. Here, the teaching process happens locally on each user's device without the data being centralized: the lessons aggregated from the data (for instance, the knowledge that the word 'weekly' can be used as an adjective and an adverb) are sent back to Google's servers, but the actual e-mails, texts and so on remain on the user's own phone. Other groups are exploring similar ideas. Thus, information systems with improved designs could be used to enhance users' ownership and privacy over their personal data, while still enabling valuable computations to be performed on those data.

Agency and identity. Some people receiving deep-brain stimulation through electrodes implanted in their brains have reported feeling an altered sense of agency and identity. In a 2016 study, a man who had used a brain stimulator to treat his depression for seven years reported in a focus group[9] that he began to wonder whether the way he was interacting with others — for example, saying something that, in retrospect, he thought was inappropriate — was due to the device, his depression or whether it reflected something deeper about himself. He said: “It blurs to the point where I'm not sure ... frankly, who I am.”

Neurotechnologies could clearly disrupt people's sense of identity and agency, and shake core assumptions about the nature of the self and personal responsibility — legal or moral.

People could end up behaving in ways that they struggle to claim as their own, if machine learning and brain-interfacing devices enable faster translation between an intention and an action, perhaps by using an 'auto-complete' or 'auto-correct' function. If people can control devices through their thoughts across great distances, or if several brains are wired to work collaboratively, our understanding of who we are and where we are acting will be disrupted.

As neurotechnologies develop and corporations, governments and others start striving to endow people with new capabilities, individual identity (our

bodily and mental integrity) and agency (our ability to choose our actions) must be protected as basic human rights.

We recommend adding clauses protecting such rights ('neurorights') to international treaties, such as the 1948 Universal Declaration of Human Rights. However, this might not be enough — international declarations and laws are just agreements between states, and even the Universal Declaration is not legally binding. Thus, we advocate the creation of an international convention to define prohibited actions related to neurotechnology and machine intelligence, similar to the prohibitions listed in the 2010 International Convention for the Protection of All Persons from Enforced Disappearance. An associated United Nations working group could review the compliance of signatory states, and recommend sanctions when needed.

Such declarations must also protect people's rights to be educated about the possible cognitive and emotional effects of neurotechnologies. Currently, consent forms typically focus only on the physical risks of surgery, rather than the possible effects of a device on mood, personality or sense of self.

Augmentation. People frequently experience prejudice if their bodies or brains function differently from most[10]. The pressure to adopt enhancing neurotechnologies, such as those that allow people to radically expand their endurance or sensory or mental capacities, is likely to change societal norms, raise issues of equitable access and generate new forms of discrimination.

Moreover, it's easy to imagine an augmentation arms race. In recent years, we have heard staff at DARPA and the US Intelligence Advanced Research Projects Activity discuss plans to provide soldiers and analysts with enhanced mental abilities ('super-intelligent agents'). These would be used for combat settings and to better decipher data streams.

Any lines drawn will inevitably be blurry, given how hard it is to predict which technologies will have negative impacts on human life. But we urge that guidelines are established at both international and national levels to set limits on the augmenting neurotechnologies that can be implemented, and to define the contexts in which they can be used — as is happening for gene editing in humans.

Privacy and individuality are valued more highly in some cultures than in others. Therefore, regulatory decisions must be made within a culture-specific context, while respecting universal rights and global guidelines. Moreover, outright bans of certain technologies could simply push them underground, so efforts to establish specific laws and regulations must include organized forums that enable in-depth and open debate.

Such efforts should draw on the many precedents for building international consensus and incorporating public opinion into scientific decision-making at the national level[11]. For instance, after the First World War, a 1925 conference led to the development and ratification of the Geneva Protocol, a treaty banning the use of chemical and biological weapons. Similarly, after the Second World War, the UN Atomic Energy Commission was established to deal with the use of atomic energy for peaceful purposes and to control the spread of nuclear weapons.

In particular, we recommend that the use of neural technology for military purposes be stringently regulated. For obvious reasons, any moratorium should be global and sponsored by a UN-led commission. Although such commissions and similar efforts might not resolve all enhancement issues, they offer the best-available model for publicly acknowledging the need for restraint, and for wide input into the development and implementation of a technology.

Bias. When scientific or technological decisions are based on a narrow set of systemic, structural or social concepts and norms, the resulting technology can privilege certain groups and harm others. A 2015 study[12] found that postings for jobs displayed to female users by Google's advertising algorithm pay less well than those displayed to men. Similarly, a ProPublica investigation revealed last year that algorithms used by US law-enforcement agencies wrongly predict that black defendants are more likely to reoffend than white defendants with a similar criminal record (go.nature.com/29aznyw). Such biases could become embedded in neural devices. Indeed, researchers who have examined these kinds of cases have shown that defining fairness in a mathematically rigorous manner is very difficult (go.nature.com/2ztfjt9).

Practical steps to counter bias within technologies are already being discussed in industry and academia. Such ongoing public discussions and debate are necessary to shape definitions of problematic biases and, more generally, of normality.

We advocate that countermeasures to combat bias become the norm for machine learning. We also recommend that probable user groups (especially those who are already marginalized) have input into the design of algorithms and devices as another way to ensure that biases are addressed from the first stages of technology development.

Responsible neuroengineering

Underlying many of these recommendations is a call for industry and academic researchers to take on the responsibilities that come with devising devices and systems capable of bringing such change. In doing so, they could draw on frameworks that have already been developed for responsible innovation.

In addition to the guidelines mentioned above, the UK Engineering and Physical Sciences Research Council, for instance, provides a framework to encourage innovators to “anticipate, reflect, engage and act” in ways that “promote ... opportunities for science and innovation that are socially desirable and undertaken in the public interest”. Among the various efforts to address this in AI, the IEEE Standards Association created a global ethics initiative in April 2016, with the aim of embedding ethics into the design of processes for all AI and autonomous systems.

History indicates that profit hunting will often trump social responsibility in the corporate world. And even if, at an individual level, most technologists set out to benefit humanity, they can come up against complex ethical dilemmas for which they aren't prepared. We think that mindsets could be altered and the producers of devices better equipped by embedding an ethical code of conduct into industry and academia.

A first step towards this would be to expose engineers, other tech developers

and academic-research trainees to ethics as part of their standard training on joining a company or laboratory. Employees could be taught to think more deeply about how to pursue advances and deploy strategies that are likely to contribute constructively to society, rather than to fracture it.

This type of approach would essentially follow that used in medicine. Medical students are taught about patient confidentiality, non-harm and their duties of beneficence and justice, and are required to take the Hippocratic Oath to adhere to the highest standards of the profession.

The possible clinical and societal benefits of neurotechnologies are vast. To reap them, we must guide their development in a way that respects, protects and enables what is best in humanity.

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The catalogue that made metrics, and changed science

08 November 2017

As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.

Alamy

Cataloguers of the Royal Society developed the first record of published scientific research.

In 1830, Charles Babbage had an unusual idea. Exasperated by how little recognition science was getting in England, the computer pioneer and scientific provocateur suggested that quantifying authorship might be a way to identify scientific eminence.

Like many of Babbage's radical ideas, this one persuaded almost nobody, but it eventually proved prophetic. Before the end of the century, listing papers and comparing publication counts had become a popular pursuit among scientific authors and other observers. Within a few decades, academic scientists were coming to fear the creed of 'publish or perish' (see 'Catalogues and counts').

This transformation can inform current debates about the value of algorithms for quantifying scientific credibility and importance. History shows how search technologies and metrics are not neutral tools that simply speed up efforts to locate and evaluate scientific work. Metrics transform the very things that they measure. By changing the reward structure, they alter researchers' behaviour — both how results are communicated and which topics receive the most attention.

But there is a second, more subtle, transformation that we must be alert to. The processes by which scientific merit is judged have long been central to the public perception of scientific authority. As these processes change, we must also consider the ways in which broader cultural beliefs about scientific expertise are transformed.

Broken pieces of fact

Babbage's suggestion to count authors' papers was met with various criticisms. One author did the calculation for each fellow in the Royal Society in London, and showed that this was a terrible guide to scientific eminence. Another pointed out[1] that “a far more satisfactory criterion” would have been “the value of those papers”.

Back then, scientific reputations were built not on periodicals but on books and other proofs of genius that demonstrated mastery of a subject. Babbage himself had little respect for most scientific journals, and he limited his proposal to counting papers in the venerable *Philosophical Transactions of the Royal Society of London*. As late as 1867, the British physiologist Michael Foster, in a retrospective written on the life of Karl von Baer, heaped praise on the embryologist's multivolume masterwork, *On the Development*

of Animals, and dismissed his periodical publications. These, Foster claimed[2], were just “specimens of those broken pieces of fact, which every scientific worker throws out to the world, hoping that on them, some time or other, some truth may come to land”.

Alamy

But things were beginning to change. A young engineer working for the US

Coast and Geodetic Survey (now the National Geodetic Survey) had suggested that it would be useful if some catalogue could be devised to keep track of the publications of European scientific societies. Once the idea crossed the Atlantic and percolated up to the Royal Society, its scope grew to become a list of all periodical papers containing original scientific research published since 1800. Some questioned the need to preserve so much insignificant writing. The physicist William Thomson (later Lord Kelvin) warned that the project would lead the society to financial ruin.

The main argument for what would become the *Catalogue of Scientific Papers* was that periodical publishing was a mess. Although many authors published in the journals of scientific societies, vast quantities of valuable information appeared in popular-science magazines, encyclopaedias and general-interest weeklies. Authors distributed huge numbers of offprints that sometimes did not even make clear what journal they had come from.

When the society's indexers got down to work in 1867, they realized that the situation was worse than they'd imagined. For thousands of papers, they couldn't even figure out who the author was. Many who published in periodicals chose to remain anonymous, or signed only their initials. In other cases, it was hard to tell to what extent the writer of a paper was responsible for its contents, or whether another person ought to be credited. Moreover, vast numbers of papers were published in various forms in different periodicals, and it was no easy matter deciding what should count as the same publication. Today, such publishing habits would probably lead to accusations of misconduct; not very long ago this was business as usual.

The Royal Society's cataloguers did what they could, contacting editors and authors to match names to papers. They turned a significant portion of the society's library into a bibliographic workroom, and made their job simpler by excluding all general-interest periodicals from the search, as well as anything that smacked of reading for non-specialists. They compiled lists of which periodicals ought to be included in the count, and circulated them to other experts and academies for feedback. The decision about whether to index some doubtful titles sometimes made it all the way to the society's council for a vote.

As their work progressed, the directors of the project came to realize that

their charge to produce a master list of all 'scientific papers' published since 1800 might actually influence publishing practices in the future. They hoped that authors would be more careful about where they published — or at least sign their contributions[3]. They probably did not anticipate the full consequences of what they were about to unleash.

Counting what counts

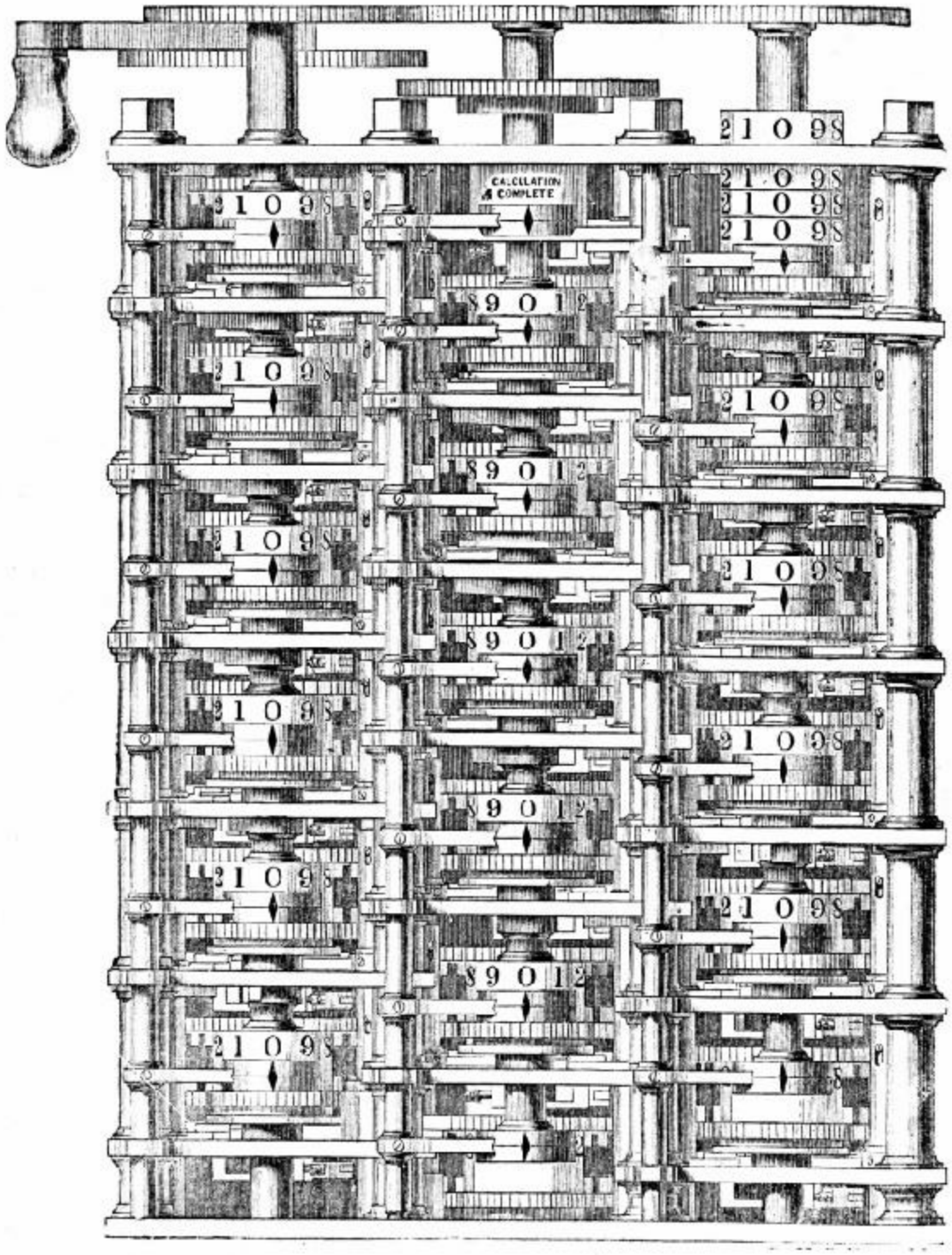
When the first volumes of the *Catalogue of Scientific Papers* appeared at the end of 1867, reaction across Europe and the United States was swift and wide-ranging. One observer wrote in awe that the catalogue made science look like a coral-island, a majestic edifice that grew imperceptibly larger with the addition of each new fact embodied in each paper. Some were less enthusiastic. One Royal Society fellow complained that the editors had distorted “the progress and history of discovery both in Physical and Natural Science” by excluding so many valuable contributions from “journals not professedly scientific”, accounts of scientific voyages, independently published treatises, encyclopaedia articles (which at the time often included original research), and much more[4].

Many observers hurried over the prospect of how helpful the catalogue would be for finding information and began comparing the productivity of individuals. By quantifying the contributions of each author, the catalogue seemed tailor-made for keeping score. A writer in *Nature* got down to business[5]: “Dr. Hooker appears for 58 papers; his late father for 72; and the late W. Hopkins, who did so much in mathematical geology, for 33 .... the indefatigable Isaac Lea, of Philadelphia, for 106, mostly about shells...”. And so forth. In a detailed review in a Viennese newspaper, the mineralogist Wilhelm von Haidinger began by urging prudence, warning that the mere comparison of numbers was no basis on which to make judgements of value[6]. But even he admitted that the numbers were somehow irresistible. Within two years, von Haidinger had taken his numerical analysis further. He published a study based on the catalogue that included a chart that compared the number of highly productive scientific authors in each region of Europe, lamenting the low position of Austria according to this ranking[7].

Such enthusiasm for counting had practical consequences. Within a decade of those first volumes appearing, the forms submitted by candidates for admission to the Royal Society transformed into long lists of papers. By the early 1870s, obituaries and biographical encyclopaedias were routinely noting the number of papers written by a researcher, and even following the chronology sketched out by those papers as guide-posts to a career. By 1900, even Foster, the physiologist once so sceptical of scientific periodicals, had changed his tune. Original science belonged in periodicals, he explained. Putting new findings in books — as Charles Darwin had famously done — was “out of place and even dangerous”[8]. To be an expert on scientific subjects meant being an author of scientific papers.

Publish or perish

There is a direct line from these developments to twentieth-century worries about scientific publishing going off the rails. A letter to *Nature* in 1932 lamented the growing practice of candidates submitting a “list of strictly technical publications” to the Royal Society, leading to the result that “our journals are filled with masses of unreadable trash” published by ambitious scholars hoping to strengthen their applications[9].



Alamy

Charles Babbage, inventor of the difference engine, was an advocate of counting papers.

This was around the same time that the phrase publish or perish began to circulate in academia. It did so first in the United States, where the spread of research universities was turning science into something resembling a profession. The slogan became shorthand for the corrupting influence of narrow, bureaucratic performance measures of research.

In the 1960s, Eugene Garfield launched a radically different search tool, known as the Science Citation Index. He hoped that it might end the harmful culture of publish or perish by showing that some papers were more cited — and hence more valuable — than others.

Immediately, commentators warned that new measures based on citations would only make things worse, leading to a “highly invidious pecking order” of journals that could distort science[10]. The journal impact factor made its public debut in 1972, soon after the US Congress called on the National Science Foundation to produce a better account of the benefits wrought by public funding of science. There is no doubt that the citation index changed practices of scientific publishing, just as the rise of counting papers had followed the introduction of the catalogue before.

Today, advocates of altmetrics argue that well-made algorithms can mimic and aggregate the everyday acts of judgement that researchers make when they read, cite, link or otherwise engage with published research. These algorithms, they claim, will turn out to be as good or better at replicating established processes — such as peer review — that are supposed to delimit what constitutes important and trustworthy research.

Whether or not these claims turn out to be true, they ignore the question of whether we deem the procedures that experts use to evaluate ideas to be intrinsically valuable (that is, independent of the content of those judgements).

Scientific judgement does not happen in a cultural vacuum. The rise of processes such as peer review to organize and evaluate research was never simply about getting scientific judgement right; it was about balancing scientists' expert cultures with public demands for accountability. The *Catalogue of Scientific Papers* was itself part of a cultural moment in which

indexes and card catalogues were celebrated for their potential to set knowledge free and even foster world peace. Interest in altmetrics has grown alongside widespread fascination with the potential of online platforms to make scientific communication both more open and more democratic.

At a time when the public status of the scientific expert is becoming increasingly uncertain, these questions are more important than ever. In a democracy, the procedures by which we decide what constitutes valuable scientific knowledge fundamentally depend on public conceptions of the aims of the scientific enterprise.

The question of whether new metrics might one day replicate the results of peer review (when it is working well) is a red herring. How we choose to judge what constitutes good science is just as important as the end results of those judgements. Even algorithms have politics.

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Further reading

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Indian scientists urged to speak out about pseudoscience

Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.

07 November 2017

Pallava Bagla/Corbis/Getty

Scientists taking part in India's march for science in August were protesting against the spread of anti-science beliefs, superstitions and myths.

A leading Indian science-advocacy group is urging the country’s researchers to speak out against pseudoscience, which it fears has gained a foothold in the past few years, partly through support from some agencies of the Indian

government.

The call to arms, made by the non-profit Breakthrough Science Society, comes after some members of an alumni association of the prestigious Indian Institute of Science (IISc), Bangalore, planned a workshop on astrology at the IISc for 25–26 November.

Strong backlash from scientists resulted in the event being cancelled on 28 October. The society's general secretary, Soumitro Banerjee, says that it would be "detrimental to Indian science" for researchers to remain neutral on such issues. "India's scientific community must be proactive in propagating a scientific bent of mind," says Banerjee, a physicist at the Indian Institute of Science Education and Research Kolkata.

Timeline of events

Two days before the alumni association cancelled the workshop, dozens of scientists signed letters to the IISc director, Anurag Kumar, objecting to the workshop. The IISc director and the faculty were not involved in organizing the workshop.

Muthya Ravindra, a computer scientist and president of the alumni association, says that the event, organized by one of its members, was still under discussion when "due to some miscommunications", e-mails promoting the event were sent out.

But Ravindra says that despite criticism from scientists and other academics, people widely believe in astrology and seek its advice in newspapers, magazines and on television. He is unsure what role scientists should play in educating society on the dangers such practices may have. "It is very confusing to me whether we as scientists [should] criticize or take some part in finding a solution," he says.

India's ruling party, the conservative Bharatiya Janata Party (BJP) has shown support for giving astrology a place in universities. In 2001, then-science minister of the BJP-led coalition government Murli Manohar Joshi took steps to allow public universities to include astrology classes in curricula.

However, the Indian government and science ministry did not have a role in the IISc alumni association's planned astrology workshop.

Pseudoscience debate

Alarm in the Indian scientific community over anti-science policies and programmes has been brewing for some time. Several scientists who spoke with *Nature* are reluctant to comment publicly about it for fear of jeopardizing their jobs. Others took part in the March for Science organized by the 7,000-member Breakthrough Science Society in August in around 40 Indian cities, in part to protest the government's support for ideas not yet backed by science. One area of concern, says Banerjee, is the government's push for a national research programme on the health and other benefits of a combination of five cow products, known as panchgavya.

The Indian Institute of Technology (IIT), Delhi, hosted a two-day workshop last December to discuss ways to validate research on panchgavya, which was supported by India's Department of Science and Technology, Department of Biotechnology, and Council of Scientific and Industrial research (CSIR), and inaugurated by India's science minister Harsh Vardhan.

According to IIT Delhi's website, Vardhan, who is a physician, "emphasised that use of panchgavya in practice and in daily routines will help to address the pressing global issues like climate change, resistance development, malnourishment, global health etc".

Following the workshop, India's science ministry formed a national steering committee to initiate a national programme on the topic.

Supporters of this research say that cow products should be considered part of India's vast traditional knowledge base. But critics say that such unverified theories are pseudoscience, and that singling out the benefits of cow products is part of a larger political agenda by Hindus, for whom the cow is a sacred animal.

They also argue that research on topics such as panchgavya should be handled in a neutral manner rather than as a way of promoting traditional

knowledge. Rahul Siddharthan, a computation biologist at the Institute of Mathematical Sciences in Chennai, says that the government must accept that any research involving traditional hypotheses about health could potentially refute those hypotheses. “Refutability is the essence of science,” he says.

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Nature
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doi:10.1038/nature.2017.22957

Comments

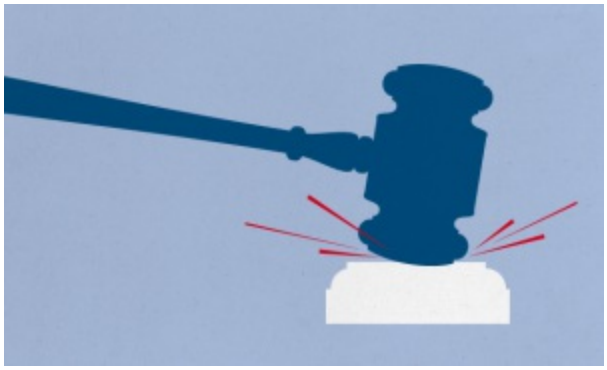
Commenting is currently unavailable.

Pirate paper website Sci-Hub dealt another blow by US courts

American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.

07 November 2017 Updated:

1. 08 November 2017



The American Chemical Society (ACS) has won a lawsuit against the pirate research-paper website Sci-Hub, over the site’s illicit use and dissemination of ACS articles.

On 3 November, a US court ordered Sci-Hub's operators to pay the ACS US$4.8 million in damages for copyright infringement and trademark violation. Sci-Hub’s owners did not appear in court to present their case.

The judge also ordered that any party “in active concert or participation” with Sci-Hub should “cease facilitating” access to the repository. This means that the ACS could request Internet services including web providers, search engines and domain-name registrars to stop linking or to block access to Sci-Hub and the various domains it is hosted under.

Which services might be approached by the ACS isn't yet clear: the meaning of the phrase "in active concert or participation with" is open to legal interpretation, says Michael Carroll, an information-justice and intellectual-property specialist at the American University Washington College of Law in Washington, DC.

There are no clear standards as to when an Internet service is in "active concert" with a pirate website, says Carroll. A user merely resolving a domain-name request to such a site, for example, does not yet qualify as active participation, he adds.

Such an order by a US court is exceptional, Carroll says. "In general, our federal courts do not have the power to issue orders against people or entities that were not part of the lawsuit." But he adds that US federal rules for civil procedures such as this do sometimes allow injunctions against persons who are in 'active participation' with an enjoined party. The current lawsuit is an example of that, he says.

The ruling is another legal blow for Sci-Hub, which provides free access to millions of paywalled research papers and is popular with researchers around the world. In June, a New York court granted the Dutch publisher Elsevier $15 million in damages from the site for large-scale copyright infringement.

But publishers are unlikely to see any money from Sci-Hub because its chief operator lives outside the United States. Alexandra Elbakyan, a former neuroscientist who created the portal in 2011, says the court order is an example of censorship.

The ACS, which filed its lawsuit in June in a Virginia court, said in a statement on 6 November that the ruling was "a victory for copyright law and the entire publishing enterprise". An analysis published in August estimated that as of March 2017, Sci-Hub's database contained 69% of the world's roughly 81.6 million scholarly articles — and 98.8% of the ACS's journal content.

The ACS says that it will now seek to enforce the court's order. Asked for comment, the society referred *Nature*'s news team to its statement. But Internet service providers are expected to resist what they may perceive as

undue censorship.

Attempts to stop people visiting Sci-Hub face another hurdle, too: the site has an alternative address that can be reached by users of the Tor network, a group of servers that encrypts Internet traffic and disguises its origins. No Internet provider can easily block access to such sites.

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Nature
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Updates

Updated:

The story has been updated with comments from Alexandra Elbakyan.

Comments

Commenting is currently unavailable.

Genetically modified apple reaches US stores, but will consumers bite?

Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.

07 November 2017 Corrected:

1. 10 November 2017

Okanagan Specialty Fruits, Inc.

The apple on the right doesn’t bruise when dropped — it lacks a gene encoding an enzyme that causes plant cells to brown on exposure to oxygen.

This month, bags of sliced apples will hit grocery-store shelves in the midwestern United States for the first time. Shoppers who purchase the

apples can leave the slices out for snacking, because of a feat of genetic engineering that prevents their flesh from browning when exposed to air.

The ‘Arctic apple’ is one of the first foods to be given a trait intended to please consumers rather than farmers, and it joins a small number of genetically modified organisms (GMOs) to be sold as a whole product, not an ingredient. Since Okanagan Specialty Fruits in Summerland, Canada, planted its first test apples in 2003, the array of foods modified in labs has expanded to include meatless burgers, made with soya protein produced by recombinant yeast, fish fillets grown from seafood stem cells, and mushrooms whose genomes have been edited with CRISPR technology. Most of these items have not yet reached the market.

Now, many small biotechnology companies developing such foods are watching the Arctic apple’s launch, eager for clues to how consumers will perceive the fruits of their labour.

“If the apple sells, it will pave the way for others,” says Yinong Yang, a plant pathologist at Pennsylvania State University in University Park, who used CRISPR to engineer a mushroom that resists browning. He hopes one day to license his mushroom to commercial growers.

Mary Maxon, who oversees biosciences programmes at Lawrence Berkeley National Laboratory in California, agrees. “The apple is not the first GMO that people would eat, but it’s the first one that consumers may value,” she says.

When Okanagan co-founder Neal Carter bought an orchard in 1995, he thought hard about how to win over the US snack market. He found his answer in Australia, where researchers at the Commonwealth Scientific and Industrial Research Organisation had figured out how to delete a gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives.

Only later did he realize that if consumers were to be enticed to buy, Americans’ distrust of GMOs would need to be overcome. Okanagan’s subsequent surveys of people in America’s top apple-growing states — New

York and Washington — revealed that about 20% were wary of GMOs. But the company also found that many people changed their minds when told that the apples were engineered to silence browning genes, and then tested for safety.

Mike Seldon, the co-founder of Finless Foods, a firm in New York City that is developing fish fillets from fish stem cells, agrees that providing more information helps to win over consumers. “We’re not going to repeat the mistakes of the GMO industries in the past, and just put foods on the market without public conversation,” he says. “If we do, you can expect a backlash — and that’s warranted.”

Seldon sees a parallel between the Arctic apple and his fillets: both were created with attributes to please consumers. Finless Foods, which has made prototypes of bluefin-tuna fillets, hopes that people will be won over by the idea of eating fish without worrying about overfishing, animal slaughter or environmental pollution.

But others say that Okanagan hasn’t gone far enough in telling consumers how its apple was made. The company does not mention GMOs on the apples’ bags; instead, the bags have a QR code — which links to online information when it is scanned by a smartphone. “Not everyone has a smartphone, and even if you have one, are you going to check every item with it?” says Bill Freese, a science-policy analyst at the Center for Food Safety, an advocacy group in Washington DC. He wants the apples to be clearly labelled as GMOs.

Consumer reaction isn’t the only concern for developers of genetically engineered or other lab-made foods who want to sell their wares in the United States. One major stumbling block is the US regulatory process, which involves a complicated tangle of federal agencies — and, for many companies, an unclear path forward. US regulators assessed the Arctic apple for five years before approving it for sale, but spent just two years reviewing a non-browning GM potato developed by agricultural firm J. R. Simplot of Boise, Idaho.

Then there is the case of the CRISPR mushroom. The US Department of Agriculture (USDA) said in 2016 that it would not evaluate the mushroom,

which was created by using CRISPR to delete a gene. That seemed to clear the fungus's path to the market. But Yang says that, after *Nature*'s news team reported on the USDA's decision, the US Food and Drug Administration contacted him to ask whether it could review the mushroom. "I agreed to that since it would give consumers a peace of mind," he says.

As far as investors are concerned, regulatory uncertainty may be less of a barrier to the success of engineered foods than customer uncertainty. James Hardiman, a partner at the venture-capital fund Data Collective in San Francisco, California, says that companies developing such foods can always build a few extra years into their long-term plans, to account for twists in the regulatory process. "The public narrative is much more difficult to control," he says. "We know the public can be irrational."

Still, Carter is optimistic about how his Arctic apple will be received. "We rarely get e-mails saying we are Satan any more," he says of his company. "Now we have people asking where they can buy the apples."

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doi:10.1038/551149a

Corrections

Corrected:

An earlier version of this story stated that Carter took over his family's orchard.

Comments

Commenting is currently unavailable.

US government approves 'killer' mosquitoes to fight disease

US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.

06 November 2017

Dennis Kunkel Microscopy/SPL

The lab-grown mosquitoes developed by MosquitoMate seek to eliminate the disease-carrying Asian tiger mosquito (*Aedes albopictus*, shown here).

The US Environmental Protection Agency (EPA) has approved the use of a common bacterium to kill wild mosquitoes that transmit viruses such as dengue, yellow fever and Zika, *Nature*'s news team has learned.

On 3 November, the agency told biotechnology start-up MosquitoMate that it could release the bacterium *Wolbachia pipientis* into the environment as a tool against the Asian tiger mosquito (*Aedes albopictus*). Lab-reared mosquitoes will deliver the bacterium to wild mosquito populations.

The decision — which the EPA has not formally announced — allows the company, which is based in Lexington, Kentucky, to release the bacteria-infected mosquitoes in 20 US states and Washington DC.

“It’s a non-chemical way of dealing with mosquitoes, so from that perspective, you’d think it would have a lot of appeal,” says David O’Brochta, an entomologist at the University of Maryland in Rockville.“I’m glad to see it pushed forward, as I think it could be potentially really important.”

MosquitoMate will rear the *Wolbachia*-infected *A. albopictus* mosquitoes in its laboratories, and then sort males from females. Then the laboratory males, which don’t bite, will be released at treatment sites. When these males mate with wild females, which do not carry the same strain of *Wolbachia*, the resulting fertilized eggs don’t hatch because the paternal chromosomes do not form properly.

The company says that over time, as more of the *Wolbachia*-infected males are released and breed with the wild partners, the pest population of *A. albopictus* mosquitoes dwindles. Other insects, including other species of mosquito, are not harmed by the practice, says Stephen Dobson, an entomologist at the University of Kentucky in Lexington and founder of MosquitoMate.

Production challenges

The EPA restricted the release of MosquitoMate’s product, called ZAP males, to 20 states and Washington DC. The agency has previously said that those places “are similar in temperature and precipitation to areas where efficacy of the ZAP males was tested” — Kentucky, New York and California. The EPA decision excludes much of the southeastern United

States, which is home to dense populations of mosquitoes and a long mosquito season, because MosquitoMate did not conduct field trials there.

MosquitoMate plans to begin selling its mosquitoes locally, in Lexington, and will expand from there to nearby cities such as Louisville, Kentucky, and Cincinnati, Ohio. The company will work with homeowners, golf courses, hotels and other customers to deploy its insects, according to Dobson. “Now the work starts,” he says.

The company will have to start small. Suppressing the mosquito population of an entire city is likely to require the weekly production of millions of these mosquitoes. To reach that level, Dobson’s company must find a way to efficiently separate male mosquitoes from females. The company’s technicians now separate them both by hand and mechanically, Dobson says.

Another group that is also developing mosquitoes infected with *Wolbachia* to control wild populations has succeeded in producing large quantities of their insects. Researchers from Sun Yat-sen University in Guangzhou, China, and Michigan State University in East Lansing say they are releasing 5 million *Wolbachia*-infected *A. albopictus* each week in Guangzhou.

The scientists use mechanical sorters to separate males from females, on the basis of size differences at the pupal stage, at more than 99% efficiency, says Zhiyong Xi, a medical entomologist and microbiologist at Michigan State University, who leads the project. They expose the remaining mosquitoes to X-ray radiation at a dose that sterilizes any remaining females, but is too low to affect the males.

Looking ahead

Using lab-grown mosquitoes to kill mosquito pests has been tested extensively in Brazil in recent years. The country has allowed large-scale releases of such mosquitoes in response to an epidemic of the Zika virus that began in 2015. Zika is a mosquito-borne virus that has been linked to severe birth defects, such as abnormally small heads — a condition known as microcephaly. *Aedes aegypti* mosquitoes are thought to be the primary vector

for the virus.

One type of mosquito being tested in Brazil is a genetically modified variety of *A. aegypti* developed by Oxitec in Milton, UK. When the modified male mosquitoes mate with wild females, they pass a lethal gene on to any progeny.

Oxitec has run into challenges when attempting to test its GM mosquitoes in the United States, however. A community in the Florida Keys voted last year against allowing Oxitec to conduct field trials there, although the rest of the county in which the community is located voted in favour of the plans.

By contrast, MosquitoMate has developed and tested a variety of *Wolbachia*-carrying *A. aegypti* mosquitoes in the Florida Keys and Fresno, California, without drawing much public attention. The EPA received only 14 comments during the public-comment period for the Florida trials, and most of them were positive. The company plans to submit an application to the EPA for nationwide release of that species, says Dobson.

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Comments

Commenting is currently unavailable.

Language patterns reveal body's hidden response to stress

Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

06 November 2017

Carlo Allegri/Getty

Listen in: the words people say may reveal the body's biological response to threat.

Subtleties in the language people use may reveal physiological stress.

Psychologists found that tracking certain words used by volunteers in randomly collected audio clips reflected stress-related changes in their gene expression. The speech patterns predicted those physiological changes more

accurately than speakers' own ratings of their stress levels.

The research, which is published on 6 November in *Proceedings of the National Academy of Sciences*[1] suggests that changes in language may track the biological effects of stress better than how we consciously feel. It's a new approach to studying stress, says David Creswell, a psychologist at Carnegie Mellon University in Pittsburgh, Pennsylvania, and one that "holds tremendous promise" for understanding how psychological adversity affects physical health.

Adverse life circumstances — such as poverty, trauma or social isolation — can have devastating effects on health, increasing the risk of a variety of chronic disorders ranging from heart disease to dementia. Researchers trying to pin down the biological mechanisms involved have found that people who experience these circumstances also undergo broad changes in gene expression in the cells of their immune system. Genes involved in inflammation become more active, for example, and antiviral genes are turned down.

These biological changes seem to represent the body's evolutionary response to threat, says Steve Cole, a genomicist at the University of California, Los Angeles, and a co-author on the paper. But he was always troubled by a "nagging observation": they don't tally well with how stressed people say they are.

Cole wondered whether stress biology is triggered instead by an automatic assessment of threat in the brain, which doesn't necessarily reach conscious awareness. To find out, he and his colleagues teamed up with Matthias Mehl, a psychologist at the University of Arizona, Tucson, who studies how stress affects language.

Stress on speech

The researchers asked 143 adult volunteers in the United States to wear audio recorders, which switched on every few minutes for two days, capturing a total of 22,627 clips. Mehl transcribed any words spoken by the volunteers,

and analysed the language they used.

He was particularly interested in what psychologists call 'function' words, such as pronouns and adjectives. “By themselves they don’t have any meaning, but they clarify what’s going on,” says Mehl. Whereas we consciously choose 'meaning' words such as nouns and verbs, researchers believe that function words “are produced more automatically and they betray a bit more about what’s going on with the speaker”. Mehl and others have found, for example, that people’s use of function words changes when they face a personal crisis or following terrorist attacks.

The researchers compared the language used by each volunteer with the expression in their white blood cells of 50 genes known to be influenced by adversity. They found that the volunteers’ use of function words predicted gene expression significantly better than self-reports of stress, depression and anxiety.

People with more stressed-out gene-expression signatures tended to talk less overall. But they used more adverbs such as 'really' or 'incredibly'. These words may act as “emotional intensifiers”, says Mehl, signifying a higher state of arousal. They were also less likely to use third-person plural pronouns, such as 'they' or 'their'. That makes sense too, he says, because when people are under threat, they may focus less on others and the outside world.

He cautions that more research is needed to test these specific effects, and to assess whether stress influences language, or vice versa. But he suggests that the approach could ultimately help to identify people at risk of developing stress-related disease. Doctors may need to “listen beyond the content” of what patients tell them, he says, “to the way it is expressed”.

Cole suggests that assessing language use could help to test whether interventions aimed at reducing stress really work. Perhaps “you could even ditch self-report stress measures”, he says, and instead listen passively to how trial participants speak.

“Language reflects how people connect with their world, but who would ever have thought that gene expression would be related to language?” says James

Pennebaker, a psychologist at the University of Texas, Austin, who has pioneered research on language and social processes (and has previously worked with Mehl). “It’s such an exciting new way of thinking,” he adds. “I was blown away.”

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Nature
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Comments

Comments

There are currently no comments.

Nature News

周二, 21 11月 2017

Nature News

[周二, 21 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Exoplanet hunters rethink search for alien life** [周一, 20 11月 08:00]
  Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.
- **UK government announces research-spending hike ahead of budget** [周一, 20 11月 08:00]
  Pledge to raise country's public research funding to £12.5 billion in 2021–22.
- **Giant telescope’s mobile-phone ‘dead zones’ rile South African residents** [周五, 17 11月 08:00]
  Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.
- **Sex matters in experiments on party drug — in mice** [周五, 17 11月 08:00]
  Ketamine lifts rodents' mood only if administered by male researchers.
- **Arecibo telescope wins reprieve from US government** [周四, 16 11月 08:00]
  National Science Foundation will look for partners to provide extra financial support for Puerto Rico facility.
- **Improved diagnostics fail to halt the rise of tuberculosis** [周四, 16 11月 08:00]
  TB remains a big killer despite the development of a better test for detecting the disease.
- **What countries' constitutions reveal about how societies evolve** [周四, 16 11月 08:00]
  Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.
- **Europe sets priorities for hunting cosmic particles** [周四, 16 11月 08:00]
  Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.
- **Hazy skies cool down Pluto** [周三, 15 11月 08:00]
  Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.

- **African scientists get their own open-access publishing platform** [周三, 15 11月 08:00]
  Venture will launch next year and seeks to strengthen continent’s science by helping academics share work more quickly.
- **Puerto Rico struggles to assess hurricane’s health effects** [周三, 15 11月 08:00]
  While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.
- **Bioethics: Justice in genomics** [周三, 15 11月 08:00]
  Rosario Isasi examines a study on the societal impact of grand sequencing projects.
- **Economics: How science got a golden ticket** [周三, 15 11月 08:00]
  Ehsan Masood hails an account of the mixed implications of governments valuing research as an investment.
- **Computer science: Visionary of virtual reality** [周三, 15 11月 08:00]
  Aldo Faisal explores the immersive journey of technology pioneer Jaron Lanier.
- **China fires up next-generation neutron-science facility** [周二, 14 11月 08:00]
  Beam generator puts country in elite company for doing experiments in materials science and other fields.
- **High-jumping beetle inspires agile robots** [周一, 13 11月 08:00]
  Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.
- **Race for quantum supremacy hits theoretical quagmire** [周一, 13 11月 08:00]
  It’s far from obvious how to tell whether a quantum computer can outperform a classical one, says Philip Ball.
- **Archaeologists say human-evolution study used stolen bone** [周一, 13 11月 08:00]
  Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.
- **Lab mice's ancestral ‘Eve’ gets her genome sequenced** [周一, 13 11月 08:00]
  Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.
- **World’s carbon emissions set to spike by 2% in 2017** [周一, 13 11月 08:00]
  Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.

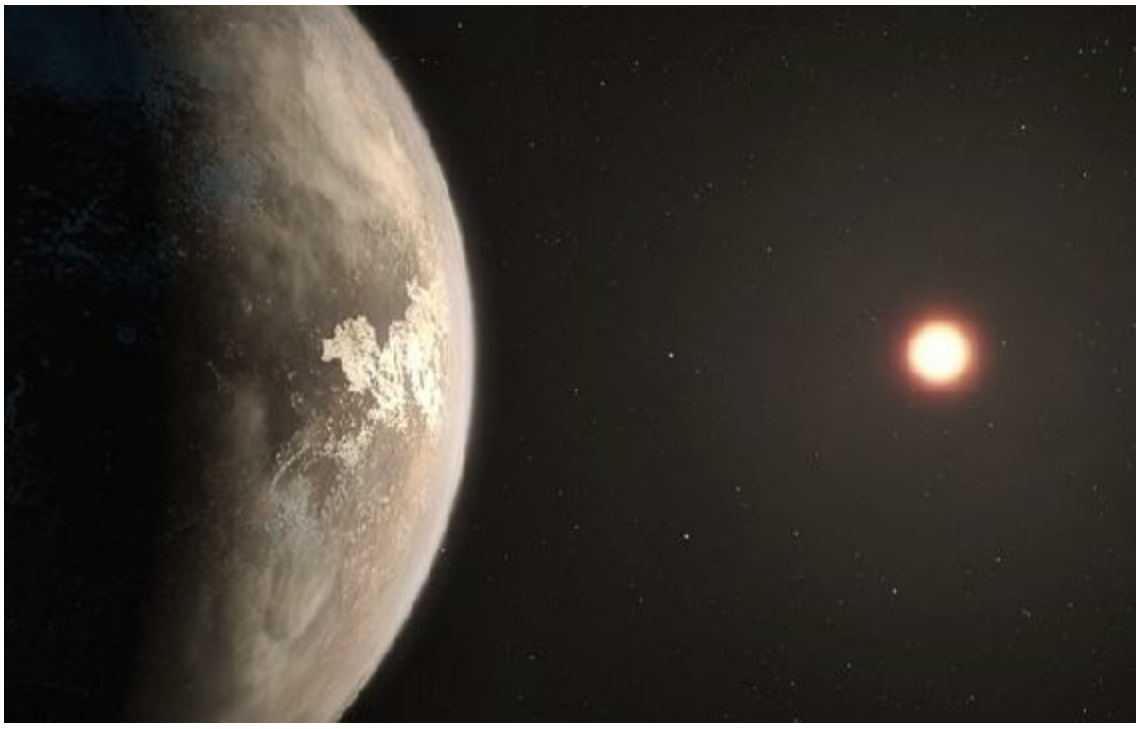
Exoplanet hunters rethink search for alien life

Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.

20 November 2017 Corrected:

1. 20 November 2017

Laramie, Wyoming



M. Kornmesser/ESO

The exoplanet Ross 128b orbits a cool dwarf star at a distance that could allov the world to have liquid water.

Steve Desch can see the future of exoplanet research, and it's not pretty. Imagine, he says, that astronomers use NASA's upcoming James Webb Space Telescope to scour the atmosphere of an Earth-mass world for signs of life. Then imagine that they chase hints of atmospheric oxygen for years — before realizing that those were false positives produced by geological activity instead of living things.

Desch, an astrophysicist at Arizona State University in Tempe, and other planet hunters met from 13-17 November in Laramie, Wyoming, to plot better ways to scout for life beyond Earth. Many are starting to argue that the standard definition of habitability — having liquid water on a planet's surface — is not the factor that should guide exoplanet exploration. Instead, the scientists say, the field should focus on the chances of detecting alien life, should it exist.

"Planets can be habitable and not have life with any impact," Desch told researchers at the meeting.

It turns out that water worlds may be some of the worst places to look for living things. One study presented at the meeting shows how a planet covered in oceans could be starved of phosphorus, a nutrient without which earthly life cannot thrive. Other work concludes that a planet swamped in even deeper water would be geologically dead, lacking any of the planetary processes that nurture life on Earth.

"Habitability is not only about finding the signature of an alien life form taking a deep breath," says Elizabeth Tasker, an astronomer and exoplanet researcher at the Japan Aerospace Exploration Agency's Institute for Space and Aeronautical Sciences in Sagamihara. It's also about how a planet's geology and chemistry interconnect to create a welcoming or hostile environment, she says — complicating the search for extraterrestrial life.

Surf and turf

Astronomers have catalogued thousands of exoplanets, of which more than a dozen are potentially habitable. The most recent, announced on 15

November, is Ross 128b, which is 3.4 parsecs (11 light years) away from Earth. It resembles the target that scientists have spent decades hunting: an Earth-sized planet orbiting a nearby star, probably at the right distance to allow liquid water.

Most of these planets have some qualities that stop them from being true Earth twins. Ross 128b orbits a cool dwarf star rather than a Sun-like host, for instance. But Tasker says the usual metrics that scientists use to rank how habitable a world is, such as its location relative to its star or how closely it resembles Earth, are misguided[1].

To figure out how to parcel out valuable observing time, some scientists suggest targeting planets that, like Earth, are thought to have a mix of ocean and land. That's because worlds with nothing but water on their surfaces may not have key nutrients available in forms that can support life — if it is based on the same chemistry as life on Earth.

“We have this stereotype that if we have oceans, we have life,” says Tessa Fisher, a microbial ecologist at Arizona State. But her recent work contradicts this idea. Fisher and her colleagues studied what would happen on an “aqua planet” with a surface that is almost or completely covered by enough water to fill Earth’s oceans five times.

On Earth, rainwater hitting rocks washes phosphorus and other nutrients into the oceans. But without any exposed land, there is no way for phosphorus to enrich water on an aqua planet over time, Fisher reported at the Laramie meeting. There would be no ocean organisms, such as plankton, to build up oxygen in the planet’s atmosphere, she says — making this type of world a terrible place to find life.

Wet blanket

The wettest planets would run into a different sort of trouble, says Cayman Unterborn, a geologist at Arizona State who analysed the planet-wide effects of having as much as 50 Earth oceans’ worth of water. The sheer weight of all that liquid would exert so much pressure on the sea floor that the planet’s

interior would not melt at all, Unterborn found.

Planets need at least some internal melting to sustain geological activity, such as plate tectonics, and to provide the right geochemical environment for life. In this case, Unterborn says, “too much water is too much of a good thing.”

Water-rich worlds are easy to make. Many planets are likely to have formed far from their parent star, Tasker says, in chilly temperatures where they could have coalesced from fragments of rock and lots of ice. If such a planet later migrated closer to its star, the ice would melt and cover the surface in vast oceans. Some of the seven small planets orbiting the star TRAPPIST-1, which is 12.6 parsecs (41 light years) from Earth, are thought to have substantial water on their surfaces[2].

Instead of instinctively studying such water worlds, Tasker says, astronomers need to think more deeply about how planets have evolved through time. “We need to look carefully at picking the right planet,” she says.

The James Webb Space Telescope is set to launch in 2019. Once in space, the telescope will spend much of its time studying potentially Earth-like worlds. Researchers have already begun to analyse how oxygen, methane or other ‘biosignature’ gases in exoplanet atmospheres might appear to the telescope’s view[3].

Towards the end of the Laramie meeting, attendees voted on whether scientists will find evidence of life on an exoplanet by 2040. They were not optimistic: 47 said no and 29 said yes. But a greater share was willing to bet that life would be found on another world in the 2050s or 2060s.

That's presumably enough time to work through the debate over which worlds are the best to target.

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Nature
DOI:
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Corrections

Corrected:

> This story misstated the outcome of the vote at the Laramie meeting as 47% no to 29% yes. In fact, the result was 47 votes yes, 29 votes no.

Comments

Comments

There are currently no comments.

UK government announces research-spending hike ahead of budget

Pledge to raise country's public research funding to £12.5 billion in 2021–22.

20 November 2017

The UK government seems to be making good on its promises to significantly increase research spending over the next decade.

In an announcement on 20 November, the government said that it would boost public spending on research and development (R&D;) to £12.5 billion (US$16.5 billion) in 2021–22, an increase of £500 million on what is already planned for the year before. The rise builds on a surprise announcement made last year, when politicians promised yearly increases in research funding until 2020.

According to the London-based Campaign for Science and Engineering (CASE), the increase puts the United Kingdom on track to hit a government target to raise combined public and private spending on R&D; to 2.4% of gross domestic product (GDP) by 2027.

That would be a huge uptick in spending for Britain: the most recent figures show that the country spent just 1.7% of its GDP on R&D; in 2015, compared with 2.9% in Germany and 2.8% in the United States.

Hitting the target will also require private investment on R&D; to rise, and some researchers had wondered whether the UK would rely on private spending to boost its budget past 2020. But writing in *The Times* newspaper to accompany the annoucement — which comes two days before the UK's annual budget is released — UK Prime Minister Theresa May confirmed that

the government planned to increase its public investment in R&D; year on year.

“This gives confidence that the government’s plan is to keep rising public R&D; investment on target over the next ten years to reach parity with our international competitors,” said Sarah Main, director of CASE. “We seem to have turned a corner. Government is matching its long-term ambition with concrete investment.”

The latest money forms part of the government’s Industrial Strategy, a range of policies aimed at boosting the economy across the country. Full details of the strategy will be published on 27 November, but May added in her article that it would include ways to encourage UK leadership in artificial intelligence, big data, clean energy and self-driving cars.

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Comments

Comments

There are currently no comments.

Giant telescope’s mobile-phone ‘dead zones’ rile South African residents

Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.

17 November 2017

Mujahid Safodien/AFP/Getty

South Africa has already built prototype dishes that will form part of the Square Kilometre Array, which will be the world’s largest radio telescope.

A map showing how mobile-phone use might be restricted because of a giant

radio telescope in South Africa has angered people who will live near the instrument — deepening a rift between the local farming community and those backing the project.

The row has arisen over the South African portion of the Square Kilometre Array (SKA), which will eventually consist of thousands of radio dishes in Africa and up to a million antennas in Australia. The array, which begins construction in 2019 for completion in the 2030s, will have a total signal-collecting area of more than 1 square kilometre, making it the world's largest radio telescope. The telescope's first phase in South Africa involves 194 radio dishes, to be laid out like a galaxy with three arms spiralling out from a core cluster.

Local residents in the Northern Cape province, where the government has acquired nearly 1,400 square kilometres of land for the initial phase, have already expressed concerns about the telescope. Some are angry that the SKA won't boost the region's economy as much as they had expected; others fear the land acquisition will damage local agricultural activity — in particular, sheep farming.

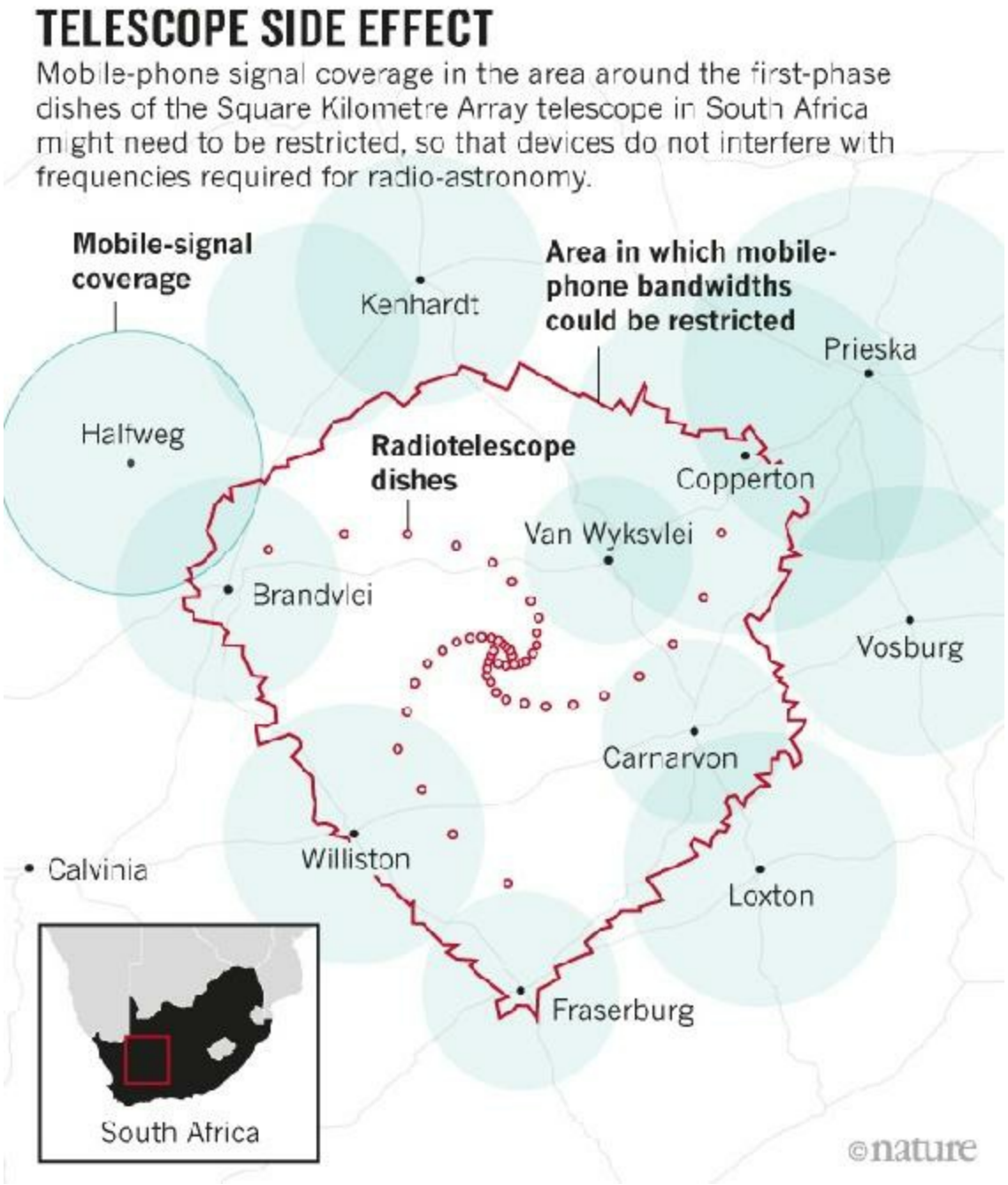
But the map of projected mobile-phone coverage around the project, uploaded to Facebook on 2 November, has brought to light another problem facing the local community. It shows the area around the SKA's radio dishes where the use of electronic devices will eventually be restricted, because their signals would interfere with the relatively weak radio signals that the dishes will try to pick up from the distant Universe.

Communications problem

Nearby residents had been aware that mobile-reception 'dead zones' could be a side effect of the SKA. But Eric Torr, a light-aircraft-business owner who uploaded the map, says it shows the area affected is "larger than we were led to believe". The map suggests that six towns fall into the dead zone, he says, and that this could have serious implications for their farming economies.

The map was produced by the South African Radio Astronomy Observatory

(SARAO), which is leading the SKA project in South Africa. Lorenzo Raynard, head of communications at the SARAO, says it shows areas where mobile-phone coverage could be reduced by 20% or more (see ‘Telescope side effect’). The chart was part of a presentation calling on businesses to submit alternative communications solutions for affected areas, he says.



Adapted from SARAO map

An informal collection of farming organizations has already been working with the observatory to find alternative communications technologies, such as satellite phones, that can be used around the antennas, according to Henning Myburgh, a farmer in the area. “Adequate electronic communications, especially for children, are a basic human right,” he says. Myburgh says that the cooperative’s search has now moved to finding cell-phone technologies that can co-exist with the SKA and replicate the phone facilities the farmers currently have. “This is a major shift and if possible will be a huge step forward,” he says.

Still, says Myburgh, there are farmers who are unhappy. “I don't think that anybody will ever be happy with the situation, taking into account the massively intrusive nature of the project in the region,” he says.

Nicol Jacobs, who farms in the spiral arms, says the SKA was originally going to affect only two farms. He says he found out about the full extent of the telescope when the government began buying more farms. “We’re going to be eaten piece by piece,” he says. Jacobs says he would like the government to return the bought farms to the agricultural community: “I will fight as long as I can,” he adds.

Despite residents’ annoyance, South African law says that the country’s science and technology minister can preserve the area of the SKA’s land for astronomy. The department of science and technology, which oversees astronomy in the country, is responsible for finalizing regulations about areas that will lose mobile-phone coverage, and to define radio-wave frequencies that will be protected for astronomy. Asked when they would be finalized, the department’s astronomy-management authority declined to give a firm date.

Environmental assessment

Although resident’s complaints may not affect the SKA’s layout, an environmental assessment — due to be finalized next year — could change matters.

Earlier this month, the SARAO tasked the South African Environmental Observation Network to implement an environmental assessment of the telescope site, and made 3 million rand (US$209,000) available for the work.

“The relative position of the dishes determines the quality of the telescope beam,” says Robert Braun, science director at SKA Organisation, which is designing the telescope.

The organization has drawn up an ideal map of dish positions, says Braun. But it might have to shift them if the environmental assessment finds that local habitats or biomes are affected, says Casper Crous, an ecologist who is part of the assessment collaboration.

The overarching plan is to turn South Africa’s SKA site into a nature reserve and a site for long-term environmental research once the telescope is operational, says Crous. So a no-go zone for dishes, for example, “would be kokerboom [quiver tree] populations or ephemeral wetlands — areas that if impacted are unlikely to ever recover,” he says.

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Comments

Comments

There are currently no comments.

Sex matters in experiments on party drug — in mice

Ketamine lifts rodents' mood only if administered by male researchers.

17 November 2017

unoL/Getty

When it comes to lab mice and antidepressants, it's complicated.

Mouse experiments with the popular club drug ketamine may be skewed by the sex of the researcher performing them, a study suggests.

The findings, presented on 14 November at the Society for Neuroscience (SfN) meeting in Washington DC, only deepen the mystery of how ketamine,

which has powerful mood-lifting properties, interacts with the brain. They also raise questions about the reproducibility of behavioural experiments in mice.

Ketamine is best known as a psychoactive recreational drug. But it has caught psychiatrists' interest because of its potential to treat depression within hours. It's unclear exactly how the drug works, however, and many researchers are using animal models to suss out the mechanism.

Polymnia Georgiou, a neuroscientist at the University of Maryland in Baltimore, is one of them. In 2015, a male colleague asked her to run some experiments for him while he was out of town, including a standard way of testing antidepressants called the forced-swim test. In this assay, researchers inject healthy mice with a drug, place them into a tank of water and measure how long they swim before they give up and wait for someone to rescue them.

Antidepressants can cause healthy mice to swim for longer than their untreated counterparts, which is what Georgiou's male colleague found during his experiments using ketamine.

Scents and the brain

But although Georgiou followed his protocol exactly, she found that treated mice did not swim for any longer than mice injected with a placebo. When she and three female and four male researchers investigated this disconnect by performing the experiments, they discovered that the ketamine acted as an antidepressant only when it was administered by men.

Suspecting that scent was involved, the researchers put the animals inside a fume hood so that the mice couldn't smell who was injecting them. This completely eliminated the effect of the ketamine, regardless of the experimenter's sex. When Georgiou and her colleagues placed a t-shirt worn by a man next to the mice in the fume hood, mice injected with ketamine swam for longer than those injected with a placebo. This suggested that male odour was necessary for the drug to work.

The head of Georgiou's lab, neuroscientist Todd Gould, learned that antidepressant researcher Ronald Duman at Yale University in New Haven, Connecticut, was seeing similar effects with female researchers in his lab that were working on ketamine experiments. So Gould asked Duman to repeat Georgiou's swim-test experiment in his own lab. When eight male and eight female researchers injected mice with ketamine, they saw the same results: mice injected by women did not respond to the drug.

Georgiou and her colleagues repeated the experiments with other antidepressants, but the researchers' sex didn't seem to matter. She and Gould suspect that the antidepressant effect is the result of a specific interaction between ketamine and the male odour in the mouse brain .

But other evidence suggests that the sex of the researcher can affect other types of behavioural experiment, not just those involving ketamine. A 2014 paper[1] in *Nature Methods* found that mice were more stressed and less likely to respond to pain when handled by a male researcher. And behavioural neuroscientist Silvana Chiavegatto of the University of São Paulo in Brazil, who was at Georgiou's SfN presentation, says that she has seen the same phenomenon in her lab, where she studies depression but doesn't use ketamine.

Rethinking the model

"I think it's really fascinating, with wide implications for our field," says Adrienne Betz, a behavioural neuroscientist at Quinnipiac University in Hamden, Connecticut. But she cautions that the results are preliminary, and it remains to be seen whether the effect is specific to ketamine and to mice.

Others disagree about the potential implications. Hundreds of papers with female experimenters demonstrate the effects of antidepressants — including ketamine — in mice, says Lisa Monteggia, a neuroscientist at the University of Texas Southwestern in Dallas. Other factors, such as whether the researcher is stressed when he or she injects the mice, might affect the animals' behaviour, she says.

Gould and Georgiou say that their results don’t necessarily invalidate previous studies; they simply show that ketamine experiments in their lab work only when men inject the mice. There is overwhelming evidence that ketamine is a powerful antidepressant in humans. Gould doubts that the sex of the person administering the drug affects how well it works in a depressed patient, but it's never been tested.

He adds that the findings suggest that researchers studying drugs' effects on mouse behaviour should report the sex of the experimenter in their publications to ensure that other labs can replicate the results. “There are a number of factors that influence replicability and are unrecognized — this is one of them,” Gould says. “For us, it is an inconvenient truth.”

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Comments

Comments

There are currently no comments.

Arecibo telescope wins reprieve from US government

National Science Foundation will look for partners to provide extra financial support for Puerto Rico facility.

16 November 2017 Updated:

1. 17 November 2017

Xavier Garcia/Bloomberg/Getty

The massive dish of the Arecibo radio telescope measures 305 metres across.

Nearly two months after Hurricane Maria devastated Puerto Rico, the people

who operate one of the world's pre-eminent radio telescopes — at the Arecibo Observatory, on the northwestern part of the island — are still without reliable water, electricity and phone service at their homes. But their jobs seem to be safe.

The US National Science Foundation (NSF), which funds about two-thirds of the observatory's annual US$12-million budget, has decided to continue operating it in collaboration with as-yet-to-be-decided partners. Over the next 5 years, the agency will reduce its annual contribution from $8.2 million to $2 million, with the rest coming from the unspecified partner institutions.

"This is very good news for the Arecibo Observatory and a huge win for the scientific community in general," says Francisco Córdova, the observatory's director. "There is definitely a sense of relief in the air."

The decision comes as part of the NSF's years-long effort to offload several of its astronomical research facilities to free up millions of dollars each year for future projects, such as the Large Synoptic Survey Telescope that is under construction in Chile.

"We have worked very hard to help bring Arecibo to a state where we still have cutting-edge research there, but with NSF not having to make the same investment that we've made historically," says James Ulvestad, acting assistant director for the agency's mathematical- and physical-sciences directorate.

The current management contract at the observatory will expire on 31 March 2018. Earlier this year, the NSF asked potential partners to come forward with ideas and funding offers to keep science operations going. Now, having made its commitment to continue funding the observatory official, the NSF can move forward with negotiating a collaboration agreement and revealing who its partners will be.

"I'm so happy they made the right decision," says Edgard Rivera-Valentín, a planetary scientist who works jointly at the observatory and the Lunar and Planetary Institute in Houston, Texas. "I'm so happy the observatory stays alive."

Slow recovery

The agency's decision is a welcome reprieve for the roughly 120 Arecibo staff who have suffered and rallied in Maria's wake. Hurricane-force winds blasted Puerto Rico on 20 September, downing power lines and damaging buildings across the island. Torrential rains washed out roads and knocked out water supplies.

At the observatory, which is nestled into the limestone mountains above the city of Arecibo, some of the staff sheltered in place during the worst of Maria. The observatory's concrete bunkers, built by the US government in 1963, weathered the storm with little problem. Still, Maria's winds tore down the 29-metre-long 'line feed' antenna that stretched across the observatory's 305-metre-wide dish, puncturing its aluminium skin in places.

Staff went to work helping to clear roads around the region, and government officials used the observatory's helipad as a distribution point for supplies. The facility's deep well supplied hundreds of local residents who had no other source of clean drinking water.

Within weeks, the Arecibo dish was cleaned up and back to doing science. On 29 September, it resumed taking observations, in a low-power mode that lets the sky drift across the field of view; on 7 November, it resumed pointing the dish at specific areas of the sky. The telescope has already observed a fast radio burst, one of a new class of astronomical phenomena that Arecibo is well suited to study with its enormous dish. Last week, the observing schedule expanded to include work at additional radio frequencies, Córdova says.

But telescope operations are still running off generators, and diesel is a precious commodity on the island, says Nicholas White, senior vice-president for science at the Universities Space Research Association in Columbia, Maryland, which helps to manage the observatory. "That's the biggest constraint — just getting back on the grid," he says.

Without a reliable power supply, the observatory cannot restart its planetary radar, which tracks and characterizes near-Earth asteroids. NASA supplies

$3.7 million — about one-third of Arecibo's budget — for this work.

The NSF estimates that it will take between $4 million and $8 million to fix the hurricane damage at the observatory, Ulvestad says. The agency "intends to repair Arecibo to its pre-hurricane condition", he says.

A long history

The NSF decision makes Arecibo the first of the agency's astronomical facilities to have completed a full environmental-impact review of its operations, with an eye towards divestment. The agency is working through a similar process to potentially divorce itself from the Green Bank Observatory in West Virginia, home to the world's premiere single-dish radio telescope, and several other observatories.

Arecibo occupies a unique place in the history of radio astronomy. On 16 November 1974, it beamed the most powerful intentional message ever sent in the hope of contacting extraterrestrial life. In the same year, it was used in the discovery of the first known binary pulsar, whose change in orbital period provided the first indirect evidence for gravitational waves — the ripples in space-time predicted by Albert Einstein.

"People have been telling us for five years: 'You guys are just out to close Arecibo,'" says Ulvestad. "This is a demonstration that that was not what we were ever out to do."

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Updates

Updated:

Added comments from Francisco Córdova.

Comments

Comments

There are currently no comments.

Improved diagnostics fail to halt the rise of tuberculosis

TB remains a big killer despite the development of a better test for detecting the disease.

16 November 2017 Corrected:

1. 17 November 2017

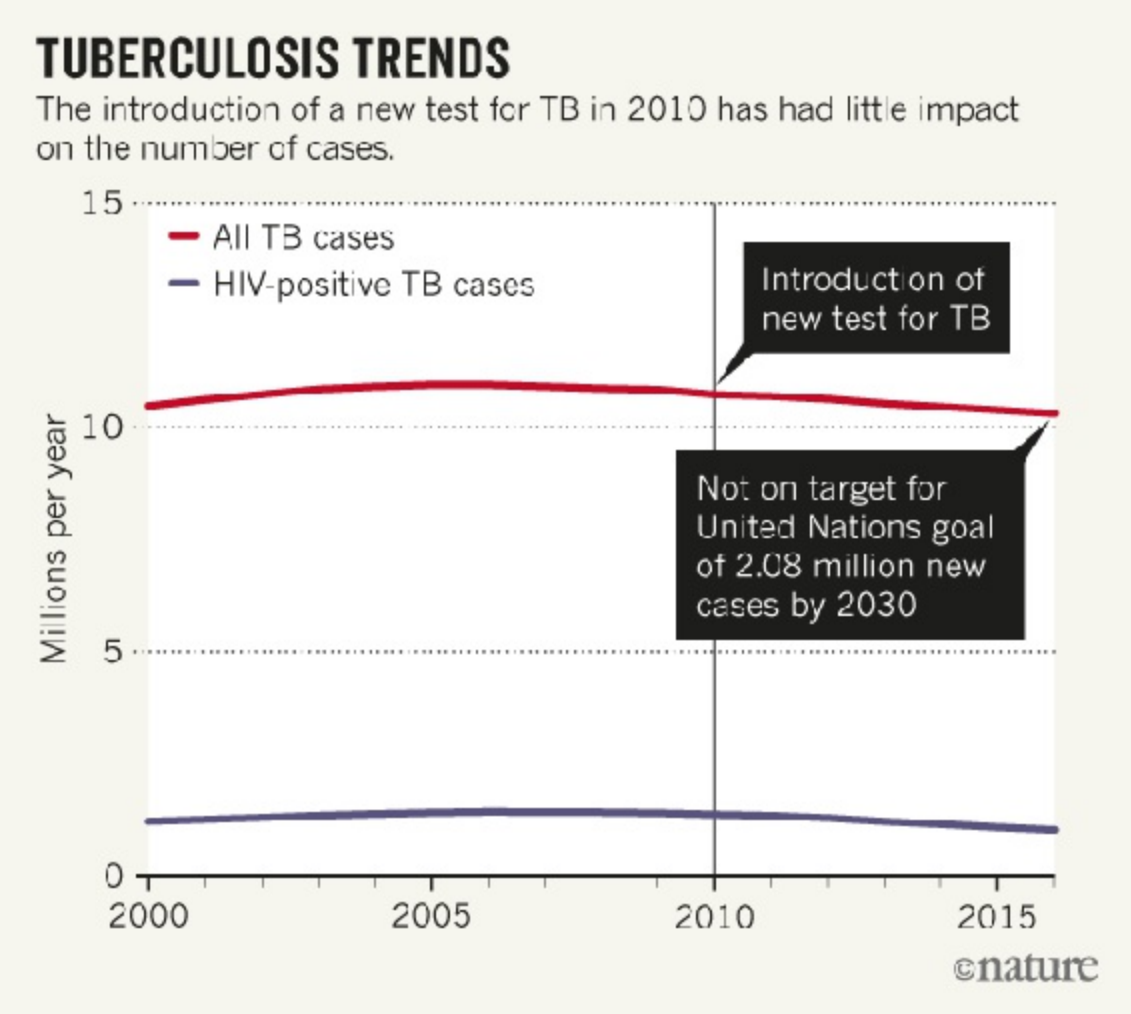
Beawiharta/Reuters

Newly diagnosed tuberculosis patients are treated at a clinic in Jakarta, Indonesia.

Seven years ago, the global community of researchers, health-care workers and activists battling tuberculosis was euphoric. A landmark 2010 trial showed that a new genetic test was highly effective at diagnosing TB, prompting hopes that countries could soon finally control the disease, which killed 1.45 million that year. The World Health Organization (WHO), promptly endorsed the test, called GeneXpert, and promoted its roll-out around the globe to replace a microscope-based test that missed half of all cases.

But the high hopes have since crashed as rates of tuberculosis rates have not fallen dramatically, and nations are now looking to address the problems that cause so many TB cases to be missed and the difficulties in treating those who are diagnosed. In an attempt to turn the tide, health ministers and officials from 100 countries are meeting in Moscow on 16–17 November. And a United Nations General Assembly devoted to TB is scheduled for September 2018. Experts say that the rollout of GeneXpert offers a cautionary lesson — although, in hindsight, an obvious one — in the battle against TB. The tale is a familiar one in global health care: a solution that seems extraordinarily promising in the lab or clinical trials falters when deployed in the struggling health-care systems of developing and middle-income countries.

“What GeneXpert has taught us in TB is that inserting one new tool into a system that isn’t working overall is not going to by itself be a game changer. We need more investment in health systems,” says Erica Lessem, deputy executive director at the Treatment Action Group, an activist organization in New York City.



Source: WHO

No game changer

Some 10.4 million people were infected with TB last year, according to a WHO report published on 30 October. More than half of the cases occurred in China, India, Indonesia, Pakistan and the Philippines. The infection, which causes coughing, weight loss and chest pain, often goes undiagnosed for months or years, spurring transmission. The US government and others spent more than US$100 million developing GeneXpert. Yet despite the WHO's ringing 2010 endorsement of the test, the roll-out of GeneXpert, which is manufactured by Cepheid, a company based in Sunnyvale, California (and

bought by Danaher, headquartered in Washington DC, earlier this year), was initially slow.

The machines cost $17,000 each and require constant electricity and air-conditioning — infrastructure that is not widely available in the TB clinics of countries with a high incidence of the disease, requiring the machines to be placed in central facilities. Until the US government together with the Bill & Melinda Gates Foundation and UNITAID, an international organization that aims to lower drug prices, began subsidizing tests in 2012, each cost $16.86 (the price fell to $9.98), compared with a few dollars for a microscope TB test.

Weak health systems

The WHO says that more than 23 million GeneXpert tests have now been purchased in the public sector in 130 countries that are eligible for the discount. But Madhukar Pai, an epidemiologist at McGill University in Montreal, Canada, says that this still represents a relatively small proportion of people suspected of having TB. Most countries use the tests on selected group of people, Pai says. India, for example, offers the test only to people co-infected with HIV.

Even countries that fully embraced GeneXpert are not seeing the returns they had hoped for. After a countrywide roll-out begun in 2011, the test is available for all suspected TB cases in South Africa. But a randomized clinical trial conducted in 2015 during the roll-out found that people diagnosed using GeneXpert were just as likely to die from TB as those diagnosed at labs still using the microscope test[1]. “Just intuitively one would think that finding TB cases earlier would avert TB deaths. The fact that we didn’t find that was surprising,” says Gavin Churchyard, a physician specializing in TB at the Aurum Institute in Johannesburg, South Africa, who led the study. Similar studies in other countries have come to much the same conclusion about GeneXpert.

Churchyard suspects that doctors have been giving people with TB-like symptoms drugs, even if their microscope test was negative or missing, and

that this helps to explain why his team found no benefit from implementing the GeneXpert test. Others have speculated that, by being involved in a clinical trial, patients in both arms of the trial received better care than they would otherwise have done, obfuscating any differences between the groups.

Either way, Churchyard says, his team's study illustrates how broken South Africa's TB treatment system is, a problem echoed across other countries with high incidences of TB. Even with accurate tests, cases are still being missed. Results from the GeneXpert tests take just as long to deliver as microscope tests, and many people never return to the clinic to get their results and drugs; those who begin antibiotics often do not complete the regimen. "What the study really unmasked was that it's not enough to have new technology and introduce it into a weak health system," Churchyard says.

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Corrections

Corrected:

An earlier version of this story have the wrong citation for the 2015 trial.

Comments

Comments

There are currently no comments.

What countries' constitutions reveal about how societies evolve

Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.

16 November 2017

Bettmann/Getty

The right to form unions usually came before child labour protections in a country's constitution.

Timing can be everything when it comes to successfully expanding constitutional rights. Now, a study[1] looking at how constitutions around the world have evolved has revealed patterns that could help people predict the best moment to introduce such changes.

Amendments are generally introduced into a country's constitution in a certain sequence, the authors report in a paper on the preprint server arXiv, and now under review at a journal. In addition, their computer analyses corroborate previously proposed ideas that the addition of some provisions is heavily influenced by the zeitgeist — the dominant social mores of the time — whereas the adoption of others reflects a country's colonial history.

The study validates computational techniques that could be applied to pressing questions about how constitutions reflect and affect societies, says Mila Versteeg, a legal scholar at the University of Virginia in Charlottesville. "These methods might be able to move the ball if applied to the right questions," she says.

Organizations and advocates could use the results to push for policies in a more strategic way, say the paper's authors. "This can be seen as a road map to help get you to where you want to be," says lead researcher Alex Rutherford, a data scientist who was working at the United Nations children's agency UNICEF in New York City when the study was conducted.

The ties that bind

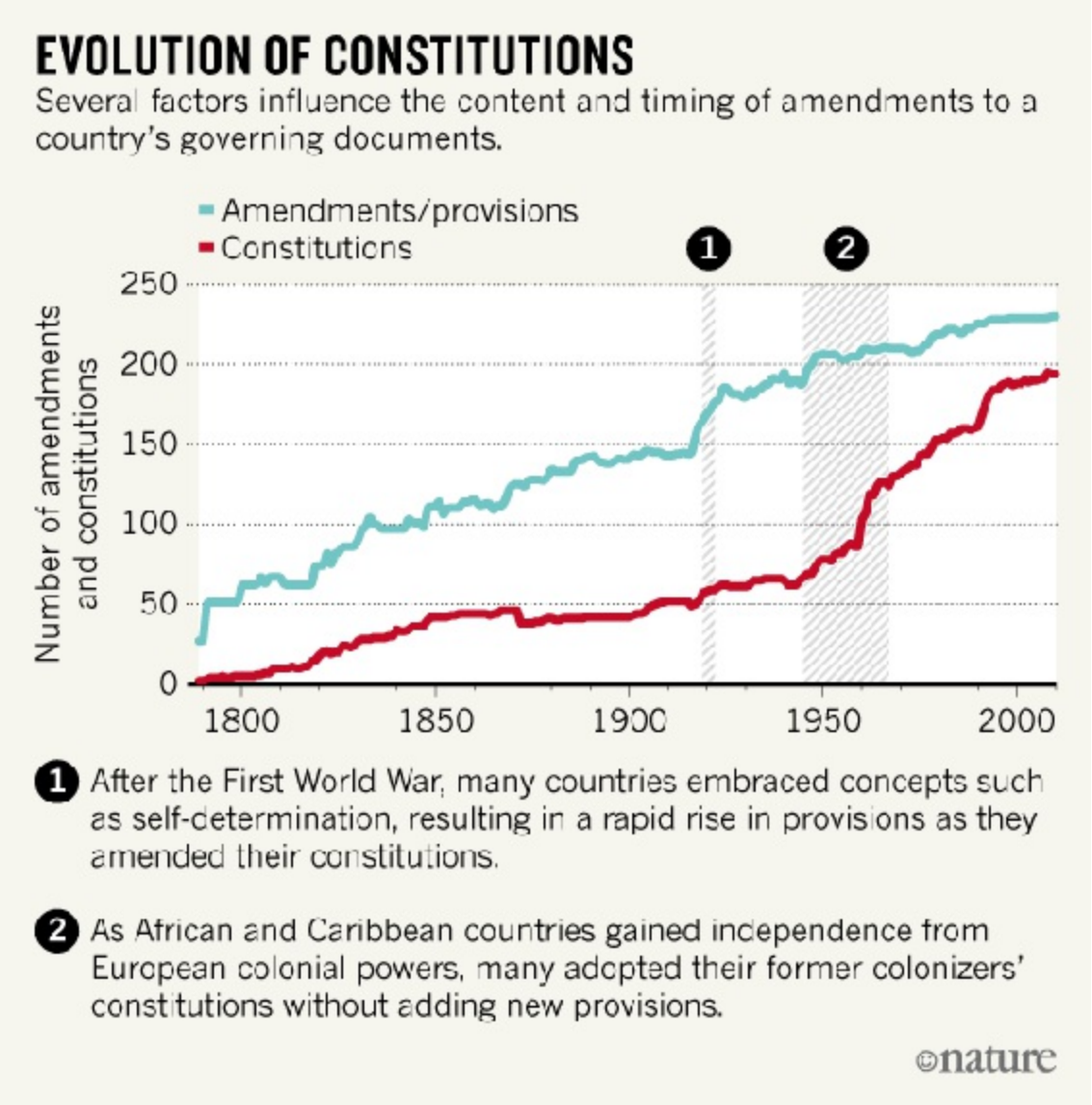
Rutherford and his colleagues used two kinds of computer analyses to look for patterns in provisions from the constitutions of 194 countries. In one, using hand-coded text, they found that the number of provisions increased over time (see 'Evolution of constitutions'). Moreover, the team found that provisions generally appeared in a particular order. Making education compulsory, for example, was usually preceded by the establishment of a right to a free education.

Some of the sequences were less straightforward: the right to form trade unions preceded laws against child labour, for example. This progression

probably reflects the identities of the people who have traditionally scripted constitutions, says Rutherford. Adult men, for instance, seem to have considered their own protections before thinking about others, including those who were unable to push for their own rights, he says. “I think we should protect the most vulnerable first, but this paper says this is not how laws have progressed historically.”

The team then performed a network analysis to identify words that the constitutions had in common and to detect how they grouped together. In some cases, with fundamental provisions such as freedom of religion, clusters included countries that had the same former colonizers.

Meanwhile, amendments such as those prohibiting torture or protecting the environment tended to emerge at specific points in time, regardless of a country’s colonial history. “If you draft a constitution now, you’d be more likely to include a clause on the environment than you would 20 years ago, since we didn’t know much about what was going on back then,” says Rutherford.



Source: REF. 1

Seeds of the future

Constitutional specialists say the team's timeline of provisions seems to be new. "It makes intuitive sense, but I don't think anyone had tried to show it empirically," says David Law, a political scientist at Washington University in St Louis, Missouri. The indexed data that Rutherford and his colleagues used came from the Comparative Constitutions Project, a US-based non-

profit organization partnered with Google. The project hand-codes constitutional texts by turning the words into zeroes and ones.

The credibility of the network approach is boosted by the fact that the analysis of constitutional language came to similar conclusions as previous, less-automated studies. Versteeg suggests that network analysis might next be applied to questions such as what sorts of rights are not well enforced, and whether constitutions can yield subtle clues signalling that a democracy is in decline.

To get at the latter query, Versteeg suggests analysing constitutional texts from democratic countries that have altered their constitutions and become increasingly authoritarian — such as Hungary and Turkey — to find language that gives a ruler more power. Next, researchers could search for these signatures in other countries, such as the United States. “Could we tell when added rights are actually red flags bearing the signs of authoritarianism?” Versteeg asks.

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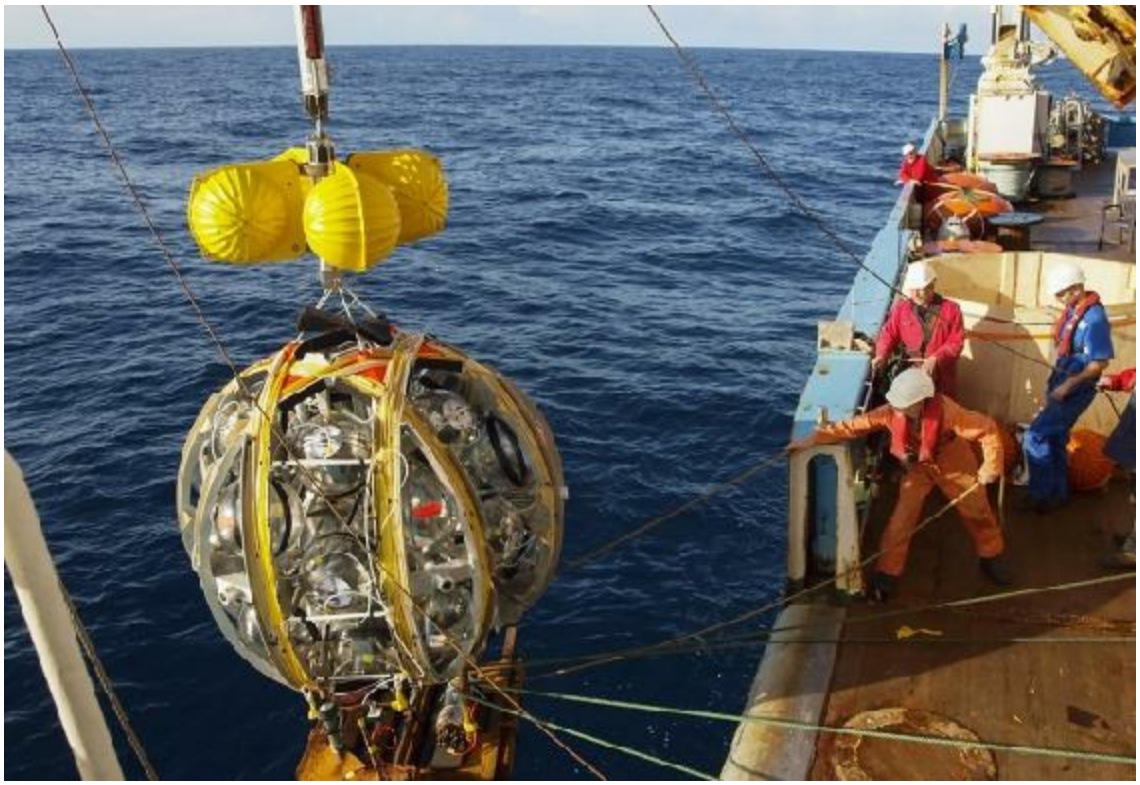
Comments

Commenting is currently unavailable.

Europe sets priorities for hunting cosmic particles

Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.

16 November 2017



KM3NeT

The KM3NeT neutrino telescope is deploying arrays of light sensors deep in the Mediterranean Sea.

Neutrinos, dark matter and γ-rays top European physicists' wish list for the next decade of efforts to catch high-energy particles from space. The

priorities are laid out in a roadmap for 2017–26, posted online last month by a group of funding agencies from fourteen European countries, ahead of being officially unveiled in January.

Twenty years ago, the field of astroparticle physics barely existed. But some of the major discoveries in particle physics — including neutrino research that earned Nobel prizes in 2002 and 2015 — are now coming from space-focused detectors, rather than through the more conventional venue of atom smashers. It's a field that ties together the largest and smallest scales of physics, says Antonio Masiero, a physicist at the University of Padua, Italy, from the expansion of the Universe to exotic types of nuclear decay: “The beauty of astroparticle physics is that it has no borders.”

The roadmap is the second such exercise by the Astroparticle Physics European Consortium (APPEC), which aims to coordinate funding plans for this fast-growing field. (CERN — Europe’s physics lab near Geneva, Switzerland — the European Southern Observatory and the European Space Agency do this for the continent’s particle-physics, astronomy and space-based facilities, respectively.) APPEC requested input from across the community, and held an open ‘town meeting’ in Paris in April 2016 before a panel of experts, chaired by Masiero, compiled the final document.

Infrastructure ideals

The resulting strategy covers huge observatories all the way down to tabletop experiments. At smaller scales, it urges funding agencies to be open to innovative proposals. But when it comes to the largest facilities, the strategy is to be “resource aware”, says Masiero: focusing on only a few projects and requiring only a modest increase over current funding levels. It’s not a “Santa Claus list”, agrees Frank Linde, a particle physicist at the Dutch National Institute for Subatomic Physics in Amsterdam and former APPEC chair.

Among the big projects endorsed by APPEC is the Cubic Kilometre Neutrino Telescope (KM3NeT), a double array of deep-sea light sensors being built by a primarily Dutch, French and Italian collaboration. One site, off the coast of Toulon, France, is designed to detect relatively low-energy neutrinos

produced by cosmic rays hitting the atmosphere, whereas the other, off the southern tip of Sicily, Italy, will aim to catch the signature of the highest-energy neutrinos coming from outer space, after they have travelled through Earth. Researchers hope to figure out where these particles come from.

So far, KM3NeT has received one third of the approximately €150 million (US$177 million) in funding it would need for building the full-size detector, says spokesperson Mauro Taiuti, a physicist at the University of Genoa, Italy. The APPEC stamp of approval could help it to win the rest.

Another major piece of infrastructure that garnered support was the Cherenkov Array Telescope, a €300-million γ-ray observatory to be split between Spain's La Palma Island and Paranal, in Chile's Atacama Desert. The two arrays of optical telescopes will seek flashes of blue light produced in the atmosphere when a high-energy photon collides with a molecule of air, creating a cascade of secondary particles across the sky.

In the nascent field of gravitational-wave astronomy, which APPEC also covers, the big priority is the Einstein Telescope (ET), a next-generation triple interferometer that will have light beams running along three 10-kilometre arms in an equilateral triangle, instead of the two perpendicular arms that current detectors use. Like the Japanese interferometer KAGRA — now under construction — the proposed ET would be built underground, to protect it from vibrations ranging from footsteps to falling leaves, says B. S. Sathyaprakash, a physicist at Pennsylvania State University in University Park, who helped to design it.

Dark-matter dash

APPEC also wants Europe to double-down on existing efforts to spot dark matter, calling for a dramatic scale-up of experiments that use tanks of liquid argon and xenon, to look for traces of collisions between these mysterious particles and atoms of ordinary matter. The largest such detectors now contain more than three tonnes of the noble gases, but according to the roadmap they need to be ten times larger.

These searches bet on the theory that dark matter is composed of weakly interacting massive particles, or WIMPs. Some physicists have called for more investment in ‘alternative’ searches for dark matter, for example, looking for particles known as axions. The road map is a “vanilla document, clearly redacted not to ruffle any feathers”, says Juan Collar, a physicist at the University of Chicago in Illinois. “If European programme managers follow this roadmap to the letter, they will turn the dark-matter field into a desert of ideas.”

But Mario Livio, an astrophysicist at the University of Nevada in Las Vegas who has also called for broadening the search for dark matter, counters that concentrating efforts on WIMPs will allow Europe “to build on existing experience and facilities”. Overall, the roadmap is “very reasonable”, he adds. “The programme, if executed as envisioned, will address some of the most exciting questions in astroparticle physics.”

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Comments

1 comment

1. *Pentcho Valev* • 2017-11-16 09:24 PM
   It seems dark matter is the unfortunate result of theoretical impotence: Cosmologists are unable to calculate the rotational curve for a system ESSENTIALLY different from our solar system, e.g. a spiral galaxy, take the solar-system rotational curve as a paradigm and fill the gap between theory and observation with dark matter. Similarly, cosmologists don't know how to model the local interaction between expansion and gravitational attraction (any such model would produce results incompatible with observations) and implicitly obey the following idiotic slogan: Wherever there is gravitational attraction, forget about expansion! Sabine Hossenfelder: "The solution of general relativity that

describes the expanding universe is a solution on average; it is good only on very large distances. But the solutions that describe galaxies are different - and just don't expand. It's not that galaxies expand unnoticeably, they just don't. The full solution, then, is both stitched together: Expanding space between non-expanding galaxies."
https://www.forbes.com/sites/startswithabang/2017/07/28/most-things-dont-actually-expand-in-an-expanding-universe/ Pentcho Valev

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Hazy skies cool down Pluto

Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.

15 November 2017

NASA/JHU-APL/SwRI

The temperature of Pluto's atmosphere is only about 70 degrees Celsius above absolute zero.

Pluto’s atmosphere is even more bone-chillingly cold than one might expect 5 billion kilometres from the Sun. New research suggests that’s because of the smog that envelops the dwarf planet.

“Haze is responsible for all the atmospheric cooling,” says Xi Zhang, a planetary scientist at the University of California in Santa Cruz. He and his colleagues describe the findings in the 16 November issue of *Nature*[1].

When NASA's New Horizons spacecraft flew past Pluto in July 2015, it discovered that the atmosphere was about -203 ºC, just 70 degrees above absolute zero[2]. That's around 30 degrees colder than predicted — and a big mystery to planetary scientists.

Figuring out how Pluto's atmosphere works is crucial for understanding atmospheres on other large icy worlds in the Solar System and beyond. "Until we know the reason for the cold temperatures, we can't extrapolate to other seasons on Pluto, much less other bodies," says Leslie Young, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, who was not involved in the study.

Smog blanket

Pluto's atmosphere is made mostly of nitrogen, with smaller amounts of compounds such as methane. High in the atmosphere — between 500 and 1,000 kilometres above the surface — sunlight triggers chemical reactions that transform some of these gases into solid hydrocarbon particles.

The particles then drift downward and, at around 350 kilometres above Pluto's surface, clump with others to form long chemical chains. By the time they reach 200 kilometres' altitude, the particles have transformed into thick layers of haze, which the New Horizons spacecraft saw dramatically blanketing Pluto.

Zhang and his colleagues compared the heating and cooling effects of the atmosphere's gas molecules to those of its haze particles. Earlier studies have suggested that the presence of gas molecules, such as hydrogen cyanide, could help explain why Pluto's atmosphere is so cold[3]. But Zhang's team found that including haze was the only way to get their model to match the temperatures that New Horizons measured as it flew by the dwarf planet.

"The fundamental difference is the size," Zhang says. Molecules are typically less than a nanometre across, whereas the haze particles are several hundred nanometres across. That means that the gas and the haze behave very differently in the way they absorb and re-radiate energy from the Sun. Haze

turns out to both heat up and cool down more efficiently than gas, Zhang says.

“It is a neat idea,” says Sarah Hörst, a planetary scientist at Johns Hopkins University in Baltimore, Maryland.

Scientists probably hadn't thought about haze as the cooling culprit before because the haze layers do not block light, says Tanguy Bertrand, a planetary scientist at the Laboratory for Dynamic Meteorology in Paris who has studied Pluto's atmosphere with his colleague François Forget[4]. “I find this study very convincing,” Bertrand says.

Competing ideas

But other researchers have proposed different ideas about why Pluto’s atmosphere is so cold. Roger Yelle, a planetary scientist at the University of Arizona in Tucson, reported one such approach at a conference in Latvia in September. His team’s model suggests that a combination of hydrogen cyanide, acetylene and ethane gas can cool things down. All three gases are known to exist in Pluto’s atmosphere.

Zhang’s team and Yelle’s team have yet to reconcile their contradictory conclusions. But after it launches in 2019, NASA’s James Webb Space Telescope could test Zhang's proposal. If the haze particles are indeed the main factor cooling Pluto’s atmosphere, they would make the dwarf planet appear relatively bright in mid-infrared wavelengths. Zhang hopes to observe Pluto with the Webb telescope to see if his team is right.

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Comments

Comments

There are currently no comments.

African scientists get their own open-access publishing platform

Venture will launch next year and seeks to strengthen continent's science by helping academics share work more quickly.

15 November 2017

Africa's academy of science has announced that it will launch an open-access publishing platform early next year — the first of its kind aimed exclusively at scientists on the continent.

The platform, called *AAS Open Research* and announced by the African Academy of Sciences (AAS) in Nairobi on 15 November, is being created with the London-based open-access publisher F1000, adopting the model of its *F1000Research* publishing platform. *AAS Open Research* will publish articles, research protocols, data sets and code, usually within days of submission and before peer review. F1000 staff will arrange post-publication peer review: the reviews and the names of their authors will be published alongside the papers. The papers will be indexed in abstract databases such as PubMed only after they pass review.

The AAS says that the platform will be especially useful for young African academics, who can face difficulties publishing in overseas journals. Some studies suggest[1] that research from low-income countries is perceived differently from that done in high-income ones, for instance. The portal will cut the time and effort scientists have to put into finding homes for their work, and will make the review process more transparent, the academy says.

Although there are already open-access publishers that focus on Africa, such as AOSIS Publishing, based in South Africa, *AAS Open Research* will be the first to adopt open peer review.

The new platform does carry a caveat, however: it will initially take submissions only from AAS fellows and affiliates (who together number around 400), as well as researchers funded through programmes managed by the Alliance for Accelerating Excellence in Africa. The Nairobi-based body manages grants for African research programmes that come from international funders, mostly targeting health research but also areas such as climate change.

Limiting eligibility to the platform is critical to ensure that submissions are of high quality, says AAS executive director Nelson Torto. Researchers who meet the initial criteria have already been vetted and selected through a rigorous grant-review process, he says. In future, to open up the platform to more researchers, the academy wants to partner with other African research funders whose selection processes are similarly rigorous, Torto adds.

Following a trend

The African venture follows a series of open publishing portals launched with F1000 in the past 18 months, including those set up by the Wellcome Trust in London and the Bill & Melinda Gates Foundation in Seattle, Washington — both large charities that fund scientific research. Research centres including the UCL Great Ormond Street Institute of Child Health and the Montreal Neurological Institute and Hospital in Canada have also teamed up with the firm; the European Commission is considering creating its own open publishing platform for outputs from its main Horizon 2020 research programme.

The AAS will not itself be covering the costs of publishing on the platform. Rather, the academy says, African researchers' grant funders will pay publishing fees directly to F1000: £120–800 (US$160–1,100) per article, depending on length.

Some scientists have raised concerns that publishing on open-research platforms might stop African academics from getting the recognition needed for career advancement that they receive for publishing in conventional journals. In South Africa, for instance, academics are rewarded for publishing

in a list of titles maintained by the country's higher-education department.

"For open publishing to be successful, it will need to be accompanied by changes in the criteria for academic recognition and promotion within African institutions of higher learning," says Salim Abdool Karim, an HIV researcher and AAS fellow in Durban, South Africa.

The risk of publishing on little-known platforms is a concern, agrees Gordon Awandare, a biochemist at the University of Ghana in Accra who will be eligible to publish on *AAS Open Research*. However, the AAS platform will help to chip away at the grip of the big journals, says Awandare, which will be good for African science. "Our approach has always been to spread our research across several platforms, so we will continue to do that."

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doi:10.1038/nature.2017.23018

Comments

1 comment

1. *PROF CHUKWUEMEKA CH AGBAKWURU* • 2017-11-16 06:15 PM
   The African Scientists Open-Access Publishing Platform is a very welcomed innovation to give African Researcher (International & National) the much needed opportunity of making worthwhile intellectual contributions to African and World Development through publishing of their research studies.
   www.mastercomputeragency.net

Puerto Rico struggles to assess hurricane’s health effects

While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.

15 November 2017

Mario Tama/Getty

Hurricane Maria, which hit Puerto Rico in mid-September, disrupted water supplies in some areas.

Nightfall sets a hard deadline for a team of public-health researchers in Puerto Rico. Since Hurricane Maria hit on 20 September, leaving large swathes of the island without a reliable power supply, the scientists have

rushed home each night to avoid being in the streets after dark. Many lack running water, and most have limited telephone access.

Yet the team —– co-led by José Cordero of the University of Georgia in Athens — has managed to contact several hundred women to begin assessing whether Hurricane Maria has worsened drinking-water contamination, stress and infectious disease that could harm developing fetuses. This wasn't what the researchers set out to study six years ago when they started a project to assess the impact of pollution on pre-term births. But Cordero's team is one of several research groups have scrambled to quantify Hurricane Maria's immediate health impacts, even as team members struggle to fulfil their own basic needs.

The devastation that Cordero saw on a recent visit to Puerto Rico, his birthplace, shocked him. "I thought I was prepared, but I wasn't," he says.

Even before the hurricane, the island's 18 'Superfund' sites — areas so polluted that the US Environmental Protection Agency deems them hazardous to human health or the environment — posed a potential risk to pregnant women, says Ingrid Padilla, an environmental engineer at the University of Puerto Rico at Mayagüez. Twelve of these sites sit on karst, a geological formation made of porous rock that allows toxic chemicals to flow down from the surface into groundwater.

Padilla's previous research suggests that flooding and other disturbances can quickly bring toxic substances in groundwater back to the surface, and carry them into the water supply. Now, she and her colleagues are collecting hair and blood samples from the research cohort to determine whether pregnant women are being exposed to hazardous chemicals, such as phthalates and chloroform. Since the hurricane hit, the researchers have begun to collect and test groundwater from karst regions and tap water from the homes of people living there.

Other research teams are worried that water that has pooled in hurricane debris could provide a breeding ground for disease-carrying mosquitoes. At the height of the Zika epidemic in 2016, experts debated whether a massive hurricane would destroy mosquito habitat or enhance it, says Carmen Zorrilla, an obstetrician and gynaecologist at the University of Puerto Rico in

San Juan. The evidence is still unclear, she says, and logistical problems may make it impossible for researchers to gather enough data to provide answers.

In some areas where hospitals faced extensive storm damage, the only medical care available is emergency treatment. Screening for the Zika virus is a low priority, and infected adults rarely experience severe symptoms and are unlikely to seek medical treatment.

There are also few labs on the island that can test samples for Zika and other mosquito-borne diseases. Like many Puerto Rican facilities, the US Centers for Disease Control and Prevention (CDC) dengue lab in San Juan lost power during the hurricane and was closed for a week. Diesel generators kept its freezers running to preserve blood and other biological samples, but the lab is still running on generator power and is behind on testing some samples. Shipping delays destroyed reagents that the lab had ordered, since the chemicals were not kept consistently cold during transport.

Lab director Stephen Waterman says that the CDC is collecting data on the incidence of mosquito-borne disease and other hurricane impacts. But its priority is to help US government workers and local communities recognize mosquito breeding grounds, and to provide technical help on efforts to control the spread of the insects. Agency staff would also like to verify reports that leptospirosis — a waterborne bacterial disease that is spread by rats — has sickened dozens of people. “We’re focused on preventing disease,” Waterman says.

Yet the ruined facilities and lack of power continue to tax public-health workers’ ability to know where hazards lie. Take the numerous diesel generators running on the island, which produce visible plumes of grey smoke. Benjamin Bolaños, a microbiologist at the University of Puerto Rico in San Juan, worries that these emissions could harm people with respiratory illnesses, but that the effect will be difficult to quantify. “We are blind because probably the [air quality] monitors were destroyed by the hurricane,” he says.

This makes the prospect of more months without reliable power even more frightening. "The kind of work we’re doing is not because it would be interesting to do,” Cordero says. “It has to be done now because a few years

from now, it’s too late.”

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Comments

Comments

There are currently no comments.

China fires up next-generation neutron-science facility

Beam generator puts country in elite company for doing experiments in materials science and other fields.

14 November 2017

Jin Liwang/Xinhua via ZUMAPRESS

Engineers work on an instrument at the China Spallation Neutron Source in Dongguan.

China is revving up its next-generation neutron generator and will soon start experiments there. That will lift the country into a select group of nations with facilities that produce intense neutron beams to study the structure of

materials.

The China Spallation Neutron Source (CSNS) in Dongguan, a 2.2-billion-yuan (US$331-million) centre, will allow the country's growing pool of top-notch physicists and material scientists, along with international collaborators, to compete in multiple physics and engineering fields. Its designers also hope that the facility will lead to commercial products and applications ranging from batteries and bridges to aeroplane engines and cancer therapy.

"It is not only a big step forward for Chinese scientists, but also a significant event for the international scientist community," says Wang Xun-Li, a physicist at the City University of Hong Kong who has been involved in planning the facility.

Beam bombardment

Spallation neutron sources produce neutrons by slamming protons onto a metal target — CSNS uses tungsten. They are more cost effective and safer than other methods, which use nuclear reactors to produce neutron beams. As neutrons have no charge, they can penetrate materials more easily than some other probing methods, and they are more sensitive to light elements such as hydrogen, making them useful for evaluating candidate materials for fuel cells. Similar facilities exist only in the United Kingdom, United States, Japan and Switzerland, and one is under construction in Sweden.

Fujio Maekawa, a specialist in neutron sources at the Japan Proton Accelerator Research Complex in Tokaimura, says that although the CSNS delivers neutrons at a lower density than other spallation sources — which means that experiments will take longer — a planned upgrade will bring it in line with other facilities. And given their scarcity, "neutron users around the world always welcome new sources", he says.

The CSNS will have capacity to host 20 beam lines, supplying as many instruments. Preliminary tests of its first three instruments began on 1 November. "Neutrons arrived at the samples as expected," says Wang

Fangwei, head of the neutron-science division at CSNS. Although debugging might take a couple of years, he expects the instruments to be calibrated and ready for initial experiments by the end of 2017.

Chinese physicists are eager to use the facility to analyse the underlying magnetic properties of materials, an area in which the country has significant experience. Wang Xun-Li says that several planned instruments will give scientists the chance to move to the forefront of fields such as the physics of skyrmions — vortex-like excitations in magnetic materials — and high-temperature superconductivity. “There are a whole bunch of early- to mid-career scientists who are hungry to use the facility for studying magnetism,” says Wang Xun-Li.

Global appeal

Wang Xun-Li thinks that the latest facility will encourage Chinese researchers to remain in the country instead of pursuing careers elsewhere. “In the past, it was common to see Chinese scientists go abroad for these kinds of studies,” he says.

The facility’s first instruments are also attracting international researchers. German material scientist Frank Klose says that the CSNS was a major factor when he and material scientist Christine Rehm, his wife, decided to join the new Guangdong Technion Israel Institute of Technology in Shantou, 400 kilometres east of Dongguan. Klose’s research focuses on designing data-storage devices and sensors that could be used in hydrogen-powered cars. He helped design one of the facility's instruments to investigate the magnetic properties of spintronic devices, which take advantage of the spin of electrons to store data.

But scientists contacted by *Nature* have raised concerns about CSNS’s location, saying that Dongguan lacks services and infrastructure, such as schools and universities, that will persuade top scientists and their families to move there. “I believe CSNS is suffering from a lack of first-grade scientists who actually are based in Dongguan,” says a researcher familiar with the facility, who asked for anonymity because of the sensitivity of the issue.

Potential users have also expressed some frustration that only 3 instruments will be ready this year, despite the facility’s capacity to host 20.

But more instruments are already being built. Shenzhen's government is funding two that are expected to be ready by the end of 2019, including one designed to model high-pressure environments, such as the Earth's core. Mao Ho-Kwang, a geophysicist at the Carnegie Institution for Science in Washington DC, is keen to use it to simulate what happens to materials in high-pressure conditions. “The CSNS instruments will be a great asset for Earth, environmental and energy science, as well as physics, chemistry and material science,” says Mao. “I am very excited, and the whole neutron community is getting very excited too”.

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Comments

Commenting is currently unavailable.

High-jumping beetle inspires agile robots

Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.

13 November 2017

Brian L. Stauffer

Click beetles have a hinged body that can propel them to great heights.

A beetle that can launch itself spectacularly into the air after falling on its back — flipping right side up without having to use its legs — could inspire a new generation of smart robots.

Imagine a rescue robot vaulting its way through a disaster zone riddled with obstacles, or a planetary robot extricating itself from an unexpected tumble on Mars. Each might use a trick or two learnt from the click beetles, a family of insects with the unique ability to catapult themselves out of trouble.

“A lot of robots out there jump using their legs,” says Aimy Wissa, a mechanical engineer at the University of Illinois in Urbana-Champaign. “What’s unique about this is if something breaks, you can still jump without legs and get out of the situation.”

Wissa and her Illinois colleagues, led by mechanical-engineering graduate student Ophelia Bolmin, described the mechanics of jumping click beetles on 7 November at a meeting of the Entomological Society of America in Denver, Colorado. They published early results in the proceedings of a bio-inspired robotics conference in July[1].

So far, the scientists have studied how click beetles manage to store and hold the energy needed to launch themselves into the air. They hope to soon start building prototype machines designed after the beetles.

Snap to it

There are about 10,000 species of click beetles around the world. The insect’s head and body are connected by a hinge that the beetle can slowly arch and then suddenly snap in the opposite direction, jack-knifing its body and sending it into the air with an audible ‘click’. Earlier work has shown that the beetles launch nearly vertically before somersaulting through the air[2].

Ophelia Bolmin/University of Illinois at Urbana-Champaign

Click beetles can launch themselves up with surprising force.

If the beetle lands on its back, it just does the same manoeuvre again. Compare that to an upended ladybird — also known as a ladybug — which has to wiggle around on its back until it manages to roll over far enough and get traction with its legs to flip itself over.

The Illinois team wanted to analyse how the click beetles pull off their acrobatic feat. “We thought we could look at, how do they really jump, how is that energy being released?” says Marianne Alleyne, an entomologist on the team.

Students measured the dimensions of dozens of beetles of four species (*Alaus oculatus*, *Ampedus nigricollis*, *Ampedus linteus* and *Melanotus* spp.), videotaped their jumps with high-speed cameras and analysed the energy required for the beetles to pull the hinge back and then release it. Muscles alone are not enough, because they contract relatively slowly, and so other body parts such as tendons must also be involved, the team says.

How high?

The researchers also measured the force drop as the hinge snapped shut, confirming that it corresponded to the click as the beetle begin to soar skyward. They are now analysing the energies involved as beetles of different sizes make the jump. Click beetles can range from just a few millimetres to a few centimetres long; early results suggest that the bigger the beetle, the higher it can jump, Wissa says.

Other engineers have developed a range of agile robots that can jump using their legs — including one inspired by the Senegal bushbaby (*Galago senegalensis*), which has the highest vertical jumping ability of any animal[3]. Compared with crawling, jumping is a fast and efficient way for small robots to get around obstacles, says Mark Cutkosky, a mechanical engineer at Stanford University in California.

The advantage of the beetle approach is that something could go wrong with the robot's legs, and it could still get out of its predicament, Wissa says. "It simplifies the design a lot."

Any robots inspired by the click beetle would probably have to be quite small — perhaps a few tens of grams, says Gal Ribak, a biomechanics specialist at Tel Aviv University who has studied the beetles' jumps[4]. "Otherwise, the jumping mechanism will require too much energy to lift the body into the air, and the repeated impacts at take-off and landing would result in mechanical damage," he says.

But those constraints might not apply to robots exploring planets other than Earth. On worlds with lower gravity, beetle-like robots could fly high.

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Comments

Comments

There are currently no comments.

Richard
Haughton

Race for quantum supremacy hits theoretical quagmire

It’s far from obvious how to tell whether a quantum computer can outperform a classical one, says Philip Ball.

13 November 2017 Corrected:

1. 14 November 2017

Quantum supremacy might sound ominously like the denouement of the *Terminator* movie franchise, or a misguided political movement. In fact, it denotes the stage at which the capabilities of a quantum computer exceed those of any available classical computer. The term, coined in 2012 by quantum theorist John Preskill at the California Institute of Technology, Pasadena[1], has gained cachet because this point seems imminent. According to various quantum-computing proponents, it could happen before the end of the year.

But does the concept of quantum supremacy make sense? A moment’s thought reveals many problems. By what measure should a quantum computer be judged to outperform a classical one? For solving which

problem? And how would anyone know the quantum computer has succeeded, if they can’t check with a classical one?

Computer scientists and engineers are rather more phlegmatic about the notion of quantum supremacy than excited commentators who foresee an impending quantum takeover of information technology. They see it not as an abrupt boundary but as a symbolic gesture: a conceptual tool on which to peg a discussion of the differences between the two methods of computation. And, perhaps, a neat advertising slogan.

IBM Research

An IBM cryostat wired for a 50-qubit system.

Magic number

Quantum computers manipulate bits of information according to the quantum rules that govern the behaviour of matter on the smallest scales. In this quantum world, information can be coded as quantum bits (qubits), physically composed of objects that represent binary 1s and 0s as quantum states. By keeping the qubits in a coherent quantum superposition of states –

so that in effect their settings are correlated, rather than being independent as in the bits (transistors) of classical computer circuitry – it becomes possible to carry out some computations much more efficiently, and thus faster, with far fewer (qu)bits, than on classical computers.

Both IBM and Google have already developed prototype quantum-computing devices. IBM has made a 5-qubit device available for public use as a cloud-based resource and on 10 November it announced that it had made a 20-qubit device available for commercial users. Its computer scientists also reported on the same day that they had successfully tested a 50-qubit circuit. Google, too, is developing devices with 49–50 qubits on which its researchers hope to demonstrate quantum supremacy by the end of this year[2].

How could anyone know, though, that a quantum computer is genuinely doing something that is impossible for a classical one to do – rather than that they just haven't yet found a classical algorithm that is clever enough to do the job? This is what makes quantum supremacy a theoretically interesting challenge: are there classes of problem for which it can be rigorously shown that quantum computing can do what classical cannot?

Among the favourite candidates are so-called sampling problems, in which in-effect random bits are transformed into bits that come from a predefined distribution. The Google team in Santa Barbara, California, led by John Martinis, has described an experimental procedure for implementing such a sampling scheme on a quantum computer, and has argued that at the 50-qubit level it could show quantum supremacy[2].

Because of this paper, 50 qubits has become something of an iconic number. That's why a recent preprint[3] from Edwin Pednault and co-workers at IBM's Thomas J. Watson Research Center in Yorktown Heights, New York, showing how, with enough ingenuity, some 49-qubit problems can be simulated classically, has been interpreted in some news reports as a challenge to Google's aim to demonstrate quantum supremacy with only 50 qubits.

It's all about depth

But it's not really that. Quantum-computing experts are now finding themselves obliged to repeat a constant refrain: it's not just about the number of qubits. One of the main measures of the power of a quantum circuit is its so-called depth: in effect, how many logical operations ('gates') can be implemented in a system of qubits before their coherence decays, at which point errors proliferate and further computation becomes impossible. How the qubits are connected also matters. So the true measure of the power of a quantum circuit is a combination of factors, which IBM researchers have called the "quantum volume".

This means that the extent to which a quantum-computational task is challenging to perform classically depends also on the algorithmic depth, not just on how many qubits you have to throw at it. Martinis says that the IBM paper is concerned only with small-depth problems, so it's not so surprising that a classical solution still exists at the 49-qubit level. "We at Google are well aware that small-depth circuits are easier to classically compute", he says. "It is an issue we covered in our original paper."

Scott Aaronson, a computer scientist at the Massachusetts Institute of Technology, agrees that the IBM work doesn't obviously put quantum supremacy further out of reach. "It is an excellent paper, which sets a new record for the classical simulation of generic quantum circuits," he writes – but "it does not undercut the rationale for quantum supremacy experiments."

Indeed, he says, the truth is almost the opposite: the paper shows that it's "possible to simulate 49-qubit circuits using a classical computer, [which] is a precondition for Google's planned quantum supremacy experiment, because it's the only way we know to check such an experiment's results." In essence, the IBM paper shows how to verify the quantum result right up to the edge of what is feasible – so computer scientists and engineers can be confident that things are OK when they go beyond it. The goal, Aaronson says, can be likened to "get[ting] as far as you can up the mountain, conditioned on people still being able to see you from the base."

These views seem to sit comfortably with the IBM team's own perspective on their work. "I think the appropriate conclusion to draw from the simulation methods we have developed is that quantum supremacy should properly be viewed as a matter of degree, and not as an absolute threshold,"

says Pednault. “I, along with others, prefer to use the term ‘quantum advantage’ to emphasize this perspective.”

Theorist Jay Gambetta at IBM agrees that for such reasons, quantum supremacy might not mean very much. “I don’t believe that quantum supremacy represents a magical milestone that we will reach and declare victory,” he says. “I see these ‘supremacy’ experiments more as a set of benchmarking experiments to help develop quantum devices.”

In any event, demonstrating quantum supremacy, says Pednault, “should not be misconstrued as the definitive moment when quantum computing will do something useful for economic and societal impact. There is still a lot of science and hard work to do.”

Which, of course, is just applied science as normal. The idea of quantum supremacy sets a nice theoretical puzzle, but says little about what quantum computers might ultimately do for society.

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Corrections

Corrected:

An earlier version of this story erroneously stated that IBM had created a 20-qubit device for public use. It is available only for commercial users, however IBM does have a 5-qubit device for public use.

Comments

Commenting is currently unavailable.

Archaeologists say human-evolution study used stolen bone

Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.

13 November 2017 Updated:

1. 13 November 2017

Marc Steinmetz

The Untermassfeld site in Germany has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago.

Serious concerns have surfaced about three research papers claiming evidence for one of the earliest human occupations of Europe.

In an extraordinary letter posted to the bioRxiv.org preprint server on 31 October[1], archaeologists allege that the papers, published in 2013, 2016 and 2017, included material of questionable provenance, and that results reported in the 2016 paper were based on at least one stolen bone. Editors at the journals concerned have now published expressions of concern about the papers.

There is no suggestion that the authors of those papers were involved in theft, but the researchers behind the letter say they are concerned that appropriate questions regarding the provenance of the material appear not to have been asked. They also reject the authors' conclusion that a German site known for animal remains was also home to hominins, ancient relatives of humans, 1 million years ago. The authors have denied the allegations and say they stand by their conclusion.

The letter was initiated by archaeologist Wil Roebroeks at Leiden University in the Netherlands, and Ralf-Dietrich Kahlke, a palaeontologist and head of the Senckenberg Research Station of Quaternary Palaeontology in Weimar, Germany, who leads excavations at Untermassfeld, a fossil site about 150 kilometres northeast of Frankfurt. Their preprint describes repeated disappearances of bones from Untermassfeld, as well as fossils delivered in anonymous packages. The authors of the disputed papers insist, however, that they analysed independent collections of bones and stones, and reject the suggestion that any of it was stolen.

Untermassfeld, which has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago, holds the most complete record of northern European wildlife from this time period. But since yearly excavations began in the late 1970s, no hominin bones or signs of occupation have been found, says Kahlke. Hominins first settled in southern Europe around 800,000 to 1 million years ago, most archaeologists agree, and expanded farther north only sporadically until around 500,000 years ago.

Uncertain origins

One of the first claims that hominins lived near Untermassfeld more than 1 million years ago appeared in a 2013 paper in the journal *Quaternary International*, which contended that rocks from the site resembled stone tools[2]. In a 2016 *Journal of Human Evolution* paper[3], two of the original paper's authors, Günter Landeck at the North Hessian Society of Prehistory and Archeology of the Medieval in Bad Hersfeld, Germany, and Joan Garcia Garriga at the Universitat Oberta de Catalunya in Barcelona, concluded that marks on animal bones from Untermassfeld were made by humans. In 2017, Landeck and Garcia Garriga published further analysis of the bones in another *Quaternary International* paper[4].

There is no suggestion that the other co-authors of the 2013 paper had any connection with the material from Untermassfeld. And after this article was published, Garcia Garriga contacted *Nature* to say that he, also, did not have connections with the material; he said that Landeck had done the analysis, while he himself helped in discussing data and writing up its archaeological implications.

In their papers, Landeck and Garcia Garriga attributed the material, along with hundreds of rock fragments of limestone and chert, to “the Schleusingen collection”, which they stated was recovered by a biology teacher in the late 1970s and early 1980s.

Kahlke says he is personally unaware of a Schleusingen collection and questions whether the material was collected at this time. Rocks like those described in the papers can be found in the vicinity of the site, but he says that animal fossils are concentrated in a small area that has been under excavation since 1978. No other research teams had permission to excavate the site during that time, Kahlke says. But he says that material was routinely stolen from the site — which he reported to the police, most recently in 2012 — until the site and fossil bed were better secured. There is no suggestion that Landeck and Garcia Garriga were involved in these thefts.

Ralf-Dietrich Kahlke

Researchers excavating at Untermassfeld allege that part of a deer bone protruding from the sediment on 28 May 2009 (in box, left) had disappeared several days later.

One fossil that Kahlke considers suspicious is a right limb-bone fragment from an extinct species of fallow deer, described in Landeck and Garcia Garriga's 2016 *Journal of Human Evolution* paper. Kahlke says that the bone in the paper seems to match a piece of deer bone that thieves broke from a larger chunk of sediment at Untermassfeld, leaving part of the bone behind. The bone fragment is present in a photograph taken on 28 May 2009, and missing in a photograph taken several days later. A rhinoceros limb fragment that disappeared from the site in 2012 also closely resembles a fossil described in the 2016 paper, Kahlke says.

Case unsolved

Deepening the mystery, a deer bone fragment was among a jumble of bones and rocks in two packages sent anonymously to a museum near Untermassfeld in March 2014. Ralf Werneburg, a palaeontologist and director of the Natural History Museum Schloss Bertholdsburg in Schleusingen, Germany, recognized the material as originating from Untermassfeld and contacted Kahlke.

Ralf-Dietrich Kahlke

An anonymous package sent to a museum in Schleusingen contained a deer bone fragment (lower bone), which appears to match a fragment left behind (upper bone) after a theft from the Untermassfeld site in 2009. (The fragments are shown pieced together in the view on the far-right).

In Kahlke's opinion, the returned deer bone fragment is the one described in the 2016 paper, and matches up with the piece left behind after the 2009 theft**.** He says that the sixty-three other bone fragments in the packages also closely resemble some of the fossils described in the 2016 paper (the rhinoceros limb bone was not among them), and 11 rock fragments resemble

artefacts in the 2013 *Quaternary International* paper.

Roebroeks and Kahlke's team analysed the material in the returned packages, and concluded that it does not support a hominin occupation at Untermassfeld. They argue that the claimed cut-marks on the animal bones, including the deer bone, were probably caused by rodents or other natural wear, they say, and the rock fragments lack telltale marks typical of hominin tools. They say that it wasn't possible to analyse other material from Landeck and Garcia Garriga's paper because its location is unclear.

Nature exchanged multiple e-mails with Landeck and Garcia Garriga about this mystery and asking for comment on the contents of this article. The researchers responded that most of the material they examined, including the deer bone fragment, was from two private collections amassed in the 1970s and early 1980s, and that much of it came from the same geological layer as Untermassfeld, but not within the site itself. They said that they presumed that some of this material was returned to the Natural History Museum Schloss Bertholdsburg in 2014 by the individual who had loaned it to them. They would not name the individual, but insisted: "We have nothing to do with a stolen bone". They added that they are planning to publish a detailed response to Roebroeks and Kahlke's allegations.

The regional prosecutor's office in Meiningen that investigated the 2009 theft told *Nature* the case had been closed unsolved later that year. A 5-year statute of limitation prevents it from being reopened. The case involving the 2012 theft of the rhinoceros bone was reopened early this year after the *Journal of Human Evolution* paper was published. The prosecutor's office said that an individual, whom it declined to name because of data protection laws, had been found guilty and fined.

Ongoing inquiry

Expressions of concern published on each of the three papers note that the location of the Untermassfeld material "was not stated accurately in the publication", and that the authors have been unable to adequately clarify where it is now. Landeck and Garcia Garriga declined to comment to *Nature*

on the specific details of the notes but said that they plan to publish a response.

Sarah Elton, an anthropologist at the University of Durham, UK, and an editor at the *Journal of Human Evolution*, says that an investigation into the accusations is ongoing. She adds that, as a result of the case, the journal now asks prospective authors to supply complete information about the location of material included in a study, as well as how it was accessed.

Other experts have been shocked by the revelations. “This paper should be retracted, of course,” says Jean-Jacques Hublin, an anthropologist and a director at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, about the 2016 paper. But the concerns go beyond questions of provenance. Hublin says that, like Roebroeks and Kahlke, he does not accept the claim that Untermassfeld contains signs of hominin presence, and he worries that its appearance in prominent journals will cause others to accept the idea, despite the lack of evidence for it.

The debate around Untermassfeld, Roebroeks and his colleagues say, underscores the importance of providing accurate descriptions of the provenance of published material, which is needed to verify claims. The desire to set the record straight about the arrival of hominins to Europe was the primary motivation for the team’s letter, he says. Based on his analysis, Roebroeks argues: “These bones and stones are not indicative of hominin presence.”

With additional reporting by Alison Abbott

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Updates

Updated:

> This article was updated on 13 November to note that expressions of concern have been published on all three papers, and to include a statement made after publication by Garcia Garriga: that he was not involved in analysing the material from Untermassfeld.

Comments

Commenting is currently unavailable.

Lab mice's ancestral ‘Eve’ gets her genome sequenced

Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.

13 November 2017

Anne Chadwick Williams/Sacramento Bee/ZUMA Press/Alamy

The genomes of lab mice can shift in subtle and unpredictable ways over generations of breeding.

Adam and Eve, a pair of black mice, lived for less than two years and never left their home at the Jackson Laboratory (JAX) in Bar Harbor, Maine. But since they were bred in 2005, their progeny have spread around the globe: the

pair's living descendants, which likely number in the hundreds of thousands. They are members of the most popular strain of mice used in biomedical research, which was created nearly a century ago.

Now, researchers at JAX are reconstructing Eve's genome in the hopes of better understanding — and compensating for — the natural mutations that occur in lab mice over the course of generations. These genetic changes can cause unanticipated physiological effects that can confound experiments. Related substrains of lab mice can differ in their taste for alcohol or their sensitivity to insulin, for example, and researchers suspect that such differences between supposedly identical mice lines have hampered some areas of research.

The scientists who founded JAX created Adam and Eve's breed, which is called C57BL/6, in 1921. To keep the mice as genetically similar as possible, researchers have repeatedly bred brothers with sisters for nearly a century — and sold the resulting offspring to customers around the world. But this strategy created a genetic bottleneck: every generation, between 10 and 30 new mutations pop up and are passed down to offspring. This 'genetic drift' quickly accumulates over the years, says Laura Reinholdt, a geneticist at JAX. The genomes of the C57BL/6 mice that the lab sells today have thousands of genetic differences from the mouse reference genome, which was created in 2002 from three mice from the substrain C57BL/6J. The genome is used as a template for researchers developing genetically modified mice.

Other suppliers have inadvertently created divergent substrains of C57BL/6 mice when they've bought rodents from JAX and bred them over several generations. Although most mutations go unnoticed, some occur in genes that affect a mouse's appearance or physiology. In 2016, mouse supplier Envigo in Somerset, New Jersey, found that C57BL/6 mice at 6 of its 19 breeding facilities around the world had acquired a mutation in a gene related to the immune system. The company notified the researchers that bought these mice, and asked customers to specify which location they preferred to source mice from in the future, given that the company's stocks were no longer identical.

Hidden changes

And although it is easy to spot a mutation that changes fur from black to white, for instance, some changes are discovered only if researchers are investigating a particular trait. A substrain of C57BL/6 mice that the US National Institutes of Health bred for 50 generations are uninterested in alcohol, whereas those bred at JAX's facility display a preference for alcoholic beverages.

In 2005, a team at JAX decided to reset the genetic clock by selling only C57BL/6J mice descended from two chosen mice: Adam and Eve. The researchers froze hundreds of embryos of the duo's grandchildren, enough to last for 25-30 years. Every five generations, the company thaws some of these embryos and raises them to adulthood as new breeding pairs.

"In some ways, the changes that are acquired are insidious and unstoppable," says Michael Wiles, the lab's senior director of technology evaluation and development, who led the project. "We've not stopped general drift, but we've slowed it considerably." Once the stockpiled embryos run out, however, JAX will have to start over with new breeding pairs from a much later generation.

Yet Eve's genome is very different from the 2002 mouse reference genome. In a presentation last month at the American Society for Human Genetics' meeting in Orlando, Florida, JAX computational scientist Anuj Srivastava spoke about the company's effort to reconstruct Eve's genome in high detail, using three different sequencing methods. Wiles says that the genome will be finished by the end of November, and that JAX plans to publish it early in 2018.

Mouse trap

Other mouse breeders have started their own efforts to account for genetic drift. Taconic Biosciences, a mouse distributor in Hudson, New York, restarts its C57BL/6 line every ten generations from its stash of frozen embryos.

Because Taconic has bred its line separately from the JAX line for decades, the Eve genome won't necessarily reflect the genetic make-up of Taconic's mice any more than the current mouse reference genome does.

Ana Perez, Taconic's global director of genetic sciences and compliance, says that the company plans to publish the genome of its own Eve. "From my perspective, each particular breeder should have their own reference genome to follow," she says. Buying mice from different breeders and expecting them to be the same is a fallacy, she adds.

But most researchers don't think about the differences between the various substrains of C57BL/6 mice and how those disparities can affect reproducibility in research, says Cory Brayton, a pathobiologist at Johns Hopkins University in Baltimore, Maryland. "The vendors are pretty good about making the information available, but the awareness is still pretty low," she says. It is impossible to quantify how often experiments or entire research programmes are wasted when researchers realize that their supposedly identical mice have genetically diverged from the ancestor they bought from a vendor, but Brayton suspects it is common.

The Eve genome will be a useful addition for researchers who use animals from JAX, says Brayton, although it won't solve all the reproducibility problems inherent to inbred mouse lines. "If you use [inbred mice] wisely, they can be highly informative," she says. "If you use them stupidly, they may really confound your studies."

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Comments

Comments

There are currently no comments.

World’s carbon emissions set to spike by 2% in 2017

Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.

13 November 2017

Kevin Frayer/Getty

China, the world’s largest emitter of greenhouse gases, is trying to reduce its reliance on coal.

Humanity’s carbon emissions are likely to surge by 2% in 2017, driven mainly by increased coal consumption in China, scientists reported on 13 November[1–3]. The unexpected rise would end a three-year period in which

emissions have remained flat despite a growing global economy.

Researchers with the Global Carbon Project, an international research consortium, presented their findings at the United Nations climate talks in Bonn, Germany. Countries there are ironing out details of how to implement the 2015 Paris climate accord, which calls for limiting global warming to a rise of 1.5–2 °C. The projected jump in the world's greenhouse-gas output underlines the challenges ahead; if the latest analysis proves correct, global carbon dioxide emissions will reach a record-breaking 41 billion tonnes in 2017.

"We were not particularly surprised that emissions are up again, but we were surprised at the size of the growth," says Corinne Le Quéré, a climate scientist at the University of East Anglia in Norwich, UK, and co-author of the work, which was published in the journals *Nature Climate Change*, *Environmental Research Letters* and *Earth System Science Data Discussions*. To Le Quéré, the question now is whether 2017 is a temporary blip or a return to business as usual. "If 2018 is as big as 2017, then I will be very discouraged," she says.

Several factors caused the world's CO_2 emissions to level out from 2014 to 2016, including an economic slowdown in China, the world's largest emitter; a shift from coal to gas in the United States; and global growth in the use of renewable energies such as solar and wind. Many climate scientists and policymakers had hoped that the pause in emissions growth represented a shift in energy use that would eventually cause global greenhouse-gas emissions to peak — and then decline.

The latest analysis projects that CO_2 emissions in the United States and the European Union will continue to decline — by 0.4% and 0.2%, respectively, in 2017 — although at a slower pace than in recent years. And emissions growth in India is set to slow, rising by just 2% this year, compared with an average of 6% per year over the past decade.

But the picture is very different in China, which produces nearly 26% of the world's output of CO_2. This year, the country's emissions of the greenhouse gas are expected to surge by 3.5%, to 10.5 billion tonnes. The main causes

are increased activity at the country's factories and reduced hydroelectric-energy production, the Global Carbon Project analysis finds.

The effort highlights nagging uncertainties about greenhouse-gas emissions trends, particularly in China, India and other countries with economies that are rapidly growing and changing, says David Victor, a political scientist at the University of California, San Diego. He is not convinced that government actions — at the national or international level — have driven the recent levelling of emissions. And although emissions are projected to grow this year, Victor says that China is still on a trajectory that would see its emissions peak well before its 2030 target.

Taken together, the projections for 2017 reinforce the notion that the world has far to go before it solves the climate problem, says Glen Peters, a climate-policy researcher at the CICERO Center for International Climate Research in Oslo and a co-author of the Global Carbon Project's 2017 analysis.

"This is basically saying that we are not safe yet," Peters says. "We can't be complacent."

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Nature News

周二, 28 11月 2017

Nature News

[周二, 28 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

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- **Black academics soon to outnumber white researchers in South Africa** [周二, 21 11月 08:00]
  Legacy of apartheid means academia has remained largely white.
- **Hungary rewards highly cited scientists with bonus grants**
  [周二, 21 11月 08:00]

Some top researchers prosper in Hungary as country tries to improve its international standing in science.

How an underwater sensor network is tracking Argentina's lost submarine

An expert from a nuclear-test-monitoring system explains how his team is trying to help in the search for the ARA *San Juan*.

27 November 2017

AP/REX/Shutterstock

Argentina's ARA *San Juan*, a diesel-powered submarine, went missing this month off the east coast of South America.

On 15 November, Argentina’s Navy lost contact with the ARA *San Juan*, a small diesel-powered submarine that had been involved in exercises off the

east coast of Patagonia.

About a week later, on 23 November, the Vienna-based Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) announced that its International Monitoring System — a network of sensors designed to detect nuclear explosions wherever they happen around the globe — had picked up a sound consistent with that of an explosion near the vessel's last-known location. The submarine is carrying 44 crew members.

The CTBTO's system has numerous scientific applications and this is not the first time that it has been put to use in the aftermath of a possible disaster. In 2000, for example, researchers searched its data for signs of the lost Russian submarine *Kursk*, and in 2014 they used it to try to determine the fate of Malaysian Airlines flight MH370. *Nature* spoke to CTBTO hydroacoustic engineer Mario Zampolli about the latest search.

How does the international monitoring system work?

The system has 289 stations worldwide and, when complete, it will have 337. We use four different technologies: seismic, atmospheric infrasound and hydroacoustic, plus the radionuclide stations, which detect traces of radioactive isotopes from possible explosions. All the information goes to our international data centre in Vienna, and also to our analysts, to examine if there are any events that are of interest with regard to the detection of nuclear explosions. These systems record data 24/7. The signals are stored and are used for a variety of scientific applications and disaster mitigation.

How can you help in the search for the ARA *San Juan*?

Six of our underwater stations are equipped with hydrophones. Two stations picked up a signal: one in Ascension Island, slightly south of the equator in the Atlantic, and the other in the Crozet Islands in the Southern Indian Ocean,

half-way between Africa and Antarctica. These two stations saw the same signal. Also, because each station has three sensors, based on the delay between the times when the signal reached each of the sensors, you can compute a bearing, and calculate the direction in which the signal was coming from. If you compute the geodesics starting at those points, the two lines cross in a location quite near to the point where the submarine last made contact.

Is this type of analysis done in real time?

For nuclear-explosion detection the CTBTO has a real-time processing pipeline. The automatic processing pipelines are optimized for detecting nuclear explosions. Whichever type of detector you build, you have to strike a balance between the probability of detecting something and the probability of false alarms. If the system is so sensitive that it detects everything, you will also have 100% probability of detecting false alarms. We would be completely swamped with events. To search for other signals, it becomes a manual job. We have to write ad-hoc pieces of software, compare signals and discuss them.

And what did your data show?

We found the location where the sound originated. It was estimated to have occurred 3 hours and 21 minutes after the last contact between the submarine and the base. We carried out a detailed analysis of the sound and are confident that this is not a natural event. It was an impulsive signal — short and sharp. The fact that it was detected with a good signal-to-noise ratio at Ascension and also at Crozet — 6,000 to 8,000 kilometres away from the source — means it must have been fairly loud. Some aspects of the signal are consistent with what has been seen in explosions before. But it is really very difficult to say that this was an explosion.

Are you able to say what caused it? For

example, could some explosives aboard the vessel have detonated accidentally?

It is very difficult to speculate. You have an undersea structure, with a steel pressure vessel. It could be something that happened inside or outside. It could be many things. We don't know the dynamics. What’s important is that this was not a natural event. We are not about trying to find out what happened. What we try to do is contribute information to the search authorities, which could help to refine the area of search. Where the signal originated can very much change the intensity — for example, whether it was near the submarine or inside of it — all these detailed aspects can change the sound level. Let alone the fact that one does not know at what depth this happened.

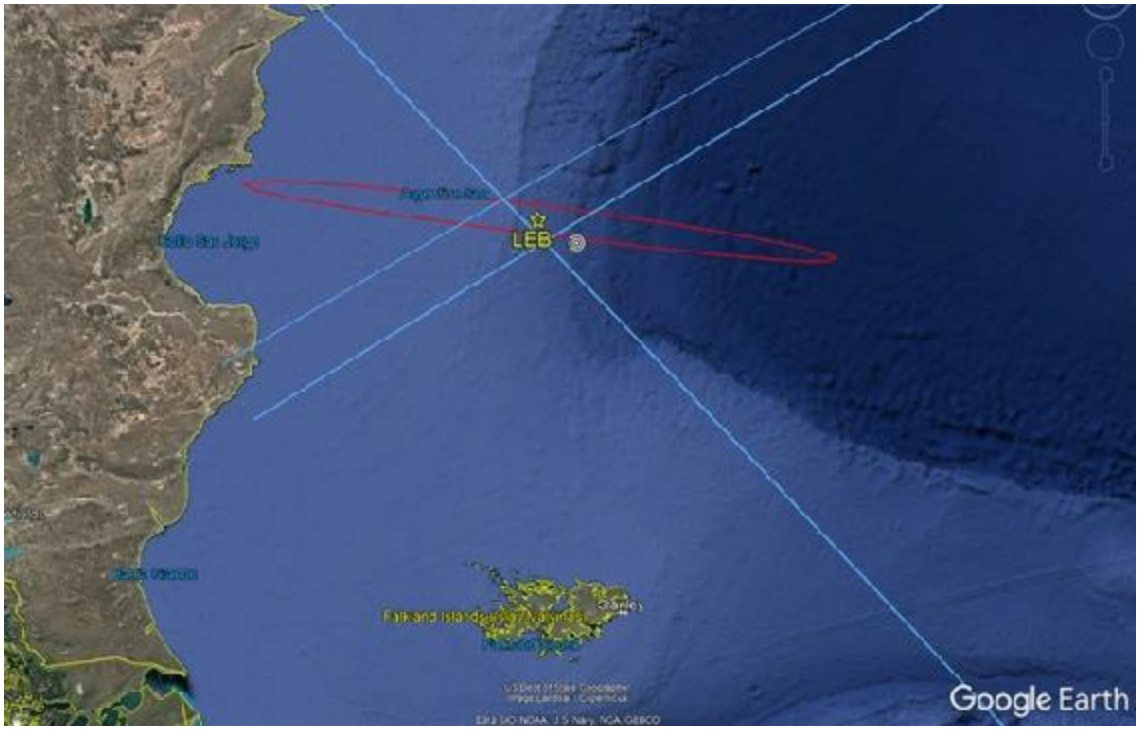
Why does water depth make a difference?

There is an optimum depth at which sound propagates. It is called the SOFAR channel, or sound fixing and ranging channel. It acts like a waveguide in which the sound propagation is more efficient. Because different layers of the ocean have different temperatures and salinities, the speed of sound also changes.

So sound waves in the SOFAR channel are reflected back at the boundaries between different layers, as in an optical fibre?

Yes. Around the time of the Second World War it was discovered that, at a particular depth, sound could be received at farther distances. Air force pilots had a charge with them that was set to detonate at that depth. If they were downed, they could eject; if they made it alive they’d throw out this charge. It would sink and explode, and then their position could be triangulated so they could be rescued. Our hydrophones are located on the axis of the SOFAR

channels.



CTBTO

The red ellipse, located off the coast of Argentina, indicates the possible location of the acoustic signal picked up by CTBTO stations.

Are your data used in other applications?

Data from the hydroacoustic network can help to characterize an earthquake. Tsunami-warning centres can use the data to understand details about the dynamics of an undersea earthquake.

We also detect underwater volcanic eruptions and we can help to locate their whereabouts. Like all the other signals from the monitoring network, the data are available for use by the scientific community. Areas of interest include research on marine mammals. We hear them from hundreds of kilometres away. Having a permanent system that records these data allows biologists to collect statistics about the number of whales that live in a given area and how

they migrate.

How much can your data help to narrow down the search for the *San Juan*?

The margin of error in our localization is still being assessed in detail, but most likely the source was in the vicinity of the submarine's last known location. With data from only two sensors we can point to an ellipse of maybe 100 to 200 kilometres wide (see above image). We have had some contact with the groups conducting the search. They seemed to be interested. But we have had no feedback from them.

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Comments

Commenting is currently unavailable.

United Kingdom relies on science to revive flagging economy

Long-awaited industrial strategy pins hopes on commercial gains from research.

27 November 2017

Geoff Pugh/AFP/Getty

UK Chancellor Philip Hammond has promised tax-credit incentives to boost private spending on research.

The United Kingdom has laid out how it will pour money into research to boost its economy — including cash for artificial intelligence and other high-

tech industries — as the country prepares to leave the European Union in 2019.

Science does not usually sit at the forefront of British economic policy documents. But the UK government's new industrial strategy, released on 27 November, is sprinkled liberally with references to research and development (R&D;) throughout, emphasizing the government's increasing focus on research as a remedy for economic woes. "It feels like science permeates this strategy," says Graeme Reid, a science-policy researcher at University College London.

The shift in emphasis is positive, but it will come with expectations, says Paul Nightingale, deputy director of the Science Policy Research Unit at the University of Sussex, UK. Historically, commercialising research has not been seen as a strength of the UK universities system. But in return for more R&D; cash, universities will now be expected to improve how they interact with local businesses and people, and to increase their commercial focus, he says. "This isn't 'strings attached', this is ropes. My impression from talking to lots of academics is that they don't understand how big this is," he says.

The industrial strategy is an effort to boost the United Kingdom's levels of worker productivity — the output per hour worked in the economy — which has remained stagnant since the financial crisis and lags behind those of other industrialized nations. In part to counter that trend, the Conservative government has promised to massively boost the country's R&D; spending over the next decade: from 1.7% of gross domestic product (GDP) in 2015 to 2.4% by 2027. (By comparison, Germany already spends 2.9% of GDP on research; the United States, 2.8%).

UK scientists have already been promised boosts in public spending. Last year, politicians committed to yearly increases in research funding until 2020–21, and last week, they announced that they would continue that increase in 2021–22, raising public research funds by a further £500 million (US$667 million) to £12.5 billion. To raise private spending, the government promises to work with industry to produce a roadmap in the coming months; the UK's chancellor Philip Hammond made a start by announcing a rise in R&D; tax credits (from 11% to 12%) in last week's budget.

Top targets

The industrial strategy has now picked out some specific areas on which to splash the cash. In particular, it identifies four ‘grand challenges’ in high-tech fields, which were agreed on after consultation with scientists: artificial intelligence (AI) and big data; clean growth; the future of mobility; and meeting the needs of an ageing society. These areas will benefit from an additional £725 million to be spent over the next 4 years from the Industrial Strategy Challenge Fund (ISCF) – a cash pot that has allocated £1 billion since its launch last year. Meanwhile, some £45 million will be spent to support more PhD students in AI and related disciplines, the strategy adds, increasing numbers by at least 200 places a year by 2020–21. And as parts of its efforts to address regional inequality, the government will launch a £115 million ‘Strength in Places Fund’ to support local pockets of excellence in science and innovation.

Other measures likely to directly affect academic scientists include a promised boost to a stream of funding that is allocated directly to universities, and spent at their discretion. This ‘quality-related’ funding (so named because it is allocated according to an audit of the quality of university research) is crucial for blue-skies and basic research, but has remained largely unchanged since 2010. An unspecified stream of money is also promised for a competitive fund designed to support multi- and interdisciplinary research that was proposed in a 2015 review by Nobel laureate Paul Nurse.

The strategy mentions a plethora of technology-based schemes, including unspecified ‘sector deals’ with industry to drive productivity in areas such as life sciences and automotive industries. It is likely that the government will not have enough capacity to manage them all internally, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School, UK.

Flanagan thinks that this will ultimately put greater responsibility into the hands of UK Research and Innovation (UKRI), an overarching organization that from 2018 will consolidate and oversee the activities of nine existing UK funding agencies, including both basic funding and commercially-focused innovation. If the organization ends up steering the direction of more

industrial R&D;, "it makes UKRI a uniquely powerful beast," he says.

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Comments

Comments

There are currently no comments.

EU nations vote to keep using controversial weedkiller glyphosate

One agency has linked the widely-used herbicide to cancer.

27 November 2017

Emmanuel Dunand/AFP/Getty

An activist in Brussels holds a sign that reads: “We are being deceived on glyphosate’s safety”. The weedkiller was deemed “probably” carcinogenic by the World Health Organization, but key EU safety bodies say it is not.

In a long-awaited decision, the European Union has voted to allow for another five years the sale and use of the controversial herbicide glyphosate. The resolution comes amid argument over whether the widely-used

weedkiller posts a cancer risk to people; one scientific body says it does, but others disagree.

The binding vote, taken on 27 November, came just before the product's current licence expires on 15 December, and ends two years of fierce divisions among the 28 EU countries.

International regulatory agencies, including the European Food Safety Authority (EFSA) and the European Chemicals Agency, have concluded that there is little evidence that the chemical causes cancer in people. But in March 2015, the International Agency for Research on Cancer (IARC), which is part of the World Health Organization, said that the substance was "probably carcinogenic" to humans and that there was "convincing evidence" that glyphosate can cause cancer in laboratory animals.

On 25 October, the European Commission proposed a 10-year extension for the substance, which is used in broad-spectrum herbicides and was launched by US agrochemical giant Monsanto as RoundUp in 1974. But France and other countries rejected the idea because of safety concerns. Eighteen countries eventually voted in favour of a 5-year extension, nine voted against and one abstained.

Mass protest

The compromise seems to have left both sides disappointed. "European governments failed European citizens and future generations today," said Genon Jensen, executive director of the Health and Environment Alliance, a non-governmental organization in Brussels that had campaigned for a ban on glyphosate. French President Emmanuel Macron responded to the vote by tweeting that glyphosate will be banned in France as soon as alternatives can be found, and within three years at the latest. A petition to stop the use of glyphosate in Europe had by 27 November gathered more than 1.3 million signatures.

Meanwhile the Glyphosate Task force, which represents 22 glyphosate manufacturers in the EU, complained that the vote "categorically ignored

scientific advice (and was) mainly influenced by public opinion and driven by politics".

Scientific conclusions on both sides have been criticised. Reuters reported in June that IARC members had not considered a large study showing no link between glyphosate and cancer in humans, because at the time it had not been published. That study, which tracked the health of tens of thousands of farmers, agricultural workers and their families in Iowa and North Carolina starting in the 1990s, was published earlier this month[1].

What's needed now is a "completely unbiased review of the evidence against glyphosate", Christopher Connolly, a neurobiologist at the University of Dundee, UK, said in a statement. "We must make the next five years count."

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Comments

There are currently no comments.

Nobel laureates demand release of Iranian scholar facing death sentence

Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.

24 November 2017

HAND OUT/Belga/PA Images

Iranian researcher Ahmadreza Djalali has appealed against the death sentence he received on 21 October.

Some 75 Nobel prizewinners have called on the Iranian government to release Ahmadreza Djalali, a researcher in disaster medicine who was

sentenced to death last month. The letter is the latest and most powerful protest against the ruling by the scientific community so far.

The group wrote to Gholamali Khoshroo, the Iranian ambassador to the United Nations, on 17 November, and the letter was made public on 21 November. The Nobel laureates express their concern for the conditions of Djalali's detention; they deem his trial "unfair" and "flawed", and they urge the Iranian authorities to let him return to Sweden, where he lived.

The list includes prominent names such as Harold Varmus, a former director of the US National Institutes of Health, now at the Weill Cornell Medicine institute in New York, and Andre Geim, a physicist based at the University of Manchester, UK. They wrote: "As members of a group of people and organizations who, according to the will of Alfred Nobel are deeply committed to the greatest benefit to mankind, we cannot stay silent, when the life and work of a similarly devoted researcher as Iranian disaster medicine scholar Ahmadreza Djalali is threatened by a death sentence."

Spying conviction

Djalali carried out research on emergency medicine — specifically, on the response of hospitals to terrorist attacks — while based at the University of Eastern Piedmont in Novara, Italy, and at the Karolinska Institute in Stockholm.

He was arrested in Tehran in April 2016 and accused of collaboration with a hostile government. On 21 October this year, Djalali was convicted of espionage and sentenced to death, according to Djalali's wife Vida Mehrannia and Italian diplomatic sources.

Tehran's prosecutor linked Djalali to the murder of several Iranian nuclear physicists. But a document thought to have been written by Djalali has claimed that he was sentenced after refusing to spy for Iran. Djalali's lawyer has appealed against the death sentence and is awaiting the court's decision.

Since the death sentence became public, many organisations have protested against Djalali's treatment. They include: Amnesty International, the human

rights group; senators in the Italian government; the directors of the European institutions at which Djalali worked; and academic groups including the Committee of Concerned Scientists and Scholars at Risk.

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Comments

Comments

There are currently no comments.

Zimbabwe’s researchers hope political change will revitalize science

Academics optimistic that the end of Robert Mugabe’s authoritarian rule could boost research and international collaboration.

24 November 2017

AFP/Getty

Protesters gathered at the University of Zimbabwe in Harare this week, amid political ructions that precipitated the end of Robert Mugabe's 37-year rule.

Scientists in Zimbabwe say they are hopeful that the sudden change of

political power in their country could spell a new era for its beleaguered research system. Those working in the nation hope that the shift will unlock and attract research funds from overseas, while Zimbabwean researchers abroad say that the potential for new order in their country could encourage them to return home.

The authoritarian regime of Robert Mugabe, the 93-year-old who had been president of Zimbabwe for 37 years, ended abruptly on 21 November when he resigned following military and political pressure. Emmerson Mnangagwa, the former vice-president whose firing by Mugabe this month set off the revolt, was sworn in as the country's leader this morning. Elections are expected to be organized next year.

The ructions have been widely celebrated both inside and outside Zimbabwe. The southern African country’s economy has been in free fall for almost two decades since Mugabe fast-tracked a programme of land expropriation, which destroyed investment in its agricultural sector and undermined confidence in the economy. The turmoil led millions — including scientists — to flee the country, many into neighbouring South Africa.

Research roots

Traditionally, much of the country's research has come from ties between Zimbabwe's universities and the agriculture industry, where research and development was considered central to its productivity. Major study areas included maize, land-management and veterinary research. But science became difficult as government funding for research dried up. Last year, the Zimbabwe Academy of Sciences' situation became so desperate that it implored the country’s large diaspora to support the organization.

International sanctions against Zimbabwe have also penalized the country’s students and academics, who have not been able to access international grants, scholarships or buy equipment from foreign companies prohibited from trading with Zimbabwe, says Dexter Tagwireyi, a pharmacist at the University of Zimbabwe in Harare and head of the Zimbabwe Young Academy of Science. If the incoming government has better relationships

with Western countries, such as the United Kingdom and the United States, it could mean that researchers are able to access new sources of funds, he says.

At his inauguration, Mnangagwa said that Zimbabwe was ready to engage with other countries and urged the international community to reconsider their economic embargoes. The African Union, a continental group of nations including Zimbabwe, has been pushing science, technology and innovation as a way for African countries to achieve economic and social development.

The promise of a more democratic government could also attract researchers who have left to return and swell the country's academic ranks. "This change of leader interests me to go back and serve in Zimbabwe as an academic," says a Zimbabwean researcher at the University of Johannesburg in South Africa, who asked to remain anonymous because he was concerned about what his employer might think. The prospect of order in his home country would tempt him to return "at the speed of light", he says, in part because Zimbabwe is not as crime-ridden as South Africa. The sentiment was echoed by several other early-career Zimbabwean scientists in South Africa contacted by *Nature*.

Zimbabwe does not keep official figures on academics, but a 2012 report by the United Nations Educational, Scientific and Cultural Organization said that 1,300 researchers were working there at the time. And despite chronic underfunding, Zimbabwe has consistently produced around 400 peer-reviewed papers a year. (By comparison, South Africa produced 17,246 research publications in 2015.)

"I just hope the new regime will resuscitate the economy and generate significant research funding for higher-education institutions," says Rudo Gaidzanwa, a sociologist at the University of Zimbabwe. "That would boost the research output of academics in state universities."

Key collaborator

South Africa, with its comparatively strong research system, is a major destination for students from around Africa, and a key collaborator for

Zimbabwean scientists. A Web of Science search shows that since 2013, roughly one-third of 1,689 research articles authored by Zimbabwe-affiliated researchers had a collaborator who was based in South Africa.

A strengthened science system in Zimbabwe would benefit the entire region, open the door to greater collaboration and offer a destination for students trained in South Africa, says Valerie Mizrahi, director of the Institute of Infectious Disease and Molecular Medicine at the University of Cape Town in South Africa.

South Africa takes scholars from across the continent, and in many cases the idea of them going home is a pipe dream, because there is often not much to go back to, Mizrahi says. “Zimbabwe has a chance to change that.” Mizrahi, who was born in Zimbabwe but has lived in South Africa for decades, says that the situation is reminiscent of South Africa when apartheid was being dismantled in the 1990s and sanctions were lifted. “Funding flowed into the country,” she says.

Despite the celebrations in Zimbabwe, there are concerns that Mnangagwa’s presidency will not bring enough change. The new leader was a close associate of Mugabe and served in various positions in his government, which was characterized by nepotism and the silencing of opposition voices. “So we are not sure whether they will do things differently or all they wanted was just power to also suppress citizens and loot resources in the country," says Farayi Moyana, a PhD candidate at South Africa's University of the Witwatersrand who is based in Zimbabwe.

The uncertainty means that academics aren't making plans just yet: “There is no hurry to return home,” says a Zimbabwean scientist at Witwatersrand in Johannesburg, who also spoke on the condition of anonymity. Rather, he says, he will let the situation stabilize before making any decisions.

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Comments

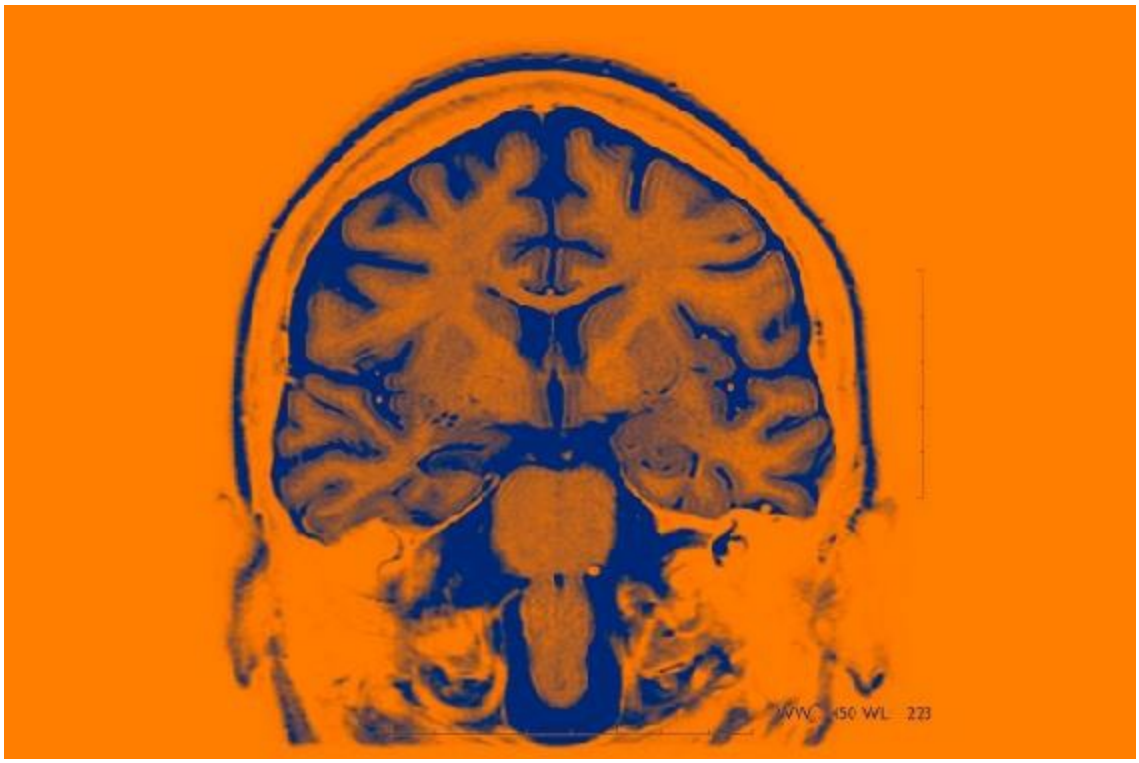
Comments

There are currently no comments.

AI-controlled brain implants for mood disorders tested in people

Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.

22 November 2017



BSIP/UIG/Getty

Brain implants are used to treat epilepsy and movement disorders.

Brain implants that deliver electrical pulses tuned to a person’s feelings and behaviour are being tested in people for the first time. Two teams funded by the US military’s research arm, the Defense Advanced Research Projects Agency (DARPA), have begun preliminary trials of ‘closed-loop’ brain

implants that use algorithms to detect patterns associated with mood disorders. These devices can shock the brain back to a healthy state without input from a physician.

The work, presented last week at the Society for Neuroscience (SfN) meeting in Washington DC, could eventually provide a way to treat severe mental illnesses that resist current therapies. It also raises thorny ethical concerns, not least because the technique could give researchers a degree of access to a person's inner feelings in real time.

The general approach — using a brain implant to deliver electric pulses that alter neural activity — is known as deep-brain stimulation. It is used to treat movement disorders such as Parkinson's disease, but has been less successful when tested against mood disorders. Early evidence suggested that constant stimulation of certain brain regions could ease chronic depression, but a major study involving 90 people with depression found no improvement after a year of treatment.[1]

The scientists behind the DARPA-funded projects say that their work might succeed where earlier attempts failed, because they have designed their brain implants specifically to treat mental illness — and to switch on only when needed. "We've learned a lot about the limitations of our current technology," says Edward Chang, a neuroscientist at the University of California, San Francisco (UCSF), who is leading one of the projects.

DARPA is supporting Chang's group and another at Massachusetts General Hospital (MGH) in Boston, with the eventual goal of treating soldiers and veterans who have depression and post-traumatic stress disorder. Each team hopes to create a system of implanted electrodes to track activity across the brain as they stimulate the organ.

The groups are developing their technologies in experiments with people with epilepsy who already have electrodes implanted in their brains to track their seizures. The researchers can use these electrodes to record what happens as they stimulate the brain intermittently — rather than constantly, as with older implants.

Mood map

At the SfN meeting, electrical engineer Omid Sani of the University of Southern California in Los Angeles — who is working with Chang's team — showed the first map of how mood is encoded in the brain over time. He and his colleagues worked with six people with epilepsy who had implanted electrodes, tracking their brain activity and moods in detail over the course of one to three weeks. By comparing the two types of information, the researchers could create an algorithm to 'decode' that person's changing moods from their brain activity. Some broad patterns emerged, particularly in brain areas that have previously been associated with mood.

Chang and his team are ready to test their new single closed-loop system in a person as soon as they find an appropriate volunteer, Sani says. Chang adds that the group has already tested some closed-loop stimulation in people, but he declined to provide details because the work is preliminary.

The MGH team is taking a different approach. Rather than detecting a particular mood or mental illness, they want to map the brain activity associated with behaviours that are present in multiple disorders — such as difficulties with concentration and empathy. At the SfN meeting, they reported on tests of algorithms they developed to stimulate the brain when a person is distracted from a set task, such as matching images of numbers or identifying emotions on faces.

The researchers found that delivering electrical pulses to areas of the brain involved in decision-making and emotion significantly improved the performance of test participants. The team also mapped the brain activity that occurred when a person began failing or slowing at a set task because they were forgetful or distracted, and found they were able to reverse it with stimulation. They are now beginning to test algorithms that use specific patterns of brain activity as a trigger to automatically stimulate the brain.

Personalized treatment

Wayne Goodman, a psychiatrist at Baylor College of Medicine in Houston, Texas, hopes that closed-loop stimulation will prove a better long-term treatment for mood disorders than previous attempts at deep-brain stimulation — partly because the latest generation of algorithms is more personalized and based on physiological signals, rather than a doctor's judgement. “You have to do a lot of tuning to get it right,” says Goodman, who is about to launch a small trial of closed-loop stimulation to treat obsessive–compulsive disorder.

One challenge with stimulating areas of the brain associated with mood, he says, is the possibility of overcorrecting emotions to create extreme happiness that overwhelms all other feelings. Other ethical considerations arise from the fact that the algorithms used in closed-loop stimulation can tell the researchers about the person’s mood, beyond what may be visible from behaviour or facial expressions. While researchers won't be able to read people's minds, “we will have access to activity that encodes their feelings,” says Alik Widge, a neuroengineer and psychiatrist at Harvard University in Cambridge, Massachusetts, and engineering director of the MGH team. Like Chang and Goodman’s teams, Widge’s group is working with neuroethicists to address the complex ethical concerns surrounding its work.

Still, Chang says, the stimulation technologies that his team and others are developing are only a first step towards better treatment for mood disorders. He predicts that data from trials of brain implants could help researchers to develop non-invasive therapies for mental illnesses that stimulate the brain through the skull. “The exciting thing about these technologies,” he says, “is that for the first time we’re going to have a window on the brain where we know what’s happening in the brain when someone relapses.”

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Comments

Commenting is currently unavailable.

Lightning makes new isotopes

Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.

22 November 2017

Magalie L’Abbé/Getty

A lightning storm illuminates clouds over Kagoshima, Japan.

A streak of lightning in the skies over Japan has generated positrons — the antimatter equivalents of electrons — and radioactive carbon-14, confirming a theoretical prediction, according to a paper published in *Nature* on 22 November[1].

Since the 1990s, orbiting observatories designed to observe the heavens have

also detected flashes of γ-rays coming from Earth, which were thought to have their origins in atmospheric phenomena. To investigate this theory, Teruaki Enoto, an astrophysicist at Kyoto University in Japan, and his collaborators set up an array of γ-ray detectors close to the Kashiwazaki-Kariwa nuclear power plant. Winter thunderstorms in Japan are famous for their spectacular lightning, he says, and the low clouds make these relatively easy to observe.

On 6 February, the detectors sensed an unusual event. A double lightning bolt just off the coast shot out an initial, one-millisecond spike of γ-rays, with relatively high energies of up to 10 megaelectronvolts. This was followed by a γ-ray afterglow of less than half a second. Then there was a telltale signal — γ-rays concentrated at 511 kiloelectronvolts of energy, which lasted for about a minute. Physicists say this is the unmistakable signature of positrons annihilating in a puff of energy as they hit electrons in the surrounding matter.

Together, the three waves of γ-rays point to a photonuclear reaction first proposed[2] a decade ago by Leonid Babich, a physicist at the Russian Federal Nuclear Center in Sarov. Lightning can accelerate some electrons to almost the speed of light, and the electrons can then produce γ-rays. Babich proposed that when one of these γ-rays hits the nucleus of a nitrogen atom in the atmosphere, the collision can dislodge a neutron. After briefly bouncing around, most of the neutrons get absorbed by another nitrogen nucleus. This adds energy to the receiving nucleus and puts it in an excited state. As the receiving nucleus relaxes to its original state, it emits another γ-ray — contributing to the giveaway γ-ray glow.

Meanwhile, the nitrogen nucleus that has lost one neutron is extremely unstable. It decays radioactively over the next minute or so; in so doing, it emits a positron, which almost immediately annihilates with an electron, producing two 511-keV photons. This was the third signal, Enoto says. He suspects that his detectors were able to see it only because the briefly radioactive cloud was low, and moving towards the detectors. This combination of circumstances might help to explain why the photonuclear signature has been seen so rarely. Enoto says that his team has observed a few similar events, but that the one described in the paper is the only clear-

cut event so far.

Babich also predicted that not all of the neutrons dislodged from nitrogen by a γ-ray are absorbed. Some of them instead will trigger the transmutation of another nitrogen nucleus into carbon-14, a radioactive isotope that has two more neutrons than ordinary carbon. This isotope can be absorbed by organisms; it then decays at a predictable rate long after the organism's death, which makes it a useful clock for archaeologists.

The main source of the carbon-14 in the atmosphere has generally been considered to be cosmic rays. In principle, lightning could also contribute to the supply. But it is not clear yet how much of the isotope is produced in this way, says Enoto, in part because it's possible that not all bolts initiate photonuclear reactions.

"I agree with their interpretation of their data," says physicist Joseph Dwyer of the University of New Hampshire in Durham. But, he adds, Enoto's team's explanation does not solve all puzzles related to positrons in the atmosphere. In particular, the photonuclear reaction does not seem to match an event Dwyer observed in 2009 from a research aeroplane. His detector spotted a signature of positrons only for a fraction of a second — too short to originate from nuclear decay, he says. Also, his detector saw no initial flash in that case. "If it was there, it should have been very obvious."

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Comments

Commenting is currently unavailable.

Black academics soon to outnumber white researchers in South Africa

Legacy of apartheid means academia has remained largely white.

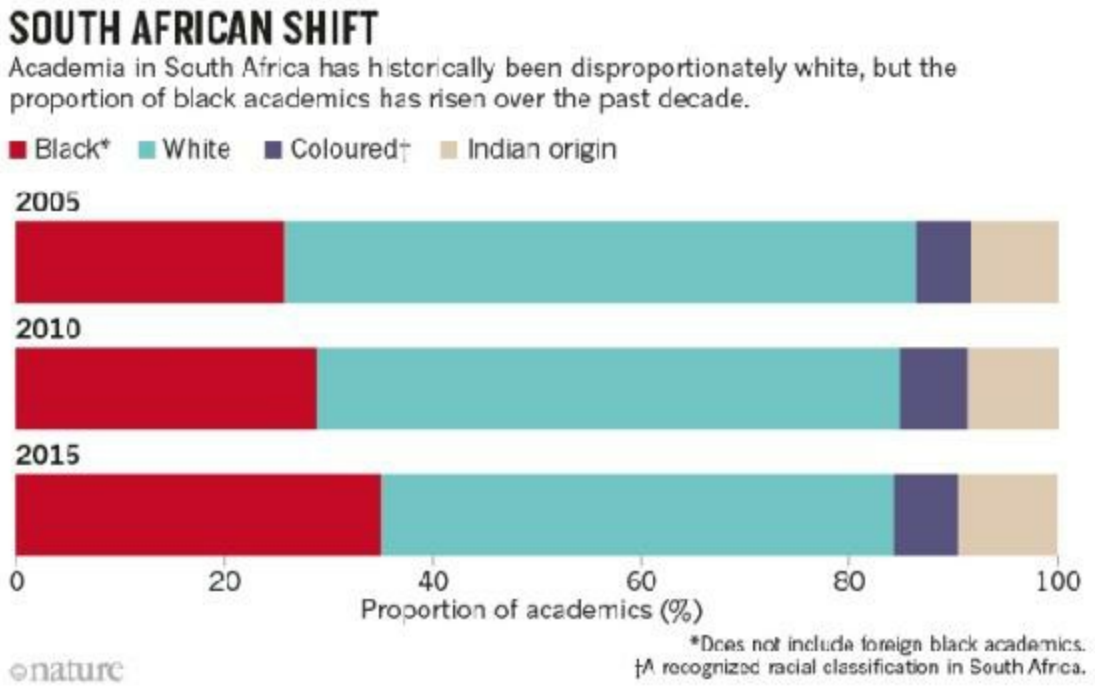
21 November 2017

There will soon be more black academics in South Africa than white ones, a study of demographic data suggests.

Although more than 80% of the country's population is black, its academic sector has remained disproportionately white — a legacy of the apartheid era.

But over the past decade, the proportion of black South African researchers has risen steadily: from 26% in 2005 to 35% in 2015, according to the study, which was published[1] in *Higher Education* last month. The proportion of white academics decreased by more than 10 percentage points over the same period, to 49% in 2015 (see 'South African shift').

"Our research shows that transformation is taking place and there are strong indications that it will accelerate in the future, particularly in the next decade," says David Hedding, a geomorphologist at the University of South Africa in Florida, Johannesburg, and co-author of the paper.



The authors suggest that in the next decade, more than 4,000 researchers — about 27% of the country's academics, and most of them white men — will retire, which should create opportunities for younger researchers. Black researchers could outnumber white ones some time between 2020 and 2025, they say.

Hedding says that it's not possible to attribute the change to a specific policy, but that the government should keep doing what it is currently doing. However, he thinks the country should focus more on nurturing PhD candidates and enticing them into academia. He and his co-author, geoinformatics specialist Greg Breetzke at the University of Pretoria, also note that black women, the country's largest demographic, remain significantly under-represented in universities, accounting for just 14% of academics in 2015.

Charles Sheppard, director of management information at Nelson Mandela University in Port Elizabeth, agrees that South Africa must focus on generating local PhDs. At the moment, it produces more doctorate-holders who hail from other African countries than from the home nation, he says. "We need to work harder on getting this right," he adds.

The latest study is the most well thought out, most evidenced-based and least anecdotal to address this complex problem yet, says Zeblon Vilakazi, deputy vice-chancellor at the University of the Witwatersrand in Johannesburg. “This is a step in the right direction,” says Vilakazi.

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Comments

Commenting is currently unavailable.

Hungary rewards highly cited scientists with bonus grants

Some top researchers prosper in Hungary as country tries to improve its international standing in science.

21 November 2017

Richard Wareham Fotografie/Alamy

Hungarian commissioner for research and innovation József Pálinkás has designed grants that reward research excellence.

Earlier this year, cell biologist Attila Reményi was facing his toughest decision since returning to his native Hungary a decade ago. With his

generous start-up funding about to run out, should he downsize his lab?

Then, in June, the government's National Research, Development and Innovation Office (NRDNI) put out a call for five-year basic-research grants of up to 300 million Hungarian forints (US$1.18 million) each for highly cited scientists such as Reményi. "It came out of the blue," says Reményi at the Hungarian Academy of Sciences (HAS) Research Centre for Natural Sciences, Budapest, who learnt on 13 November that he was among 12 winners.

But for NRDNI president József Pálinkás, the Frontline Research Excellence grants are the result of years of work. They are part of a plan to create a long-term, systematic plan of grants and rewards to encourage researchers in all fields to strive for world-class publications and to tempt Hungarian scientists working abroad to return. In a country whose leaders are coming under increasing criticism for autocratic and xenophobic tendencies, scientists say that the situation for science has never been rosier.

Under Viktor Orbán's nationalist government, this small, post-communist country has been steadily falling on *The Economist* magazine's Democracy Index. Last year, several foreign members of the HAS resigned, citing the failure of the academy to protest against what they saw as anti-democratic moves by the government. HAS president, mathematician László Lovász, responded that the academy is not a political organization. Scientists in the country are noticeably reluctant to comment publicly on politics, and several young researchers told *Nature* they fear that criticizing the government might compromise their careers.

Yet within this troubled political environment, Pálinkás, a physicist, has spent the past few years quietly persuading the government that basic science matters as much as product-focused research. Shortly after becoming president of the HAS in 2008, he created the Momentum system of start-up funding — one-time, five-year grants of up to 50 million forints per year — to encourage Hungarian scientists to set up independent labs back home. Reményi was a Momentum recipient in 2013.

In 2015, Pálinkás left HAS to become the founding director of the NRDNI, where he designed a system of regular grants to help ensure that returnees

stay after the start-up money runs out. The frontline grants are a key part of this, giving the recipients salaries equivalent to the European Union average, which is two-and-a-half times higher than the salary that a scientist would normally earn in Hungary. Around 50 of these grants will eventually run each year. The programme is modelled on European Research Council grants, but with a twist: only those who have published a paper in the past five years that counted among the top 10% most-cited papers in their discipline are eligible to apply. This approach “creates a lot of tension in the community, but without such serious selection science won’t work well,” says Pálinkás. To further encourage scientists to aim for quality over quantity, last year he introduced another reward for high-impact publication: researchers who within two years have a paper among the top 5% most highly cited in their field automatically receive a one-off payment of 20 million forints.

Hungary has a long tradition of research and outperforms other former communist countries in the EU on many measures. It has won more European Research Council grants and was the only country this year to win two Teaming grants: prestigious EU awards to create centres of excellence in 15 mostly eastern European countries in partnership with a western European research organization. It has also made some large investments, most generously in the Hungarian Brain Research Programme, launched in 2014, which has received 18.5 million forints up to 2021 and enabled many principal investigators to start their own labs. A 3-billion-forints programme has just been agreed in quantum technology. Five new programmes in areas including artificial intelligence and water research will be added next year, thanks to a 3% increase in the NRDNI budget, agreed in principle this month.

Hungary’s research performance still lags behind that of science-strong western European countries, however, and at 1.2% of gross domestic product, its research investment is well below the EU average of 2%. To support its scientific ambitions, Hungary has heavily invested its EU structural funds — subsidies to poorer regions — in expanding research infrastructure. The country’s scientists fear that when the current round of these funds runs out in 2019, these major investments may go to waste.

Pálinkás says that to avoid this, he will request a doubling of the national research budget in 2019. And despite the political challenges, Hungarian

scientists seem optimistic: “The situation for science is better than it has been before,” says Reményi. Immunologist Adam Dénes returned from the United Kingdom in 2012 to start his own lab at the HAS Institute of Experimental Medicine in Budapest, a move he describes as a “political, philosophical and career challenge”. But for now, he says, “the pluses are more than the minuses.”

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Comments

Comments

There are currently no comments.

Nature News

周六, 04 11月 2017

Nature News

[周六, 04 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Energy researcher sues the US National Academy of Sciences for millions of dollars** [周五, 03 11月 08:00]
  Rare move stems from a conflict over two journal articles about renewable energy.
- **US government report says that climate change is real — and humans are to blame** [周五, 03 11月 08:00]
  Conclusions of climate-change science analysis are at odds with US President Donald Trump's policies.
- **Newly discovered orangutan species is also the most endangered** [周四, 02 11月 08:00]
  The first new species of great ape described in more than eight decades faces threats to its habitat.
- **Gut microbes can shape responses to cancer immunotherapy** [周四, 02 11月 08:00]
  Studies find that species diversity and antibiotics influence cutting-edge treaments.
- **Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid** [周四, 02 11月 08:00]
  Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.
- **Controversial chairman of US House science committee to retire** [周四, 02 11月 08:00]
  Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.
- **Infusions of young blood tested in patients with dementia** [周三, 01 11月 08:00]
  The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.
- **Pay for US postdocs varies wildly by institution** [周三, 01 11月 08:00]
  Analysis of universities' salary data suggests major disparities in pay for early-career researchers.
- **Citation is not the only impact** [周三, 01 11月 08:00]

A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.

- **University systems allow sexual harassers to thrive** [周三, 01 11月 08:00]
  It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen.
- **Interstellar visitor, Arctic shipwrecks and a retraction recommendation** [周三, 01 11月 08:00]
  The week in science: 27 October–2 November 2017.
- **Plans to promote German research excellence come under fire** [周三, 01 11月 08:00]
  Critics say selection process for high-stakes funding programme is flawed.
- **The new thermodynamics: how quantum physics is bending the rules** [周三, 01 11月 08:00]
  Experiments are starting to probe the limits of the classical laws of thermodynamics.
- **Join the disruptors of health science** [周三, 01 11月 08:00]
  Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.
- **Astrophysics: Chasing ghosts in Antarctica** [周三, 01 11月 08:00]
  Alexandra Witze welcomes a history of IceCube, an ambitious neutrino observatory.
- **Books in brief** [周三, 01 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.
- **Zoology: The joys of spinelessness** [周三, 01 11月 08:00]
  Lisa-ann Gershwin delights in two books on marine invertebrates.
- **Human embryos: Collect reliable data on embryo selection** [周三, 01 11月 08:00]
- **Night shifts: Circadian biology for public health** [周三, 01 11月 08:00]
- **Crime fiction: Sherlock Holmes — a family likeness?** [周三, 01 11月 08:00]
- **Forestry: Sustainability crisis brews in EU forestry** [周三, 01 11月 08:00]
- **Spanish government takes control of Catalonian universities** [周二, 31 10月 08:00]
  Madrid will oversee the finances of the region's research centres and seven public universities.
- **Seeds, sponges and spinal surgery** [周二, 31 10月 08:00]
  October’s sharpest science shots, selected by Nature ’s photo team.
- **Small group scoops international effort to sequence huge**

wheat genome [周二, 31 10月 08:00]

Just six scientists conquer one of the most complicated genomes ever read.

- ## Astronomers race to learn from first interstellar asteroid ever seen [周二, 31 10月 08:00]

  Wonky orbit confirms that this visitor isn’t from around here.

- ## How baby bats develop their dialects [周二, 31 10月 08:00]

  The young animals crowdsource the pitch of their calls from colony members.

- ## US environment agency bars scientists it funds from serving on its advisory boards [周二, 31 10月 08:00]

  The US Environmental Protection Agency says the policy will address potential conflicts of interest, but scientists raise alarms.

- ## Frédéric Chopin’s telltale heart [周二, 31 10月 08:00]

  Scientists have written another chapter in the curious case of the composer’s heart. But it is unlikely to be the end of the story.

- ## Lower emissions on the high seas [周二, 31 10月 08:00]

  Global regulations to limit carbon dioxide from the shipping industry are overdue.

- ## Lessons from first campus carbon-pricing scheme [周二, 31 10月 08:00]

  Putting a value on emissions can lower energy use, write Kenneth Gillingham, Stefano Carattini and Daniel Esty.

- ## Huge microwave observatory to search for cosmic inflation [周一, 30 10月 08:00]

  Multi-telescope project has ambitious goals and a big price tag.

- ## Geneticists are starting to unravel evolution's role in mental illness [周一, 30 10月 08:00]

  Hints emerge that past environments could have influenced psychiatric disorders.

Energy researcher sues the US National Academy of Sciences for millions of dollars

Rare move stems from a conflict over two journal articles about renewable energy.

03 November 2017

Eric Thayer/Bloomberg/Getty

Renewable energy, including from wind, is at the heart of a multi-million dollar lawsuit.

A scientific dispute about the future of alternative energy has landed in a US

court. Mark Jacobson, an environmental and civil engineer at Stanford University in California, has filed a libel lawsuit against the US National Academy of Sciences (NAS) and a researcher who published a study in the academy's journal that criticized Jacobson's work.

Jacobson, who filed suit in superior court in Washington DC in late September, is seeking damages of US$10 million. He also wants the *Proceedings of the National Academy of Sciences* (*PNAS*) to retract the article it published by mathematician Christopher Clack in 2015. The NAS and Clack have until late November to respond, according to court documents. Some experts are worried that the lawsuit could dampen scientific progress on renewable energies. But others defend the move, saying researchers should be able to take advantage of all civil avenues in defense of their work.

Jacobson was the lead author of a high-profile *PNAS* paper[1] published in December 2015 making the case that the continental United States could meet nearly 100% of its energy needs using wind, water and solar sources as early as 2050. A rebuttal[2] written by Clack — then at the University of Colorado Boulder — and 20 co-authors, and published in *PNAS* in June 2017, questioned Jacobson's methodology and challenged his conclusions. The authors argued, among other things, that Jacobson’s paper overestimated the maximum outputs from hydroelectric facilities and the nation’s capacity to store energy produced by renewable sources.

In the lawsuit, Jacobson says that he had alerted *PNAS* to 30 falsehoods and five “materially misleading statements” in Clack’s paper before its publication. The complaint states that almost all of those inaccuracies remained in the published version. Jacobson also argues that “the decision by NAS to publish the Clack Paper in PNAS has had grave ramifications” for his reputation and career.

In a letter[3] accompanying Clack’s paper in *PNAS*, Jacobson and three co-authors wrote that Clack’s criticisms are “demonstrably false”. They maintained that their projections regarding hydroelectric power were based on an assumed increase in the number of turbines and were not a “modeling mistake”.

Conflict resolution

Some observers are disappointed to see the conflict play out in court. The diversity of engineering models that form the basis of long-term energy projections should be celebrated, not litigated, says chemical engineer Daniel Schwartz, director of the Clean Energy Institute at the University of Washington in Seattle. “Bringing this dispute into the court of law, regardless of outcome, is a step towards devaluing the debate of underlying engineering assumptions,” he says.

“This dispute is likely to be most harmful to the scientific community, which has already been subject to lawsuits from groups sceptical of climate change,” says David Adelman, who studies environmental law at the University of Texas in Austin.

Suing a journal over a scientific disagreement is a rare move, says Adil Shamoo, a biochemist at the University of Maryland School of Medicine in Baltimore and editor-in-chief of the journal *Accountability in Research*, which is published by Taylor & Francis. But Shamoo thinks that scientists should be able to sue if they feel that a paper is “reckless” or “malicious”. “I’m a great believer in using all of the avenues of a civil society,” he says.

Shamoo does think that Clack’s paper was “unduly harsh and personal”. He says that “it was not written as if it was part of a scientific dialogue”.

Clack declined to respond to Shamoo’s characterization of his paper, but says that he is disappointed that Jacobson filed the lawsuit. Clack — now chief executive of Vibrant Clean Energy LLC in Boulder — says that his rebuttal paper “underwent very vigorous peer review”, and that the *PNAS* editors had considered Jacobson’s criticisms but found them to be “without merit”.

Jacobson says that he “cannot comment” on the lawsuit. And a spokesperson for the NAS says that “we do not comment on pending litigation”.

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Comments

Commenting is currently unavailable.

US government report says that climate change is real — and humans are to blame

Conclusions of climate-change science analysis are at odds with US President Donald Trump's policies.

03 November 2017

Drew Angerer/Getty

Heat waves are growing more common in many parts of the United States.

From warmer temperatures to more extreme weather, melting glaciers and rising sea levels, humanity is fundamentally changing the planet by pumping

greenhouse gases into the atmosphere, US government scientists said on 3 November in their latest assessment of climate science.

The average global temperature has increased by 1 °C since the start of the Industrial Revolution, the 600-page report says — adding that the last 115 years comprise “the warmest period in the history of modern civilization”. The analysis warns that temperatures could increase another 4 °C by the end of the century, with dramatic consequences for humans and natural ecosystems.

The findings are at odds with the policies of US President Donald Trump, who has questioned well-established tenets of climate science and vowed to protect and promote the US fossil-fuel industry. Trump's stances led many scientists to worry that his administration would try to block or tamper with the climate-change assessment, but several scientists who helped to write the document reported no problems.

“We weren’t interfered with, and we ended up producing something that I think is of tremendous value,” says David Fahey, an atmospheric scientist with the National Oceanic and Atmospheric Administration in Boulder, Colorado, and a coordinating lead author of the analysis.

The climate-science report is the first volume of the fourth National Climate Assessment, a legally mandated analysis of the causes and impacts of global warming that is due in 2018. The other two parts of the forthcoming assessment were released today in draft form, for public comment. One analysis focuses on how climate change is affecting life in the United States, from crop yields to property damage from extreme weather. The other summarizes the latest findings on the global carbon cycle. Both of those documents will undergo a formal review by the US National Academy of Sciences.

“The science speaks for itself,” says Don Wuebbles, a a climate scientist at the University of Illinois at Urbana-Champaign and co-chair of the climate-science report. “It’s hard to counteract the basic observations and the truth of the science with any kind of political playing around.”

The trio of documents paints a dramatic picture of how global warming is

affecting people and communities across the United States. Tidal flooding is accelerating in more than 25 coastal cities along the Atlantic Ocean and Gulf of Mexico. Large forest fires have become more frequent in the western part of the country, while warmer spring temperatures and shrinking mountain snowpack are combining to reduce the amount of water available to the region's cities and farms. As a result, the draft climate-impacts report warns, “chronic, long-duration hydrological drought is increasingly possible before the end of the century”.

The report comes just days before the latest United Nations climate talks kick off in Bonn, Germany. It will also be the first major summit since Trump vowed to pull the United States out of the 2015 Paris climate pact.

Few observers expect US government's latest set of climate-change analyses to affect how the Trump administation approaches energy and environmental issues. In August, the US National Oceanic and Atmospheric Administration disbanded an advisory committee that was intended to help the nation prepare for a warmer climate, by translating the findings of the coming climate assessment into guidance for cities, states and industry.

Nor is it clear whether senior Trump administration officials will accept the reports' core scientific conclusions. As recently as March, US Environmental Protection Agency administrator Scott Pruitt said he did not believe that carbon dioxide is major driver of global warming.

Nonetheless, many scientists and environmentalists lauded the new reports for bolstering the case for more-aggressive action against climate change.

“The full assessment, when it gets published, is going to show that there are palpable impacts that are going to hit every part of the country,” says Andrew Light, a senior fellow at the World Resources Institute, an environmental think-tank in Washington DC. “It’s the responsibility of leaders to take note of that and act accordingly.”

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Nature
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Comments

There are currently no comments.

Newly discovered orangutan species is also the most endangered

The first new species of great ape described in more than eight decades faces threats to its habitat.

02 November 2017

Maxime Aliaga/SOCP-Batang Toru Programme

Orangutans in Sumatra's Batang Toru forest are now officially a new species: *Pongo tapanuliensis.*

Almost a century after scientists first heard rumours of its existence, an isolated population of orangutans on the Indonesian island of Sumatra has

been confirmed as a new species — just as its habitat faces imminent threats.

The population, estimated at fewer than 800 individuals, inhabits the Batang Toru forest in western Sumatra. A researcher exploring the area in the 1930s wrote of reports of an isolated orangutan population. But it wasn't until biological anthropologist Erik Meijaard, the founder of conservation group Borneo Futures in Jakarta, discovered the paper in the mid-1990s that scientists went looking for the Batang Toru group. Local villagers showed researchers the remains of a female orangutan, and nests in the area confirmed the presence of a population. A male orangutan killed by locals in 2013 provided key evidence: intact tissue and bone.

From the start, scientists noticed that these apes looked different from other orangutans. They had smaller heads, with flatter faces, and their hair was frizzier than that of their cousins living farther north on Sumatra or on the nearby island of Borneo.

Gene gap

Now, genetic tests, field observations and a comparison of the male skeleton against 33 orangutan specimens in museums have revealed that the Batang Toru group is, in fact, a distinct species. Named *Pongo tapanuliensis*, the newly identified great ape is described in *Current Biology*[1] on 2 November by a team that included most of the world's orangutan experts. "It's taken 20 years to come to the realization of what this is," Meijaard says.

Although the genetic analysis of *P. tapanuliensis* relies on a single skeleton, Meijaard says that's not unusual in taxonomy. Many studies, including others he's contributed to, rely on a single piece of evidence, and typically consider only morphology. The latest study shows that the group is distinct not only in morphology, but also in genetics and behaviour, he says.

Matthew G. Nowak

P. tapanuliensis orangutans have smaller heads and flatter faces than their cousins elsewhere on Sumatra and on Borneo.

Russ Mittermeier, executive vice-chair of Washington, DC-based Conservation International and chair of the primate-specialist group at the International Union for Conservation of Nature (IUCN), describes the evidence as “unquestionably” sufficient to support the new species designation. “Although we have had 87 new species of primates described since 2000, this is the first new great ape species since 1929.”

Biruté Mary Galdikas, an orangutan specialist in Los Angeles who founded Orangutan Foundation International, says that the study confirms what she and other orangutan researchers have suspected for decades. “I am not surprised that there is a new species or subspecies of orangutan described from Sumatra,” she says.

Ancestral ties

Key to the determination was tracing the population’s ancestry. Surprisingly, Meijaard says, genetic testing of the Batang Toru skeleton revealed that the population is more closely related to Bornean orangutans, despite living on the same island as the other Sumatran group. That’s probably because of how

orangutans migrated to the region, he says.

All orangutans trace their origins to ancestors that lived on the Asian mainland about 8 million years ago. Those great apes migrated to what is now Sumatra, when sea levels were lower and the lands were connected. Genetic data suggest the Batang Toru species is the closest descendant of those first arrivals.

The other Sumatran orangutans, which live in the island's far north, split off from the Batang Toru group about 3.4 million years ago, modelling based on genetic data suggests. The Bornean orangutans also split from the Batang Toru group, but much later — about 674,000 years ago — which explains why those two populations are more similar, Meijaard says.

Even as Batang Toru's orangutans are named a new species, the animals' long-term survival is uncertain. Previous population analyses suggest there are fewer than 800 individuals, making it the most endangered of the great apes. Although much of its habitat is protected by the Indonesian government, a proposed hydroelectric dam on the Batang Toru river would flood part of the area and divide the population into two, isolating the groups on either side of the river. That's likely to further shrink the gene pool in the already inbred population, Meijaard says. The dam would also bring more people to the area, potentially increasing hunting pressure.

Conservation groups are working with government officials to find an alternative site for the project, says Meijaard. "There is no doubt that conservation efforts are needed immediately," Mittermeier says.

The IUCN primate-specialist group has recently recommended that the species be included on the IUCN Red List of Threatened Species. A decision is expected in December. "It would be bitterly ironic if it goes extinct as a biologically viable population just as it is described as a new species," says Galdikas.

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doi:10.1038/nature.2017.22934

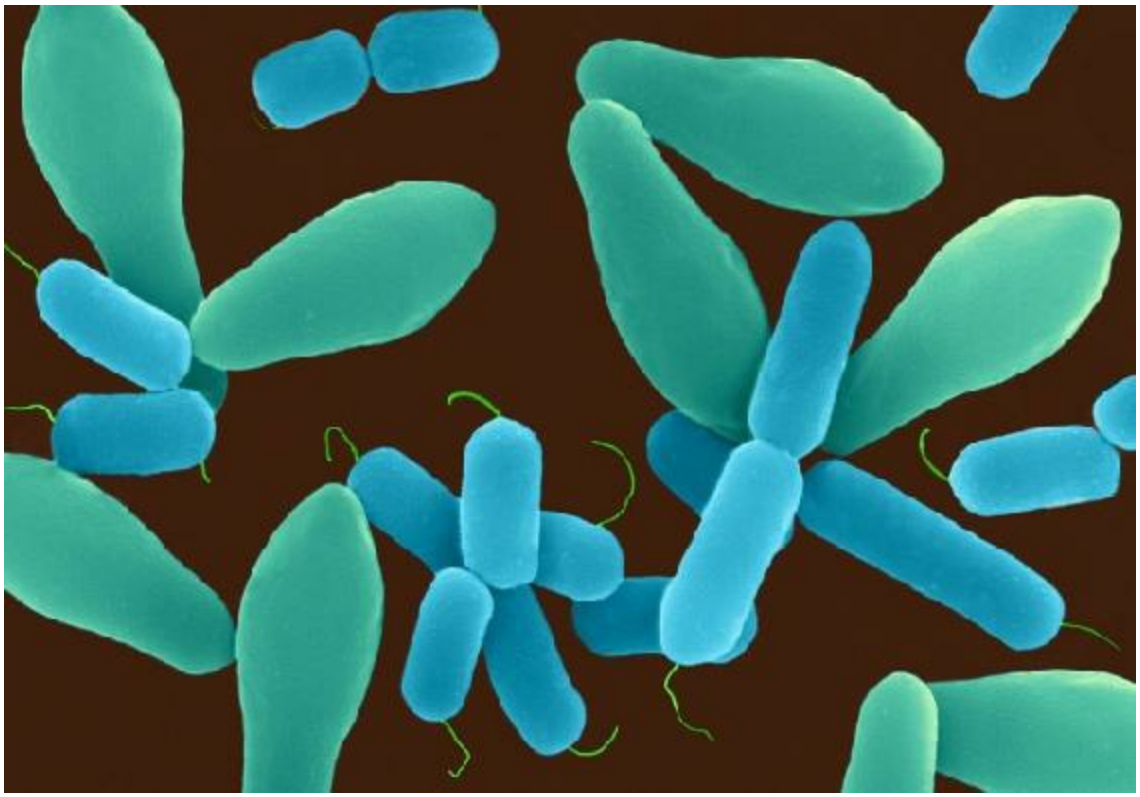
Comments

There are currently no comments.

Gut microbes can shape responses to cancer immunotherapy

Studies find that species diversity and antibiotics influence cutting-edge treaments.

02 November 2017



Dennis Kunkel Microscopy/SPL

Gut bacteria such as these *Clostridium* could improve a patient's reponse to cancer immunotherapies.

Cancer immunotherapies unleash the body’s immune system to fight cancer, but microbes living in a patient’s gut can affect the outcome of those

treatments, two research teams have found.

Their studies, published on 2 November in *Science*[1, 2], are the latest in a wave of results linking two of the hottest fields in biomedical research: cancer immunotherapy and the role of the body's resident microbes, referred to collectively as the microbiome, in disease.

They also highlight the impact of antibiotics on cancer immunotherapies, particularly drugs that block either of two related proteins called PD-1 and PD-L1. One of the studies found that people treated with antibiotics for unrelated infections had a reduced response to these immunotherapies.

“It raises important questions,” says cancer researcher Jennifer Wargo of the University of Texas MD Anderson Cancer Center in Houston, and an author of one of the studies. “Should we be limiting or tightly monitoring antibiotic use in these patients? And can we actually change the microbiome to enhance responses to therapy?”

The composition and diversity of the microbiome has been linked to everything from mental-health disorders to some side effects of cancer chemotherapy. In 2015, researchers working on mice reported that a specific genus of bacterium in the gut enhanced anti-tumour responses to drugs that target PD-L1[3].

Wargo saw a presentation about the work at a cancer meeting several years ago. “I was floored,” she says. Wargo saw an opportunity to expand the work to humans through her access to clinical samples at MD Anderson.

Exerting influence

Wargo teamed up with epidemiologist Vancheswaran Gopalakrishnan and other researchers to collect faecal samples from more than 100 people with advanced melanoma before they began treatment with anti-PD-1 immunotherapy drugs. The scientists found that those who had the most diverse gut microbes were most likely to respond to the immunotherapy[1]. And tumour growth was reduced in mice that received faecal transplants from

people who responded to immunotherapy.

The type of microbe was also linked to differences in responses to treatment, the researchers discovered. For example, people whose guts contained a lot of bacteria from a group called Clostridiales were more likely to respond to treatment, whereas those who had more Bacteroidales bacteria were less likely to respond.

A second study[2] showed that people who received antibiotics to treat infections shortly before or after starting immunotherapy did not respond as well to PD-1-blocking therapies. The researchers — led by cancer immunologist Laurence Zitvogel and cancer biologist Guido Kroemer, both of the Gustave Roussy Cancer Campus in Villejuif, France — also found that the presence of the bacterium *Akkermansia muciniphila* in both humans and mice was linked to better responses to immunotherapy.

Although it's too early for clinicians to change how they use antibiotics in people with cancer, the work is a step beyond previous studies that relied mainly on mouse models of cancer, says immunologist Romina Goldszmid of the National Cancer Institute in Bethesda, Maryland.

Now, she says, researchers need to learn more about how those microbes exert their influence on the immune system. "What's really missing in the field, rather than knowing who is there and who isn't there, is knowing what the bugs are doing," she says. "We need more information about that."

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Comments

Comments

There are currently no comments.

Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid

Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.

02 November 2017

Tomasz Tomaszewski/VISUM creativ/eyevine

A previously unknown chamber has been found in the largest of the pyramids in Giza, Egypt.

Physicists have used the by-products of cosmic rays to reveal a large,

previously unidentified chamber inside the 4,500-year-old Great Pyramid in Giza, Egypt. The find is the first discovery since the nineteenth century of a major new space inside the pyramid.

Egyptologists have been quick to dismiss any idea of finding lost treasure in the 30-metre-long void. “There’s zero chance of hidden burial chambers,” says Aidan Dodson, an Egyptologist at the University of Bristol, UK, who studies ancient Egyptian tombs. But experts hope that the finding will lead to significant insights into how this spectacular pyramid was built.

The Great Pyramid was constructed by the pharaoh Khufu (also known as Cheops), who reigned from 2509–2483 BC. Constructed from limestone and granite blocks, and rising to 139 metres, it is the oldest and largest of the Egyptian pyramids and one of the most impressive structures to survive from the ancient world.

Chamber layout

Whereas other pyramids from this period sit above underground burial chambers, Khufu’s Pyramid contains several large rooms inside the body of the structure itself. These include the King’s chamber, which still holds a stone sarcophagus, the smaller Queen’s chamber and a sloping passageway known as the Grand Gallery.

These large chambers were discovered in the ninth century AD and explored extensively by Western archaeologists in the nineteenth century. But enthusiasts have wondered ever since whether there might be more hidden chambers inside the pyramid, or even whether the king’s real burial chamber is yet to be found.

“There are so many theories — nice ones but also crazy ones,” says Mehdi Tayoubi, president of the Heritage Innovation Preservation institute in Paris. So, he co-founded an international collaboration called Scan Pyramids to find out; the project was supervised by the Egyptian Ministry of Antiquities. The group is “agnostic” about particular theories, he says, but is using non-invasive technologies to search for hidden chambers.

ScanPyramids

Researchers placed muons detectors inside and outside the pyramid to find ou whether theories of a hidden space in the Great Pyramid were true.

To see through the Great Pyramid, the researchers used a technique developed in high-energy particle physics: they tracked particles called muons, which are produced when cosmic rays strike atoms in the upper atmosphere. Around 10,000 muons rain down on each square metre of Earth's surface every minute. Sensitive muon detectors have been developed for use in particle accelerators, but they have also been used in the past decade or so to determine the inner structures of volcanoes and to study the damaged nuclear reactor at Fukushima, Japan.

Muon maps

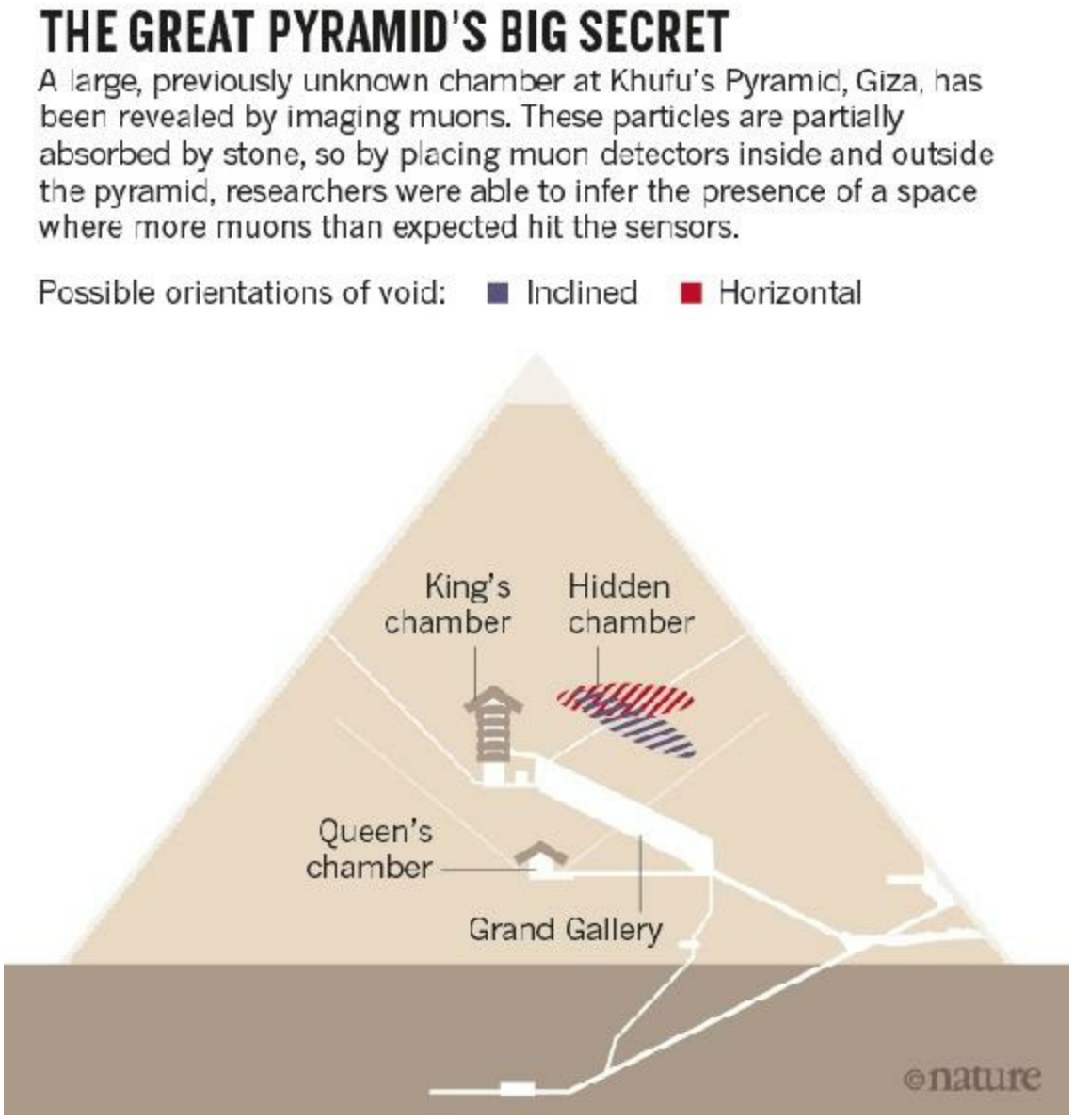
In December 2015, physicist Kunihiro Morishima of Nagoya University, Japan, and his colleagues placed a series of detectors inside the Queen's

chamber, where they would detect muons passing through the pyramid from above. The particles are partially absorbed by stone, so any large holes in the pyramid would result in more muons than expected hitting the detectors.

After several months, “we had an unexpected line”, says Tayoubi. To check the result, two other teams of physicists, from the Japanese High Energy Accelerator Research Organization in Tsukuba and the French Alternative Energies and Atomic Energy Commision in Paris, then used different types of muon detector placed in other locations both inside and outside the pyramid.

All three teams observed a large, unexpected void in the same location above the Grand Gallery (see 'The Great Pyramid's big secret'). Their results were reported in *Nature*[1] on 2 November. The space is at least 30 metres long, with a similar cross section to the Grand Gallery. “It was a big surprise,” says Tayoubi. “We’re really excited.”

The chamber could be either horizontal or inclined, the researchers say, and might be made up of two or more smaller spaces. The purpose of the space is unknown, but Tayoubi suggests that it could be “a second Grand Gallery”.



With high, corbelled — or stepped — ceilings and mysterious stone benches, the Grand Gallery is “one of the most fantastic rooms constructed in the ancient world”, says Bob Brier, an Egyptologist at Long Island University in Brookville, New York, who co-wrote the 2008 book *The Secret of the Great Pyramid* (Smithsonian). “If there’s another one, that’s real news.”

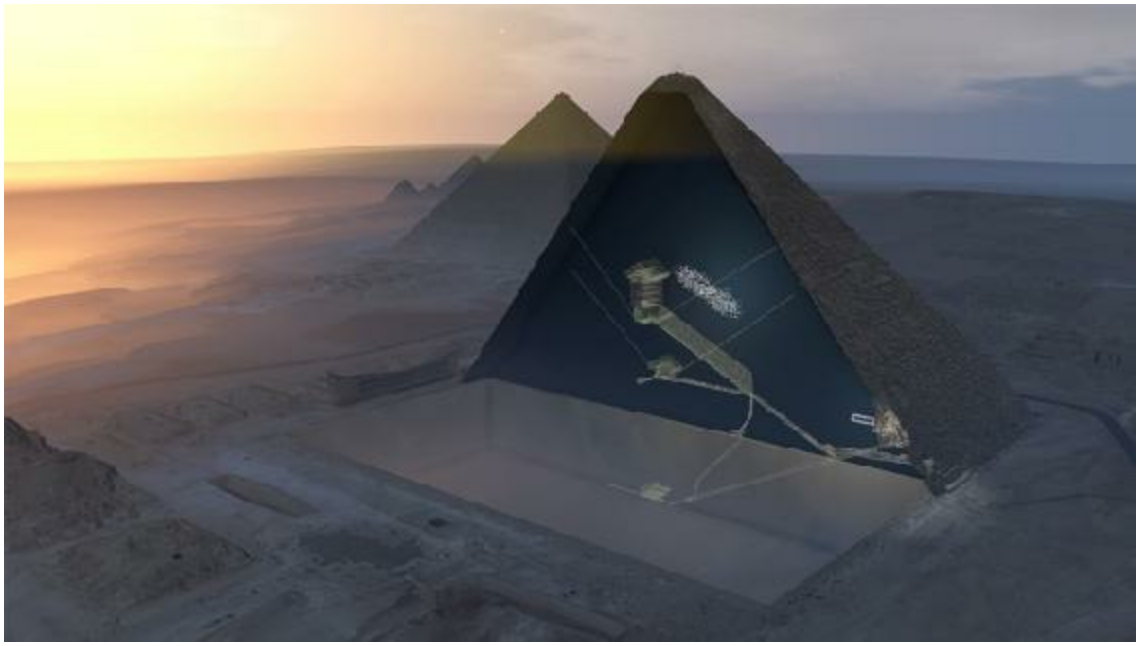
Theories abound

The newly discovered space is unlikely to contain any artefacts relating to the

king’s burial, says Dodson, because there’s already a burial chamber with a sarcophagus in it. Instead he speculates that the space might be a “relieving chamber”, intended to reduce the weight of masonry pressing down on the Grand Gallery. Similar relieving chambers are seen above the King’s chamber and in the pyramid of Khufu’s father, Sneferu, at Meidum, another pyramid site in Egypt.

But Colin Reader, an independent geologist and engineer based in Liverpool, UK, who has studied Egyptian pyramids, suggests that the new chamber is too far from the Grand Gallery to serve this purpose. He wonders whether, just as the Grand Gallery leads to the King’s chamber, the void might lead to another, higher chamber. “You would want to investigate and rule that out,” he says.

Brier has a third theory. In 2007, he and French architect Jean-Pierre Houdin suggested that the Grand Gallery formed part of a huge counterweight system. Weights sliding down the floor of the Grand Gallery could have raised the hefty, granite blocks that comprise the King’s chamber, he says. He speculates that the new space could be part of a second counterweight system higher up.



ScanPyramids

A 3D visualization of the Great Pyramid and its hidden chamber (white dots).

The results also seem to reject the theory, put forward by Houdin and Brier, that the builders of the Great Pyramid used an internal ramp to raise blocks up to the highest levels. “These data suggest that the ramp is not there,” says Brier. “I think we’ve lost.”

Tayoubi says that he next wants to scan Khafre’s (also known as Chephren’s) Pyramid, Egypt’s second largest pyramid. A team led by Nobel-prizewinning physicist Luis Alvarez carried out muon imaging in this pyramid in the late 1960s, using spark chambers as detectors and recording the cosmic-ray data on magnetic tape.

They reported no new chambers in the areas scanned[2]. But technology has improved dramatically since then, points out Tayoubi.

“I think Alvarez was a real visionary guy,” says Tayoubi. “He had the right idea, maybe too early. Our dream would be to give a tribute to Alvarez and redo the Khafre experiment, to see if he was right.”

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Nature
DOI:
doi:10.1038/nature.2017.22939

Comments

Commenting is currently unavailable.

Controversial chairman of US House science committee to retire

Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.

02 November 2017

Bill Clark/CQ Roll Call/Getty

Representative Lamar Smith was first elected to the US Congress in 1987.

Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, will retire when his term expires late next year.

Smith, a Texas Republican, has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation (NSF) and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. Since taking the helm of the science committee in 2013, he has transformed it from a relatively deliberative panel into an investigative weapon.

Under the rules of the House of Representatives, which limit committee chairs to six years in the role, Smith would have been forced to relinquish his post on the science panel in 2019. That is one of the reasons he decided against running for re-election, according to news reports; the other is the upcoming birth of his second grandchild. As the news of his retirement made the rounds, many scientists and environmentalists celebrated.

“It is a relief,” says Katharine Hayhoe, director of the Climate Science Center at Texas Tech University in Lubbock. Although many politicians have rejected the conclusions of climate science out of political expediency, she says, Smith has been more aggressive than most.

The congressman has repeatedly tried to reshape the NSF, sponsoring multiple pieces of legislation that would require the agency to justify its grants and explain how they serve the “national interest”. He has also pushed unsuccessfully to scale back programmes in geoscience and social sciences, among other fields.

Smith has notably scrutinized the work of climate scientists. In 2015, he attempted to compel the US National Oceanic and Atmospheric Administration (NOAA) to hand over internal documents related to a climate-change study. The research, published in *Science* in 2015[1], sought to dispel the idea that the rate of global warming had slowed down around the turn of the century. Smith went so far as to accuse a NOAA official — Thomas Karl, who has since retired — of manipulating data to advance an “extreme climate change agenda”.

In 2016, Smith came to the defence of oil giant Exxon Mobil when it was being investigated by the attorneys-general of New York and Massachusetts, who wanted to know whether the firm had misled investors about the

financial implications of global warming. Smith issued subpoenas to the attorneys-general as part of a broader probe, which also targeted environmental groups that have accused Exxon Mobil of suppressing internal research and spreading false information about climate change.

“I think [Smith’s] position on peer review, on the NSF and climate science put him at odds with the science community,” says physicist Neal Lane, a former NSF director who served as science adviser to former president Bill Clinton. “But it was consistent with that of the leadership in the House, which can hardly be described as pro-science.”

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Nature
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doi:10.1038/nature.2017.22954

Comments

Comments

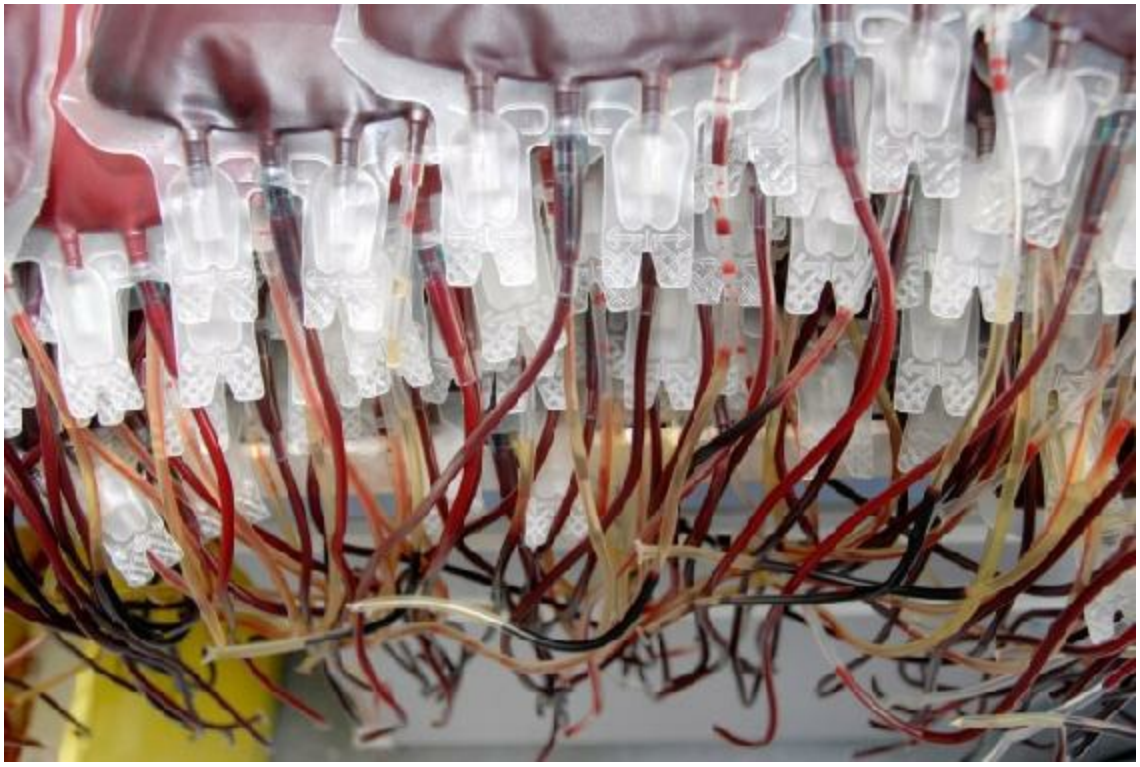
There are currently no comments.

Infusions of young blood tested in patients with dementia

The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.

01 November 2017 Corrected:

1. 03 November 2017



AJ Photo/SPL

Donor blood from young people has been transfused into people with dementia.

The first controlled, but controversial and small, clinical trial of giving young blood to people with dementia has reported that the procedure appears safe. It has also hinted that it may even produce modest improvements in the daily lives of people who have Alzheimer's disease.

Researchers who conducted the trial and others caution that the results are based on just 18 people and therefore are only a first step in exploring this type of treatment. "This is a really very small trial and the results should not be over-interpreted," says Tony Wyss-Coray, a neuroscientist at Stanford University in California. The trial was conducted by his start-up company Alkahest, which is based in San Carlos, California, and was led by Stanford neurologist Sharon Sha.

The results suggest the procedure is safe and hint that it could even boost the ability of people with dementia to undertake everyday skills, such as shopping or preparing a meal. The team announced the results on 1 November and plans to present them on 4 November at the 10th Clinical Trials on Alzheimer's Disease conference in Boston, Massachusetts.

The team tested people aged between 54 and 86 with mild to moderate Alzheimer's disease. The team gave the 18 subjects weekly infusions for four weeks. They received either a saline placebo or plasma — blood from which the red cells have been removed — from blood donors aged 18–30. During the study, the team monitored the patients to assess their cognitive skills, mood and general abilities to manage their lives independently.

The study detected no serious adverse reactions. It saw no significant effect on cognition, but two different batteries of tests assessing daily living skills both showed significant improvement.

The human trial grew out of earlier 'parabiosis' experiments, in which the blood systems of two rodents are surgically joined together to see what happens when molecules circulating in one animal enter another animal.

Alkahest now plans to conduct a second, larger trial using plasma from which many proteins and other molecules have been removed. Wyss-Coray, whose group did most of the mouse studies that inspired the clinical trial[1] told *Nature* that his experiments suggest that such a treatment could be more

effective than using whole plasma.

Transfusion confusion

Blood-transfusion trials are controversial because the active molecules in plasma that seem to lead to the purported effects are unknown.

Irina Conboy, a neurologist at the University of California, Berkeley, and her colleagues have performed extensive parabiosis experiments stitching together young and old mice that have been genetically matched. She has found that young blood clearly rejuvenates mouse tissues such as the heart and the brain[2]. But she says that the effects are probably coordinated by a complex orchestration of factors in the blood that needs to be understood more fully before moving to the clinic.

“The scientific basis for the trial is simply not there,” she says. “The effects of young blood on cognition have not been replicated by an independent group, and there has never been a test with a mouse model of Alzheimer’s.” She says that frequently exposing older people to foreign plasma may be unsafe, because hyperactivation of their immune systems could lead to autoimmune or inflammatory disease.

But, Wyss-Coray says, “Alzheimer’s patients don’t want to wait until the exact mode of action is discovered.”

He says that it is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain, which has so far failed to result in any treatments.

Blood transfusions used for this purpose do not require approval by the US Food and Drug Administration, and some American companies are already charging hefty fees for transfusions of blood from young people.

Journal name:
Nature
DOI:

doi:10.1038/nature.2017.22930

Corrections

Corrected:

An earlier version of this story wrongly identified Tony Wyss-Coray as leading the clinical trial. In fact, the trial was led by neurologist Sharon Sha of Stanford University and doctors working for Alkahest. Alkahest, not Wyss-Coray, will conduct the second, larger trial. Wyss-Coray was also wrongly identified as a neurologist.

Comments

1 comment

1. *Chris Exley* • 2017-11-02 03:10 PM

   Wyss-Coray is clearly wrong to suggest that this 'is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain'. We showed that silicon-rich mineral waters provided some cognitive improvements in individuals with AD over only 12 weeks (https://content.iospress.com/articles/journal-of-alzheimers-disease-reports/adr170010) and similar research published today has suggested benefits in individuals with multiple sclerosis (http://www.ebiomedicine.com/article/S2352-3964(17)30428-0/fulltext). Unfortunately we do not have the resources of Wyss-Coray to take these prospective therapies further.

Pay for US postdocs varies wildly by institution

Analysis of universities' salary data suggests major disparities in pay for early-career researchers.

01 November 2017

Some postdoctoral researchers at public universities in the United States apparently work for fast-food wages whereas others make more than US$100,000 a year, an analysis of postdoc pay has revealed.

The salary data, which a science-advocacy group released on 1 November after a year-long investigation, are incomplete and — in some cases — appear to be incorrect. Some researchers are listed as earning nothing, and another study underway suggests a higher overall rate of pay for US postdocs. But the latest analysis underscores the challenges of getting basic information about an under-recognized and misunderstood segment of the

academic workforce.

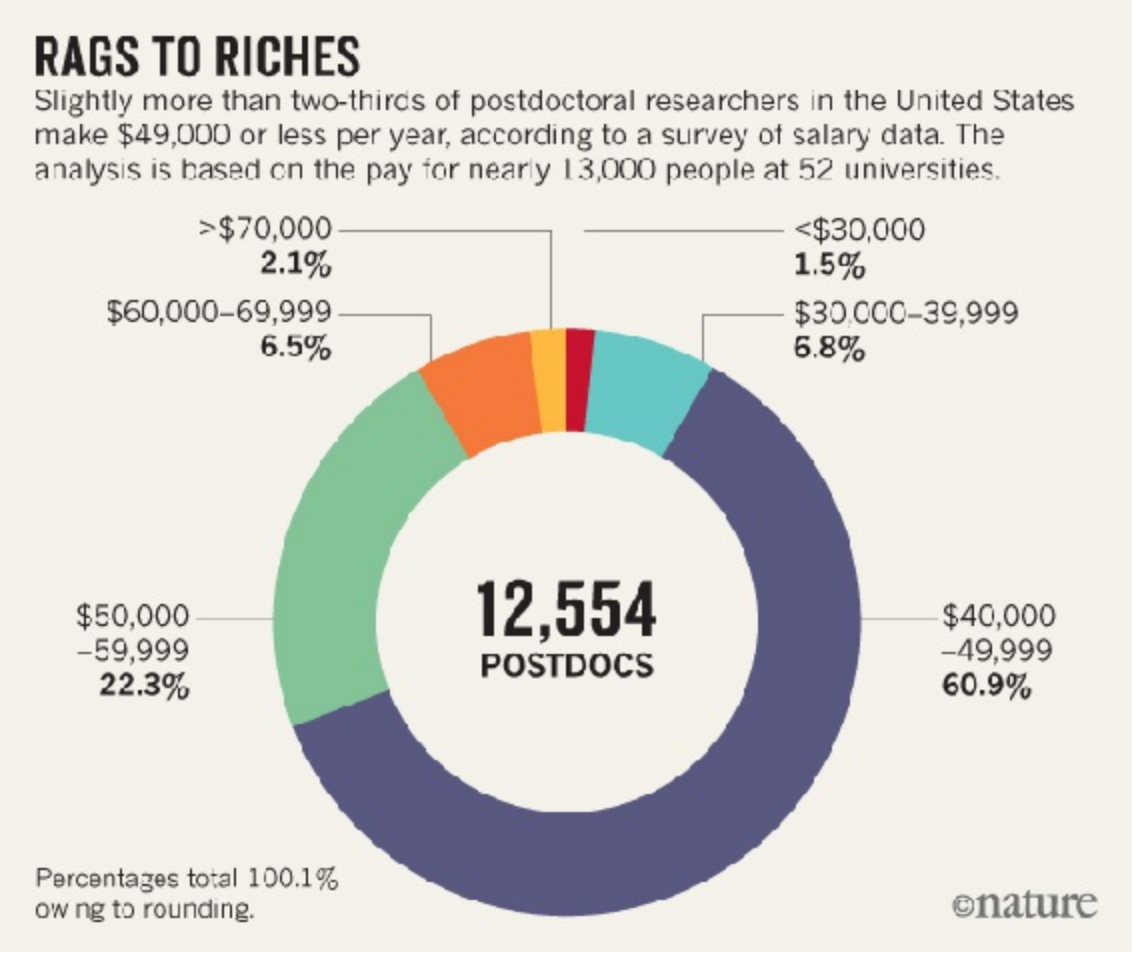
Gary McDowell, a former developmental biologist and executive director of Future of Research, an advocacy group in Boston, Massachusetts, used the US Freedom of Information Act to gather salary reports for nearly 13,000 postdocs at 51 public universities. Through personal connections, he also received salary information from one private institution, Boston University in Massachusetts.

Most universities made a good-faith effort to provide salary information, McDowell says, but few had the numbers at hand when he contacted them. McDowell says that he had to spend considerable time on the phone explaining to university employees what 'postdoc' means. “I asked a basic question — 'How much do your postdocs get paid?' — but there was a lot of confusion,” he says. “It points to how much interest there is in postdocs at these institutions.”

Multiply by zero?

Some universities still provided improbable numbers. They include the University of Utah in Salt Lake City, which reported that 50 postdocs each made $0 per year. McDowell says it is unlikely that these researchers were unpaid volunteers. Instead, he suspects that some institutions — including the University of Utah — reported only the money that postdocs received from the institution's payroll, and overlooked fellowships and other external sources of income. “University of Utah postdoctoral scholars are being paid for their work,” a university spokesman said.

While compiling data, McDowell opted to disregard the 411 reported salaries that were less than $23,660 a year. That is the threshold below which many postdocs would be eligible for overtime pay under a federal law called the Fair Labor Standards Act. “I gave them the benefit of the doubt,” McDowell says of those entries. “Those are likely reporting errors.”



Gary McDowell/Future of Research

The remaining 12,554 salary reports ranged from $23,660 to $114,600 a year (see 'Rags to riches'). McDowell suspects that some institutions mistakenly included pay data for staff scientists or other employees in their reports, which could explain some of the highest salaries. Even with that caveat, his survey suggests that postdoc salaries range widely. At any given institution, McDowell says, “It’s not uncommon for there to be fourfold differences between the highest and the lowest paid.”

Overall, 61% of reported salaries were between $40,000 and $49,999, and about 31% were reported at $50,000 or more. (The $50,000 figure is the minimum postdoctoral salary recommended in 2014 by the US National Academies of Sciences, Engineering, and Medicine.) The University of Illinois at Urbana-Champaign reported the lowest median salary at $27,515.

The University of Maryland at College Park reported the highest median figure — $56,000.

Emerging trends

McDowell notes that the data set is still incomplete. Some institutions reported salaries for only a small fraction of their workforce, and the University of California (UC) system denied his request outright. The university system's public-records office told *Nature* in a statement that it lacks the capacity to do "the programming required to create the custom data report that Mr McDowell requested". The University of California, Santa Barbara, had already provided numbers to McDowell when the broader UC system denied his request for data.

Other attempts to gather information on postdoctoral salaries have met with less resistance. The National Postdoctoral Association (NPA) in Rockville, Maryland, solicited salary information from its more than 200 member institutions for a forthcoming report. "We've worked with these institutions for over a decade, and when we ask for information they readily give it," says Kate Sleeth, chairwoman of the NPA's board of directors. "We didn't have to explain to anyone what a postdoc is."

Of the 127 NPA member institutions that participated in the survey, 85% reported paying all postdocs at least $47,484 — the minimum salary established by the US National Institutes of Health for the 2017 fiscal year. The NPA is set to publish the full results of its poll in January 2018.

In the meantime, McDowell is still combing through his data set. Throughout November, he plans to publish daily analyses on the Future of Research website, futureofresearch.org, that will examine salaries at individual institutions and university systems. In doing so, he hopes to promote conversation about the treatment of early-career researchers.

"In academia, we're not supposed to talk about money and we're not supposed to aspire to having money," McDowell says. "I think scientists should value scientists."

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Comments

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Citation is not the only impact

A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.

01 November 2017

Getty

A research paper on drying coffee stains had unusual and unexpected applications.

What makes good science? And how do *Nature*'s editors select papers to publish? The answers to both questions are many and varied. But they have one thing in common: neither is necessarily reflected in citations.

Nature publishes about 800 papers each year. Over, say, two years following

publication, the pattern of citations typically ranges from a few papers with citations in the hundreds, to a large number with tens of citations, and a tail with single figures.

We are pleased when our papers make an impact. But there is much more to scientific impact than citations. For example, last week, in an 'In Retrospect' article in News & Views, Ronald Larson described a remarkable story (R. Larson *Nature* **550,** 466–467; 2017). In 1997, *Nature* published a paper by Robert Deegan and his colleagues that provided an explanation of the 'coffee-ring effect' in spilt liquids, based on considerations of evaporation and surface interactions (R. D. Deegan *et al. Nature* **389,** 827–829; 1997). For several years, the paper sat proudly in our pages, typically gathering about 20 citations per year. In 2006, as new implications and applications became clear, the rate picked up to well over 100 a year. So far, it has attracted about 4,000 citations. The paper is worth highlighting as an example of the varied types of judgement that *Nature* editors use to select papers.

Our most highly cited papers are indeed often key landmarks in their fields. But there are papers that turn out to have low citations that we are equally happy to have published. The work by Deegan *et al.* was selected not because of any editorial ability to anticipate advances years in the future, but because, at the time, we considered it to be a noteworthy and pleasing piece of insight. Nothing more, nothing less. The developments celebrated by Larson are an editor's unexpected bonus.

Most papers that we publish, with the invaluable help of our reviewers, are selected with a view to their scientific significance, whether as a powerful insight or an unusually empowering resource. And often that will correlate closely with citations (although citation patterns differ across disciplines). But it's important also, for editors in all the disciplines from which we publish, sometimes to appreciate the interest in a paper using quite different criteria. It may be compelling for its sheer creativity or logical elegance, for making the reader stop and think very differently about a question, or for a stimulating and even mysterious observation. Many of these may be slow burners citation-wise — or simply be textbook examples that never get taken up in abundance. Here are other examples, drawn from the physical sciences,

that, despite low citations, we like to celebrate.

One such paper illustrated how images could be taken using X-rays radiated when sticky tape was peeled (C. G. Camara *et al. Nature* **455,** 1089–1092; 2008). The citations are not huge by physics standards (165 since 2008) but we still love it, and we did not fully anticipate how it would go viral on social media. Another (11 citations) reported an actual sample of Cretaceous seawater from 145 million years ago. (W. E. Sanford *et al. Nature* **503,** 252–256; 2013). And finally, a theoretical paper providing an exact textbook solution for the capacity of noisy quantum communication channels has been cited just six times since 2013 (G. Smith and J. A. Smolin *Nature* **504,** 263–267; 2013), but we value it for what it is and anticipate that its take-up could increase as research moves from idealized 'noise-free' systems to more realistic noisy ones.

There are examples in other disciplines too. Why highlight such papers? Because we are glad to have published them. And because it's perhaps salutary to appreciate just how unrelated scientific interest (at least, as we at *Nature* see it) and citation numbers can be.

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Urban Vibe
Studios
London

University systems allow sexual harassers to thrive

It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen[1].

01 November 2017

Harvey Weinstein, Roger Ailes, Geoff Marcy. From entertainment to academia, accusations of these people's abuses of power have helped to create a sea change in the numbers of people willing to discuss sexual harassment in the workplace. Much of the conversation has concerned condemnation of harassers and praise for those who come forward to talk about what they have seen and experienced. This puts an interpersonal frame on a systemic problem. Attention must also be paid to systems that allow harassers to thrive.

In 2006, I joined the Brain and Cognitive Sciences Department at the University of Rochester, New York, as a PhD student. This August, I joined other female graduate students and postdocs who contributed testimony to a complaint to the US Equal Employment Opportunity Commission over

sexual harassment, poor handling of investigations of our claims and discrimination. We described how we actively avoided Florian Jaeger, a professor in our department, because of his frequent sexual innuendos, pressure to have intimate relationships and other unprofessional behaviour. We were faced with the unfair and unreasonable choice of losing professional opportunities or exposing ourselves to profoundly disturbing encounters. (According to *The New York Times*, Jaeger has since taken a leave of absence but said this was not an admission of guilt.)

I knew this behaviour was not acceptable. I was also convinced that if I came forward alone, I risked retribution and the university would not take my claims seriously. I felt my best option was to warn other students privately and make it known that I would come forward if we reached a critical mass.

After I chose to move away to finish my dissertation, I learnt that in 2013 two colleagues had complained to the department chair about Jaeger's behaviour and given my name as someone who should be interviewed. I was not contacted. In 2016, other senior faculty members learnt of these claims and filed a second complaint to the university to investigate. This time the university first contacted me during an appeal, after issuing a report that cleared Jaeger. The first person to secure testimony from me was from McAllister Olivarius, a London-based legal firm hired by the plaintiffs. My former colleagues had found a powerful ally in getting their complaints taken seriously.

It should not have taken such heroic efforts.

In this regard, Hollywood and academia have troubling similarities. Both rely too much on mentor–protégé relationships, with few checks on individual power. In academia, there is scant protection for lab members. Graduate students and postdocs are viewed more as part of their supervisor's lab than part of the university community. By contrast, institutions have many incentives to protect their powerful, permanent and often lucrative faculty members.

Administrators can reasonably assume that, if they ignore claims for long enough, they will never be held to account. People like me graduate or leave without a degree, the statute of limitations passes, and the harassers get

promoted. Sometimes universities don't interview suggested witnesses or collect other evidence; in my view, this allows them to claim that they investigated complaints but found insufficient reasons for further action. (The University of Rochester has said it took the allegations seriously and that its investigation was thorough.)

Since completing my PhD, I've taken a position at a large company. There are still power differentials in such settings, and sexual harassment can occur unpunished anywhere. However, I've seen several practices that I think academia could learn from.

In my first week of employment, the company explained my rights to a safe workplace and gave me options for reporting concerns. As a graduate student, I had mistakenly believed that the only instances of sexual harassment that could be brought forward were the most egregious: assault or quid-pro-quo propositions. I was unaware of legal precedents involving pervasive harassment creating a hostile and unequal environment. I was also unaware of the standard of preponderance of evidence, and thought that every instance had to be recorded and irrefutable. Graduate students and employees should not have to be legal scholars to win protections.

Another problem is how much the fate of a graduate student or postdoc depends on a supervisor who controls funding for their position, when they can submit a dissertation or paper and what other opportunities they can apply for. Power is less likely to be abused when it is more distributed.

My current company holds drop-in conference calls throughout the year, some of which are reserved for women only. We can discuss concerns off the record or even anonymously; topics range from standardizing the promotion process and improving diversity in recruitment, to discussing comments that have made us feel undermined or uncomfortable. People bringing concerns have options about whether and how they are reported outside the call. At the same time, leaders can become aware of even minor problems and address them (through discussion with staff and line managers, or through memos) before they become patterns that lead to a toxic work environment.

We used to consider those in leadership positions blameless simply by virtue of not being harassers themselves. We now expect better.

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Interstellar visitor, Arctic shipwrecks and a retraction recommendation

The week in science: 27 October–2 November 2017.

01 November 2017

History | Universities | People | Medicines | Research | Space | Events | Facilities | Climate | Trend watch | Awards

HISTORY

Arctic explorer's wrecks given to Canada The UK government is giving Canada two historic shipwrecks: those of HMS *Erebus* and HMS *Terror*. The vessels were part of British explorer Sir John Franklin's ill-fated 1845 expedition to find the Northwest Passage, a long-sought shipping route that connects the Atlantic and Pacific oceans through the Canadian Arctic. Franklin died, along with his entire crew, after the ships became ice-bound and the team abandoned them. Marine archaeologists discovered *Erebus* and *Terror* in 2014 and 2016, respectively, off King William Island. In 1997, an agreement had granted custody of the yet-to-be located wrecks to Canada, although they remained property of the United Kingdom. On 23 October, the UK government said that it would transfer ownership of the ships to Parks Canada, a government agency.

Parks Canada

Part of the wreck of the HMS *Terror*.

UNIVERSITIES

Institute dissolved The Swiss Federal Institute of Technology in Zurich (ETH Zurich), one of Europe's leading universities, has launched an investigation into allegations that PhD students were regularly bullied in its Institute for Astronomy. ETH Zurich released a statement on 25 October saying that it had closed the institute in August in response to the accusations, which were made earlier this year. Newspaper reports say students had complained that astrophysicist Marcella Carollo — a professor, and wife of the institute's director Simon Lilly — had been inappropriately and personally critical, and overly demanding of their time. The university did not publicly name the couple, but said that it had transferred their professorships to the university's physics department. It moved other Institute for Astronomy staff to a newly created Institute for Particle Physics and

Astronomy, and assigned the students new supervisors.

Science cluster French President Emmanuel Macron has announced a plan to save the troubled Paris-Saclay project, an attempt to create a single science 'super-campus' southwest of the city. During a visit to the site on 25 October, Macron said that the project would now proceed in two clusters, one made up of elite institutions called *grandes écoles*, and one made up largely of universities. The project, which initially aimed to bring together nearly 20 research and teaching institutions under one umbrella university, had been mired by the *grandes écoles*' refusal to give up their names and autonomy. A previous effort this year to find a compromise solution had failed. "The time of procrastination is behind us," Macron said.

PEOPLE

Surgeon's papers Six research papers co-written by disgraced thoracic surgeon Paolo Macchiarini should be retracted because they contain evidence of scientific misconduct, the Swedish Central Ethical Review Board said in a statement dated 27 October. The papers had been central to Macchiarini's claims about a radical stem-cell-based tracheal transplant, which he developed partly during his employment by the Karolinska Institute in Stockholm. The institute had asked the ethics board to examine the papers. Earlier last month, Swedish public prosecutors dropped their investigations into charges of manslaughter and grievous bodily harm by the surgeon. The charges involved four people on whom Macchiarini had performed operations at the Karolinska University Hospital between 2011 and 2013. Three have since died, but the prosecutors said there was a lack of conclusive evidence that the surgery caused the deaths. They noted negligent procedures in some of the operations.

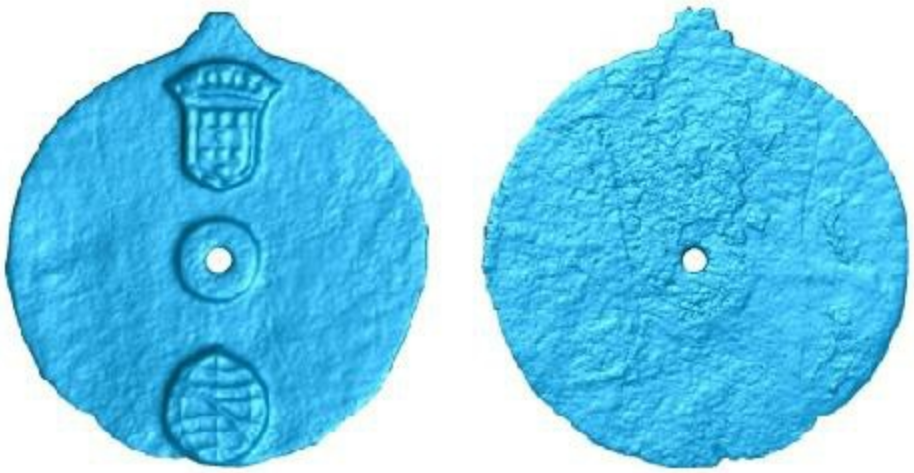
MEDICINES

Hepatitis C drugs On 25 October, a US non-profit organization filed challenges against six core patents for sofosbuvir, a key component of three hepatitis C drugs. The medicines — Sovaldi, Harvoni and Epclusa — belong

to Gilead Sciences in Foster City, California. The Initiative for Medicines, Access and Knowledge (I-MAK) in New York City argues that Gilead's patents are unmerited because the drug is not different enough to warrant a US patent, saying that the company developed the compound by tweaking existing HIV and cancer drugs. The patents prevent cheaper, generic drugs from entering the US market. Using a similar argument, I-MAK had a sofosbuvir patent removed in China in 2015.

RESEARCH

Old astrolabe A 500-year-old bronze disc recovered from a shipwreck in 2014 might be the oldest-known example of a technology that changed world history. The artefact was retrieved from the wreck of the *Esmeralda*, part of the fleet of the Portuguese explorer Vasco da Gama. On 24 October, researchers at the University of Warwick in Coventry, UK, said that laser scanning has now revealed markings at 5-degree intervals around its circumference, suggesting that the 17.5-centimetre-diameter object is a mariner's astrolabe. Developed by Portuguese navigators in the late fifteenth century, these devices determine latitude by measuring the Sun's altitude, and helped sailors to explore the oceans and map the world. The *Esmeralda* sank in the Indian Ocean in 1503, making this mariner's astrolabe several decades older than any of the hundred or so others that survive.



WMG/University of Warwick

Composite image of scans of a 500-year-old bronze astrolabe.

SPACE

Foreign object Astronomers have spotted a space rock that might have come from outside the Solar System. The small asteroid or comet, named A/2017 U1, swooped towards and then past the Sun from an angle almost perpendicular to the plane in which most of the planets orbit. Its trajectory — a hyperbolic orbit — suggests that it came from interstellar space, NASA said on 26 October, a week after the object's discovery. If further observations confirm its orbit, it would be the first such interstellar object known.

Earth mission ends The paired satellites of the US–German Gravity Recovery and Climate Experiment (GRACE), which have been making fundamental observations of Earth since their 2002 launch, have ceased science operations. Mission controllers realized on 12 October that the

batteries in one of the satellites had failed because of its age, a long-expected outcome. NASA and the German space agency DLR announced the mission's end on 27 October, and said the other satellite will be decommissioned next year. GRACE has provided crucial measurements of melting ice sheets and groundwater storage, among other things.

EVENTS

Weedkiller dispute The European Union postponed a decisive vote on 25 October on proposals to renew its licence for the controversial weedkiller glyphosate. The current EU authorization expires on 15 December. But member states were unable to settle on a compromise for how long the licence should be extended by. The World Health Organization says that glyphosate is "probably" carcinogenic to humans, but key EU safety agencies say it is not. Member states will be asked to vote on a five-year extension on 9 November. More than 1.3 million Europeans have signed a petition calling for the substance to be banned.

Harassment probe The US House Committee on Science, Space, and Technology is investigating allegations of sexual harassment against geologist David Marchant of Boston University, Massachusetts. Marchant has received about US$5.4 million in funding since the 1990s from federal agencies, including the National Science Foundation (NSF) and NASA. In letters sent to the NSF, NASA and Boston University on 26 October, the committee asked for all documents and communications involving federal grants awarded to Marchant, as well as complaints of alleged assault and harassment and any actions taken by each institution. Two of Marchant's former graduate students filed complaints with Boston University, in October 2016 and May 2017, for behaviour that allegedly occurred while they were on research trips with him in Antarctica in the 1990s.

FACILITIES

Genome database A Chinese province is building a large sequencing centre that will create a database of genetic information from Chinese people. The

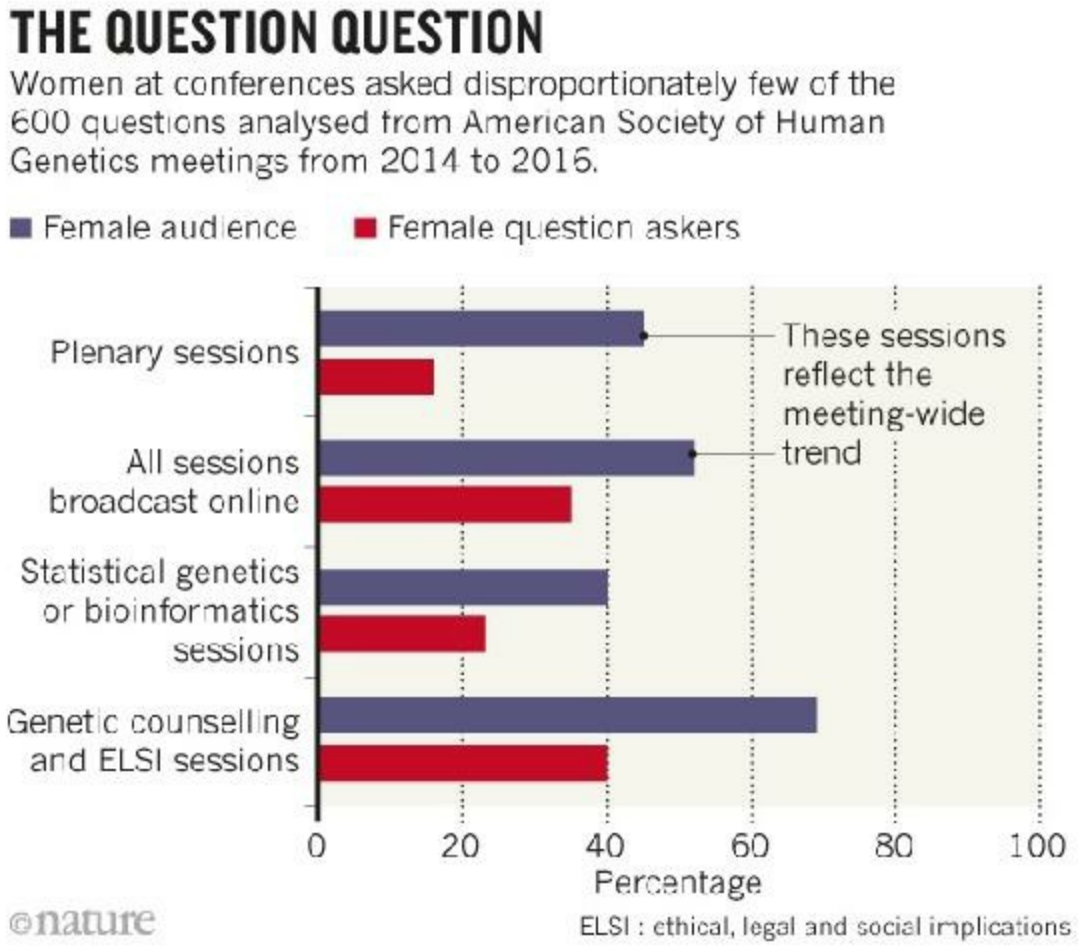
National Health & Medicine Big Data Center is being built in Nanjing, the capital of Jiangsu province, as part of a 6-billion-yuan (US$905-million) genome project announced by the local government on 29 October. The centre will house multiple firms that will together sequence up to 500,000 samples a year. Data will be used to look for mutations related to disease, as well as environmental factors that might trigger illness. Researchers will also use the data to tailor treatments to individual patients.

CLIMATE

Record CO_2 levels Atmospheric concentrations of carbon dioxide surged at a record pace and to a record high in 2016 because of human emissions and an El Niño warming event, the World Meteorological Organization said on 30 October. Average global CO_2 concentrations rose from 400 to 403.3 parts per million, roughly 45% above pre-industrial levels. The last time Earth had comparable CO_2 levels was during the mid-Pliocene epoch around 4 million years ago, when temperatures were 2–3 °C warmer than those today and sea levels were 10–20 metres higher. Concentrations of the greenhouse gases methane and nitrous oxide also increased, to 157% and 22% above pre-industrial levels, respectively.

TREND WATCH

Women ask fewer questions than men at conferences, even if there are more women in the room, according to an analysis of talks at American Society of Human Genetics (ASHG) meetings in 2014–16. Natalie Telis of Stanford University in California and her colleagues looked at 600 questions asked at 222 conference talks. To reach parity in question-asking, the audience would have to be at least 85% women, they say. Women are most likely to question female speakers, but still speak up less often than men.



Source: Natalie Telis

AWARDS

Space pioneers The first woman and the first Chinese national in space were among four recipients of the inaugural medal for space science from the United Nations Educational, Scientific and Cultural Organization (UNESCO). Awards for Chinese astronaut Yang Liwei, who completed the country's first crewed space mission in October 2003, and Russian cosmonaut Valentina Tereshkova were announced at a ceremony in Paris on 27 October. Also honoured were Koichi Wakata, the first Japanese commander of the International Space Station, and Arnaldo Tamayo Mendez, the first Cuban in space. The medal, established in June, recognizes

prominent researchers or public figures who have contributed to space science.

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Plans to promote German research excellence come under fire

Critics say selection process for high-stakes funding programme is flawed.

01 November 2017

Bern Lauter/vario images GmbH/Alamy

Peter Strohschneider, president of the DFG.

Germany’s latest programme to boost research at its universities and make them more competitive internationally risks missing its goals, according to

observers.

The Excellence Initiative was launched in 2005 with €4.6 billion (US$5.4 billion) in funding and the aim of creating a handful of elite universities. Researchers across Germany are now preparing for the programme's next round, dubbed the Excellence Strategy, which starts in 2019.

Earlier this year, almost 200 groups of scientists submitted proposals to form Clusters of Excellence — large collaborations of research groups at one or more universities that form the core element of the strategy. And last month, an international committee invited 88 of the groups to submit full project proposals by late February. Up to 50 such clusters will from 2019 receive top-up funding of about €8 million per year for seven years.

But observers question whether the 88 selected projects represent Germany's best science, particularly because the focus for selection has shifted away from basic science and towards applied research. Unsuccessful applicants say that the rules for submitting proposals for the initiative were not clearly defined and communicated. Several high-profile groups came away empty-handed, including biology teams in Frankfurt, Heidelberg and Munich involving dozens of scientists funded by the prestigious European Research Council.

"The Excellence Initiative has brought German science some welcome structural change," says Dieter Imboden, a Swiss environmental physicist who chaired a 2016 review of the initiative. "But its achievements must not obscure the view of its flaws."

The competition to form clusters should be run independently of that for elite-university status, he says. Otherwise, second-tier universities could outperform those with a much stronger overall research portfolio and gain the sought-after title, which is currently held by 11 universities.

Critics also say that the geographic spread of positively reviewed applications for future excellence clusters — across 41 universities in 13 of Germany's 16 states — hints at a political desire to distribute the funds more evenly across the country.

But Peter Strohschneider, president of Germany's main research-funding agency, the DFG, which runs the programme, says the selection panels chose the projects strictly on the basis of scientific quality, without any regional or political considerations. Scientists will figure strongly on the Excellence Commission, which will make the final selection in September 2018 and will also include federal and state science ministers, he says.

Until 2005, responsibility for funding universities in Germany lay exclusively with the states. The Excellence Initiative was created to allow central government to inject federal money into research, a move now guaranteed by a change to the German constitution. But many say the changes have not gone far enough.

"The initiative has quite lost sight of its goal," says a former president of a large German university, speaking on condition of anonymity. "Universities here remain trapped in a federal political system that is unable to create a powerhouse like Yale or Harvard."

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| 章节菜单 | 主菜单 |

The new thermodynamics: how quantum physics is bending the rules

Experiments are starting to probe the limits of the classical laws of thermodynamics.

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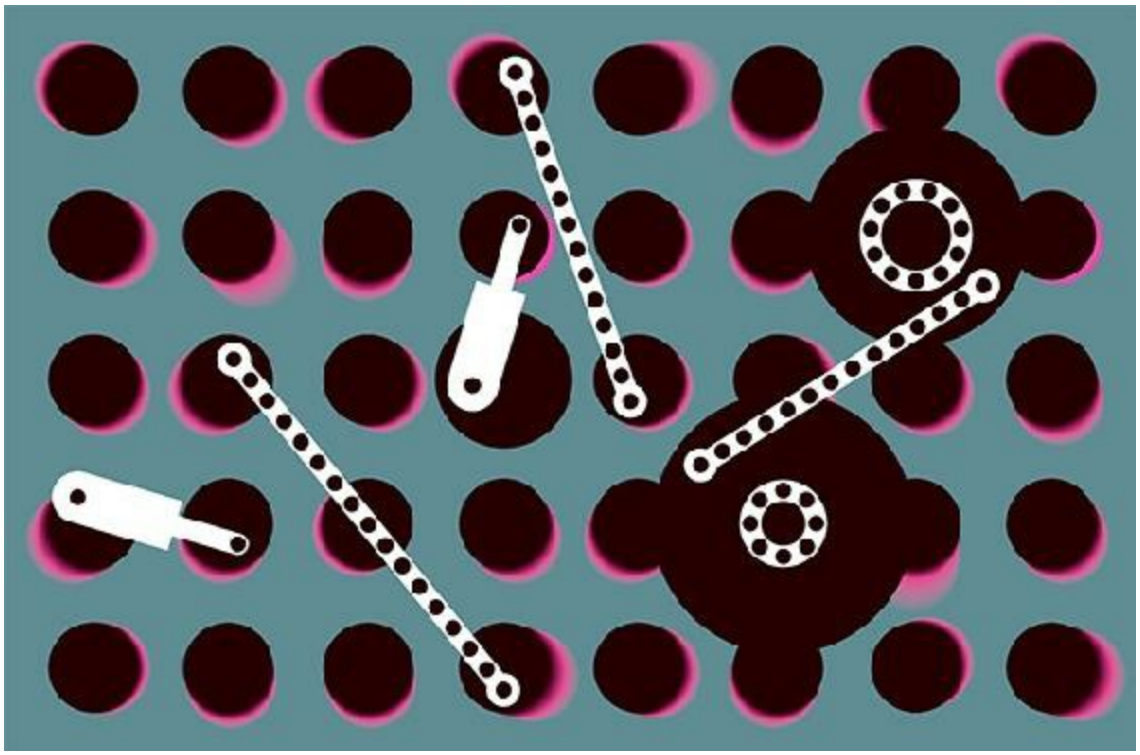


Illustration by Edgar Bąk

It would take a foolhardy physicist to dare attempt to break the laws of thermodynamics. But it turns out that there may be ways to bend them. At a lab at the University of Oxford, UK, quantum physicists are trying to do so with a small lump of synthetic diamond. At first, the diamond is barely

visible, nestled inside a chaotic mess of optical fibres and mirrors. But when they switch on a green laser, defects in the diamond are illuminated, and the crystal begins to glow red.

In that light, the team has found preliminary evidence of an effect that was theorized only a few years ago[1]: a quantum boost that would push the diamond's power output above the level prescribed by classical thermodynamics. If the results hold up, they will be a tangible boon for the study of quantum thermodynamics, a relatively new field that aims to uncover the rules that govern heat and energy flow at the atomic scale.

There is reason to suspect that the laws of thermodynamics, which are based on how large numbers of particles behave, are different in the quantum realm. Over the past five years or so, a quantum-thermodynamics community has grown around that idea. What was once the domain of a handful of theoreticians now includes a few hundred theoretical and experimental physicists around the globe. “The field is moving so fast I can barely keep up,” says Ronnie Kosloff, an early pioneer of the field at the Hebrew University of Jerusalem in Israel.

A number of quantum thermodynamicists hope to find behaviour outside the remit of conventional thermodynamics that could be adapted for practical purposes, including improving lab-based refrigeration techniques, creating batteries with enhanced capabilities and refining technology for quantum computing.

But the field is still in its infancy. Experiments such as the one taking place at Oxford are just starting to put theoretical predictions to the test. And physicists working at the periphery are watching such tests closely for evidence of the useful applications that theorists have predicted. “Quantum thermodynamics is clearly hot — pardon the pun,” says Ronald Walsworth, a physicist at Harvard University in Cambridge, Massachusetts, who specializes in developing precision atomic-scale tools. “But for those of us looking in from the outside, the question is: can it really shed new light on the development of technologies?”

Breaking the law

The development of the classical laws of thermodynamics stretches back to the nineteenth century. They emerged from the effort to understand steam engines and other macroscopic systems. Thermodynamic quantities such as temperature and heat are statistical in nature and defined in reference to the average motion of large ensembles of particles. But back in the 1980s, Kosloff began pondering whether this picture would continue to make sense for much smaller systems.

It wasn't a popular line of research at the time, says Kosloff, because the questions being asked were largely abstract, with little hope of connection to experiments. “The field developed very slowly,” he says. “I was alone for years.”

That changed dramatically around a decade ago, as questions about the limits of technological miniaturization became more pressing and experimental techniques advanced. A flurry of attempts were made to calculate how thermodynamics and quantum theory might combine. But the resulting proposals created more confusion than clarity, Kosloff says. Some claimed that quantum devices could violate classical thermodynamic constraints with impunity and so act as perpetual-motion machines, capable of performing work without needing any energy input. Others, suggesting that the laws of thermodynamics should hold unmodified at very small scales, were equally perplexing. “In some sense, you can use the same equations to work out the performance of a single atom engine and your car engine,” says Kosloff. “But that seems shocking, too — surely as you get smaller and smaller you should hit some quantum limit.” In classical thermodynamics, a single particle doesn't have a temperature. So as both the system generating work and its environment approach that limit, it becomes increasingly absurd to imagine that they would obey standard thermodynamic rules, says Tobias Schaetz, a quantum physicist at the University of Freiburg in Germany.

The preponderance of conflicting theoretical claims and predictions initially undermined the burgeoning field's credibility. “I have been very critical of the field because there is far too much theory and not enough experiment,” says quantum physicist Peter Hänggi, at the University of Augsburg in Germany. But the community is beginning to coalesce more formally around core questions in an effort to cut through the chaos. One goal has been to use

experiments to uncover the point at which the classical laws of thermodynamics no longer perfectly predict the thermal behaviour of quantum systems.

Experiments are starting to pin down that quantum–classical boundary. Last year, for example, Schaetz and his colleagues showed that, under certain conditions, strings of five or fewer magnesium ions in a crystal do not reach and remain in thermal equilibrium with their surroundings like larger systems do[2]. In their test, each ion started in a high-energy state and its spin oscillated between two states corresponding to the direction of its magnetism — 'up' and 'down'. Standard thermodynamics predicts that such spin oscillations should die down as the ions cool by interacting with the other atoms in the crystal around them, just as hot coffee cools when its molecules collide with molecules in the colder surrounding air.

Such collisions transfer energy from the coffee molecules to the air molecules. A similar cooling mechanism is at play in the crystal, where quantized vibrations in the lattice called phonons carry heat away from the oscillating spins. Schaetz and his colleagues found that their small ion systems did stop oscillating, suggesting that they had cooled. But after a few milliseconds, the ions began oscillating vigorously again. This resurgence has a quantum origin, says Schaetz. Rather than dissipating away entirely, the phonons rebounded at the edges of the crystal and returned, in phase, to their source ions, reinstating the original spin oscillations.

Schaetz says that his experiment sends a warning to engineers attempting to reduce the size of existing electronics. “You may have a wire that is only 10 or 15 atoms wide, and you may think that it has successfully carried the heat away from your chip, but then boop — suddenly this quantum revival happens,” Schaetz says. “It is very disturbing.”

Rebounding phonons could present a challenge in some applications, but other quantum phenomena could turn out to be useful. Efforts to identify such phenomena had been stalled by the difficulty in defining basic quantities, such as heat and temperature, in quantum systems. But the solution to a famous thought experiment, laid out 150 years ago by Scottish physicist James Clerk Maxwell, provided a clue about where to turn, posing an intriguing link between information and energy. Maxwell imagined an entity

that could sort slow- and fast-moving molecules, creating a temperature difference between two chambers simply by opening and closing a door between them.

Such a 'demon', as it was later called, thus generates a hot and a cold chamber that can be harnessed to produce useful energy. The problem is that by sorting particles in this way, the demon reduces the system's entropy — a measure of the disorder of the particles' arrangements — without having done any work on the particles themselves. This seemingly violates the second law of thermodynamics.

But physicists eventually realized that the demon would pay a thermodynamic price to process the information about the molecules' speeds. It would need to store, erase and rewrite that information in its brain. That process consumes energy and creates an overall increase in entropy[3]. Information was once thought to be immaterial, “but Maxwell's demon shows that it can have objective physical consequences”, says quantum physicist Arnau Riera, at the Institute of Photonic Sciences in Barcelona, Spain.

Finding the limit

Inspired by the idea that information is a physical quantity — and that it is intimately linked to thermodynamics — researchers have attempted to recast the laws of thermodynamics so that they work in the quantum regime.

Perpetual-motion machines may be impossible. But an early hope was that limits prescribed by quantum thermodynamics might be less stringent than those that hold in the classical realm. “This was the train of thought we had learned from quantum computing — that quantum effects help you beat classical bounds,” says Raam Uzdin, a quantum physicist at the Technion–Israel Institute of Technology in Haifa.

Disappointingly, Uzdin says, this is not the case. Recent analyses suggest that quantum versions of the second law, which governs efficiency, and the third law, which prohibits systems from reaching absolute zero, retain similar and, in some cases, more-stringent constraints than their classical incarnations.

Some differences arise because the macroscopic thermodynamic quantity 'free energy'— the energy a system has available to do work — doesn't have just one counterpart at the microscale, but many, says Jonathan Oppenheim, a quantum physicist at University College London. Classically, the free energy is calculated by assuming that all states of the system, determined by the arrangement of particles at a given energy, are equally likely. But that assumption isn't true on tiny scales, says Oppenheim; certain states might be much more probable than others. To account for this, additional free energies need to be defined in order to accurately describe the system and how it will evolve. Oppenheim and his colleagues propose that individual second laws exist for each type of free energy, and that quantum devices must obey all of them[4]. “Since the second law tells you what you aren't allowed to do, in some ways, it seems that having more laws on the microscale leaves you worse off,” says Oppenheim.

Much of the work done to calculate equivalents of the second and third laws remains, for now, theoretical. But proponents argue that it can help to illuminate how thermodynamic bounds are physically enforced at small scales. For instance, a theoretical analysis carried out by a pair of quantum physicists based in Argentina showed that as a quantum refrigerator nears absolute zero, photons will spontaneously appear in the vicinity of the device[5]. “This dumps energy into the surroundings, causing a heating effect that counters the cooling and stops you ever reaching absolute zero,” explains team member Nahuel Freitas of Ciudad University in Buenos Aires.

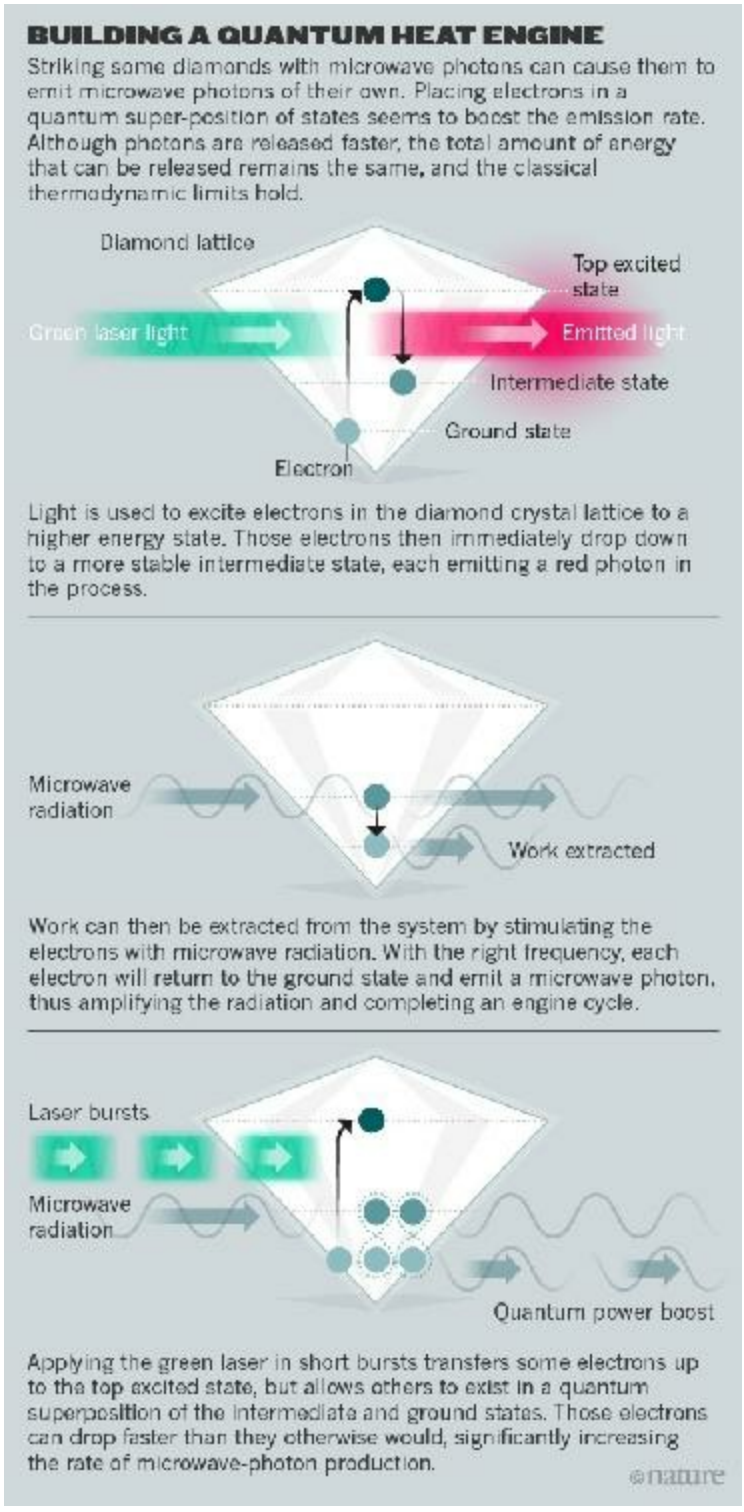
Theory has also revealed some potential wiggle room. In a theoretical analysis examining information flow between hot and cold chambers, or 'baths', of particles, a team based in Barcelona that included Riera and quantum physicist Manabendra Nath Bera discovered a strange scenario in which the hot bath seemed to spontaneously get hotter, while the cold bath became colder[6]. “At first, this looks crazy, like we can violate thermodynamics,” says Bera. But the researchers soon realized that they had overlooked the quantum twist: the particles in the baths can become entangled. In theory, making and breaking these correlations provides a way to store and release energy. Once this quantum resource was budgeted for, the laws of thermodynamics fell into place.

A number of independent groups have proposed using such entanglement to store energy in a 'quantum battery', and a group at the Italian Institute of Technology in Genoa is attempting to confirm the Barcelona team's predictions with batteries built from superconducting quantum bits, or 'qubits'[7]. In principle, such quantum batteries could charge considerably faster than their classical equivalents. “You won't be able to extract and store more energy than the classical bound allows — that's set by the second law,” says Riera. “But you may be able to speed things up.”

Some researchers are looking for easier ways to manipulate qubits for quantum-computing applications. Quantum physicist Nayeli Azucena Rodríguez Briones at the University of Waterloo in Canada and her colleagues have devised[8] an operation that might enhance the cooling needed for quantum-computing operations by manipulating pairs of qubit energy levels. They are currently planning to test this idea in the lab using superconducting qubits.

A small spark

The concept that quantum effects could be exploited to improve thermodynamic performance also inspired the diamond experiment under way at Oxford, which was first proposed by Kosloff, Uzdin and Amikam Levy, also at the Hebrew University[1]. Defects created by nitrogen atoms scattered through the diamond can serve as an engine — a machine that performs an operation after being brought into contact with first a hot reservoir (in this case a laser) and then a cold one. But Kosloff and his colleagues expect that such an engine can be operated in an enhanced mode, by exploiting a quantum effect that enables some of the electrons to exist in two energy states simultaneously. Maintaining these superpositions by pulsing the laser light rather than using a continuous beam should enable the crystal to emit microwave photons more rapidly than it otherwise would (see 'Building a quantum heat engine').



Last week, the Oxford-based team posted a preliminary analysis[9] showing evidence of the predicted quantum boost. The paper has yet to be peer reviewed, but if the work holds up, then “it is a groundbreaking result,” says

Janet Anders, a quantum physicist at Exeter University, UK. But, she adds, it's still not clear exactly what enables this feat. “It seems to be a magic fuel, not so much adding energy, but enabling the engine to extract energy faster,” Anders says. “Theoretical physicists will need to examine just how it does this.”

Focusing on experiments is a major step in the right direction for revitalizing the field, says Hänggi. But, for him, the experiments are not yet bold enough to give truly ground-breaking insights. There is also the challenge that quantum systems can be irrevocably disturbed by measurement and interaction with the environment. These effects are rarely sufficiently accounted for in theoretical proposals for new experiments, he says. “That is difficult to calculate, and much more difficult to implement in an experiment,” he says.

Ian Walmsley, who heads the Oxford lab where the diamond experiment was conducted, is also circumspect about the future of the field. Although he and other experimenters have been drawn to quantum thermodynamics research in recent years, he says that their interest has been largely “opportunistic”. They have spotted the chance to carry out relatively quick and easy experiments by piggybacking on set-ups already in place for other uses; the diamond-defect set-up, for instance, is already being widely studied for quantum computing and sensor applications. Today, quantum thermodynamics is fizzing with energy, Walmsley says. “But whether it will continue to sparkle, or just explode into nothing, well, we will have to wait and see.”

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Comments

8 comments

1. *Pentcho Valev* • 2017-11-03 08:02 AM

   Clifford Truesdell, The Tragicomical History of Thermodynamics, 1822-1854, p. 6: "Finally, I confess to a heartfelt hope - very slender but tough - that even some thermodynamicists of the old tribe will study this book, master the contents, and so share in my discovery: Thermodynamics need never have been the Dismal Swamp of Obscurity that from the first it was and that today in common instruction it is; in consequence, it need not so remain." [...] p. 333: "Clausius' verbal statement of the "Second Law" makes no sense, for "some other change connected therewith" introduces two new and unexplained concepts: "other change" and "connection" of changes. Neither of these finds any place in Clausius' formal structure. All that remains is a Mosaic prohibition. A century of philosophers and journalists have acclaimed this commandment; a century of mathematicians have shuddered and averted their eyes from the unclean."
   https://www.amazon.com/Tragicomical-Thermodynamics-1822-1854-Mathematics-Physical/dp/1461394465 Jos Uffink, Bluff your way in the Second Law of Thermodynamics: "Before one can claim that acquaintance with the Second Law is as indispensable to a cultural education as Macbeth or Hamlet, it should obviously be clear what this law states. This question is surprisingly difficult. The Second Law made its appearance in physics around 1850, but a half century later it was already surrounded by so much confusion that the British Association for the Advancement of Science decided to appoint a special committee with the task of providing clarity about the meaning of this law. However, its final report (Bryan 1891) did not settle the issue. Half a century later, the physicist/philosopher Bridgman still complained that there are almost as many formulations of the second law as there have been discussions of it. And even today, the Second Law remains so obscure that it continues to attract new efforts at clarification."

http://philsci-archive.pitt.edu/313/1/engtot.pdf As Clifford Truesdell suggests, the confusion started with Clausius's 1850 idiotic argument - later formulations of the second law of thermodynamics have all been defective. However previous formulations - those of Carnot - were both clear and correct. The simplest one is this: "A cold body is necessary" That is, heat cannot be cyclically converted into work unless a hot body, source of heat, and a cold body, receiver of heat, are available. The problem is that in 1824 Carnot deduced "A cold body is necessary" from a postulate that eventually turned out to be false: Carnot's (false) postulate: Heat is an indestructible substance (caloric) that cannot be converted into work by the heat engine. Unpublished notes written in the period 1824-1832 reveal that, after realizing that his postulate was false (and discovering the first law of thermodynamics), Carnot found "A cold body is necessary" implausible: Sadi Carnot, REFLECTIONS ON THE MOTIVE POWER OF HEAT, p. 225: "Heat is simply motive power, or rather motion which has changed form. It is a movement among the particles of bodies. Wherever there is destruction of motive power there is, at the same time, production of heat in quantity exactly proportional to the quantity of motive power destroyed. Reciprocally, wherever there is destruction of heat, there is production of motive power." p. 222: "Could a motion (that of radiating heat) produce matter (caloric)? No, undoubtedly; it can only produce a motion. Heat is then the result of a motion. Then it is plain that it could be produced by the consumption of motive power, and that it could produce this power. All the other phenomena - composition and decomposition of bodies, passage to the gaseous state, specific heat, equilibrium of heat, its more or less easy transmission, its constancy in experiments with the calorimeter - could be explained by this hypothesis. But it would be DIFFICULT TO EXPLAIN WHY, IN THE DEVELOPMENT OF MOTIVE POWER BY HEAT, A COLD BODY IS NECESSARY; why, in consuming the heat of a warm body, motion cannot be produced." http://www.nd.edu/~powers/ame.20231/carnot1897.pdf Generally, a cold body is not necessary, that is, the second law of thermodynamics is false. The cold body is only

TECHNOLOGICALLY necessary – non-isothermal heat engines are fast-working and powerful. Heat engines working under isothermal conditions (in the absence of a cold body) are commonplace but are too slow and impuissant to be of any technological importance. Except, perhaps, for the case where water is placed in an electric field - the non-conservative force (pressure) that emerges seems to be able to convert ambient heat into work quite vigorously: Wolfgang K. H. Panofsky, Melba Phillips, Classical Electricity and Magnetism, pp.115-116: "Thus the decrease in force that is experienced between two charges when they are immersed in a dielectric liquid can be understood only by considering the effect of the PRESSURE OF THE LIQUID ON THE CHARGES themselves." http://www.amazon.com/Classical-Electricity-Magnetism-Second-Physics/dp/0486439240?tag=viglink21401-20 "However, in experiments in which a capacitor is submerged in a dielectric liquid the force per unit area exerted by one plate on another is observed to decrease... [...] This apparent paradox can be explained by taking into account the DIFFERENCE IN LIQUID PRESSURE in the field filled space between the plates and the field free region outside the capacitor." http://farside.ph.utexas.edu/teaching/jk1/lectures/node46.html Tai Chow, Introduction to Electromagnetic Theory: A Modern Perspective, p. 267: "The strictly electric forces between charges on the conductors are not influenced by the presence of the dielectric medium. The medium is polarized, however, and the interaction of the electric field with the polarized medium results in an INCREASED FLUID PRESSURE ON THE CONDUCTORS that reduces the net forces acting on them." http://www.amazon.com/Introduction-To-Electromagnetic-Theory-Perspective/dp/0763738271 "Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ Pentcho Valev

2. *Vyacheslav Somsikov* • 2017-11-03 04:34 AM

   For the verification of the deterministic mechanism of irreversibility, which obtained within the framework of the classical mechanics laws [Somsikov V.M. Non-Linearity of Dynamics of the

Non-Equilibrium Systems. World Journal of Mechanics, 2017, Vol.7 No.2, 11-23], we was performed the numerical calculations of the change of D-entropy for the system with different number of the potentially interacting material points (MP) when it moves through a potential barrier. D – entropy is a relation of the value of change of the systems internal energy to its full value. [Somsikov V. M. and Andreev A. B. On criteria of transition to a thermodynamic description of system dynamics. Russian Physics Journal, Vol. 58, No. 11, March, 2016; http://www.ijSciences.com Volume 4 – May 2015 (05)]. The calculations were carried 400 times for a given number of particles for different initial states of the system, but for the same predetermined amount of energy. This made it possible to determine the change of the D-entropy for different states of the system for a given value of its energy and a given number of MP. It was found that the fluctuations of internal energy decreasing with increasing number of particles in the system for different initial conditions. When number of particles less 64, the D –entropy can be as positive as negative.When number of particles more 64 then none of the 400 numerical experiments gave a negative value change of the internal energy. This means that when number of particles more 64 the dynamics of the system becomes irreversible. Therefore, the number 64 can be called as a first critical number of the system, beyond which the system becomes irreversible. When number of particles more than 1000, the dispersion of the internal energy reaches to the minimum. With further increase in the number of MP the increment of the internal energy is not changed. This number can be called as a second critical number. Thus if the system consist from number of particles more than 1000, the thermodynamic description is a correct. Obviously, in the general case, these critical numbers will depend on the parameters of the task, for example, the width and height of the barrier.

3. *Pentcho Valev* • 2017-11-02 07:25 PM

   "Entropy was discovered when it was noticed to be a quantity that behaves as a function of state, as a consequence of the second law of thermodynamics." https://en.wikipedia.org/wiki/Entropy It was Clausius who "noticed" that the entropy is a state function, but was

he correct? Here is the story: If you define the entropy S as a quantity that obeys the equation dS=dQrev/T, you will find that, so defined, the entropy is a state function FOR AN IDEAL GAS. Clausius was very impressed by this statefunctionness and decided to prove that the entropy (so defined) is a state function for ANY system. So "Entropy is a state function" became a fundamental theorem in thermodynamics. Clausius deduced it from the assumption that any cycle can be disintegrated into small Carnot cycles, and nowadays this deduction remains the only justification of "Entropy is a state function": "Carnot Cycles: S is a State Function. Any reversible cycle can be thought of as a collection of Carnot cycles - this approximation becomes exact as cycles become infinitesimal. Entropy change around an individual cycle is zero. Sum of entropy changes over all cycles is zero." http://mutuslab.cs.uwindsor.ca/schurko/introphyschem/lectures/240 "Entropy Changes in Arbitrary Cycles. What if we have a process which occurs in a cycle other than the Carnot cycle, e.g., the cycle depicted in Fig. 3. If entropy is a state function, cyclic integral of dS = 0, no matter what the nature of the cycle. In order to see that this is true, break up the cycle into sub-cycles, each of which is a Carnot cycle, as shown in Fig. 3. If we apply Eq. (7) to each piece, and add the results, we get zero for the sum." http://ronispc.chem.mcgill.ca/ronis/chem213/hnd8.pdf The assumption on which "Entropy is a state function" is based - that any cycle can be subdivided into small Carnot cycles - is obviously false. An isothermal cycle CANNOT be subdivided into small Carnot cycles. A cycle involving the action of conservative forces CANNOT be subdivided into small Carnot cycles. Conclusion: The belief that the entropy is a state function is totally unjustified. Any time scientists use the term "entropy", they don't know what they are talking about. "My greatest concern was what to call it. I thought of calling it 'information', but the word was overly used, so I decided to call it 'uncertainty'. When I discussed it with John von Neumann, he had a better idea. Von Neumann told me, 'You should call it entropy, for two reasons: In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important,

nobody knows what entropy really is, so in a debate you will always have the advantage."
https://en.wikipedia.org/wiki/History_of_entropy Pentcho Valev

4. *Pentcho Valev* • 2017-11-02 10:05 PM
   The version of the second law of thermodynamics known as "Entropy always increases" (a version which, according to A. Eddington, holds "the supreme position among the laws of Nature") is in fact a theorem deduced by Clausius in 1865: Jos Uffink, Bluff your Way in the Second Law of Thermodynamics, p. 37: "Hence we obtain: THE ENTROPY PRINCIPLE (Clausius' version) For every nicht umkehrbar [irreversible] process in an adiabatically isolated system which begins and ends in an equilibrium state, the entropy of the final state is greater than or equal to that of the initial state. For every umkehrbar [reversible] process in an adiabatical system, the entropy of the final state is equal to that of the initial state." http://philsci-archive.pitt.edu/archive/00000313/ Clausius' deduction was based on three postulates: Postulate 1 (implicit): The entropy is a state function. Postulate 2: Clausius' inequality (formula 10 on p. 33 in Uffink's paper) is correct. Postulate 3: Any irreversible process can be closed by a reversible process to become a cycle. All the three postulates remain totally unjustified even nowadays. Postulate 1 can easily be disproved by considering cycles (heat engines) converting heat into work in ISOTHERMAL conditions. Postulate 3 is also false: Uffink, p.39: "A more important objection, it seems to me, is that Clausius bases his conclusion that the entropy increases in a nicht umkehrbar [irreversible] process on the assumption that such a process can be closed by an umkehrbar [reversible] process to become a cycle. This is essential for the definition of the entropy difference between the initial and final states. But the assumption is far from obvious for a system more complex than an ideal gas, or for states far from equilibrium, or for processes other than the simple exchange of heat and work. Thus, the generalisation to all transformations occurring in Nature is somewhat rash." Note that, even if Clausius's theorem were true (it is not), it only holds for "an adiabatically isolated system which begins and ends in an equilibrium state". This means that (even if Clausius's theorem were true) applications of "Entropy

always increases" to processes which do not begin and end in equilibrium, that is, to processes in Nature, not in a cylinder with a piston, would still be incorrect: Jos Uffink, in the same article: "I therefore argue for the view that the second law has nothing to do with the arrow of time. [...] This summary leads to the question whether it is fruitful to see irreversibility or time-asymmetry as the essence of the second law. Is it not more straightforward, in view of the unargued statements of Kelvin, the bold claims of Clausius and the strained attempts of Planck, to give up this idea? I believe that Ehrenfest-Afanassjewa was right in her verdict that the discussion about the arrow of time as expressed in the second law of the thermodynamics is actually a RED HERRING." Pentcho Valev

5. *Raji Heyrovska* • 2017-11-02 02:45 PM

   I just saw the interesting article by Merali [1]. In this context, I wish to draw attention to the First International Conference [2] on Quantum Limits to the Second Law. In her contribution [3] to this conference, she points out that thermodynamic functions and laws were developed over the years to "bridge" the gap between the equations of state and thermal properties of matter. In [3] the author has incorporated the thermodynamic properties into the equation of state thereby forming one simple composite equation. The heat capacity difference is introduced in place of the gas constant in her earlier concise equation of state for gases, based on free volume and molecular association/dissociation. This provides a new and simple relation between the P, V, T properties, internal energy (E), enthalpy (H), Gibbs (G) and Helmholtz (A) free energies, heat energy (Q), entropy (S), partition function (f) and the thermodynamic laws. Since a proper definition of "heat" is essential for the discussion of the second law, Q for a gas at the given P, V, T, S is defined as TS = PVflnW, where W is the thermodynamic probability related to f. The latter is expressed as the ratio of free volume to volume corresponding to the de Broglie wave length. Also, for the first time experimental heat capacities at various P, V and T are correlated with the extent of molecular association. The available data for nitrogen have been used to demonstrate the validity of the new equation of state. References: 1. Merali, Z., Nature 551, 20–22 (02 November 2017) doi:10.1038/551020a 2.

“QUANTUM LIMITS TO THE SECOND LAW: First International Conference on Quantum Limits to the Second Law”: 29-31 July 2002, San Diego, California (USA), ISBN: 0-7354-0098-9, Editors: Daniel P. Sheehan, Volume number: 643, Published: Nov 20, 2002, http://aip.scitation.org/toc/apc/643/1?expanded=643 3. Heyrovska, R., AIP Conference Proceedings 643, 157-162 (2002); http://aip.scitation.org/doi/10.1063/1.1523797

6. *Pentcho Valev* • 2017-11-02 09:37 AM

The second law of thermodynamics has an absurd implication that proves its falsehood: If we have a reversible chemical reaction and a catalyst increases the rate of the forward reaction by a factor of, say, 745492, it obligatorily increases the rate of the reverse reaction by exactly the same factor, 745492, despite the fact that the two reactions - forward and reverse - may be entirely different (e.g. the diffusion factor is crucial for one but not important for the other) and accordingly require entirely different catalytic mechanisms. The absurd implication is usually referred to as "Catalysts do not shift chemical equilibrium": "A catalyst reduces the time taken to reach equilibrium, but does not change the position of the equilibrium. This is because the catalyst increases the rates of the forward and reverse reactions BY THE SAME AMOUNT." http://www.bbc.co.uk/bitesize/higher/chemistry/reactions/equilibriu "In the presence of a catalyst, both the forward and reverse reaction rates will speed up EQUALLY... [...] If the addition of catalysts could possibly alter the equilibrium state of the reaction, this would violate the second rule of thermodynamics..." https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/chemical-equilibrium-14/factors-that-affect-chemical-equilibrium-106/the-effect-of-a-catalyst-447-3459/ The absurd implication is not obeyed by chemical reactions of course. Here is a publication in Nature describing a catalyst accelerating the forward and SUPPRESSING the reverse reaction: http://images.nature.com/m685/nature-assets/ncomms/2013/130917/ncomms3500/images_hires/ncomms35 f1.jpg Yu Hang Li et al. Unidirectional suppression of hydrogen oxidation on oxidized platinum clusters. https://www.nature.com/articles/ncomms3500 Another example of

disobedience: Perpetual (limited only by the deterioration of the system) motion of dimer A_2 and monomer A between two catalytic surfaces, S1 and S2 (a time crystal par excellence): http://upload.wikimedia.org/wikipedia/commons/c/ce/NatureSLTD-Fig1c.jpg See the explanations here: https://en.wikipedia.org/wiki/Duncan%27s_Paradox That catalysts can violate the second law of thermodynamics by shifting chemical equilibrium is presented by Wikipedia as a fact: "Epicatalysis is a newly identified class of gas-surface heterogeneous catalysis in which specific gas-surface reactions shift gas phase species concentrations away from those normally associated with gas-phase equilibrium. [...] A traditional catalyst adheres to three general principles, namely: 1) it speeds up a chemical reaction; 2) it participates in, but is not consumed by, the reaction; and 3) it does not change the chemical equilibrium of the reaction. Epicatalysts overcome the third principle..." https://en.wikipedia.org/wiki/Epicatalysis Pentcho Valev

7. *Pentcho Valev* • 2017-11-01 07:17 PM

   The second law of thermodynamics has long been under attack but only for small, microscopic, quantum etc. systems: Nature 2002: "Second law broken. Researchers have shown for the first time that, on the level of thousands of atoms and molecules, fleeting energy increases violate the second law of thermodynamics." http://www.nature.com/news/2002/020722/full/news020722-2.html The truth is that MACROSCOPIC systems violating the second law of thermodynamics are COMMONPLACE. The problem is that misleading education diverts the attention from relevant examples: "A necessary component of a heat engine, then, is that two temperatures are involved. At one stage the system is heated, at another it is cooled." http://physics.bu.edu/~duffy/py105/Heatengines.html So educators present the two temperatures as NECESSARY and deal with non-isothermal heat engines only: http://readingpenrose.files.wordpress.com/2015/07/rubber-band-engine.gif "All materials react to heat in some way. But this new shape-changing polymer reacts to temperatures as small as the touch of human skin to contract - in the process lifting as much as

1,000 times its own weight." http://gizmodo.com/this-new-shape-changing-polymer-can-lift-1-000-times-it-1759165438 "Stretchy Science: A Rubber Band Heat Engine. Learn how a rubber band can turn heat into mechanical work with this simple activity. [...] Your blow dryer essentially turned your rubber band into a heat engine - a machine that turns thermal energy into mechanical work." https://www.scientificamerican.com/article/bring-science-home-rubber-band-heat/ The second law of thermodynamics would be long forgotten if isothermal analogs which almost obviously violate the second law of thermodynamics had been analyzed (one should only evaluate the work involved in a quasi-static cycle): http://www.gsjournal.net/old/valev/val3.gif "When the pH is lowered (that is, on raising the chemical potential, μ, of the protons present) at the isothermal condition of 37°C, these matrices can exert forces, f, sufficient to lift weights that are a thousand times their dry weight." http://www.google.com/patents/US5520672 A. KATCHALSKY, POLYELECTROLYTES AND THEIR BIOLOGICAL INTERACTIONS, p. 15, Figure 4: "Polyacid gel in sodium hydroxide solution: expanded. Polyacid gel in acid solution: contracted; weight is lifted." https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1367611/pdf/bioph0017.pdf The following four-step isothermal cycle, if carried out quasi-statically (reversibly), clearly violates the second law of thermodynamics: 1. The polymer is initially stretched. The operator adds hydrogen ions (H+) to the system. The force of contraction increases. 2. The polymers contracts and lifts a weight. 3. The operator removes the same amount of H+ from the system. The force of contraction decreases. 4. The operator stretches the polymer and restores the initial state of the system. The net work extracted from the cycle is positive unless the following is the case: The operator, as he decreases and then increases the pH of the system (steps 1 and 3), does (loses; wastes) more work than the work he gains from weight-lifting. However electrochemists know that, if both adding hydrogen ions to the system and then removing them are performed quasi-statically, the net work involved is virtually zero (the operator gains work if the hydrogen ions are transported from a high to a low concentration and then loses the

same amount of work in the backward transport). That is, the net work involved in steps 1 and 3 is zero, and the net work extracted from steps 2 and 4 is positive, in violation of the second law of thermodynamics. Pentcho Valev

8. *Pentcho Valev* • 2017-11-01 06:36 PM

    Philip Ball explains why Frank Wilczek's time crystals are bogus: "But to make that happen, the researchers must deliver kicks to the spins, provided by a laser or pulses of microwaves, to keep them out of equilibrium. The time crystals are sustained only by constant kicking, even though - crucially - their oscillation doesn't match the rhythm of the kicking. The experiments are ingenious and the results show that this modified version of Wilczek's vision is feasible. But are we right to award the new findings this eye-catching new label, or are they really just a new example of a phenomenon that has been going on since the first primeval heart started beating? If these fancy arrangements of quantum spins deserve to be called time crystals, can we then say that we each already have a time crystal pulsing inside of us, keeping us alive?" http://www.prospectmagazine.co.uk/blogs/philip-ball/time-crystals-could-they-exist-science-physics That is, Frank Wilczek's time crystals are regularly "kicked" by the experimentalist. However, there are genuine time crystals "kicked" by ambient heat and breathtakingly violating the second law of thermodynamics. Here is perpetual (limited only by the deterioration of the system) motion of water in an electric field, obviously able to produce work - e.g. by rotating a waterwheel: "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ "The water movement is bidirectional, i.e., it simultaneously flows in both directions." https://www.wetsus.nl/home/wetsus-news/more-than-just-a-party-trick-the-floating-water-bridge-holds-insight-into-nature-and-human-innovation/1 The work will be done at the expense of what energy? The first hypothesis that comes to mind is: At the expense of electric energy. The system is, essentially, an electric motor. However, close inspection would suggest that the hypothesis is untenable. Scientists use triply distilled water to reduce the conductivity and the electric current passing through the

system to minimum. If, for some reason, the current is increased, the motion stops - the system cannot be an electric motor. If the system is not an electric motor, then it is ... a perpetual-motion machine of the second kind! Here arguments describing perpetual-motion machines as impossible, idiotic, etc. are irrelevant - the following conditional is valid: IF THE SYSTEM IS NOT AN ELECTRIC MOTOR, then it is a perpetual-motion machine of the second kind. In other words, if the work is not done at the expense of electric energy, then it is done at the expense of ambient heat, in violation of the second law of thermodynamics. No third source of energy is conceivable. In the electric field between the plates of a capacitor, the same perpetual motion of water can be seen (we have a time crystal again): " Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg In the capacitor system the rising water can repeatedly do work, e.g. by lifting floating weights. The crucial question is: The work (lifting floating weights) will be done at the expense of what energy? Obviously "electric energy" is not the correct answer - the capacitor is not an electric motor. Then the only possible answer remains "ambient heat". The system is a heat engine violating the second law of thermodynamics! Pentcho Valev

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Join the disruptors of health science

01 November 2017

Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.

Gabriela Hasbun for *Nature*

Thomas Insel left Verily, a health-science spin-off formed by Google's parent company, to co-found a start-up called Mindstrong Health this year.

In early 2015, I testified with several other National Institutes of Health (NIH) directors at an annual hearing held by the US Senate. It was my 13th and final year as director of the US National Institute of Mental Health

(NIMH) in Bethesda, Maryland. What struck me most was how the harsh fiscal reality tempered the passionate bipartisan support for the NIH. As one senator noted, with a federal deficit of nearly US$500 billion, there was little hope of any significant increase in funding.

Six months after that hearing, I left the NIH for Silicon Valley, first working at Verily in South San Francisco, California, a health-science spin-off formed by Google's parent company Alphabet. Since May, I've been president and co-founder of a start-up called Mindstrong Health in Palo Alto, California. I've witnessed the tremendous possibilities that immense resources, massive computing power and the application of data science can bring to biomedical research. I've watched some of today's best junior faculty members and postdocs launch their careers in Silicon Valley instead of in academic departments. And I've wondered how technology giants and start-ups will change biomedical and health-care research.

These companies have transformed the worlds of information, entertainment and commerce. But by moving into health care, they face some formidable challenges. In my view, solving them will require deep partnerships between technology companies, clinical experts, patient advocates and academic scientists.

A financial frontier

In the United States, public funding for science has not kept up with inflation over the past decade. The proposed 2018 budget from the White House recommends funding cuts for the NIH and the National Science Foundation of more than 10% each. Appropriations may ultimately be more generous, but no one is expecting Congress to repair a decade's loss of purchasing power.

Meanwhile, private-sector investment has become a bigger piece of the research-funding pie — increasing from 46% in 1994 to 58% in 2012 for biomedical research[1]. Tech companies, in particular, have been ploughing more funds into research, and moving into areas such as health and life sciences that have typically been the domain of the NIH, pharmaceutical and

biotechnology companies. By any measure, tech companies have enormous sums to spend. The collective cash reserves of Apple, Microsoft, Alphabet and Facebook — roughly $500 billion — exceed by tenfold the annual federal investment in biomedical research.

So what does this changing ecosystem mean for US biomedical science? Has the locus of innovation shifted from academia to Google and Facebook?

In some areas, such as artificial intelligence (AI), tech companies already dominate. According to a 2017 report, the tech giants invested between US$20 billion and $30 billion in AI in 2016, with 90% of this going towards research and development. Some, such as Google and the Chinese web-services company Baidu, are rebranding themselves as AI or deep-learning companies, with a focus on both expanding the science of machine learning and applying the approach to big-data problems[2].

In health research, the landscape is still evolving. Three years ago, IBM began selling a software suite called Watson for Oncology to cancer-treatment centres around the world. The program is built around what IBM call cognitive computing and is designed to help clinicians to select the best treatment. The company claimed that by using its cloud-based data on cancer, Watson could recommend interventions for individual patients, although some say the effort was premature and oversold[3].

Over the past 12 months, Fitbit, the developer of several fitness trackers, has expanded into a health-care and health-research company. With more than 50 million registered users, it is involved in 400 research projects, including studies of diabetes and heart disease. In fact, Fitbit has just been listed as one of nine digital health companies to be considered by the US Food and Drug Administration (FDA) in its precertification pilot programme — a new, supposedly more agile, approach to regulation that will focus on the software developer rather than on individual products.

Since March 2015, Apple's ResearchKit has made it easier for developers to create health apps for the iPhone or Apple Watch. It has also provided a platform for enrolling thousands of participants remotely in clinical projects, for instance in diabetes, cancer and diseases of the central nervous system. A study at Johns Hopkins University in Baltimore, Maryland, for instance, has

used ResearchKit to capture data just before and throughout seizures in nearly 1,000 people with epilepsy[4].

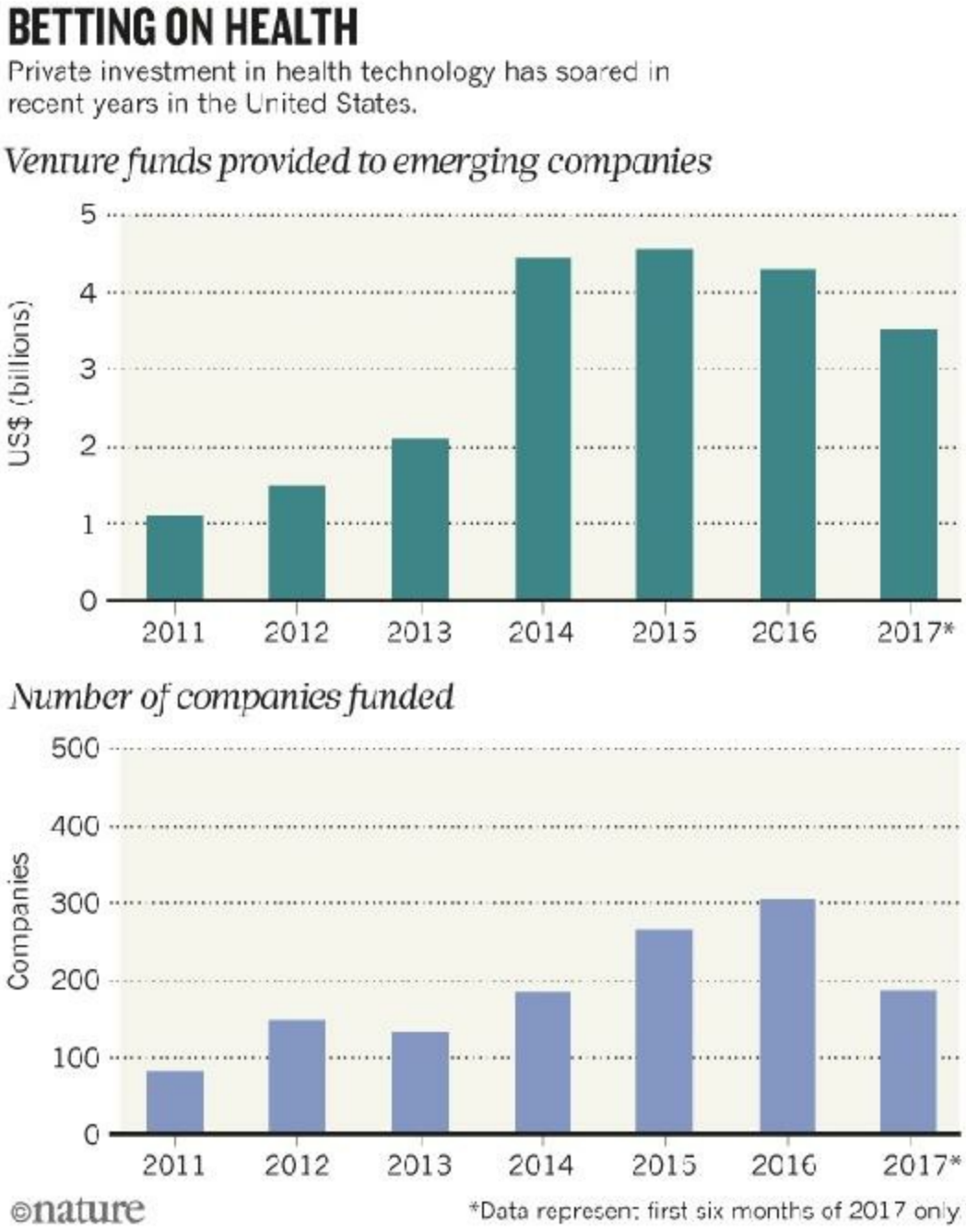
Kiyoshi Ota/Bloomberg/Getty

Fitbit, the developer of these sleep-monitoring wristbands, is currently involved in 400 research projects.

Also in 2015, Alphabet launched Verily — a company focused on creating software and hardware to transform health care. After growing to more than 500 employees in just over 2 years, Verily seeks to address diabetes, heart disease, cancer and diseases of the central nervous system using miniaturized sensors in smart devices — such as a contact lens that estimates blood sugar levels.

Just six months ago, Facebook revealed the existence of Building 8, a division focused on delivering consumer “hardware products that are social first”, including brain–computer interfaces designed to aid people with disabilities.

Meanwhile, health tech has become one of the hottest areas for venture investment in the United States: more than 1,000 new digital-health companies have started up since 2012. A report from Rock Health, a US venture-capital fund headquartered in San Francisco that invests in digital-health start-ups, estimates[5] that $15 billion has poured in to the sector over the past 5 years, up from $1.5 billion in 2012 and $1.1 billion in 2011 (see 'Betting on health').



Source: Rock Health

Like pharma and biotech, big and small tech companies are product-focused and team-based. This contrasts with academia, where scientists are rewarded for publishing papers and incentives are built around individual promotion

within a departmental structure.

But what struck me most on moving from the Beltway to the Bay Area was that, unlike pharma and biotech, tech companies enter biomedical and health research with a pedigree of software research and development, and a confident, even cocky, spirit of disruption and innovation. They have grown by learning how to move quickly from concept to execution. Software development may generate a minimally viable product within weeks. That product can be refined through 'dogfooding' (testing it on a few hundred employees, families or friends) in a month, then released to thousands of users for rapid iterative improvement.

During my first month working at Verily, I returned to Bethesda for the winter holidays; when I went back to work in early January, I found that a group of engineers had developed an entirely new product between Christmas and New Year's Day. Contrast that with the NIH-funded world of research, where it usually takes at least 18 months to go from proposing an idea to getting a project funded, or the years it can take to transform the discovery of a molecule into a marketable drug.

This intense focus on the rapid development of consumer products is very different from the pursuit of fundamental knowledge that has been a hallmark of academic research. And as a newcomer (what Google calls a noogler), I found the language of product development and the drive towards 'quarterly OKRs' (objectives and key results) a bit off-putting. But the truly disruptive impact of tech companies is not the rapid-fire push for consumer products or their deep pockets; it's their focus on AI and data resources.

Mining data

It is not surprising that companies that are dependent on information processing for their main revenue would be at the vanguard of developing the tools for collecting, storing and analysing data. A by-product of this is that tech companies are transforming data science — much as pharma and biotech transformed medicinal chemistry and molecular biology in the last decades of the twentieth century. In an era when biology is increasingly an information

science, the tools being created by tech companies can provide insights that will almost certainly be translated into advances for health.

The potential is awesome — for discovery as well as for product development.

Three examples illustrate what can be achieved through having extraordinary access to population data as well as massive data-storage and data-processing capacity. Importantly, none connects in an obvious way to a primary business of the company.

First, in 2016 a team at Google used a version of machine learning called convolutional neural nets to create an algorithm to detect diabetic retinopathy[6]. The researchers started by having 54 ophthalmologists rate 128,175 retinal images. Once the algorithm had been trained on this data set, the team used two new sets of retinal images to test against eight board-certified ophthalmologists. The results were striking: depending on how the researchers set its parameters, the algorithm performed better than seven of the eight clinical experts, in terms of sensitivity and specificity. This approach is not markedly different from previous efforts to identify cats and faces with machine learning, but the potential impact on diagnostics and clinical care is profound.

Second, a team in Facebook's Building 8 is seeking to develop new brain–computer interfaces that (with the use of non-invasive optical sensors) will enable people to type simply by thinking — what is now called 'silent speech'. Although several universities have teams working on brain–computer interactions, the number of engineers and the computational resources that Facebook can muster would be difficult for any academic investigator to fund using federal grants. Importantly, Facebook is supporting some of these academic scientists (as well as recruiting many) to expedite this project.

Third, a team at Microsoft has used anonymous Bing search histories from 9.2 million users to predict cases of pancreatic cancer several months before people are usually diagnosed with the disease[7]. The team identified characteristic patterns of historical symptom searches in more than 3,000 anonymous users who subsequently indicated a probable diagnosis of

pancreatic cancer — indicated by searches such as 'just diagnosed with pancreatic cancer'. This approach lacks the corroboration of a pathological diagnosis and the sensitivity is poor (only 5–15% of cases can be identified). But false-positive rates are extremely low (less than 0.0001).

In short, tech companies have scale and speed: an experiment can involve millions of people and be completed in months. But scale and speed aren't everything.

Sticking points

In moving from software or hardware development to biomedical research and health care, tech companies large and small face formidable challenges. They usually do not have the regulatory expertise needed to develop medical products, they rarely have access to clinical samples and they often lack a deep understanding of the clinical problem to be solved.

Gabriela Hasbun for *Nature*

At its California office, Mindstrong Health is developing digital phenotyping as a diagnostic tool.

Various moves are being made to try to address these issues. In May, Verily hired Robert Califf, former chief of the FDA, to help with its personalized-medicine effort called Project Baseline. In 2015, 23andMe, a personal-genomics company based in Mountain View, California, recruited Richard Scheller, former head of research at the biotech company Genentech in San Francisco, to lead its research programme. And in 2016, Apple brought Stephen Friend, an open-science advocate from the non-profit research organization Sage Bionetworks in Seattle, Washington, to assist with its health projects.

How a culture built around engineers and designers will incorporate people from different sectors remains to be seen, and whether companies that build consumer products will be able to work with health-care payers and providers is unclear. But the willingness of tech companies to hire national experts on health, regulation and health data to aid in discoveries that will have clinical utility is a hopeful sign.

Yet there are at least four further major areas of uncertainty.

Open science increasingly drives innovation in the public sector. It is unclear to what degree the drive for intellectual property and profits will limit the transparency of research in the tech sector[8]. The stereotype is that for-profit companies will focus only on commercial end points. But there are notable counter-examples from AI research, in addition to the biomedical examples above. In 2015, Google made its machine-learning software library, TensorFlow, open source, and AI researchers across the board quickly adopted this powerful tool. Likewise, the *Apple Machine Learning Journal* launched in July to provide more transparency about the company's current projects (see go.nature.com/2yckpi9).

It's too early to say whether big or small tech companies will favour open source for their biomedical scientific initiatives. The success of ResearchKit gives some indication of what could be accomplished if they do.

Another uncertainty is whether the business model in tech, which is often based on advertising revenue or the sales of devices, will limit the rigour, generalizability and validity of the science carried out. Especially in start-ups that are dependent on rapid returns for their investors, the financial runway may be too short for lengthy or large clinical trials.

And then there's the issue of trust. It has become the norm for tech companies to use personal shopping or geolocation data for commerce. It's unclear whether the public will be as accepting about the use of personal health data, especially by behemoths such as Google or Facebook.

The recent commitments of big and small tech companies to discovery and clinical research are exciting. But during an economic downturn, these projects could be the first to be axed to protect the company's bottom line.

Science needs commitment. Bell Labs — at its peak, the premier research and development company of the United States — is an example of extraordinary scientific success in a for-profit organization. But as author Jon Gertner pointed out[9] in *The New York Times* in 2012: “Mark Zuckerberg noted that one of his firm's mottoes was 'move fast and break things'; that of Bell Labs' might just as well have been 'move deliberately and build things'.”

Partners, In time

The practical questions are these. What will each of the sectors in the evolving ecosystem do best? What can be done across sectors? How can bridges be built between companies with unprecedented access to data and massive computational resources, and academic scientists who may have a deep understanding of a clinical problem or access to unique clinical populations?

It seems likely that the academic sector will continue to lead on those aspects of fundamental biology and clinical research that do not require big data or machine learning — the purification of an enzyme, perhaps, or the development of a mouse model for a rare disease. Pharma and biotech will continue to be the source of new medicines. The domain of the tech industry

will be research that is data-intensive, and product development that requires a legion of software engineers working with designers.

Transformative medical products that require clinical testing, regulatory standards and insights about the health-care marketplace, including the practical constraints faced by providers in the clinic, will almost certainly require partnerships between public research entities and private companies. These must include precompetitive partnerships across tech, pharma–biotech, academia and patient-advocacy groups. Developing these partnerships will not be easy, given the different stakeholders, cultures and incentives.

Yet there are successful public–private partnerships to learn from.

Since 2006, the Biomarkers Consortium, managed by the US charitable organization the Foundation for the NIH, has brought academics and private companies together to develop biomarkers across a range of diseases. The Alzheimer's Disease Neuroimaging Initiative, which since 2004 has worked to establish standards for imaging biomarkers in dementia, is among the studies it has supported. As is I-SPY2, which since 2010 has created treatment pathways based on biomarkers for breast cancer. Another Foundation for the NIH initiative is the Accelerating Medicines Partnership. This has paired the NIH and the FDA with 10 pharma and biotech companies as well as 12 non-profit patient-advocacy foundations to define new targets for drug development for rheumatoid arthritis, type 2 diabetes and Alzheimer's disease.

A new sector in the research ecosystem means that health problems, even those that do not present an obvious commercial opportunity, can be approached from a fresh angle. Data science could integrate the full stack of patient information, from genomics to socio-economic factors, to guide clinical care. Sensors and big data could transform our description of phenomics — each person's set of behavioural, physical and biochemical traits. For example, digital phenotyping through the use of smartphone sensors, keyboard performance and voice or speech features can provide, for the first time, an objective, continuous, passive measure of behaviour and cognition at the global scale. Mindstrong Health is using this approach to detect the earliest phases of dementia, mental illness and possibly a range of medical disorders[10].

As just one example of an urgent opportunity, attempts to prevent suicide worldwide have been remarkably ineffective — including public-health measures to reduce stigma, raise awareness and reduce access to guns. Social media, just-in-time interventions and new analytical tools for prediction could change our understanding of risk and yield new strategies for prevention[11]. Tech companies, paired with other players, could start to solve this and many other historically intractable problems.

There is an old African proverb: “To go fast, go alone; to go far, go together.” Science to improve health has proved frustratingly slow. Perhaps, with a new fast partner, all of us in research can go farther.

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Comments

Comments

There are currently no comments.

Spanish government takes control of Catalonian universities

Madrid will oversee the finances of the region's research centres and seven public universities.

31 October 2017

Alain Pitton/NurPhoto/Getty

Supporters of independence for Catalonia.

The Spanish government has taken over responsibility for higher education and research in Catalonia, following the region’s unilateral declaration of independence on 27 October. It will retain control of spending on research centres and universities, which the League of European Research Universities

says threatens institutional autonomy.

The Catalonia region of north-east Spain has been in political turmoil ever since a highly controversial vote on independence was taken on 1 October. For the past 32 years the Catalan government has set and financed the budgets of universities, which were allocated €700 million (US$814 million) of the nearly €1-billion Catalan budget for science and universities in 2017. The region is strong in science: between 2007 and 2015, its universities won a 210 grants from the European Research Council, totalling €334 million. In the most recent round, 10 of the 22 ERC starting grants awarded to researchers in Spain were won by researchers based at Catalan institutions.

The Ministry of Education, Culture and Sport in Madrid will run Catalan universities and the Ministry of Economy, Industry and Competitiveness will oversee the region's research policy with immediate effect.

The changes mean that the Spanish government will be able to make decisions affecting research centres and universities in Catalonia, after it dismissed all the members of the Catalan government.

Carmen Vela, Spain's secretary of state for research, development and innovation, says that the government hopes the difficulties will be resolved shortly. "Today's situation is a bit different, but it has a very clear goal: restoring normality and tranquility. We are going to work to ensure that there are no negative impacts on research and innovation in Catalonia." She says that the Spanish government will manage but not devise science policy in Catalonia ahead of regional elections due in December.

University connections

Santi Vila, minister of business and knowledge in the Catalan government, stepped down a day before the independence declaration. Arcadi Navarro, secretary of state for universities and research in the Catalan government and a geneticist at Pompeu Fabra University in Barcelona, who used to report to Vila, might yet remain in his job. Vela says that she would like him to continue. "Arcadi is an excellent researcher and someone with whom we

have always had an excellent relationship," Vela says. "We want to keep working with him."

Jaume Casals, rector of Pompeu Fabra University, says that he does not expect the Spanish government to interfere directly in universities' affairs. "The relationship between Madrid and Barcelona when it comes to science and universities has always been fluid, and I hope that will not change," says Casals, who also leads the Alliance 4 Universities, a group of research-intensive universities consisting of two based in Madrid and another two in Catalonia.

Enric Banda, senior adviser at the Barcelona Supercomputing Centre and former president of the grass-roots association EuroScience, agrees. "This is the first time these type of measures, stipulated in the Spanish constitution, are applied. The uncertainty is high because nobody knows exactly how they will be implemented. But I don't expect any additional disruption in the daily activities of the Catalan universities," he says.

Financial ties

The League of European Research Universities, headquartered in Leuven, Belgium, has criticized the financial arrangements on the grounds that they undermine institutional autonomy. In a statement issued on 23 October, the group's secretary-general, Kurt Deketelaere, wrote: "Just like academic freedom, institutional autonomy is key for the academic world and society at large. It cannot be limited on the basis of political considerations, or to serve political goals."

Ahead of the Catalan elections in December, both Casals and Banda are calling on the Spanish government to lift the financial controls and to minimise the impact of the political upheaval on the region's international image. "Catalonia has done very well at attracting international researchers and students and we would like that to continue," says Casals.

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Comments

Commenting is currently unavailable.

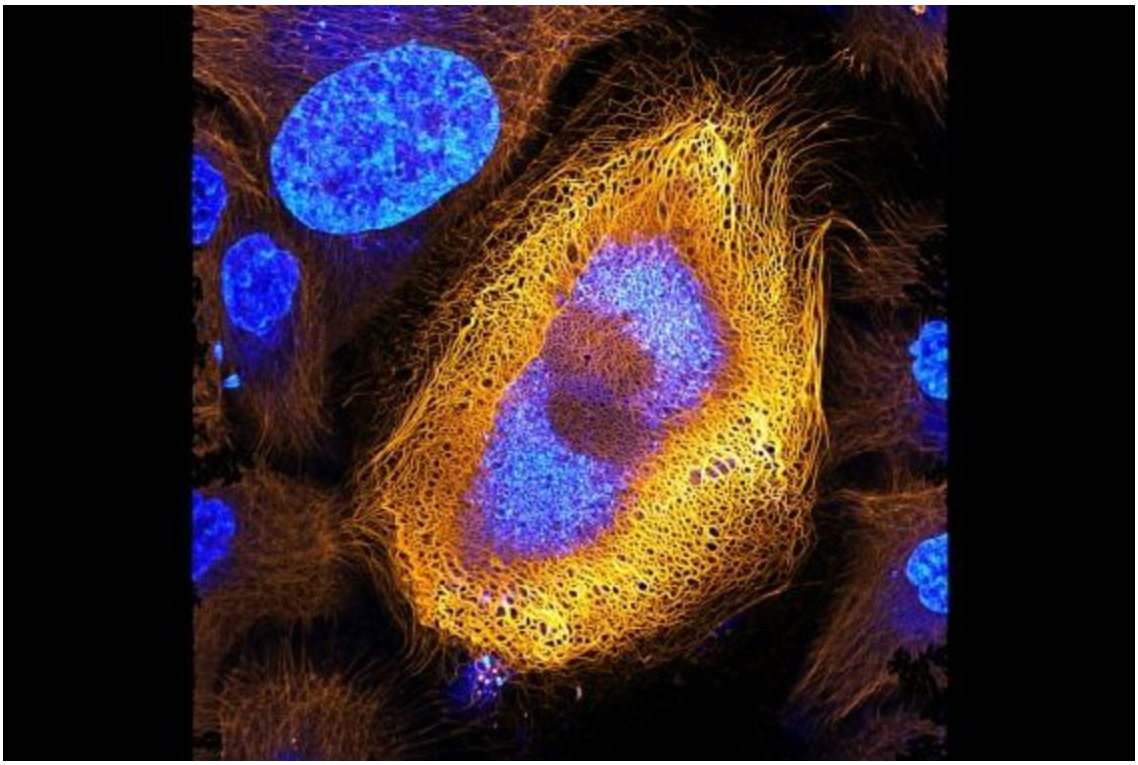
Seeds, sponges and spinal surgery

October’s sharpest science shots, selected by *Nature*’s photo team.

31 October 2017

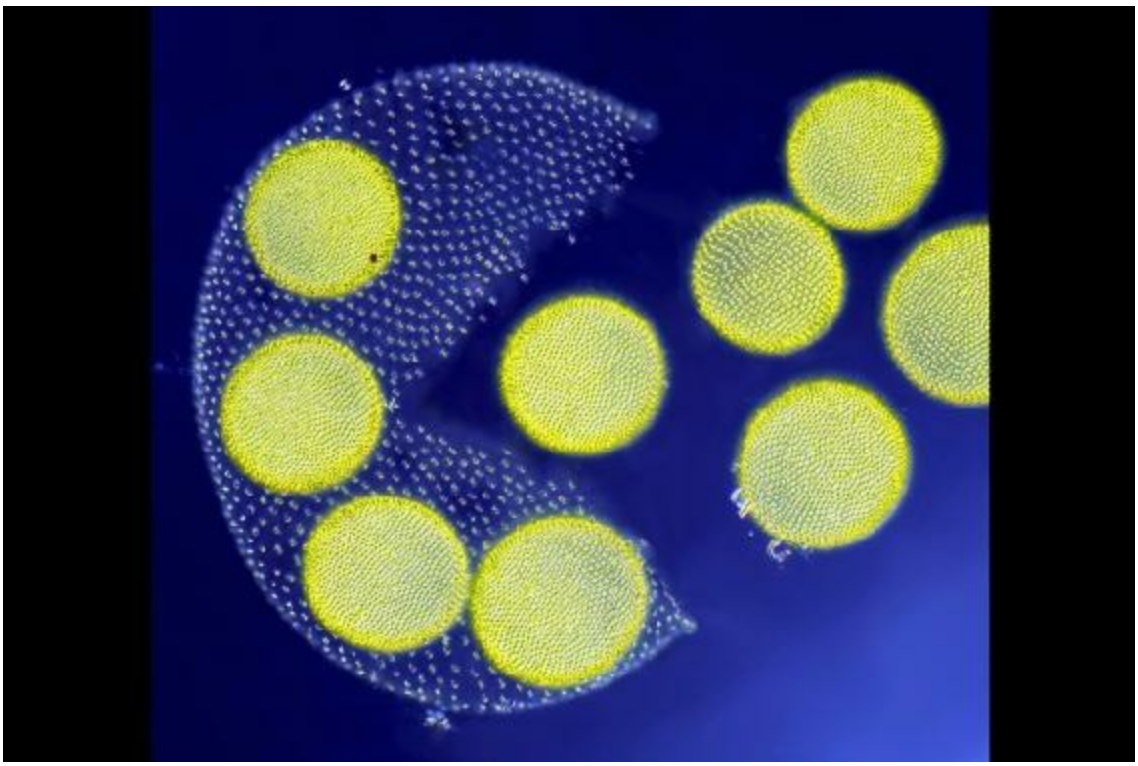
Small beauties

Image Slideshow

1. 

   This image of an immortalized human skin cell won first place in the Nikon Small World Photomicrography Competition. It was taken by Bram van den Broek, a biophysicist at the Netherlands Cancer Institute in Amsterdam.

B. van den Broek, A. Volkov, K. Jalink, N. Schwartz, R. Windoffer/Nikon Small World 2017

2. 

This might look like computer-game character Pac-Man, but it is actually a type of alga called Volvox releasing daughter colonies to continue its line.

Jean-Marc Babalian/Nikon Small World 2017

3. 

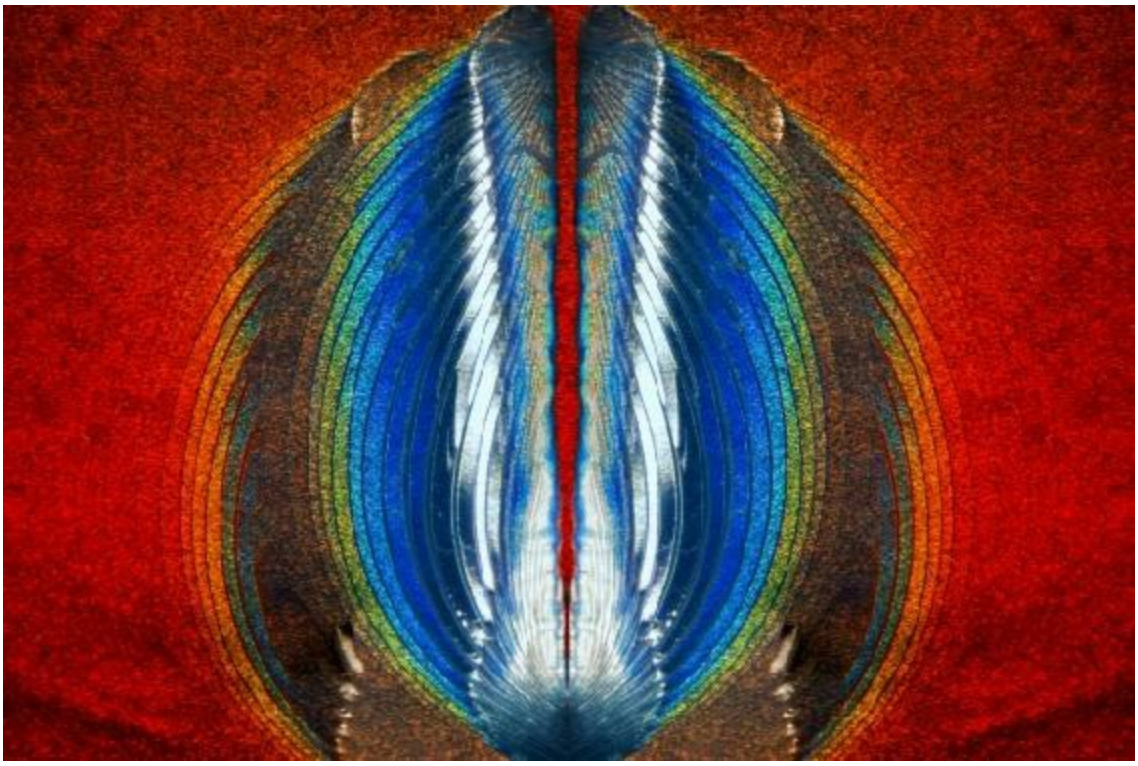
This portrait of a tropical weevil (*Rhigus nigrosparsus*) was given an ‘image of distinction’ award.

M. Clemens/Nikon Small World 2017

4. 

An eerie green crystal of the mineral pyromorphite featured in another shot that received an image of distinction.

E. C. Márquez/Nikon Small World 2017

5. 

This butterfly-like shape is in fact the fractured plastic of a credit-card hologram, seen at ten times its real size.

S. Simon/Nikon Small World 2017

6. 

   This startlingly alien shape is a cross-section through something very common: a needle from a Scots pine tree (*Pinus sylvestris*).

   A. Klepnev/Nikon Small World 2017

From tragic to touching

Image Slideshow

1. 

   The grand-title winner of this year's Wildlife Photographer of the Year competition features a black rhino (*Diceros bicornis*) in Hluhluwe Imfolozi Game Reserve in South Africa, after it was butchered by poachers who were after its horns. Brent Stirton has seen more than 30 such tragic scenes.

   Brent Stirton/Wildlife Photographer of the Year

2. 

This Maori octopus (*Macroctopus maorum*) was spoilt for choice when it came across a huge congregation of giant spider crabs off Tasmania, Australia. The photograph won the invertebrate-behaviour category of the Wildlife Photographer of the Year competition, which is developed and produced by the Natural History Museum, London.

Justin Gilligan/Wildlife Photographer of the Year

3. 

Divers from the Dumont d’Urville scientific base in East Antarctica worked for 3 days in the frigid waters off the continent to capture this image of an ice berg, which was stitched together from 147 separate shots. It won the Earth’s environments category.

Laurent Ballesta/Wildlife Photographer of the Year

4. 

These polar bears (*Ursus maritimus*) near Norway's Arctic island of Svalbard were photographed feeding on waste from a ship's kitchen. The image won the black-and-white category in this year's awards.

Eilo Elvinger/Wildlife Photographer of the Year

5. 

Controversial oil drilling is an increasing threat to the residents of Yasuní National Park in Ecuador. Among the animals imperilled is this toad, the star of this finalist in the animal-portraits category.

Jaime Culebras/Wildlife Photographer of the Year

6. 

The Sonoran Desert in the United States and Mexico hosts many saguaro cacti (*Carnegiea gigantea*), including this example that has suffered frost damage, causing its limbs to fall to the ground. The image is a finalist in the plants and fungi category.

Jack Dykinga/Wildlife Photographer of the Year

Syrian seeds

Diego Ibarra Sanchez/The New York Times/eyevine

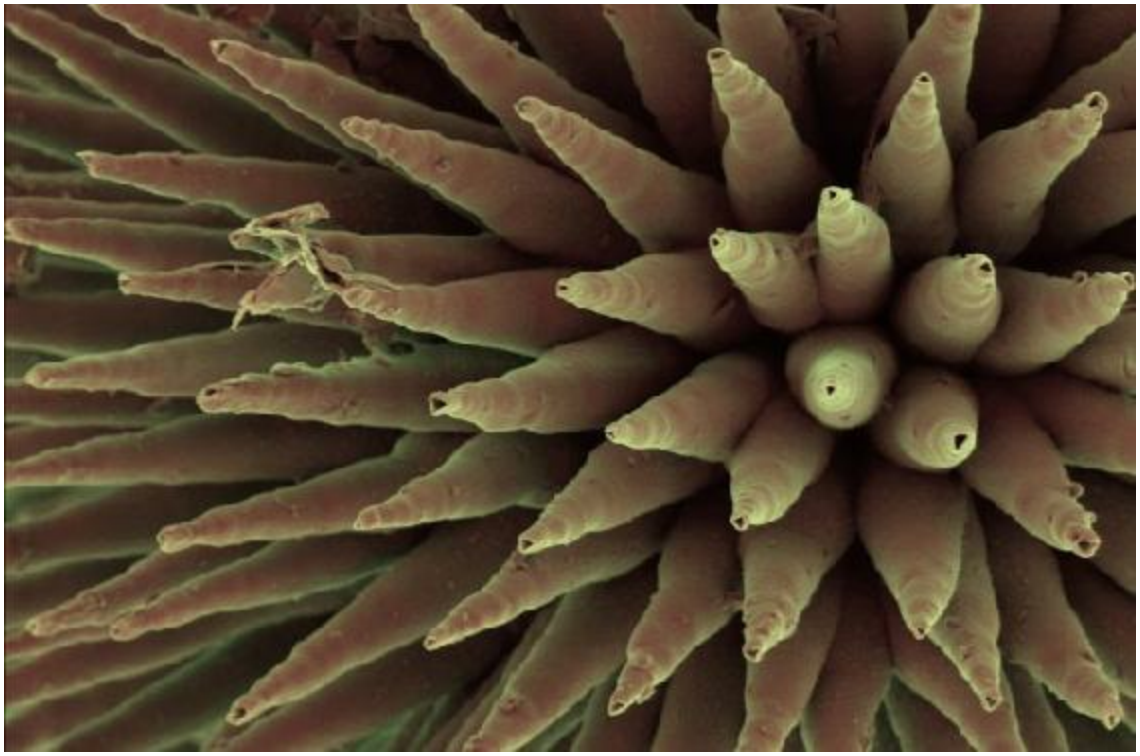
Among the people forced out of their country by the war in Syria are researchers from the nation's seed bank, who are now rebuilding their lives in locations around the world. Ali Shehadeh (pictured) is one of them. A researcher who was based at a International Center for Agricultural Research in the Dry Areas seed bank in Aleppo, he now works in Terbol, Lebanon.

Capturing sunlight

Xu Haijing/Xinhua/ZUMA Wire

The 2017 World Solar Challenge this month saw strange vehicles racing 3,00(kilometres across Australia, powered only by sunlight. Here, the Dutch-built vehicle RED Shift passes a rock formation known as the Devil's Marbles, near Tennant Creek in the Northern Territory.

Sponge spikes



Zlotnikov Group, B CUBE, TU Dresden

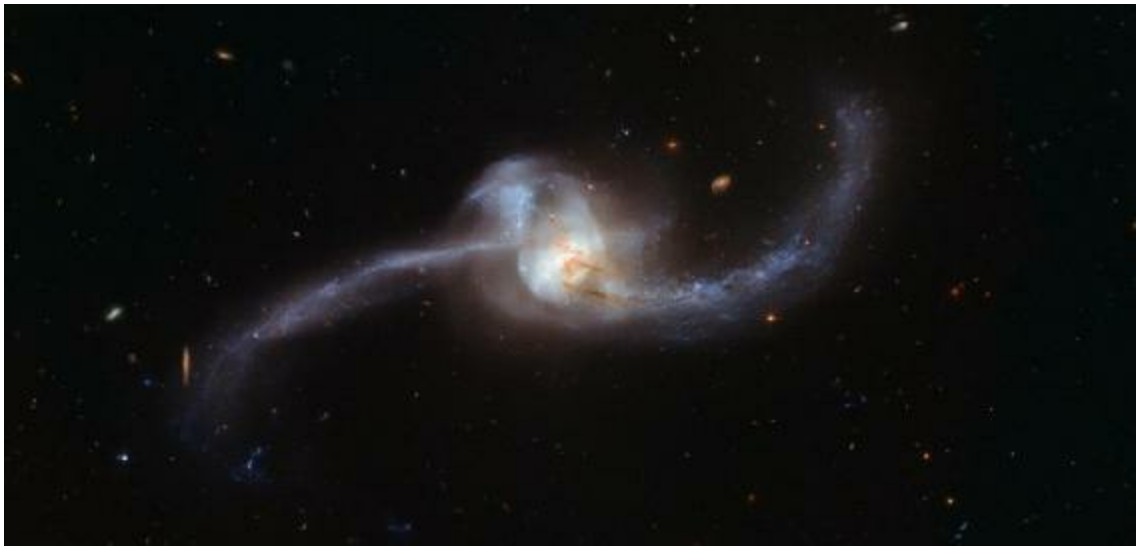
Marine sponges called demospongiae make their skeletons out of silica-glass structures called spicules. Using this image and others, researchers have been unpicking what they call the “half-a-billion-year-old fabrication concept” that produces these structures.

Spinal surgery

Beatrice de Gea/The New York Times/Redux/eyevine

Physicians at Texas Children’s Hospital in Houston now operate on fetuses with spina bifida while they are still in the womb using a new, experimental technique. This technique involves lifting the mother’s uterus out of her body to operate on the spine of the baby inside it.

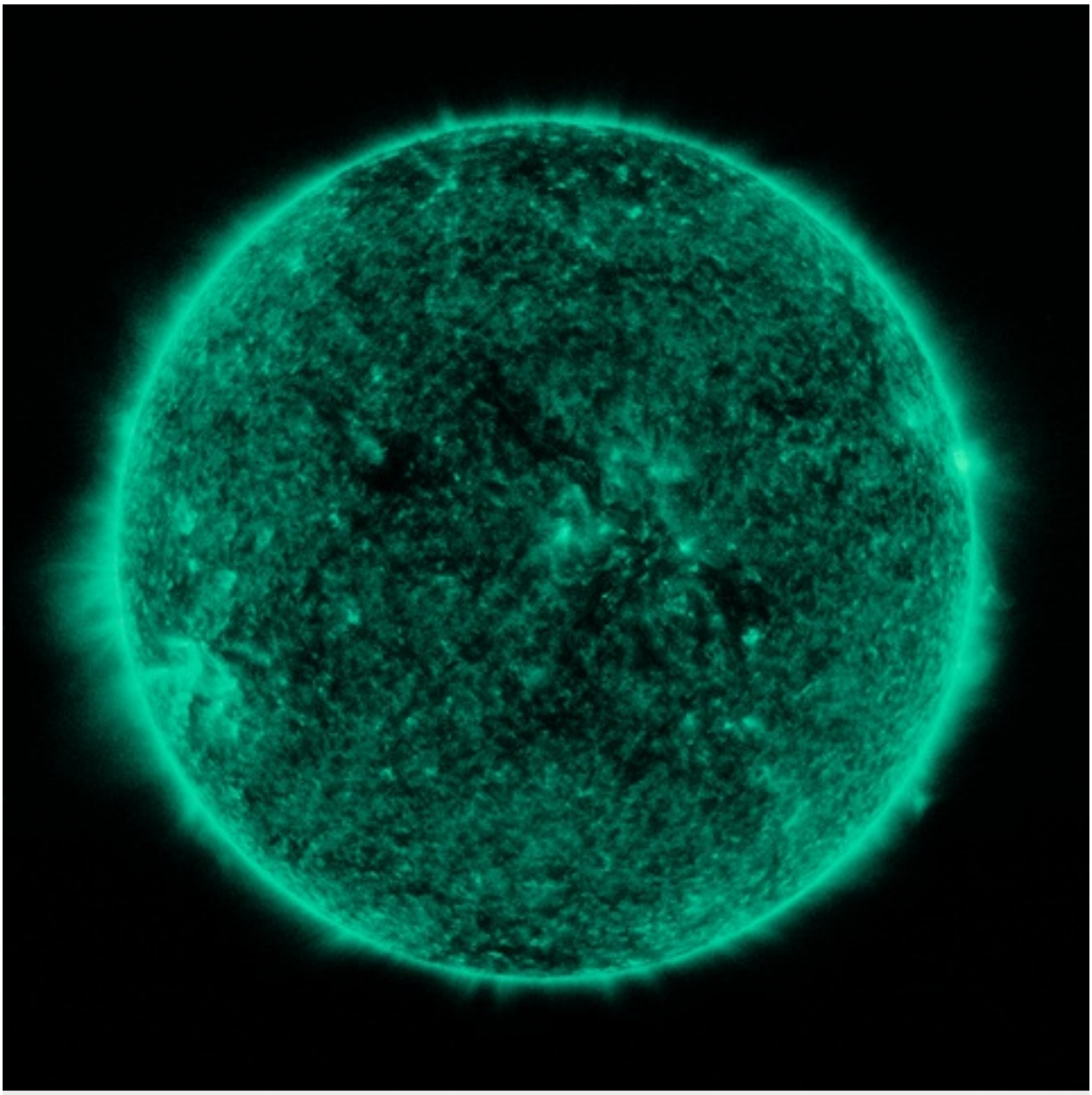
A cosmic collision’s aftermath



ESA/Hubble & NASA

Two galaxies smashed together into one to form this cluster of stars, with tails some 15,000 parsecs (50,000 light years) long. NASA released the image this month, and cheerfully pointed out that this is what our Milky Way will look like in 4 billion years' time, after it collides with neighbouring galaxy Andromeda.

Sun block



NASA’s Goddard Space Flight Center/SDO/Joy Ng

NASA’s Solar Dynamics Observatory was launched into space in 2010 to supply researchers back on Earth with an uninterrupted view of the Sun. Uninterrupted, that is, except when the Moon gets in the way, as shown in this ultraviolet spectrum from 19 October.

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Comments

Comments

There are currently no comments.

Small group scoops international effort to sequence huge wheat genome

Just six scientists conquer one of the most complicated genomes ever read.

31 October 2017

Nico van Kappel/Minden Pictures/Getty

The genome of wheat (*Triticum aestivum*) is huge, and full of repetitive sequences.

The wheat genome is finally complete. A giant international consortium of academics and companies has been trying to finish the challenging DNA

sequence for more than a decade, but in the end, it was a small US-led team that scooped the prize. Researchers hope that the genome of bread wheat (*Triticum aestivum*) — described in the journal *GigaScience* this month[1] — will aid efforts to study and improve a staple crop on which around 2 billion people rely.

The wheat genome is crop geneticists' Mount Everest. It is huge — more than five times the size of a single copy of the human genome — and harbours six copies of each chromosome, adding up to between 16 billion and 17 billion letters of DNA. And more than 80% of it is made of repetitive sequences. These stretches are especially vexing for scientists trying to assemble the short DNA segments generated by sequencing machines into much longer chromosome sequences.

It’s like putting together a jigsaw puzzle filled with pieces of blue sky, says Steven Salzberg, a genomicist at Johns Hopkins University in Baltimore, Maryland, who led the latest sequencing effort. “The wheat genome is full of blue sky. All these pieces look like a lot of other pieces, but they’re not exactly alike.”

As a result, previous wheat-genome sequences contained gaps that made it hard for scientists to locate and examine any particular gene, says Klaus Mayer, a plant genomicist at the Helmholtz Center in Munich, Germany, and one of 1,800 members of the International Wheat Genome Sequencing Consortium (IWGSC) that have been tackling the genome since 2005.

A sequence released by the consortium in 2014 covered about two-thirds of the genome, but it was highly fragmented and lacked details about the sequences between genes[2]. Improved versions were released in 2016 and 2017, but the use of these data is restricted until the IWGSC publishes its analysis (Mayer says the team is preparing to submit its report to a journal). The sequence was also produced using proprietary software from a company called NRGene, preventing other scientists from reproducing the effort.

Puzzle pieces

Salzberg, who specializes in assembling genome sequences, and his five colleagues decided to tackle the problem themselves. To overcome the challenge of ordering repetitive DNA — the puzzle pieces of blue sky — the researchers used a sequencing technology that generates very long DNA stretches (often in excess of 10,000 DNA letters). They also created much shorter, but highly accurate sequences, using another technology.

Stitching these ‘reads’ together — which amounted to 1.5 trillion DNA letters and consumed 880,000 hours of processor time on a cluster of parallel computers — resulted in nearly continuous chromosome sequences that encompassed 15.3 billion letters of the wheat genome.

Mayer calls the new sequence “a major leap forward”. Postdocs can spend whole fellowships locating a single wheat gene of interest, he says. “Those genes which took 10 man- or woman-years to clone, this will melt down to a couple of months, hopefully.” The results of such research should help breeders to develop strains of wheat that are better able to tolerate climate change, disease and other stresses.

Some scientists are already using the new wheat genome — including, Salzberg says, members of the IWGSC working on one particular chromosome. But if it is to be of widespread use, all of the genes and sequences will need to be identified and labelled, a laborious process known as annotation. Salzberg says that a collaborator of his is planning to do this, “unless someone does it sooner”.

Neil Hall, a genomicist and director of the Earlham Institute, a genomics research centre in Norwich, UK, sees Salzberg’s approach as a sign of the times. If the wheat genome — considered one of the most complicated to be tackled by scientists — can be sequenced by a small team using the latest technology, almost any genome could.

“I think we’ve moved beyond the era where genome projects have to be these monolithic international cooperations,” Hall says. “Genomics is more like the gig economy now.”

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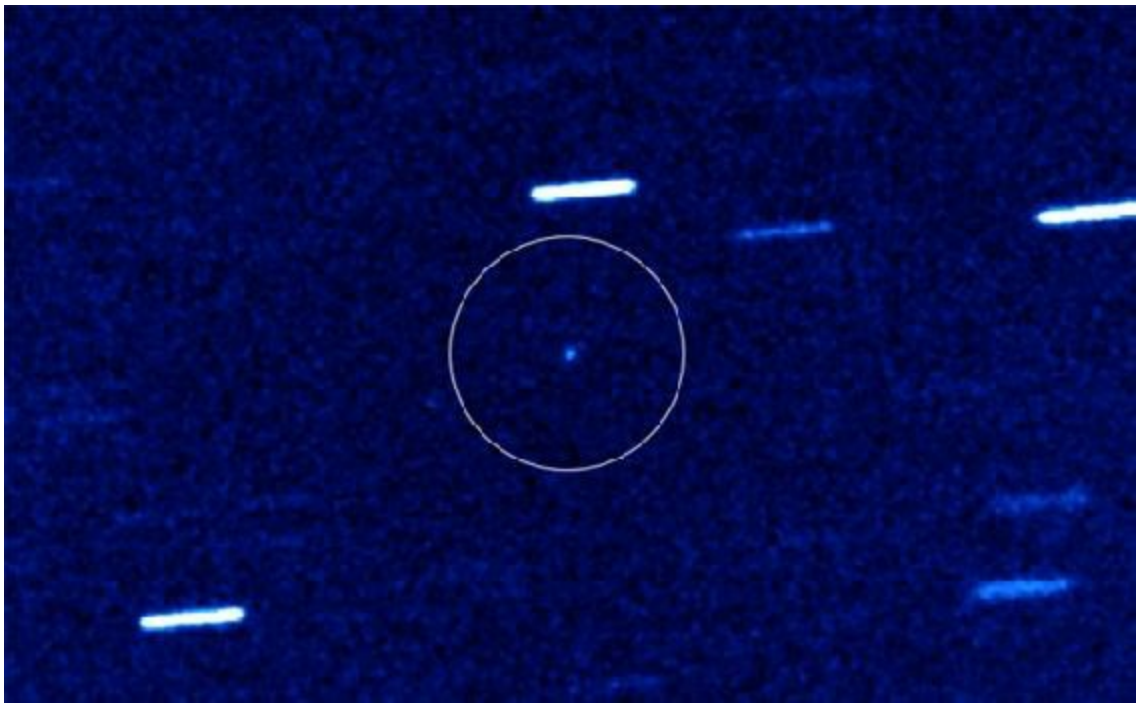
Comments

Commenting is currently unavailable.

Astronomers race to learn from first interstellar asteroid ever seen

Wonky orbit confirms that this visitor isn’t from around here.

31 October 2017



Alan Fitzsimmons, Queen’s University Belfast/Isaac Newton Group, La Palma.

The interstellar asteroid A/2017 U1 (circled) is rushing away from Earth and is currently traversing the Pisces constellation.

Scientists are trying to learn everything that they can from the first interstellar asteroid they have ever observed crossing into our Solar System. Spotted less than two weeks ago, the object is now whizzing across the constellation Pisces and, in a couple of months, will be too faint and far away for even the

largest telescopes to see.

“It’s fascinating,” says astronomer David Jewitt of the University of California, Los Angeles. “We are seeing a body from elsewhere in the Galaxy passing through our Solar System. It’s the first time we’ve seen such a thing.”

Unfortunately, the asteroid, dubbed A/2017 U1, is dashing away, never to return. “It’s going really fast,” says Jewitt. “So we have a limited time to get any measurements at all.” Astronomers would love to know what it’s made of, but it’s so dim that spectra — light that observers use to determine the compositions of celestial objects — have so far revealed little information[1]. Nor can anyone say what solar system it came from, or how old it is.

A curious path

Researchers with the Pan-STARRS1 telescope atop Haleakala in Maui, Hawaii, spied the first images of the intruder, made during the new Moon, in mid-October. “It didn’t move like comets or asteroids normally do,” says astronomer Rob Weryk at the University of Hawaii at Manoa, who first noticed the object on the morning of 19 October.

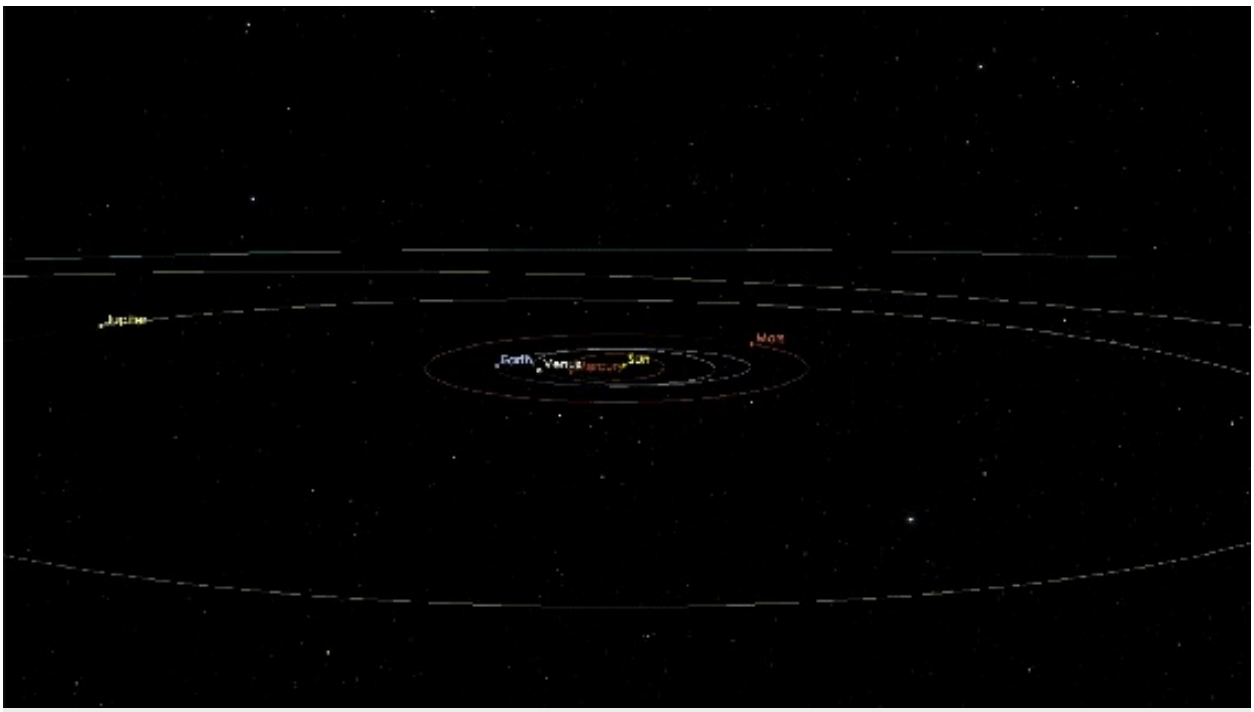
Comets and asteroids usually move on elliptical orbits around the Sun. These orbits have an eccentricity — a measure used to describe orbital shape — of less than 1. But an object zipping through the Solar System from beyond should instead follow a hyperbolic orbit, whose eccentricity exceeds 1.

The latest observations of the asteroid’s changing position indicate that its orbital eccentricity is a whopping 1.20. “It is virtually certain that the object moves in a hyperbolic trajectory,” says Carlos de la Fuente Marcos, an astronomer at the Complutense University of Madrid.

The asteroid skirted the Sun on 9 September, when it was inside Mercury’s orbit, and then passed by Earth at a distance of 24 million kilometres on 14 October.

On the lookout

Astronomers know little else about the exotic visitor. It’s faint, which means that it’s small: fewer than 400 metres across. And despite its excursion near the Sun, it did not develop a tail — as a comet would — and so astronomers are currently classifying it as an asteroid.



NASA/JPL-Caltech

The path of A/2017 U1, an interstellar object that swung through our Solar System.

Researchers have anticipated interstellar visitors for years. “We have waited a long time,” says planetary scientist Alan Stern at the Southwest Research Institute in Boulder, Colorado, who studied the matter in the 1990s.

That expectation is based on the knowledge that the gravitational pulls of the giant planets Jupiter, Saturn, Uranus and Neptune catapulted trillions of comets and asteroids from the young Solar System into interstellar

space. Planets in other solar systems presumably did the same, littering interstellar space with rogue objects. “By measuring how many there are sweeping through our Solar System, we can get a gauge of how many are in the entire Galaxy, and how many solar systems have contributed to that population,” says Stern.

“If one hadn’t been discovered fairly soon, that would start to worry me a bit,” says astronomer David Hughes, emeritus professor at the University of Sheffield, UK.

The asteroid came from the direction of the constellation Lyra, which is roughly where our Solar System is heading. Given this trajectory, researchers are expecting to see more objects coming from this direction than from elsewhere, just as runners heading into the rain encounter more drops on their chests than their backs.

A/2017 U1 is the first of many such objects, predicts Jewitt.

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Comments

Comments

There are currently no comments.

How baby bats develop their dialects

The young animals crowdsource the pitch of their calls from colony members.

31 October 2017

Joel Sartore/National Geographic Creative

Adult Egyptian fruit bats have a hand in what young bats learn.

It takes a village to teach a bat how to communicate. Baby Egyptian fruit bats learn calls from their mothers, but research now shows that they can learn new dialects, or the pitch of their vocalizations, from the colony members around them.

Learning to communicate by repeating the noises that others make is something only a few mammal groups — including humans, whales and dolphins — are known to do. Researchers call this vocal learning, and it's something that they're starting to study in bats. Findings published on 31 October in *PLOS Biology*[1] show that bats can also pick things up from the group around them, a process that the authors dub crowd vocal learning.

Bats are becoming the best organism to use in studies of how mammals learn to vocalize, because they’re more easily manipulated in the lab than whales or dolphins. The latest research underscores their importance, says neuroscientist Michael Yartsev of the University of California, Berkeley, who was not involved with the work.

Songbirds demonstrate vocal learning beautifully, but their brains are organized differently from human brains. Pinning down a mammalian model to explore how this function develops is important for neurologists studying vocal learning, says Yartsev.

The call of the colony

Egyptian fruit bats (*Rousettus aegyptiacus*) are highly social and live in colonies with dozens to thousands of other bats. To see how the pups learn dialects, researchers caught 15 pregnant Egyptian fruit bats and took them into the lab. To control for potential genetic effects, they ensured that the mothers weren't closely related. The team then split the mothers into three groups of five and put each group into one of three chambers, where the mothers gave birth to their young. The scientists used recordings of wild Egyptian fruit bat colonies that were low in frequency, high or a mix of both frequencies, and then piped one pitch into each chamber.

The team released the mothers back into the wild after 14 weeks, around the time the young would naturally be weaned. After another 17 weeks in the enclosures, the young bats were mimicking the pitch of the recordings they had grown up with: bats in the high-frequency chamber made more high-frequency calls than the bats that grew up hearing the other two frequency soundscapes.

The findings make sense, says Yossi Yovel, a neuroecologist at Tel Aviv University in Israel and a study co-author. Baby bats grow up in the dark, surrounded by noisy neighbours, so it would be odd if they didn't pick things up from the animals around them. "It's perhaps not surprising, but it was never demonstrated before now."

Yovel and his team plan to release the young bats into the wild and observe whether their dialect changes to match that of the wild bats, or whether the colony members pick up the experimental bats' dialect.

Studying how this process works in mammalian brains could provide insight into how humans learn language, too, says Sonja Vernes, a neurogeneticist at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands. "If we can understand how bats do it, I think we can learn something about how humans do it."

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Comments

Comments

There are currently no comments.

US environment agency bars scientists it funds from serving on its advisory boards

The US Environmental Protection Agency says the policy will address potential conflicts of interest, but scientists raise alarms.

31 October 2017 Updated:

1. 31 October 2017

Andrew Harrer/Bloomberg/Getty

EPA administrator Scott Pruitt is poised to reshape the mix of experts that advise his agency.

The US Environmental Protection Agency (EPA) moved today to ban researchers who receive agency grants from serving on EPA advisory boards.

In crafting the policy, EPA administrator Scott Pruitt sided with his agency's most vociferous critics, who claim that EPA science panels are stacked with scientists who are biased in favour of the agency's regulatory agenda. The policy does not extend to scientists who work for local, state and tribal agencies that receive EPA grants, instead focusing on academic researchers. At a press conference, Pruitt said that scientists on three major EPA advisory panels have received US$77 million in grants over the past three years.

"When you receive that much money, there's a question that arises about independence," Pruitt said. Moving forward, he said, scientists "will have to choose — either the grant, or service, but not both."

Scientists and environmentalists blasted the policy as hypocritical and dangerous, saying it will exclude many top researchers while rendering the volunteer posts less attractive for those who remain eligible. The EPA's multitude of science advisory boards provide input on everything from proposed regulations to the agency's long-term research agenda.

"It's a disturbing and short-sighted action," says Peter Thorne, who chaired the agency's main science advisory board until the end of September. Thorne, a toxicologist at the University of Iowa in Iowa City, says that the board already has policies in place to deal with conflicts of interest — such as those related to research by a board member or financial interests among industry scientists. "I'm really baffled as to why this is necessary," he says.

The EPA's new policy borrows from legislation backed by Republican lawmakers that has been circulating in the US Congress for several years. In March, the US House of Representatives passed the latest version, which would restrict scientists with EPA grants from serving on the Science Advisory Board and loosen rules that seek to address any conflicts of interest related to industry scientists who serve on the panel. The fate of that bill is uncertain, however, since the Senate — which would have to give its approval before the legislation could become law — has not taken action on

the matter.

“The reason it couldn’t get through Congress is that it doesn’t make any sense,” says Andrew Rosenberg, who heads the Center for Science and Democracy at the Union of Concerned Scientists (UCS), an advocacy group in Cambridge, Massachusetts. “It turns the idea of conflict of interest on its head.”

Competing interests

Rosenberg’s group analysed the current membership of the EPA’s main science advisory board and found that 5 of the 47 members could be barred by the new policy. But the EPA restrictions on advisory-board members could soon affect a much larger swathe of panel appointments. The terms of 15 people on the agency’s main science advisory board expired at the end of September. EPA watchers are also expecting to soon see appointments to the Board of Scientific Counselors, which advises the EPA’s main research arm, and a third panel that advises the agency on air regulations.

All three of those boards have new leaders, Pruitt announced today. Michael Honeycutt, a toxicologist at the Texas Commission on Environmental Quality, will lead the agency’s main science advisory board. Honeycutt has long opposed EPA proposals to enact stricter air-quality standards. Tony Cox, an independent consultant, will lead the Clean Air Safety Advisory Committee, while Paul Gilman, chief sustainability officer at the energy firm Covanta in Morristown, New Jersey, will lead the Board of Scientific Counselors.

One senior EPA official, who declined to be named for fear of retaliation, says that agency leadership initially considered barring any scientist who had ever received an EPA grant from serving on any agency advisory panel. Ultimately, the agency decided to focus on researchers with active grants — in part because EPA officials discovered that it was hard to find qualified scientists who had never received EPA grants.

The agency’s overhaul of its advisory boards has been in the works for

months. The EPA sparked an uproar in May and June by dismissing dozens of scientists who had served a single three-year term on the Board of Scientific Counselors. In the past, the agency has appointed many scientists for a second term to provide more continuity for programme managers who are seeking input on the vast array of research efforts at the agency.

For Thorne, the question is how the administration is going to engage with its new science advisers. In September, the main science advisory board issued a letter describing its activities and inviting Pruitt to attend one of its meetings. Whether Pruitt will take the committee up on its invitation remains to be seen, but Thorne says one thing is clear: if the agency chooses to marginalize or ignore the board, it will do so “at its own peril”.

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Updates

Updated:

The story has been updated with information from the EPA press conference.

Comments

1 comment

1. *Rainald Koch* • 2017-11-01 12:58 PM
   "Tony Cox, an independent consultant, will lead the Clean Air Safety Advisory Committee" -- reminds me to Richard Anthony (Tony) Cox www-tonycox.ch.cam.ac.uk -- would be a better fit.

http://www.nature.com/doifinder/10.1038/nature.2017.22929

| 章节菜单 | 主菜单 |

Frédéric Chopin’s telltale heart

Scientists have written another chapter in the curious case of the composer’s heart. But it is unlikely to be the end of the story.

31 October 2017

De Agostini/A. Dagli Orti/Getty

The composer Frédéric Chopin died in 1849, but the debate about what killed him continues.

Edgar Allen Poe was a master of the macabre. His 1843 *The Tell-Tale Heart*

is a classic gothic tale for Halloween with its roots in guilt and fear: a murderer is haunted by the imagined beating of the excised heart of his victim.

The piano works of Frédéric Chopin — one of the greatest composers of the same period — tend more towards the uplifting. But events after his death have puzzled experts for more than a century and are worthy of any horror story. Scientists in Poland now claim to have solved the mystery. As the researchers conclude in a long-awaited report, he almost certainly died of complications caused by tuberculosis (M. Witt *et al. Am. J. Med.*; in the press; available at http://doi.org/cfpt). The evidence? The scientists have examined Chopin's own telltale heart.

The macabre afterlife of Chopin began with his recorded last words: "Swear to make them cut me open, so that I won't be buried alive." Taphephobia, as this fear is called, was a nineteenth-century obsession (shared by Alfred Nobel, among others), and saw some coffins made with alarm systems to be rung from within. Chopin's sister had an autopsy performed on him, during which his heart was removed. So although most of her brother lies in the famous Père Lachaise Cemetery in Paris, the city in which he died, she sealed his heart in a jar of (probably) brandy and took it back to Warsaw, the city closest to where he was born.

This wasn't too unusual. Remote burial of the heart was a fairly common practice, partly because it was too difficult to repatriate the bodies of kings and nobles who fell in foreign fields. (The heart of the English writer Thomas Hardy is said to be buried in his beloved Dorset, UK, although a more gruesome version of the story has the precious organ being eaten by a cat, and that of the offending animal interred instead.) But Chopin's status as a Polish national hero has helped to make sure that his heart never really rested in peace. His sister smuggled it into Poland past Russian border guards and it was later sealed inside a church pillar. Decades afterwards, during the Second World War, it was retrieved and protected by a Nazi SS commander who claimed to love Chopin's music. After the war, the heart was returned to rest in the church — but only until 2014.

Then, scientists were invited to join an official inspection of the jar and its contents. Their examination — and brief comments to journalists months

later — focused on how he died. The original autopsy notes are lost, and an entire academic subfield across many disciplines has emerged to discuss whether Chopin had tuberculosis or something much rarer, perhaps an early known case of cystic fibrosis. Those academics now have a Halloween treat: a draft of a paper to appear in *The American Journal of Medicine* offers more details on the state of the heart.

The original autopsy caused significant damage to both atria, but the paper claims "with high probability" that the remains show that Chopin had chronic tuberculosis, and that the immediate cause of death was a life-threatening complication called pericarditis — inflammation of the membrane enclosing the heart.

Chopin is not the only ghost from the past to offer their secrets to scientists. The artist Salvador Dalí was exhumed in July, moustache reportedly intact, to provide samples to decide a paternity case (he was not the father); and 2015 tests on bones of the Communist poet and winner of the Nobel Prize in Literature, Pablo Neruda, have fuelled theories that he was poisoned in Chile after Augusto Pinochet seized power in 1973.

There could yet be a twist in Chopin's tale. Some scholars are unsure that the heart is the composer's, and DNA tests to check for cystic fibrosis have so far been refused. The scientists were not allowed to open the jar in 2014, and Michał Witt at the Polish Academy of Sciences' Institute of Human Genetics in Poznan, who worked on the project, says that they didn't want to. The next opportunity will be in 50 years, when the heart is again scheduled for inspection. Witt does not expect to be around to see it. Still, he does have something more planned: the team was allowed to take photographs of the embalmed heart, and although none is yet public, he does plan to include them in the final manuscript. The full tale, after all, has not yet been told.

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Comments

Comments

There are currently no comments.

Lower emissions on the high seas

Global regulations to limit carbon dioxide from the shipping industry are overdue.

31 October 2017

Getty

Voluntary efforts to tackle carbon pollution from the shipping industry have failed.

In Herman Melville’s novel *Moby-Dick*, seafaring is the occupation of adventure-lovers. But since the maritime classic was published in 1851, the act of ‘sailing about a little’ has become a huge commercial undertaking. Today, a massive fleet of cargo ships transports 90% of global consumer goods. Shipping is efficient — but comes with an environmental cost that has

not been adequately accounted for.

Worldwide, there are about half a million ships in operation, together producing almost one billion tonnes of carbon dioxide each year. That's between 2% and 3% of the global total, and more CO_2 than Germany emits annually. But unlike greenhouse-gas emissions from Germany and other nations, shipping emissions are not subject to the reduction pledges made by individual nations under the Paris climate agreement. (The Paris deal does, however, include shipping emissions in its global carbon-budget calculations.)

After years of inaction, the great white whale of greenhouse-gas pollution is now in the cross hairs of the International Maritime Organization (IMO), the specialized United Nations agency that sets safety and environmental standards for the global shipping industry. The IMO is under pressure from campaigners and representatives of other, regulated sectors to agree a global cap on shipping emissions.

Following sharp increases in the early 2000s, the sector's emissions have remained more or less stable since the global financial crisis of 2008. But that is unlikely to continue. The current overcapacity in the maritime cargo market means that ship traffic (and emissions) can increase quickly to meet demand. Moreover, the shipping industry at large — including the cruise sector — has potential to grow, and rapidly.

The IMO has a specialist greenhouse-gas working group that is grappling with the idea of a cap. But its latest meeting, held last week in London, closed without declaring much progress. Overall, the IMO is committed to tightening environmental standards for new ships. Yet its technology-oriented strategy — including an Energy Efficiency Design Index that requires the engines of vessels to burn less fuel — is unlikely to be enough. Cleaning up the industry will require adequate market instruments and economic incentives to encourage owners and operators of both ships and ports to adopt climate-friendly practices, such as enforcing lower speeds.

Owing to the peculiarities of this volatile business, the routes, speed and fuel consumption of tens of thousands of container ships are hard to monitor and verify. An emissions-trading system, for example, would be difficult to

implement and even harder to manage. The IMO agreed last year to set up a global CO_2 data-collection system that will yield welcome knowledge, as will improvements in tracking the positions and movements of ships from space. But a tax by national governments on fossil fuels used by ships — incurred at refinery level — might be a more effective economic mechanism.

Voluntary efforts alone will not do. The industry has set up a series of half-hearted and overlapping eco-ratings schemes since the 2000s. But an analysis published online on 16 October shows that these have had no notable effect on the environmental performance of ships (R. T. Poulsen *et al. Mar. Policy* **87,** 94–103; 2018). Whereas eco-ratings can steer companies to make more-efficient refrigerators and washing machines in line with the preferences of consumers and regulators, maritime transport is different. The pressure of end-users is too distant to influence ship owners and operators. And price remains the dominant factor for builders and buyers of cargo ships.

As a global business, shipping must be tackled by global regulations, and not through a patchwork of voluntary efforts and regional laws. It is true that some regional efforts, such as the European Union's scheme to monitor, report and verify CO_2 emissions from large ships using its ports, might be a step towards global regulations.

The IMO has already shown that it can tackle other environmental issues. Measures it introduced in the wake of the *Exxon Valdez* oil spill in 1989 ensure that oil tankers are now much safer. An international convention for ballast-water management, which aims to control the spread of harmful invasive species, came into force in September after years of preparation (although it does not address biofouling on ships' hulls, which is potentially more harmful to local ecology). The IMO has also agreed measures to encourage environmentally responsible ship recycling and minimize uncontrolled shipbreaking, much of which occurs on South Asian beaches. However, this 2009 Hong Kong convention is still not implemented and is awaiting ratification by most member parties.

When it comes to the impact on climate, there is no excuse for delay. Emissions from shipping largely escape the public scrutiny and criticism attracted by those from aviation. Parties to the IMO should step up and hasten

the implementation of the necessary standards.

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Commenting is currently unavailable.

Lessons from first campus carbon-pricing scheme

31 October 2017

Putting a value on emissions can lower energy use, write Kenneth Gillingham, Stefano Carattini and Daniel Esty.

Enzo Figueres/Getty

Kroon Hall, home to Yale University's environment school in New Haven, Connecticut, reduced emissions substantially in the face of the carbon charge.

In July, Yale became the first university to launch a carbon-price programme across its campus. More than 250 buildings, together accounting for nearly

70% of the institution's emissions, will be charged US$40 per tonne of carbon dioxide that they emit as a result of energy use. Buildings that reduce their emissions more than the average will receive a share of the funds collected.

More than 500 firms around the world — three times more than a year ago — consider a carbon price of some kind when judging where to invest their money. Hundreds more are expected to start doing so in the coming months. Faced with higher prices, these organizations are shifting to forms of energy that generate less emissions and are more efficient.

Although some large companies have tried internal carbon pricing over the past two decades — BP was the first, in 1998 — little has been published about the value of such programmes. Here, we share initial insights and ideas for future research from a pilot scheme tried in 2015–16 at Yale — a prelude to the university's decision to roll out carbon pricing more broadly this year.

Price signals

Carbon pricing offers a direct incentive to reduce energy consumption and thus mitigate global climate change. In 2015, 13% of global greenhouse-gas emissions were subject to some form of carbon price, and this percentage is rising[1], despite the challenges currently facing government-backed schemes (see 'Faltering policies').

Faltering policies

Governments are struggling to put an appropriate price on carbon dioxide. In 2016, voters in the state of Washington rejected an initiative that would have set a tax on carbon emissions, despite broad support in polls for policy action on climate change. US President Donald Trump has backed away from the previous administration's Clean Power Plan. South Africa has delayed implementing a carbon tax. The United Kingdom has frozen its price floor for trading carbon at £18 (US$24) per tonne of CO_2 until 2021, rather than gradually raising it, as intended. According to the International Monetary Fund, most developed countries should price carbon at at least US$100 per

tonne of CO_2 equivalent to reach their emissions-reduction targets for the 2015 Paris climate -change agreement. The longer they wait, the higher these prices will need to be.

A company or institution can implement a carbon price through an internal emissions-trading programme, a carbon charge or a 'proxy price' (or 'shadow price') on greenhouse-gas emissions.

In the first case, the firm caps its emissions at a given level for a fixed period and divides its allowances between its organizational units — in a similar way to the European Union Emissions Trading Scheme. Units then trade their allowances with each other. Buying allowances from units with lower pollution-reduction costs minimizes the overall cost to the company. BP used this approach to reduce its company emissions, quickly achieving its goal of a 10% cut from 1990 levels by 2010[2].

An internal charge increases the price of carbon-intensive goods and services exchanged within the organization. The higher the price, the greater the incentive for the firm to decarbonize.

Companies can redistribute the revenue raised, or invest it in emissions-abatement schemes, as the luxury-goods conglomerate LVMH does. Ice-cream manufacturer Ben & Jerry's invests its revenue in programmes to reduce emissions across its supply chain, on the basis of a “cow-to-cone” life-cycle analysis.

For the past five years, Microsoft has charged its business groups a carbon fee that appears quarterly in their profit-and-loss statements. The fee covers energy consumption (adjusted for employee count) from data centres, offices and software-development labs, as well as from business air travel[3]. The revenue raised goes towards buying renewable energy or improving the treatment of electronic waste or the energy efficiency of lighting, heating, ventilation and air-conditioning systems[4]. In 2015, this fee was about $4 per tonne of CO_2 (ref. 5); this is much less than the US government estimate of the 'social cost of carbon', which is $44 per tonne. Low fees are common, with most internal carbon charges below $30 per tonne of carbon dioxide.

Proxy prices — which involve no financial transactions but are taken into account when weighing up business decisions — are often higher. No revenue is raised, but the carbon price shapes long-term investment choices. When deciding what sorts of buildings to construct or equipment to buy, the proxy price favours low-carbon solutions.

Ben & Jerry's

A solar-energy installation under construction next to the Ben & Jerry's ice-cream factory in Vermont.

For example, ExxonMobil, the Texas-based oil-and-gas multinational, is using a proxy price of $10 per tonne of CO_2; that will rise to $80 per tonne by 2040 (ref. 5). Proxy pricing drove Bristol Water, a British public utility company, to install more energy-efficient water pumps[6]. Saint-Gobain, a building-materials manufacturer based in Paris, uses a carbon price to drive investments in research and development for breakthrough technologies[6]. Some companies, such as the Dutch multinational Royal DSM in Heerlen, present two business cases for investments: one with and one without carbon

pricing[6].

Getting ahead

Organizations are implementing internal carbon pricing for many reasons. By aligning investment decisions now, firms are preparing for more-stringent domestic climate policies and for future mandatory carbon pricing. They are also avoiding becoming locked into unprofitable investments and 'stranded assets', which are a concern for investors and others, and are preparing for changed future circumstances. For example, more than 80% of current coal reserves might need to remain untouched if countries are to limit warming to 2° C (ref. 7). Committing to carbon pricing sends a signal to rating agencies and regulators that an enterprise is forward-looking and attentive to emerging climate risks[8].

Internal carbon pricing is part of broader corporate or organizational social-responsibility efforts[4]. By using a carbon price rather than targets for renewable-energy procurement, or internal energy-efficiency standards, organizations achieve those goals in the most cost-effective way. Innovations may result from directing managerial attention to cheaper projects that improve operations or that reduce energy expenditure[2]. Managers do not need to know the exact costs of abatement to achieve progress.

Organizations can also pilot internal carbon-pricing schemes to shape future governmental decisions. Policy leadership was one of the motivations behind BP's internal carbon pricing[9].

Lessons from Yale

Yale University's carbon-charge pilot was launched as part of the university's broader sustainability initiative and ran from December 2015 to May 2016. The charges covered direct and indirect emissions from consuming energy sources such as electricity, gas, steam and chilled water. The price was set at $40 per tonne of CO_2, which was close to the US government's estimated social cost.

Each of the 20 buildings selected for the pilot received a monthly report that detailed energy consumption and carbon use. They were all randomly allocated to one of four approaches: no carbon price; carbon pricing with 20% of the revenue earmarked for energy-efficiency actions; pricing with the revenue redistributed to buildings that reduced their emissions by at least 1% relative to their historic level of emissions; and pricing with revenue that was returned to buildings whose percentage reduction in emissions exceeded the average. This last approach is revenue-neutral: a net charge applied if emissions reductions were below average, and a net rebate if cuts were above average. Campus buildings outside the scheme served as a control group. Emissions were estimated in proportion to the amount of energy used, with different factors for different sources.

By the end of the trial, buildings that had faced carbon charges had used less energy than those that had not (see 'Energy savings'). Reasons for this included increased awareness of energy use, competition between buildings and the higher price of energy.

Building managers were mainly responsible for responding to the charge. Some favoured cheap options, such as turning down the heat by 1° C. Behavioural or operational changes, such as turning off lights and unused electrical equipment, also cost little. Others, including the departments of economics, environmental studies, public health and the boathouse, took more expensive measures such as installing occupancy sensors, thermal window shades or bulbs that use light-emitting diodes.

At the end of the pilot, the university selected the revenue-neutral pricing structure to implement campus-wide, because of its financial stability. The structure is not subject to potentially large outflows of funds if buildings exceed a target, saving energy because of an unusually mild winter, for example, or if energy needs rise unexpectedly owing to a cold snap or other reasons.

Of course, there are caveats. The scheme's novelty might have boosted engagement. Academics might be more interested than others in adopting challenging and original innovations. The sample size is small and the findings might not generalize to other situations.

Nonetheless, we feel that Yale's experience highlights important ingredients and challenges for internal carbon pricing.

First, information and incentives must be conveyed clearly for carbon charges to change behaviour.

After the pilot, more than half of the staff involved reported an improved understanding of energy use. The flow of information began with the energy reports to managers and spread through meetings with the staff and faculty, and through posters that explained energy savings. Students carried out energy audits. Actions were often collectively identified and followed up by monthly e-mail updates.

Second, the details of the scheme matter. How energy information is presented and carbon-charge revenue is redistributed influence the effectiveness of the scheme. For example, exit surveys of managers indicated that they responded more to the 'net' carbon charge, calculated after they had received a rebate, than to the higher 'gross' charge. Thus, many perceived the price signal as smaller. To increase managers' response to the price signal, one of them suggested a “bump in pay” for good performance on the carbon charge.

Third, carbon pricing is more effective when participants consider the rules to be fair. Perceived fairness increases engagement and encourages competition. The baseline from which emissions reductions are compared is a crucial design factor because it influences winners and losers. Yale's carbon-pricing system recognizes that buildings vary in size, age and energy efficiency, and that research in some disciplines is more energy-intensive than in others. Hence, only emissions above the historic baseline count towards the carbon charge. Emissions in the divinity school might be 100 times lower than those in the medical school, which hosts magnetic-resonance equipment.

For the pilot, the average emissions in the previous three fiscal years, 2013–15, were used as the baseline. In the campus-wide scheme, fiscal years 2011–15 are being used, with adjustments for a few buildings with large renovations, additions, construction or directed growth. For example, emissions at Ezra Stiles College were exceptionally low in 2011–12. during a period of major renovation. Brand new buildings will require projections.

Future research

Four areas of research could improve the design of internal carbon-pricing schemes. First, scientists, engineers and economists need to identify and test design options using rigorous pilot projects, similar to Yale's. These should span organizations of many different sizes and complexities. Such tests would provide insights for policymakers.

Second, no evidence exists on how internal carbon charges interact with non-carbon-pricing policies, such as tax credits or other incentives for renewable energy or energy efficiency. Economists should explore these interactions through data analysis and natural experiments, such as from regulatory changes, including effects on consumers.

Third, building scientists and other metrics experts must develop methods to assure high-quality benchmarking and data analytics for emissions inventories and baseline calculations. Ideally, these metrics should cover a wide range of energy uses before an internal carbon price is set up.

Fourth, accounting and managerial expertise is required to define the tax and financial implications of internal carbon pricing, in particular for multinational and transnational organizations.

We are only beginning to understand internal carbon pricing, but it seems to hold great promise as a way to sharpen incentives and reduce greenhouse-gas emissions.

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Supplementary information

PDF files

1. Supplementary information (258K)

Comments

Comments

There are currently no comments.

Huge microwave observatory to search for cosmic inflation

Multi-telescope project has ambitious goals and a big price tag.

30 October 2017

NSF/Steffen Richter/Harvard Univ./SPL

Telescopes in Antarctica track the cosmic microwave background radiation left over from the Big Bang.

US researchers have drafted plans to study the faint afterglow of the Big Bang using a new facility. They hope it will be sensitive enough to confirm whether or not the infant Universe underwent a brief period of explosive expansion known as inflation.

The Cosmic Microwave Background Stage-4 experiment (CMB-S4) would comprise three 6-metre and 14 half-metre telescopes distributed across two sites in Antarctica and Chile, according to a preliminary design due to be made public this week. Potentially up and running within a decade, the facility would be nearly 100 times as sensitive as existing ground-based CMB experiments.

It won't be cheap, however. Construction will cost a little over US$400 million, according to the expert task force commissioned by the US Department of Energy (DOE) and National Science Foundation (NSF) to produce the design. That is at least twice as much as envisioned in a less-detailed review 3 years ago, and 30 times the cost of existing experiments.

The price tag is "not necessarily" a showstopper, says Richard Barvainis, who directs the NSF's extragalactic astronomy and cosmology programme. But CMB-S4 will have to compete for limited funding with other large proposed facilities.

Primordial ripples

The CMB provides an image of the Universe as it was just 380,000 years after the Big Bang. Discovered in 1964, the radiation has since been observed by experiments on the ground, on balloons and in space, yielding increasingly precise insights into the Universe's geometry, contents and age — currently calculated at a little under 14 billion years.

But physicists think that the CMB has more to offer. In particular, distinctive patterns in its polarization known as B modes could reveal the existence of primordial gravitational waves. Gravitational waves — ripples in space-time — were first observed directly in 2015, but their detection in the very early Universe would be a major breakthrough, providing the strongest evidence yet for inflation, according to Charles Lawrence, an astrophysicist at NASA's Jet Propulsion Laboratory in Pasadena, California, who chairs the CMB-S4 task force.

Current ground-based CMB experiments typically detect microwaves using a

few thousand pixels and are based either near the South Pole or in Chile's Atacama Desert, where very dry conditions make the atmosphere nearly transparent to microwave radiation. None of the experiments has so far spotted the telltale B mode. One group did make a well-publicized claim in 2014, but it transpired that the sighting was actually caused by emissions from Galactic dust. Researchers are now building several more experiments that will be ten times as sensitive.

But Lawrence says that detecting the gravitational waves predicted by many of today's models of inflation would require sensitivity boosted by a further order of magnitude. Hence CMB-S4, which would comprise nearly 400,000 pixels. If it, too, came up empty-handed, the task force writes, it might be necessary "to give up on inflation".

Fight for funding

CMB-S4 is too large for any single group to build, so researchers across the US started collaborating on the design in 2013. Their initial plans were approved a year later by a panel advising the DOE on particle physics. But they must wait until 2020 to see how they fare in the next round of the once-per-decade survey of astronomy and astrophysics that the NSF uses to assess funding priorities.

Barvainis says that the agency will support CMB-S4 only if it gets "a very high priority" in the decadal survey, which is also likely to include a proposed upgrade to the National Radio Astronomy Observatory's Very Large Array in New Mexico, along with the development of one or more large optical telescopes. Even if the project does prevail, he adds, further agency reviews could delay the envisaged start of operations — due in 2026 — by at least two years.

The task force suggests that instead, CMB-S4 could be started by adding DOE detectors to existing telescopes in Chile while installing a few of the smaller telescopes at the South Pole. Under that strategy, the NSF would initially fund only operations. However, officials at the DOE also foresee snags. James Siegrist, the agency's associate director for high-energy

physics, says budgetary disagreements between the White House and Congress are creating “a lot of uncertainty” in Washington DC. A delay until 2027 or 2028 “could easily happen”, he predicts.

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Comments

2 comments

1. *Pentcho Valev* • 2017-10-30 10:41 PM
   Vacuum is not empty, and this makes the Cosmic Microwave Background concept rather silly. It is unreasonable to believe that the vacuum is full of energy and at the same time to claim that the noise known as CMB is not a product of this energy but just traverses it, unchanged. You have vacuum energy, detectors in contact with the vacuum which register strange noise coming from all directions, and you conclude that the noise is not produced by the vacuum energy but comes from the miraculous beginning of space and time. In addition, you implicitly assume that the vacuum energy does not change the noise. Silly, isn't it? Vacuum slows down light - this explains the Hubble redshift (in a STATIC universe): "...explains Liberati. "If spacetime is a kind of fluid, then we must also take into account its viscosity and other dissipative effects, which had never been considered in detail". Liberati and Maccione catalogued these effects and showed that viscosity tends to rapidly dissipate photons and other particles along their path, "And yet we can see photons travelling from astrophysical objects located millions of light years away!" he continues. "If spacetime is a fluid, then according to our calculations it must necessarily be a superfluid. This means that its viscosity value is extremely low, close to zero"." https://phys.org/news/2014-04-liquid-spacetime-slippery-superfluid.html Nature: "As waves travel through a

medium, they lose energy over time. This dampening effect would also happen to photons traveling through spacetime, the researchers found." http://www.nature.com/news/superfluid-spacetime-points-to-unification-of-physics-1.15437 "Some physicists, however, suggest that there might be one other cosmic factor that could influence the speed of light: quantum vacuum fluctuation. This theory holds that so-called empty spaces in the Universe aren't actually empty - they're teeming with particles that are just constantly changing from existent to non-existent states. Quantum fluctuations, therefore, could slow down the speed of light." https://www.sciencealert.com/how-much-do-we-really-know-about-the-speed-of-light?perpetual=yes&limitstart;=1 The transition from expanding to STATIC universe is unavoidable because the implications of the expanding universe theory are absurd: Sabine Hossenfelder: "If The Universe Is Expanding, Then Why Aren't We? The solution of general relativity that describes the expanding universe is a solution on average; it is good only on very large distances. But the solutions that describe galaxies are different - and just don't expand. It's not that galaxies expand unnoticeably, they just don't. The full solution, then, is both stitched together: Expanding space between non-expanding galaxies."
https://www.forbes.com/sites/startswithabang/2017/07/28/most-things-dont-actually-expand-in-an-expanding-universe/ "The Multiverse Is Inevitable, And We're Living In It. Alan Guth: "It's hard to build models of inflation that don't lead to a multiverse. It's not impossible, so I think there's still certainly research that needs to be done. But most models of inflation do lead to a multiverse, and evidence for inflation will be pushing us in the direction of taking [it] seriously." The Multiverse itself may not give rise to any observable, testable predictions, but arises as a direct consequences of other physical theories that have already been validated." http://scienceblogs.com/startswithabang/2017/10/12/the-multiverse-is-inevitable-and-were-living-in-it-synopsis/ Pentcho Valev

2. *Pentcho Valev* • 2017-10-31 07:35 AM
In my view, the following dialog marks the beginning of a

sweeping revolution in cosmology: http://backreaction.blogspot.bg/2017/10/space-may-not-be-as-immaterial-as-we.html Sabine Hossenfelder: "Is Space-Time Fluid? We have known at least since Einstein that space and time are inseparable, two hemispheres of the same cosmic brain, joined to a single entity: space-time. Einstein also taught us that space-time isn't flat, like paper, but bent and wiggly, like a rubber sheet. Space-time curves around mass and energy and this gives rise to the effect we call gravity. That's what Einstein said. But turns out... [...] That space itself isn't fundamental but made of other things is one way to approach the problem. Not everyone likes the idea. What irks physicists most about giving substance to space-time is that this breaks Einstein's bond between space and time which has worked dramatically well - so far. Only further experiment will reveal whether Einstein's theory holds up." Arun: "How does a fluid analog of general relativity avoid having a preferred reference frame?" Sabine Hossenfelder: "Arun, it doesn't. It's why I write it breaks the union between space and time." [END OF QUOTATION] Sabine Hossenfelder is on the right track. The "preferred reference frame" does not affect the validity of the principle of relativity in its traditional usage - it is only responsible for the vacuum friction that slows down photons coming from distant stars, in a STATIC universe. So the Hubble redshift is produced, but at the end of their journey photons redshift less vigorously than at the beginning. This has wrongly been interpreted as accelerating expansion: "In the mid 1990s two teams of scientists, one led by Brian Schmidt and Adam Riess, and the other by Saul Perlmutter, independently measured distances to Type 1a supernovae in the distant universe, finding that they appeared to be further way than they should be if the universe's rate of expansion was constant. The observations led to the hypothesis that some kind of dark energy anti-gravitational force has caused the expansion of the universe to accelerate over the past six billion years." https://cosmosmagazine.com/physics/dark-energy-may-not-exist Below I'm showing that the redshifting varies EXPONENTIALLY with time. The "finding that they appeared to be further way than they should be" is an illusion due to using an approximation to the

exponential function. Assume that, as the photon travels through space (in a STATIC universe), a factor equivalent to vacuum friction (see relevant references below) slows it down so that the photon loses speed in much the same way that a golf ball loses speed due to the resistance of the air. On this hypothesis the resistive force (Fr) is proportional to the speed of the photon (V): Fr = - KV That is, the speed of light decreases with time in accordance with the equation: dV/dt = - K'V Clearly, at the end of a very long journey of photons (coming from a very distant object), the contribution to the redshift is much smaller than the contribution at the beginning of the journey. Light coming from nearer objects is less subject to this effect, that is, the increase of the redshift with distance is closer to LINEAR for short distances. For distant light sources we have: f' = f(exp(-kt)) where f is the initial and f' the measured (redshifted) frequency. For short distances the following approximations can be made: f' = f(exp(-kt)) ~ f(1-kt) ~ f - kd/λ where d is the distance between the light source and the observer and λ is the wavelength. The approximate equation, f' = f - kd/λ, is only valid for short distances and corresponds to the Hubble law. The original equation, f' = f(exp(-kt)), shows that at the end of a very long journey (in a STATIC universe) photons redshift much less vigorously than at the beginning of the journey. This means that photons coming from very distant objects have undergone some initial "vigorous" redshifting which is unaccounted for by the Hubble law. This explains why the very distant objects "appeared to be further way than they should be if the universe's rate of expansion was constant". Is there "vacuum friction" that slows down photons? Yes there is: "This leads to the prediction of vacuum friction: The quantum vacuum can act in a manner reminiscent of a viscous fluid." http://philpapers.org/rec/DAVQVN New Scientist: "Vacuum has friction after all." https://www.newscientist.com/article/mg20927994.100-vacuum-has-friction-after-all "So how can a vacuum carry force? One of the first things we learn in classical physics is that in a perfect vacuum - a place entirely devoid of matter - friction can't exist, because empty space can't exert a force on objects traveling through it. But,

in recent years, quantum physicists have shown that vacuums are actually filled by tiny electromagnetic fluctuations that can interfere with the activity of photons - particles of light - and produce a measurable force on objects."
http://www.businessinsider.com/casimir-effect-vacuum-space-nanoparticles-2017-4 Pentcho Valev

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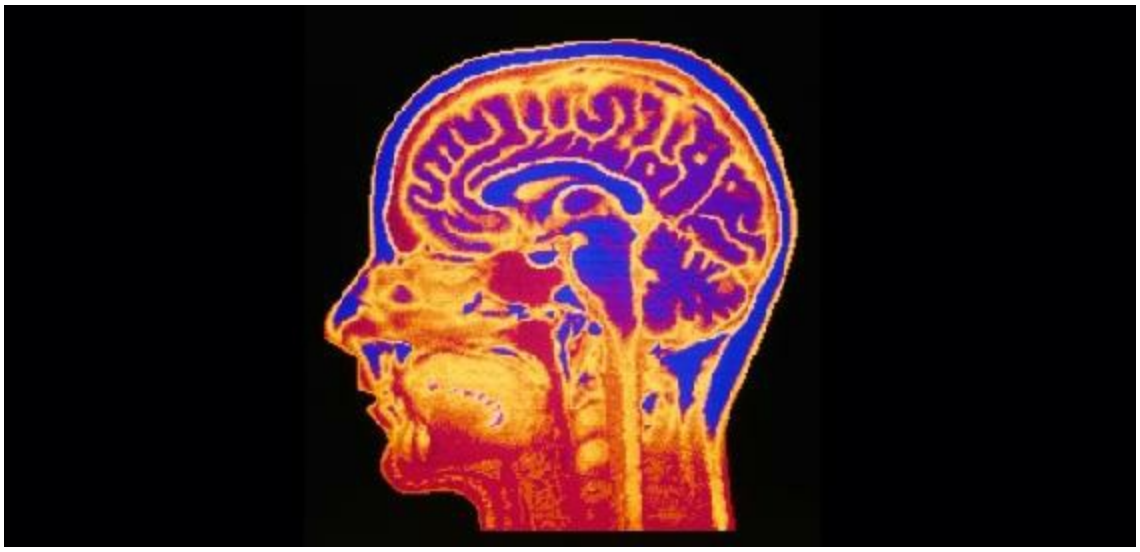
Geneticists are starting to unravel evolution's role in mental illness

Hints emerge that past environments could have influenced psychiatric disorders.

30 October 2017



Mehau Kulyk/SPL

Human genome databases are enabling researchers to take a deeper dive into the evolution of psychiatric disorders.

Psychiatric disorders can be debilitating and often involve a genetic component, yet, evolution hasn’t weeded them out. Now, recent work is beginning to reveal the role of natural selection — offering a peek at how the genetic underpinnings of mental illness has changed over time.

Many psychiatric disorders are polygenic: they can involve hundreds or thousands of genes and DNA mutations. It can be difficult to track how so

many genetic regions evolved, and such studies require large genome data sets. But the advent of massive human genome databases is enabling researchers to look for possible connections between mental illnesses and the environmental and societal conditions that might have driven their emergence and development. Others are looking to Neanderthal genetic sequences to help inform the picture of these disorders, as well as cognitive abilities, in humans. Several of these teams presented their findings at the American Society of Human Genetics (ASHG) meeting in Orlando, Florida, in late October.

One project found that evolution selected for DNA variants thought to protect against schizophrenia. The study, led by population geneticist Barbara Stranger of the University of Chicago in Illinois, looked at hundreds of thousands of human genomes using a statistical method that identified signals of selection over the past 2,000 years[1]. There were no signs of selection in genetic regions associated with any other mental illness.

Many of schizophrenia's symptoms, such as auditory hallucinations and jumbling sentences, involve brain regions tied to speech, says Bernard Crespi, an evolutionary biologist at Simon Fraser University in Burnaby, Canada. Over the course of hominid evolution, he says, the ability to speak could have outweighed the small, but unavoidable risk that the genes involved in language could malfunction and result in schizophrenia in a small percentage of the population.

A quest for context

Another team, lead by human geneticist Renato Polimanti at Yale University in New Haven, Connecticut, is trying to tease out links between environmental factors, mental illnesses and behavioural traits. Polimanti and his colleagues looked at 2,455 DNA samples from individuals at 23 sites across Europe and quantified each person’s overall genetic risk for mental disorders, such as autism, and personality traits, such as extraversion. They then calculated whether that risk was associated with certain environmental factors, such as rainfall, winter temperatures or the prevalence of infectious disease — exploring the idea that these factors might have been involved in

selecting for the human traits.

People who live in European regions with relatively lower winter temperatures, they found, were slightly more genetically prone to schizophrenia. Polimanti suggests that if genes that helped people tolerate cold were located close to variants that promote schizophrenia in the genome, then the latter could have been inadvertently carried along during evolution as a “fellow traveller”.

“This was a nice first attempt to put some environmental context” on the polygenic variants associated with mental illness, says Tony Capra, an evolutionary geneticist at Vanderbilt University in Nashville, Tennessee. Polimanti now plans to repeat the study in other parts of the world.

For and against

Untangling the roles of genetics and the environment will be difficult, however, because unknown environmental conditions in the past could have selected for traits that were advantageous then, but considered negative today. And other evolutionary factors could contribute to mental illness indirectly. An overactive immune system is thought to be involved in many psychiatric disorders, such as depression[2], but a stronger immune system would have made human ancestors more resistant to diseases, says Stranger.

Some researchers are exploring the evolution of mental illness through a different lens: by looking at possible differences in gene activity in tissues of Neanderthals and humans. A group lead by Capra and Vanderbilt human geneticist Laura Colbran used databases of modern human genomes to find DNA markers that suggest a gene is differently regulated in various tissues in the body. They then looked for these markers in two Neanderthal genomes. The team found that genes associated with neurological development were regulated differently in the Neanderthal brain compared with that of humans.

So while the DNA sequence of a gene such as *FOXP2* — which is associated with language — is identical[3] in humans and Neanderthals, human brains might have produced more of the associated protein, accounting for increased

language ability. The results could eventually lead to a better understanding of how Neanderthal brains functioned, if they were similar to human brains and whether they might have suffered from similar psychiatric disorders.

Studying how mental illness evolved is still at an early stage, but the ability to use massive human genome databases is an exciting step forward, says Capra. He and his colleagues plan to take advantage of this with a survey of genetic areas that differ between Neanderthals and humans, searching for differences in how the genes are expressed.

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Comments

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Nature News

周六, 11 11月 2017

Nature News

[周六, 11 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **South Africa tackles crime at sea with ship-spotting satellites** [周五, 10 11月 08:00]
  Automated vessel-tracking system aims to spy poachers and smugglers.
- **Resurrected malaria strategy saves thousands of lives in Africa** [周五, 10 11月 08:00]
  Pre-emptively treating kids for malaria is working, despite logistical challenges.
- **Physicists shrink plans for next major collider** [周四, 09 11月 08:00]
  Large Hadron Collider's failure to detect new particles beyond the Higgs has eroded the case for Japan's proposed linear accelerator.
- **UK government appoints next chief scientific adviser** [周三, 08 11月 08:00]
  A former pharmaceutical boss will help navigate the UK's exit from the European Union.
- **Skin regeneration with insights** [周三, 08 11月 08:00]
  A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.
- **Too many academics study the same people** [周三, 08 11月 08:00]
  Researchers should recognize communities that feel over-researched and under-rewarded.
- **Grant recipients can still give objective advice** [周三, 08 11月 08:00]
  The US environment agency should not ban researchers it funds from its advisory boards.
- **Rohingya refugees, Bulgarian protests and a prize for negative results** [周三, 08 11月 08:00]
  The week in science: 3–9 November 2017.
- **Dark-matter hunt fails to find the elusive particles** [周三, 08 11月 08:00]
  Physicists begin to embrace alternative explanations for the missing material.
- **The bitter battle over the world's most popular insecticides** [周三, 08 11月 08:00]
  As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.
- **Four ethical priorities for neurotechnologies and AI** [周三, 08 11月 08:00]

Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

- **The catalogue that made metrics, and changed science** [周三, 08 11月 08:00]
  As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.
- **Polar exploration: The forgotten journey** [周三, 08 11月 08:00]
  Huw Lewis-Jones revisits a pioneering, ill-fated expedition to map the Arctic.
- **Books in brief** [周三, 08 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.
- **Indian scientists urged to speak out about pseudoscience** [周二, 07 11月 08:00]
  Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.
- **Pirate paper website Sci-Hub dealt another blow by US courts** [周二, 07 11月 08:00]
  American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.
- **Genetically modified apple reaches US stores, but will consumers bite?** [周二, 07 11月 08:00]
  Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.
- **US government approves 'killer' mosquitoes to fight disease** [周一, 06 11月 08:00]
  US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.
- **Language patterns reveal body's hidden response to stress** [周一, 06 11月 08:00]
  Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

South Africa tackles crime at sea with ship-spotting satellites

Automated vessel-tracking system aims to spy poachers and smugglers.

10 November 2017

Leeman/Getty

South Africa has started to combine data from satellites, vessel transponders and radar to monitor ships in its waters in real time.

In October last year, a fishing boat set out from Velddrif, a small town on South Africa's west coast. It sailed northwest for about 25 nautical miles (46 kilometres), then turned sharply and headed back the way it had come. Staying clear of coastal settlements, it entered the West Coast National Park

marine protected area — a strictly no-fishing zone — where it slowed down and began to sail in a zigzag pattern.

“It was obvious what they were doing,” says Niel Malan, a marine biologist who works in South Africa’s Department of Environmental Affairs in Cape Town. “They were poaching.”

On any other day, the transgression would probably have passed undetected. But Malan and his colleagues were testing a new vessel-tracking system that — when fully operational — will send out alerts when ships are acting suspiciously anywhere in South African waters.

A test version of the Integrated Vessel Tracking Decision Support Tool was launched on 7 November by the South African Oceans and Coastal Information Management System (OCIMS), at its annual meeting in Cape Town. The tracking system, which has taken US$1 million and 5 years to develop, combines data from satellites, vessel transponders and radar to monitor ships in real time and spot any that might be engaged in criminal activities, such as illegal fishing or smuggling.

Similar remote-sensing systems have been developed over the last decade or so by countries including the United States, Australia and India. But South Africa is a particularly crucial area for maritime crime-fighting, because of its geographical location at the joining of three oceans — the Atlantic, Indian and Southern — and because of the sheer extent of its waters. The country’s Exclusive Economic Zone, which extends 200 miles off the coastline and includes an additional 400-mile-diameter circle around the Prince Edward Islands, exceeds its land area by 25%. “Because of the vastness of our EEZ, we see this as a critical technology,” says Waldo Kleynhans, the system’s lead developer based in Pretoria.

South Africa's coast is also a busy shipping lane and an area rich in natural resources. Cold, nutrient-rich waters sustain extensive commercial fishing on South Africa's west coast and to the south, while every year billions of sardines migrate down the east coast, attracting flocks of birds, as well as dolphins, sharks and whales.

South Africa has a well-documented problem with coastal poaching of high-

value species such as abalone and rock lobster, whereas the extent of illegal fishing in its open oceans is largely unknown. The area around the Prince Edward Islands — home to the prized Patagonian toothfish (*Dissostichus eleginoides*) — is particularly vulnerable, says Timothy Walker, a researcher focusing on maritime and water security at the Institute for Security Studies in Pretoria. South African authorities are also concerned about human trafficking and the smuggling of drugs or banned wildlife items, such as rhino horn and ivory.

Yet the navy has scant physical resources to monitor illegal activities, says Mark Blaine, a captain in the South African Navy and a part-time researcher in nautical science at Stellenbosch University — four frigates, three submarines and a handful of patrol vessels and aircraft — which he describes as equivalent to "a country the size of Algeria using around six police cars to patrol the entire country".

Satellite spotting

The satellite data used by the new system includes information from automated identification system (AIS) trackers, which all ships above a certain size are required to carry. South Africa currently buys this data from third-party suppliers, but plans to launch its own constellation of AIS nano-satellites in 2018 to collect the information. Meanwhile, satellites using synthetic-aperture radar, which can spot vessels in the dark or through thick cloud, will help to detect 'dark targets' that are not carrying trackers or that have turned them off.

Malan says that the tracking system can be set to flag up different suspicious behaviours. Users such as the fisheries department or the South African navy might create a digital fence around a marine reserve or other sensitive area, for example, and ask to receive alerts when ships enter it. Or they could request to be alerted if two ships meet in the open ocean for an extended time.

Ultimately, Malan says, the system's success will depend on the end-users, who will have to monitor incoming data, set up appropriate alerts and decide

how to respond. Enforcement will also be a challenge. Malan says that details of the suspicious boat he spotted in October 2016 were relayed to the fisheries department. “But we're not sure if they finished the investigation,” he says.

He hopes that once a few miscreants have been caught using the tracking system, however, its existence will act as a deterrent: “I think once we start prosecuting a few people, then the word will spread quickly — and we hope that will lead to better behaviour.”

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Comments

Commenting is currently unavailable.

Resurrected malaria strategy saves thousands of lives in Africa

Pre-emptively treating kids for malaria is working, despite logistical challenges.

10 November 2017

Amy Maxmen

A healthworker in Mali prepares a dose of malaria chemoprevention.

In a sea of high-tech malaria fixes — everything from drug-delivery by drone to gene-edited mosquitoes — an old-fashioned approach is saving thousands of children in West Africa, according to studies presented this week at the American Society of Tropical Medicine and Hygiene (ASTMH) meeting in

Baltimore, Maryland.

The measure, called seasonal malaria chemoprevention, involves giving children a dose of antimalarial drugs once each month in the rainy season to prevent the disease in hard-hit regions. Researchers have previously demonstrated this strategy in large clinical trials but they had feared that their positive results wouldn't be replicated in the messy, real world, because chemoprevention requires thousands of local health workers to deliver drugs to children in villages far from hospitals, pharmacies and paved roads.

"People were doubtful this intervention would work, because it's so demanding," says Brian Greenwood, an infectious disease specialist at the London School of Hygiene and Tropical Medicine who helped to conduct trials that showed reductions in malaria prevalence up to 84%[1]. As a result of those studies, more than 6.4 million children in nine countries in sub-Saharan Africa (Burkina Faso, Cameroon, Chad, Gambia, Guinea, Mali, Niger, Nigeria, Senegal) received the drugs in 2016.

It seems to be working, according to data presented at the ASTMH meeting. "They are seeing the same level of efficacy against malaria that we saw in clinical trials and reducing hospital admissions," says Greenwood. "I am very happy." But researchers are also finding signs that this approach may not work for long.

Data driven

Malaria researchers deployed chemoprevention in the 1950s, but it fell out of favour when the widespread use of malaria drugs led to drug resistance. Yet by 2000, more than 830,000 people were dying of the disease each year — mainly children in Africa — and there were no blockbuster vaccines on the horizon. So malariologists revisited the approach. Between 2002 and 2012, clinical trials conducted in West Africa suggested that combinations of older malaria drugs had the power to prevent 8.8 million cases and 80,000 deaths every year if implemented solely during the rainy season, when the disease spikes.

Amy Maxmen

Children in Mali receive a dose of malaria drugs, to reduce their risk of becoming infected with the disease.

In 2012, the World Health Organization recommended the strategy with three old drugs — sulphadoxine, pyrimethamine and amodiaquine — so that the only sure-fire cure for malaria, artemisinin, would remain effective. Alassane Dicko, a malariologist at the University of Bamako in Mali, says that he did not take the intervention for granted when it launched in Mali in 2013, because he knew that funds were limited and drug resistance inevitable. “Research is essential,” he says. His lab began assessing chemoprevention’s efficacy, cost and effects on drug resistance.

In August, Dicko and his colleagues reported[2] that malaria prevalence was reduced by 65% in children under age 5 who were treated with chemoprevention in the Malian district of Kita, compared to a similar number of children in a neighbouring district that lacked the funds to roll out the intervention.

Race against resistance

On the basis of results such as these, malaria researchers at the meeting estimate that chemoprevention has averted roughly 6 million cases and 40,000 deaths in 2015 and 2016 in the countries where it is practised. “This intervention has been extremely well documented over three or four years,” says Erin Eckert, an epidemiologist at the US Agency for International Development’s President’s Malaria Initiative, based in Washington DC. As a result, the agency plans to help fund chemoprevention in eight countries next year.

Also at the ASTMH meeting, Dicko reported a 80-person trial showing that adding another old malaria drug, primaquine, to the regimen combo blocks the transfer of the malaria parasite, *Plasmodium falciparum*, from humans into mosquitoes. This would further reduce the amount of the parasite in circulation. Dicko aims to hit the disease hard and fast — with multiple drugs, as soon as possible — because he and his colleagues are already detecting genetic signs of drug resistance in parasites[3].

New chemoprevention drugs in the pipeline might not be ready before existing drugs fail because of resistance, Greenwood says. This year, he helped to launch a trial combining chemoprevention and a less effective malaria vaccine in Burkina Faso and Mali. The vaccine was previously shown to reduce the number of malaria cases by less than 36% in children[4], but Greenwood hopes the combined tools, together with bed nets, can suppress malaria enough to stop it from bouncing back once today’s drugs fail. By that time, he says, genetically engineered mosquitoes might be ready to fly.

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Comments

Comments

There are currently no comments.

Physicists shrink plans for next major collider

Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.

09 November 2017

CERN/SPL

The Large Hadron Collider (pictured) collides protons, whereas the proposed linear accelerator would smash together electrons and positrons.

Limited funding and a dearth of newly discovered particles are forcing physicists to cut back plans for their next major accelerator project: a multibillion-dollar facility known as the International Linear Collider (ILC)

in Japan.

On 7 November, the International Committee for Future Accelerators (ICFA), which oversees work on the ILC, endorsed halving the machine's planned energy from 500 to 250 gigaelectronvolts (GeV), and shortening its proposed 33.5-kilometre-long tunnel by as much as 13 kilometres. The scaled-down version would have to forego some of its planned research such as studies of the 'top' flavour of quark, which is produced only at higher energies.

Instead, the collider would focus on studying the particle that endows all others with mass — the Higgs boson, which was detected in 2012 by the Large Hadron Collider (LHC) at CERN, Europe's particle-physics lab near Geneva, Switzerland.

Leading particle physicists nevertheless remain upbeat. A 250-GeV machine still has "a convincing physics case", says Hugh Montgomery at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia. He says that it could be upgraded to higher energies in future.

High-energy physicists have been planning a future linear collider for 25 years, but the ILC is now unlikely to see the light of day until at least 2030. They viewed the linear collider as complementary to the LHC, allowing physicists to scrutinize in detail any particles discovered at CERN.

Linear design

The circular LHC smashes together protons, which allows it to reach very high energies (13 teraelectronvolts). But, as composite particles (made of quarks), protons create messy collisions with clouds of debris.

By contrast, the ILC would collide electrons and positrons head on after accelerating them in thousands of superconducting cavities joined end to end. Although yielding lower energies, its collisions — between fundamental particles — would be cleaner and more precise than those in a proton–proton machine.

The international physics community had hoped that Japan would foot much of the estimated US$10 billion needed to realize the original design, after researchers there put forward a proposal to host the facility in October 2012, just after the Higgs discovery. But the Japanese government — deterred by the project's huge price tag, according to Tatsuya Nakada, a physicist at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland — has not yet made any offer of funding.

That fact, coupled with an absence of any other new particle discoveries at the LHC beyond the Higgs, led the Japan Association of High Energy Physicists in July to propose capping the ILC's energy at 250 GeV.

Aiming for a higher energy, the association explained, made less sense after data collected by the LHC in 2015 and 2016 showed that any particles outside physicists' standard model are unlikely to weigh less than 1,000 GeV, and therefore would be out of reach even for a full-scale version of the ILC. However, 250 GeV is high enough to produce large numbers of Higgs bosons, which, the association said, could yield indirect signs of new physics through measurements of their interactions with other known particles.

Energy debate

This proposed 'Higgs factory' has also been endorsed by an international working group responsible for formulating the ILC's science case, in a paper uploaded to the preprint server arXiv last month[1]. The ICFA then gave the pared-down collider its thumbs up at a meeting held in Ottawa, Canada, this week.

Not all physicists are enthusiastic, however. John Ellis, a theorist at King's College London and CERN, maintains that only when operating at around 1,000 GeV will a linear collider provide "a more complete picture of the Higgs". He acknowledges that costs need to be reined in, but says that in limiting the ILC to 250 GeV, "you are making significant scientific compromises".

A report uploaded to arXiv last week[2] describes three possible layouts for the

250 GeV model (a technical design for the higher-energy ILC was published in 2013). Each requires halving the length of the superconducting electron–positron accelerators, but two of the options retain extra tunnel space to accommodate future upgrades.

Taking into account projected savings from ongoing research into accelerators, the report estimates that the collider's core construction cost could be reduced by as much as 40% — bringing it down to around $5 billion in 2012 prices. Manpower and detectors would then raise the total to about $7 billion, according to Lyn Evans, an accelerator physicist at CERN who is directing research on the ILC.

Michael Peskin, a theoretical partical physicist at the SLAC National Accelerator Laboratory in Menlo Park, California, and a member of the ILC working group, has no doubt about the value of a Higgs factory. He says that theoretical studies of the Higgs boson and the weak nuclear force — one of the four known fundamental forces — done over the past year have strengthened the case for experimental probes of the Higgs' interaction strength (the Higgs is required to give the carriers of the weak force finite mass). "The 250-GeV stage is actually more interesting scientifically than we thought," he says.

The ILC decision now rests with Japan. Evans describes the Japanese government's ongoing assessment of the linear-collider project as "very long and very frustrating". But other countries won't commit money until the host country makes its plans known, he says. "The rest of the world is waiting for the Japanese government to decide," he says.

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Comments

2 comments

1. *Pentcho Valev* • 2017-11-11 07:32 AM

    Dead (schizophrenic) science - colliders are not necessary: "...Lorenzo Maccone, of the University of Pavia in Italy, Seth Lloyd at MIT in Cambridge, USA, and Vittorio Giovannetti at the Scuola Normale Superiore in Pisa, Italy. [...] They hope their strategy may make it possible to solve one of the biggest problems in physics: the apparent incompatibility of quantum mechanics, which governs the physics of the very small, and general relativity, which describes the motion of stars and planets. [...] In general relativity, space and time are woven together into a pliable thing called spacetime, but quantum mechanics runs on quaintly separate, classical notions of space and time. And when physicists try to apply the equations of general relativity to the realm of quantum mechanics, those equations spit out nonsense." http://fqxi.org/community/articles/display/224 Big Brother replaced 2+2=4 with 2+2=5: "In the end the Party would announce that two and two made five, and you would have to believe it. It was inevitable that they should make that claim sooner or later: the logic of their position demanded it. Not merely the validity of experience, but the very existence of external reality, was tacitly denied by their philosophy. The heresy of heresies was common sense. And what was terrifying was not that they would kill you for thinking otherwise, but that they might be right. For, after all, how do we know that two and two make four? Or that the force of gravity works? Or that the past is unchangeable? If both the past and the external world exist only in the mind, and if the mind itself is controllable what then?" https://ebooks.adelaide.edu.au/o/orwell/george/o79n/chapter1.7.htm Einstein replaced Newton's absolute time with spacetime: "Special relativity is based on the observation that the speed of light is always the same, independently of who measures it, or how fast the source of the light is moving with respect to the observer. Einstein demonstrated that as an immediate consequence, space and time can no longer be independent, but should rather be considered a new joint entity called "spacetime." http://community.bowdoin.edu/news/2015/04/professor-baumgarte-describes-100-years-of-gravity/ Scientists in Big Brother's world

are trying to reconcile 2+2=4 and 2+2=5. Scientists in Einstein's schizophrenic world are trying to reconcile Newton's absolute time and Einstein's spacetime: Natalie Wolchover: "The effort to unify quantum mechanics and general relativity means reconciling totally different notions of time. In quantum mechanics, time is universal and absolute; its steady ticks dictate the evolving entanglements between particles. But in general relativity (Albert Einstein's theory of gravity), time is relative and dynamical, a dimension that's inextricably interwoven with directions X, Y and Z into a four-dimensional "space-time" fabric." https://www.quantamagazine.org/20161201-quantum-gravitys-time-problem/ Perimeter Institute: "Quantum mechanics has one thing, time, which is absolute. But general relativity tells us that space and time are both dynamical so there is a big contradiction there. So the question is, can quantum gravity be formulated in a context where quantum mechanics still has absolute time?" https://www.perimeterinstitute.ca/research/conferences/convergence discussion-questions/what-are-lessons-quantum http://negrjp.fotoblog.uol.com.br/images/photo20150819051851.jpg Pentcho Valev

2. *Pentcho Valev* • 2017-11-09 08:59 PM

   Nowadays the conclusion "Physics is dead" is getting more and more explicit - it has even entered popular culture: Leonard: "I know I said physics is dead, but it is the opposite of dead. If anything, it is undead, like a zombie." https://www.youtube.com/watch?v=GDNP9KOEdh0 The problem is theoretical - experimentalists are just misguided: "The Large Hadron Collider is a particle accelerator currently under construction in the research centre CERN. From the point of view of relativity theory, it has several points of interest: First of all, the protons it accelerates will reach higher energies than ever, allowing new tests of the relativistic quantum field theories that are at the core of modern particle physics. Secondly, at such high energies, there should be first traces of an as-yet unproven symmetry of nature called supersymmetry, which plays an important role in string theory, one of the candidates for a theory of quantum gravity (the quantum theory version of Einstein's general relativity).

Finally, the high energies are interesting because they give information about the very early high temperature universe, and about the physics that should be included in the big bang models of relativistic cosmology." http://www.einstein-online.info/dictionary/large-hadron-collider There is a tenet which, if false, does convert modern physics into a zombie, and this is Einstein's constant-speed-of-light postulate. Here is the original formulation: Albert Einstein, ON THE ELECTRODYNAMICS OF MOVING BODIES, 1905: "...light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body." http://www.fourmilab.ch/etexts/einstein/specrel/www/ If interpreted correctly, the Doppler effect directly refutes the postulated independence from "the state of motion of the emitting body". Here is an incorrect interpretation - the postulate is saved by wrongly assuming that the light pulses bunch up in front of the moving source: Albert Einstein Institute: "We will start with a very simple set-up, which you can see in the following animation. On the right-hand side, drawn in green, there is a sender that emits pulses in regular succession. On the left-hand side there is a receiver, drawn in blue. The pulses themselves are drawn in red, and they all travel at the same speed from right to left. Everytime the sender emits a new pulse, a yellow indicator light flashes once. Likewise, a flashing light indicates when a pulse has reached the receiver: http://www.einstein-online.info/images/spotlights/doppler/doppler_static.gif Next, let us look at a slightly different situation, where the source is moving towards the detector. We assume that the motion of the sender does not influence the speed at which the pulses travel, and that the pulses are sent with the same frequency as before. Still, as we can see in the following animation, the motion influences the pulse pattern: http://www.einstein-online.info/images/spotlights/doppler/doppler_source_blue.gif The distance between successive pulses is now smaller than when both sender and receiver were at rest. Consequently, the pulses arrive at the receiver in quicker succession. If we compare the rates at which the indicator lights at the receiver and at the sender are flashing, we

find that the indicator light at the receiver is flashing faster." [END OF QUOTATION] http://www.einstein-online.info/spotlights/doppler Einsteinians make the following assumption above, which is essentially identical to Einstein's 1905 constant-speed-of-light postulate: Assumption 1: "The motion of the sender does not influence the speed at which the pulses travel." Assumption 1 goes hand in hand with another assumption: Assumption 2: "The distance between successive pulses is now smaller than when both sender and receiver were at rest." Assumption 2 is false - the pulses do not bunch up when the source (sender) is moving. If they did, by measuring the (variable) distance between the pulses, an observer associated with the source would know whether he is moving or at rest, which contradicts the principle of relativity. Since Assumption 2 is false, Assumption 1 is false as well. If the speed of the moving source is v, the speed of the light relative to the receiver is c'=c+v, in violation of Einstein's relativity. The following quotations suggest that, if the speed of light is variable, modern physics is dead: "The speaker Joao Magueijo, is a Reader in Theoretical Physics at Imperial College, London and author of Faster Than the Speed of Light: The Story of a Scientific Speculation. He opened by explaining how Einstein's theory of relativity is the foundation of every other theory in modern physics and that the assumption that the speed of light is constant is the foundation of that theory. Thus a constant speed of light is embedded in all of modern physics and to propose a varying speed of light (VSL) is worse than swearing! It is like proposing a language without vowels." http://www.thegreatdebate.org.uk/VSLRevPrnt.html "But the researchers said they spent a lot of time working on a theory that wouldn't destabilise our understanding of physics. "The whole of physics is predicated on the constancy of the speed of light," Joao Magueijo told Motherboard. "So we had to find ways to change the speed of light without wrecking the whole thing too much." http://www.telegraph.co.uk/technology/2016/12/06/speed-light-discovered/ Pentcho Valev

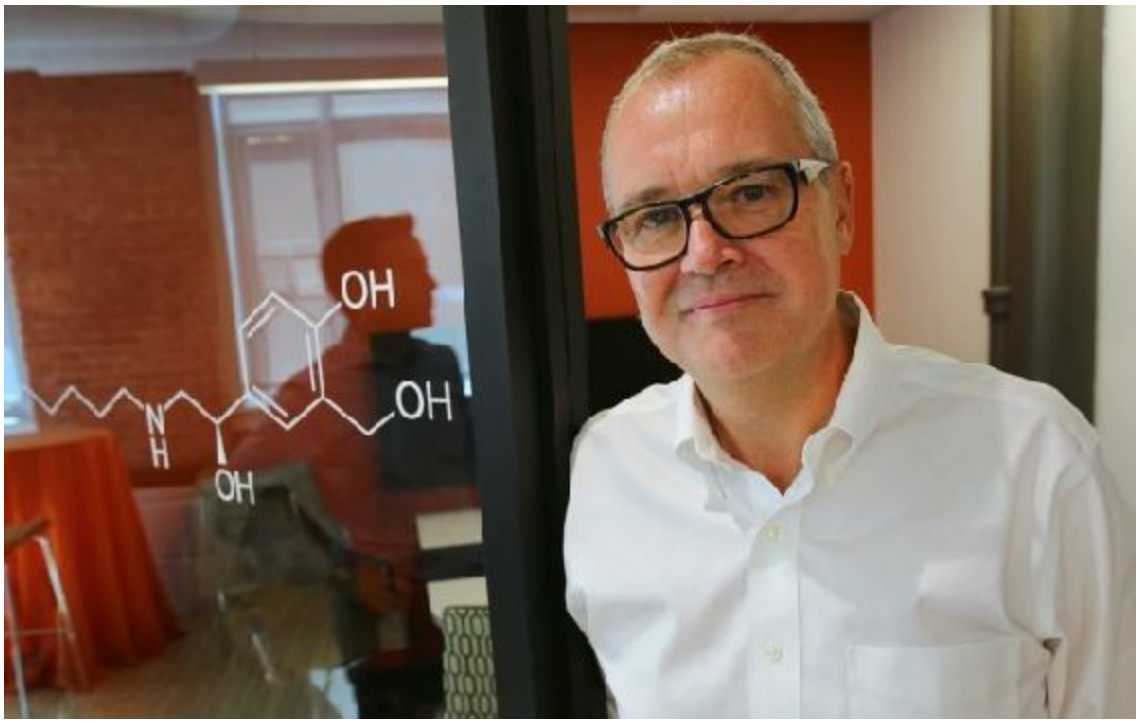
http://www.nature.com/doifinder/10.1038/nature.2017.22983

| 章节菜单 | 主菜单 |

UK government appoints next chief scientific adviser

A former pharmaceutical boss will help navigate the UK's exit from the European Union.

08 November 2017



Pat Greenhouse/Boston Globe/Getty

Patrick Vallance is the third successive biomedial scientist to be appointed chief scientific adviser.

Patrick Vallance, president of research and development at the pharmaceutical giant GlaxoSmithKline, has been appointed as chief scientific adviser, the UK government announced on 8 November.

Vallance, a clinical pharmacologist who previously led the medical division at University College London, will replace Mark Walport in April 2018. Walport has left the government to become head of a powerful new funding body called UK Research and Innovation.

As chief scientific adviser, Vallance will advise the prime minister and her cabinet, the government's most senior decision-making body. He will also lead the Government Office for Science, which promotes the use of scientific evidence in policymaking across government.

A major part of his role will be to ensure that high-quality advice is available across government departments as they deal with the legal and regulatory consequences of the UK's decision to leave the European Union, says Graeme Reid, a science-policy researcher at University College London. The United Kingdom needs to manage the impact of Brexit on the regulation of the nuclear industry and the UK's role in fusion research, as well as on environment policy and other science-related issues. "Patrick Vallance's experience in both business and universities will be of huge value," says Reid.

Brexit is likely to boost the day-to-day importance of chief scientific advisor's role, but Vallance will also have to reinvent other, more informal aspects of the position, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School. The creation of UK Research and Innovation, intended to increase the power of UK research-funding bodies, means Walport will continue to wield great influence over science in government. The chief scientific adviser has traditionally been the voice of science in government, Flanagan says.

The relationship between Vallance and Walport will be an interesting dynamic to watch, says James Wilsdon, a research-policy specialist based at the University of Sheffield, UK. He says he hopes that Vallance will act as a bridge between the science community and policymakers, and will be open to a wide range of people and perspectives. The network of chief scientific advisers is not yet operating at full strength, he says, "so re-energising the collegiality and connectivity of that network though Whitehall is a really important thing".

The role is less well-paid than Vallance's present position. His base salary at GlaxoSmithKline is £780,000 (US$1.02 million), but the science-adviser job was advertised in the salary range of £160,000–£180,000.

Vallance will be the third successive chief scientific adviser to come from the biomedical sciences. He follows Walport, who is a former director of the Wellcome Trust, and John Beddington, a population biologist now at the Oxford Martin School and the University of Oxford, UK.

In a separate announcement, GlaxoSmithKline announced that it had appointed Hal Barron, current president of research and development at Alphabet-funded California Life Sciences, to replace Vallance.

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Comments

Commenting is currently unavailable.

Skin regeneration with insights

A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.

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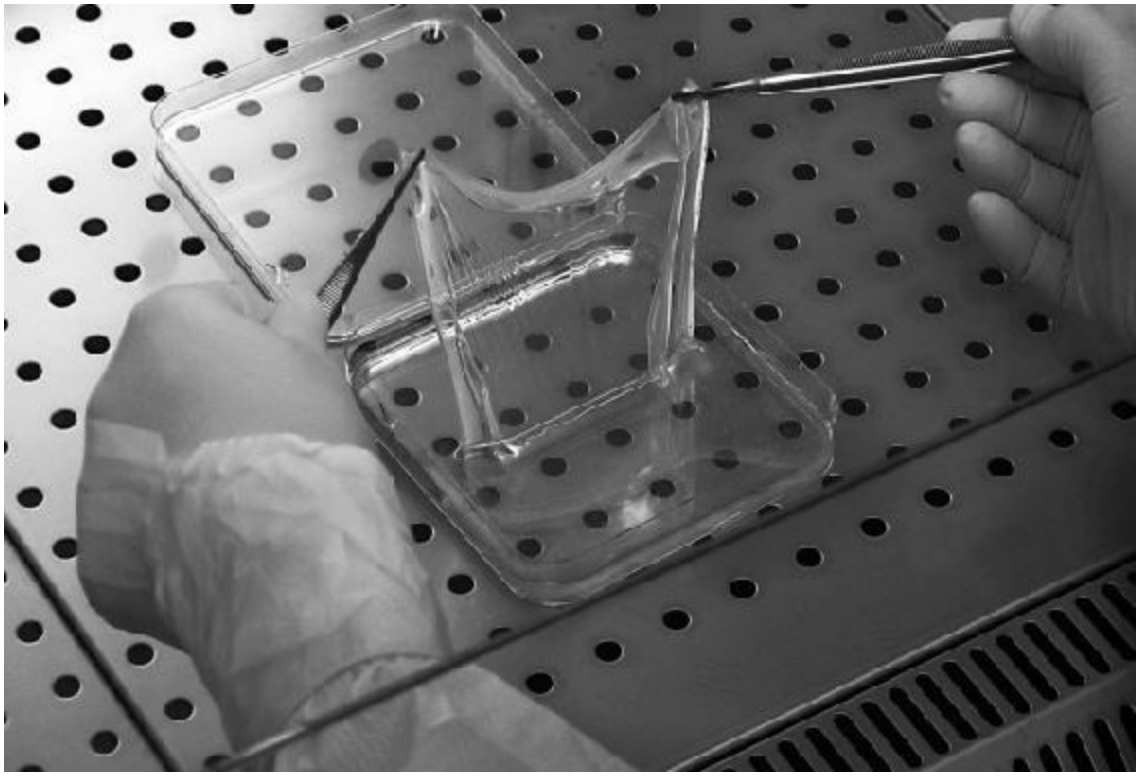

A sheet of skin cells grown in culture.

Somewhere in Germany’s Ruhr valley, a nine-year-old boy is doing what children do: playing football, joking around with friends and going to school. Two years ago, he was confined to a hospital bed, dying of a rare and cruel genetic skin disease. In a landmark paper online in *Nature* this week, scientists and clinicians present the details of his astonishing recovery (T. Hirsch *et al.* *Nature* http://dx.doi.org/10.1038/nature24487; 2017).

The boy had junctional epidermolysis bullosa, or JEB. He, like other people with the disease, carried a mutation in a gene that controls the integrity of the skin. Doctors could only try to ease his suffering as some 80% of his skin simply fell away.

A team of Italian researchers came to his aid by combining stem-cell techniques with gene therapy. As a young scientist at Harvard Medical School in Boston, Massachusetts, in the 1980s, Michele De Luca — the lead author of the new study — watched pioneers in skin regeneration learn to grow small sheets of skin from cells taken from burns patients, and to use them in grafts. He extended the work in Italy, applying new genetic and stem-cell technologies. He developed ways to generate stem cells from human skin, replace disease-causing genes in them and grow sheets of healthy skin on scaffolds in the lab.

He chose JEB for his first clinical trial, which he registered with the Italian Medicines Agency in 2002. Four years later, he reported his first success, in which he created healthy skin patches from biopsies to replace small areas of sloughed-off skin on the legs of a patient with a form of JEB (F. Mavilio *et al. Nature Med.* **12,** 1397–1402; 2006). New European Commission regulations introduced in 2007 required him to pause the project while he created facilities adhering to ‘good manufacturing practices’ (GMPs) and a spin-off company to meet the demands for strengthened oversight of cell-based therapies.

Having a company refocused his team’s attention on a different type of stem-cell therapy, one likely to yield a product for the market faster. Holoclar, a treatment that replaces the eye’s cornea in a form of blindness, became the world’s first commercial stem-cell therapy in 2015.

A few months later, at the University of Modena, De Luca got a call out of the blue from doctors in Germany who were trying to treat the little boy. Because the therapy had been in a clinical trial, albeit one on hold at the time, and because De Luca could provide GMP services, German regulatory authorities quickly approved the one-off compassionate use of the JEB therapy. Surgeons in Germany sent a skin biopsy to Modena, and two major skin transplants followed. Six months after the initial biopsy, the boy returned to school. During the many months since, he has not had so much as a blister,

and loves to show off his ‘new skin’.

This major clinical development was based on decades of basic research. The clinical data gathered during 21 months of follow-up after the boy’s treatment have also led to major insights into human skin biology, as discussed in an accompanying News & Views (M. Aragona and C. Blanpain *Nature* http://dx.doi.org/10.1038/nature24753; 2017). For example, normal regeneration of the epidermis is directed by only a few stem-cell clones that can self-renew.

By their nature, highly personalized treatments using gene therapies and products derived from an individual’s stem cells are likely to be applicable to only a subset of patients. Although the report presents the treatment of one patient, it is a classic case of researchers standing on the shoulders of others. This project, for example, relied on long-term follow-up of a patient treated in 2006, as well as parallel studies that underpinned the development of tools for *ex vivo* gene therapy and for growing transplantable sheets of epidermis *in vitro*.

The work is both a technical achievement and an example of how translational medicine should be conducted. It involves research informing the clinic and the clinic informing research, with seamless collaboration between doctors, scientists, regulators and technicians at many levels — a particularly important aspect in areas such as stem-cell biology. It requires the highest standards of scientific and ethical diligence. Similar treatments are starting to be rolled out in other labs for other diseases. *Nature* is glad to celebrate and support such an enterprise.

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Too many academics study the same people

Researchers should recognize communities that feel over-researched and under-rewarded.

08 November 2017

Susanna D'Aliesio/SOPA Images/LightRocket/Getty

Two women in Lebanon’s Shatila camp.

In southern Beirut, a temporary shelter has become a permanent home. The Shatila refugee camp was established to house displaced Palestinians in 1949 and now has thousands of families within its walls. Residents have learnt to contend with overcrowding, pollution — and a steady stream of well-funded

foreign researchers who come to study them.

Drawn by its unusual story and convenient position close to the airport, researchers flock to Shatila to track the effects of prolonged refugee status and cultural isolation on the community. Well-meaning researchers are so common in Shatila that locals have learnt how to spot them.

Before she became a social anthropologist at King's College London, Mayssoun Sukarieh did voluntary work in Shatila. Residents who saw her reach for her notebook would ask if she was a social researcher: "They come for a tiny bit, and then they leave," the locals explained.

Sukarieh realized that scholars' repeated visits were affecting the community. Academics were among the few contacts that people in Shatila had with the wider world. Again and again, the outsiders would fly out with what they wanted and offer little or nothing in return. The community started to view the visitors with amusement, then resentment.

Some people in Shatila, Sukarieh feared, were being 'over-researched' — an anecdotal concern that social scientists and biomedical researchers increasingly encounter at 'high-traffic' research sites around the world. Sometimes, it is a point raised by ethical-review committees. Occasionally, the community under study makes its own frustrations heard loud and clear.

How big is the problem? Ironically, the issue of over-research has not been researched much. In a study published last month, scientists in South Africa analysed concerns about over-research at two sites of HIV-prevention studies (J. Koen, D. Wassenaar and N. Mamotte *Soc. Sci. Med.* **194,** 1–9; 2017).

They found that the term 'over-research' is poorly defined and encompasses a range of concerns. For example, some use it to describe how other communities are being neglected in favour of one with a pre-established research structure or proximity to a university. This can lead to skewed data, and misconceptions about a particular phenomenon or place.

Alternatively, the term could be used to describe a local community that bears the burden of research participation without sufficient reward, creating a sense of frustration that leads to dwindling participation. In biomedical

studies, researchers sometimes worry that involvement in multiple clinical trials — and exposure to multiple medications — can increase the risk to participants and cloud results.

Repeated studies can certainly exaggerate the frustration that local people feel when their cooperation produces only data, publications and further research. In the South African study, many locals argued that the research should be more closely linked to developing their communities. Some projects, including certain grants from UNAIDS, a global United Nations effort to tackle HIV/AIDS, do require researchers to invest in infrastructure and education. More funders should look at this model. However, several HIV-prevention studies have done such a good job that their results are inconclusive: too few participants contracted the disease for the data to be statistically meaningful.

It is crucial that efforts to reward research participation are developed in consultation with the community being studied. Sukarieh describes well-intentioned educational courses aimed at Shatila-research participants that were impractically long — one consisted of 20 hourly sessions — and discussed issues irrelevant to the people's needs.

Over-research can bring benefits, though: a heavily studied community can become savvy in making its needs known to researchers and in influencing how a study is done. In Hackney, an ethnically diverse borough of London that underwent a period of rapid gentrification, a sociologist who came to study participants in a creative-writing group, for example, was told that, to do so, she had to join the group and write pieces like everyone else. The researcher reported how this strengthened her involvement and built stronger links to the community that helped the project to succeed (S. Neal *et al. Qual. Res.* **16,** 491–507; 2016).

Forging deep links with a community takes time, and time requires funding. Funders should recognize the need to build resources for such efforts into their grants; institutions should recognize and reward this time and effort, and acknowledge that it can eat into a researcher's publication record. It is not good enough to come in for a tiny bit, and then leave.

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Comments

Comments

There are currently no comments.

Grant recipients can still give objective advice

The US environment agency should not ban researchers it funds from its advisory boards.

08 November 2017

KEENPRESS/Getty

Melting ice caps are raising sea levels.

Scott Pruitt, administrator of the US Environmental Protection Agency (EPA), levelled a damning accusation against scientists on 31 October. In the interests of restoring scientific “integrity”, Pruitt signed a directive stating that the EPA would no longer allow researchers with active grants from the

agency to serve on the EPA's scientific advisory boards. By his tally, an unspecified number of scientists in voluntary positions on those boards had received US$77 million in EPA grants over the past three years — more than enough, Pruitt declared, to raise questions about their ability to provide independent scientific advice.

It was a cynical move — and entirely unnecessary. After all, it is ultimately up to Pruitt and his team to make the appointments to the boards, which advise the agency on everything from basic research programmes to contentious regulatory decisions. If Pruitt wanted to increase the geographical diversity, or include more people from local, state and tribal agencies, as claimed, he could have done so without raising a fuss. Instead, he opted for a public proclamation that singles out active academic scientists as a unique source of bias. He is wrong, on multiple counts.

Scientific enquiry requires money. That's a fact of life. But receiving a research grant is very different from being on the payroll of an institution, advocacy group or company. Those are all very real conflicts of interest that were ignored in Pruitt's directive.

Moreover, winning competitive research grants does not imply fealty to the granting institution. What drives EPA-funded researchers above all is the desire to deliver a public good: discovery and understanding.

Of course, scientific conflicts of interest do exist. So there are established procedures that require scientists to excuse themselves when their own work is under consideration by the boards. These same procedures apply to industry scientists — who are also rightfully represented on the advisory boards — when deliberations involve issues that could affect their companies' bottom lines.

What Pruitt either fails to understand, or has chosen to ignore, is that his advisory boards are designed to focus on science, not policy. Understanding the latest research requires perspectives from the leading scientists. And when it comes to environmental and human-health issues, it is only to be expected that many of those people will have research grants from the EPA.

In the end, Pruitt's directive seems crafted to incite US President Donald

Trump’s political base, and it’s yet another example of researchers being dragged into the political and cultural wars rending the country.

Happily, it is harder to argue with data. This might explain why the first volume of a comprehensive — and congressionally mandated — assessment of climate science released on 3 November (see page 152) sailed through reviews from officials at the EPA and other federal agencies.

That report, which integrates the latest climate research, found that greenhouse-gas emissions caused by human activity are altering the planet in fundamental ways. It lays out what we know about the threat of global warming — from deep in the ocean to the highest mountain peaks. And it stands in direct opposition to the climate scepticism voiced by Pruitt and Trump.

Some scientists had feared political interference, but senior officials at federal agencies gave the report the green light, without major changes. This is as it should be: scientists can assess what’s known and probe what is not. And it is up to policymakers to decide what to do with that information. This should be a lesson for Pruitt: the current administration has the right to create its own priorities, but it should not and cannot override what science reveals.

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Rohingya refugees, Bulgarian protests and a prize for negative results

The week in science: 3–9 November 2017.

08 November 2017

Events | Research | Policy | Climate | People | Publishing | Trend watch

EVENTS

Ice crack to close Antarctic base again For the second time in two years, the British Antarctic Survey (BAS) will close its Halley VI research station for the winter season because of an enormous crack in the floating ice shelf on which it rests. In March, operators finished moving the transportable station 23 kilometres inland from its initial 2012 location because of an ice chasm nearby. Now, another crack in the Brunt Ice Shelf, this one 50 kilometres long, is threatening the station from the other side. Halley VI will close between March and November 2018, the BAS said on 31 October, because it is too difficult to evacuate personnel quickly in winter if the crack develops further.

Michal Krzysztofowicz/BAS

Money for nothing A data organization has launched what it says is the world's first prize for publishing negative scientific results. The European College of Neuropsychopharmacology's Preclinical Data Forum says that the aim of the €10,000 (US$11,600) prize is to encourage researchers to publish data that don't confirm the hypothesis being tested. Such negative studies are much less likely to be published than positive results, meaning that other scientists may waste time trying to repeat the work. The call for entries — initially just for neuroscience research — opened on 8 November.

Bulgarian protest Hundreds of Bulgarian researchers took to the streets of Sofia on 1 November to demand higher wages and an increase in science funding marked out in the government's 2018 budget. Bulgaria has one of the lowest levels of research investment in the European Union. The demonstrators are threatening further protests when Bulgaria takes over the rotating EU presidency next January.

Rohingya refugees A survey of Rohingya refugees in Bangladesh suggests

that 7.5% of the children have life-threatening malnutrition. The United Nations children's charity UNICEF reported the figure on 3 November. More than 2,700 children are being treated for acute malnutrition in refugee camps, where conditions are expected to worsen because of poor sanitation and crowding. Since late August, more than 600,000 Rohingya people have fled from Myanmar to Bangladesh, following attacks by Myanmar's police.

RESEARCH

Weather forecasts Improving forecasts of severe weather is important, but meteorologists should also listen to social scientists to help save lives during storms, says a 1 November report from the US National Academies of Sciences, Engineering, and Medicine. It recommends that federal agencies do more to incorporate social- and behavioural-sciences research into their preparation for weather hazards. These changes might include researching people's processes for deciding how to respond to threats such as tornado or hurricane warnings, and evaluating how weather forecasters communicate with media and emergency-management officials to convey messages more effectively.

POLICY

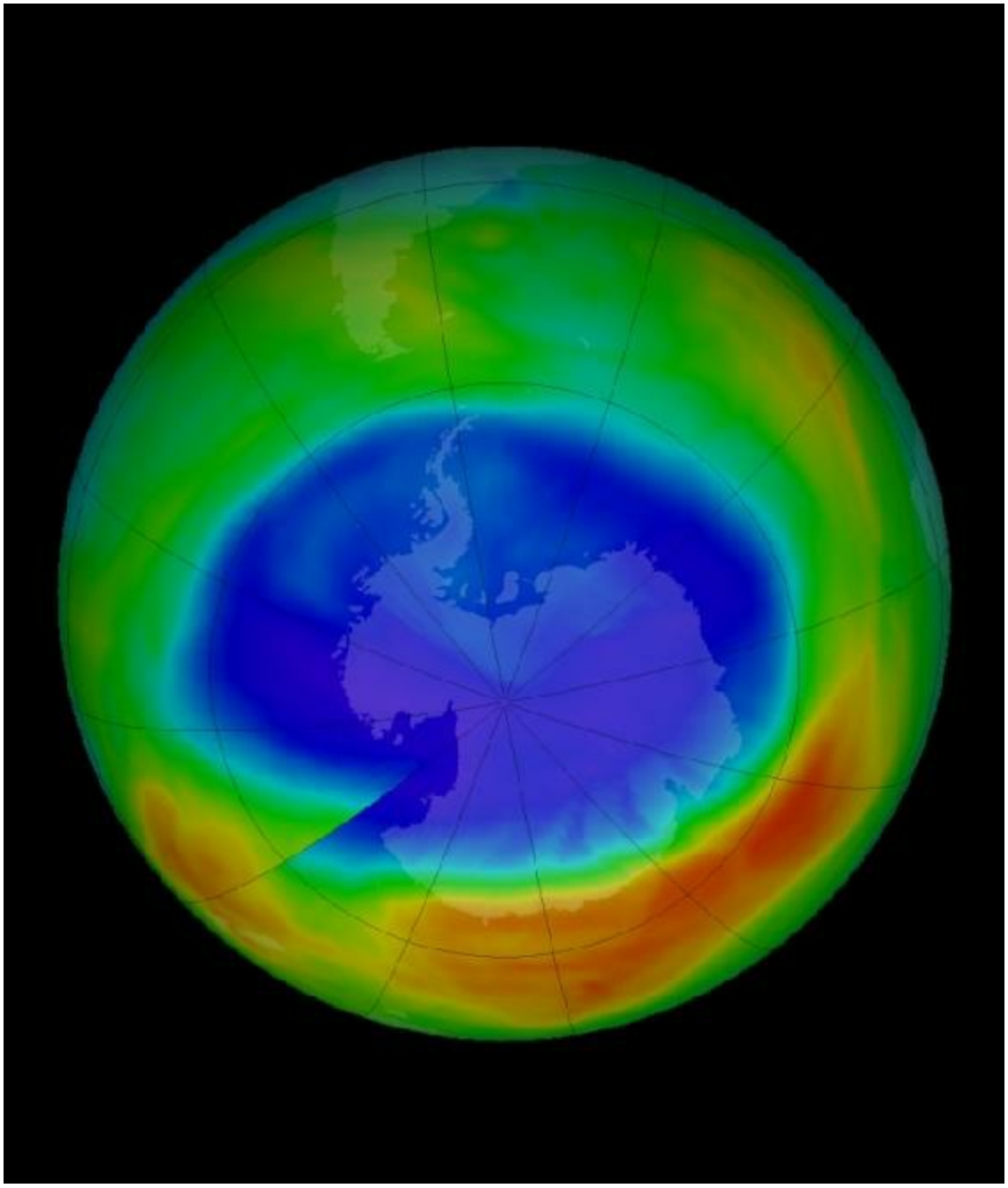
Antibiotic advice The World Health Organization (WHO) has recommended that animal-food industries curb the routine use of antibiotics for growth promotion and disease prevention. Healthy animals should receive the drugs only if others in the same flock or herdare diagnosed with communicable infections, the agency said in guidance published on 7 November. The recommendations were informed by a review of 179 studies; it found that the prevalence of multidrug-resistant bacteria in farmed animals dropped by up to 32% in places that had cut back on antibiotic use (K. L. Tang *et al. Lancet Planet. Health* http://doi.org/cfxh; 2017). The evidence connecting antibiotic restrictions in farm animals to drug resistance in humans was less robust, but hinted at a similar correlation.

Genetic-test rules The US Food and Drug Administration (FDA) is seeking

to loosen its regulation of genetic tests that are marketed directly to consumers, its commissioner, Scott Gottlieb, announced on 6 November. The FDA has proposed a policy that would allow genetic-testing companies to submit a product to the agency for a one-time review; if approved, the company would be allowed to market more tests without further review. The proposal is open for public comment until January. The agency also said that it has decided to exempt from review tests that are used to determine whether potential parents carry disease-causing genetic mutations that could cause an inherited disorder in their children.

CLIMATE

Small ozone hole This year's hole in the ozone layer was the smallest since 1988, NASA said on 2 November. The hole above Antarctica, which opens each September, was unusually small, owing to warm weather in the Southern Hemisphere. At its peak, the area of the hole was almost 2 billion hectares, or roughly two and a half times the size of the contiguous United States. Scientists attribute the shrinkage to natural variation, and not to rapid healing because of human intervention, NASA said. This year, warm air above Antarctica depleted cloud cover, which is where ozone-destroying chemical reactions occur. The hole has been shrinking since the introduction in 1987 of the Montreal Protocol to phase out ozone-depleting chemicals.



Katy Mersmann/NASA Ozone Watch/NASA

PUBLISHING

Censorship in China Springer Nature, one of the world's largest academic

publishers, has stopped readers in China from accessing some of its content. *The Financial Times* reported on 1 November that the publisher had blocked access to more than 1,000 articles from the websites of two of its journals, *The Journal of Chinese Political Science* and*International Politics*. The publishing house, which also owns *Nature*, said that the articles accounted for less than 1% of its content and had been blocked to comply with local Chinese laws. (*Nature*'s news team is editorially independent of its publisher.) The articles included politically sensitive terms such as Tibet, Taiwan and Cultural Revolution. Some in the academic community criticized the decision, which comes two-and-a-half months after UK firm Cambridge University Press blocked access to some articles in China and then swiftly reversed its decision.

Copyright battle The scholarly social network ResearchGate has over the past month disabled public access to 1.7 million papers on its site, according to five scientific publishers who have been tracking its activities. Early last month, the publishers formed a coalition to get ResearchGate to take down papers that breach copyright; two publishers have also filed a lawsuit against the site. The coalition says that the site has since disabled access to around 93% of its copyrighted material, although academics have re-uploaded some papers for public view. The publishers have now sent an undisclosed number of take-down notices to order the removal of remaining infringing content. ResearchGate, which is based in Berlin, declined to comment.

Piracy-site lawsuit The American Chemical Society (ACS) has won a lawsuit against the pirate site Sci-Hub over the website's illicit dissemination of copyrighted research articles. On 3 November, a US court granted the ACS US$4.8 million in damages for copyright infringement and trademark violation. The court also issued an injunction ordering Internet services that are "in active concert or participation" with Sci-Hub, including providers and search engines, to stop facilitating access to the site. Representatives of Sci-Hub, which was launched in 2011, did not appear in court to present their case.

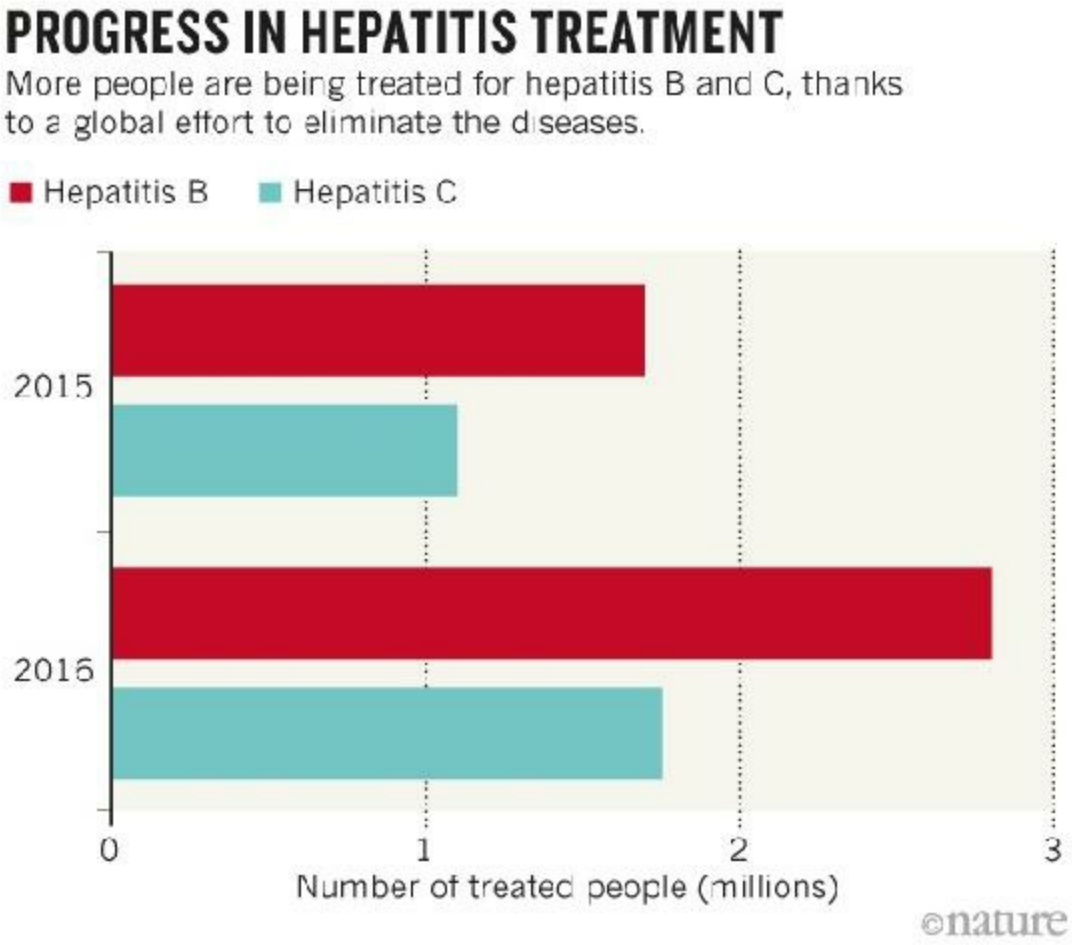
PEOPLE

Nominee withdraws Sam Clovis, the controversial nominee for the post of chief scientist at the US Department of Agriculture, withdrew from consideration on 2 November. The announcement came shortly after Clovis's name surfaced in the ongoing investigation into links between US President Donald Trump's election campaign and Russia. Clovis, a former conservative talk-show host and economics professor, was already a controversial pick for the chief-scientist position, which, by law, must be filled by a distinguished scientist.

Science chair to quit Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, said on 2 November that he will retire when his term expires late next year. The Texas Republican has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. The House of Representatives limits committee chairs to six years in the role, so Smith would have been forced to relinquish his post on the science panel in 2019.

TREND WATCH

The number of people who were able to access treatment for viral hepatitis C grew by some 1.7 million in 2016, a 60% increase over 2015, the World Health Organization (WHO) said on 31 October. A further 2.8 million people were given lifelong treatment for hepatitis B in 2016, a 65% jump over 2015. The WHO estimates that there were between 6 million and 10 million new cases of viral hepatitis B and C in 2015. The agency wants 80% of people diagnosed to be receiving treatment by 2030.



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Dark-matter hunt fails to find the elusive particles

Physicists begin to embrace alternative explanations for the missing material.

08 November 2017

XENON Collab.

Scientists working on the XENON1T experiment are searching for signs of dark matter.

Physicists are growing ever more frustrated in their hunt for dark matter — the massive but hard-to-detect substance that is thought to comprise 85% of the material Universe. Teams working with the world's most sensitive dark-matter detectors report that they have failed to find the

particles, and that the ongoing drought has challenged theorists' prevailing views.

The latest results from an experiment called XENON1T at the Gran Sasso National Laboratory in Italy, published on 30 October[1], continue a dry spell stretching back 30 years in the quest to nab dark-matter particles. An attempt by a Chinese team to detect the elusive stuff, the results of which were published on the same day[2], also came up empty-handed. Ongoing attempts by space-based telescopes, as well as at CERN, the European particle-physics laboratory near Geneva, Switzerland, have also not spotted any hints of dark-matter particles.

The findings have left researchers struggling for answers. "We do not understand how the Universe works at a deeper and more profound level than most of us care to admit," says Stacy McGaugh, an astrophysicist at Case Western Reserve University in Cleveland, Ohio.

Physicists have widely accepted the existence of dark matter since the 1980s as an explanation for why galaxies remain intact rather than flying apart, which would be expected given the amount of observable mass they contain and how fast they rotate. Researchers surmised that halos of invisible dark matter surround galaxies and stabilize them. Physicists grew more confident when dark-matter models successfully predicted the fluctuations detected in an observable echo of the Big Bang, known as the cosmic microwave background.

These observations became the most dramatic evidence for a proposal in the 1980s that dark matter might be formed of weakly interacting massive particles, known as WIMPs. The existence of such particles fits with how physicists think that the Universe evolved, and with the relative abundance of matter. Moreover, the properties of WIMPs would match those predicted by a branch of particle physics called supersymmetry.

The latest round of results seems to rule out the simplest and most elegant supersymmetry theories, casting doubt on the idea that the still-undetected particles are the missing dark matter. If simple supersymmetry theories are no longer viable, scientists say, any WIMP particle has to interact with matter much more feebly than physicists once thought. "It's not a wholesale retreat

from the WIMP paradigm, but it is definitely a change in emphasis," says Dan Hooper, a physicist at the Fermi National Accelerator Laboratory in Batavia, Illinois.

Attitudes are shifting, and physicists are increasingly embracing other possible explanations for dark matter, says David Spergel, a theoretical astrophysicist at Princeton University in New Jersey, who was an early proponent of WIMP models. "These experiments haven't completely closed the window. However, we also need to be thinking about other types of dark matter and new experiments," he says.

Dedicated detectors

It has taken decades to build experiments capable of detecting the minuscule rate at which WIMPs were thought to interact with matter. Only in the past ten years have experiments, carried out at about a dozen laboratories, reached the level of sensitivity needed to detect them. The most sensitive detector in the world is Gran Sasso's XENON1T, which looks for flashes of light created when dark matter interacts with atoms in its 3.5-tonne tank of extremely pure liquid xenon. But the team reported no dark matter from its first run. Neither was there any signal in data collected over two years during the second iteration of China's PandaX experiment, based in Jinping in Sichuan province. Hunts in space have also failed to find WIMPs, and hopes are fading that a once-promising γ-ray signal detected by NASA's Fermi telescope from the centre of the Milky Way was due to dark matter — more-conventional sources seem to explain the observation. There has been only one major report[3] of a dark-matter detection, made by the DAMA collaboration at Gran Sasso, but no group has succeeded in replicating that highly controversial result; renewed attempts to match it are under way.

Future generations of detectors based on the same principle as XENON1T are already in the works, and will be needed if physicists are to finally close the window on WIMPs. But the particles' continuing no-show is making theorists more open-minded and has allowed other theories to gain prominence, says Hooper. Perhaps dark matter consists of exotic axion particles, which are akin to strange, massive photons. Theorists are also

looking at whether dark matter might not interact with known particles at all, but exist in a “hidden sector”, he says.

The looming rejection of the WIMP hypothesis is encouraging for the few physicists who claim that dark matter itself is a red herring. “I hope people will become even more open-minded,” says McGaugh, who has studied modified versions of gravity that negate the need for dark matter. However, Hooper stresses that the fading support for WIMPs does not weaken the case for dark matter, which he thinks will eventually be found. “I’m not worried about the never possibility, but it could be very, very difficult,” he says.

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The bitter battle over the world's most popular insecticides

As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.

08 November 2017

Lucy Hulmes/CEH

Researchers have monitored the health of the red mason bee (*Osmia bicornis-rufa*), which nests in hollow cavities.

Maj Rundlöf remembers the moment she changed her mind about neonicotinoids. In December 2013, in her office at Lund University in Sweden, she and postdoc Georg Andersson were peering at data from their

latest study. It was designed to test what would happen to bees if they fed on crops treated with neonicotinoids — the world's most widely used insecticides. “I didn't expect to see any effect at all, to be honest,” says Rundlöf.

Hives of honeybees (*Apis mellifera*) weren't greatly affected by the chemicals in their pollen and nectar, the study suggested[1]. But the data on bumblebees (*Bombus terrestris*) told a different story. Bumblebee colonies that hadn't fed on the treated crops looked normal: they were packing on weight to survive the winter. But in the colonies exposed to neonicotinoids, the growth chart was a flat line.

When the Swedish study was published in April 2015, it made headlines around the world. It was the first to show that neonicotinoid chemicals — known as neonics — could harm bees in a real-world farming situation.

Bee populations are declining in many parts of the globe, a worrying sign for the crops and wild plants that rely on these pollinators for their survival. Parasites, disease and shrinking food resources are all prime suspects. But a link to neonics has become a major flashpoint.

Even before Rundlöf's results were revealed, the European Union had placed heavy restrictions on the three most widely used neonics in flowering crops — plants that might be attractive to bees — amid rising concerns that the chemicals might harm pollinators. The restricted neonics were imidacloprid and clothianidin, made by agrochemical giant Bayer, and thiamethoxam, made by Syngenta. But farmers, the agrochemical industry and some scientists pointed out that the moratorium was precautionary and based on limited evidence, gathered mostly from lab tests.

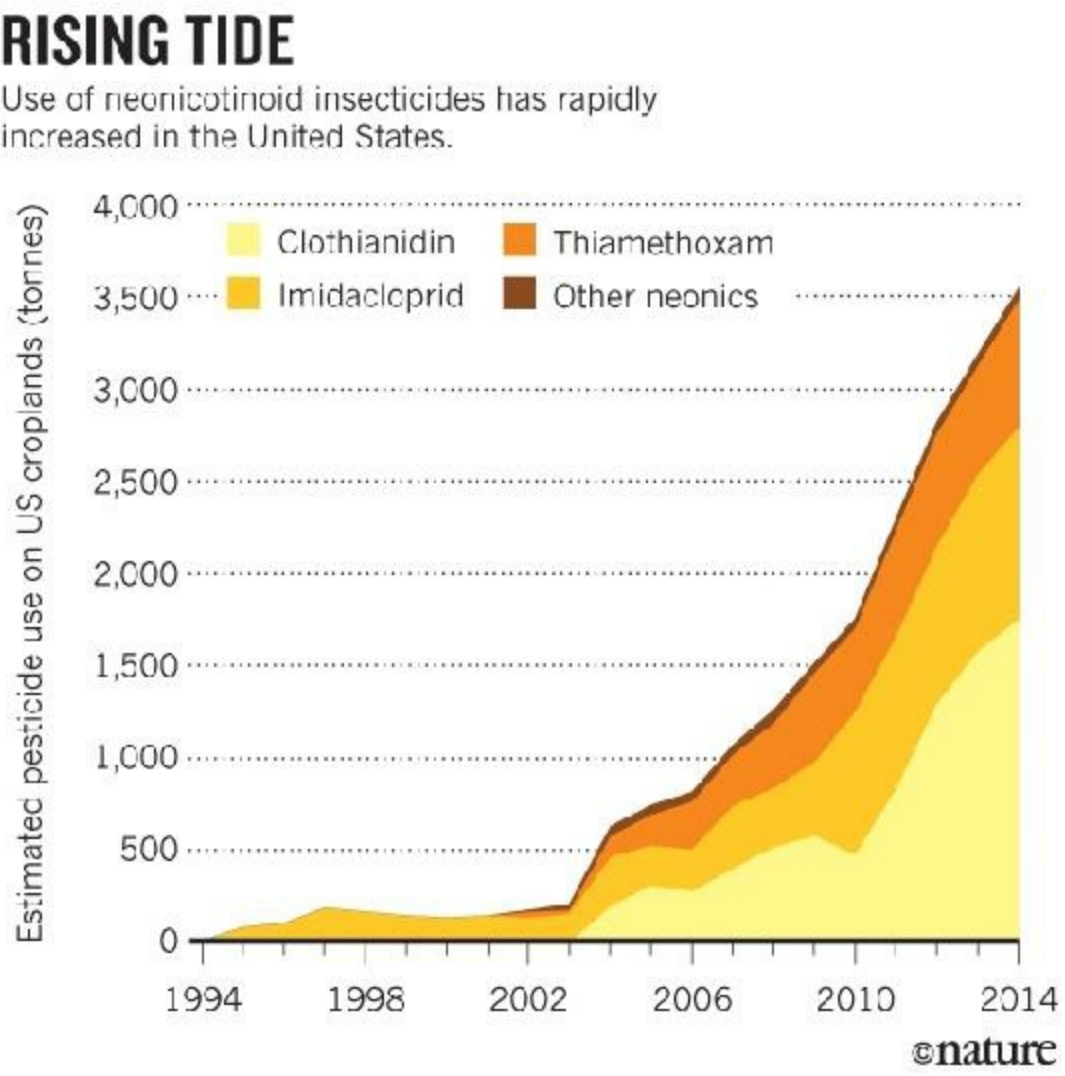
Since Rundlöf's paper, studies showing real-world evidence of harm from pesticides in the field have been mounting — and environmental organizations have demanded wide-ranging bans. Regulatory agencies will soon decide what to do about neonics, which have a global market worth more than US$1.5 billion per year. This month, the EU's European Food Safety Authority is due to complete a re-evaluation of evidence for restricting neonics; the EU will then need to decide what action to take. The US Environmental Protection Agency is expected to complete its own review of

the insecticides next year. France's parliament has passed a law that would ban neonics in 2018, although some exemptions will be allowed.

But industry groups and some scientists say the evidence still isn't conclusive. The picture is complicated: some studies show harm to some bees in some circumstances, whereas others find no harm. The results seem to be affected by many factors, including the species of bee and the kinds of crops involved. Scientists working on the question say the subject has become toxic: any new study is instantly and furiously picked at by entrenched advocates on both sides. Even the results of the largest study on the matter, funded by the agrochemical industry, failed to produce a consensus. Published this year[2], it launched another round of recriminations — including complaints from funders who criticized the paper that they had paid for. Ultimately, it's likely that political or regulatory decisions will settle the matter before opposing parties agree, says Sainath Suryanarayanan, an entomologist and sociologist at the University of Wisconsin–Madison who has studied the bee-health issue. “It is a common pattern for highly contentious and polarized debates,” he says.

The world's favourite insecticide

In the early 1980s, scientists at Nihon Tokushu Noyaku Seizo in Tokyo, an arm of Bayer, started to play around with nithiazine, an insecticide created in California a decade earlier. They discovered a new compound that was more than 100 times as effective at killing crop pests, such as aphids. Named imidacloprid, the chemical was launched onto the market in the 1990s, and it quickly became one of the most widely used insecticides in the world. By the mid-2000s, imidacloprid and similar compounds made up one-quarter of all insecticides (see 'Rising tide'). The compounds damage insects' nervous systems by causing the nerves to fire continually until they fail, eventually leading to death. Many neonics are applied directly to seeds, and are taken up by growing plants. If the plant flowers, the chemicals find their way into pollen and nectar.



Source: USGS/CalPIP

In France, where sunflower seeds coated with imidacloprid came on the market in 1994, beekeepers raised the alarm. They said that their honeybees were failing to make it home after foraging flights, and they pinned the blame on the sunflowers. The concerns triggered a 1999 French ban on imidacloprid-coated sunflower seeds, which continues to this day — although it was based on the precautionary principle, rather than formal proofs of harm, says Axel Decourtye, a researcher at the Institute for Bees in Avignon, France.

Scientists hurried to find those proofs — or evidence that the concern was overblown. Researchers quickly discovered that honeybees fed high doses of neonicotinoids died. And even sub-lethal doses triggered unusual behaviour: exposed honeybees changed their dining habits, foraging less often but for longer periods[3]. Other research showed[4] that neonics act on parts of a bee's brain associated with memory and learning. Honeybees trained to respond to particular scents by sticking out their tongues, for example, performed worse — or failed to learn the task at all — when dosed with a neonic.

At every stage, critics raised new queries about how realistic the experiments were, says Decourtye. “How do we know if the neonicotinoid doses are realistic? Does the effect on the individual have any effect on the colony?”

Out in the field

As work continued in the laboratory, researchers also began to turn to the fields. In 2012, Decourtye and his colleagues published a paper[5] showing that what they called “thiamethoxam intoxication” seemed to interfere with the ability of honeybees to return to their hives after looking for food in a realistic, outdoor setting. Yet that study still dosed bees' food with neonics, rather than allowing them to feed on treated crops.

Around the same time, a UK team found[6] that it was not just honeybees that could be at risk. They reported that colonies of bumblebees exposed to “field-realistic” levels of imidacloprid in the lab and then left to grow in field conditions grew slower than controls. They also produced 85% fewer new queens to carry on their line. That work was led by Dave Goulson, a bee researcher now at the University of Sussex in Brighton, UK. In 2006, Goulson had started a charity dedicated to conserving bumblebees, and people began telling him their concerns about neonics. “To start with, I was pretty dubious,” he says. But by 2014, the Task Force on Systemic Pesticides (TFSP) — a group of 30 scientists, including Goulson — announced that it had analysed 800 peer-reviewed studies on neonics and bees, and found “clear evidence of harm sufficient to trigger regulatory action”[8].

Rundlöf's study set out to be the most realistic yet. Her team sowed eight

Swedish fields with oilseed-rape seeds coated in clothianidin, and eight with untreated seeds. They found[1] not only that bumblebee colonies in treated fields grew less well than the controls, but also that the numbers of wild bees in the treated fields fell. Industry spokespeople noted that honeybee colonies weren't affected, and also quibbled with the study — arguing, for example, that the researchers had only placed a small number of wild bees into fields, so findings might not be statistically robust. Rundlöf, however, points out that the researchers also surveyed wild bees flying around, and had the bumblebee-colony data to draw on. “I know we have robust evidence,” she says.

Maj Rundlöf

Researchers examine the health of honeybees during a field study led by Maj Rundlöf in Sweden.

In mid-2017, the largest field study yet — funded with some $3 million from

industry — reported its long-awaited results[2]. Scientists from the Centre for Ecology and Hydrology (CEH) near Wallingford, UK, had put honeybees, mason bees (*Osmia bicornis*) and bumblebees in 33 oilseed-rape fields in the United Kingdom, Germany and Hungary. This time, the seeds, sown in winter, had been coated with either clothianidin or thiamethoxam, or with a neonicotinoid-free pesticide treatment.

The researchers, led by CEH entomologist Ben Woodcock, found that bumblebees and mason bees fared less well the more neonics they were exposed to. The honeybee picture was more complicated: in some cases, neonics seemed to affect bee health, but in others, they didn't. In the United Kingdom and Hungary, neonic compounds seemed to reduce worker-bee numbers in honeybee hives; in Hungary, researchers also saw fewer egg cells in these hives, an indication of reduced reproductive success. In Germany, however, the honeybee hives exposed to neonics had more egg cells — a puzzling result. Overall, the CEH study concluded that neonicotinoids reduced bees' ability to establish new colonies after winter. The journal editor's summary of the paper came under the headline: “Damage confirmed”.

The agrochemical firms that funded the study don't agree. At a press conference in June, when CEH scientists presented their results — without Woodcock, who was overseas — spokespeople from Syngenta and Bayer told reporters that both the study's analysis and its conclusions were questionable. They noted that Woodcock's team had analysed more than 200 pieces of information about honeybees; 9 showed a negative effect from neonicotinoids, whereas 7 were positive. “The one-line simplistic summary conclusion published does not reflect the data presented in this paper,” argued Peter Campbell, an environmental specialist at Syngenta in Reading, UK, in a separate statement released to the media.

Woodcock was incensed by the criticism. In an interview with environmental group Greenpeace, he said that industry had accused him of being a liar. Now, he says, he regrets that choice of words, but he still thinks industry took a blinkered view of the results. “I do feel that the sentiment of what I implied, while inappropriate, was not an unreasonable reaction,” he says. The negative effects were in key areas related to bee health, he says, adding that for

industrial firms to deny that neonics are having an effect on bees is “probably naive”.

Many of the academics *Nature* talked to agree. “I think the majority of researchers highlight that the weakening of bee populations caused by neonicotinoids is proved,” says Decourtye. But not everyone is so certain. “The question of whether the damage to bees is translated to an effect in fields on whole populations of bees is much harder to show,” says Linda Field, head of the department of Biointeractions and Crop Protection at Rothamsted Research in Harpenden, UK. Mature colonies may survive even if individual bees are impaired, because other worker bees compensate, notes Nigel Raine, a biologist at the University of Guelph in Canada. But solitary bees, such as wild bees and queen bumblebees emerging from hibernation, might be at greater risk.

Campbell thinks that many academics are “neutral” on the matter, but are not vocal about it. Studies showing harm to bees tend to garner media attention, and are published in widely read journals, whereas those showing no impact are relegated to less highly cited publications, he says. But Goulson and Woodcock say some of the studies that industry cites as showing no harm are statistically dubious, and more flawed than the headline-garnering trials that show harm.

Christian Maus, global lead scientist for bee care at Bayer in Monheim am Rhein, Germany, picks his words carefully. “I think it is clear and undebated that neonicotinoids do have some intrinsic toxicity to bees,” he says. “But under realistic conditions, as prevailing in the field and agricultural practice, we have not seen any evidence that they would be harming honeybee colonies, for instance, when they are correctly applied.”

Combinatorial effects

Researchers are looking beyond simple relationships between a single pesticide and bee harm. In a 2012 paper[8], Raine and his colleagues showed that exposing bumblebees to a neonicotinoid in combination with a pesticide called a pyrethroid hampered their ability to collect pollen. Colonies exposed

to both compounds experienced higher losses of worker bees than did controls, or colonies dosed with only one. The study was the first to show combinatorial effects, Raine says — which is important, because bees will be exposed to multiple compounds in the wild. And this year, in a paper[9] published alongside Woodcock's, a Canadian team studying honeybee colonies near maize (corn) plants found that the presence of the fungicide boscalid halved the dose of neonics needed to cause death.

That work also suggested that neonic chemicals can migrate away from the plants that they are supposed to protect: by identifying the sources of pollen grains in the hives, the researchers showed that bees were exposed to neonics mainly through pollen from untreated plants. Neonicotinoids are water-soluble — which is how they move from seeds into growing plant tissues. “But that also means they can be washed off the seed, into the soil, and maybe into other plants,” says Christian Krupke, an entomologist at Purdue University in West Lafayette, Indiana.

In one study[10], Krupke found that just 1.34% of clothianidin applied as seed treatment to maize ended up in the crop’s tissues. Neonics that get into the wider environment might cause other, more indirect problems. A 2014 study[11] in the Netherlands, for instance, reported a fall in populations of insect-eating birds in areas with high concentrations of neonicotinoids in the water. It suggested that the chemicals might have depleted the birds’ food resource.

Some researchers are now questioning whether there is any benefit to using neonicotinoids at all. In another study[12], Krupke’s group found no benefits on maize yield from the use of neonicotinoids in Indiana. In this crop, he says, the prophylactic use of neonicotinoids — which are often part of a bundle of pesticides sold pre-applied to seeds — is foolish.

“The way they’re used doesn’t make any sense,” he says. “It only makes sense from one motive. That is the profit motive for the manufacturer.”

Campbell insists that neonicotinoids do provide yield increases, but much of the evidence is proprietary and unpublished. Since the EU neonicotinoid restrictions, Maus says, research suggests there has been a 4% decline in

oilseed-rape yield. Whether or not the restrictions have had any effect, farmers have furiously protested against losing the ability to use neonics. Anecdotal reports suggest many are attempting to compensate by applying increasing amounts of pyrethroids, which are sprayed over crops, rather than applied to seeds; these chemicals may bring their own health risks if used in large quantities, because they are toxic to fish and aquatic insects.

The B word

Regulators in some countries will soon decide whether to take further action to restrict neonics — and here, researchers are split. Some campaign groups, such as Greenpeace and the Pesticide Action Network, have argued for a ban on the use of neonics on all outdoor crops, not just those that might be attractive to bees, such as the bright-yellow flowers of oilseed rape.

“A lot of farmers do fundamentally rely on neonicotinoids,” says Woodcock. And clamping down severely on one chemical might mean that greater amounts of other damaging substances are used. “If people can't use neonicotinoids and they go to other insecticides, is that any better? There are lots of knock-on effects,” says Field.

That concern points to wider doubts about the regulatory systems that allowed agrichemicals such as neonics onto the market in the first place, says Goulson. Many researchers are hesitant to advocate outright bans. Some, such as Rundlöf, say it isn't their job to make policy recommendations. But Goulson says his view has changed as the evidence has mounted. In 2014 — at the time of the TFSP's first synthesis report — he thought that there might be certain situations in which neonics were the best option. But since then, he says, there's been even stronger evidence of collapsing insect populations — and it is hard to regulate partial bans. “I think now I'd vote for a complete ban,” he says.

Whatever regulators do, Goulson says, he is growing increasingly downbeat about the chances of any consensus forming between industry and academia on the issue. “I'm starting to come to the conclusion there will never be a game-changer,” he says. “There is nothing I think any scientist could do at

this point to make people all sit down and have any answer.”

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Four ethical priorities for neurotechnologies and AI

08 November 2017

Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

BSIP/UIG/Getty

A man with a spinal-cord injury (right) prepares for a virtual cycle race in which competitors steer avatars using brain signals.

Consider the following scenario. A paralysed man participates in a clinical

trial of a brain–computer interface (BCI). A computer connected to a chip in his brain is trained to interpret the neural activity resulting from his mental rehearsals of an action. The computer generates commands that move a robotic arm. One day, the man feels frustrated with the experimental team. Later, his robotic hand crushes a cup after taking it from one of the research assistants, and hurts the assistant. Apologizing for what he says must have been a malfunction of the device, he wonders whether his frustration with the team played a part.

This scenario is hypothetical. But it illustrates some of the challenges that society might be heading towards.

Current BCI technology is mainly focused on therapeutic outcomes, such as helping people with spinal-cord injuries. It already enables users to perform relatively simple motor tasks — moving a computer cursor or controlling a motorized wheelchair, for example. Moreover, researchers can already interpret a person's neural activity from functional magnetic resonance imaging scans at a rudimentary level[1] — that the individual is thinking of a person, say, rather than a car.

It might take years or even decades until BCI and other neurotechnologies are part of our daily lives. But technological developments mean that we are on a path to a world in which it will be possible to decode people's mental processes and directly manipulate the brain mechanisms underlying their intentions, emotions and decisions; where individuals could communicate with others simply by thinking; and where powerful computational systems linked directly to people's brains aid their interactions with the world such that their mental and physical abilities are greatly enhanced.

Such advances could revolutionize the treatment of many conditions, from brain injury and paralysis to epilepsy and schizophrenia, and transform human experience for the better. But the technology could also exacerbate social inequalities and offer corporations, hackers, governments or anyone else new ways to exploit and manipulate people. And it could profoundly alter some core human characteristics: private mental life, individual agency and an understanding of individuals as entities bound by their bodies.

It is crucial to consider the possible ramifications now.

The Morningside Group comprises neuroscientists, neurotechnologists, clinicians, ethicists and machine-intelligence engineers. It includes representatives from Google and Kernel (a neurotechnology start-up in Los Angeles, California); from international brain projects; and from academic and research institutions in the United States, Canada, Europe, Israel, China, Japan and Australia. We gathered at a workshop sponsored by the US National Science Foundation at Columbia University, New York, in May 2017 to discuss the ethics of neurotechnologies and machine intelligence.

We believe that existing ethics guidelines are insufficient for this realm[2]. These include the Declaration of Helsinki, a statement of ethical principles first established in 1964 for medical research involving human subjects (go.nature.com/2z262ag); the Belmont Report, a 1979 statement crafted by the US National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research (go.nature.com/2hrezmb); and the Asilomar artificial intelligence (AI) statement of cautionary principles, published early this year and signed by business leaders and AI researchers, among others (go.nature.com/2ihnqac).

To begin to address this deficit, here we lay out recommendations relating to four areas of concern: privacy and consent; agency and identity; augmentation; and bias. Different nations and people of varying religions, ethnicities and socio-economic backgrounds will have differing needs and outlooks. As such, governments must create their own deliberative bodies to mediate open debate involving representatives from all sectors of society, and to determine how to translate these guidelines into policy, including specific laws and regulations.

Intelligent investments

Some of the world's wealthiest investors are betting on the interplay between neuroscience and AI. More than a dozen companies worldwide, including Kernel and Elon Musk's start-up firm Neuralink, which launched this year, are investing in the creation of devices that can both 'read' human brain activity and 'write' neural information into the brain. We estimate that current spending on neurotechnology by for-profit industry is already US$100

million per year, and growing fast.

BSIP/UIG/Getty

After having electrodes implanted in the brain to stimulate neural activity, some people have reported feeling an altered sense of identity.

Investment from other sectors is also considerable. Since 2013, more than $500 million in federal funds has gone towards the development of neurotechnology under the US BRAIN initiative alone.

Current capabilities are already impressive. A neuroscientist paralysed by amyotrophic lateral sclerosis (ALS; also known as Lou Gehrig's or motor neuron disease) has used a BCI to run his laboratory, write grant applications and send e-mails[3]. Meanwhile, researchers at Duke University in Durham, North Carolina, have shown that three monkeys with electrode implants can operate as a 'brain net' to move an avatar arm collaboratively[4]. These devices can work across thousands of kilometres if the signal is transmitted wirelessly by the Internet.

Soon such coarse devices, which can stimulate and read the activity of a few dozen neurons at most, will be surpassed. Earlier this year, the US Defense Advanced Research Projects Agency (DARPA) launched a project called Neural Engineering System Design. It aims to win approval from the US Food and Drug Administration within 4 years for a wireless human brain device that can monitor brain activity using 1 million electrodes simultaneously and selectively stimulate up to 100,000 neurons.

Meanwhile, Google, IBM, Microsoft, Facebook, Apple and numerous start-ups are building ever-more-sophisticated artificial neural networks that can already outperform humans on tasks with well-defined inputs and outputs.

Last year, for example, researchers at the University of Washington in Seattle demonstrated that Google's FaceNet system could recognize one face from a million others. Another Google system with similar neural-network architecture far outperforms well-travelled humans at guessing where in the world a street scene has been photographed, demonstrating the generality of the technique. In August, Microsoft announced that, in certain metrics, its neural network for recognizing conversational speech has matched the abilities of even trained professionals, who have the option of repeatedly rewinding and listening to words used in context. And using electroencephalogram (EEG) data, researchers at the University of Freiburg in Germany showed in July how neural networks can be used to decode planning-related brain activity and so control robots[5].

Future neural networks derived from a better understanding of how real ones work will almost certainly be much more powerful even than these examples. The artificial networks in current use have been inspired by models of brain circuits that are more than 50 years old, which are based on recording the activity of individual neurons in anaesthetized animals[6]. In today's neuroscience labs, researchers can monitor and manipulate the activity of thousands of neurons in awake, behaving animals, owing to advances in optical methods, computing, molecular engineering and microelectronics.

We are already intimately connected to our machines. Researchers at Google calculated this year that the average user touches their phone nearly one million times annually (unpublished data). The human brain controls auditory

and visual systems to decipher sounds and images, and commands limbs to hold and manipulate our gadgets. Yet the convergence of developments in neurotechnologies and AI would offer something qualitatively different — the direct linking of people's brains to machine intelligence, and the bypassing of the normal sensorimotor functions of brains and bodies.

Four concerns

For neurotechnologies to take off in general consumer markets, the devices would have to be non-invasive, of minimal risk, and require much less expense to deploy than current neurosurgical procedures. Nonetheless, even now, companies that are developing devices must be held accountable for their products, and be guided by certain standards, best practices and ethical norms.

We highlight four areas of concern that call for immediate action. Although we raise these issues in the context of neurotechnology, they also apply to AI.

Privacy and consent. An extraordinary level of personal information can already be obtained from people's data trails. Researchers at the Massachusetts Institute of Technology in Cambridge, for example, discovered in 2015 that fine-grained analysis of people's motor behaviour, revealed through their keyboard typing patterns on personal devices, could enable earlier diagnosis of Parkinson's disease[7]. A 2017 study suggests that measures of mobility patterns, such as those obtained from people carrying smartphones during their normal daily activities, can be used to diagnose early signs of cognitive impairment resulting from Alzheimer's disease[8].

Algorithms that are used to target advertising, calculate insurance premiums or match potential partners will be considerably more powerful if they draw on neural information — for instance, activity patterns from neurons associated with certain states of attention. And neural devices connected to the Internet open up the possibility of individuals or organizations (hackers, corporations or government agencies) tracking or even manipulating an individual's mental experience.

We believe that citizens should have the ability — and right — to keep their neural data private (see also 'Agency and identity'). We propose the following steps to ensure this.

For all neural data, the ability to opt out of sharing should be the default choice, and assiduously protected. People readily give up their privacy rights to commercial providers of services, such as Internet browsing, social media or entertainment, without fully understanding what they are surrendering. A default of opting out would mean that neural data are treated in the same way that organs or tissues are in most countries. Individuals would need to explicitly opt in to share neural data from any device. This would involve a safe and secure process, including a consent procedure that clearly specifies who will use the data, for what purposes and for how long.

Even with this approach, neural data from many willing sharers, combined with massive amounts of non-neural data — from Internet searches, fitness monitors and so on — could be used to draw 'good enough' conclusions about individuals who choose not to share. To limit this problem, we propose that the sale, commercial transfer and use of neural data be strictly regulated. Such regulations — which would also limit the possibility of people giving up their neural data or having neural activity written directly into their brains for financial reward — may be analogous to legislation that prohibits the sale of human organs, such as the 1984 US National Organ Transplant Act.

Another safeguard is to restrict the centralized processing of neural data. We advocate that computational techniques, such as differential privacy or 'federated learning', be deployed to protect user privacy (see 'Protecting privacy'). The use of other technologies specifically designed to protect people's data would help, too. Blockchain-based techniques, for instance, allow data to be tracked and audited, and 'smart contracts' can give transparent control over how data are used, without the need for a centralized authority. Lastly, open-data formats and open-source code would allow for greater transparency about what stays private and what is transmitted.

Protecting privacy: Federated learning

When technology companies use machine learning to improve their software, they typically gather user information on their servers to analyse how a particular service is being used and then train new algorithms on the aggregated data. Researchers at Google are experimenting with an alternative method of artificial-intelligence training called federated learning. Here, the teaching process happens locally on each user's device without the data being centralized: the lessons aggregated from the data (for instance, the knowledge that the word 'weekly' can be used as an adjective and an adverb) are sent back to Google's servers, but the actual e-mails, texts and so on remain on the user's own phone. Other groups are exploring similar ideas. Thus, information systems with improved designs could be used to enhance users' ownership and privacy over their personal data, while still enabling valuable computations to be performed on those data.

Agency and identity. Some people receiving deep-brain stimulation through electrodes implanted in their brains have reported feeling an altered sense of agency and identity. In a 2016 study, a man who had used a brain stimulator to treat his depression for seven years reported in a focus group[9] that he began to wonder whether the way he was interacting with others — for example, saying something that, in retrospect, he thought was inappropriate — was due to the device, his depression or whether it reflected something deeper about himself. He said: “It blurs to the point where I'm not sure ... frankly, who I am.”

Neurotechnologies could clearly disrupt people's sense of identity and agency, and shake core assumptions about the nature of the self and personal responsibility — legal or moral.

People could end up behaving in ways that they struggle to claim as their own, if machine learning and brain-interfacing devices enable faster translation between an intention and an action, perhaps by using an 'auto-complete' or 'auto-correct' function. If people can control devices through their thoughts across great distances, or if several brains are wired to work collaboratively, our understanding of who we are and where we are acting will be disrupted.

As neurotechnologies develop and corporations, governments and others start striving to endow people with new capabilities, individual identity (our

bodily and mental integrity) and agency (our ability to choose our actions) must be protected as basic human rights.

We recommend adding clauses protecting such rights ('neurorights') to international treaties, such as the 1948 Universal Declaration of Human Rights. However, this might not be enough — international declarations and laws are just agreements between states, and even the Universal Declaration is not legally binding. Thus, we advocate the creation of an international convention to define prohibited actions related to neurotechnology and machine intelligence, similar to the prohibitions listed in the 2010 International Convention for the Protection of All Persons from Enforced Disappearance. An associated United Nations working group could review the compliance of signatory states, and recommend sanctions when needed.

Such declarations must also protect people's rights to be educated about the possible cognitive and emotional effects of neurotechnologies. Currently, consent forms typically focus only on the physical risks of surgery, rather than the possible effects of a device on mood, personality or sense of self.

Augmentation. People frequently experience prejudice if their bodies or brains function differently from most[10]. The pressure to adopt enhancing neurotechnologies, such as those that allow people to radically expand their endurance or sensory or mental capacities, is likely to change societal norms, raise issues of equitable access and generate new forms of discrimination.

Moreover, it's easy to imagine an augmentation arms race. In recent years, we have heard staff at DARPA and the US Intelligence Advanced Research Projects Activity discuss plans to provide soldiers and analysts with enhanced mental abilities ('super-intelligent agents'). These would be used for combat settings and to better decipher data streams.

Any lines drawn will inevitably be blurry, given how hard it is to predict which technologies will have negative impacts on human life. But we urge that guidelines are established at both international and national levels to set limits on the augmenting neurotechnologies that can be implemented, and to define the contexts in which they can be used — as is happening for gene editing in humans.

Privacy and individuality are valued more highly in some cultures than in others. Therefore, regulatory decisions must be made within a culture-specific context, while respecting universal rights and global guidelines. Moreover, outright bans of certain technologies could simply push them underground, so efforts to establish specific laws and regulations must include organized forums that enable in-depth and open debate.

Such efforts should draw on the many precedents for building international consensus and incorporating public opinion into scientific decision-making at the national level[11]. For instance, after the First World War, a 1925 conference led to the development and ratification of the Geneva Protocol, a treaty banning the use of chemical and biological weapons. Similarly, after the Second World War, the UN Atomic Energy Commission was established to deal with the use of atomic energy for peaceful purposes and to control the spread of nuclear weapons.

In particular, we recommend that the use of neural technology for military purposes be stringently regulated. For obvious reasons, any moratorium should be global and sponsored by a UN-led commission. Although such commissions and similar efforts might not resolve all enhancement issues, they offer the best-available model for publicly acknowledging the need for restraint, and for wide input into the development and implementation of a technology.

Bias. When scientific or technological decisions are based on a narrow set of systemic, structural or social concepts and norms, the resulting technology can privilege certain groups and harm others. A 2015 study[12] found that postings for jobs displayed to female users by Google's advertising algorithm pay less well than those displayed to men. Similarly, a ProPublica investigation revealed last year that algorithms used by US law-enforcement agencies wrongly predict that black defendants are more likely to reoffend than white defendants with a similar criminal record (go.nature.com/29aznyw). Such biases could become embedded in neural devices. Indeed, researchers who have examined these kinds of cases have shown that defining fairness in a mathematically rigorous manner is very difficult (go.nature.com/2ztfjt9).

Practical steps to counter bias within technologies are already being discussed in industry and academia. Such ongoing public discussions and debate are necessary to shape definitions of problematic biases and, more generally, of normality.

We advocate that countermeasures to combat bias become the norm for machine learning. We also recommend that probable user groups (especially those who are already marginalized) have input into the design of algorithms and devices as another way to ensure that biases are addressed from the first stages of technology development.

Responsible neuroengineering

Underlying many of these recommendations is a call for industry and academic researchers to take on the responsibilities that come with devising devices and systems capable of bringing such change. In doing so, they could draw on frameworks that have already been developed for responsible innovation.

In addition to the guidelines mentioned above, the UK Engineering and Physical Sciences Research Council, for instance, provides a framework to encourage innovators to “anticipate, reflect, engage and act” in ways that “promote ... opportunities for science and innovation that are socially desirable and undertaken in the public interest”. Among the various efforts to address this in AI, the IEEE Standards Association created a global ethics initiative in April 2016, with the aim of embedding ethics into the design of processes for all AI and autonomous systems.

History indicates that profit hunting will often trump social responsibility in the corporate world. And even if, at an individual level, most technologists set out to benefit humanity, they can come up against complex ethical dilemmas for which they aren't prepared. We think that mindsets could be altered and the producers of devices better equipped by embedding an ethical code of conduct into industry and academia.

A first step towards this would be to expose engineers, other tech developers

and academic-research trainees to ethics as part of their standard training on joining a company or laboratory. Employees could be taught to think more deeply about how to pursue advances and deploy strategies that are likely to contribute constructively to society, rather than to fracture it.

This type of approach would essentially follow that used in medicine. Medical students are taught about patient confidentiality, non-harm and their duties of beneficence and justice, and are required to take the Hippocratic Oath to adhere to the highest standards of the profession.

The possible clinical and societal benefits of neurotechnologies are vast. To reap them, we must guide their development in a way that respects, protects and enables what is best in humanity.

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Comments

Comments

There are currently no comments.

The catalogue that made metrics, and changed science

08 November 2017

As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.

Alamy

Cataloguers of the Royal Society developed the first record of published scientific research.

In 1830, Charles Babbage had an unusual idea. Exasperated by how little recognition science was getting in England, the computer pioneer and scientific provocateur suggested that quantifying authorship might be a way to identify scientific eminence.

Like many of Babbage's radical ideas, this one persuaded almost nobody, but it eventually proved prophetic. Before the end of the century, listing papers and comparing publication counts had become a popular pursuit among scientific authors and other observers. Within a few decades, academic scientists were coming to fear the creed of 'publish or perish' (see 'Catalogues and counts').

This transformation can inform current debates about the value of algorithms for quantifying scientific credibility and importance. History shows how search technologies and metrics are not neutral tools that simply speed up efforts to locate and evaluate scientific work. Metrics transform the very things that they measure. By changing the reward structure, they alter researchers' behaviour — both how results are communicated and which topics receive the most attention.

But there is a second, more subtle, transformation that we must be alert to. The processes by which scientific merit is judged have long been central to the public perception of scientific authority. As these processes change, we must also consider the ways in which broader cultural beliefs about scientific expertise are transformed.

Broken pieces of fact

Babbage's suggestion to count authors' papers was met with various criticisms. One author did the calculation for each fellow in the Royal Society in London, and showed that this was a terrible guide to scientific eminence. Another pointed out[1] that “a far more satisfactory criterion” would have been “the value of those papers”.

Back then, scientific reputations were built not on periodicals but on books and other proofs of genius that demonstrated mastery of a subject. Babbage himself had little respect for most scientific journals, and he limited his proposal to counting papers in the venerable *Philosophical Transactions of the Royal Society of London*. As late as 1867, the British physiologist Michael Foster, in a retrospective written on the life of Karl von Baer, heaped praise on the embryologist's multivolume masterwork, *On the Development*

of Animals, and dismissed his periodical publications. These, Foster claimed[2], were just “specimens of those broken pieces of fact, which every scientific worker throws out to the world, hoping that on them, some time or other, some truth may come to land”.

Alamy

But things were beginning to change. A young engineer working for the US

Coast and Geodetic Survey (now the National Geodetic Survey) had suggested that it would be useful if some catalogue could be devised to keep track of the publications of European scientific societies. Once the idea crossed the Atlantic and percolated up to the Royal Society, its scope grew to become a list of all periodical papers containing original scientific research published since 1800. Some questioned the need to preserve so much insignificant writing. The physicist William Thomson (later Lord Kelvin) warned that the project would lead the society to financial ruin.

The main argument for what would become the *Catalogue of Scientific Papers* was that periodical publishing was a mess. Although many authors published in the journals of scientific societies, vast quantities of valuable information appeared in popular-science magazines, encyclopaedias and general-interest weeklies. Authors distributed huge numbers of offprints that sometimes did not even make clear what journal they had come from.

When the society's indexers got down to work in 1867, they realized that the situation was worse than they'd imagined. For thousands of papers, they couldn't even figure out who the author was. Many who published in periodicals chose to remain anonymous, or signed only their initials. In other cases, it was hard to tell to what extent the writer of a paper was responsible for its contents, or whether another person ought to be credited. Moreover, vast numbers of papers were published in various forms in different periodicals, and it was no easy matter deciding what should count as the same publication. Today, such publishing habits would probably lead to accusations of misconduct; not very long ago this was business as usual.

The Royal Society's cataloguers did what they could, contacting editors and authors to match names to papers. They turned a significant portion of the society's library into a bibliographic workroom, and made their job simpler by excluding all general-interest periodicals from the search, as well as anything that smacked of reading for non-specialists. They compiled lists of which periodicals ought to be included in the count, and circulated them to other experts and academies for feedback. The decision about whether to index some doubtful titles sometimes made it all the way to the society's council for a vote.

As their work progressed, the directors of the project came to realize that

their charge to produce a master list of all 'scientific papers' published since 1800 might actually influence publishing practices in the future. They hoped that authors would be more careful about where they published — or at least sign their contributions[3]. They probably did not anticipate the full consequences of what they were about to unleash.

Counting what counts

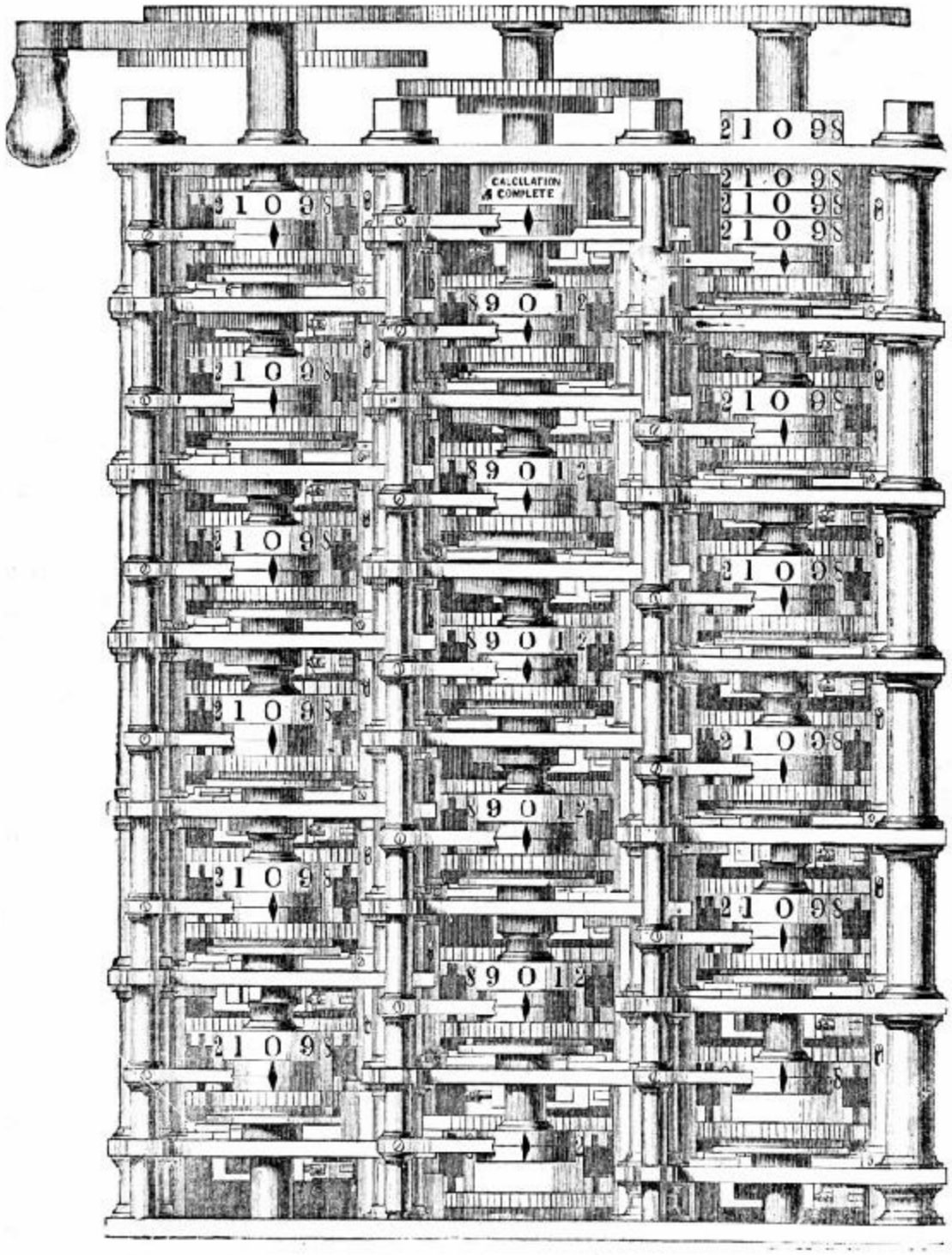
When the first volumes of the *Catalogue of Scientific Papers* appeared at the end of 1867, reaction across Europe and the United States was swift and wide-ranging. One observer wrote in awe that the catalogue made science look like a coral-island, a majestic edifice that grew imperceptibly larger with the addition of each new fact embodied in each paper. Some were less enthusiastic. One Royal Society fellow complained that the editors had distorted “the progress and history of discovery both in Physical and Natural Science” by excluding so many valuable contributions from “journals not professedly scientific”, accounts of scientific voyages, independently published treatises, encyclopaedia articles (which at the time often included original research), and much more[4].

Many observers hurried over the prospect of how helpful the catalogue would be for finding information and began comparing the productivity of individuals. By quantifying the contributions of each author, the catalogue seemed tailor-made for keeping score. A writer in *Nature* got down to business[5]: “Dr. Hooker appears for 58 papers; his late father for 72; and the late W. Hopkins, who did so much in mathematical geology, for 33 .... the indefatigable Isaac Lea, of Philadelphia, for 106, mostly about shells...”. And so forth. In a detailed review in a Viennese newspaper, the mineralogist Wilhelm von Haidinger began by urging prudence, warning that the mere comparison of numbers was no basis on which to make judgements of value[6]. But even he admitted that the numbers were somehow irresistible. Within two years, von Haidinger had taken his numerical analysis further. He published a study based on the catalogue that included a chart that compared the number of highly productive scientific authors in each region of Europe, lamenting the low position of Austria according to this ranking[7].

Such enthusiasm for counting had practical consequences. Within a decade of those first volumes appearing, the forms submitted by candidates for admission to the Royal Society transformed into long lists of papers. By the early 1870s, obituaries and biographical encyclopaedias were routinely noting the number of papers written by a researcher, and even following the chronology sketched out by those papers as guide-posts to a career. By 1900, even Foster, the physiologist once so sceptical of scientific periodicals, had changed his tune. Original science belonged in periodicals, he explained. Putting new findings in books — as Charles Darwin had famously done — was “out of place and even dangerous”[8]. To be an expert on scientific subjects meant being an author of scientific papers.

Publish or perish

There is a direct line from these developments to twentieth-century worries about scientific publishing going off the rails. A letter to *Nature* in 1932 lamented the growing practice of candidates submitting a “list of strictly technical publications” to the Royal Society, leading to the result that “our journals are filled with masses of unreadable trash” published by ambitious scholars hoping to strengthen their applications[9].



Alamy

Charles Babbage, inventor of the difference engine, was an advocate of counting papers.

This was around the same time that the phrase publish or perish began to circulate in academia. It did so first in the United States, where the spread of research universities was turning science into something resembling a profession. The slogan became shorthand for the corrupting influence of narrow, bureaucratic performance measures of research.

In the 1960s, Eugene Garfield launched a radically different search tool, known as the Science Citation Index. He hoped that it might end the harmful culture of publish or perish by showing that some papers were more cited — and hence more valuable — than others.

Immediately, commentators warned that new measures based on citations would only make things worse, leading to a “highly invidious pecking order” of journals that could distort science[10]. The journal impact factor made its public debut in 1972, soon after the US Congress called on the National Science Foundation to produce a better account of the benefits wrought by public funding of science. There is no doubt that the citation index changed practices of scientific publishing, just as the rise of counting papers had followed the introduction of the catalogue before.

Today, advocates of altmetrics argue that well-made algorithms can mimic and aggregate the everyday acts of judgement that researchers make when they read, cite, link or otherwise engage with published research. These algorithms, they claim, will turn out to be as good or better at replicating established processes — such as peer review — that are supposed to delimit what constitutes important and trustworthy research.

Whether or not these claims turn out to be true, they ignore the question of whether we deem the procedures that experts use to evaluate ideas to be intrinsically valuable (that is, independent of the content of those judgements).

Scientific judgement does not happen in a cultural vacuum. The rise of processes such as peer review to organize and evaluate research was never simply about getting scientific judgement right; it was about balancing scientists' expert cultures with public demands for accountability. The *Catalogue of Scientific Papers* was itself part of a cultural moment in which

indexes and card catalogues were celebrated for their potential to set knowledge free and even foster world peace. Interest in altmetrics has grown alongside widespread fascination with the potential of online platforms to make scientific communication both more open and more democratic.

At a time when the public status of the scientific expert is becoming increasingly uncertain, these questions are more important than ever. In a democracy, the procedures by which we decide what constitutes valuable scientific knowledge fundamentally depend on public conceptions of the aims of the scientific enterprise.

The question of whether new metrics might one day replicate the results of peer review (when it is working well) is a red herring. How we choose to judge what constitutes good science is just as important as the end results of those judgements. Even algorithms have politics.

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Further reading

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Comments

Comments

There are currently no comments.

Indian scientists urged to speak out about pseudoscience

Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.

07 November 2017

Pallava Bagla/Corbis/Getty

Scientists taking part in India's march for science in August were protesting against the spread of anti-science beliefs, superstitions and myths.

A leading Indian science-advocacy group is urging the country’s researchers to speak out against pseudoscience, which it fears has gained a foothold in the past few years, partly through support from some agencies of the Indian

government.

The call to arms, made by the non-profit Breakthrough Science Society, comes after some members of an alumni association of the prestigious Indian Institute of Science (IISc), Bangalore, planned a workshop on astrology at the IISc for 25–26 November.

Strong backlash from scientists resulted in the event being cancelled on 28 October. The society's general secretary, Soumitro Banerjee, says that it would be "detrimental to Indian science" for researchers to remain neutral on such issues. "India's scientific community must be proactive in propagating a scientific bent of mind," says Banerjee, a physicist at the Indian Institute of Science Education and Research Kolkata.

Timeline of events

Two days before the alumni association cancelled the workshop, dozens of scientists signed letters to the IISc director, Anurag Kumar, objecting to the workshop. The IISc director and the faculty were not involved in organizing the workshop.

Muthya Ravindra, a computer scientist and president of the alumni association, says that the event, organized by one of its members, was still under discussion when "due to some miscommunications", e-mails promoting the event were sent out.

But Ravindra says that despite criticism from scientists and other academics, people widely believe in astrology and seek its advice in newspapers, magazines and on television. He is unsure what role scientists should play in educating society on the dangers such practices may have. "It is very confusing to me whether we as scientists [should] criticize or take some part in finding a solution," he says.

India's ruling party, the conservative Bharatiya Janata Party (BJP) has shown support for giving astrology a place in universities. In 2001, then-science minister of the BJP-led coalition government Murli Manohar Joshi took steps to allow public universities to include astrology classes in curricula.

However, the Indian government and science ministry did not have a role in the IISc alumni association's planned astrology workshop.

Pseudoscience debate

Alarm in the Indian scientific community over anti-science policies and programmes has been brewing for some time. Several scientists who spoke with *Nature* are reluctant to comment publicly about it for fear of jeopardizing their jobs. Others took part in the March for Science organized by the 7,000-member Breakthrough Science Society in August in around 40 Indian cities, in part to protest the government's support for ideas not yet backed by science. One area of concern, says Banerjee, is the government's push for a national research programme on the health and other benefits of a combination of five cow products, known as panchgavya.

The Indian Institute of Technology (IIT), Delhi, hosted a two-day workshop last December to discuss ways to validate research on panchgavya, which was supported by India's Department of Science and Technology, Department of Biotechnology, and Council of Scientific and Industrial research (CSIR), and inaugurated by India's science minister Harsh Vardhan.

According to IIT Delhi's website, Vardhan, who is a physician, "emphasised that use of panchgavya in practice and in daily routines will help to address the pressing global issues like climate change, resistance development, malnourishment, global health etc".

Following the workshop, India's science ministry formed a national steering committee to initiate a national programme on the topic.

Supporters of this research say that cow products should be considered part of India's vast traditional knowledge base. But critics say that such unverified theories are pseudoscience, and that singling out the benefits of cow products is part of a larger political agenda by Hindus, for whom the cow is a sacred animal.

They also argue that research on topics such as panchgavya should be handled in a neutral manner rather than as a way of promoting traditional

knowledge. Rahul Siddharthan, a computation biologist at the Institute of Mathematical Sciences in Chennai, says that the government must accept that any research involving traditional hypotheses about health could potentially refute those hypotheses. “Refutability is the essence of science,” he says.

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Comments

Commenting is currently unavailable.

Pirate paper website Sci-Hub dealt another blow by US courts

American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.

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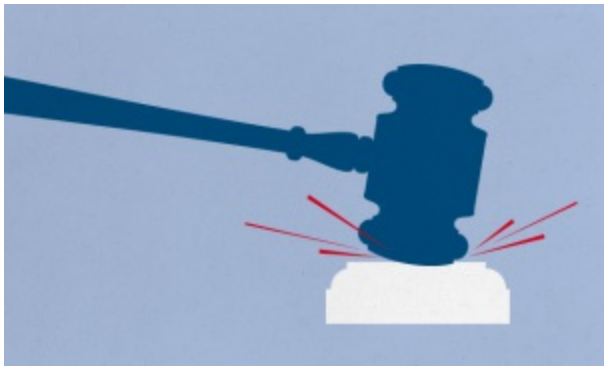
1. 08 November 2017



The American Chemical Society (ACS) has won a lawsuit against the pirate research-paper website Sci-Hub, over the site’s illicit use and dissemination of ACS articles.

On 3 November, a US court ordered Sci-Hub's operators to pay the ACS US$4.8 million in damages for copyright infringement and trademark violation. Sci-Hub’s owners did not appear in court to present their case.

The judge also ordered that any party “in active concert or participation” with Sci-Hub should “cease facilitating” access to the repository. This means that the ACS could request Internet services including web providers, search engines and domain-name registrars to stop linking or to block access to Sci-Hub and the various domains it is hosted under.

Which services might be approached by the ACS isn't yet clear: the meaning of the phrase "in active concert or participation with" is open to legal interpretation, says Michael Carroll, an information-justice and intellectual-property specialist at the American University Washington College of Law in Washington, DC.

There are no clear standards as to when an Internet service is in "active concert" with a pirate website, says Carroll. A user merely resolving a domain-name request to such a site, for example, does not yet qualify as active participation, he adds.

Such an order by a US court is exceptional, Carroll says. "In general, our federal courts do not have the power to issue orders against people or entities that were not part of the lawsuit." But he adds that US federal rules for civil procedures such as this do sometimes allow injunctions against persons who are in 'active participation' with an enjoined party. The current lawsuit is an example of that, he says.

The ruling is another legal blow for Sci-Hub, which provides free access to millions of paywalled research papers and is popular with researchers around the world. In June, a New York court granted the Dutch publisher Elsevier $15 million in damages from the site for large-scale copyright infringement.

But publishers are unlikely to see any money from Sci-Hub because its chief operator lives outside the United States. Alexandra Elbakyan, a former neuroscientist who created the portal in 2011, says the court order is an example of censorship.

The ACS, which filed its lawsuit in June in a Virginia court, said in a statement on 6 November that the ruling was "a victory for copyright law and the entire publishing enterprise". An analysis published in August estimated that as of March 2017, Sci-Hub's database contained 69% of the world's roughly 81.6 million scholarly articles — and 98.8% of the ACS's journal content.

The ACS says that it will now seek to enforce the court's order. Asked for comment, the society referred *Nature*'s news team to its statement. But Internet service providers are expected to resist what they may perceive as

undue censorship.

Attempts to stop people visiting Sci-Hub face another hurdle, too: the site has an alternative address that can be reached by users of the Tor network, a group of servers that encrypts Internet traffic and disguises its origins. No Internet provider can easily block access to such sites.

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Updates

Updated:

The story has been updated with comments from Alexandra Elbakyan.

Comments

Commenting is currently unavailable.

Genetically modified apple reaches US stores, but will consumers bite?

Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.

07 November 2017 Corrected:

1. 10 November 2017

Okanagan Specialty Fruits, Inc.

The apple on the right doesn’t bruise when dropped — it lacks a gene encoding an enzyme that causes plant cells to brown on exposure to oxygen.

This month, bags of sliced apples will hit grocery-store shelves in the midwestern United States for the first time. Shoppers who purchase the

apples can leave the slices out for snacking, because of a feat of genetic engineering that prevents their flesh from browning when exposed to air.

The ‘Arctic apple’ is one of the first foods to be given a trait intended to please consumers rather than farmers, and it joins a small number of genetically modified organisms (GMOs) to be sold as a whole product, not an ingredient. Since Okanagan Specialty Fruits in Summerland, Canada, planted its first test apples in 2003, the array of foods modified in labs has expanded to include meatless burgers, made with soya protein produced by recombinant yeast, fish fillets grown from seafood stem cells, and mushrooms whose genomes have been edited with CRISPR technology. Most of these items have not yet reached the market.

Now, many small biotechnology companies developing such foods are watching the Arctic apple’s launch, eager for clues to how consumers will perceive the fruits of their labour.

“If the apple sells, it will pave the way for others,” says Yinong Yang, a plant pathologist at Pennsylvania State University in University Park, who used CRISPR to engineer a mushroom that resists browning. He hopes one day to license his mushroom to commercial growers.

Mary Maxon, who oversees biosciences programmes at Lawrence Berkeley National Laboratory in California, agrees. “The apple is not the first GMO that people would eat, but it’s the first one that consumers may value,” she says.

When Okanagan co-founder Neal Carter bought an orchard in 1995, he thought hard about how to win over the US snack market. He found his answer in Australia, where researchers at the Commonwealth Scientific and Industrial Research Organisation had figured out how to delete a gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives.

Only later did he realize that if consumers were to be enticed to buy, Americans’ distrust of GMOs would need to be overcome. Okanagan’s subsequent surveys of people in America’s top apple-growing states — New

York and Washington — revealed that about 20% were wary of GMOs. But the company also found that many people changed their minds when told that the apples were engineered to silence browning genes, and then tested for safety.

Mike Seldon, the co-founder of Finless Foods, a firm in New York City that is developing fish fillets from fish stem cells, agrees that providing more information helps to win over consumers. “We’re not going to repeat the mistakes of the GMO industries in the past, and just put foods on the market without public conversation,” he says. “If we do, you can expect a backlash — and that’s warranted.”

Seldon sees a parallel between the Arctic apple and his fillets: both were created with attributes to please consumers. Finless Foods, which has made prototypes of bluefin-tuna fillets, hopes that people will be won over by the idea of eating fish without worrying about overfishing, animal slaughter or environmental pollution.

But others say that Okanagan hasn’t gone far enough in telling consumers how its apple was made. The company does not mention GMOs on the apples’ bags; instead, the bags have a QR code — which links to online information when it is scanned by a smartphone. “Not everyone has a smartphone, and even if you have one, are you going to check every item with it?” says Bill Freese, a science-policy analyst at the Center for Food Safety, an advocacy group in Washington DC. He wants the apples to be clearly labelled as GMOs.

Consumer reaction isn’t the only concern for developers of genetically engineered or other lab-made foods who want to sell their wares in the United States. One major stumbling block is the US regulatory process, which involves a complicated tangle of federal agencies — and, for many companies, an unclear path forward. US regulators assessed the Arctic apple for five years before approving it for sale, but spent just two years reviewing a non-browning GM potato developed by agricultural firm J. R. Simplot of Boise, Idaho.

Then there is the case of the CRISPR mushroom. The US Department of Agriculture (USDA) said in 2016 that it would not evaluate the mushroom,

which was created by using CRISPR to delete a gene. That seemed to clear the fungus's path to the market. But Yang says that, after *Nature*'s news team reported on the USDA's decision, the US Food and Drug Administration contacted him to ask whether it could review the mushroom. "I agreed to that since it would give consumers a peace of mind," he says.

As far as investors are concerned, regulatory uncertainty may be less of a barrier to the success of engineered foods than customer uncertainty. James Hardiman, a partner at the venture-capital fund Data Collective in San Francisco, California, says that companies developing such foods can always build a few extra years into their long-term plans, to account for twists in the regulatory process. "The public narrative is much more difficult to control," he says. "We know the public can be irrational."

Still, Carter is optimistic about how his Arctic apple will be received. "We rarely get e-mails saying we are Satan any more," he says of his company. "Now we have people asking where they can buy the apples."

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Corrections

Corrected:

An earlier version of this story stated that Carter took over his family's orchard.

Comments

Commenting is currently unavailable.

US government approves 'killer' mosquitoes to fight disease

US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.

06 November 2017

Dennis Kunkel Microscopy/SPL

The lab-grown mosquitoes developed by MosquitoMate seek to eliminate the disease-carrying Asian tiger mosquito (*Aedes albopictus*, shown here).

The US Environmental Protection Agency (EPA) has approved the use of a common bacterium to kill wild mosquitoes that transmit viruses such as dengue, yellow fever and Zika, *Nature*'s news team has learned.

On 3 November, the agency told biotechnology start-up MosquitoMate that it could release the bacterium *Wolbachia pipientis* into the environment as a tool against the Asian tiger mosquito (*Aedes albopictus*). Lab-reared mosquitoes will deliver the bacterium to wild mosquito populations.

The decision — which the EPA has not formally announced — allows the company, which is based in Lexington, Kentucky, to release the bacteria-infected mosquitoes in 20 US states and Washington DC.

“It’s a non-chemical way of dealing with mosquitoes, so from that perspective, you’d think it would have a lot of appeal,” says David O’Brochta, an entomologist at the University of Maryland in Rockville.“I’m glad to see it pushed forward, as I think it could be potentially really important.”

MosquitoMate will rear the *Wolbachia*-infected *A. albopictus* mosquitoes in its laboratories, and then sort males from females. Then the laboratory males, which don’t bite, will be released at treatment sites. When these males mate with wild females, which do not carry the same strain of *Wolbachia*, the resulting fertilized eggs don’t hatch because the paternal chromosomes do not form properly.

The company says that over time, as more of the *Wolbachia*-infected males are released and breed with the wild partners, the pest population of *A. albopictus* mosquitoes dwindles. Other insects, including other species of mosquito, are not harmed by the practice, says Stephen Dobson, an entomologist at the University of Kentucky in Lexington and founder of MosquitoMate.

Production challenges

The EPA restricted the release of MosquitoMate’s product, called ZAP males, to 20 states and Washington DC. The agency has previously said that those places “are similar in temperature and precipitation to areas where efficacy of the ZAP males was tested” — Kentucky, New York and California. The EPA decision excludes much of the southeastern United

States, which is home to dense populations of mosquitoes and a long mosquito season, because MosquitoMate did not conduct field trials there.

MosquitoMate plans to begin selling its mosquitoes locally, in Lexington, and will expand from there to nearby cities such as Louisville, Kentucky, and Cincinnati, Ohio. The company will work with homeowners, golf courses, hotels and other customers to deploy its insects, according to Dobson. “Now the work starts,” he says.

The company will have to start small. Suppressing the mosquito population of an entire city is likely to require the weekly production of millions of these mosquitoes. To reach that level, Dobson’s company must find a way to efficiently separate male mosquitoes from females. The company’s technicians now separate them both by hand and mechanically, Dobson says.

Another group that is also developing mosquitoes infected with *Wolbachia* to control wild populations has succeeded in producing large quantities of their insects. Researchers from Sun Yat-sen University in Guangzhou, China, and Michigan State University in East Lansing say they are releasing 5 million *Wolbachia*-infected *A. albopictus* each week in Guangzhou.

The scientists use mechanical sorters to separate males from females, on the basis of size differences at the pupal stage, at more than 99% efficiency, says Zhiyong Xi, a medical entomologist and microbiologist at Michigan State University, who leads the project. They expose the remaining mosquitoes to X-ray radiation at a dose that sterilizes any remaining females, but is too low to affect the males.

Looking ahead

Using lab-grown mosquitoes to kill mosquito pests has been tested extensively in Brazil in recent years. The country has allowed large-scale releases of such mosquitoes in response to an epidemic of the Zika virus that began in 2015. Zika is a mosquito-borne virus that has been linked to severe birth defects, such as abnormally small heads — a condition known as microcephaly. *Aedes aegypti* mosquitoes are thought to be the primary vector

for the virus.

One type of mosquito being tested in Brazil is a genetically modified variety of *A. aegypti* developed by Oxitec in Milton, UK. When the modified male mosquitoes mate with wild females, they pass a lethal gene on to any progeny.

Oxitec has run into challenges when attempting to test its GM mosquitoes in the United States, however. A community in the Florida Keys voted last year against allowing Oxitec to conduct field trials there, although the rest of the county in which the community is located voted in favour of the plans.

By contrast, MosquitoMate has developed and tested a variety of *Wolbachia*-carrying *A. aegypti* mosquitoes in the Florida Keys and Fresno, California, without drawing much public attention. The EPA received only 14 comments during the public-comment period for the Florida trials, and most of them were positive. The company plans to submit an application to the EPA for nationwide release of that species, says Dobson.

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Comments

Commenting is currently unavailable.

Language patterns reveal body's hidden response to stress

Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

06 November 2017

Carlo Allegri/Getty

Listen in: the words people say may reveal the body's biological response to threat.

Subtleties in the language people use may reveal physiological stress.

Psychologists found that tracking certain words used by volunteers in randomly collected audio clips reflected stress-related changes in their gene expression. The speech patterns predicted those physiological changes more

accurately than speakers' own ratings of their stress levels.

The research, which is published on 6 November in *Proceedings of the National Academy of Sciences*[1] suggests that changes in language may track the biological effects of stress better than how we consciously feel. It's a new approach to studying stress, says David Creswell, a psychologist at Carnegie Mellon University in Pittsburgh, Pennsylvania, and one that "holds tremendous promise" for understanding how psychological adversity affects physical health.

Adverse life circumstances — such as poverty, trauma or social isolation — can have devastating effects on health, increasing the risk of a variety of chronic disorders ranging from heart disease to dementia. Researchers trying to pin down the biological mechanisms involved have found that people who experience these circumstances also undergo broad changes in gene expression in the cells of their immune system. Genes involved in inflammation become more active, for example, and antiviral genes are turned down.

These biological changes seem to represent the body's evolutionary response to threat, says Steve Cole, a genomicist at the University of California, Los Angeles, and a co-author on the paper. But he was always troubled by a "nagging observation": they don't tally well with how stressed people say they are.

Cole wondered whether stress biology is triggered instead by an automatic assessment of threat in the brain, which doesn't necessarily reach conscious awareness. To find out, he and his colleagues teamed up with Matthias Mehl, a psychologist at the University of Arizona, Tucson, who studies how stress affects language.

Stress on speech

The researchers asked 143 adult volunteers in the United States to wear audio recorders, which switched on every few minutes for two days, capturing a total of 22,627 clips. Mehl transcribed any words spoken by the volunteers,

and analysed the language they used.

He was particularly interested in what psychologists call 'function' words, such as pronouns and adjectives. “By themselves they don’t have any meaning, but they clarify what’s going on,” says Mehl. Whereas we consciously choose 'meaning' words such as nouns and verbs, researchers believe that function words “are produced more automatically and they betray a bit more about what’s going on with the speaker”. Mehl and others have found, for example, that people’s use of function words changes when they face a personal crisis or following terrorist attacks.

The researchers compared the language used by each volunteer with the expression in their white blood cells of 50 genes known to be influenced by adversity. They found that the volunteers’ use of function words predicted gene expression significantly better than self-reports of stress, depression and anxiety.

People with more stressed-out gene-expression signatures tended to talk less overall. But they used more adverbs such as 'really' or 'incredibly'. These words may act as “emotional intensifiers”, says Mehl, signifying a higher state of arousal. They were also less likely to use third-person plural pronouns, such as 'they' or 'their'. That makes sense too, he says, because when people are under threat, they may focus less on others and the outside world.

He cautions that more research is needed to test these specific effects, and to assess whether stress influences language, or vice versa. But he suggests that the approach could ultimately help to identify people at risk of developing stress-related disease. Doctors may need to “listen beyond the content” of what patients tell them, he says, “to the way it is expressed”.

Cole suggests that assessing language use could help to test whether interventions aimed at reducing stress really work. Perhaps “you could even ditch self-report stress measures”, he says, and instead listen passively to how trial participants speak.

“Language reflects how people connect with their world, but who would ever have thought that gene expression would be related to language?” says James

Pennebaker, a psychologist at the University of Texas, Austin, who has pioneered research on language and social processes (and has previously worked with Mehl). “It’s such an exciting new way of thinking,” he adds. “I was blown away.”

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Comments

Comments

There are currently no comments.

Nature News

周六, 25 11月 2017

Nature News

[周六, 25 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Nobel laureates demand release of Iranian scholar facing death sentence** [周五, 24 11月 08:00]
  Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.
- **Zimbabwe’s researchers hope political change will revitalize science** [周五, 24 11月 08:00]
  Academics optimistic that the end of Robert Mugabe’s authoritarian rule could boost research and international collaboration.
- **AI-controlled brain implants for mood disorders tested in people** [周三, 22 11月 08:00]
  Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.
- **Lightning makes new isotopes** [周三, 22 11月 08:00]
  Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.
- **Black academics soon to outnumber white researchers in South Africa** [周二, 21 11月 08:00]
  Legacy of apartheid means academia has remained largely white.
- **Hungary rewards highly cited scientists with bonus grants** [周二, 21 11月 08:00]
  Some top researchers prosper in Hungary as country tries to improve its international standing in science.
- **European Medicines Agency to move to Amsterdam** [周一, 20 11月 08:00]
  The European Union’s drug regulatory body will leave London because of the United Kingdom’s Brexit plans.
- **How alkali flies stay dry** [周一, 20 11月 08:00]
  Waxy and hairy covering enables flies to dive underwater without getting wet.
- **UK government announces research-spending hike ahead of budget** [周一, 20 11月 08:00]
  Pledge would raise country’s public research funding to £12.5 billion in 2021–22.

- **Exoplanet hunters rethink search for alien life** [周一, 20 11月 08:00]
  Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.
- **Online software spots genetic errors in cancer papers** [周一, 20 11月 08:00]
  Tool to scrutinize research papers identifies mistakes in gene sequences.
- **Sex matters in experiments on party drug — in mice** [周五, 17 11月 08:00]
  Ketamine lifts rodents' mood only if administered by male researchers.
- **Giant telescope’s mobile-phone ‘dead zones’ rile South African residents** [周五, 17 11月 08:00]
  Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.

Nobel laureates demand release of Iranian scholar facing death sentence

Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.

24 November 2017

HAND OUT/Belga/PA Images

Iranian researcher Ahmadreza Djalali has appealed against the death sentence he received on 21 October.

Some 75 Nobel prizewinners have called on the Iranian government to release Ahmadreza Djalali, a researcher in disaster medicine who was

sentenced to death last month. The letter is the latest and most powerful protest against the ruling by the scientific community so far.

The group wrote to Gholamali Khoshroo, the Iranian ambassador to the United Nations, on 17 November, and the letter was made public on 21 November. The Nobel laureates express their concern for the conditions of Djalali's detention; they deem his trial "unfair" and "flawed", and they urge the Iranian authorities to let him return to Sweden, where he lived.

The list includes prominent names such as Harold Varmus, a former director of the US National Institutes of Health, now at the Weill Cornell Medicine institute in New York, and Andre Geim, a physicist based at the University of Manchester, UK. They wrote: "As members of a group of people and organizations who, according to the will of Alfred Nobel are deeply committed to the greatest benefit to mankind, we cannot stay silent, when the life and work of a similarly devoted researcher as Iranian disaster medicine scholar Ahmadreza Djalali is threatened by a death sentence."

Spying conviction

Djalali carried out research on emergency medicine — specifically, on the response of hospitals to terrorist attacks — while based at the University of Eastern Piedmont in Novara, Italy, and at the Karolinska Institute in Stockholm.

He was arrested in Tehran in April 2016 and accused of collaboration with a hostile government. On 21 October this year, Djalali was convicted of espionage and sentenced to death, according to Djalali's wife Vida Mehrannia and Italian diplomatic sources.

Tehran's prosecutor linked Djalali to the murder of several Iranian nuclear physicists. But a document thought to have been written by Djalali has claimed that he was sentenced after refusing to spy for Iran. Djalali's lawyer has appealed against the death sentence and is awaiting the court's decision.

Since the death sentence became public, many organisations have protested against Djalali's treatment. They include: Amnesty International, the human

rights group; senators in the Italian government; the directors of the European institutions at which Djalali worked; and academic groups including the Committee of Concerned Scientists and Scholars at Risk.

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Comments

Comments

There are currently no comments.

Zimbabwe’s researchers hope political change will revitalize science

Academics optimistic that the end of Robert Mugabe’s authoritarian rule could boost research and international collaboration.

24 November 2017

AFP/Getty

Protesters gathered at the University of Zimbabwe in Harare this week, amid political ructions that precipitated the end of Robert Mugabe's 37-year rule.

Scientists in Zimbabwe say they are hopeful that the sudden change of

political power in their country could spell a new era for its beleaguered research system. Those working in the nation hope that the shift will unlock and attract research funds from overseas, while Zimbabwean researchers abroad say that the potential for new order in their country could encourage them to return home.

The authoritarian regime of Robert Mugabe, the 93-year-old who had been president of Zimbabwe for 37 years, ended abruptly on 21 November when he resigned following military and political pressure. Emmerson Mnangagwa, the former vice-president whose firing by Mugabe this month set off the revolt, was sworn in as the country's leader this morning. Elections are expected to be organized next year.

The ructions have been widely celebrated both inside and outside Zimbabwe. The southern African country’s economy has been in free fall for almost two decades since Mugabe fast-tracked a programme of land expropriation, which destroyed investment in its agricultural sector and undermined confidence in the economy. The turmoil led millions — including scientists — to flee the country, many into neighbouring South Africa.

Research roots

Traditionally, much of the country's research has come from ties between Zimbabwe's universities and the agriculture industry, where research and development was considered central to its productivity. Major study areas included maize, land-management and veterinary research. But science became difficult as government funding for research dried up. Last year, the Zimbabwe Academy of Sciences' situation became so desperate that it implored the country’s large diaspora to support the organization.

International sanctions against Zimbabwe have also penalized the country’s students and academics, who have not been able to access international grants, scholarships or buy equipment from foreign companies prohibited from trading with Zimbabwe, says Dexter Tagwireyi, a pharmacist at the University of Zimbabwe in Harare and head of the Zimbabwe Young Academy of Science. If the incoming government has better relationships

with Western countries, such as the United Kingdom and the United States, it could mean that researchers are able to access new sources of funds, he says.

At his inauguration, Mnangagwa said that Zimbabwe was ready to engage with other countries and urged the international community to reconsider their economic embargoes. The African Union, a continental group of nations including Zimbabwe, has been pushing science, technology and innovation as a way for African countries to achieve economic and social development.

The promise of a more democratic government could also attract researchers who have left to return and swell the country's academic ranks. "This change of leader interests me to go back and serve in Zimbabwe as an academic," says a Zimbabwean researcher at the University of Johannesburg in South Africa, who asked to remain anonymous because he was concerned about what his employer might think. The prospect of order in his home country would tempt him to return "at the speed of light", he says, in part because Zimbabwe is not as crime-ridden as South Africa. The sentiment was echoed by several other early-career Zimbabwean scientists in South Africa contacted by *Nature*.

Zimbabwe does not keep official figures on academics, but a 2012 report by the United Nations Educational, Scientific and Cultural Organization said that 1,300 researchers were working there at the time. And despite chronic underfunding, Zimbabwe has consistently produced around 400 peer-reviewed papers a year. (By comparison, South Africa produced 17,246 research publications in 2015.)

"I just hope the new regime will resuscitate the economy and generate significant research funding for higher-education institutions," says Rudo Gaidzanwa, a sociologist at the University of Zimbabwe. "That would boost the research output of academics in state universities."

Key collaborator

South Africa, with its comparatively strong research system, is a major destination for students from around Africa, and a key collaborator for

Zimbabwean scientists. A Web of Science search shows that since 2013, roughly one-third of 1,689 research articles authored by Zimbabwe-affiliated researchers had a collaborator who was based in South Africa.

A strengthened science system in Zimbabwe would benefit the entire region, open the door to greater collaboration and offer a destination for students trained in South Africa, says Valerie Mizrahi, director of the Institute of Infectious Disease and Molecular Medicine at the University of Cape Town in South Africa.

South Africa takes scholars from across the continent, and in many cases the idea of them going home is a pipe dream, because there is often not much to go back to, Mizrahi says. “Zimbabwe has a chance to change that.” Mizrahi, who was born in Zimbabwe but has lived in South Africa for decades, says that the situation is reminiscent of South Africa when apartheid was being dismantled in the 1990s and sanctions were lifted. “Funding flowed into the country,” she says.

Despite the celebrations in Zimbabwe, there are concerns that Mnangagwa’s presidency will not bring enough change. The new leader was a close associate of Mugabe and served in various positions in his government, which was characterized by nepotism and the silencing of opposition voices. “So we are not sure whether they will do things differently or all they wanted was just power to also suppress citizens and loot resources in the country," says Farayi Moyana, a PhD candidate at South Africa's University of the Witwatersrand who is based in Zimbabwe.

The uncertainty means that academics aren't making plans just yet: “There is no hurry to return home,” says a Zimbabwean scientist at Witwatersrand in Johannesburg, who also spoke on the condition of anonymity. Rather, he says, he will let the situation stabilize before making any decisions.

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Comments

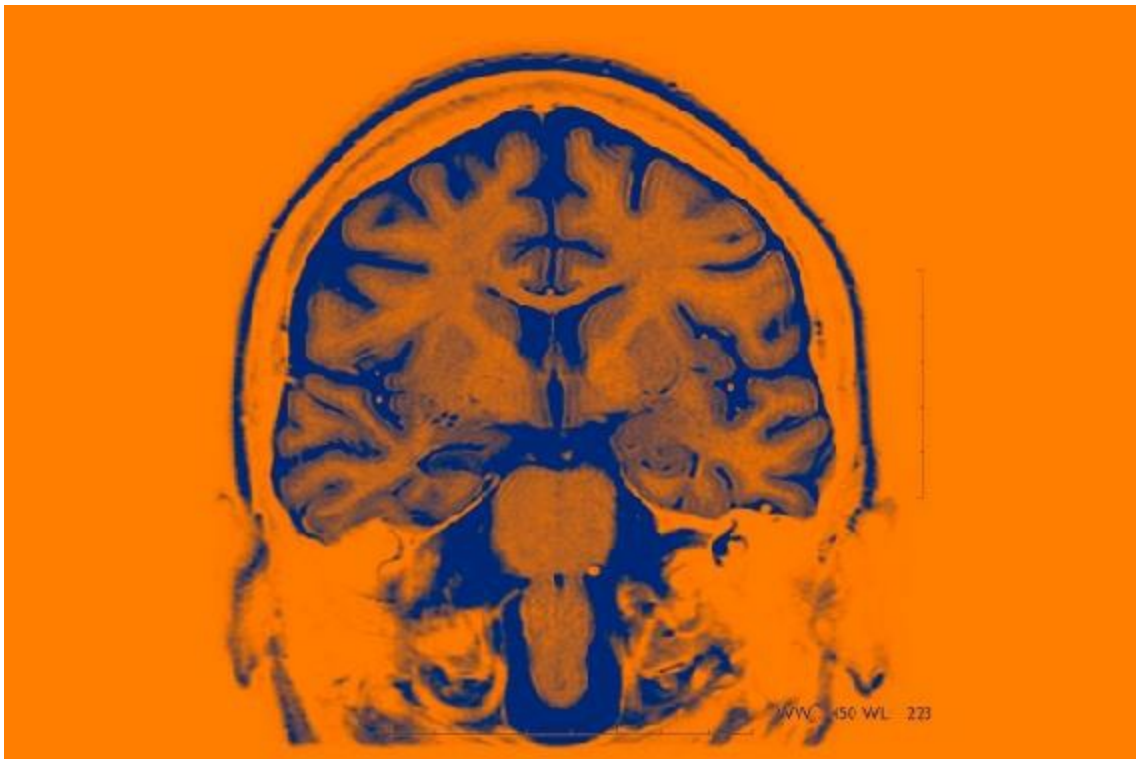
Comments

There are currently no comments.

AI-controlled brain implants for mood disorders tested in people

Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.

22 November 2017



BSIP/UIG/Getty

Brain implants that deliver electrical pulses tuned to a person’s feelings and behaviour are being tested in people for the first time. Two teams funded by the US military’s research arm, the Defense Advanced Research Projects Agency (DARPA), have begun preliminary trials of ‘closed-loop’ brain implants that use algorithms to detect patterns associated with mood disorders. These devices can shock the brain back to a healthy state without

input from a physician.

The work, presented last week at the Society for Neuroscience (SfN) meeting in Washington DC, could eventually provide a way to treat severe mental illnesses that resist current therapies. It also raises thorny ethical concerns, not least because the technique could give researchers a degree of access to a person's inner feelings in real time.

The general approach — using a brain implant to deliver electric pulses that alter neural activity — is known as deep-brain stimulation. It is used to treat movement disorders such as Parkinson's disease, but has been less successful when tested against mood disorders. Early evidence suggested that constant stimulation of certain brain regions could ease chronic depression, but a major study involving 90 people with depression found no improvement after a year of treatment.[1]

The scientists behind the DARPA-funded projects say that their work might succeed where earlier attempts failed, because they have designed their brain implants specifically to treat mental illness — and to switch on only when needed. "We've learned a lot about the limitations of our current technology," says Edward Chang, a neuroscientist at the University of California, San Francisco (UCSF), who is leading one of the projects.

DARPA is supporting Chang's group and another at Massachusetts General Hospital (MGH) in Boston, with the eventual goal of treating soldiers and veterans who have depression and post-traumatic stress disorder. Each team hopes to create a system of implanted electrodes to track activity across the brain as they stimulate the organ.

The groups are developing their technologies in experiments with people with epilepsy who already have electrodes implanted in their brains to track their seizures. The researchers can use these electrodes to record what happens as they stimulate the brain intermittently — rather than constantly, as with older implants.

Mood map

At the SfN meeting, electrical engineer Omid Sani of the University of Southern California in Los Angeles — who is working with Chang's team — showed the first map of how mood is encoded in the brain over time. He and his colleagues worked with six people with epilepsy who had implanted electrodes, tracking their brain activity and moods in detail over the course of one to three weeks. By comparing the two types of information, the researchers could create an algorithm to 'decode' that person's changing moods from their brain activity. Some broad patterns emerged, particularly in brain areas that have previously been associated with mood.

Chang and his team are ready to test their new single closed-loop system in a person as soon as they find an appropriate volunteer, Sani says. Chang adds that the group has already tested some closed-loop stimulation in people, but he declined to provide details because the work is preliminary.

The MGH team is taking a different approach. Rather than detecting a particular mood or mental illness, they want to map the brain activity associated with behaviours that are present in multiple disorders — such as difficulties with concentration and empathy. At the SfN meeting, they reported on tests of algorithms they developed to stimulate the brain when a person is distracted from a set task, such as matching images of numbers or identifying emotions on faces.

The researchers found that delivering electrical pulses to areas of the brain involved in decision-making and emotion significantly improved the performance of test participants. The team also mapped the brain activity that occurred when a person began failing or slowing at a set task because they were forgetful or distracted, and found they were able to reverse it with stimulation. They are now beginning to test algorithms that use specific patterns of brain activity as a trigger to automatically stimulate the brain.

Personalized treatment

Wayne Goodman, a psychiatrist at Baylor College of Medicine in Houston, Texas, hopes that closed-loop stimulation will prove a better long-term treatment for mood disorders than previous attempts at deep-brain stimulation

— partly because the latest generation of algorithms is more personalized and based on physiological signals, rather than a doctor's judgement. “You have to do a lot of tuning to get it right,” says Goodman, who is about to launch a small trial of closed-loop stimulation to treat obsessive–compulsive disorder.

One challenge with stimulating areas of the brain associated with mood, he says, is the possibility of overcorrecting emotions to create extreme happiness that overwhelms all other feelings. Other ethical considerations arise from the fact that the algorithms used in closed-loop stimulation can tell the researchers about the person’s mood, beyond what may be visible from behaviour or facial expressions. While researchers won't be able to read people's minds, “we will have access to activity that encodes their feelings,” says Alik Widge, a neuroengineer and psychiatrist at Harvard University in Cambridge, Massachusetts, and engineering director of the MGH team. Like Chang and Goodman’s teams, Widge’s group is working with neuroethicists to address the complex ethical concerns surrounding its work.

Still, Chang says, the stimulation technologies that his team and others are developing are only a first step towards better treatment for mood disorders. He predicts that data from trials of brain implants could help researchers to develop non-invasive therapies for mental illnesses that stimulate the brain through the skull. “The exciting thing about these technologies,” he says, “is that for the first time we’re going to have a window on the brain where we know what’s happening in the brain when someone relapses.”

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Comments

Comments

There are currently no comments.

Lightning makes new isotopes

Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.

22 November 2017

Magalie L’Abbé/Getty

A lightning storm illuminates clouds over Kagoshima, Japan.

A streak of lightning in the skies over Japan has generated positrons — the antimatter equivalents of electrons — and radioactive carbon-14, confirming a theoretical prediction, according to a paper published in *Nature* on 22 November[1].

Since the 1990s, orbiting observatories designed to observe the heavens have

also detected flashes of γ-rays coming from Earth, which were thought to have their origins in atmospheric phenomena. To investigate this theory, Teruaki Enoto, an astrophysicist at Kyoto University in Japan, and his collaborators set up an array of γ-ray detectors close to the Kashiwazaki-Kariwa nuclear power plant. Winter thunderstorms in Japan are famous for their spectacular lightning, he says, and the low clouds make these relatively easy to observe.

On 6 February, the detectors sensed an unusual event. A double lightning bolt just off the coast shot out an initial, one-millisecond spike of γ-rays, with relatively high energies of up to 10 megaelectronvolts. This was followed by a γ-ray afterglow of less than half a second. Then there was a telltale signal — γ-rays concentrated at 511 kiloelectronvolts of energy, which lasted for about a minute. Physicists say this is the unmistakable signature of positrons annihilating in a puff of energy as they hit electrons in the surrounding matter.

Together, the three waves of γ-rays point to a photonuclear reaction first proposed[2] a decade ago by Leonid Babich, a physicist at the Russian Federal Nuclear Center in Sarov. Lightning can accelerate some electrons to almost the speed of light, and the electrons can then produce γ-rays. Babich proposed that when one of these γ-rays hits the nucleus of a nitrogen atom in the atmosphere, the collision can dislodge a neutron. After briefly bouncing around, most of the neutrons get absorbed by another nitrogen nucleus. This adds energy to the receiving nucleus and puts it in an excited state. As the receiving nucleus relaxes to its original state, it emits another γ-ray — contributing to the giveaway γ-ray glow.

Meanwhile, the nitrogen nucleus that has lost one neutron is extremely unstable. It decays radioactively over the next minute or so; in so doing, it emits a positron, which almost immediately annihilates with an electron, producing two 511-keV photons. This was the third signal, Enoto says. He suspects that his detectors were able to see it only because the briefly radioactive cloud was low, and moving towards the detectors. This combination of circumstances might help to explain why the photonuclear signature has been seen so rarely. Enoto says that his team has observed a few similar events, but that the one described in the paper is the only clear-

cut event so far.

Babich also predicted that not all of the neutrons dislodged from nitrogen by a γ-ray are absorbed. Some of them instead will trigger the transmutation of another nitrogen nucleus into carbon-14, a radioactive isotope that has two more neutrons than ordinary carbon. This isotope can be absorbed by organisms; it then decays at a predictable rate long after the organism's death, which makes it a useful clock for archaeologists.

The main source of the carbon-14 in the atmosphere has generally been considered to be cosmic rays. In principle, lightning could also contribute to the supply. But it is not clear yet how much of the isotope is produced in this way, says Enoto, in part because it's possible that not all bolts initiate photonuclear reactions.

"I agree with their interpretation of their data," says physicist Joseph Dwyer of the University of New Hampshire in Durham. But, he adds, Enoto's team's explanation does not solve all puzzles related to positrons in the atmosphere. In particular, the photonuclear reaction does not seem to match an event Dwyer observed in 2009 from a research aeroplane. His detector spotted a signature of positrons only for a fraction of a second — too short to originate from nuclear decay, he says. Also, his detector saw no initial flash in that case. "If it was there, it should have been very obvious."

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Comments

Commenting is currently unavailable.

Black academics soon to outnumber white researchers in South Africa

Legacy of apartheid means academia has remained largely white.

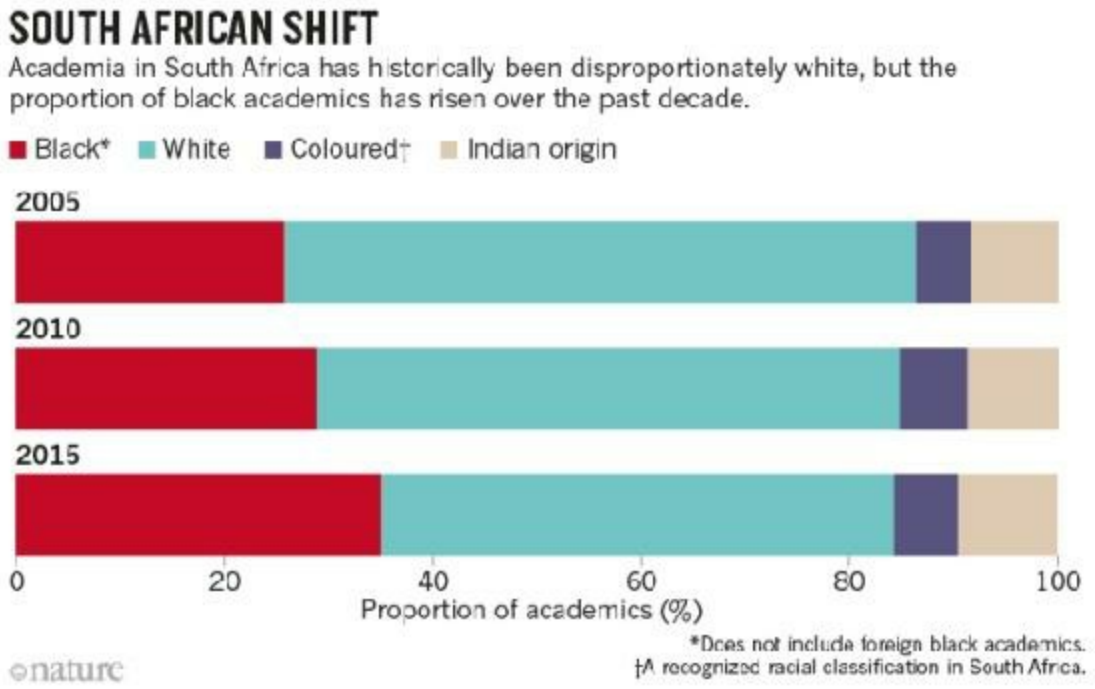
21 November 2017

There will soon be more black academics in South Africa than white ones, a study of demographic data suggests.

Although more than 80% of the country's population is black, its academic sector has remained disproportionately white — a legacy of the apartheid era.

But over the past decade, the proportion of black South African researchers has risen steadily: from 26% in 2005 to 35% in 2015, according to the study, which was published[1] in *Higher Education* last month. The proportion of white academics decreased by more than 10 percentage points over the same period, to 49% in 2015 (see 'South African shift').

"Our research shows that transformation is taking place and there are strong indications that it will accelerate in the future, particularly in the next decade," says David Hedding, a geomorphologist at the University of South Africa in Florida, Johannesburg, and co-author of the paper.



The authors suggest that in the next decade, more than 4,000 researchers — about 27% of the country's academics, and most of them white men — will retire, which should create opportunities for younger researchers. Black researchers could outnumber white ones some time between 2020 and 2025, they say.

Hedding says that it's not possible to attribute the change to a specific policy, but that the government should keep doing what it is currently doing. However, he thinks the country should focus more on nurturing PhD candidates and enticing them into academia. He and his co-author, geoinformatics specialist Greg Breetzke at the University of Pretoria, also note that black women, the country's largest demographic, remain significantly under-represented in universities, accounting for just 14% of academics in 2015.

Charles Sheppard, director of management information at Nelson Mandela University in Port Elizabeth, agrees that South Africa must focus on generating local PhDs. At the moment, it produces more doctorate-holders who hail from other African countries than from the home nation, he says. "We need to work harder on getting this right," he adds.

The latest study is the most well thought out, most evidenced-based and least anecdotal to address this complex problem yet, says Zeblon Vilakazi, deputy vice-chancellor at the University of the Witwatersrand in Johannesburg. “This is a step in the right direction,” says Vilakazi.

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Comments

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Hungary rewards highly cited scientists with bonus grants

Some top researchers prosper in Hungary as country tries to improve its international standing in science.

21 November 2017

Richard Wareham Fotografie/Alamy

Hungarian commissioner for research and innovation József Pálinkás has designed grants that reward research excellence.

Earlier this year, cell biologist Attila Reményi was facing his toughest decision since returning to his native Hungary a decade ago. With his

generous start-up funding about to run out, should he downsize his lab?

Then, in June, the government's National Research, Development and Innovation Office (NRDNI) put out a call for five-year basic-research grants of up to 300 million Hungarian forints (US$1.18 million) each for highly cited scientists such as Reményi. "It came out of the blue," says Reményi at the Hungarian Academy of Sciences (HAS) Research Centre for Natural Sciences, Budapest, who learnt on 13 November that he was among 12 winners.

But for NRDNI president József Pálinkás, the Frontline Research Excellence grants are the result of years of work. They are part of a plan to create a long-term, systematic plan of grants and rewards to encourage researchers in all fields to strive for world-class publications and to tempt Hungarian scientists working abroad to return. In a country whose leaders are coming under increasing criticism for autocratic and xenophobic tendencies, scientists say that the situation for science has never been rosier.

Under Viktor Orbán's nationalist government, this small, post-communist country has been steadily falling on *The Economist* magazine's Democracy Index. Last year, several foreign members of the HAS resigned, citing the failure of the academy to protest against what they saw as anti-democratic moves by the government. HAS president, mathematician László Lovász, responded that the academy is not a political organization. Scientists in the country are noticeably reluctant to comment publicly on politics, and several young researchers told *Nature* they fear that criticizing the government might compromise their careers.

Yet within this troubled political environment, Pálinkás, a physicist, has spent the past few years quietly persuading the government that basic science matters as much as product-focused research. Shortly after becoming president of the HAS in 2008, he created the Momentum system of start-up funding — one-time, five-year grants of up to 50 million forints per year — to encourage Hungarian scientists to set up independent labs back home. Reményi was a Momentum recipient in 2013.

In 2015, Pálinkás left HAS to become the founding director of the NRDNI, where he designed a system of regular grants to help ensure that returnees

stay after the start-up money runs out. The frontline grants are a key part of this, giving the recipients salaries equivalent to the European Union average, which is two-and-a-half times higher than the salary that a scientist would normally earn in Hungary. Around 50 of these grants will eventually run each year. The programme is modelled on European Research Council grants, but with a twist: only those who have published a paper in the past five years that counted among the top 10% most-cited papers in their discipline are eligible to apply. This approach “creates a lot of tension in the community, but without such serious selection science won’t work well,” says Pálinkás. To further encourage scientists to aim for quality over quantity, last year he introduced another reward for high-impact publication: researchers who within two years have a paper among the top 5% most highly cited in their field automatically receive a one-off payment of 20 million forints.

Hungary has a long tradition of research and outperforms other former communist countries in the EU on many measures. It has won more European Research Council grants and was the only country this year to win two Teaming grants: prestigious EU awards to create centres of excellence in 15 mostly eastern European countries in partnership with a western European research organization. It has also made some large investments, most generously in the Hungarian Brain Research Programme, launched in 2014, which has received 18.5 million forints up to 2021 and enabled many principal investigators to start their own labs. A 3-billion-forints programme has just been agreed in quantum technology. Five new programmes in areas including artificial intelligence and water research will be added next year, thanks to a 3% increase in the NRDNI budget, agreed in principle this month.

Hungary’s research performance still lags behind that of science-strong western European countries, however, and at 1.2% of gross domestic product, its research investment is well below the EU average of 2%. To support its scientific ambitions, Hungary has heavily invested its EU structural funds — subsidies to poorer regions — in expanding research infrastructure. The country’s scientists fear that when the current round of these funds runs out in 2019, these major investments may go to waste.

Pálinkás says that to avoid this, he will request a doubling of the national research budget in 2019. And despite the political challenges, Hungarian

scientists seem optimistic: “The situation for science is better than it has been before,” says Reményi. Immunologist Adam Dénes returned from the United Kingdom in 2012 to start his own lab at the HAS Institute of Experimental Medicine in Budapest, a move he describes as a “political, philosophical and career challenge”. But for now, he says, “the pluses are more than the minuses.”

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Comments

Comments

There are currently no comments.

European Medicines Agency to move to Amsterdam

The European Union’s drug regulatory body will leave London because of the United Kingdom’s Brexit plans.

20 November 2017

Aurore Belot/AFP/Getty

A man crosses a canal in Amsterdam.

After more than a year of uncertainty, the new home of the European Medicines Agency (EMA) is finally clear. The European Union member states chose Amsterdam from among 19 candidates, after a secret ballot on 20 November.

The transition is expected to be relatively smooth because more than 80% of staff indicated in a survey earlier this year that they would be prepared to relocate to Amsterdam with the agency.

Slovakian capital Bratislava had also been a hot favourite among commentators, most particularly because Slovakia does not yet host any EU agency. However, only 14% of the staff said they would be prepared to go there. In an interview with *Nature* last month, EMA executive director Guido Rasi said that a catastrophic loss of staff on such a scale might have crippled the agency.

The EMA, with its 900 or so employees, is responsible for determining the safety and efficacy of therapies and licensing them for marketing in the EU. It also monitors adverse reactions to marketed treatments. And it has been fundamental to the development of harmonized EU-wide regulations on 'advanced therapies' for serious diseases such as cancer — including treatments involving biological molecules, stem cells or cells that have been genetically manipulated.

In an analysis of the various bids in September, the EMA said that any transfer could result in delays to the approval of new medicines and a slowing down of some public-health initiatives such as those to tackle antimicrobial resistance. But full recovery could be expected in two to three years, it said.

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Comments

Comments

There are currently no comments.

How alkali flies stay dry

Waxy and hairy covering enables flies to dive underwater without getting wet.

20 November 2017

Floris van Breugel/Caltech

More than 150 years ago, American writer Mark Twain described how flies enter Mono Lake in California then “pop up to the surface as dry as a patent office report”. Now scientists have identified how they do so.

The alkali fly *Ephydra hians* can crawl down the side of the lake to depths of 8 metres and remain submerged for 15 minutes before emerging unscathed. Not only can it achieve this unusual feat, it does so in a lake whose waters are so alkaline and so salty that they support only algae, bacteria and brine

shrimps.

Diving bubble

Now two biologists at the California Institute of Technology in Pasadena have worked out how the fly creates the bubble of air that surrounds it during the dive. Floris van Breugel and Michael Dickinson filmed flies entering a solution that mimics the sodium-carbonate-rich conditions of the lake. The flies are covered in hairs that are coated in a waxy substance that repels water. As they enter the water, an air bubble forms around their entire bodies, apart from their eyes. Not only is this bubble protective, it also provides the flies with breathable oxygen.

The scientists found that the flies had a denser coat of hairs than other species that were unable to stay dry underwater. They also found that the waxy substance that coats these hairs contained smaller hydrocarbons than those of other species. They think that these two traits combine to help prevent *E. hians* from getting wet, in particular as it emerges to the surface through the negatively electrically charged air-water interface created by the conditions in the lake. The researchers report their findings in the *Proceedings of the National Academy of Sciences*[1].

There are other shore flies of the same family (Ephydridae) that crawl underwater to lay eggs, but not in such hostile conditions, says van Breugel. He hopes to compare alkali flies from different lakes around the world.

During the annual autumn migration, there can be as many as 2 million birds at Mono Lake at any given time, says van Breugel, and the flies are an important source of food. “This story is a beautiful example of how tiny interactions can have global ecological effects, because Mono Lake is such an important habitat for migratory birds,” he says.

“Van Breugel and Dickinson's paper not only provides an insightful and detailed explanation of underlying mechanisms for this behaviour, it is also an elegant bit of insect natural history,” says Stephen Marshall, an entomologist at the University of Guelph in Canada.

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Comments

Comments

There are currently no comments.

UK government announces research-spending hike ahead of budget

Pledge would raise country’s public research funding to £12.5 billion in 2021–22.

20 November 2017

The UK government seems to be making good on its promises to increase research spending significantly over the next decade.

In an announcement on 20 November, the government said that it would boost public spending on research and development (R&D;) to £12.5 billion (US$16.5 billion) in 2021–22, an increase of £500 million on what is planned for the year before. The hike builds on a surprise announcement made last year, when politicians promised yearly increases in research funding until 2020.

According to the London-based Campaign for Science and Engineering (CASE), the increase puts the United Kingdom on track to hit a government target to raise combined public and private spending on R&D; to 2.4% of gross domestic product (GDP) by 2027.

That would be a huge uptick in spending for Britain: the most recent figures show that the country spent just 1.7% of its GDP on R&D; in 2015, compared with 2.9% in Germany and 2.8% in the United States.

Hitting the target will also require private investment in R&D; to rise, and some researchers had wondered whether the United Kingdom would rely on private spending to boost its budget past 2020. But writing in the *Times* newspaper to accompany the announcement — which came two days before

the release of Britain's annual budget — Prime Minister Theresa May confirmed that the government planned to increase its public spending on R&D; year on year.

"This gives confidence that the government's plan is to keep rising public R&D; investment on target over the next ten years to reach parity with our international competitors," said Sarah Main, director of CASE. "We seem to have turned a corner. Government is matching its long-term ambition with concrete investment."

The latest money forms part of the government's Industrial Strategy, a range of policies aimed at boosting the economy across the country. Full details of the strategy will be published on 27 November, but May added in her article that it would include ways to encourage UK leadership in artificial intelligence, big data, clean energy and self-driving cars.

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Comments

Comments

There are currently no comments.

Exoplanet hunters rethink search for alien life

Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.

20 November 2017 Corrected:

1. 20 November 2017

Laramie, Wyoming

M. Kornmesser/ESO

The exoplanet Ross 128b orbits a cool dwarf star at a distance that could allov the world to have liquid water.

Steve Desch can see the future of exoplanet research, and it's not pretty. Imagine, he says, that astronomers use NASA's upcoming James Webb Space Telescope to scour the atmosphere of an Earth-mass world for signs of life. Then imagine that they chase hints of atmospheric oxygen for years — before realizing that those were false positives produced by geological activity instead of living things.

Desch, an astrophysicist at Arizona State University in Tempe, and other planet hunters met from 13-17 November in Laramie, Wyoming, to plot better ways to scout for life beyond Earth. Many are starting to argue that the standard definition of habitability — having liquid water on a planet's surface — is not the factor that should guide exoplanet exploration. Instead, the scientists say, the field should focus on the chances of detecting alien life, should it exist.

"Planets can be habitable and not have life with any impact," Desch told researchers at the meeting.

It turns out that water worlds may be some of the worst places to look for living things. One study presented at the meeting shows how a planet covered in oceans could be starved of phosphorus, a nutrient without which earthly life cannot thrive. Other work concludes that a planet swamped in even deeper water would be geologically dead, lacking any of the planetary processes that nurture life on Earth.

"Habitability is not only about finding the signature of an alien life form taking a deep breath," says Elizabeth Tasker, an astronomer and exoplanet researcher at the Japan Aerospace Exploration Agency's Institute for Space and Aeronautical Sciences in Sagamihara. It's also about how a planet's geology and chemistry interconnect to create a welcoming or hostile environment, she says — complicating the search for extraterrestrial life.

Surf and turf

Astronomers have catalogued thousands of exoplanets, of which more than a dozen are potentially habitable. The most recent, announced on 15

November, is Ross 128b, which is 3.4 parsecs (11 light years) away from Earth. It resembles the target that scientists have spent decades hunting: an Earth-sized planet orbiting a nearby star, probably at the right distance to allow liquid water.

Most of these planets have some qualities that stop them from being true Earth twins. Ross 128b orbits a cool dwarf star rather than a Sun-like host, for instance. But Tasker says the usual metrics that scientists use to rank how habitable a world is, such as its location relative to its star or how closely it resembles Earth, are misguided[1].

To figure out how to parcel out valuable observing time, some scientists suggest targeting planets that, like Earth, are thought to have a mix of ocean and land. That's because worlds with nothing but water on their surfaces may not have key nutrients available in forms that can support life — if it is based on the same chemistry as life on Earth.

“We have this stereotype that if we have oceans, we have life,” says Tessa Fisher, a microbial ecologist at Arizona State. But her recent work contradicts this idea. Fisher and her colleagues studied what would happen on an “aqua planet” with a surface that is almost or completely covered by enough water to fill Earth’s oceans five times.

On Earth, rainwater hitting rocks washes phosphorus and other nutrients into the oceans. But without any exposed land, there is no way for phosphorus to enrich water on an aqua planet over time, Fisher reported at the Laramie meeting. There would be no ocean organisms, such as plankton, to build up oxygen in the planet’s atmosphere, she says — making this type of world a terrible place to find life.

Wet blanket

The wettest planets would run into a different sort of trouble, says Cayman Unterborn, a geologist at Arizona State who analysed the planet-wide effects of having as much as 50 Earth oceans’ worth of water. The sheer weight of all that liquid would exert so much pressure on the sea floor that the planet’s

interior would not melt at all, Unterborn found.

Planets need at least some internal melting to sustain geological activity, such as plate tectonics, and to provide the right geochemical environment for life. In this case, Unterborn says, “too much water is too much of a good thing.”

Water-rich worlds are easy to make. Many planets are likely to have formed far from their parent star, Tasker says, in chilly temperatures where they could have coalesced from fragments of rock and lots of ice. If such a planet later migrated closer to its star, the ice would melt and cover the surface in vast oceans. Some of the seven small planets orbiting the star TRAPPIST-1, which is 12.6 parsecs (41 light years) from Earth, are thought to have substantial water on their surfaces[2].

Instead of instinctively studying such water worlds, Tasker says, astronomers need to think more deeply about how planets have evolved through time. “We need to look carefully at picking the right planet,” she says.

The James Webb Space Telescope is set to launch in 2019. Once in space, the telescope will spend much of its time studying potentially Earth-like worlds. Researchers have already begun to analyse how oxygen, methane or other ‘biosignature’ gases in exoplanet atmospheres might appear to the telescope’s view[3].

Towards the end of the Laramie meeting, attendees voted on whether scientists will find evidence of life on an exoplanet by 2040. They were not optimistic: 47 said no and 29 said yes. But a greater share was willing to bet that life would be found on another world in the 2050s or 2060s.

That's presumably enough time to work through the debate over which worlds are the best to target.

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Corrections

Corrected:

This story misstated the outcome of the vote at the Laramie meeting as 47% no to 29% yes. In fact, the result was 47 votes yes, 29 votes no.

Comments

Commenting is currently unavailable.

Online software spots genetic errors in cancer papers

Tool to scrutinize research papers identifies mistakes in gene sequences.

20 November 2017

Two scientists have rolled out a program that spots incorrect gene sequences reported in experiments — and have used it to identify flaws in more than 60 papers, almost all of them studies of cancer.

Jennifer Byrne, a cancer researcher at the Kids Research Institute of the Children's Hospital at Westmead in Sydney, Australia, and Cyril Labbé, a computer scientist at the University of Grenoble Alpes in Grenoble, France, made public an early version of the program, called Seek & Blastn, in October and now they want other researchers to test the program and help to improve it. They then plan to offer it to journal editors and publishers as an addition to the tools that most already use to check papers, such as software

to detect plagiarism.

Byrne has been working on identifying errors in human cancer papers since 2015, when she noticed problems with five papers on gene function in cancer cells. The authors of the papers described performing a common experiment in which they inactivated a gene using a short targeted nucleotide sequence, to observe its effects on tumour cells. Byrne was familiar with the gene because she was part of the team that reported it in 1998. And she realized that the papers reported using the wrong nucleotide sequences for the experiment they claimed to conduct. Two of these papers have since been retracted. Another two are expected to be retracted on 21 November.

Experimental errors

After noticing similar errors in another 25 papers, Byrne and Labbé developed the Seek & Blastn tool to discover more papers with incorrectly identified nucleotide fragments. The software extracts nucleotide sequences from uploaded papers and cross-checks them against a public database of nucleotides, called the Nucleotide Basic Local Alignment Search Tool (Blastn).

“Seek & Blastn tries to find mismatches between the claimed status of a sequence — what the paper says it does — and what the sequence actually is,” says Byrne. A mismatch is flagged, for instance, when a sequence described as targeting a human gene doesn’t find a match in the Blastn database. Sequences described as non-targeting that do have a match in the Blastn database are also detected.

So far, the program detects only misidentified human sequences, says Labbé, but the pair hope to develop it to check sequences from other species, such as mice. The program also struggles to pick up misidentified sequences if the description is unclear in the original paper. This can cause the program to miss some mistakes and to flag papers that have no errors, so all papers put through the software should also be checked manually, he says.

The pair say that they used Seek & Blastn to detect mismatched sequences in

another 60 papers. Many of these manuscripts have other problems, such as poor-quality images, graphs and large chunks of overlapping text, all of which make some of the papers “strikingly similar” to each other, says Byrne. With the help of colleagues, they are now manually checking the papers.

Although some errors are minor or accidental, Byrne says the majority of the mismatches they have detected in papers may invalidate the results and conclusions. When you see these incorrectly identified sequences, she says, “you do get concerned about how the results were produced and whether the results in the paper actually reflect the experiments that were done”.

In a 2016 study[1] in *Scientometrics*, Byrne and Labbé reported 48 problematic papers, including the 30 papers that had incorrectly identified nucleotide fragments. These were all written by authors from China. The duo did not publicly identify the papers, apart from the five papers from 2015, but privately contacted journal editors, Byrne says. Many of the editors have not responded, she says. But three more papers have been retracted. In total, the pair have identified incorrect sequences in more than 90 papers.

Automated tools such as Seek & Blastn are most valuable if they are used to promote good scientific practice and encourage scientists to avoid errors in the first place, rather than just catch people out, says statistician David Allison at Indiana University in Bloomington, who has spotted many papers with substantial errors. Such tools could also help to quantify error rates in particular journals and fields, he says.

Matt Hodgkinson, head of research integrity for open-access publisher Hindawi in London, which retracted two of the papers from its journal *BioMed Research International*, says he could see publishers using Seek & Blastn as part of the article-screening process. “It would depend on the cost and ease of use, whether it can be used and interpreted at scale,” says Hodgkinson. Staff or academic editors would also need to check the output, given the risk for false positives, he says.

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Comments

Commenting is currently unavailable.

Sex matters in experiments on party drug — in mice

Ketamine lifts rodents' mood only if administered by male researchers.

17 November 2017

unoL/Getty

When it comes to lab mice and antidepressants, it's complicated.

Mouse experiments with the popular club drug ketamine may be skewed by the sex of the researcher performing them, a study suggests.

The findings, presented on 14 November at the Society for Neuroscience (SfN) meeting in Washington DC, only deepen the mystery of how ketamine,

which has powerful mood-lifting properties, interacts with the brain. They also raise questions about the reproducibility of behavioural experiments in mice.

Ketamine is best known as a psychoactive recreational drug. But it has caught psychiatrists' interest because of its potential to treat depression within hours. It's unclear exactly how the drug works, however, and many researchers are using animal models to suss out the mechanism.

Polymnia Georgiou, a neuroscientist at the University of Maryland in Baltimore, is one of them. In 2015, a male colleague asked her to run some experiments for him while he was out of town, including a standard way of testing antidepressants called the forced-swim test. In this assay, researchers inject healthy mice with a drug, place them into a tank of water and measure how long they swim before they give up and wait for someone to rescue them.

Antidepressants can cause healthy mice to swim for longer than their untreated counterparts, which is what Georgiou's male colleague found during his experiments using ketamine.

Scents and the brain

But although Georgiou followed his protocol exactly, she found that treated mice did not swim for any longer than mice injected with a placebo. When she and three female and four male researchers investigated this disconnect by performing the experiments, they discovered that the ketamine acted as an antidepressant only when it was administered by men.

Suspecting that scent was involved, the researchers put the animals inside a fume hood so that the mice couldn't smell who was injecting them. This completely eliminated the effect of the ketamine, regardless of the experimenter's sex. When Georgiou and her colleagues placed a t-shirt worn by a man next to the mice in the fume hood, mice injected with ketamine swam for longer than those injected with a placebo. This suggested that male odour was necessary for the drug to work.

The head of Georgiou's lab, neuroscientist Todd Gould, learned that antidepressant researcher Ronald Duman at Yale University in New Haven, Connecticut, was seeing similar effects with female researchers in his lab that were working on ketamine experiments. So Gould asked Duman to repeat Georgiou's swim-test experiment in his own lab. When eight male and eight female researchers injected mice with ketamine, they saw the same results: mice injected by women did not respond to the drug.

Georgiou and her colleagues repeated the experiments with other antidepressants, but the researchers' sex didn't seem to matter. She and Gould suspect that the antidepressant effect is the result of a specific interaction between ketamine and the male odour in the mouse brain .

But other evidence suggests that the sex of the researcher can affect other types of behavioural experiment, not just those involving ketamine. A 2014 paper[1] in *Nature Methods* found that mice were more stressed and less likely to respond to pain when handled by a male researcher. And behavioural neuroscientist Silvana Chiavegatto of the University of São Paulo in Brazil, who was at Georgiou's SfN presentation, says that she has seen the same phenomenon in her lab, where she studies depression but doesn't use ketamine.

Rethinking the model

"I think it's really fascinating, with wide implications for our field," says Adrienne Betz, a behavioural neuroscientist at Quinnipiac University in Hamden, Connecticut. But she cautions that the results are preliminary, and it remains to be seen whether the effect is specific to ketamine and to mice.

Others disagree about the potential implications. Hundreds of papers with female experimenters demonstrate the effects of antidepressants — including ketamine — in mice, says Lisa Monteggia, a neuroscientist at the University of Texas Southwestern in Dallas. Other factors, such as whether the researcher is stressed when he or she injects the mice, might affect the animals' behaviour, she says.

Gould and Georgiou say that their results don’t necessarily invalidate previous studies; they simply show that ketamine experiments in their lab work only when men inject the mice. There is overwhelming evidence that ketamine is a powerful antidepressant in humans. Gould doubts that the sex of the person administering the drug affects how well it works in a depressed patient, but it's never been tested.

He adds that the findings suggest that researchers studying drugs' effects on mouse behaviour should report the sex of the experimenter in their publications to ensure that other labs can replicate the results. “There are a number of factors that influence replicability and are unrecognized — this is one of them,” Gould says. “For us, it is an inconvenient truth.”

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Comments

Comments

There are currently no comments.

Giant telescope’s mobile-phone ‘dead zones’ rile South African residents

Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.

17 November 2017

Mujahid Safodien/AFP/Getty

South Africa has already built prototype dishes that will form part of the Square Kilometre Array, which will be the world’s largest radio telescope.

A map showing how mobile-phone use might be restricted because of a giant

radio telescope in South Africa has angered people who will live near the instrument — deepening a rift between the local farming community and those backing the project.

The row has arisen over the South African portion of the Square Kilometre Array (SKA), which will eventually consist of thousands of radio dishes in Africa and up to a million antennas in Australia. The array, which begins construction in 2019 for completion in the 2030s, will have a total signal-collecting area of more than 1 square kilometre, making it the world's largest radio telescope. The telescope's first phase in South Africa involves 194 radio dishes, to be laid out like a galaxy with three arms spiralling out from a core cluster.

Local residents in the Northern Cape province, where the government has acquired nearly 1,400 square kilometres of land for the initial phase, have already expressed concerns about the telescope. Some are angry that the SKA won't boost the region's economy as much as they had expected; others fear the land acquisition will damage local agricultural activity — in particular, sheep farming.

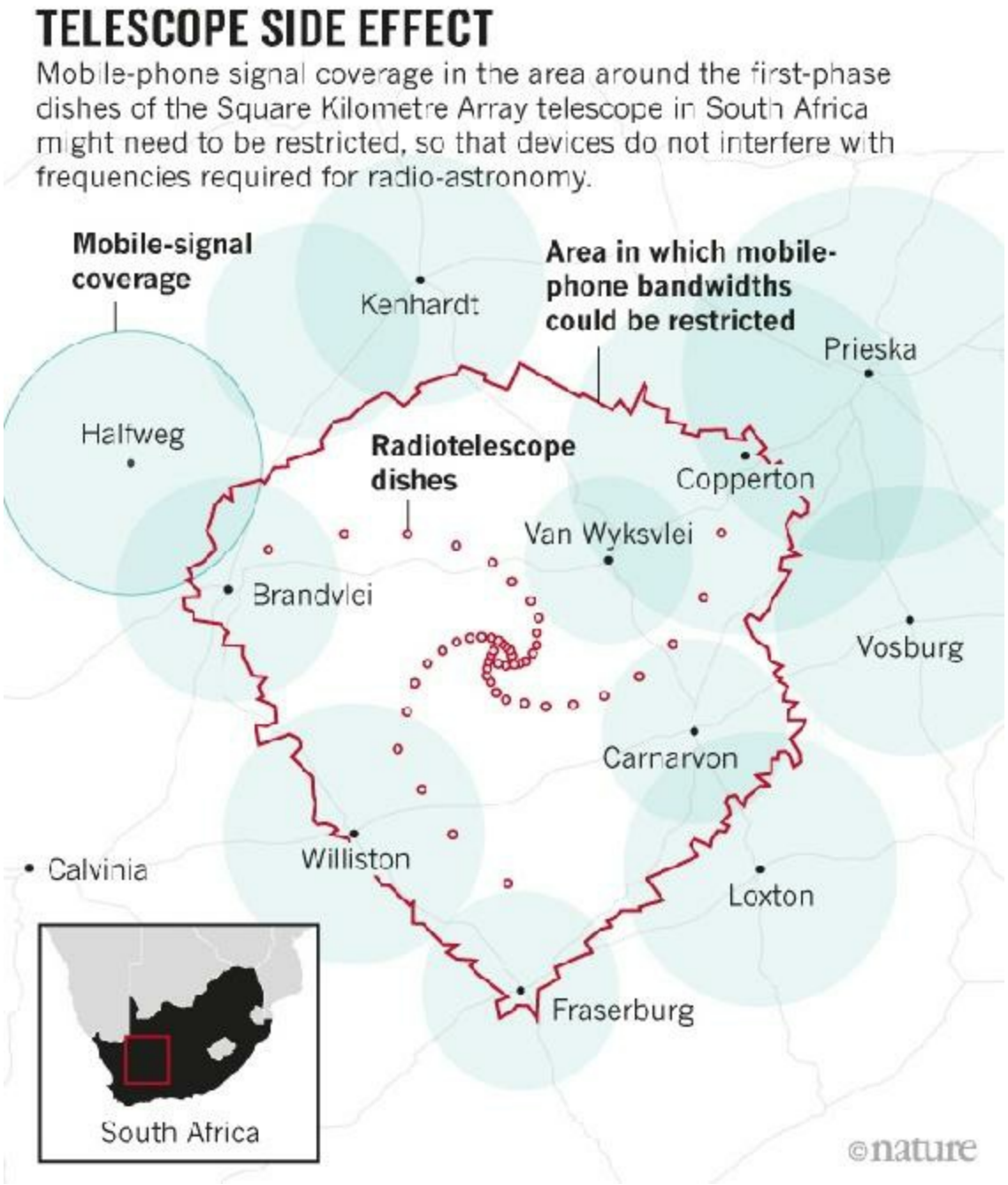
But the map of projected mobile-phone coverage around the project, uploaded to Facebook on 2 November, has brought to light another problem facing the local community. It shows the area around the SKA's radio dishes where the use of electronic devices will eventually be restricted, because their signals would interfere with the relatively weak radio signals that the dishes will try to pick up from the distant Universe.

Communications problem

Nearby residents had been aware that mobile-reception 'dead zones' could be a side effect of the SKA. But Eric Torr, a light-aircraft-business owner who uploaded the map, says it shows the area affected is "larger than we were led to believe". The map suggests that six towns fall into the dead zone, he says, and that this could have serious implications for their farming economies.

The map was produced by the South African Radio Astronomy Observatory

(SARAO), which is leading the SKA project in South Africa. Lorenzo Raynard, head of communications at the SARAO, says it shows areas where mobile-phone coverage could be reduced by 20% or more (see ‘Telescope side effect’). The chart was part of a presentation calling on businesses to submit alternative communications solutions for affected areas, he says.



Adapted from SARAO map

An informal collection of farming organizations has already been working with the observatory to find alternative communications technologies, such as satellite phones, that can be used around the antennas, according to Henning Myburgh, a farmer in the area. “Adequate electronic communications, especially for children, are a basic human right,” he says. Myburgh says that the cooperative’s search has now moved to finding cell-phone technologies that can co-exist with the SKA and replicate the phone facilities the farmers currently have. “This is a major shift and if possible will be a huge step forward,” he says.

Still, says Myburgh, there are farmers who are unhappy. “I don't think that anybody will ever be happy with the situation, taking into account the massively intrusive nature of the project in the region,” he says.

Nicol Jacobs, who farms in the spiral arms, says the SKA was originally going to affect only two farms. He says he found out about the full extent of the telescope when the government began buying more farms. “We’re going to be eaten piece by piece,” he says. Jacobs says he would like the government to return the bought farms to the agricultural community: “I will fight as long as I can,” he adds.

Despite residents’ annoyance, South African law says that the country’s science and technology minister can preserve the area of the SKA’s land for astronomy. The department of science and technology, which oversees astronomy in the country, is responsible for finalizing regulations about areas that will lose mobile-phone coverage, and to define radio-wave frequencies that will be protected for astronomy. Asked when they would be finalized, the department’s astronomy-management authority declined to give a firm date.

Environmental assessment

Although resident’s complaints may not affect the SKA’s layout, an environmental assessment — due to be finalized next year — could change matters.

Earlier this month, the SARAO tasked the South African Environmental Observation Network to implement an environmental assessment of the telescope site, and made 3 million rand (US$209,000) available for the work.

“The relative position of the dishes determines the quality of the telescope beam,” says Robert Braun, science director at SKA Organisation, which is designing the telescope.

The organization has drawn up an ideal map of dish positions, says Braun. But it might have to shift them if the environmental assessment finds that local habitats or biomes are affected, says Casper Crous, an ecologist who is part of the assessment collaboration.

The overarching plan is to turn South Africa’s SKA site into a nature reserve and a site for long-term environmental research once the telescope is operational, says Crous. So a no-go zone for dishes, for example, “would be kokerboom [quiver tree] populations or ephemeral wetlands — areas that if impacted are unlikely to ever recover,” he says.

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Commenting is currently unavailable.

Nature News

周日, 05 11月 2017

Nature News

[周日, 05 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Energy researcher sues the US National Academy of Sciences for millions of dollars** [周五, 03 11月 08:00]
  Rare move stems from a conflict over two journal articles about renewable energy.
- **US government report says that climate change is real — and humans are to blame** [周五, 03 11月 08:00]
  Conclusions of climate-change science analysis are at odds with US President Donald Trump's policies.
- **Newly discovered orangutan species is also the most endangered** [周四, 02 11月 08:00]
  The first new species of great ape described in more than eight decades faces threats to its habitat.
- **Gut microbes can shape responses to cancer immunotherapy** [周四, 02 11月 08:00]
  Studies find that species diversity and antibiotics influence cutting-edge treaments.
- **Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid** [周四, 02 11月 08:00]
  Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.
- **Controversial chairman of US House science committee to retire** [周四, 02 11月 08:00]
  Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.
- **Infusions of young blood tested in patients with dementia** [周三, 01 11月 08:00]
  The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.
- **Pay for US postdocs varies wildly by institution** [周三, 01 11月 08:00]
  Analysis of universities' salary data suggests major disparities in pay for early-career researchers.
- **Citation is not the only impact** [周三, 01 11月 08:00]

A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.

- **University systems allow sexual harassers to thrive** [周三, 01 11月 08:00]
  It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen.
- **Interstellar visitor, Arctic shipwrecks and a retraction recommendation** [周三, 01 11月 08:00]
  The week in science: 27 October–2 November 2017.
- **Plans to promote German research excellence come under fire** [周三, 01 11月 08:00]
  Critics say selection process for high-stakes funding programme is flawed.
- **The new thermodynamics: how quantum physics is bending the rules** [周三, 01 11月 08:00]
  Experiments are starting to probe the limits of the classical laws of thermodynamics.
- **Join the disruptors of health science** [周三, 01 11月 08:00]
  Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.
- **Astrophysics: Chasing ghosts in Antarctica** [周三, 01 11月 08:00]
  Alexandra Witze welcomes a history of IceCube, an ambitious neutrino observatory.
- **Books in brief** [周三, 01 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.
- **Zoology: The joys of spinelessness** [周三, 01 11月 08:00]
  Lisa-ann Gershwin delights in two books on marine invertebrates.
- **Human embryos: Collect reliable data on embryo selection** [周三, 01 11月 08:00]
- **Night shifts: Circadian biology for public health** [周三, 01 11月 08:00]
- **Crime fiction: Sherlock Holmes — a family likeness?** [周三, 01 11月 08:00]
- **Forestry: Sustainability crisis brews in EU forestry** [周三, 01 11月 08:00]
- **Spanish government takes control of Catalonian universities** [周二, 31 10月 08:00]
  Madrid will oversee the finances of the region's research centres and seven public universities.
- **Seeds, sponges and spinal surgery** [周二, 31 10月 08:00]
  October’s sharpest science shots, selected by Nature ’s photo team.
- **Small group scoops international effort to sequence huge**

wheat genome [周二, 31 10月 08:00]

Just six scientists conquer one of the most complicated genomes ever read.

- ## Astronomers race to learn from first interstellar asteroid ever seen [周二, 31 10月 08:00]

  Wonky orbit confirms that this visitor isn’t from around here.

- ## How baby bats develop their dialects [周二, 31 10月 08:00]

  The young animals crowdsource the pitch of their calls from colony members.

- ## US environment agency bars scientists it funds from serving on its advisory boards [周二, 31 10月 08:00]

  The US Environmental Protection Agency says the policy will address potential conflicts of interest, but scientists raise alarms.

- ## Frédéric Chopin’s telltale heart [周二, 31 10月 08:00]

  Scientists have written another chapter in the curious case of the composer’s heart. But it is unlikely to be the end of the story.

- ## Lower emissions on the high seas [周二, 31 10月 08:00]

  Global regulations to limit carbon dioxide from the shipping industry are overdue.

- ## Lessons from first campus carbon-pricing scheme [周二, 31 10月 08:00]

  Putting a value on emissions can lower energy use, write Kenneth Gillingham, Stefano Carattini and Daniel Esty.

- ## Huge microwave observatory to search for cosmic inflation [周一, 30 10月 08:00]

  Multi-telescope project has ambitious goals and a big price tag.

- ## Geneticists are starting to unravel evolution's role in mental illness [周一, 30 10月 08:00]

  Hints emerge that past environments could have influenced psychiatric disorders.

Energy researcher sues the US National Academy of Sciences for millions of dollars

Rare move stems from a conflict over two journal articles about renewable energy.

03 November 2017

Eric Thayer/Bloomberg/Getty

Renewable energy, including from wind, is at the heart of a multi-million dollar lawsuit.

A scientific dispute about the future of alternative energy has landed in a US

court. Mark Jacobson, an environmental and civil engineer at Stanford University in California, has filed a libel lawsuit against the US National Academy of Sciences (NAS) and a researcher who published a study in the academy's journal that criticized Jacobson's work.

Jacobson, who filed suit in superior court in Washington DC in late September, is seeking damages of US$10 million. He also wants the *Proceedings of the National Academy of Sciences* (*PNAS*) to retract the article it published by mathematician Christopher Clack in 2015. The NAS and Clack have until late November to respond, according to court documents. Some experts are worried that the lawsuit could dampen scientific progress on renewable energies. But others defend the move, saying researchers should be able to take advantage of all civil avenues in defense of their work.

Jacobson was the lead author of a high-profile *PNAS* paper[1] published in December 2015 making the case that the continental United States could meet nearly 100% of its energy needs using wind, water and solar sources as early as 2050. A rebuttal[2] written by Clack — then at the University of Colorado Boulder — and 20 co-authors, and published in *PNAS* in June 2017, questioned Jacobson's methodology and challenged his conclusions. The authors argued, among other things, that Jacobson’s paper overestimated the maximum outputs from hydroelectric facilities and the nation’s capacity to store energy produced by renewable sources.

In the lawsuit, Jacobson says that he had alerted *PNAS* to 30 falsehoods and five “materially misleading statements” in Clack’s paper before its publication. The complaint states that almost all of those inaccuracies remained in the published version. Jacobson also argues that “the decision by NAS to publish the Clack Paper in PNAS has had grave ramifications” for his reputation and career.

In a letter[3] accompanying Clack’s paper in *PNAS*, Jacobson and three co-authors wrote that Clack’s criticisms are “demonstrably false”. They maintained that their projections regarding hydroelectric power were based on an assumed increase in the number of turbines and were not a “modeling mistake”.

Conflict resolution

Some observers are disappointed to see the conflict play out in court. The diversity of engineering models that form the basis of long-term energy projections should be celebrated, not litigated, says chemical engineer Daniel Schwartz, director of the Clean Energy Institute at the University of Washington in Seattle. “Bringing this dispute into the court of law, regardless of outcome, is a step towards devaluing the debate of underlying engineering assumptions,” he says.

“This dispute is likely to be most harmful to the scientific community, which has already been subject to lawsuits from groups sceptical of climate change,” says David Adelman, who studies environmental law at the University of Texas in Austin.

Suing a journal over a scientific disagreement is a rare move, says Adil Shamoo, a biochemist at the University of Maryland School of Medicine in Baltimore and editor-in-chief of the journal *Accountability in Research*, which is published by Taylor & Francis. But Shamoo thinks that scientists should be able to sue if they feel that a paper is “reckless” or “malicious”. “I’m a great believer in using all of the avenues of a civil society,” he says.

Shamoo does think that Clack’s paper was “unduly harsh and personal”. He says that “it was not written as if it was part of a scientific dialogue”.

Clack declined to respond to Shamoo’s characterization of his paper, but says that he is disappointed that Jacobson filed the lawsuit. Clack — now chief executive of Vibrant Clean Energy LLC in Boulder — says that his rebuttal paper “underwent very vigorous peer review”, and that the *PNAS* editors had considered Jacobson’s criticisms but found them to be “without merit”.

Jacobson says that he “cannot comment” on the lawsuit. And a spokesperson for the NAS says that “we do not comment on pending litigation”.

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Comments

Commenting is currently unavailable.

US government report says that climate change is real — and humans are to blame

Conclusions of climate-change science analysis are at odds with US President Donald Trump's policies.

03 November 2017

Drew Angerer/Getty

Heat waves are growing more common in many parts of the United States.

From warmer temperatures to more extreme weather, melting glaciers and rising sea levels, humanity is fundamentally changing the planet by pumping

greenhouse gases into the atmosphere, US government scientists said on 3 November in their latest assessment of climate science.

The average global temperature has increased by 1 °C since the start of the Industrial Revolution, the 600-page report says — adding that the last 115 years comprise “the warmest period in the history of modern civilization”. The analysis warns that temperatures could increase another 4 °C by the end of the century, with dramatic consequences for humans and natural ecosystems.

The findings are at odds with the policies of US President Donald Trump, who has questioned well-established tenets of climate science and vowed to protect and promote the US fossil-fuel industry. Trump's stances led many scientists to worry that his administration would try to block or tamper with the climate-change assessment, but several scientists who helped to write the document reported no problems.

“We weren’t interfered with, and we ended up producing something that I think is of tremendous value,” says David Fahey, an atmospheric scientist with the National Oceanic and Atmospheric Administration in Boulder, Colorado, and a coordinating lead author of the analysis.

The climate-science report is the first volume of the fourth National Climate Assessment, a legally mandated analysis of the causes and impacts of global warming that is due in 2018. The other two parts of the forthcoming assessment were released today in draft form, for public comment. One analysis focuses on how climate change is affecting life in the United States, from crop yields to property damage from extreme weather. The other summarizes the latest findings on the global carbon cycle. Both of those documents will undergo a formal review by the US National Academy of Sciences.

“The science speaks for itself,” says Don Wuebbles, a climate scientist at the University of Illinois at Urbana-Champaign and co-chair of the climate-science report. “It’s hard to counteract the basic observations and the truth of the science with any kind of political playing around.”

The trio of documents paints a dramatic picture of how global warming is

affecting people and communities across the United States. Tidal flooding is accelerating in more than 25 coastal cities along the Atlantic Ocean and Gulf of Mexico. Large forest fires have become more frequent in the western part of the country, while warmer spring temperatures and shrinking mountain snowpack are combining to reduce the amount of water available to the region's cities and farms. As a result, the draft climate-impacts report warns, “chronic, long-duration hydrological drought is increasingly possible before the end of the century”.

The report comes just days before the latest United Nations climate talks kick off in Bonn, Germany. It will also be the first major summit since Trump vowed to pull the United States out of the 2015 Paris climate pact.

Few observers expect US government's latest set of climate-change analyses to affect how the Trump administation approaches energy and environmental issues. In August, the US National Oceanic and Atmospheric Administration disbanded an advisory committee that was intended to help the nation prepare for a warmer climate, by translating the findings of the coming climate assessment into guidance for cities, states and industry.

Nor is it clear whether senior Trump administration officials will accept the reports' core scientific conclusions. As recently as March, US Environmental Protection Agency administrator Scott Pruitt said he did not believe that carbon dioxide is a major driver of global warming.

Nonetheless, many scientists and environmentalists lauded the new reports for bolstering the case for more-aggressive action against climate change.

“The full assessment, when it gets published, is going to show that there are palpable impacts that are going to hit every part of the country,” says Andrew Light, a senior fellow at the World Resources Institute, an environmental think-tank in Washington DC. “It’s the responsibility of leaders to take note of that and act accordingly.”

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Comments

There are currently no comments.

Newly discovered orangutan species is also the most endangered

The first new species of great ape described in more than eight decades faces threats to its habitat.

02 November 2017

Maxime Aliaga/SOCP-Batang Toru Programme

Orangutans in Sumatra's Batang Toru forest are now officially a new species: *Pongo tapanuliensis.*

Almost a century after scientists first heard rumours of its existence, an isolated population of orangutans on the Indonesian island of Sumatra has

been confirmed as a new species — just as its habitat faces imminent threats.

The population, estimated at fewer than 800 individuals, inhabits the Batang Toru forest in western Sumatra. A researcher exploring the area in the 1930s wrote of reports of an isolated orangutan population. But it wasn't until biological anthropologist Erik Meijaard, the founder of conservation group Borneo Futures in Jakarta, discovered the paper in the mid-1990s that scientists went looking for the Batang Toru group. Local villagers showed researchers the remains of a female orangutan, and nests in the area confirmed the presence of a population. A male orangutan killed by locals in 2013 provided key evidence: intact tissue and bone.

From the start, scientists noticed that these apes looked different from other orangutans. They had smaller heads, with flatter faces, and their hair was frizzier than that of their cousins living farther north on Sumatra or on the nearby island of Borneo.

Gene gap

Now, genetic tests, field observations and a comparison of the male skeleton against 33 orangutan specimens in museums have revealed that the Batang Toru group is, in fact, a distinct species. Named *Pongo tapanuliensis*, the newly identified great ape is described in *Current Biology*[1] on 2 November by a team that included most of the world's orangutan experts. "It's taken 20 years to come to the realization of what this is," Meijaard says.

Although the genetic analysis of *P. tapanuliensis* relies on a single skeleton, Meijaard says that's not unusual in taxonomy. Many studies, including others he's contributed to, rely on a single piece of evidence, and typically consider only morphology. The latest study shows that the group is distinct not only in morphology, but also in genetics and behaviour, he says.

Matthew G. Nowak

P. tapanuliensis orangutans have smaller heads and flatter faces than their cousins elsewhere on Sumatra and on Borneo.

Russ Mittermeier, executive vice-chair of Washington, DC-based Conservation International and chair of the primate-specialist group at the International Union for Conservation of Nature (IUCN), describes the evidence as “unquestionably” sufficient to support the new species designation. “Although we have had 87 new species of primates described since 2000, this is the first new great ape species since 1929.”

Biruté Mary Galdikas, an orangutan specialist in Los Angeles who founded Orangutan Foundation International, says that the study confirms what she and other orangutan researchers have suspected for decades. “I am not surprised that there is a new species or subspecies of orangutan described from Sumatra,” she says.

Ancestral ties

Key to the determination was tracing the population’s ancestry. Surprisingly, Meijaard says, genetic testing of the Batang Toru skeleton revealed that the population is more closely related to Bornean orangutans, despite living on the same island as the other Sumatran group. That’s probably because of how

orangutans migrated to the region, he says.

All orangutans trace their origins to ancestors that lived on the Asian mainland about 8 million years ago. Those great apes migrated to what is now Sumatra, when sea levels were lower and the lands were connected. Genetic data suggest the Batang Toru species is the closest descendant of those first arrivals.

The other Sumatran orangutans, which live in the island's far north, split off from the Batang Toru group about 3.4 million years ago, modelling based on genetic data suggests. The Bornean orangutans also split from the Batang Toru group, but much later — about 674,000 years ago — which explains why those two populations are more similar, Meijaard says.

Even as Batang Toru's orangutans are named a new species, the animals' long-term survival is uncertain. Previous population analyses suggest there are fewer than 800 individuals, making it the most endangered of the great apes. Although much of its habitat is protected by the Indonesian government, a proposed hydroelectric dam on the Batang Toru river would flood part of the area and divide the population into two, isolating the groups on either side of the river. That's likely to further shrink the gene pool in the already inbred population, Meijaard says. The dam would also bring more people to the area, potentially increasing hunting pressure.

Conservation groups are working with government officials to find an alternative site for the project, says Meijaard. "There is no doubt that conservation efforts are needed immediately," Mittermeier says.

The IUCN primate-specialist group has recently recommended that the species be included on the IUCN Red List of Threatened Species. A decision is expected in December. "It would be bitterly ironic if it goes extinct as a biologically viable population just as it is described as a new species," says Galdikas.

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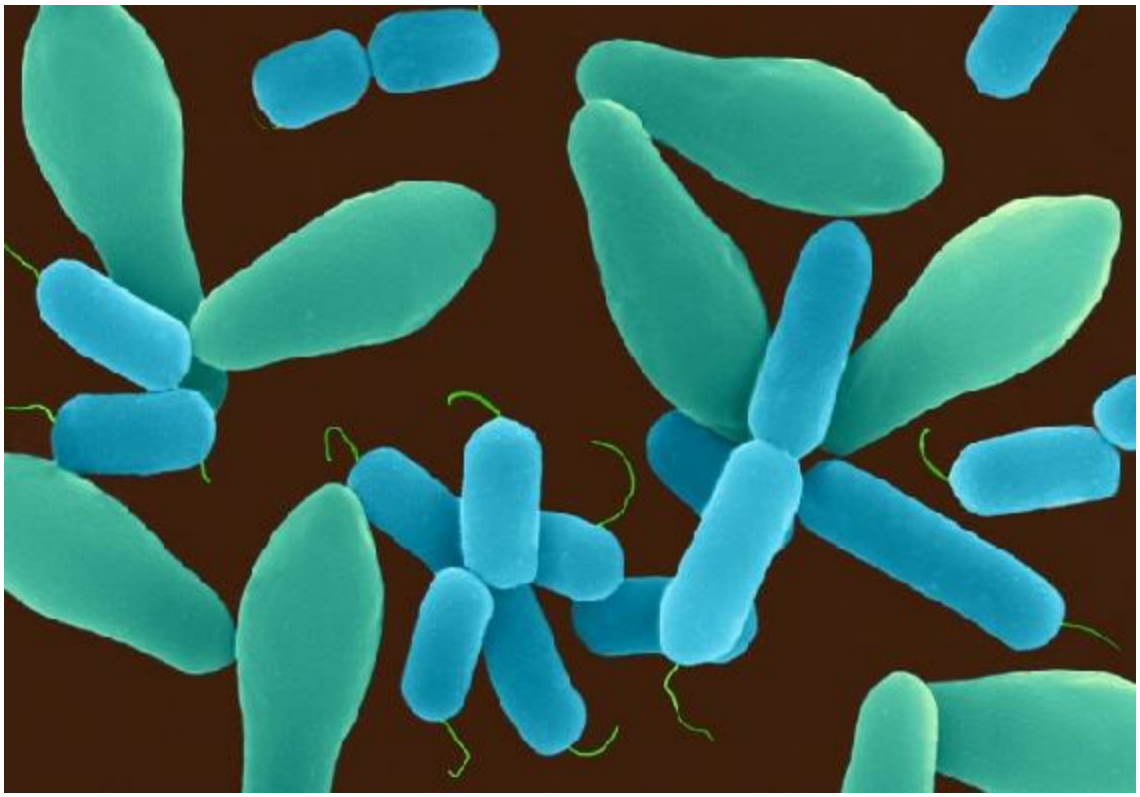
Comments

There are currently no comments.

Gut microbes can shape responses to cancer immunotherapy

Studies find that species diversity and antibiotics influence cutting-edge treaments.

02 November 2017



Dennis Kunkel Microscopy/SPL

Gut bacteria such as these *Clostridium* could improve a patient's reponse to cancer immunotherapies.

Cancer immunotherapies unleash the body’s immune system to fight cancer, but microbes living in a patient’s gut can affect the outcome of those

treatments, two research teams have found.

Their studies, published on 2 November in *Science*[1, 2], are the latest in a wave of results linking two of the hottest fields in biomedical research: cancer immunotherapy and the role of the body's resident microbes, referred to collectively as the microbiome, in disease.

They also highlight the impact of antibiotics on cancer immunotherapies, particularly drugs that block either of two related proteins called PD-1 and PD-L1. One of the studies found that people treated with antibiotics for unrelated infections had a reduced response to these immunotherapies.

“It raises important questions,” says cancer researcher Jennifer Wargo of the University of Texas MD Anderson Cancer Center in Houston, and an author of one of the studies. “Should we be limiting or tightly monitoring antibiotic use in these patients? And can we actually change the microbiome to enhance responses to therapy?”

The composition and diversity of the microbiome has been linked to everything from mental-health disorders to some side effects of cancer chemotherapy. In 2015, researchers working on mice reported that a specific genus of bacterium in the gut enhanced anti-tumour responses to drugs that target PD-L1[3].

Wargo saw a presentation about the work at a cancer meeting several years ago. “I was floored,” she says. Wargo saw an opportunity to expand the work to humans through her access to clinical samples at MD Anderson.

Exerting influence

Wargo teamed up with epidemiologist Vancheswaran Gopalakrishnan and other researchers to collect faecal samples from more than 100 people with advanced melanoma before they began treatment with anti-PD-1 immunotherapy drugs. The scientists found that those who had the most diverse gut microbes were most likely to respond to the immunotherapy[1]. And tumour growth was reduced in mice that received faecal transplants from

people who responded to immunotherapy.

The type of microbe was also linked to differences in responses to treatment, the researchers discovered. For example, people whose guts contained a lot of bacteria from a group called Clostridiales were more likely to respond to treatment, whereas those who had more Bacteroidales bacteria were less likely to respond.

A second study[2] showed that people who received antibiotics to treat infections shortly before or after starting immunotherapy did not respond as well to PD-1-blocking therapies. The researchers — led by cancer immunologist Laurence Zitvogel and cancer biologist Guido Kroemer, both of the Gustave Roussy Cancer Campus in Villejuif, France — also found that the presence of the bacterium *Akkermansia muciniphila* in both humans and mice was linked to better responses to immunotherapy.

Although it's too early for clinicians to change how they use antibiotics in people with cancer, the work is a step beyond previous studies that relied mainly on mouse models of cancer, says immunologist Romina Goldszmid of the National Cancer Institute in Bethesda, Maryland.

Now, she says, researchers need to learn more about how those microbes exert their influence on the immune system. "What's really missing in the field, rather than knowing who is there and who isn't there, is knowing what the bugs are doing," she says. "We need more information about that."

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Comments

Comments

There are currently no comments.

Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid

Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.

02 November 2017

Tomasz Tomaszewski/VISUM creativ/eyevine

A previously unknown chamber has been found in the largest of the pyramids in Giza, Egypt.

Physicists have used the by-products of cosmic rays to reveal a large,

previously unidentified chamber inside the 4,500-year-old Great Pyramid in Giza, Egypt. The find is the first discovery since the nineteenth century of a major new space inside the pyramid.

Egyptologists have been quick to dismiss any idea of finding lost treasure in the 30-metre-long void. “There’s zero chance of hidden burial chambers,” says Aidan Dodson, an Egyptologist at the University of Bristol, UK, who studies ancient Egyptian tombs. But experts hope that the finding will lead to significant insights into how this spectacular pyramid was built.

The Great Pyramid was constructed by the pharaoh Khufu (also known as Cheops), who reigned from 2509–2483 BC. Constructed from limestone and granite blocks, and rising to 139 metres, it is the oldest and largest of the Egyptian pyramids and one of the most impressive structures to survive from the ancient world.

Chamber layout

Whereas other pyramids from this period sit above underground burial chambers, Khufu’s Pyramid contains several large rooms inside the body of the structure itself. These include the King’s chamber, which still holds a stone sarcophagus, the smaller Queen’s chamber and a sloping passageway known as the Grand Gallery.

These large chambers were discovered in the ninth century AD and explored extensively by Western archaeologists in the nineteenth century. But enthusiasts have wondered ever since whether there might be more hidden chambers inside the pyramid, or even whether the king’s real burial chamber is yet to be found.

“There are so many theories — nice ones but also crazy ones,” says Mehdi Tayoubi, president of the Heritage Innovation Preservation institute in Paris. So, he co-founded an international collaboration called Scan Pyramids to find out; the project was supervised by the Egyptian Ministry of Antiquities. The group is “agnostic” about particular theories, he says, but is using non-invasive technologies to search for hidden chambers.

ScanPyramids

Researchers placed muons detectors inside and outside the pyramid to find ou whether theories of a hidden space in the Great Pyramid were true.

To see through the Great Pyramid, the researchers used a technique developed in high-energy particle physics: they tracked particles called muons, which are produced when cosmic rays strike atoms in the upper atmosphere. Around 10,000 muons rain down on each square metre of Earth's surface every minute. Sensitive muon detectors have been developed for use in particle accelerators, but they have also been used in the past decade or so to determine the inner structures of volcanoes and to study the damaged nuclear reactor at Fukushima, Japan.

Muon maps

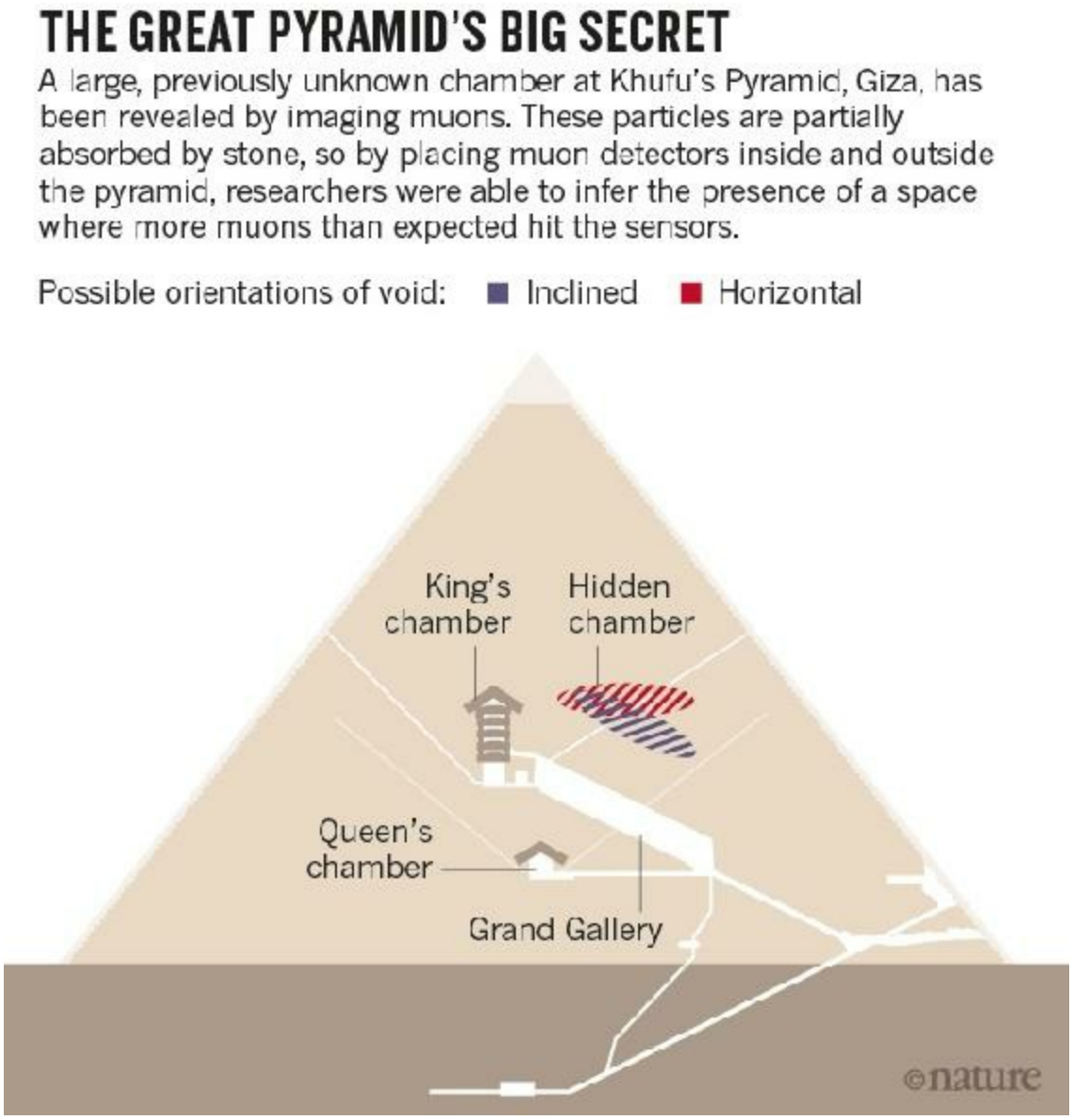
In December 2015, physicist Kunihiro Morishima of Nagoya University, Japan, and his colleagues placed a series of detectors inside the Queen's

chamber, where they would detect muons passing through the pyramid from above. The particles are partially absorbed by stone, so any large holes in the pyramid would result in more muons than expected hitting the detectors.

After several months, “we had an unexpected line”, says Tayoubi. To check the result, two other teams of physicists, from the Japanese High Energy Accelerator Research Organization in Tsukuba and the French Alternative Energies and Atomic Energy Commision in Paris, then used different types of muon detector placed in other locations both inside and outside the pyramid.

All three teams observed a large, unexpected void in the same location above the Grand Gallery (see 'The Great Pyramid's big secret'). Their results were reported in *Nature*[1] on 2 November. The space is at least 30 metres long, with a similar cross section to the Grand Gallery. “It was a big surprise,” says Tayoubi. “We’re really excited.”

The chamber could be either horizontal or inclined, the researchers say, and might be made up of two or more smaller spaces. The purpose of the space is unknown, but Tayoubi suggests that it could be “a second Grand Gallery”.



With high, corbelled — or stepped — ceilings and mysterious stone benches, the Grand Gallery is “one of the most fantastic rooms constructed in the ancient world”, says Bob Brier, an Egyptologist at Long Island University in Brookville, New York, who co-wrote the 2008 book *The Secret of the Great Pyramid* (Smithsonian). “If there’s another one, that’s real news.”

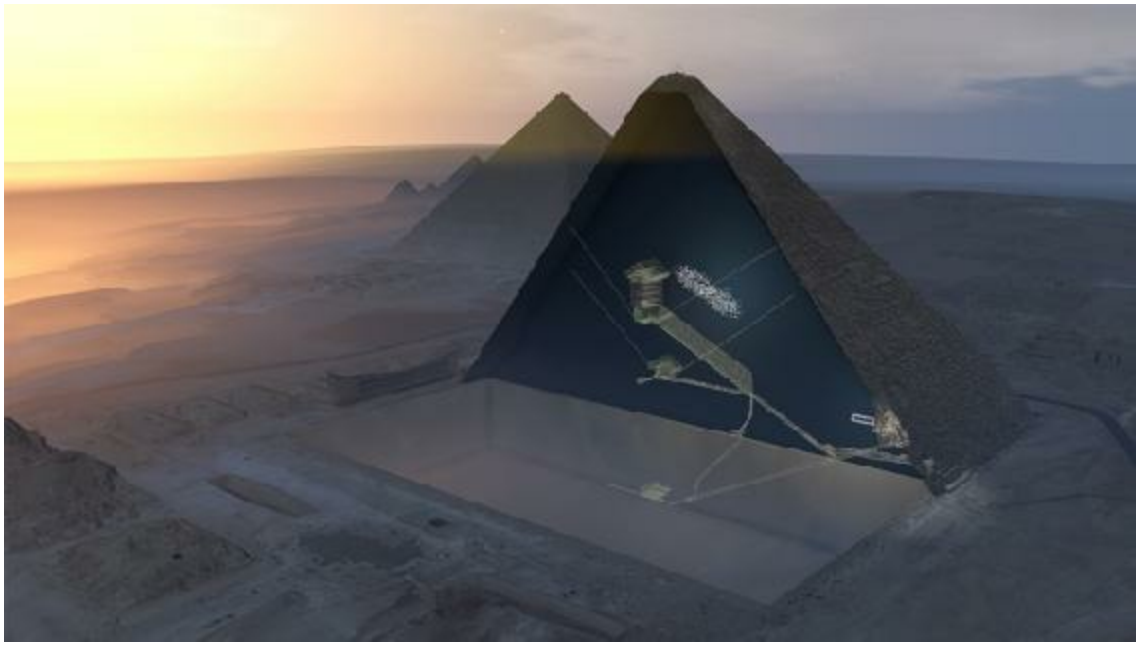
Theories abound

The newly discovered space is unlikely to contain any artefacts relating to the

king’s burial, says Dodson, because there’s already a burial chamber with a sarcophagus in it. Instead he speculates that the space might be a “relieving chamber”, intended to reduce the weight of masonry pressing down on the Grand Gallery. Similar relieving chambers are seen above the King’s chamber and in the pyramid of Khufu’s father, Sneferu, at Meidum, another pyramid site in Egypt.

But Colin Reader, an independent geologist and engineer based in Liverpool, UK, who has studied Egyptian pyramids, suggests that the new chamber is too far from the Grand Gallery to serve this purpose. He wonders whether, just as the Grand Gallery leads to the King’s chamber, the void might lead to another, higher chamber. “You would want to investigate and rule that out,” he says.

Brier has a third theory. In 2007, he and French architect Jean-Pierre Houdin suggested that the Grand Gallery formed part of a huge counterweight system. Weights sliding down the floor of the Grand Gallery could have raised the hefty, granite blocks that comprise the King’s chamber, he says. He speculates that the new space could be part of a second counterweight system higher up.



ScanPyramids

A 3D visualization of the Great Pyramid and its hidden chamber (white dots).

The results also seem to reject the theory, put forward by Houdin and Brier, that the builders of the Great Pyramid used an internal ramp to raise blocks up to the highest levels. “These data suggest that the ramp is not there,” says Brier. “I think we’ve lost.”

Tayoubi says that he next wants to scan Khafre’s (also known as Chephren’s) Pyramid, Egypt’s second largest pyramid. A team led by Nobel-prizewinning physicist Luis Alvarez carried out muon imaging in this pyramid in the late 1960s, using spark chambers as detectors and recording the cosmic-ray data on magnetic tape.

They reported no new chambers in the areas scanned[2]. But technology has improved dramatically since then, points out Tayoubi.

“I think Alvarez was a real visionary guy,” says Tayoubi. “He had the right idea, maybe too early. Our dream would be to give a tribute to Alvarez and redo the Khafre experiment, to see if he was right.”

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Comments

Commenting is currently unavailable.

Controversial chairman of US House science committee to retire

Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.

02 November 2017

Bill Clark/CQ Roll Call/Getty

Representative Lamar Smith was first elected to the US Congress in 1987.

Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, will retire when his term expires late next year.

Smith, a Texas Republican, has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation (NSF) and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. Since taking the helm of the science committee in 2013, he has transformed it from a relatively deliberative panel into an investigative weapon.

Under the rules of the House of Representatives, which limit committee chairs to six years in the role, Smith would have been forced to relinquish his post on the science panel in 2019. That is one of the reasons he decided against running for re-election, according to news reports; the other is the upcoming birth of his second grandchild. As the news of his retirement made the rounds, many scientists and environmentalists celebrated.

“It is a relief,” says Katharine Hayhoe, director of the Climate Science Center at Texas Tech University in Lubbock. Although many politicians have rejected the conclusions of climate science out of political expediency, she says, Smith has been more aggressive than most.

The congressman has repeatedly tried to reshape the NSF, sponsoring multiple pieces of legislation that would require the agency to justify its grants and explain how they serve the “national interest”. He has also pushed unsuccessfully to scale back programmes in geoscience and social sciences, among other fields.

Smith has notably scrutinized the work of climate scientists. In 2015, he attempted to compel the US National Oceanic and Atmospheric Administration (NOAA) to hand over internal documents related to a climate-change study. The research, published in *Science* in 2015[1], sought to dispel the idea that the rate of global warming had slowed down around the turn of the century. Smith went so far as to accuse a NOAA official — Thomas Karl, who has since retired — of manipulating data to advance an “extreme climate change agenda”.

In 2016, Smith came to the defence of oil giant Exxon Mobil when it was being investigated by the attorneys-general of New York and Massachusetts, who wanted to know whether the firm had misled investors about the

financial implications of global warming. Smith issued subpoenas to the attorneys-general as part of a broader probe, which also targeted environmental groups that have accused Exxon Mobil of suppressing internal research and spreading false information about climate change.

“I think [Smith’s] position on peer review, on the NSF and climate science put him at odds with the science community,” says physicist Neal Lane, a former NSF director who served as science adviser to former president Bill Clinton. “But it was consistent with that of the leadership in the House, which can hardly be described as pro-science.”

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Comments

Comments

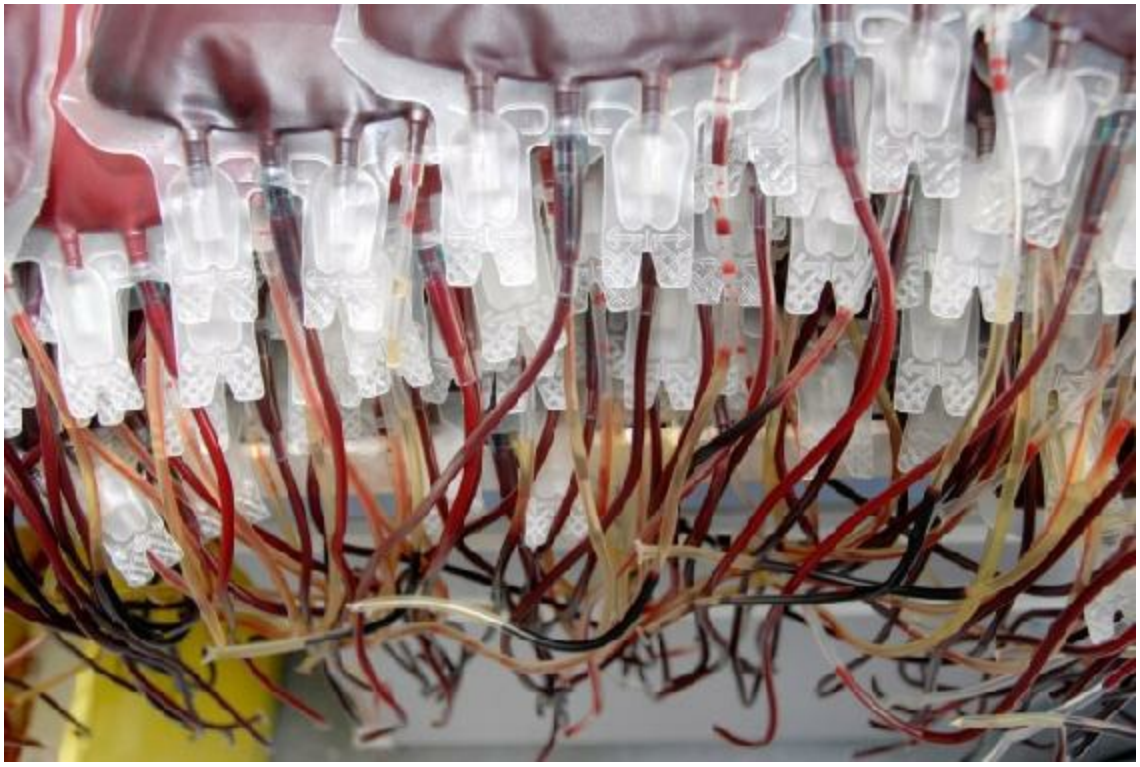
There are currently no comments.

Infusions of young blood tested in patients with dementia

The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.

01 November 2017 Corrected:

1. 03 November 2017



AJ Photo/SPL

Donor blood from young people has been transfused into people with dementia.

The first controlled, but controversial and small, clinical trial of giving young blood to people with dementia has reported that the procedure appears safe. It has also hinted that it may even produce modest improvements in the daily lives of people who have Alzheimer's disease.

Researchers who conducted the trial and others caution that the results are based on just 18 people and therefore are only a first step in exploring this type of treatment. "This is a really very small trial and the results should not be over-interpreted," says Tony Wyss-Coray, a neuroscientist at Stanford University in California. The trial was conducted by his start-up company Alkahest, which is based in San Carlos, California, and was led by Stanford neurologist Sharon Sha.

The results suggest the procedure is safe and hint that it could even boost the ability of people with dementia to undertake everyday skills, such as shopping or preparing a meal. The team announced the results on 1 November and plans to present them on 4 November at the 10th Clinical Trials on Alzheimer's Disease conference in Boston, Massachusetts.

The team tested people aged between 54 and 86 with mild to moderate Alzheimer's disease. The team gave the 18 subjects weekly infusions for four weeks. They received either a saline placebo or plasma — blood from which the red cells have been removed — from blood donors aged 18–30. During the study, the team monitored the patients to assess their cognitive skills, mood and general abilities to manage their lives independently.

The study detected no serious adverse reactions. It saw no significant effect on cognition, but two different batteries of tests assessing daily living skills both showed significant improvement.

The human trial grew out of earlier 'parabiosis' experiments, in which the blood systems of two rodents are surgically joined together to see what happens when molecules circulating in one animal enter another animal.

Alkahest now plans to conduct a second, larger trial using plasma from which many proteins and other molecules have been removed. Wyss-Coray, whose group did most of the mouse studies that inspired the clinical trial[1] told *Nature* that his experiments suggest that such a treatment could be more

effective than using whole plasma.

Transfusion confusion

Blood-transfusion trials are controversial because the active molecules in plasma that seem to lead to the purported effects are unknown.

Irina Conboy, a neurologist at the University of California, Berkeley, and her colleagues have performed extensive parabiosis experiments stitching together young and old mice that have been genetically matched. She has found that young blood clearly rejuvenates mouse tissues such as the heart and the brain[2]. But she says that the effects are probably coordinated by a complex orchestration of factors in the blood that needs to be understood more fully before moving to the clinic.

“The scientific basis for the trial is simply not there,” she says. “The effects of young blood on cognition have not been replicated by an independent group, and there has never been a test with a mouse model of Alzheimer’s.” She says that frequently exposing older people to foreign plasma may be unsafe, because hyperactivation of their immune systems could lead to autoimmune or inflammatory disease.

But, Wyss-Coray says, “Alzheimer’s patients don’t want to wait until the exact mode of action is discovered.”

He says that it is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain, which has so far failed to result in any treatments.

Blood transfusions used for this purpose do not require approval by the US Food and Drug Administration, and some American companies are already charging hefty fees for transfusions of blood from young people.

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Corrections

Corrected:

An earlier version of this story wrongly identified Tony Wyss-Coray as leading the clinical trial. In fact, the trial was led by neurologist Sharon Sha of Stanford University and doctors working for Alkahest. Alkahest, not Wyss-Coray, will conduct the second, larger trial. Wyss-Coray was also wrongly identified as a neurologist.

Comments

1 comment

1. *Chris Exley* • 2017-11-02 03:10 PM

   Wyss-Coray is clearly wrong to suggest that this 'is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain'. We showed that silicon-rich mineral waters provided some cognitive improvements in individuals with AD over only 12 weeks (https://content.iospress.com/articles/journal-of-alzheimers-disease-reports/adr170010) and similar research published today has suggested benefits in individuals with multiple sclerosis (http://www.ebiomedicine.com/article/S2352-3964(17)30428-0/fulltext). Unfortunately we do not have the resources of Wyss-Coray to take these prospective therapies further.

Pay for US postdocs varies wildly by institution

Analysis of universities' salary data suggests major disparities in pay for early-career researchers.

01 November 2017

Some postdoctoral researchers at public universities in the United States apparently work for fast-food wages whereas others make more than US$100,000 a year, an analysis of postdoc pay has revealed.

The salary data, which a science-advocacy group released on 1 November after a year-long investigation, are incomplete and — in some cases — appear to be incorrect. Some researchers are listed as earning nothing, and another study underway suggests a higher overall rate of pay for US postdocs. But the latest analysis underscores the challenges of getting basic information about an under-recognized and misunderstood segment of the

academic workforce.

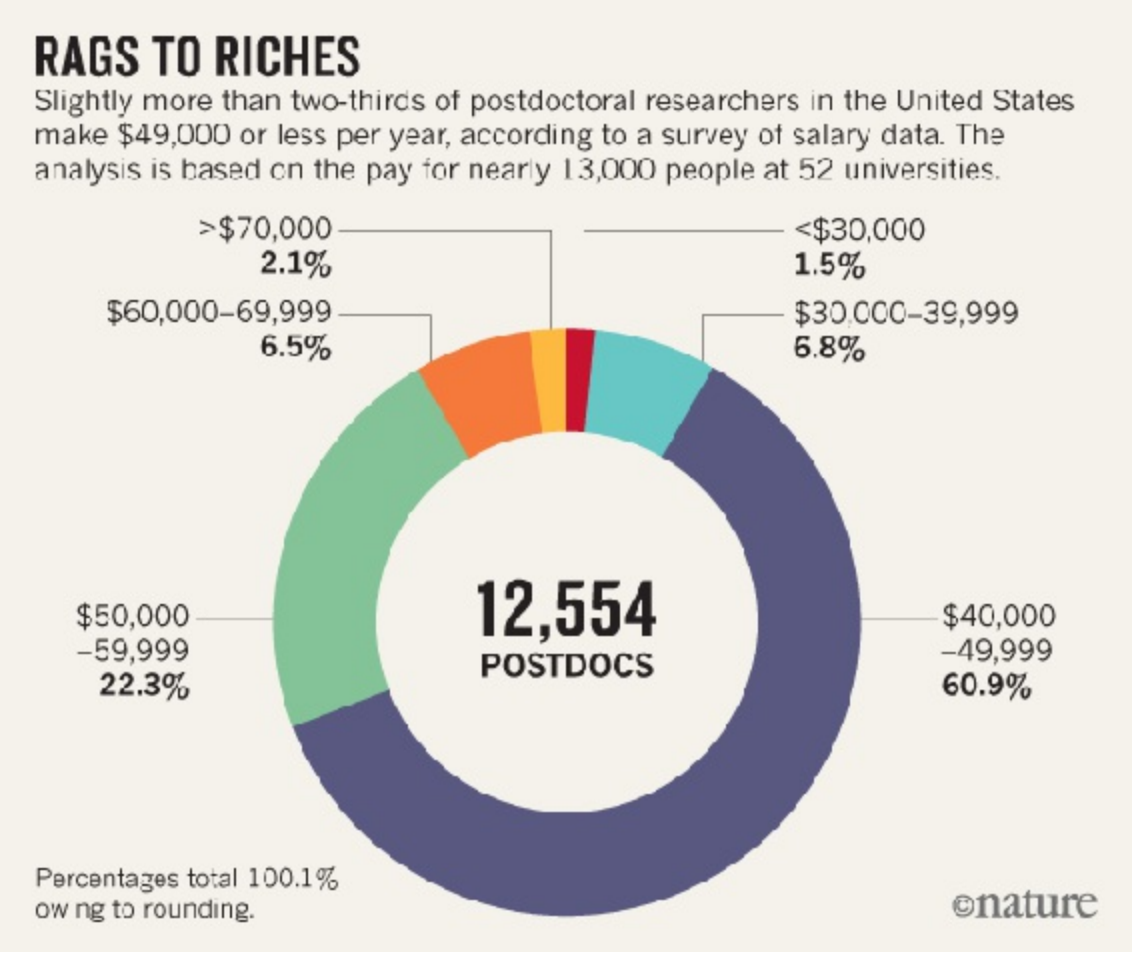
Gary McDowell, a former developmental biologist and executive director of Future of Research, an advocacy group in Boston, Massachusetts, used the US Freedom of Information Act to gather salary reports for nearly 13,000 postdocs at 51 public universities. Through personal connections, he also received salary information from one private institution, Boston University in Massachusetts.

Most universities made a good-faith effort to provide salary information, McDowell says, but few had the numbers at hand when he contacted them. McDowell says that he had to spend considerable time on the phone explaining to university employees what 'postdoc' means. “I asked a basic question — 'How much do your postdocs get paid?' — but there was a lot of confusion,” he says. “It points to how much interest there is in postdocs at these institutions.”

Multiply by zero?

Some universities still provided improbable numbers. They include the University of Utah in Salt Lake City, which reported that 50 postdocs each made $0 per year. McDowell says it is unlikely that these researchers were unpaid volunteers. Instead, he suspects that some institutions — including the University of Utah — reported only the money that postdocs received from the institution's payroll, and overlooked fellowships and other external sources of income. “University of Utah postdoctoral scholars are being paid for their work,” a university spokesman said.

While compiling data, McDowell opted to disregard the 411 reported salaries that were less than $23,660 a year. That is the threshold below which many postdocs would be eligible for overtime pay under a federal law called the Fair Labor Standards Act. “I gave them the benefit of the doubt,” McDowell says of those entries. “Those are likely reporting errors.”



Gary McDowell/Future of Research

The remaining 12,554 salary reports ranged from $23,660 to $114,600 a year (see 'Rags to riches'). McDowell suspects that some institutions mistakenly included pay data for staff scientists or other employees in their reports, which could explain some of the highest salaries. Even with that caveat, his survey suggests that postdoc salaries range widely. At any given institution, McDowell says, “It’s not uncommon for there to be fourfold differences between the highest and the lowest paid.”

Overall, 61% of reported salaries were between $40,000 and $49,999, and about 31% were reported at $50,000 or more. (The $50,000 figure is the minimum postdoctoral salary recommended in 2014 by the US National Academies of Sciences, Engineering, and Medicine.) The University of Illinois at Urbana-Champaign reported the lowest median salary at $27,515.

The University of Maryland at College Park reported the highest median figure — $56,000.

Emerging trends

McDowell notes that the data set is still incomplete. Some institutions reported salaries for only a small fraction of their workforce, and the University of California (UC) system denied his request outright. The university system's public-records office told *Nature* in a statement that it lacks the capacity to do "the programming required to create the custom data report that Mr McDowell requested". The University of California, Santa Barbara, had already provided numbers to McDowell when the broader UC system denied his request for data.

Other attempts to gather information on postdoctoral salaries have met with less resistance. The National Postdoctoral Association (NPA) in Rockville, Maryland, solicited salary information from its more than 200 member institutions for a forthcoming report. "We've worked with these institutions for over a decade, and when we ask for information they readily give it," says Kate Sleeth, chairwoman of the NPA's board of directors. "We didn't have to explain to anyone what a postdoc is."

Of the 127 NPA member institutions that participated in the survey, 85% reported paying all postdocs at least $47,484 — the minimum salary established by the US National Institutes of Health for the 2017 fiscal year. The NPA is set to publish the full results of its poll in January 2018.

In the meantime, McDowell is still combing through his data set. Throughout November, he plans to publish daily analyses on the Future of Research website, futureofresearch.org, that will examine salaries at individual institutions and university systems. In doing so, he hopes to promote conversation about the treatment of early-career researchers.

"In academia, we're not supposed to talk about money and we're not supposed to aspire to having money," McDowell says. "I think scientists should value scientists."

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Comments

Commenting is currently unavailable.

Citation is not the only impact

A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.

01 November 2017

Getty

A research paper on drying coffee stains had unusual and unexpected applications.

What makes good science? And how do *Nature*'s editors select papers to publish? The answers to both questions are many and varied. But they have one thing in common: neither is necessarily reflected in citations.

Nature publishes about 800 papers each year. Over, say, two years following

publication, the pattern of citations typically ranges from a few papers with citations in the hundreds, to a large number with tens of citations, and a tail with single figures.

We are pleased when our papers make an impact. But there is much more to scientific impact than citations. For example, last week, in an 'In Retrospect' article in News & Views, Ronald Larson described a remarkable story (R. Larson *Nature* **550,** 466–467; 2017). In 1997, *Nature* published a paper by Robert Deegan and his colleagues that provided an explanation of the 'coffee-ring effect' in spilt liquids, based on considerations of evaporation and surface interactions (R. D. Deegan *et al. Nature* **389,** 827–829; 1997). For several years, the paper sat proudly in our pages, typically gathering about 20 citations per year. In 2006, as new implications and applications became clear, the rate picked up to well over 100 a year. So far, it has attracted about 4,000 citations. The paper is worth highlighting as an example of the varied types of judgement that *Nature* editors use to select papers.

Our most highly cited papers are indeed often key landmarks in their fields. But there are papers that turn out to have low citations that we are equally happy to have published. The work by Deegan *et al.* was selected not because of any editorial ability to anticipate advances years in the future, but because, at the time, we considered it to be a noteworthy and pleasing piece of insight. Nothing more, nothing less. The developments celebrated by Larson are an editor's unexpected bonus.

Most papers that we publish, with the invaluable help of our reviewers, are selected with a view to their scientific significance, whether as a powerful insight or an unusually empowering resource. And often that will correlate closely with citations (although citation patterns differ across disciplines). But it's important also, for editors in all the disciplines from which we publish, sometimes to appreciate the interest in a paper using quite different criteria. It may be compelling for its sheer creativity or logical elegance, for making the reader stop and think very differently about a question, or for a stimulating and even mysterious observation. Many of these may be slow burners citation-wise — or simply be textbook examples that never get taken up in abundance. Here are other examples, drawn from the physical sciences,

that, despite low citations, we like to celebrate.

One such paper illustrated how images could be taken using X-rays radiated when sticky tape was peeled (C. G. Camara *et al. Nature* **455,** 1089–1092; 2008). The citations are not huge by physics standards (165 since 2008) but we still love it, and we did not fully anticipate how it would go viral on social media. Another (11 citations) reported an actual sample of Cretaceous seawater from 145 million years ago. (W. E. Sanford *et al. Nature* **503,** 252–256; 2013). And finally, a theoretical paper providing an exact textbook solution for the capacity of noisy quantum communication channels has been cited just six times since 2013 (G. Smith and J. A. Smolin *Nature* **504,** 263–267; 2013), but we value it for what it is and anticipate that its take-up could increase as research moves from idealized 'noise-free' systems to more realistic noisy ones.

There are examples in other disciplines too. Why highlight such papers? Because we are glad to have published them. And because it's perhaps salutary to appreciate just how unrelated scientific interest (at least, as we at *Nature* see it) and citation numbers can be.

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Comments

Commenting is currently unavailable.

Urban Vibe
Studios
London

University systems allow sexual harassers to thrive

It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen[1].

01 November 2017

Harvey Weinstein, Roger Ailes, Geoff Marcy. From entertainment to academia, accusations of these people's abuses of power have helped to create a sea change in the numbers of people willing to discuss sexual harassment in the workplace. Much of the conversation has concerned condemnation of harassers and praise for those who come forward to talk about what they have seen and experienced. This puts an interpersonal frame on a systemic problem. Attention must also be paid to systems that allow harassers to thrive.

In 2006, I joined the Brain and Cognitive Sciences Department at the University of Rochester, New York, as a PhD student. This August, I joined other female graduate students and postdocs who contributed testimony to a complaint to the US Equal Employment Opportunity Commission over

sexual harassment, poor handling of investigations of our claims and discrimination. We described how we actively avoided Florian Jaeger, a professor in our department, because of his frequent sexual innuendos, pressure to have intimate relationships and other unprofessional behaviour. We were faced with the unfair and unreasonable choice of losing professional opportunities or exposing ourselves to profoundly disturbing encounters. (According to *The New York Times*, Jaeger has since taken a leave of absence but said this was not an admission of guilt.)

I knew this behaviour was not acceptable. I was also convinced that if I came forward alone, I risked retribution and the university would not take my claims seriously. I felt my best option was to warn other students privately and make it known that I would come forward if we reached a critical mass.

After I chose to move away to finish my dissertation, I learnt that in 2013 two colleagues had complained to the department chair about Jaeger's behaviour and given my name as someone who should be interviewed. I was not contacted. In 2016, other senior faculty members learnt of these claims and filed a second complaint to the university to investigate. This time the university first contacted me during an appeal, after issuing a report that cleared Jaeger. The first person to secure testimony from me was from McAllister Olivarius, a London-based legal firm hired by the plaintiffs. My former colleagues had found a powerful ally in getting their complaints taken seriously.

It should not have taken such heroic efforts.

In this regard, Hollywood and academia have troubling similarities. Both rely too much on mentor–protégé relationships, with few checks on individual power. In academia, there is scant protection for lab members. Graduate students and postdocs are viewed more as part of their supervisor's lab than part of the university community. By contrast, institutions have many incentives to protect their powerful, permanent and often lucrative faculty members.

Administrators can reasonably assume that, if they ignore claims for long enough, they will never be held to account. People like me graduate or leave without a degree, the statute of limitations passes, and the harassers get

promoted. Sometimes universities don't interview suggested witnesses or collect other evidence; in my view, this allows them to claim that they investigated complaints but found insufficient reasons for further action. (The University of Rochester has said it took the allegations seriously and that its investigation was thorough.)

Since completing my PhD, I've taken a position at a large company. There are still power differentials in such settings, and sexual harassment can occur unpunished anywhere. However, I've seen several practices that I think academia could learn from.

In my first week of employment, the company explained my rights to a safe workplace and gave me options for reporting concerns. As a graduate student, I had mistakenly believed that the only instances of sexual harassment that could be brought forward were the most egregious: assault or quid-pro-quo propositions. I was unaware of legal precedents involving pervasive harassment creating a hostile and unequal environment. I was also unaware of the standard of preponderance of evidence, and thought that every instance had to be recorded and irrefutable. Graduate students and employees should not have to be legal scholars to win protections.

Another problem is how much the fate of a graduate student or postdoc depends on a supervisor who controls funding for their position, when they can submit a dissertation or paper and what other opportunities they can apply for. Power is less likely to be abused when it is more distributed.

My current company holds drop-in conference calls throughout the year, some of which are reserved for women only. We can discuss concerns off the record or even anonymously; topics range from standardizing the promotion process and improving diversity in recruitment, to discussing comments that have made us feel undermined or uncomfortable. People bringing concerns have options about whether and how they are reported outside the call. At the same time, leaders can become aware of even minor problems and address them (through discussion with staff and line managers, or through memos) before they become patterns that lead to a toxic work environment.

We used to consider those in leadership positions blameless simply by virtue of not being harassers themselves. We now expect better.

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Comments

Comments

There are currently no comments.

Interstellar visitor, Arctic shipwrecks and a retraction recommendation

The week in science: 27 October–2 November 2017.

01 November 2017

History | Universities | People | Medicines | Research | Space | Events | Facilities | Climate | Trend watch | Awards

HISTORY

Arctic explorer's wrecks given to Canada The UK government is giving Canada two historic shipwrecks: those of HMS *Erebus* and HMS *Terror*. The vessels were part of British explorer Sir John Franklin's ill-fated 1845 expedition to find the Northwest Passage, a long-sought shipping route that connects the Atlantic and Pacific oceans through the Canadian Arctic. Franklin died, along with his entire crew, after the ships became ice-bound and the team abandoned them. Marine archaeologists discovered *Erebus* and *Terror* in 2014 and 2016, respectively, off King William Island. In 1997, an agreement had granted custody of the yet-to-be located wrecks to Canada, although they remained property of the United Kingdom. On 23 October, the UK government said that it would transfer ownership of the ships to Parks Canada, a government agency.

Parks Canada

Part of the wreck of the HMS *Terror*.

UNIVERSITIES

Institute dissolved The Swiss Federal Institute of Technology in Zurich (ETH Zurich), one of Europe's leading universities, has launched an investigation into allegations that PhD students were regularly bullied in its Institute for Astronomy. ETH Zurich released a statement on 25 October saying that it had closed the institute in August in response to the accusations, which were made earlier this year. Newspaper reports say students had complained that astrophysicist Marcella Carollo — a professor, and wife of the institute's director Simon Lilly — had been inappropriately and personally critical, and overly demanding of their time. The university did not publicly name the couple, but said that it had transferred their professorships to the university's physics department. It moved other Institute for Astronomy staff to a newly created Institute for Particle Physics and

Astronomy, and assigned the students new supervisors.

Science cluster French President Emmanuel Macron has announced a plan to save the troubled Paris-Saclay project, an attempt to create a single science 'super-campus' southwest of the city. During a visit to the site on 25 October, Macron said that the project would now proceed in two clusters, one made up of elite institutions called *grandes écoles*, and one made up largely of universities. The project, which initially aimed to bring together nearly 20 research and teaching institutions under one umbrella university, had been mired by the *grandes écoles*' refusal to give up their names and autonomy. A previous effort this year to find a compromise solution had failed. "The time of procrastination is behind us," Macron said.

PEOPLE

Surgeon's papers Six research papers co-written by disgraced thoracic surgeon Paolo Macchiarini should be retracted because they contain evidence of scientific misconduct, the Swedish Central Ethical Review Board said in a statement dated 27 October. The papers had been central to Macchiarini's claims about a radical stem-cell-based tracheal transplant, which he developed partly during his employment by the Karolinska Institute in Stockholm. The institute had asked the ethics board to examine the papers. Earlier last month, Swedish public prosecutors dropped their investigations into charges of manslaughter and grievous bodily harm by the surgeon. The charges involved four people on whom Macchiarini had performed operations at the Karolinska University Hospital between 2011 and 2013. Three have since died, but the prosecutors said there was a lack of conclusive evidence that the surgery caused the deaths. They noted negligent procedures in some of the operations.

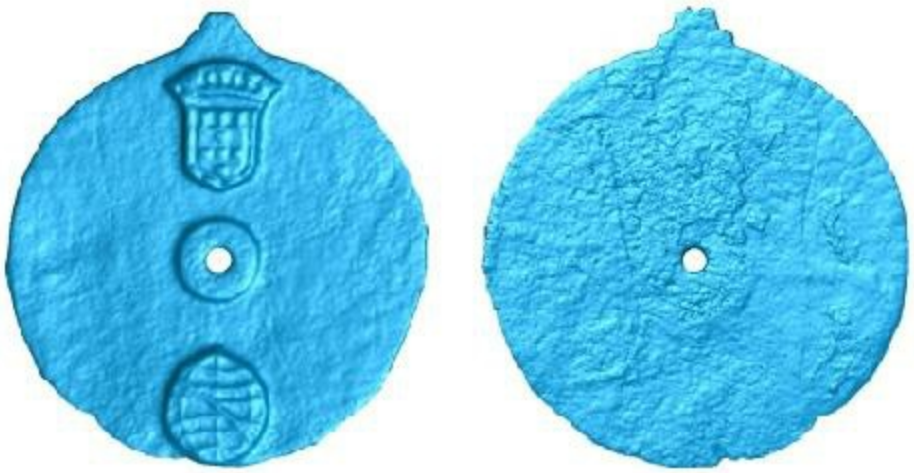
MEDICINES

Hepatitis C drugs On 25 October, a US non-profit organization filed challenges against six core patents for sofosbuvir, a key component of three hepatitis C drugs. The medicines — Sovaldi, Harvoni and Epclusa — belong

to Gilead Sciences in Foster City, California. The Initiative for Medicines, Access and Knowledge (I-MAK) in New York City argues that Gilead's patents are unmerited because the drug is not different enough to warrant a US patent, saying that the company developed the compound by tweaking existing HIV and cancer drugs. The patents prevent cheaper, generic drugs from entering the US market. Using a similar argument, I-MAK had a sofosbuvir patent removed in China in 2015.

RESEARCH

Old astrolabe A 500-year-old bronze disc recovered from a shipwreck in 2014 might be the oldest-known example of a technology that changed world history. The artefact was retrieved from the wreck of the *Esmeralda*, part of the fleet of the Portuguese explorer Vasco da Gama. On 24 October, researchers at the University of Warwick in Coventry, UK, said that laser scanning has now revealed markings at 5-degree intervals around its circumference, suggesting that the 17.5-centimetre-diameter object is a mariner's astrolabe. Developed by Portuguese navigators in the late fifteenth century, these devices determine latitude by measuring the Sun's altitude, and helped sailors to explore the oceans and map the world. The *Esmeralda* sank in the Indian Ocean in 1503, making this mariner's astrolabe several decades older than any of the hundred or so others that survive.



WMG/University of Warwick

Composite image of scans of a 500-year-old bronze astrolabe.

SPACE

Foreign object Astronomers have spotted a space rock that might have come from outside the Solar System. The small asteroid or comet, named A/2017 U1, swooped towards and then past the Sun from an angle almost perpendicular to the plane in which most of the planets orbit. Its trajectory — a hyperbolic orbit — suggests that it came from interstellar space, NASA said on 26 October, a week after the object's discovery. If further observations confirm its orbit, it would be the first such interstellar object known.

Earth mission ends The paired satellites of the US–German Gravity Recovery and Climate Experiment (GRACE), which have been making fundamental observations of Earth since their 2002 launch, have ceased science operations. Mission controllers realized on 12 October that the

batteries in one of the satellites had failed because of its age, a long-expected outcome. NASA and the German space agency DLR announced the mission's end on 27 October, and said the other satellite will be decommissioned next year. GRACE has provided crucial measurements of melting ice sheets and groundwater storage, among other things.

EVENTS

Weedkiller dispute The European Union postponed a decisive vote on 25 October on proposals to renew its licence for the controversial weedkiller glyphosate. The current EU authorization expires on 15 December. But member states were unable to settle on a compromise for how long the licence should be extended by. The World Health Organization says that glyphosate is "probably" carcinogenic to humans, but key EU safety agencies say it is not. Member states will be asked to vote on a five-year extension on 9 November. More than 1.3 million Europeans have signed a petition calling for the substance to be banned.

Harassment probe The US House Committee on Science, Space, and Technology is investigating allegations of sexual harassment against geologist David Marchant of Boston University, Massachusetts. Marchant has received about US$5.4 million in funding since the 1990s from federal agencies, including the National Science Foundation (NSF) and NASA. In letters sent to the NSF, NASA and Boston University on 26 October, the committee asked for all documents and communications involving federal grants awarded to Marchant, as well as complaints of alleged assault and harassment and any actions taken by each institution. Two of Marchant's former graduate students filed complaints with Boston University, in October 2016 and May 2017, for behaviour that allegedly occurred while they were on research trips with him in Antarctica in the 1990s.

FACILITIES

Genome database A Chinese province is building a large sequencing centre that will create a database of genetic information from Chinese people. The

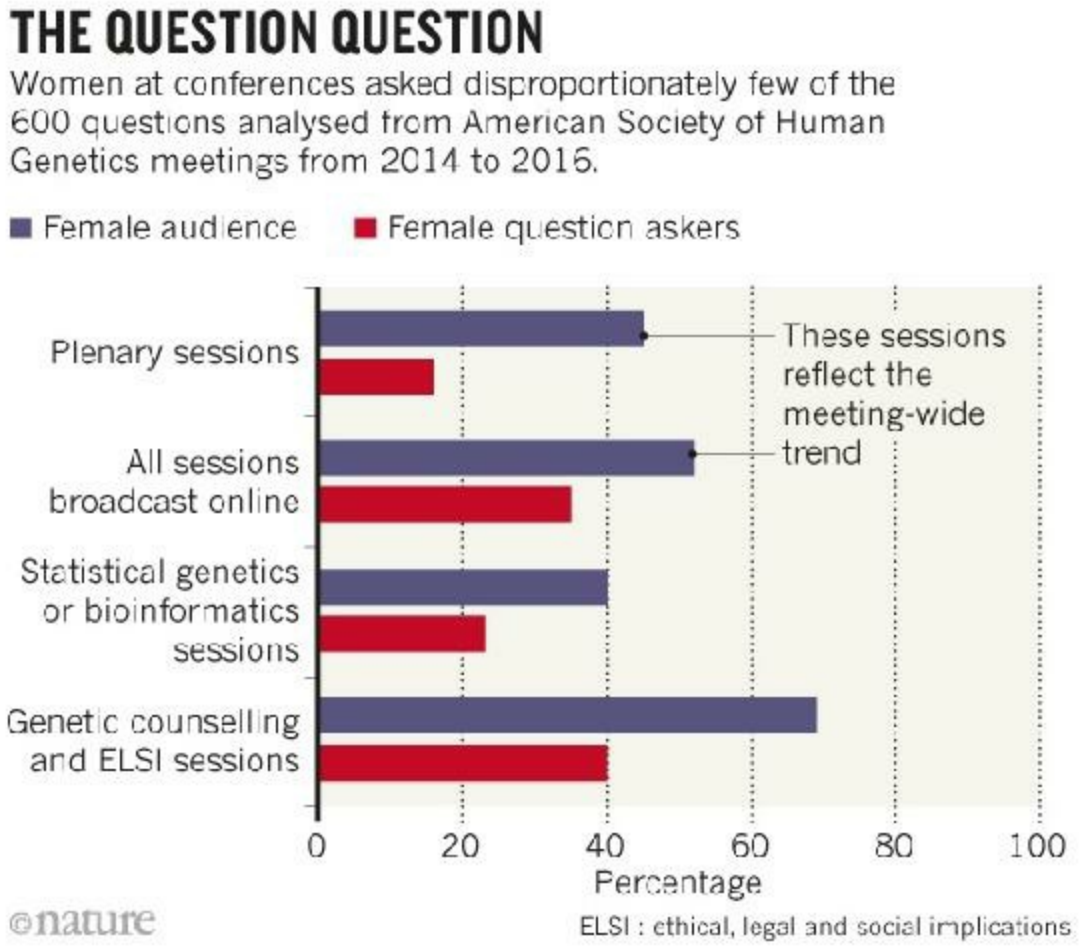
National Health & Medicine Big Data Center is being built in Nanjing, the capital of Jiangsu province, as part of a 6-billion-yuan (US$905-million) genome project announced by the local government on 29 October. The centre will house multiple firms that will together sequence up to 500,000 samples a year. Data will be used to look for mutations related to disease, as well as environmental factors that might trigger illness. Researchers will also use the data to tailor treatments to individual patients.

CLIMATE

Record CO_2 levels Atmospheric concentrations of carbon dioxide surged at a record pace and to a record high in 2016 because of human emissions and an El Niño warming event, the World Meteorological Organization said on 30 October. Average global CO_2 concentrations rose from 400 to 403.3 parts per million, roughly 45% above pre-industrial levels. The last time Earth had comparable CO_2 levels was during the mid-Pliocene epoch around 4 million years ago, when temperatures were 2–3 °C warmer than those today and sea levels were 10–20 metres higher. Concentrations of the greenhouse gases methane and nitrous oxide also increased, to 157% and 22% above pre-industrial levels, respectively.

TREND WATCH

Women ask fewer questions than men at conferences, even if there are more women in the room, according to an analysis of talks at American Society of Human Genetics (ASHG) meetings in 2014–16. Natalie Telis of Stanford University in California and her colleagues looked at 600 questions asked at 222 conference talks. To reach parity in question-asking, the audience would have to be at least 85% women, they say. Women are most likely to question female speakers, but still speak up less often than men.



Source: Natalie Telis

AWARDS

Space pioneers The first woman and the first Chinese national in space were among four recipients of the inaugural medal for space science from the United Nations Educational, Scientific and Cultural Organization (UNESCO). Awards for Chinese astronaut Yang Liwei, who completed the country's first crewed space mission in October 2003, and Russian cosmonaut Valentina Tereshkova were announced at a ceremony in Paris on 27 October. Also honoured were Koichi Wakata, the first Japanese commander of the International Space Station, and Arnaldo Tamayo Mendez, the first Cuban in space. The medal, established in June, recognizes

prominent researchers or public figures who have contributed to space science.

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Comments

There are currently no comments.

Plans to promote German research excellence come under fire

Critics say selection process for high-stakes funding programme is flawed.

01 November 2017

Bern Lauter/vario images GmbH/Alamy

Peter Strohschneider, president of the DFG.

Germany’s latest programme to boost research at its universities and make them more competitive internationally risks missing its goals, according to

observers.

The Excellence Initiative was launched in 2005 with €4.6 billion (US$5.4 billion) in funding and the aim of creating a handful of elite universities. Researchers across Germany are now preparing for the programme's next round, dubbed the Excellence Strategy, which starts in 2019.

Earlier this year, almost 200 groups of scientists submitted proposals to form Clusters of Excellence — large collaborations of research groups at one or more universities that form the core element of the strategy. And last month, an international committee invited 88 of the groups to submit full project proposals by late February. Up to 50 such clusters will from 2019 receive top-up funding of about €8 million per year for seven years.

But observers question whether the 88 selected projects represent Germany's best science, particularly because the focus for selection has shifted away from basic science and towards applied research. Unsuccessful applicants say that the rules for submitting proposals for the initiative were not clearly defined and communicated. Several high-profile groups came away empty-handed, including biology teams in Frankfurt, Heidelberg and Munich involving dozens of scientists funded by the prestigious European Research Council.

"The Excellence Initiative has brought German science some welcome structural change," says Dieter Imboden, a Swiss environmental physicist who chaired a 2016 review of the initiative. "But its achievements must not obscure the view of its flaws."

The competition to form clusters should be run independently of that for elite-university status, he says. Otherwise, second-tier universities could outperform those with a much stronger overall research portfolio and gain the sought-after title, which is currently held by 11 universities.

Critics also say that the geographic spread of positively reviewed applications for future excellence clusters — across 41 universities in 13 of Germany's 16 states — hints at a political desire to distribute the funds more evenly across the country.

But Peter Strohschneider, president of Germany's main research-funding agency, the DFG, which runs the programme, says the selection panels chose the projects strictly on the basis of scientific quality, without any regional or political considerations. Scientists will figure strongly on the Excellence Commission, which will make the final selection in September 2018 and will also include federal and state science ministers, he says.

Until 2005, responsibility for funding universities in Germany lay exclusively with the states. The Excellence Initiative was created to allow central government to inject federal money into research, a move now guaranteed by a change to the German constitution. But many say the changes have not gone far enough.

"The initiative has quite lost sight of its goal," says a former president of a large German university, speaking on condition of anonymity. "Universities here remain trapped in a federal political system that is unable to create a powerhouse like Yale or Harvard."

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The new thermodynamics: how quantum physics is bending the rules

Experiments are starting to probe the limits of the classical laws of thermodynamics.

01 November 2017

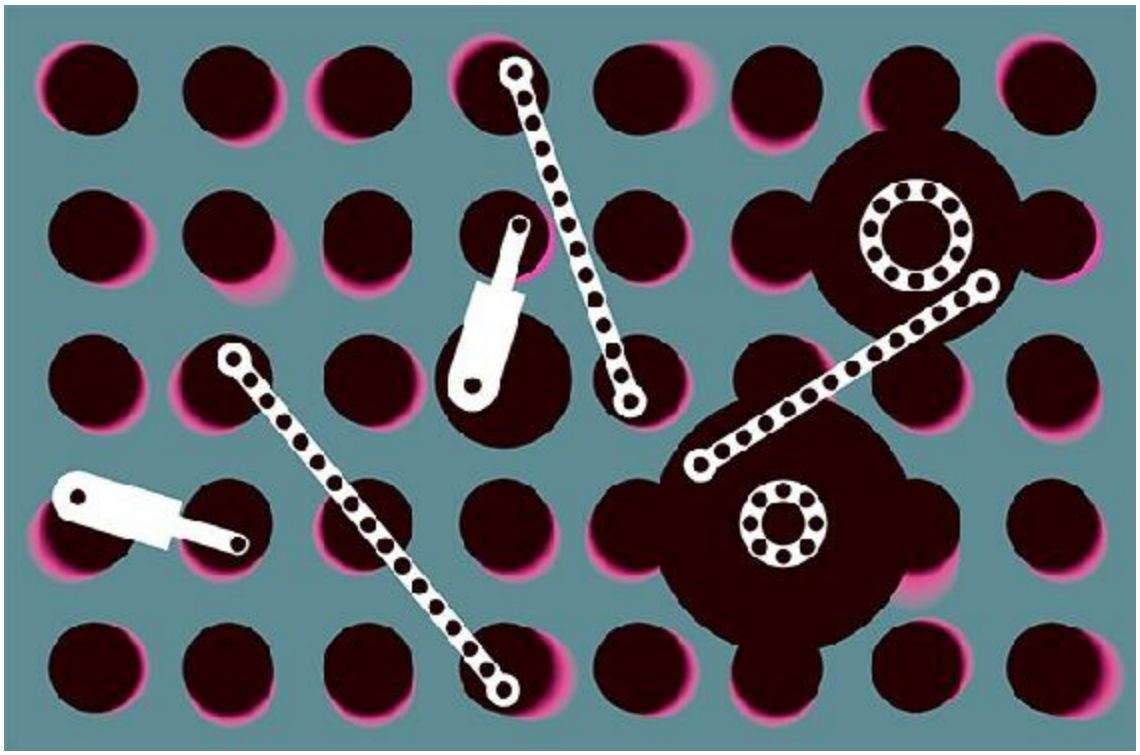


Illustration by Edgar Bąk

It would take a foolhardy physicist to dare attempt to break the laws of thermodynamics. But it turns out that there may be ways to bend them. At a lab at the University of Oxford, UK, quantum physicists are trying to do so with a small lump of synthetic diamond. At first, the diamond is barely

visible, nestled inside a chaotic mess of optical fibres and mirrors. But when they switch on a green laser, defects in the diamond are illuminated, and the crystal begins to glow red.

In that light, the team has found preliminary evidence of an effect that was theorized only a few years ago[1]: a quantum boost that would push the diamond's power output above the level prescribed by classical thermodynamics. If the results hold up, they will be a tangible boon for the study of quantum thermodynamics, a relatively new field that aims to uncover the rules that govern heat and energy flow at the atomic scale.

There is reason to suspect that the laws of thermodynamics, which are based on how large numbers of particles behave, are different in the quantum realm. Over the past five years or so, a quantum-thermodynamics community has grown around that idea. What was once the domain of a handful of theoreticians now includes a few hundred theoretical and experimental physicists around the globe. “The field is moving so fast I can barely keep up,” says Ronnie Kosloff, an early pioneer of the field at the Hebrew University of Jerusalem in Israel.

A number of quantum thermodynamicists hope to find behaviour outside the remit of conventional thermodynamics that could be adapted for practical purposes, including improving lab-based refrigeration techniques, creating batteries with enhanced capabilities and refining technology for quantum computing.

But the field is still in its infancy. Experiments such as the one taking place at Oxford are just starting to put theoretical predictions to the test. And physicists working at the periphery are watching such tests closely for evidence of the useful applications that theorists have predicted. “Quantum thermodynamics is clearly hot — pardon the pun,” says Ronald Walsworth, a physicist at Harvard University in Cambridge, Massachusetts, who specializes in developing precision atomic-scale tools. “But for those of us looking in from the outside, the question is: can it really shed new light on the development of technologies?”

Breaking the law

The development of the classical laws of thermodynamics stretches back to the nineteenth century. They emerged from the effort to understand steam engines and other macroscopic systems. Thermodynamic quantities such as temperature and heat are statistical in nature and defined in reference to the average motion of large ensembles of particles. But back in the 1980s, Kosloff began pondering whether this picture would continue to make sense for much smaller systems.

It wasn't a popular line of research at the time, says Kosloff, because the questions being asked were largely abstract, with little hope of connection to experiments. “The field developed very slowly,” he says. “I was alone for years.”

That changed dramatically around a decade ago, as questions about the limits of technological miniaturization became more pressing and experimental techniques advanced. A flurry of attempts were made to calculate how thermodynamics and quantum theory might combine. But the resulting proposals created more confusion than clarity, Kosloff says. Some claimed that quantum devices could violate classical thermodynamic constraints with impunity and so act as perpetual-motion machines, capable of performing work without needing any energy input. Others, suggesting that the laws of thermodynamics should hold unmodified at very small scales, were equally perplexing. “In some sense, you can use the same equations to work out the performance of a single atom engine and your car engine,” says Kosloff. “But that seems shocking, too — surely as you get smaller and smaller you should hit some quantum limit.” In classical thermodynamics, a single particle doesn't have a temperature. So as both the system generating work and its environment approach that limit, it becomes increasingly absurd to imagine that they would obey standard thermodynamic rules, says Tobias Schaetz, a quantum physicist at the University of Freiburg in Germany.

The preponderance of conflicting theoretical claims and predictions initially undermined the burgeoning field's credibility. “I have been very critical of the field because there is far too much theory and not enough experiment,” says quantum physicist Peter Hänggi, at the University of Augsburg in Germany. But the community is beginning to coalesce more formally around core questions in an effort to cut through the chaos. One goal has been to use

experiments to uncover the point at which the classical laws of thermodynamics no longer perfectly predict the thermal behaviour of quantum systems.

Experiments are starting to pin down that quantum–classical boundary. Last year, for example, Schaetz and his colleagues showed that, under certain conditions, strings of five or fewer magnesium ions in a crystal do not reach and remain in thermal equilibrium with their surroundings like larger systems do[2]. In their test, each ion started in a high-energy state and its spin oscillated between two states corresponding to the direction of its magnetism — 'up' and 'down'. Standard thermodynamics predicts that such spin oscillations should die down as the ions cool by interacting with the other atoms in the crystal around them, just as hot coffee cools when its molecules collide with molecules in the colder surrounding air.

Such collisions transfer energy from the coffee molecules to the air molecules. A similar cooling mechanism is at play in the crystal, where quantized vibrations in the lattice called phonons carry heat away from the oscillating spins. Schaetz and his colleagues found that their small ion systems did stop oscillating, suggesting that they had cooled. But after a few milliseconds, the ions began oscillating vigorously again. This resurgence has a quantum origin, says Schaetz. Rather than dissipating away entirely, the phonons rebounded at the edges of the crystal and returned, in phase, to their source ions, reinstating the original spin oscillations.

Schaetz says that his experiment sends a warning to engineers attempting to reduce the size of existing electronics. “You may have a wire that is only 10 or 15 atoms wide, and you may think that it has successfully carried the heat away from your chip, but then boop — suddenly this quantum revival happens,” Schaetz says. “It is very disturbing.”

Rebounding phonons could present a challenge in some applications, but other quantum phenomena could turn out to be useful. Efforts to identify such phenomena had been stalled by the difficulty in defining basic quantities, such as heat and temperature, in quantum systems. But the solution to a famous thought experiment, laid out 150 years ago by Scottish physicist James Clerk Maxwell, provided a clue about where to turn, posing an intriguing link between information and energy. Maxwell imagined an entity

that could sort slow- and fast-moving molecules, creating a temperature difference between two chambers simply by opening and closing a door between them.

Such a 'demon', as it was later called, thus generates a hot and a cold chamber that can be harnessed to produce useful energy. The problem is that by sorting particles in this way, the demon reduces the system's entropy — a measure of the disorder of the particles' arrangements — without having done any work on the particles themselves. This seemingly violates the second law of thermodynamics.

But physicists eventually realized that the demon would pay a thermodynamic price to process the information about the molecules' speeds. It would need to store, erase and rewrite that information in its brain. That process consumes energy and creates an overall increase in entropy[3]. Information was once thought to be immaterial, “but Maxwell's demon shows that it can have objective physical consequences”, says quantum physicist Arnau Riera, at the Institute of Photonic Sciences in Barcelona, Spain.

Finding the limit

Inspired by the idea that information is a physical quantity — and that it is intimately linked to thermodynamics — researchers have attempted to recast the laws of thermodynamics so that they work in the quantum regime.

Perpetual-motion machines may be impossible. But an early hope was that limits prescribed by quantum thermodynamics might be less stringent than those that hold in the classical realm. “This was the train of thought we had learned from quantum computing — that quantum effects help you beat classical bounds,” says Raam Uzdin, a quantum physicist at the Technion–Israel Institute of Technology in Haifa.

Disappointingly, Uzdin says, this is not the case. Recent analyses suggest that quantum versions of the second law, which governs efficiency, and the third law, which prohibits systems from reaching absolute zero, retain similar and, in some cases, more-stringent constraints than their classical incarnations.

Some differences arise because the macroscopic thermodynamic quantity 'free energy'— the energy a system has available to do work — doesn't have just one counterpart at the microscale, but many, says Jonathan Oppenheim, a quantum physicist at University College London. Classically, the free energy is calculated by assuming that all states of the system, determined by the arrangement of particles at a given energy, are equally likely. But that assumption isn't true on tiny scales, says Oppenheim; certain states might be much more probable than others. To account for this, additional free energies need to be defined in order to accurately describe the system and how it will evolve. Oppenheim and his colleagues propose that individual second laws exist for each type of free energy, and that quantum devices must obey all of them[4]. “Since the second law tells you what you aren't allowed to do, in some ways, it seems that having more laws on the microscale leaves you worse off,” says Oppenheim.

Much of the work done to calculate equivalents of the second and third laws remains, for now, theoretical. But proponents argue that it can help to illuminate how thermodynamic bounds are physically enforced at small scales. For instance, a theoretical analysis carried out by a pair of quantum physicists based in Argentina showed that as a quantum refrigerator nears absolute zero, photons will spontaneously appear in the vicinity of the device[5]. “This dumps energy into the surroundings, causing a heating effect that counters the cooling and stops you ever reaching absolute zero,” explains team member Nahuel Freitas of Ciudad University in Buenos Aires.

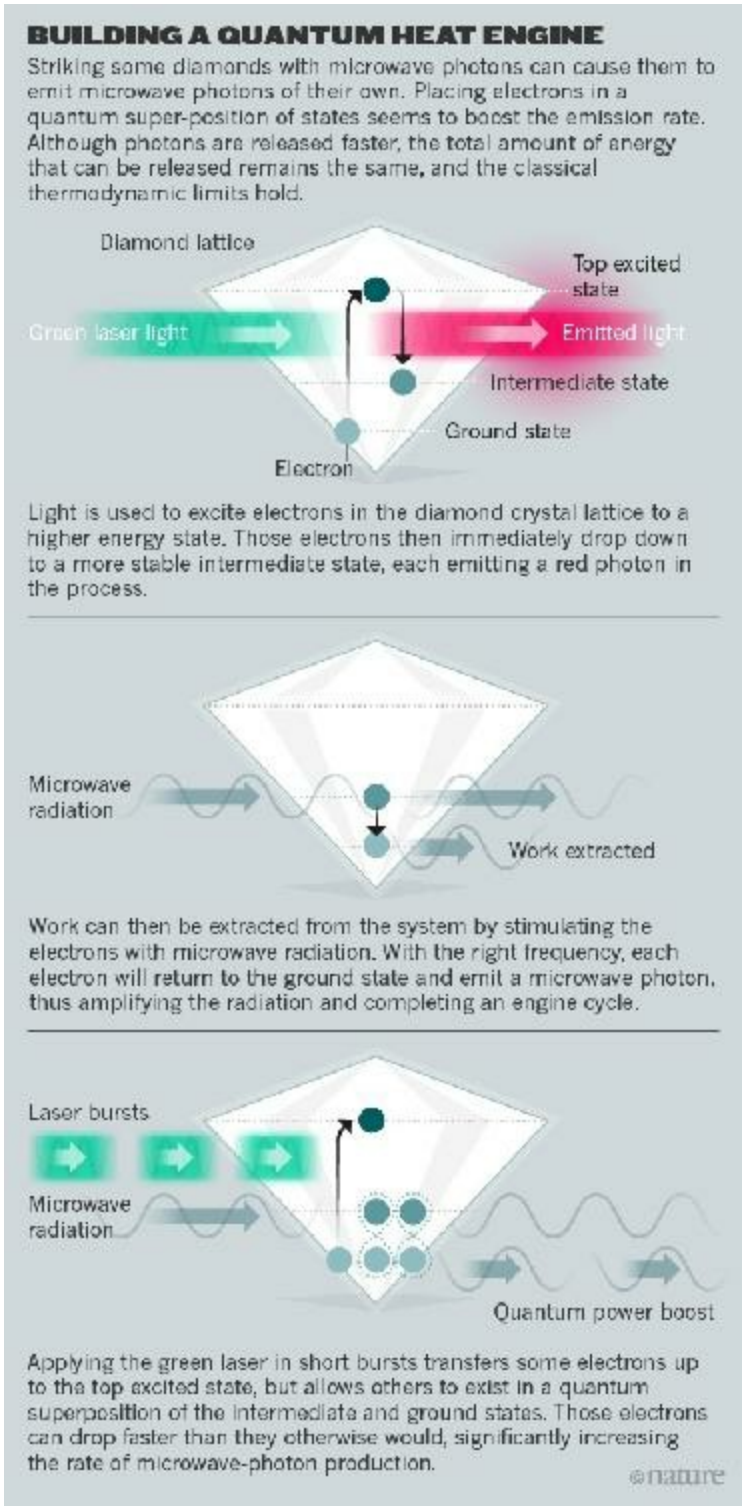
Theory has also revealed some potential wiggle room. In a theoretical analysis examining information flow between hot and cold chambers, or 'baths', of particles, a team based in Barcelona that included Riera and quantum physicist Manabendra Nath Bera discovered a strange scenario in which the hot bath seemed to spontaneously get hotter, while the cold bath became colder[6]. “At first, this looks crazy, like we can violate thermodynamics,” says Bera. But the researchers soon realized that they had overlooked the quantum twist: the particles in the baths can become entangled. In theory, making and breaking these correlations provides a way to store and release energy. Once this quantum resource was budgeted for, the laws of thermodynamics fell into place.

A number of independent groups have proposed using such entanglement to store energy in a 'quantum battery', and a group at the Italian Institute of Technology in Genoa is attempting to confirm the Barcelona team's predictions with batteries built from superconducting quantum bits, or 'qubits'[7]. In principle, such quantum batteries could charge considerably faster than their classical equivalents. “You won't be able to extract and store more energy than the classical bound allows — that's set by the second law,” says Riera. “But you may be able to speed things up.”

Some researchers are looking for easier ways to manipulate qubits for quantum-computing applications. Quantum physicist Nayeli Azucena Rodríguez Briones at the University of Waterloo in Canada and her colleagues have devised[8] an operation that might enhance the cooling needed for quantum-computing operations by manipulating pairs of qubit energy levels. They are currently planning to test this idea in the lab using superconducting qubits.

A small spark

The concept that quantum effects could be exploited to improve thermodynamic performance also inspired the diamond experiment under way at Oxford, which was first proposed by Kosloff, Uzdin and Amikam Levy, also at the Hebrew University[1]. Defects created by nitrogen atoms scattered through the diamond can serve as an engine — a machine that performs an operation after being brought into contact with first a hot reservoir (in this case a laser) and then a cold one. But Kosloff and his colleagues expect that such an engine can be operated in an enhanced mode, by exploiting a quantum effect that enables some of the electrons to exist in two energy states simultaneously. Maintaining these superpositions by pulsing the laser light rather than using a continuous beam should enable the crystal to emit microwave photons more rapidly than it otherwise would (see 'Building a quantum heat engine').



Last week, the Oxford-based team posted a preliminary analysis[9] showing evidence of the predicted quantum boost. The paper has yet to be peer reviewed, but if the work holds up, then “it is a groundbreaking result,” says

Janet Anders, a quantum physicist at Exeter University, UK. But, she adds, it's still not clear exactly what enables this feat. “It seems to be a magic fuel, not so much adding energy, but enabling the engine to extract energy faster,” Anders says. “Theoretical physicists will need to examine just how it does this.”

Focusing on experiments is a major step in the right direction for revitalizing the field, says Hänggi. But, for him, the experiments are not yet bold enough to give truly ground-breaking insights. There is also the challenge that quantum systems can be irrevocably disturbed by measurement and interaction with the environment. These effects are rarely sufficiently accounted for in theoretical proposals for new experiments, he says. “That is difficult to calculate, and much more difficult to implement in an experiment,” he says.

Ian Walmsley, who heads the Oxford lab where the diamond experiment was conducted, is also circumspect about the future of the field. Although he and other experimenters have been drawn to quantum thermodynamics research in recent years, he says that their interest has been largely “opportunistic”. They have spotted the chance to carry out relatively quick and easy experiments by piggybacking on set-ups already in place for other uses; the diamond-defect set-up, for instance, is already being widely studied for quantum computing and sensor applications. Today, quantum thermodynamics is fizzing with energy, Walmsley says. “But whether it will continue to sparkle, or just explode into nothing, well, we will have to wait and see.”

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Comments

8 comments

1. *Pentcho Valev* • 2017-11-03 08:02 AM

   Clifford Truesdell, The Tragicomical History of Thermodynamics, 1822-1854, p. 6: "Finally, I confess to a heartfelt hope - very slender but tough - that even some thermodynamicists of the old tribe will study this book, master the contents, and so share in my discovery: Thermodynamics need never have been the Dismal Swamp of Obscurity that from the first it was and that today in common instruction it is; in consequence, it need not so remain." [...] p. 333: "Clausius' verbal statement of the "Second Law" makes no sense, for "some other change connected therewith" introduces two new and unexplained concepts: "other change" and "connection" of changes. Neither of these finds any place in Clausius' formal structure. All that remains is a Mosaic prohibition. A century of philosophers and journalists have acclaimed this commandment; a century of mathematicians have shuddered and averted their eyes from the unclean."
   https://www.amazon.com/Tragicomical-Thermodynamics-1822-1854-Mathematics-Physical/dp/1461394465 Jos Uffink, Bluff your way in the Second Law of Thermodynamics: "Before one can claim that acquaintance with the Second Law is as indispensable to a cultural education as Macbeth or Hamlet, it should obviously be clear what this law states. This question is surprisingly difficult. The Second Law made its appearance in physics around 1850, but a half century later it was already surrounded by so much confusion that the British Association for the Advancement of Science decided to appoint a special committee with the task of providing clarity about the meaning of this law. However, its final report (Bryan 1891) did not settle the issue. Half a century later, the physicist/philosopher Bridgman still complained that there are almost as many formulations of the second law as there have been discussions of it. And even today, the Second Law remains so obscure that it continues to attract new efforts at clarification."

http://philsci-archive.pitt.edu/313/1/engtot.pdf As Clifford Truesdell suggests, the confusion started with Clausius's 1850 idiotic argument - later formulations of the second law of thermodynamics have all been defective. However previous formulations - those of Carnot - were both clear and correct. The simplest one is this: "A cold body is necessary" That is, heat cannot be cyclically converted into work unless a hot body, source of heat, and a cold body, receiver of heat, are available. The problem is that in 1824 Carnot deduced "A cold body is necessary" from a postulate that eventually turned out to be false: Carnot's (false) postulate: Heat is an indestructible substance (caloric) that cannot be converted into work by the heat engine. Unpublished notes written in the period 1824-1832 reveal that, after realizing that his postulate was false (and discovering the first law of thermodynamics), Carnot found "A cold body is necessary" implausible: Sadi Carnot, REFLECTIONS ON THE MOTIVE POWER OF HEAT, p. 225: "Heat is simply motive power, or rather motion which has changed form. It is a movement among the particles of bodies. Wherever there is destruction of motive power there is, at the same time, production of heat in quantity exactly proportional to the quantity of motive power destroyed. Reciprocally, wherever there is destruction of heat, there is production of motive power." p. 222: "Could a motion (that of radiating heat) produce matter (caloric)? No, undoubtedly; it can only produce a motion. Heat is then the result of a motion. Then it is plain that it could be produced by the consumption of motive power, and that it could produce this power. All the other phenomena - composition and decomposition of bodies, passage to the gaseous state, specific heat, equilibrium of heat, its more or less easy transmission, its constancy in experiments with the calorimeter - could be explained by this hypothesis. But it would be DIFFICULT TO EXPLAIN WHY, IN THE DEVELOPMENT OF MOTIVE POWER BY HEAT, A COLD BODY IS NECESSARY; why, in consuming the heat of a warm body, motion cannot be produced." http://www.nd.edu/~powers/ame.20231/carnot1897.pdf Generally, a cold body is not necessary, that is, the second law of thermodynamics is false. The cold body is only

TECHNOLOGICALLY necessary – non-isothermal heat engines are fast-working and powerful. Heat engines working under isothermal conditions (in the absence of a cold body) are commonplace but are too slow and impuissant to be of any technological importance. Except, perhaps, for the case where water is placed in an electric field - the non-conservative force (pressure) that emerges seems to be able to convert ambient heat into work quite vigorously: Wolfgang K. H. Panofsky, Melba Phillips, Classical Electricity and Magnetism, pp.115-116: "Thus the decrease in force that is experienced between two charges when they are immersed in a dielectric liquid can be understood only by considering the effect of the PRESSURE OF THE LIQUID ON THE CHARGES themselves." http://www.amazon.com/Classical-Electricity-Magnetism-Second-Physics/dp/0486439240?tag=viglink21401-20 "However, in experiments in which a capacitor is submerged in a dielectric liquid the force per unit area exerted by one plate on another is observed to decrease... [...] This apparent paradox can be explained by taking into account the DIFFERENCE IN LIQUID PRESSURE in the field filled space between the plates and the field free region outside the capacitor." http://farside.ph.utexas.edu/teaching/jk1/lectures/node46.html Tai Chow, Introduction to Electromagnetic Theory: A Modern Perspective, p. 267: "The strictly electric forces between charges on the conductors are not influenced by the presence of the dielectric medium. The medium is polarized, however, and the interaction of the electric field with the polarized medium results in an INCREASED FLUID PRESSURE ON THE CONDUCTORS that reduces the net forces acting on them." http://www.amazon.com/Introduction-To-Electromagnetic-Theory-Perspective/dp/0763738271 "Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ Pentcho Valev

2. *Vyacheslav Somsikov* • 2017-11-03 04:34 AM

   For the verification of the deterministic mechanism of irreversibility, which obtained within the framework of the classical mechanics laws [Somsikov V.M. Non-Linearity of Dynamics of the

Non-Equilibrium Systems. World Journal of Mechanics, 2017, Vol.7 No.2, 11-23], we was performed the numerical calculations of the change of D-entropy for the system with different number of the potentially interacting material points (MP) when it moves through a potential barrier. D – entropy is a relation of the value of change of the systems internal energy to its full value. [Somsikov V. M. and Andreev A. B. On criteria of transition to a thermodynamic description of system dynamics. Russian Physics Journal, Vol. 58, No. 11, March, 2016; http://www.ijSciences.com Volume 4 – May 2015 (05)]. The calculations were carried 400 times for a given number of particles for different initial states of the system, but for the same predetermined amount of energy. This made it possible to determine the change of the D-entropy for different states of the system for a given value of its energy and a given number of MP. It was found that the fluctuations of internal energy decreasing with increasing number of particles in the system for different initial conditions. When number of particles less 64, the D –entropy can be as positive as negative.When number of particles more 64 then none of the 400 numerical experiments gave a negative value change of the internal energy. This means that when number of particles more 64 the dynamics of the system becomes irreversible. Therefore, the number 64 can be called as a first critical number of the system, beyond which the system becomes irreversible. When number of particles more than 1000, the dispersion of the internal energy reaches to the minimum. With further increase in the number of MP the increment of the internal energy is not changed. This number can be called as a second critical number. Thus if the system consist from number of particles more than 1000, the thermodynamic description is a correct. Obviously, in the general case, these critical numbers will depend on the parameters of the task, for example, the width and height of the barrier.

3. *Pentcho Valev* • 2017-11-02 07:25 PM

   "Entropy was discovered when it was noticed to be a quantity that behaves as a function of state, as a consequence of the second law of thermodynamics." https://en.wikipedia.org/wiki/Entropy It was Clausius who "noticed" that the entropy is a state function, but was

he correct? Here is the story: If you define the entropy S as a quantity that obeys the equation dS=dQrev/T, you will find that, so defined, the entropy is a state function FOR AN IDEAL GAS. Clausius was very impressed by this statefunctionness and decided to prove that the entropy (so defined) is a state function for ANY system. So "Entropy is a state function" became a fundamental theorem in thermodynamics. Clausius deduced it from the assumption that any cycle can be disintegrated into small Carnot cycles, and nowadays this deduction remains the only justification of "Entropy is a state function": "Carnot Cycles: S is a State Function. Any reversible cycle can be thought of as a collection of Carnot cycles - this approximation becomes exact as cycles become infinitesimal. Entropy change around an individual cycle is zero. Sum of entropy changes over all cycles is zero." http://mutuslab.cs.uwindsor.ca/schurko/introphyschem/lectures/240 "Entropy Changes in Arbitrary Cycles. What if we have a process which occurs in a cycle other than the Carnot cycle, e.g., the cycle depicted in Fig. 3. If entropy is a state function, cyclic integral of dS = 0, no matter what the nature of the cycle. In order to see that this is true, break up the cycle into sub-cycles, each of which is a Carnot cycle, as shown in Fig. 3. If we apply Eq. (7) to each piece, and add the results, we get zero for the sum." http://ronispc.chem.mcgill.ca/ronis/chem213/hnd8.pdf The assumption on which "Entropy is a state function" is based - that any cycle can be subdivided into small Carnot cycles - is obviously false. An isothermal cycle CANNOT be subdivided into small Carnot cycles. A cycle involving the action of conservative forces CANNOT be subdivided into small Carnot cycles. Conclusion: The belief that the entropy is a state function is totally unjustified. Any time scientists use the term "entropy", they don't know what they are talking about. "My greatest concern was what to call it. I thought of calling it 'information', but the word was overly used, so I decided to call it 'uncertainty'. When I discussed it with John von Neumann, he had a better idea. Von Neumann told me, 'You should call it entropy, for two reasons: In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important,

nobody knows what entropy really is, so in a debate you will always have the advantage."
https://en.wikipedia.org/wiki/History_of_entropy Pentcho Valev

4. *Pentcho Valev* • 2017-11-02 10:05 PM
   The version of the second law of thermodynamics known as "Entropy always increases" (a version which, according to A. Eddington, holds "the supreme position among the laws of Nature") is in fact a theorem deduced by Clausius in 1865: Jos Uffink, Bluff your Way in the Second Law of Thermodynamics, p. 37: "Hence we obtain: THE ENTROPY PRINCIPLE (Clausius' version) For every nicht umkehrbar [irreversible] process in an adiabatically isolated system which begins and ends in an equilibrium state, the entropy of the final state is greater than or equal to that of the initial state. For every umkehrbar [reversible] process in an adiabatical system, the entropy of the final state is equal to that of the initial state." http://philsci-archive.pitt.edu/archive/00000313/ Clausius' deduction was based on three postulates: Postulate 1 (implicit): The entropy is a state function. Postulate 2: Clausius' inequality (formula 10 on p. 33 in Uffink's paper) is correct. Postulate 3: Any irreversible process can be closed by a reversible process to become a cycle. All the three postulates remain totally unjustified even nowadays. Postulate 1 can easily be disproved by considering cycles (heat engines) converting heat into work in ISOTHERMAL conditions. Postulate 3 is also false: Uffink, p.39: "A more important objection, it seems to me, is that Clausius bases his conclusion that the entropy increases in a nicht umkehrbar [irreversible] process on the assumption that such a process can be closed by an umkehrbar [reversible] process to become a cycle. This is essential for the definition of the entropy difference between the initial and final states. But the assumption is far from obvious for a system more complex than an ideal gas, or for states far from equilibrium, or for processes other than the simple exchange of heat and work. Thus, the generalisation to all transformations occurring in Nature is somewhat rash." Note that, even if Clausius's theorem were true (it is not), it only holds for "an adiabatically isolated system which begins and ends in an equilibrium state". This means that (even if Clausius's theorem were true) applications of "Entropy

always increases" to processes which do not begin and end in equilibrium, that is, to processes in Nature, not in a cylinder with a piston, would still be incorrect: Jos Uffink, in the same article: "I therefore argue for the view that the second law has nothing to do with the arrow of time. [...] This summary leads to the question whether it is fruitful to see irreversibility or time-asymmetry as the essence of the second law. Is it not more straightforward, in view of the unargued statements of Kelvin, the bold claims of Clausius and the strained attempts of Planck, to give up this idea? I believe that Ehrenfest-Afanassjewa was right in her verdict that the discussion about the arrow of time as expressed in the second law of the thermodynamics is actually a RED HERRING." Pentcho Valev

5. *Raji Heyrovska* • 2017-11-02 02:45 PM

   I just saw the interesting article by Merali [1]. In this context, I wish to draw attention to the First International Conference [2] on Quantum Limits to the Second Law. In her contribution [3] to this conference, she points out that thermodynamic functions and laws were developed over the years to "bridge" the gap between the equations of state and thermal properties of matter. In [3] the author has incorporated the thermodynamic properties into the equation of state thereby forming one simple composite equation. The heat capacity difference is introduced in place of the gas constant in her earlier concise equation of state for gases, based on free volume and molecular association/dissociation. This provides a new and simple relation between the P, V, T properties, internal energy (E), enthalpy (H), Gibbs (G) and Helmholtz (A) free energies, heat energy (Q), entropy (S), partition function (f) and the thermodynamic laws. Since a proper definition of "heat" is essential for the discussion of the second law, Q for a gas at the given P, V, T, S is defined as TS = PVflnW, where W is the thermodynamic probability related to f. The latter is expressed as the ratio of free volume to volume corresponding to the de Broglie wave length. Also, for the first time experimental heat capacities at various P, V and T are correlated with the extent of molecular association. The available data for nitrogen have been used to demonstrate the validity of the new equation of state. References: 1. Merali, Z., Nature 551, 20–22 (02 November 2017) doi:10.1038/551020a 2.

“QUANTUM LIMITS TO THE SECOND LAW: First International Conference on Quantum Limits to the Second Law”: 29-31 July 2002, San Diego, California (USA), ISBN: 0-7354-0098-9, Editors: Daniel P. Sheehan, Volume number: 643, Published: Nov 20, 2002, http://aip.scitation.org/toc/apc/643/1?expanded=643 3. Heyrovska, R., AIP Conference Proceedings 643, 157-162 (2002); http://aip.scitation.org/doi/10.1063/1.1523797

6. *Pentcho Valev* • 2017-11-02 09:37 AM

The second law of thermodynamics has an absurd implication that proves its falsehood: If we have a reversible chemical reaction and a catalyst increases the rate of the forward reaction by a factor of, say, 745492, it obligatorily increases the rate of the reverse reaction by exactly the same factor, 745492, despite the fact that the two reactions - forward and reverse - may be entirely different (e.g. the diffusion factor is crucial for one but not important for the other) and accordingly require entirely different catalytic mechanisms. The absurd implication is usually referred to as "Catalysts do not shift chemical equilibrium": "A catalyst reduces the time taken to reach equilibrium, but does not change the position of the equilibrium. This is because the catalyst increases the rates of the forward and reverse reactions BY THE SAME AMOUNT." http://www.bbc.co.uk/bitesize/higher/chemistry/reactions/equilibriu "In the presence of a catalyst, both the forward and reverse reaction rates will speed up EQUALLY... [...] If the addition of catalysts could possibly alter the equilibrium state of the reaction, this would violate the second rule of thermodynamics..." https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/chemical-equilibrium-14/factors-that-affect-chemical-equilibrium-106/the-effect-of-a-catalyst-447-3459/ The absurd implication is not obeyed by chemical reactions of course. Here is a publication in Nature describing a catalyst accelerating the forward and SUPPRESSING the reverse reaction: http://images.nature.com/m685/nature-assets/ncomms/2013/130917/ncomms3500/images_hires/ncomms35 f1.jpg Yu Hang Li et al. Unidirectional suppression of hydrogen oxidation on oxidized platinum clusters. https://www.nature.com/articles/ncomms3500 Another example of

disobedience: Perpetual (limited only by the deterioration of the system) motion of dimer A_2 and monomer A between two catalytic surfaces, S1 and S2 (a time crystal par excellence): http://upload.wikimedia.org/wikipedia/commons/c/ce/NatureSLTD-Fig1c.jpg See the explanations here: https://en.wikipedia.org/wiki/Duncan%27s_Paradox That catalysts can violate the second law of thermodynamics by shifting chemical equilibrium is presented by Wikipedia as a fact: "Epicatalysis is a newly identified class of gas-surface heterogeneous catalysis in which specific gas-surface reactions shift gas phase species concentrations away from those normally associated with gas-phase equilibrium. [...] A traditional catalyst adheres to three general principles, namely: 1) it speeds up a chemical reaction; 2) it participates in, but is not consumed by, the reaction; and 3) it does not change the chemical equilibrium of the reaction. Epicatalysts overcome the third principle..." https://en.wikipedia.org/wiki/Epicatalysis Pentcho Valev

7. *Pentcho Valev* • 2017-11-01 07:17 PM

   The second law of thermodynamics has long been under attack but only for small, microscopic, quantum etc. systems: Nature 2002: "Second law broken. Researchers have shown for the first time that, on the level of thousands of atoms and molecules, fleeting energy increases violate the second law of thermodynamics." http://www.nature.com/news/2002/020722/full/news020722-2.html The truth is that MACROSCOPIC systems violating the second law of thermodynamics are COMMONPLACE. The problem is that misleading education diverts the attention from relevant examples: "A necessary component of a heat engine, then, is that two temperatures are involved. At one stage the system is heated, at another it is cooled." http://physics.bu.edu/~duffy/py105/Heatengines.html So educators present the two temperatures as NECESSARY and deal with non-isothermal heat engines only: http://readingpenrose.files.wordpress.com/2015/07/rubber-band-engine.gif "All materials react to heat in some way. But this new shape-changing polymer reacts to temperatures as small as the touch of human skin to contract - in the process lifting as much as

1,000 times its own weight." http://gizmodo.com/this-new-shape-changing-polymer-can-lift-1-000-times-it-1759165438 "Stretchy Science: A Rubber Band Heat Engine. Learn how a rubber band can turn heat into mechanical work with this simple activity. [...] Your blow dryer essentially turned your rubber band into a heat engine - a machine that turns thermal energy into mechanical work." https://www.scientificamerican.com/article/bring-science-home-rubber-band-heat/ The second law of thermodynamics would be long forgotten if isothermal analogs which almost obviously violate the second law of thermodynamics had been analyzed (one should only evaluate the work involved in a quasi-static cycle): http://www.gsjournal.net/old/valev/val3.gif "When the pH is lowered (that is, on raising the chemical potential, μ, of the protons present) at the isothermal condition of 37°C, these matrices can exert forces, f, sufficient to lift weights that are a thousand times their dry weight." http://www.google.com/patents/US5520672 A. KATCHALSKY, POLYELECTROLYTES AND THEIR BIOLOGICAL INTERACTIONS, p. 15, Figure 4: "Polyacid gel in sodium hydroxide solution: expanded. Polyacid gel in acid solution: contracted; weight is lifted." https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1367611/pdf/bioph0017.pdf The following four-step isothermal cycle, if carried out quasi-statically (reversibly), clearly violates the second law of thermodynamics: 1. The polymer is initially stretched. The operator adds hydrogen ions (H+) to the system. The force of contraction increases. 2. The polymers contracts and lifts a weight. 3. The operator removes the same amount of H+ from the system. The force of contraction decreases. 4. The operator stretches the polymer and restores the initial state of the system. The net work extracted from the cycle is positive unless the following is the case: The operator, as he decreases and then increases the pH of the system (steps 1 and 3), does (loses; wastes) more work than the work he gains from weight-lifting. However electrochemists know that, if both adding hydrogen ions to the system and then removing them are performed quasi-statically, the net work involved is virtually zero (the operator gains work if the hydrogen ions are transported from a high to a low concentration and then loses the

same amount of work in the backward transport). That is, the net work involved in steps 1 and 3 is zero, and the net work extracted from steps 2 and 4 is positive, in violation of the second law of thermodynamics. Pentcho Valev

8. *Pentcho Valev* • 2017-11-01 06:36 PM

    Philip Ball explains why Frank Wilczek's time crystals are bogus: "But to make that happen, the researchers must deliver kicks to the spins, provided by a laser or pulses of microwaves, to keep them out of equilibrium. The time crystals are sustained only by constant kicking, even though - crucially - their oscillation doesn't match the rhythm of the kicking. The experiments are ingenious and the results show that this modified version of Wilczek's vision is feasible. But are we right to award the new findings this eye-catching new label, or are they really just a new example of a phenomenon that has been going on since the first primeval heart started beating? If these fancy arrangements of quantum spins deserve to be called time crystals, can we then say that we each already have a time crystal pulsing inside of us, keeping us alive?" http://www.prospectmagazine.co.uk/blogs/philip-ball/time-crystals-could-they-exist-science-physics That is, Frank Wilczek's time crystals are regularly "kicked" by the experimentalist. However, there are genuine time crystals "kicked" by ambient heat and breathtakingly violating the second law of thermodynamics. Here is perpetual (limited only by the deterioration of the system) motion of water in an electric field, obviously able to produce work - e.g. by rotating a waterwheel: "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ "The water movement is bidirectional, i.e., it simultaneously flows in both directions." https://www.wetsus.nl/home/wetsus-news/more-than-just-a-party-trick-the-floating-water-bridge-holds-insight-into-nature-and-human-innovation/1 The work will be done at the expense of what energy? The first hypothesis that comes to mind is: At the expense of electric energy. The system is, essentially, an electric motor. However, close inspection would suggest that the hypothesis is untenable. Scientists use triply distilled water to reduce the conductivity and the electric current passing through the

system to minimum. If, for some reason, the current is increased, the motion stops - the system cannot be an electric motor. If the system is not an electric motor, then it is ... a perpetual-motion machine of the second kind! Here arguments describing perpetual-motion machines as impossible, idiotic, etc. are irrelevant - the following conditional is valid: IF THE SYSTEM IS NOT AN ELECTRIC MOTOR, then it is a perpetual-motion machine of the second kind. In other words, if the work is not done at the expense of electric energy, then it is done at the expense of ambient heat, in violation of the second law of thermodynamics. No third source of energy is conceivable. In the electric field between the plates of a capacitor, the same perpetual motion of water can be seen (we have a time crystal again): " Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg In the capacitor system the rising water can repeatedly do work, e.g. by lifting floating weights. The crucial question is: The work (lifting floating weights) will be done at the expense of what energy? Obviously "electric energy" is not the correct answer - the capacitor is not an electric motor. Then the only possible answer remains "ambient heat". The system is a heat engine violating the second law of thermodynamics! Pentcho Valev

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Join the disruptors of health science

01 November 2017

Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.

Gabriela Hasbun for *Nature*

Thomas Insel left Verily, a health-science spin-off formed by Google's parent company, to co-found a start-up called Mindstrong Health this year.

In early 2015, I testified with several other National Institutes of Health (NIH) directors at an annual hearing held by the US Senate. It was my 13th and final year as director of the US National Institute of Mental Health

(NIMH) in Bethesda, Maryland. What struck me most was how the harsh fiscal reality tempered the passionate bipartisan support for the NIH. As one senator noted, with a federal deficit of nearly US$500 billion, there was little hope of any significant increase in funding.

Six months after that hearing, I left the NIH for Silicon Valley, first working at Verily in South San Francisco, California, a health-science spin-off formed by Google's parent company Alphabet. Since May, I've been president and co-founder of a start-up called Mindstrong Health in Palo Alto, California. I've witnessed the tremendous possibilities that immense resources, massive computing power and the application of data science can bring to biomedical research. I've watched some of today's best junior faculty members and postdocs launch their careers in Silicon Valley instead of in academic departments. And I've wondered how technology giants and start-ups will change biomedical and health-care research.

These companies have transformed the worlds of information, entertainment and commerce. But by moving into health care, they face some formidable challenges. In my view, solving them will require deep partnerships between technology companies, clinical experts, patient advocates and academic scientists.

A financial frontier

In the United States, public funding for science has not kept up with inflation over the past decade. The proposed 2018 budget from the White House recommends funding cuts for the NIH and the National Science Foundation of more than 10% each. Appropriations may ultimately be more generous, but no one is expecting Congress to repair a decade's loss of purchasing power.

Meanwhile, private-sector investment has become a bigger piece of the research-funding pie — increasing from 46% in 1994 to 58% in 2012 for biomedical research[1]. Tech companies, in particular, have been ploughing more funds into research, and moving into areas such as health and life sciences that have typically been the domain of the NIH, pharmaceutical and

biotechnology companies. By any measure, tech companies have enormous sums to spend. The collective cash reserves of Apple, Microsoft, Alphabet and Facebook — roughly $500 billion — exceed by tenfold the annual federal investment in biomedical research.

So what does this changing ecosystem mean for US biomedical science? Has the locus of innovation shifted from academia to Google and Facebook?

In some areas, such as artificial intelligence (AI), tech companies already dominate. According to a 2017 report, the tech giants invested between US$20 billion and $30 billion in AI in 2016, with 90% of this going towards research and development. Some, such as Google and the Chinese web-services company Baidu, are rebranding themselves as AI or deep-learning companies, with a focus on both expanding the science of machine learning and applying the approach to big-data problems[2].

In health research, the landscape is still evolving. Three years ago, IBM began selling a software suite called Watson for Oncology to cancer-treatment centres around the world. The program is built around what IBM call cognitive computing and is designed to help clinicians to select the best treatment. The company claimed that by using its cloud-based data on cancer, Watson could recommend interventions for individual patients, although some say the effort was premature and oversold[3].

Over the past 12 months, Fitbit, the developer of several fitness trackers, has expanded into a health-care and health-research company. With more than 50 million registered users, it is involved in 400 research projects, including studies of diabetes and heart disease. In fact, Fitbit has just been listed as one of nine digital health companies to be considered by the US Food and Drug Administration (FDA) in its precertification pilot programme — a new, supposedly more agile, approach to regulation that will focus on the software developer rather than on individual products.

Since March 2015, Apple's ResearchKit has made it easier for developers to create health apps for the iPhone or Apple Watch. It has also provided a platform for enrolling thousands of participants remotely in clinical projects, for instance in diabetes, cancer and diseases of the central nervous system. A study at Johns Hopkins University in Baltimore, Maryland, for instance, has

used ResearchKit to capture data just before and throughout seizures in nearly 1,000 people with epilepsy[4].

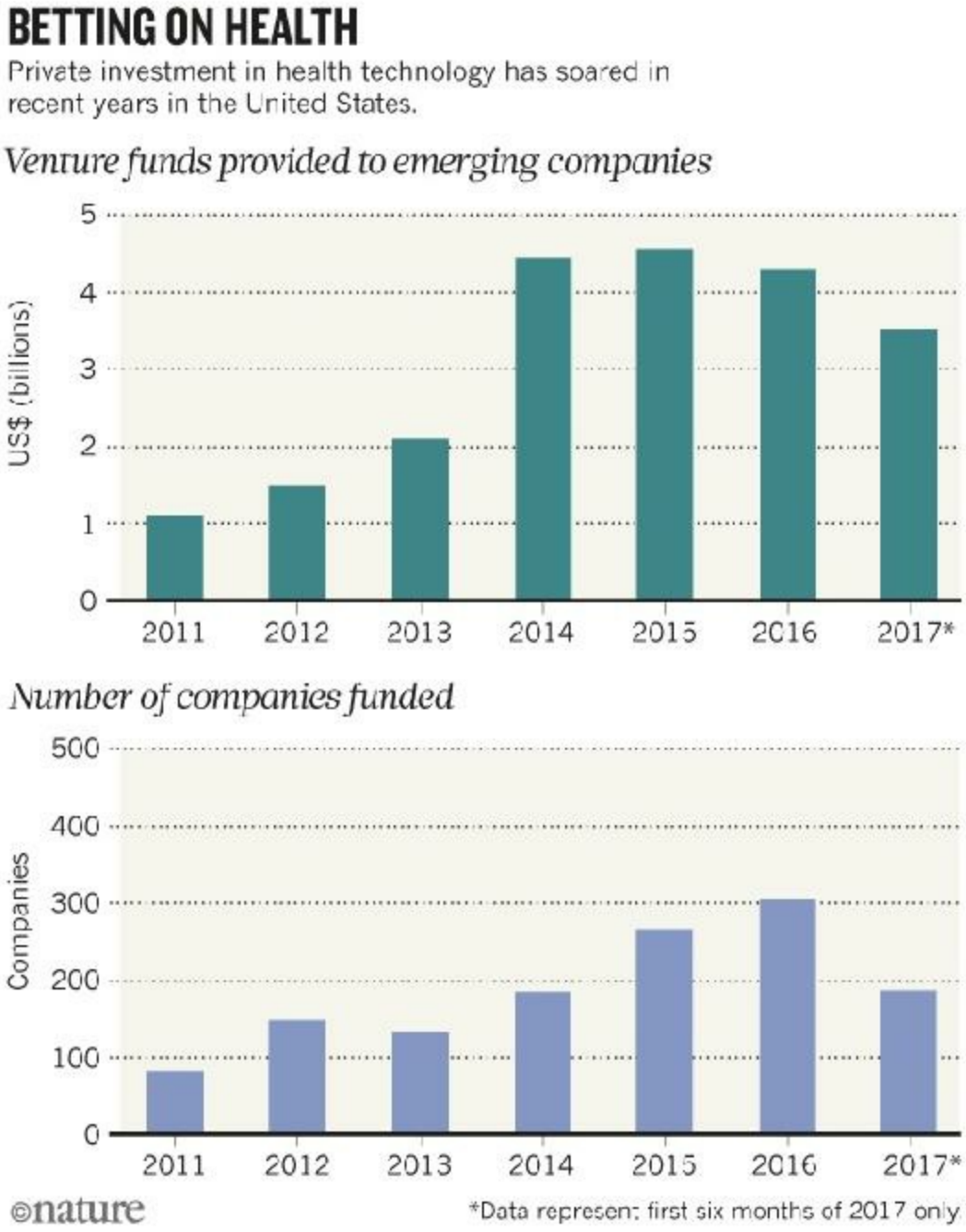
Kiyoshi Ota/Bloomberg/Getty

Fitbit, the developer of these sleep-monitoring wristbands, is currently involved in 400 research projects.

Also in 2015, Alphabet launched Verily — a company focused on creating software and hardware to transform health care. After growing to more than 500 employees in just over 2 years, Verily seeks to address diabetes, heart disease, cancer and diseases of the central nervous system using miniaturized sensors in smart devices — such as a contact lens that estimates blood sugar levels.

Just six months ago, Facebook revealed the existence of Building 8, a division focused on delivering consumer “hardware products that are social first”, including brain–computer interfaces designed to aid people with disabilities.

Meanwhile, health tech has become one of the hottest areas for venture investment in the United States: more than 1,000 new digital-health companies have started up since 2012. A report from Rock Health, a US venture-capital fund headquartered in San Francisco that invests in digital-health start-ups, estimates[5] that $15 billion has poured in to the sector over the past 5 years, up from $1.5 billion in 2012 and $1.1 billion in 2011 (see 'Betting on health').



Source: Rock Health

Like pharma and biotech, big and small tech companies are product-focused and team-based. This contrasts with academia, where scientists are rewarded for publishing papers and incentives are built around individual promotion

within a departmental structure.

But what struck me most on moving from the Beltway to the Bay Area was that, unlike pharma and biotech, tech companies enter biomedical and health research with a pedigree of software research and development, and a confident, even cocky, spirit of disruption and innovation. They have grown by learning how to move quickly from concept to execution. Software development may generate a minimally viable product within weeks. That product can be refined through 'dogfooding' (testing it on a few hundred employees, families or friends) in a month, then released to thousands of users for rapid iterative improvement.

During my first month working at Verily, I returned to Bethesda for the winter holidays; when I went back to work in early January, I found that a group of engineers had developed an entirely new product between Christmas and New Year's Day. Contrast that with the NIH-funded world of research, where it usually takes at least 18 months to go from proposing an idea to getting a project funded, or the years it can take to transform the discovery of a molecule into a marketable drug.

This intense focus on the rapid development of consumer products is very different from the pursuit of fundamental knowledge that has been a hallmark of academic research. And as a newcomer (what Google calls a noogler), I found the language of product development and the drive towards 'quarterly OKRs' (objectives and key results) a bit off-putting. But the truly disruptive impact of tech companies is not the rapid-fire push for consumer products or their deep pockets; it's their focus on AI and data resources.

Mining data

It is not surprising that companies that are dependent on information processing for their main revenue would be at the vanguard of developing the tools for collecting, storing and analysing data. A by-product of this is that tech companies are transforming data science — much as pharma and biotech transformed medicinal chemistry and molecular biology in the last decades of the twentieth century. In an era when biology is increasingly an information

science, the tools being created by tech companies can provide insights that will almost certainly be translated into advances for health.

The potential is awesome — for discovery as well as for product development.

Three examples illustrate what can be achieved through having extraordinary access to population data as well as massive data-storage and data-processing capacity. Importantly, none connects in an obvious way to a primary business of the company.

First, in 2016 a team at Google used a version of machine learning called convolutional neural nets to create an algorithm to detect diabetic retinopathy[6]. The researchers started by having 54 ophthalmologists rate 128,175 retinal images. Once the algorithm had been trained on this data set, the team used two new sets of retinal images to test against eight board-certified ophthalmologists. The results were striking: depending on how the researchers set its parameters, the algorithm performed better than seven of the eight clinical experts, in terms of sensitivity and specificity. This approach is not markedly different from previous efforts to identify cats and faces with machine learning, but the potential impact on diagnostics and clinical care is profound.

Second, a team in Facebook's Building 8 is seeking to develop new brain–computer interfaces that (with the use of non-invasive optical sensors) will enable people to type simply by thinking — what is now called 'silent speech'. Although several universities have teams working on brain–computer interactions, the number of engineers and the computational resources that Facebook can muster would be difficult for any academic investigator to fund using federal grants. Importantly, Facebook is supporting some of these academic scientists (as well as recruiting many) to expedite this project.

Third, a team at Microsoft has used anonymous Bing search histories from 9.2 million users to predict cases of pancreatic cancer several months before people are usually diagnosed with the disease[7]. The team identified characteristic patterns of historical symptom searches in more than 3,000 anonymous users who subsequently indicated a probable diagnosis of

pancreatic cancer — indicated by searches such as 'just diagnosed with pancreatic cancer'. This approach lacks the corroboration of a pathological diagnosis and the sensitivity is poor (only 5–15% of cases can be identified). But false-positive rates are extremely low (less than 0.0001).

In short, tech companies have scale and speed: an experiment can involve millions of people and be completed in months. But scale and speed aren't everything.

Sticking points

In moving from software or hardware development to biomedical research and health care, tech companies large and small face formidable challenges. They usually do not have the regulatory expertise needed to develop medical products, they rarely have access to clinical samples and they often lack a deep understanding of the clinical problem to be solved.

Gabriela Hasbun for *Nature*

At its California office, Mindstrong Health is developing digital phenotyping as a diagnostic tool.

Various moves are being made to try to address these issues. In May, Verily hired Robert Califf, former chief of the FDA, to help with its personalized-medicine effort called Project Baseline. In 2015, 23andMe, a personal-genomics company based in Mountain View, California, recruited Richard Scheller, former head of research at the biotech company Genentech in San Francisco, to lead its research programme. And in 2016, Apple brought Stephen Friend, an open-science advocate from the non-profit research organization Sage Bionetworks in Seattle, Washington, to assist with its health projects.

How a culture built around engineers and designers will incorporate people from different sectors remains to be seen, and whether companies that build consumer products will be able to work with health-care payers and providers is unclear. But the willingness of tech companies to hire national experts on health, regulation and health data to aid in discoveries that will have clinical utility is a hopeful sign.

Yet there are at least four further major areas of uncertainty.

Open science increasingly drives innovation in the public sector. It is unclear to what degree the drive for intellectual property and profits will limit the transparency of research in the tech sector[8]. The stereotype is that for-profit companies will focus only on commercial end points. But there are notable counter-examples from AI research, in addition to the biomedical examples above. In 2015, Google made its machine-learning software library, TensorFlow, open source, and AI researchers across the board quickly adopted this powerful tool. Likewise, the *Apple Machine Learning Journal* launched in July to provide more transparency about the company's current projects (see go.nature.com/2yckpi9).

It's too early to say whether big or small tech companies will favour open source for their biomedical scientific initiatives. The success of ResearchKit gives some indication of what could be accomplished if they do.

Another uncertainty is whether the business model in tech, which is often based on advertising revenue or the sales of devices, will limit the rigour, generalizability and validity of the science carried out. Especially in start-ups that are dependent on rapid returns for their investors, the financial runway may be too short for lengthy or large clinical trials.

And then there's the issue of trust. It has become the norm for tech companies to use personal shopping or geolocation data for commerce. It's unclear whether the public will be as accepting about the use of personal health data, especially by behemoths such as Google or Facebook.

The recent commitments of big and small tech companies to discovery and clinical research are exciting. But during an economic downturn, these projects could be the first to be axed to protect the company's bottom line.

Science needs commitment. Bell Labs — at its peak, the premier research and development company of the United States — is an example of extraordinary scientific success in a for-profit organization. But as author Jon Gertner pointed out[9] in *The New York Times* in 2012: “Mark Zuckerberg noted that one of his firm's mottoes was 'move fast and break things'; that of Bell Labs' might just as well have been 'move deliberately and build things'.”

Partners, In time

The practical questions are these. What will each of the sectors in the evolving ecosystem do best? What can be done across sectors? How can bridges be built between companies with unprecedented access to data and massive computational resources, and academic scientists who may have a deep understanding of a clinical problem or access to unique clinical populations?

It seems likely that the academic sector will continue to lead on those aspects of fundamental biology and clinical research that do not require big data or machine learning — the purification of an enzyme, perhaps, or the development of a mouse model for a rare disease. Pharma and biotech will continue to be the source of new medicines. The domain of the tech industry

will be research that is data-intensive, and product development that requires a legion of software engineers working with designers.

Transformative medical products that require clinical testing, regulatory standards and insights about the health-care marketplace, including the practical constraints faced by providers in the clinic, will almost certainly require partnerships between public research entities and private companies. These must include precompetitive partnerships across tech, pharma–biotech, academia and patient-advocacy groups. Developing these partnerships will not be easy, given the different stakeholders, cultures and incentives.

Yet there are successful public–private partnerships to learn from.

Since 2006, the Biomarkers Consortium, managed by the US charitable organization the Foundation for the NIH, has brought academics and private companies together to develop biomarkers across a range of diseases. The Alzheimer's Disease Neuroimaging Initiative, which since 2004 has worked to establish standards for imaging biomarkers in dementia, is among the studies it has supported. As is I-SPY2, which since 2010 has created treatment pathways based on biomarkers for breast cancer. Another Foundation for the NIH initiative is the Accelerating Medicines Partnership. This has paired the NIH and the FDA with 10 pharma and biotech companies as well as 12 non-profit patient-advocacy foundations to define new targets for drug development for rheumatoid arthritis, type 2 diabetes and Alzheimer's disease.

A new sector in the research ecosystem means that health problems, even those that do not present an obvious commercial opportunity, can be approached from a fresh angle. Data science could integrate the full stack of patient information, from genomics to socio-economic factors, to guide clinical care. Sensors and big data could transform our description of phenomics — each person's set of behavioural, physical and biochemical traits. For example, digital phenotyping through the use of smartphone sensors, keyboard performance and voice or speech features can provide, for the first time, an objective, continuous, passive measure of behaviour and cognition at the global scale. Mindstrong Health is using this approach to detect the earliest phases of dementia, mental illness and possibly a range of medical disorders[10].

As just one example of an urgent opportunity, attempts to prevent suicide worldwide have been remarkably ineffective — including public-health measures to reduce stigma, raise awareness and reduce access to guns. Social media, just-in-time interventions and new analytical tools for prediction could change our understanding of risk and yield new strategies for prevention[11]. Tech companies, paired with other players, could start to solve this and many other historically intractable problems.

There is an old African proverb: “To go fast, go alone; to go far, go together.” Science to improve health has proved frustratingly slow. Perhaps, with a new fast partner, all of us in research can go farther.

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Nature
Volume:
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23–26
Date published:
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DOI:
doi:10.1038/551023a

Comments

Comments

There are currently no comments.

Spanish government takes control of Catalonian universities

Madrid will oversee the finances of the region's research centres and seven public universities.

31 October 2017

Alain Pitton/NurPhoto/Getty

Supporters of independence for Catalonia.

The Spanish government has taken over responsibility for higher education and research in Catalonia, following the region’s unilateral declaration of independence on 27 October. It will retain control of spending on research centres and universities, which the League of European Research Universities

says threatens institutional autonomy.

The Catalonia region of north-east Spain has been in political turmoil ever since a highly controversial vote on independence was taken on 1 October. For the past 32 years the Catalan government has set and financed the budgets of universities, which were allocated €700 million (US$814 million) of the nearly €1-billion Catalan budget for science and universities in 2017. The region is strong in science: between 2007 and 2015, its universities won a 210 grants from the European Research Council, totalling €334 million. In the most recent round, 10 of the 22 ERC starting grants awarded to researchers in Spain were won by researchers based at Catalan institutions.

The Ministry of Education, Culture and Sport in Madrid will run Catalan universities and the Ministry of Economy, Industry and Competitiveness will oversee the region's research policy with immediate effect.

The changes mean that the Spanish government will be able to make decisions affecting research centres and universities in Catalonia, after it dismissed all the members of the Catalan government.

Carmen Vela, Spain's secretary of state for research, development and innovation, says that the government hopes the difficulties will be resolved shortly. "Today's situation is a bit different, but it has a very clear goal: restoring normality and tranquility. We are going to work to ensure that there are no negative impacts on research and innovation in Catalonia." She says that the Spanish government will manage but not devise science policy in Catalonia ahead of regional elections due in December.

University connections

Santi Vila, minister of business and knowledge in the Catalan government, stepped down a day before the independence declaration. Arcadi Navarro, secretary of state for universities and research in the Catalan government and a geneticist at Pompeu Fabra University in Barcelona, who used to report to Vila, might yet remain in his job. Vela says that she would like him to continue. "Arcadi is an excellent researcher and someone with whom we

have always had an excellent relationship," Vela says. "We want to keep working with him."

Jaume Casals, rector of Pompeu Fabra University, says that he does not expect the Spanish government to interfere directly in universities' affairs. "The relationship between Madrid and Barcelona when it comes to science and universities has always been fluid, and I hope that will not change," says Casals, who also leads the Alliance 4 Universities, a group of research-intensive universities consisting of two based in Madrid and another two in Catalonia.

Enric Banda, senior adviser at the Barcelona Supercomputing Centre and former president of the grass-roots association EuroScience, agrees. "This is the first time these type of measures, stipulated in the Spanish constitution, are applied. The uncertainty is high because nobody knows exactly how they will be implemented. But I don't expect any additional disruption in the daily activities of the Catalan universities," he says.

Financial ties

The League of European Research Universities, headquartered in Leuven, Belgium, has criticized the financial arrangements on the grounds that they undermine institutional autonomy. In a statement issued on 23 October, the group's secretary-general, Kurt Deketelaere, wrote: "Just like academic freedom, institutional autonomy is key for the academic world and society at large. It cannot be limited on the basis of political considerations, or to serve political goals."

Ahead of the Catalan elections in December, both Casals and Banda are calling on the Spanish government to lift the financial controls and to minimise the impact of the political upheaval on the region's international image. "Catalonia has done very well at attracting international researchers and students and we would like that to continue," says Casals.

Journal name:
Nature

DOI:
doi:10.1038/nature.2017.22922

Comments

Commenting is currently unavailable.

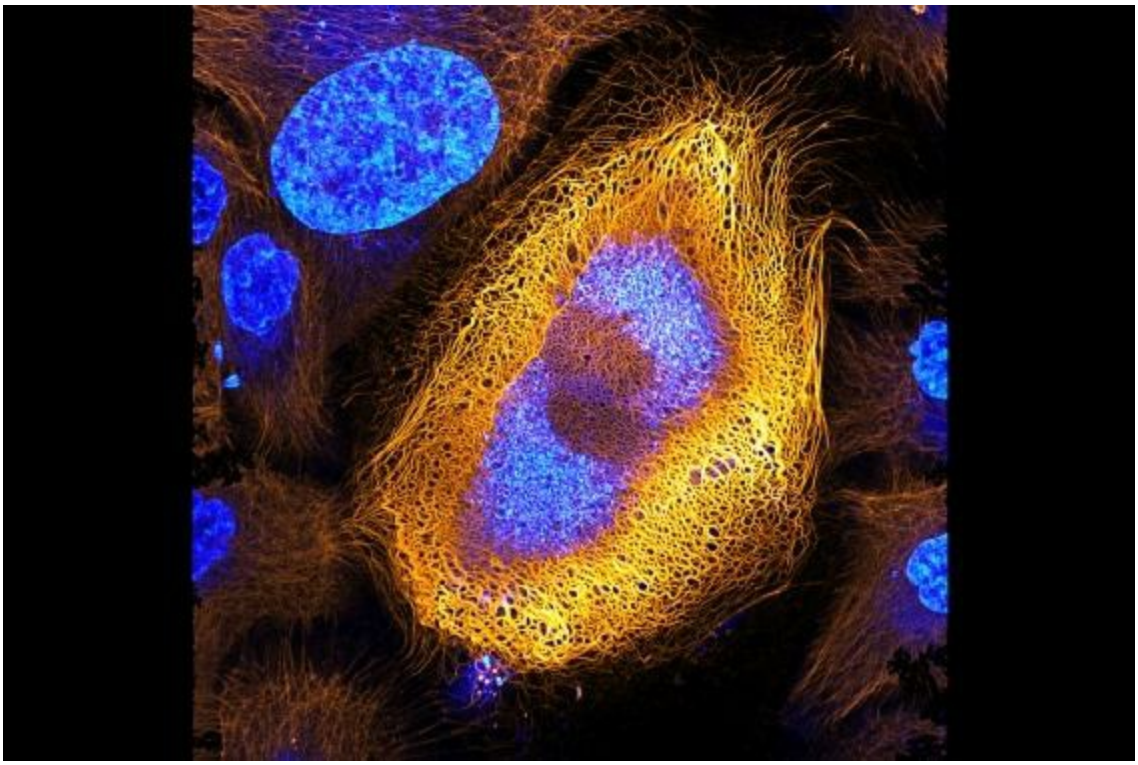
Seeds, sponges and spinal surgery

October’s sharpest science shots, selected by *Nature*’s photo team.

31 October 2017

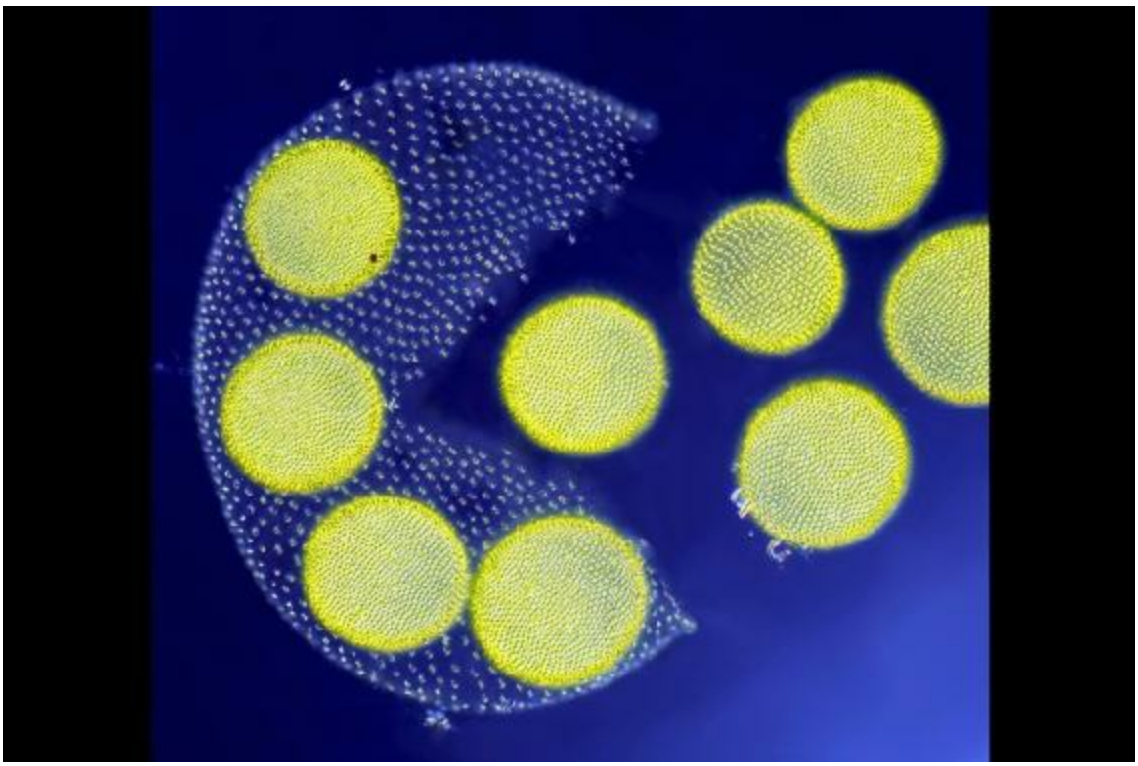
Small beauties

Image Slideshow

1. 

   This image of an immortalized human skin cell won first place in the Nikon Small World Photomicrography Competition. It was taken by Bram van den Broek, a biophysicist at the Netherlands Cancer Institute in Amsterdam.

B. van den Broek, A. Volkov, K. Jalink, N. Schwartz, R. Windoffer/Nikon Small World 2017

2. 

This might look like computer-game character Pac-Man, but it is actually a type of alga called Volvox releasing daughter colonies to continue its line.

Jean-Marc Babalian/Nikon Small World 2017

3. 

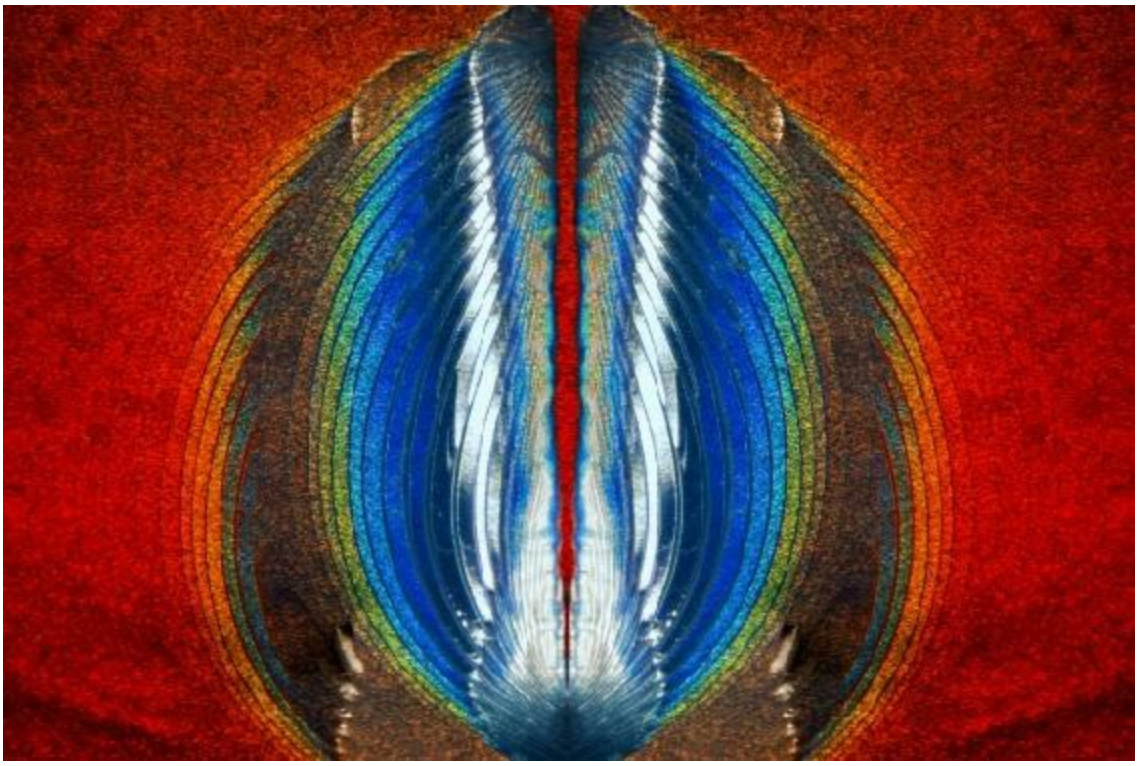
This portrait of a tropical weevil (*Rhigus nigrosparsus*) was given an ‘image of distinction’ award.

M. Clemens/Nikon Small World 2017

4. 

An eerie green crystal of the mineral pyromorphite featured in another shot that received an image of distinction.

E. C. Márquez/Nikon Small World 2017

5. 

This butterfly-like shape is in fact the fractured plastic of a credit-card hologram, seen at ten times its real size.

S. Simon/Nikon Small World 2017

6. 

   This startlingly alien shape is a cross-section through something very common: a needle from a Scots pine tree (*Pinus sylvestris*).

   A. Klepnev/Nikon Small World 2017

From tragic to touching

Image Slideshow

1. 

   The grand-title winner of this year's Wildlife Photographer of the Year competition features a black rhino (*Diceros bicornis*) in Hluhluwe Imfolozi Game Reserve in South Africa, after it was butchered by poachers who were after its horns. Brent Stirton has seen more than 30 such tragic scenes.

   Brent Stirton/Wildlife Photographer of the Year

2. 

This Maori octopus (*Macroctopus maorum*) was spoilt for choice when it came across a huge congregation of giant spider crabs off Tasmania, Australia. The photograph won the invertebrate-behaviour category of the Wildlife Photographer of the Year competition, which is developed and produced by the Natural History Museum, London.

Justin Gilligan/Wildlife Photographer of the Year

3. 

Divers from the Dumont d’Urville scientific base in East Antarctica worked for 3 days in the frigid waters off the continent to capture this image of an ice berg, which was stitched together from 147 separate shots. It won the Earth’s environments category.

Laurent Ballesta/Wildlife Photographer of the Year

4. 

These polar bears (*Ursus maritimus*) near Norway's Arctic island of Svalbard were photographed feeding on waste from a ship's kitchen. The image won the black-and-white category in this year's awards.

Eilo Elvinger/Wildlife Photographer of the Year

5. 

Controversial oil drilling is an increasing threat to the residents of Yasuní National Park in Ecuador. Among the animals imperilled is this toad, the star of this finalist in the animal-portraits category.

Jaime Culebras/Wildlife Photographer of the Year

6. 

The Sonoran Desert in the United States and Mexico hosts many saguaro cacti (*Carnegiea gigantea*), including this example that has suffered frost damage, causing its limbs to fall to the ground. The image is a finalist in the plants and fungi category.

Jack Dykinga/Wildlife Photographer of the Year

Syrian seeds

Diego Ibarra Sanchez/The New York Times/eyevine

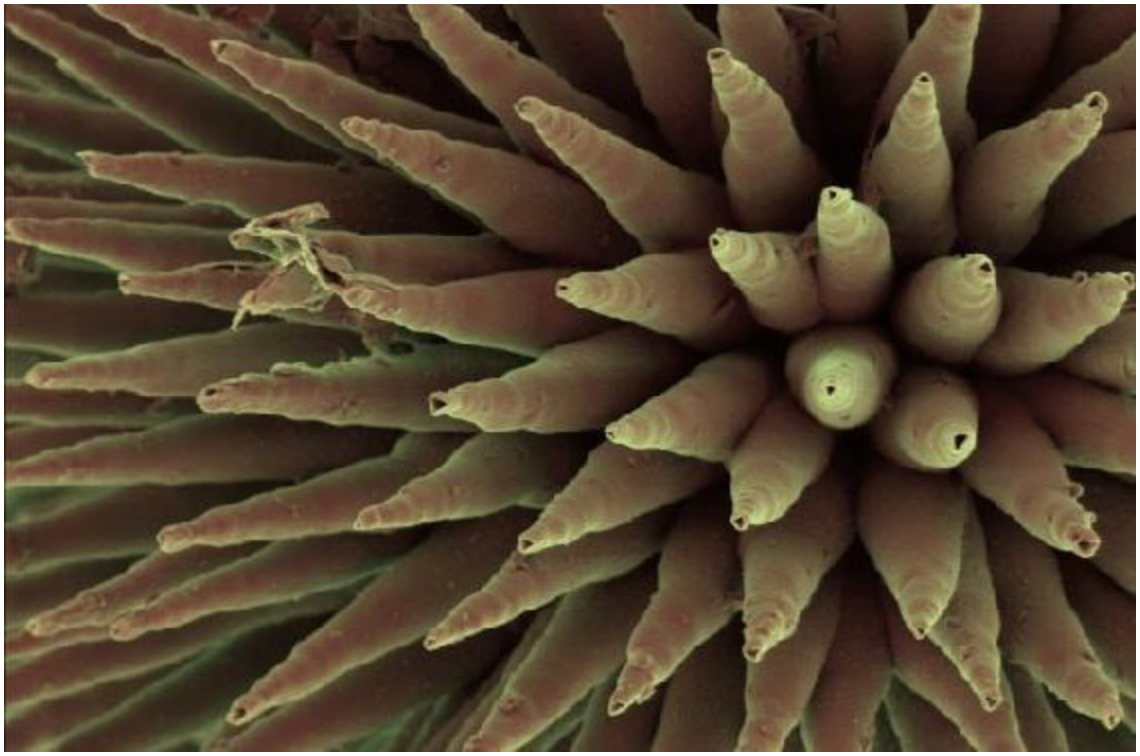
Among the people forced out of their country by the war in Syria are researchers from the nation's seed bank, who are now rebuilding their lives in locations around the world. Ali Shehadeh (pictured) is one of them. A researcher who was based at a International Center for Agricultural Research in the Dry Areas seed bank in Aleppo, he now works in Terbol, Lebanon.

Capturing sunlight

Xu Haijing/Xinhua/ZUMA Wire

The 2017 World Solar Challenge this month saw strange vehicles racing 3,00(kilometres across Australia, powered only by sunlight. Here, the Dutch-built vehicle RED Shift passes a rock formation known as the Devil's Marbles, near Tennant Creek in the Northern Territory.

Sponge spikes



Zlotnikov Group, B CUBE, TU Dresden

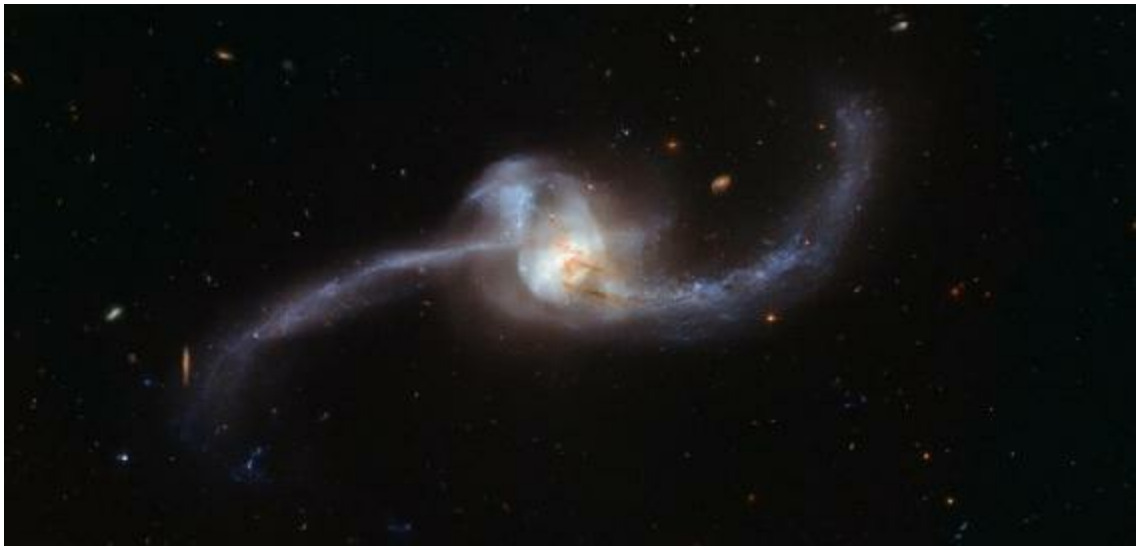
Marine sponges called demospongiae make their skeletons out of silica-glass structures called spicules. Using this image and others, researchers have been unpicking what they call the “half-a-billion-year-old fabrication concept” that produces these structures.

Spinal surgery

Beatrice de Gea/The New York Times/Redux/eyevine

Physicians at Texas Children’s Hospital in Houston now operate on fetuses with spina bifida while they are still in the womb using a new, experimental technique. This technique involves lifting the mother’s uterus out of her body to operate on the spine of the baby inside it.

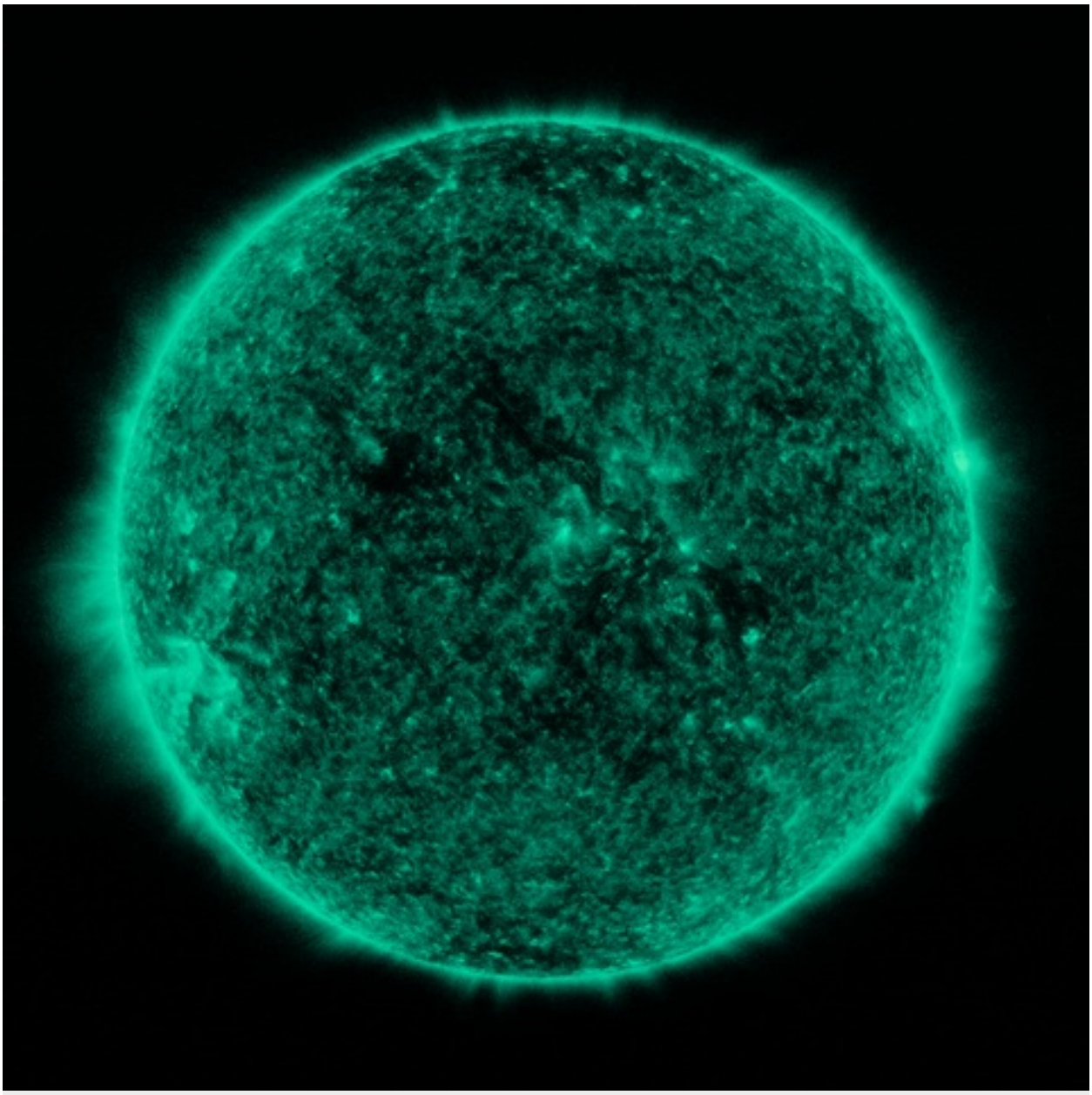
A cosmic collision’s aftermath



ESA/Hubble & NASA

Two galaxies smashed together into one to form this cluster of stars, with tails some 15,000 parsecs (50,000 light years) long. NASA released the image this month, and cheerfully pointed out that this is what our Milky Way will look like in 4 billion years' time, after it collides with neighbouring galaxy Andromeda.

Sun block



NASA’s Goddard Space Flight Center/SDO/Joy Ng

NASA’s Solar Dynamics Observatory was launched into space in 2010 to supply researchers back on Earth with an uninterrupted view of the Sun. Uninterrupted, that is, except when the Moon gets in the way, as shown in this ultraviolet spectrum from 19 October.

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Nature

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Comments

Comments

There are currently no comments.

Small group scoops international effort to sequence huge wheat genome

Just six scientists conquer one of the most complicated genomes ever read.

31 October 2017

Nico van Kappel/Minden Pictures/Getty

The genome of wheat (*Triticum aestivum*) is huge, and full of repetitive sequences.

The wheat genome is finally complete. A giant international consortium of academics and companies has been trying to finish the challenging DNA

sequence for more than a decade, but in the end, it was a small US-led team that scooped the prize. Researchers hope that the genome of bread wheat (*Triticum aestivum*) — described in the journal *GigaScience* this month[1] — will aid efforts to study and improve a staple crop on which around 2 billion people rely.

The wheat genome is crop geneticists' Mount Everest. It is huge — more than five times the size of a single copy of the human genome — and harbours six copies of each chromosome, adding up to between 16 billion and 17 billion letters of DNA. And more than 80% of it is made of repetitive sequences. These stretches are especially vexing for scientists trying to assemble the short DNA segments generated by sequencing machines into much longer chromosome sequences.

It’s like putting together a jigsaw puzzle filled with pieces of blue sky, says Steven Salzberg, a genomicist at Johns Hopkins University in Baltimore, Maryland, who led the latest sequencing effort. “The wheat genome is full of blue sky. All these pieces look like a lot of other pieces, but they’re not exactly alike.”

As a result, previous wheat-genome sequences contained gaps that made it hard for scientists to locate and examine any particular gene, says Klaus Mayer, a plant genomicist at the Helmholtz Center in Munich, Germany, and one of 1,800 members of the International Wheat Genome Sequencing Consortium (IWGSC) that have been tackling the genome since 2005.

A sequence released by the consortium in 2014 covered about two-thirds of the genome, but it was highly fragmented and lacked details about the sequences between genes[2]. Improved versions were released in 2016 and 2017, but the use of these data is restricted until the IWGSC publishes its analysis (Mayer says the team is preparing to submit its report to a journal). The sequence was also produced using proprietary software from a company called NRGene, preventing other scientists from reproducing the effort.

Puzzle pieces

Salzberg, who specializes in assembling genome sequences, and his five colleagues decided to tackle the problem themselves. To overcome the challenge of ordering repetitive DNA — the puzzle pieces of blue sky — the researchers used a sequencing technology that generates very long DNA stretches (often in excess of 10,000 DNA letters). They also created much shorter, but highly accurate sequences, using another technology.

Stitching these ‘reads’ together — which amounted to 1.5 trillion DNA letters and consumed 880,000 hours of processor time on a cluster of parallel computers — resulted in nearly continuous chromosome sequences that encompassed 15.3 billion letters of the wheat genome.

Mayer calls the new sequence “a major leap forward”. Postdocs can spend whole fellowships locating a single wheat gene of interest, he says. “Those genes which took 10 man- or woman-years to clone, this will melt down to a couple of months, hopefully.” The results of such research should help breeders to develop strains of wheat that are better able to tolerate climate change, disease and other stresses.

Some scientists are already using the new wheat genome — including, Salzberg says, members of the IWGSC working on one particular chromosome. But if it is to be of widespread use, all of the genes and sequences will need to be identified and labelled, a laborious process known as annotation. Salzberg says that a collaborator of his is planning to do this, “unless someone does it sooner”.

Neil Hall, a genomicist and director of the Earlham Institute, a genomics research centre in Norwich, UK, sees Salzberg’s approach as a sign of the times. If the wheat genome — considered one of the most complicated to be tackled by scientists — can be sequenced by a small team using the latest technology, almost any genome could.

“I think we’ve moved beyond the era where genome projects have to be these monolithic international cooperations,” Hall says. “Genomics is more like the gig economy now.”

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Nature

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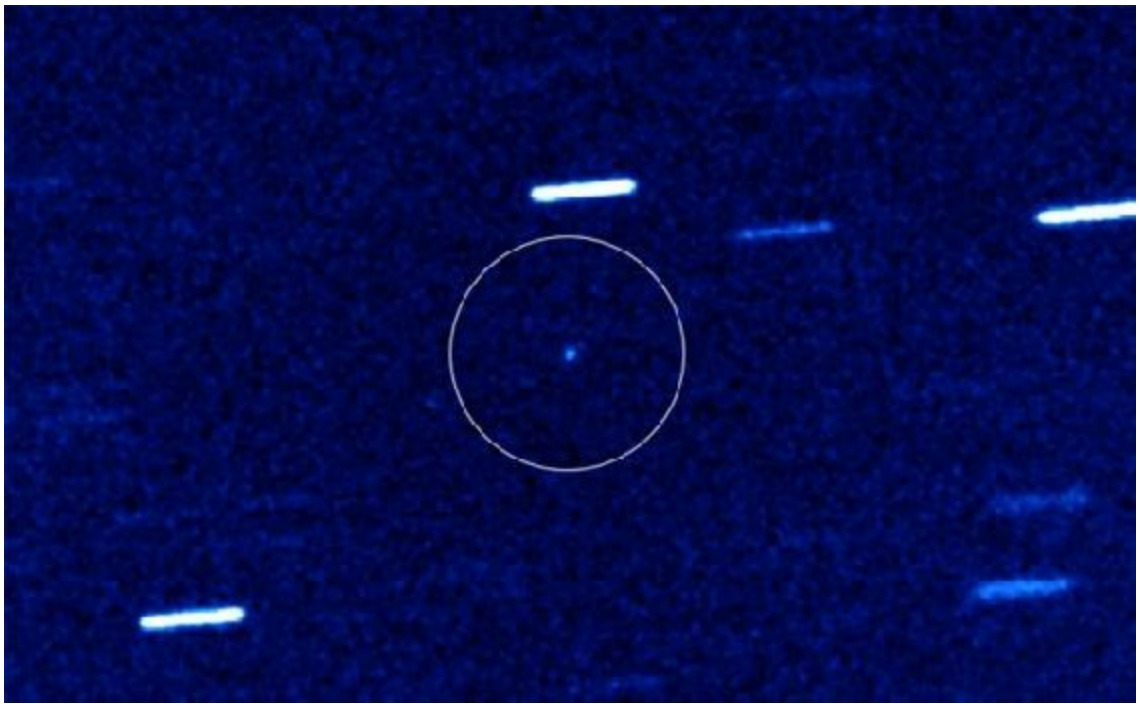
Comments

Commenting is currently unavailable.

Astronomers race to learn from first interstellar asteroid ever seen

Wonky orbit confirms that this visitor isn’t from around here.

31 October 2017



Alan Fitzsimmons, Queen’s University Belfast/Isaac Newton Group, La Palma.

The interstellar asteroid A/2017 U1 (circled) is rushing away from Earth and is currently traversing the Pisces constellation.

Scientists are trying to learn everything that they can from the first interstellar asteroid they have ever observed crossing into our Solar System. Spotted less than two weeks ago, the object is now whizzing across the constellation Pisces and, in a couple of months, will be too faint and far away for even the

largest telescopes to see.

“It’s fascinating,” says astronomer David Jewitt of the University of California, Los Angeles. “We are seeing a body from elsewhere in the Galaxy passing through our Solar System. It’s the first time we’ve seen such a thing.”

Unfortunately, the asteroid, dubbed A/2017 U1, is dashing away, never to return. “It’s going really fast,” says Jewitt. “So we have a limited time to get any measurements at all.” Astronomers would love to know what it’s made of, but it’s so dim that spectra — light that observers use to determine the compositions of celestial objects — have so far revealed little information[1]. Nor can anyone say what solar system it came from, or how old it is.

A curious path

Researchers with the Pan-STARRS1 telescope atop Haleakala in Maui, Hawaii, spied the first images of the intruder, made during the new Moon, in mid-October. “It didn’t move like comets or asteroids normally do,” says astronomer Rob Weryk at the University of Hawaii at Manoa, who first noticed the object on the morning of 19 October.

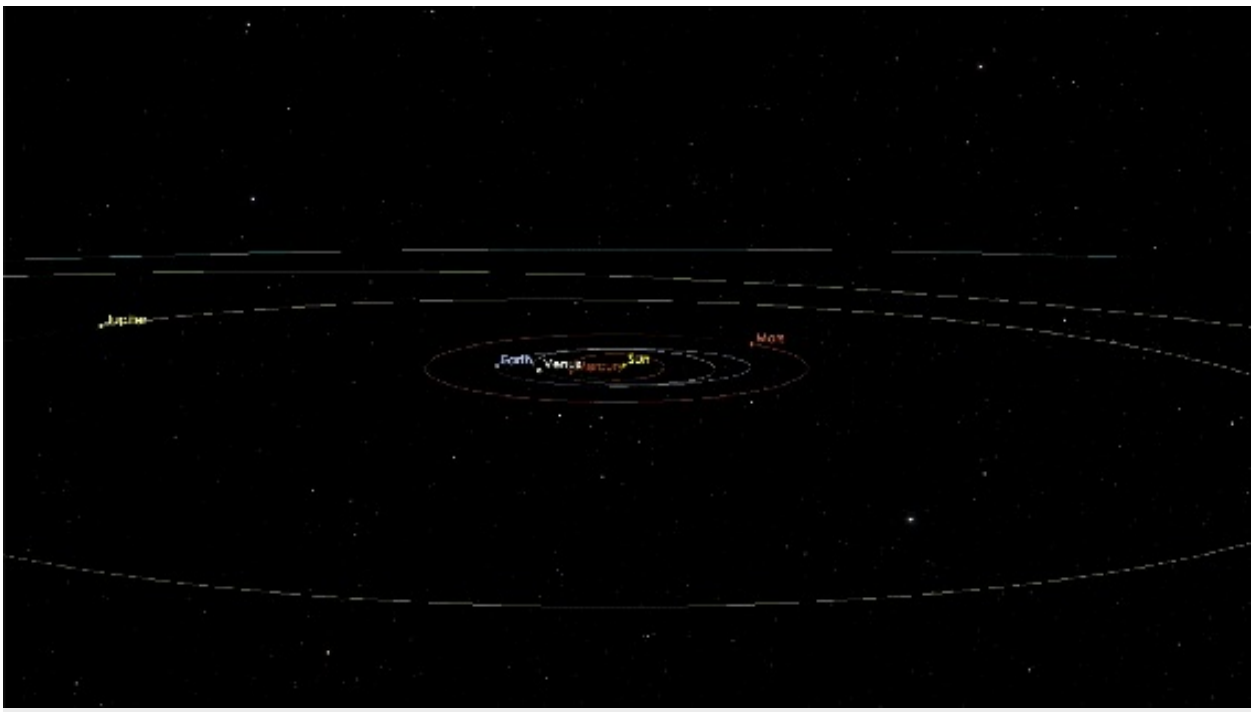
Comets and asteroids usually move on elliptical orbits around the Sun. These orbits have an eccentricity — a measure used to describe orbital shape — of less than 1. But an object zipping through the Solar System from beyond should instead follow a hyperbolic orbit, whose eccentricity exceeds 1.

The latest observations of the asteroid’s changing position indicate that its orbital eccentricity is a whopping 1.20. “It is virtually certain that the object moves in a hyperbolic trajectory,” says Carlos de la Fuente Marcos, an astronomer at the Complutense University of Madrid.

The asteroid skirted the Sun on 9 September, when it was inside Mercury’s orbit, and then passed by Earth at a distance of 24 million kilometres on 14 October.

On the lookout

Astronomers know little else about the exotic visitor. It’s faint, which means that it’s small: fewer than 400 metres across. And despite its excursion near the Sun, it did not develop a tail — as a comet would — and so astronomers are currently classifying it as an asteroid.



NASA/JPL-Caltech

The path of A/2017 U1, an interstellar object that swung through our Solar System.

Researchers have anticipated interstellar visitors for years. “We have waited a long time,” says planetary scientist Alan Stern at the Southwest Research Institute in Boulder, Colorado, who studied the matter in the 1990s.

That expectation is based on the knowledge that the gravitational pulls of the giant planets Jupiter, Saturn, Uranus and Neptune catapulted trillions of comets and asteroids from the young Solar System into interstellar

space. Planets in other solar systems presumably did the same, littering interstellar space with rogue objects. “By measuring how many there are sweeping through our Solar System, we can get a gauge of how many are in the entire Galaxy, and how many solar systems have contributed to that population,” says Stern.

“If one hadn’t been discovered fairly soon, that would start to worry me a bit,” says astronomer David Hughes, emeritus professor at the University of Sheffield, UK.

The asteroid came from the direction of the constellation Lyra, which is roughly where our Solar System is heading. Given this trajectory, researchers are expecting to see more objects coming from this direction than from elsewhere, just as runners heading into the rain encounter more drops on their chests than their backs.

A/2017 U1 is the first of many such objects, predicts Jewitt.

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Comments

Comments

There are currently no comments.

How baby bats develop their dialects

The young animals crowdsource the pitch of their calls from colony members.

31 October 2017

Joel Sartore/National Geographic Creative

Adult Egyptian fruit bats have a hand in what young bats learn.

It takes a village to teach a bat how to communicate. Baby Egyptian fruit bats learn calls from their mothers, but research now shows that they can learn new dialects, or the pitch of their vocalizations, from the colony members around them.

Learning to communicate by repeating the noises that others make is something only a few mammal groups — including humans, whales and dolphins — are known to do. Researchers call this vocal learning, and it's something that they're starting to study in bats. Findings published on 31 October in *PLOS Biology*[1] show that bats can also pick things up from the group around them, a process that the authors dub crowd vocal learning.

Bats are becoming the best organism to use in studies of how mammals learn to vocalize, because they’re more easily manipulated in the lab than whales or dolphins. The latest research underscores their importance, says neuroscientist Michael Yartsev of the University of California, Berkeley, who was not involved with the work.

Songbirds demonstrate vocal learning beautifully, but their brains are organized differently from human brains. Pinning down a mammalian model to explore how this function develops is important for neurologists studying vocal learning, says Yartsev.

The call of the colony

Egyptian fruit bats (*Rousettus aegyptiacus*) are highly social and live in colonies with dozens to thousands of other bats. To see how the pups learn dialects, researchers caught 15 pregnant Egyptian fruit bats and took them into the lab. To control for potential genetic effects, they ensured that the mothers weren't closely related. The team then split the mothers into three groups of five and put each group into one of three chambers, where the mothers gave birth to their young. The scientists used recordings of wild Egyptian fruit bat colonies that were low in frequency, high or a mix of both frequencies, and then piped one pitch into each chamber.

The team released the mothers back into the wild after 14 weeks, around the time the young would naturally be weaned. After another 17 weeks in the enclosures, the young bats were mimicking the pitch of the recordings they had grown up with: bats in the high-frequency chamber made more high-frequency calls than the bats that grew up hearing the other two frequency soundscapes.

The findings make sense, says Yossi Yovel, a neuroecologist at Tel Aviv University in Israel and a study co-author. Baby bats grow up in the dark, surrounded by noisy neighbours, so it would be odd if they didn't pick things up from the animals around them. "It's perhaps not surprising, but it was never demonstrated before now."

Yovel and his team plan to release the young bats into the wild and observe whether their dialect changes to match that of the wild bats, or whether the colony members pick up the experimental bats' dialect.

Studying how this process works in mammalian brains could provide insight into how humans learn language, too, says Sonja Vernes, a neurogeneticist at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands. "If we can understand how bats do it, I think we can learn something about how humans do it."

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Nature
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doi:10.1038/nature.2017.22926

Comments

Comments

There are currently no comments.

US environment agency bars scientists it funds from serving on its advisory boards

The US Environmental Protection Agency says the policy will address potential conflicts of interest, but scientists raise alarms.

31 October 2017 Updated:

1. 31 October 2017

Andrew Harrer/Bloomberg/Getty

EPA administrator Scott Pruitt is poised to reshape the mix of experts that advise his agency.

The US Environmental Protection Agency (EPA) moved today to ban researchers who receive agency grants from serving on EPA advisory boards.

In crafting the policy, EPA administrator Scott Pruitt sided with his agency's most vociferous critics, who claim that EPA science panels are stacked with scientists who are biased in favour of the agency's regulatory agenda. The policy does not extend to scientists who work for local, state and tribal agencies that receive EPA grants, instead focusing on academic researchers. At a press conference, Pruitt said that scientists on three major EPA advisory panels have received US$77 million in grants over the past three years.

"When you receive that much money, there's a question that arises about independence," Pruitt said. Moving forward, he said, scientists "will have to choose — either the grant, or service, but not both."

Scientists and environmentalists blasted the policy as hypocritical and dangerous, saying it will exclude many top researchers while rendering the volunteer posts less attractive for those who remain eligible. The EPA's multitude of science advisory boards provide input on everything from proposed regulations to the agency's long-term research agenda.

"It's a disturbing and short-sighted action," says Peter Thorne, who chaired the agency's main science advisory board until the end of September. Thorne, a toxicologist at the University of Iowa in Iowa City, says that the board already has policies in place to deal with conflicts of interest — such as those related to research by a board member or financial interests among industry scientists. "I'm really baffled as to why this is necessary," he says.

The EPA's new policy borrows from legislation backed by Republican lawmakers that has been circulating in the US Congress for several years. In March, the US House of Representatives passed the latest version, which would restrict scientists with EPA grants from serving on the Science Advisory Board and loosen rules that seek to address any conflicts of interest related to industry scientists who serve on the panel. The fate of that bill is uncertain, however, since the Senate — which would have to give its approval before the legislation could become law — has not taken action on

the matter.

“The reason it couldn’t get through Congress is that it doesn’t make any sense,” says Andrew Rosenberg, who heads the Center for Science and Democracy at the Union of Concerned Scientists (UCS), an advocacy group in Cambridge, Massachusetts. “It turns the idea of conflict of interest on its head.”

Competing interests

Rosenberg’s group analysed the current membership of the EPA’s main science advisory board and found that 5 of the 47 members could be barred by the new policy. But the EPA restrictions on advisory-board members could soon affect a much larger swathe of panel appointments. The terms of 15 people on the agency’s main science advisory board expired at the end of September. EPA watchers are also expecting to soon see appointments to the Board of Scientific Counselors, which advises the EPA’s main research arm, and a third panel that advises the agency on air regulations.

All three of those boards have new leaders, Pruitt announced today. Michael Honeycutt, a toxicologist at the Texas Commission on Environmental Quality, will lead the agency’s main science advisory board. Honeycutt has long opposed EPA proposals to enact stricter air-quality standards. Tony Cox, an independent consultant, will lead the Clean Air Safety Advisory Committee, while Paul Gilman, chief sustainability officer at the energy firm Covanta in Morristown, New Jersey, will lead the Board of Scientific Counselors.

One senior EPA official, who declined to be named for fear of retaliation, says that agency leadership initially considered barring any scientist who had ever received an EPA grant from serving on any agency advisory panel. Ultimately, the agency decided to focus on researchers with active grants — in part because EPA officials discovered that it was hard to find qualified scientists who had never received EPA grants.

The agency’s overhaul of its advisory boards has been in the works for

months. The EPA sparked an uproar in May and June by dismissing dozens of scientists who had served a single three-year term on the Board of Scientific Counselors. In the past, the agency has appointed many scientists for a second term to provide more continuity for programme managers who are seeking input on the vast array of research efforts at the agency.

For Thorne, the question is how the administration is going to engage with its new science advisers. In September, the main science advisory board issued a letter describing its activities and inviting Pruitt to attend one of its meetings. Whether Pruitt will take the committee up on its invitation remains to be seen, but Thorne says one thing is clear: if the agency chooses to marginalize or ignore the board, it will do so “at its own peril”.

Journal name:
Nature
DOI:
doi:10.1038/nature.2017.22929

Updates

Updated:

The story has been updated with information from the EPA press conference.

Comments

1 comment

1. *Rainald Koch* • 2017-11-01 12:58 PM
   "Tony Cox, an independent consultant, will lead the Clean Air Safety Advisory Committee" -- reminds me to Richard Anthony (Tony) Cox www-tonycox.ch.cam.ac.uk -- would be a better fit.

http://www.nature.com/doifinder/10.1038/nature.2017.22929

| 章节菜单 | 主菜单 |

Frédéric Chopin’s telltale heart

Scientists have written another chapter in the curious case of the composer’s heart. But it is unlikely to be the end of the story.

31 October 2017

De Agostini/A. Dagli Orti/Getty

The composer Frédéric Chopin died in 1849, but the debate about what killed him continues.

Edgar Allen Poe was a master of the macabre. His 1843 *The Tell-Tale Heart*

is a classic gothic tale for Halloween with its roots in guilt and fear: a murderer is haunted by the imagined beating of the excised heart of his victim.

The piano works of Frédéric Chopin — one of the greatest composers of the same period — tend more towards the uplifting. But events after his death have puzzled experts for more than a century and are worthy of any horror story. Scientists in Poland now claim to have solved the mystery. As the researchers conclude in a long-awaited report, he almost certainly died of complications caused by tuberculosis (M. Witt *et al. Am. J. Med.*; in the press; available at http://doi.org/cfpt). The evidence? The scientists have examined Chopin's own telltale heart.

The macabre afterlife of Chopin began with his recorded last words: "Swear to make them cut me open, so that I won't be buried alive." Taphephobia, as this fear is called, was a nineteenth-century obsession (shared by Alfred Nobel, among others), and saw some coffins made with alarm systems to be rung from within. Chopin's sister had an autopsy performed on him, during which his heart was removed. So although most of her brother lies in the famous Père Lachaise Cemetery in Paris, the city in which he died, she sealed his heart in a jar of (probably) brandy and took it back to Warsaw, the city closest to where he was born.

This wasn't too unusual. Remote burial of the heart was a fairly common practice, partly because it was too difficult to repatriate the bodies of kings and nobles who fell in foreign fields. (The heart of the English writer Thomas Hardy is said to be buried in his beloved Dorset, UK, although a more gruesome version of the story has the precious organ being eaten by a cat, and that of the offending animal interred instead.) But Chopin's status as a Polish national hero has helped to make sure that his heart never really rested in peace. His sister smuggled it into Poland past Russian border guards and it was later sealed inside a church pillar. Decades afterwards, during the Second World War, it was retrieved and protected by a Nazi SS commander who claimed to love Chopin's music. After the war, the heart was returned to rest in the church — but only until 2014.

Then, scientists were invited to join an official inspection of the jar and its contents. Their examination — and brief comments to journalists months

later — focused on how he died. The original autopsy notes are lost, and an entire academic subfield across many disciplines has emerged to discuss whether Chopin had tuberculosis or something much rarer, perhaps an early known case of cystic fibrosis. Those academics now have a Halloween treat: a draft of a paper to appear in *The American Journal of Medicine* offers more details on the state of the heart.

The original autopsy caused significant damage to both atria, but the paper claims "with high probability" that the remains show that Chopin had chronic tuberculosis, and that the immediate cause of death was a life-threatening complication called pericarditis — inflammation of the membrane enclosing the heart.

Chopin is not the only ghost from the past to offer their secrets to scientists. The artist Salvador Dalí was exhumed in July, moustache reportedly intact, to provide samples to decide a paternity case (he was not the father); and 2015 tests on bones of the Communist poet and winner of the Nobel Prize in Literature, Pablo Neruda, have fuelled theories that he was poisoned in Chile after Augusto Pinochet seized power in 1973.

There could yet be a twist in Chopin's tale. Some scholars are unsure that the heart is the composer's, and DNA tests to check for cystic fibrosis have so far been refused. The scientists were not allowed to open the jar in 2014, and Michał Witt at the Polish Academy of Sciences' Institute of Human Genetics in Poznan, who worked on the project, says that they didn't want to. The next opportunity will be in 50 years, when the heart is again scheduled for inspection. Witt does not expect to be around to see it. Still, he does have something more planned: the team was allowed to take photographs of the embalmed heart, and although none is yet public, he does plan to include them in the final manuscript. The full tale, after all, has not yet been told.

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Comments

Comments

There are currently no comments.

Lower emissions on the high seas

Global regulations to limit carbon dioxide from the shipping industry are overdue.

31 October 2017

Getty

Voluntary efforts to tackle carbon pollution from the shipping industry have failed.

In Herman Melville’s novel *Moby-Dick*, seafaring is the occupation of adventure-lovers. But since the maritime classic was published in 1851, the act of ‘sailing about a little’ has become a huge commercial undertaking. Today, a massive fleet of cargo ships transports 90% of global consumer goods. Shipping is efficient — but comes with an environmental cost that has

not been adequately accounted for.

Worldwide, there are about half a million ships in operation, together producing almost one billion tonnes of carbon dioxide each year. That's between 2% and 3% of the global total, and more CO_2 than Germany emits annually. But unlike greenhouse-gas emissions from Germany and other nations, shipping emissions are not subject to the reduction pledges made by individual nations under the Paris climate agreement. (The Paris deal does, however, include shipping emissions in its global carbon-budget calculations.)

After years of inaction, the great white whale of greenhouse-gas pollution is now in the cross hairs of the International Maritime Organization (IMO), the specialized United Nations agency that sets safety and environmental standards for the global shipping industry. The IMO is under pressure from campaigners and representatives of other, regulated sectors to agree a global cap on shipping emissions.

Following sharp increases in the early 2000s, the sector's emissions have remained more or less stable since the global financial crisis of 2008. But that is unlikely to continue. The current overcapacity in the maritime cargo market means that ship traffic (and emissions) can increase quickly to meet demand. Moreover, the shipping industry at large — including the cruise sector — has potential to grow, and rapidly.

The IMO has a specialist greenhouse-gas working group that is grappling with the idea of a cap. But its latest meeting, held last week in London, closed without declaring much progress. Overall, the IMO is committed to tightening environmental standards for new ships. Yet its technology-oriented strategy — including an Energy Efficiency Design Index that requires the engines of vessels to burn less fuel — is unlikely to be enough. Cleaning up the industry will require adequate market instruments and economic incentives to encourage owners and operators of both ships and ports to adopt climate-friendly practices, such as enforcing lower speeds.

Owing to the peculiarities of this volatile business, the routes, speed and fuel consumption of tens of thousands of container ships are hard to monitor and verify. An emissions-trading system, for example, would be difficult to

implement and even harder to manage. The IMO agreed last year to set up a global CO_2 data-collection system that will yield welcome knowledge, as will improvements in tracking the positions and movements of ships from space. But a tax by national governments on fossil fuels used by ships — incurred at refinery level — might be a more effective economic mechanism.

Voluntary efforts alone will not do. The industry has set up a series of half-hearted and overlapping eco-ratings schemes since the 2000s. But an analysis published online on 16 October shows that these have had no notable effect on the environmental performance of ships (R. T. Poulsen *et al. Mar. Policy* **87,** 94–103; 2018). Whereas eco-ratings can steer companies to make more-efficient refrigerators and washing machines in line with the preferences of consumers and regulators, maritime transport is different. The pressure of end-users is too distant to influence ship owners and operators. And price remains the dominant factor for builders and buyers of cargo ships.

As a global business, shipping must be tackled by global regulations, and not through a patchwork of voluntary efforts and regional laws. It is true that some regional efforts, such as the European Union's scheme to monitor, report and verify CO_2 emissions from large ships using its ports, might be a step towards global regulations.

The IMO has already shown that it can tackle other environmental issues. Measures it introduced in the wake of the *Exxon Valdez* oil spill in 1989 ensure that oil tankers are now much safer. An international convention for ballast-water management, which aims to control the spread of harmful invasive species, came into force in September after years of preparation (although it does not address biofouling on ships' hulls, which is potentially more harmful to local ecology). The IMO has also agreed measures to encourage environmentally responsible ship recycling and minimize uncontrolled shipbreaking, much of which occurs on South Asian beaches. However, this 2009 Hong Kong convention is still not implemented and is awaiting ratification by most member parties.

When it comes to the impact on climate, there is no excuse for delay. Emissions from shipping largely escape the public scrutiny and criticism attracted by those from aviation. Parties to the IMO should step up and hasten

the implementation of the necessary standards.

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Commenting is currently unavailable.

Lessons from first campus carbon-pricing scheme

31 October 2017

Putting a value on emissions can lower energy use, write Kenneth Gillingham, Stefano Carattini and Daniel Esty.

Enzo Figueres/Getty

Kroon Hall, home to Yale University's environment school in New Haven, Connecticut, reduced emissions substantially in the face of the carbon charge.

In July, Yale became the first university to launch a carbon-price programme across its campus. More than 250 buildings, together accounting for nearly

70% of the institution's emissions, will be charged US$40 per tonne of carbon dioxide that they emit as a result of energy use. Buildings that reduce their emissions more than the average will receive a share of the funds collected.

More than 500 firms around the world — three times more than a year ago — consider a carbon price of some kind when judging where to invest their money. Hundreds more are expected to start doing so in the coming months. Faced with higher prices, these organizations are shifting to forms of energy that generate less emissions and are more efficient.

Although some large companies have tried internal carbon pricing over the past two decades — BP was the first, in 1998 — little has been published about the value of such programmes. Here, we share initial insights and ideas for future research from a pilot scheme tried in 2015–16 at Yale — a prelude to the university's decision to roll out carbon pricing more broadly this year.

Price signals

Carbon pricing offers a direct incentive to reduce energy consumption and thus mitigate global climate change. In 2015, 13% of global greenhouse-gas emissions were subject to some form of carbon price, and this percentage is rising[1], despite the challenges currently facing government-backed schemes (see 'Faltering policies').

Faltering policies

Governments are struggling to put an appropriate price on carbon dioxide. In 2016, voters in the state of Washington rejected an initiative that would have set a tax on carbon emissions, despite broad support in polls for policy action on climate change. US President Donald Trump has backed away from the previous administration's Clean Power Plan. South Africa has delayed implementing a carbon tax. The United Kingdom has frozen its price floor for trading carbon at £18 (US$24) per tonne of CO_2 until 2021, rather than gradually raising it, as intended. According to the International Monetary Fund, most developed countries should price carbon at at least US$100 per

tonne of CO_2 equivalent to reach their emissions-reduction targets for the 2015 Paris climate -change agreement. The longer they wait, the higher these prices will need to be.

A company or institution can implement a carbon price through an internal emissions-trading programme, a carbon charge or a 'proxy price' (or 'shadow price') on greenhouse-gas emissions.

In the first case, the firm caps its emissions at a given level for a fixed period and divides its allowances between its organizational units — in a similar way to the European Union Emissions Trading Scheme. Units then trade their allowances with each other. Buying allowances from units with lower pollution-reduction costs minimizes the overall cost to the company. BP used this approach to reduce its company emissions, quickly achieving its goal of a 10% cut from 1990 levels by 2010[2].

An internal charge increases the price of carbon-intensive goods and services exchanged within the organization. The higher the price, the greater the incentive for the firm to decarbonize.

Companies can redistribute the revenue raised, or invest it in emissions-abatement schemes, as the luxury-goods conglomerate LVMH does. Ice-cream manufacturer Ben & Jerry's invests its revenue in programmes to reduce emissions across its supply chain, on the basis of a “cow-to-cone” life-cycle analysis.

For the past five years, Microsoft has charged its business groups a carbon fee that appears quarterly in their profit-and-loss statements. The fee covers energy consumption (adjusted for employee count) from data centres, offices and software-development labs, as well as from business air travel[3]. The revenue raised goes towards buying renewable energy or improving the treatment of electronic waste or the energy efficiency of lighting, heating, ventilation and air-conditioning systems[4]. In 2015, this fee was about $4 per tonne of CO_2 (ref. 5); this is much less than the US government estimate of the 'social cost of carbon', which is $44 per tonne. Low fees are common, with most internal carbon charges below $30 per tonne of carbon dioxide.

Proxy prices — which involve no financial transactions but are taken into account when weighing up business decisions — are often higher. No revenue is raised, but the carbon price shapes long-term investment choices. When deciding what sorts of buildings to construct or equipment to buy, the proxy price favours low-carbon solutions.

Ben & Jerry's

A solar-energy installation under construction next to the Ben & Jerry's ice-cream factory in Vermont.

For example, ExxonMobil, the Texas-based oil-and-gas multinational, is using a proxy price of $10 per tonne of CO_2; that will rise to $80 per tonne by 2040 (ref. 5). Proxy pricing drove Bristol Water, a British public utility company, to install more energy-efficient water pumps[6]. Saint-Gobain, a building-materials manufacturer based in Paris, uses a carbon price to drive investments in research and development for breakthrough technologies[6]. Some companies, such as the Dutch multinational Royal DSM in Heerlen, present two business cases for investments: one with and one without carbon

pricing[6].

Getting ahead

Organizations are implementing internal carbon pricing for many reasons. By aligning investment decisions now, firms are preparing for more-stringent domestic climate policies and for future mandatory carbon pricing. They are also avoiding becoming locked into unprofitable investments and 'stranded assets', which are a concern for investors and others, and are preparing for changed future circumstances. For example, more than 80% of current coal reserves might need to remain untouched if countries are to limit warming to 2° C (ref. 7). Committing to carbon pricing sends a signal to rating agencies and regulators that an enterprise is forward-looking and attentive to emerging climate risks[8].

Internal carbon pricing is part of broader corporate or organizational social-responsibility efforts[4]. By using a carbon price rather than targets for renewable-energy procurement, or internal energy-efficiency standards, organizations achieve those goals in the most cost-effective way. Innovations may result from directing managerial attention to cheaper projects that improve operations or that reduce energy expenditure[2]. Managers do not need to know the exact costs of abatement to achieve progress.

Organizations can also pilot internal carbon-pricing schemes to shape future governmental decisions. Policy leadership was one of the motivations behind BP's internal carbon pricing[9].

Lessons from Yale

Yale University's carbon-charge pilot was launched as part of the university's broader sustainability initiative and ran from December 2015 to May 2016. The charges covered direct and indirect emissions from consuming energy sources such as electricity, gas, steam and chilled water. The price was set at $40 per tonne of CO_2, which was close to the US government's estimated social cost.

Each of the 20 buildings selected for the pilot received a monthly report that detailed energy consumption and carbon use. They were all randomly allocated to one of four approaches: no carbon price; carbon pricing with 20% of the revenue earmarked for energy-efficiency actions; pricing with the revenue redistributed to buildings that reduced their emissions by at least 1% relative to their historic level of emissions; and pricing with revenue that was returned to buildings whose percentage reduction in emissions exceeded the average. This last approach is revenue-neutral: a net charge applied if emissions reductions were below average, and a net rebate if cuts were above average. Campus buildings outside the scheme served as a control group. Emissions were estimated in proportion to the amount of energy used, with different factors for different sources.

By the end of the trial, buildings that had faced carbon charges had used less energy than those that had not (see 'Energy savings'). Reasons for this included increased awareness of energy use, competition between buildings and the higher price of energy.

Building managers were mainly responsible for responding to the charge. Some favoured cheap options, such as turning down the heat by 1° C. Behavioural or operational changes, such as turning off lights and unused electrical equipment, also cost little. Others, including the departments of economics, environmental studies, public health and the boathouse, took more expensive measures such as installing occupancy sensors, thermal window shades or bulbs that use light-emitting diodes.

At the end of the pilot, the university selected the revenue-neutral pricing structure to implement campus-wide, because of its financial stability. The structure is not subject to potentially large outflows of funds if buildings exceed a target, saving energy because of an unusually mild winter, for example, or if energy needs rise unexpectedly owing to a cold snap or other reasons.

Of course, there are caveats. The scheme's novelty might have boosted engagement. Academics might be more interested than others in adopting challenging and original innovations. The sample size is small and the findings might not generalize to other situations.

Nonetheless, we feel that Yale's experience highlights important ingredients and challenges for internal carbon pricing.

First, information and incentives must be conveyed clearly for carbon charges to change behaviour.

After the pilot, more than half of the staff involved reported an improved understanding of energy use. The flow of information began with the energy reports to managers and spread through meetings with the staff and faculty, and through posters that explained energy savings. Students carried out energy audits. Actions were often collectively identified and followed up by monthly e-mail updates.

Second, the details of the scheme matter. How energy information is presented and carbon-charge revenue is redistributed influence the effectiveness of the scheme. For example, exit surveys of managers indicated that they responded more to the 'net' carbon charge, calculated after they had received a rebate, than to the higher 'gross' charge. Thus, many perceived the price signal as smaller. To increase managers' response to the price signal, one of them suggested a “bump in pay” for good performance on the carbon charge.

Third, carbon pricing is more effective when participants consider the rules to be fair. Perceived fairness increases engagement and encourages competition. The baseline from which emissions reductions are compared is a crucial design factor because it influences winners and losers. Yale's carbon-pricing system recognizes that buildings vary in size, age and energy efficiency, and that research in some disciplines is more energy-intensive than in others. Hence, only emissions above the historic baseline count towards the carbon charge. Emissions in the divinity school might be 100 times lower than those in the medical school, which hosts magnetic-resonance equipment.

For the pilot, the average emissions in the previous three fiscal years, 2013–15, were used as the baseline. In the campus-wide scheme, fiscal years 2011–15 are being used, with adjustments for a few buildings with large renovations, additions, construction or directed growth. For example, emissions at Ezra Stiles College were exceptionally low in 2011–12. during a period of major renovation. Brand new buildings will require projections.

Future research

Four areas of research could improve the design of internal carbon-pricing schemes. First, scientists, engineers and economists need to identify and test design options using rigorous pilot projects, similar to Yale's. These should span organizations of many different sizes and complexities. Such tests would provide insights for policymakers.

Second, no evidence exists on how internal carbon charges interact with non-carbon-pricing policies, such as tax credits or other incentives for renewable energy or energy efficiency. Economists should explore these interactions through data analysis and natural experiments, such as from regulatory changes, including effects on consumers.

Third, building scientists and other metrics experts must develop methods to assure high-quality benchmarking and data analytics for emissions inventories and baseline calculations. Ideally, these metrics should cover a wide range of energy uses before an internal carbon price is set up.

Fourth, accounting and managerial expertise is required to define the tax and financial implications of internal carbon pricing, in particular for multinational and transnational organizations.

We are only beginning to understand internal carbon pricing, but it seems to hold great promise as a way to sharpen incentives and reduce greenhouse-gas emissions.

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Supplementary information

PDF files

1. Supplementary information (258K)

Comments

Comments

There are currently no comments.

Huge microwave observatory to search for cosmic inflation

Multi-telescope project has ambitious goals and a big price tag.

30 October 2017

NSF/Steffen Richter/Harvard Univ./SPL

Telescopes in Antarctica track the cosmic microwave background radiation left over from the Big Bang.

US researchers have drafted plans to study the faint afterglow of the Big Bang using a new facility. They hope it will be sensitive enough to confirm whether or not the infant Universe underwent a brief period of explosive expansion known as inflation.

The Cosmic Microwave Background Stage-4 experiment (CMB-S4) would comprise three 6-metre and 14 half-metre telescopes distributed across two sites in Antarctica and Chile, according to a preliminary design due to be made public this week. Potentially up and running within a decade, the facility would be nearly 100 times as sensitive as existing ground-based CMB experiments.

It won't be cheap, however. Construction will cost a little over US$400 million, according to the expert task force commissioned by the US Department of Energy (DOE) and National Science Foundation (NSF) to produce the design. That is at least twice as much as envisioned in a less-detailed review 3 years ago, and 30 times the cost of existing experiments.

The price tag is "not necessarily" a showstopper, says Richard Barvainis, who directs the NSF's extragalactic astronomy and cosmology programme. But CMB-S4 will have to compete for limited funding with other large proposed facilities.

Primordial ripples

The CMB provides an image of the Universe as it was just 380,000 years after the Big Bang. Discovered in 1964, the radiation has since been observed by experiments on the ground, on balloons and in space, yielding increasingly precise insights into the Universe's geometry, contents and age — currently calculated at a little under 14 billion years.

But physicists think that the CMB has more to offer. In particular, distinctive patterns in its polarization known as B modes could reveal the existence of primordial gravitational waves. Gravitational waves — ripples in space-time — were first observed directly in 2015, but their detection in the very early Universe would be a major breakthrough, providing the strongest evidence yet for inflation, according to Charles Lawrence, an astrophysicist at NASA's Jet Propulsion Laboratory in Pasadena, California, who chairs the CMB-S4 task force.

Current ground-based CMB experiments typically detect microwaves using a

few thousand pixels and are based either near the South Pole or in Chile's Atacama Desert, where very dry conditions make the atmosphere nearly transparent to microwave radiation. None of the experiments has so far spotted the telltale B mode. One group did make a well-publicized claim in 2014, but it transpired that the sighting was actually caused by emissions from Galactic dust. Researchers are now building several more experiments that will be ten times as sensitive.

But Lawrence says that detecting the gravitational waves predicted by many of today's models of inflation would require sensitivity boosted by a further order of magnitude. Hence CMB-S4, which would comprise nearly 400,000 pixels. If it, too, came up empty-handed, the task force writes, it might be necessary "to give up on inflation".

Fight for funding

CMB-S4 is too large for any single group to build, so researchers across the US started collaborating on the design in 2013. Their initial plans were approved a year later by a panel advising the DOE on particle physics. But they must wait until 2020 to see how they fare in the next round of the once-per-decade survey of astronomy and astrophysics that the NSF uses to assess funding priorities.

Barvainis says that the agency will support CMB-S4 only if it gets "a very high priority" in the decadal survey, which is also likely to include a proposed upgrade to the National Radio Astronomy Observatory's Very Large Array in New Mexico, along with the development of one or more large optical telescopes. Even if the project does prevail, he adds, further agency reviews could delay the envisaged start of operations — due in 2026 — by at least two years.

The task force suggests that instead, CMB-S4 could be started by adding DOE detectors to existing telescopes in Chile while installing a few of the smaller telescopes at the South Pole. Under that strategy, the NSF would initially fund only operations. However, officials at the DOE also foresee snags. James Siegrist, the agency's associate director for high-energy

physics, says budgetary disagreements between the White House and Congress are creating “a lot of uncertainty” in Washington DC. A delay until 2027 or 2028 “could easily happen”, he predicts.

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Comments

2 comments

1. *Pentcho Valev* • 2017-10-30 10:41 PM
   Vacuum is not empty, and this makes the Cosmic Microwave Background concept rather silly. It is unreasonable to believe that the vacuum is full of energy and at the same time to claim that the noise known as CMB is not a product of this energy but just traverses it, unchanged. You have vacuum energy, detectors in contact with the vacuum which register strange noise coming from all directions, and you conclude that the noise is not produced by the vacuum energy but comes from the miraculous beginning of space and time. In addition, you implicitly assume that the vacuum energy does not change the noise. Silly, isn't it? Vacuum slows down light - this explains the Hubble redshift (in a STATIC universe): "...explains Liberati. "If spacetime is a kind of fluid, then we must also take into account its viscosity and other dissipative effects, which had never been considered in detail". Liberati and Maccione catalogued these effects and showed that viscosity tends to rapidly dissipate photons and other particles along their path, "And yet we can see photons travelling from astrophysical objects located millions of light years away!" he continues. "If spacetime is a fluid, then according to our calculations it must necessarily be a superfluid. This means that its viscosity value is extremely low, close to zero"." https://phys.org/news/2014-04-liquid-spacetime-slippery-superfluid.html Nature: "As waves travel through a

medium, they lose energy over time. This dampening effect would also happen to photons traveling through spacetime, the researchers found." http://www.nature.com/news/superfluid-spacetime-points-to-unification-of-physics-1.15437 "Some physicists, however, suggest that there might be one other cosmic factor that could influence the speed of light: quantum vacuum fluctuation. This theory holds that so-called empty spaces in the Universe aren't actually empty - they're teeming with particles that are just constantly changing from existent to non-existent states. Quantum fluctuations, therefore, could slow down the speed of light." https://www.sciencealert.com/how-much-do-we-really-know-about-the-speed-of-light?perpetual=yes&limitstart;=1 The transition from expanding to STATIC universe is unavoidable because the implications of the expanding universe theory are absurd: Sabine Hossenfelder: "If The Universe Is Expanding, Then Why Aren't We? The solution of general relativity that describes the expanding universe is a solution on average; it is good only on very large distances. But the solutions that describe galaxies are different - and just don't expand. It's not that galaxies expand unnoticeably, they just don't. The full solution, then, is both stitched together: Expanding space between non-expanding galaxies."
https://www.forbes.com/sites/startswithabang/2017/07/28/most-things-dont-actually-expand-in-an-expanding-universe/ "The Multiverse Is Inevitable, And We're Living In It. Alan Guth: "It's hard to build models of inflation that don't lead to a multiverse. It's not impossible, so I think there's still certainly research that needs to be done. But most models of inflation do lead to a multiverse, and evidence for inflation will be pushing us in the direction of taking [it] seriously." The Multiverse itself may not give rise to any observable, testable predictions, but arises as a direct consequences of other physical theories that have already been validated." http://scienceblogs.com/startswithabang/2017/10/12/the-multiverse-is-inevitable-and-were-living-in-it-synopsis/ Pentcho Valev

2. *Pentcho Valev* • 2017-10-31 07:35 AM
In my view, the following dialog marks the beginning of a

sweeping revolution in cosmology: http://backreaction.blogspot.bg/2017/10/space-may-not-be-as-immaterial-as-we.html Sabine Hossenfelder: "Is Space-Time Fluid? We have known at least since Einstein that space and time are inseparable, two hemispheres of the same cosmic brain, joined to a single entity: space-time. Einstein also taught us that space-time isn't flat, like paper, but bent and wiggly, like a rubber sheet. Space-time curves around mass and energy and this gives rise to the effect we call gravity. That's what Einstein said. But turns out... [...] That space itself isn't fundamental but made of other things is one way to approach the problem. Not everyone likes the idea. What irks physicists most about giving substance to space-time is that this breaks Einstein's bond between space and time which has worked dramatically well - so far. Only further experiment will reveal whether Einstein's theory holds up." Arun: "How does a fluid analog of general relativity avoid having a preferred reference frame?" Sabine Hossenfelder: "Arun, it doesn't. It's why I write it breaks the union between space and time." [END OF QUOTATION] Sabine Hossenfelder is on the right track. The "preferred reference frame" does not affect the validity of the principle of relativity in its traditional usage - it is only responsible for the vacuum friction that slows down photons coming from distant stars, in a STATIC universe. So the Hubble redshift is produced, but at the end of their journey photons redshift less vigorously than at the beginning. This has wrongly been interpreted as accelerating expansion: "In the mid 1990s two teams of scientists, one led by Brian Schmidt and Adam Riess, and the other by Saul Perlmutter, independently measured distances to Type 1a supernovae in the distant universe, finding that they appeared to be further way than they should be if the universe's rate of expansion was constant. The observations led to the hypothesis that some kind of dark energy anti-gravitational force has caused the expansion of the universe to accelerate over the past six billion years." https://cosmosmagazine.com/physics/dark-energy-may-not-exist Below I'm showing that the redshifting varies EXPONENTIALLY with time. The "finding that they appeared to be further way than they should be" is an illusion due to using an approximation to the

exponential function. Assume that, as the photon travels through space (in a STATIC universe), a factor equivalent to vacuum friction (see relevant references below) slows it down so that the photon loses speed in much the same way that a golf ball loses speed due to the resistance of the air. On this hypothesis the resistive force (Fr) is proportional to the speed of the photon (V): Fr = - KV That is, the speed of light decreases with time in accordance with the equation: dV/dt = - K'V Clearly, at the end of a very long journey of photons (coming from a very distant object), the contribution to the redshift is much smaller than the contribution at the beginning of the journey. Light coming from nearer objects is less subject to this effect, that is, the increase of the redshift with distance is closer to LINEAR for short distances. For distant light sources we have: f' = f(exp(-kt)) where f is the initial and f' the measured (redshifted) frequency. For short distances the following approximations can be made: f' = f(exp(-kt)) ~ f(1-kt) ~ f - kd/λ where d is the distance between the light source and the observer and λ is the wavelength. The approximate equation, f' = f - kd/λ, is only valid for short distances and corresponds to the Hubble law. The original equation, f' = f(exp(-kt)), shows that at the end of a very long journey (in a STATIC universe) photons redshift much less vigorously than at the beginning of the journey. This means that photons coming from very distant objects have undergone some initial "vigorous" redshifting which is unaccounted for by the Hubble law. This explains why the very distant objects "appeared to be further way than they should be if the universe's rate of expansion was constant". Is there "vacuum friction" that slows down photons? Yes there is: "This leads to the prediction of vacuum friction: The quantum vacuum can act in a manner reminiscent of a viscous fluid." http://philpapers.org/rec/DAVQVN New Scientist: "Vacuum has friction after all." https://www.newscientist.com/article/mg20927994.100-vacuum-has-friction-after-all "So how can a vacuum carry force? One of the first things we learn in classical physics is that in a perfect vacuum - a place entirely devoid of matter - friction can't exist, because empty space can't exert a force on objects traveling through it. But,

in recent years, quantum physicists have shown that vacuums are actually filled by tiny electromagnetic fluctuations that can interfere with the activity of photons - particles of light - and produce a measurable force on objects."
http://www.businessinsider.com/casimir-effect-vacuum-space-nanoparticles-2017-4 Pentcho Valev

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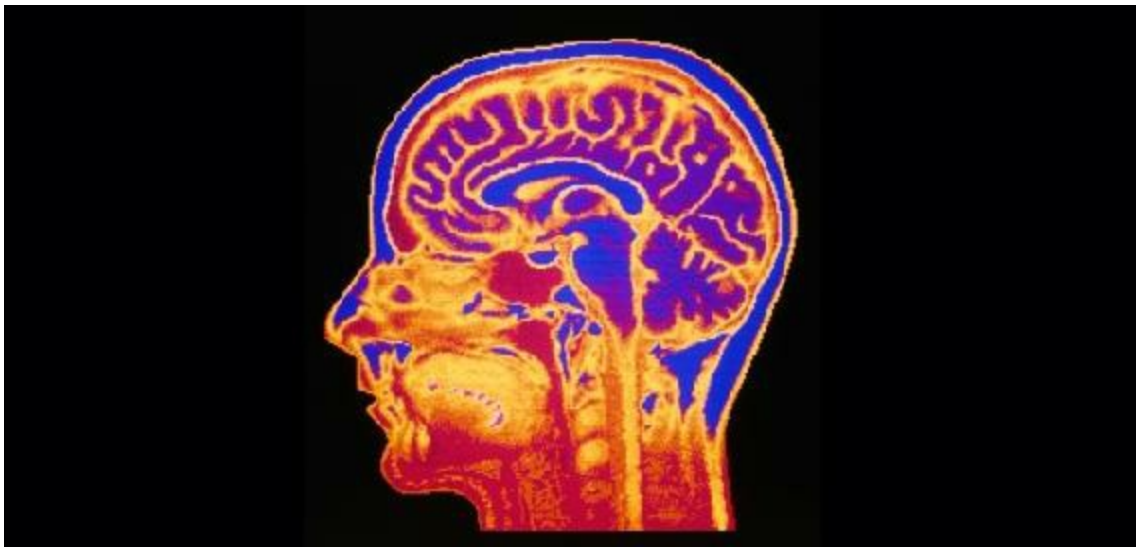
Geneticists are starting to unravel evolution's role in mental illness

Hints emerge that past environments could have influenced psychiatric disorders.

30 October 2017



Mehau Kulyk/SPL

Human genome databases are enabling researchers to take a deeper dive into the evolution of psychiatric disorders.

Psychiatric disorders can be debilitating and often involve a genetic component, yet, evolution hasn’t weeded them out. Now, recent work is beginning to reveal the role of natural selection — offering a peek at how the genetic underpinnings of mental illness has changed over time.

Many psychiatric disorders are polygenic: they can involve hundreds or thousands of genes and DNA mutations. It can be difficult to track how so

many genetic regions evolved, and such studies require large genome data sets. But the advent of massive human genome databases is enabling researchers to look for possible connections between mental illnesses and the environmental and societal conditions that might have driven their emergence and development. Others are looking to Neanderthal genetic sequences to help inform the picture of these disorders, as well as cognitive abilities, in humans. Several of these teams presented their findings at the American Society of Human Genetics (ASHG) meeting in Orlando, Florida, in late October.

One project found that evolution selected for DNA variants thought to protect against schizophrenia. The study, led by population geneticist Barbara Stranger of the University of Chicago in Illinois, looked at hundreds of thousands of human genomes using a statistical method that identified signals of selection over the past 2,000 years[1]. There were no signs of selection in genetic regions associated with any other mental illness.

Many of schizophrenia's symptoms, such as auditory hallucinations and jumbling sentences, involve brain regions tied to speech, says Bernard Crespi, an evolutionary biologist at Simon Fraser University in Burnaby, Canada. Over the course of hominid evolution, he says, the ability to speak could have outweighed the small, but unavoidable risk that the genes involved in language could malfunction and result in schizophrenia in a small percentage of the population.

A quest for context

Another team, lead by human geneticist Renato Polimanti at Yale University in New Haven, Connecticut, is trying to tease out links between environmental factors, mental illnesses and behavioural traits. Polimanti and his colleagues looked at 2,455 DNA samples from individuals at 23 sites across Europe and quantified each person’s overall genetic risk for mental disorders, such as autism, and personality traits, such as extraversion. They then calculated whether that risk was associated with certain environmental factors, such as rainfall, winter temperatures or the prevalence of infectious disease — exploring the idea that these factors might have been involved in

selecting for the human traits.

People who live in European regions with relatively lower winter temperatures, they found, were slightly more genetically prone to schizophrenia. Polimanti suggests that if genes that helped people tolerate cold were located close to variants that promote schizophrenia in the genome, then the latter could have been inadvertently carried along during evolution as a “fellow traveller”.

“This was a nice first attempt to put some environmental context” on the polygenic variants associated with mental illness, says Tony Capra, an evolutionary geneticist at Vanderbilt University in Nashville, Tennessee. Polimanti now plans to repeat the study in other parts of the world.

For and against

Untangling the roles of genetics and the environment will be difficult, however, because unknown environmental conditions in the past could have selected for traits that were advantageous then, but considered negative today. And other evolutionary factors could contribute to mental illness indirectly. An overactive immune system is thought to be involved in many psychiatric disorders, such as depression[2], but a stronger immune system would have made human ancestors more resistant to diseases, says Stranger.

Some researchers are exploring the evolution of mental illness through a different lens: by looking at possible differences in gene activity in tissues of Neanderthals and humans. A group lead by Capra and Vanderbilt human geneticist Laura Colbran used databases of modern human genomes to find DNA markers that suggest a gene is differently regulated in various tissues in the body. They then looked for these markers in two Neanderthal genomes. The team found that genes associated with neurological development were regulated differently in the Neanderthal brain compared with that of humans.

So while the DNA sequence of a gene such as *FOXP2* — which is associated with language — is identical[3] in humans and Neanderthals, human brains might have produced more of the associated protein, accounting for increased

language ability. The results could eventually lead to a better understanding of how Neanderthal brains functioned, if they were similar to human brains and whether they might have suffered from similar psychiatric disorders.

Studying how mental illness evolved is still at an early stage, but the ability to use massive human genome databases is an exciting step forward, says Capra. He and his colleagues plan to take advantage of this with a survey of genetic areas that differ between Neanderthals and humans, searching for differences in how the genes are expressed.

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Comments

There are currently no comments.

Nature News

周日, 12 11月 2017

Nature News

[周日, 12 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **South Africa tackles crime at sea with ship-spotting satellites** [周五, 10 11月 08:00]
  Automated vessel-tracking system aims to spy poachers and smugglers.
- **Resurrected malaria strategy saves thousands of lives in Africa** [周五, 10 11月 08:00]
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- **Physicists shrink plans for next major collider** [周四, 09 11月 08:00]
  Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.
- **UK government appoints next chief scientific adviser** [周三, 08 11月 08:00]
  A former pharmaceutical boss will help navigate the UK’s exit from the European Union.
- **Skin regeneration with insights** [周三, 08 11月 08:00]
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  The US environment agency should not ban researchers it funds from its advisory boards.
- **Rohingya refugees, Bulgarian protests and a prize for negative results** [周三, 08 11月 08:00]
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- **The bitter battle over the world’s most popular insecticides** [周三, 08 11月 08:00]
  As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.
- **Four ethical priorities for neurotechnologies and AI** [周三, 08 11月 08:00]
  Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

- **The catalogue that made metrics, and changed science** [周三, 08 11月 08:00]
  As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.
- **Polar exploration: The forgotten journey** [周三, 08 11月 08:00]
  Huw Lewis-Jones revisits a pioneering, ill-fated expedition to map the Arctic.
- **Books in brief** [周三, 08 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.
- **Indian scientists urged to speak out about pseudoscience** [周二, 07 11月 08:00]
  Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.
- **Pirate paper website Sci-Hub dealt another blow by US courts** [周二, 07 11月 08:00]
  American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.
- **Genetically modified apple reaches US stores, but will consumers bite?** [周二, 07 11月 08:00]
  Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.
- **US government approves 'killer' mosquitoes to fight disease** [周一, 06 11月 08:00]
  US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.
- **Language patterns reveal body's hidden response to stress** [周一, 06 11月 08:00]
  Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

South Africa tackles crime at sea with ship-spotting satellites

Automated vessel-tracking system aims to spy poachers and smugglers.

10 November 2017

Leeman/Getty

South Africa has started to combine data from satellites, vessel transponders and radar to monitor ships in its waters in real time.

In October last year, a fishing boat set out from Velddrif, a small town on South Africa's west coast. It sailed northwest for about 25 nautical miles (46 kilometres), then turned sharply and headed back the way it had come. Staying clear of coastal settlements, it entered the West Coast National Park

marine protected area — a strictly no-fishing zone — where it slowed down and began to sail in a zigzag pattern.

“It was obvious what they were doing,” says Niel Malan, a marine biologist who works in South Africa’s Department of Environmental Affairs in Cape Town. “They were poaching.”

On any other day, the transgression would probably have passed undetected. But Malan and his colleagues were testing a new vessel-tracking system that — when fully operational — will send out alerts when ships are acting suspiciously anywhere in South African waters.

A test version of the Integrated Vessel Tracking Decision Support Tool was launched on 7 November by the South African Oceans and Coastal Information Management System (OCIMS), at its annual meeting in Cape Town. The tracking system, which has taken US$1 million and 5 years to develop, combines data from satellites, vessel transponders and radar to monitor ships in real time and spot any that might be engaged in criminal activities, such as illegal fishing or smuggling.

Similar remote-sensing systems have been developed over the last decade or so by countries including the United States, Australia and India. But South Africa is a particularly crucial area for maritime crime-fighting, because of its geographical location at the joining of three oceans — the Atlantic, Indian and Southern — and because of the sheer extent of its waters. The country’s Exclusive Economic Zone, which extends 200 miles off the coastline and includes an additional 400-mile-diameter circle around the Prince Edward Islands, exceeds its land area by 25%. “Because of the vastness of our EEZ, we see this as a critical technology,” says Waldo Kleynhans, the system’s lead developer based in Pretoria.

South Africa's coast is also a busy shipping lane and an area rich in natural resources. Cold, nutrient-rich waters sustain extensive commercial fishing on South Africa's west coast and to the south, while every year billions of sardines migrate down the east coast, attracting flocks of birds, as well as dolphins, sharks and whales.

South Africa has a well-documented problem with coastal poaching of high-

value species such as abalone and rock lobster, whereas the extent of illegal fishing in its open oceans is largely unknown. The area around the Prince Edward Islands — home to the prized Patagonian toothfish (*Dissostichus eleginoides*) — is particularly vulnerable, says Timothy Walker, a researcher focusing on maritime and water security at the Institute for Security Studies in Pretoria. South African authorities are also concerned about human trafficking and the smuggling of drugs or banned wildlife items, such as rhino horn and ivory.

Yet the navy has scant physical resources to monitor illegal activities, says Mark Blaine, a captain in the South African Navy and a part-time researcher in nautical science at Stellenbosch University — four frigates, three submarines and a handful of patrol vessels and aircraft — which he describes as equivalent to "a country the size of Algeria using around six police cars to patrol the entire country".

Satellite spotting

The satellite data used by the new system includes information from automated identification system (AIS) trackers, which all ships above a certain size are required to carry. South Africa currently buys this data from third-party suppliers, but plans to launch its own constellation of AIS nano-satellites in 2018 to collect the information. Meanwhile, satellites using synthetic-aperture radar, which can spot vessels in the dark or through thick cloud, will help to detect 'dark targets' that are not carrying trackers or that have turned them off.

Malan says that the tracking system can be set to flag up different suspicious behaviours. Users such as the fisheries department or the South African navy might create a digital fence around a marine reserve or other sensitive area, for example, and ask to receive alerts when ships enter it. Or they could request to be alerted if two ships meet in the open ocean for an extended time.

Ultimately, Malan says, the system's success will depend on the end-users, who will have to monitor incoming data, set up appropriate alerts and decide

how to respond. Enforcement will also be a challenge. Malan says that details of the suspicious boat he spotted in October 2016 were relayed to the fisheries department. “But we're not sure if they finished the investigation,” he says.

He hopes that once a few miscreants have been caught using the tracking system, however, its existence will act as a deterrent: “I think once we start prosecuting a few people, then the word will spread quickly — and we hope that will lead to better behaviour.”

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Comments

Commenting is currently unavailable.

Resurrected malaria strategy saves thousands of lives in Africa

Pre-emptively treating kids for malaria is working, despite logistical challenges.

10 November 2017

Amy Maxmen

A healthworker in Mali prepares a dose of malaria chemoprevention.

In a sea of high-tech malaria fixes — everything from drug-delivery by drone to gene-edited mosquitoes — an old-fashioned approach is saving thousands of children in West Africa, according to studies presented this week at the American Society of Tropical Medicine and Hygiene (ASTMH) meeting in

Baltimore, Maryland.

The measure, called seasonal malaria chemoprevention, involves giving children a dose of antimalarial drugs once each month in the rainy season to prevent the disease in hard-hit regions. Researchers have previously demonstrated this strategy in large clinical trials but they had feared that their positive results wouldn't be replicated in the messy, real world, because chemoprevention requires thousands of local health workers to deliver drugs to children in villages far from hospitals, pharmacies and paved roads.

"People were doubtful this intervention would work, because it's so demanding," says Brian Greenwood, an infectious disease specialist at the London School of Hygiene and Tropical Medicine who helped to conduct trials that showed reductions in malaria prevalence up to 84%[1]. As a result of those studies, more than 6.4 million children in nine countries in sub-Saharan Africa (Burkina Faso, Cameroon, Chad, Gambia, Guinea, Mali, Niger, Nigeria, Senegal) received the drugs in 2016.

It seems to be working, according to data presented at the ASTMH meeting. "They are seeing the same level of efficacy against malaria that we saw in clinical trials and reducing hospital admissions," says Greenwood. "I am very happy." But researchers are also finding signs that this approach may not work for long.

Data driven

Malaria researchers deployed chemoprevention in the 1950s, but it fell out of favour when the widespread use of malaria drugs led to drug resistance. Yet by 2000, more than 830,000 people were dying of the disease each year — mainly children in Africa — and there were no blockbuster vaccines on the horizon. So malariologists revisited the approach. Between 2002 and 2012, clinical trials conducted in West Africa suggested that combinations of older malaria drugs had the power to prevent 8.8 million cases and 80,000 deaths every year if implemented solely during the rainy season, when the disease spikes.

Amy Maxmen

Children in Mali receive a dose of malaria drugs, to reduce their risk of becoming infected with the disease.

In 2012, the World Health Organization recommended the strategy with three old drugs — sulphadoxine, pyrimethamine and amodiaquine — so that the only sure-fire cure for malaria, artemisinin, would remain effective. Alassane Dicko, a malariologist at the University of Bamako in Mali, says that he did not take the intervention for granted when it launched in Mali in 2013, because he knew that funds were limited and drug resistance inevitable. “Research is essential,” he says. His lab began assessing chemoprevention’s efficacy, cost and effects on drug resistance.

In August, Dicko and his colleagues reported[2] that malaria prevalence was reduced by 65% in children under age 5 who were treated with chemoprevention in the Malian district of Kita, compared to a similar number of children in a neighbouring district that lacked the funds to roll out the intervention.

Race against resistance

On the basis of results such as these, malaria researchers at the meeting estimate that chemoprevention has averted roughly 6 million cases and 40,000 deaths in 2015 and 2016 in the countries where it is practised. “This intervention has been extremely well documented over three or four years,” says Erin Eckert, an epidemiologist at the US Agency for International Development’s President’s Malaria Initiative, based in Washington DC. As a result, the agency plans to help fund chemoprevention in eight countries next year.

Also at the ASTMH meeting, Dicko reported a 80-person trial showing that adding another old malaria drug, primaquine, to the regimen combo blocks the transfer of the malaria parasite, *Plasmodium falciparum*, from humans into mosquitoes. This would further reduce the amount of the parasite in circulation. Dicko aims to hit the disease hard and fast — with multiple drugs, as soon as possible — because he and his colleagues are already detecting genetic signs of drug resistance in parasites[3].

New chemoprevention drugs in the pipeline might not be ready before existing drugs fail because of resistance, Greenwood says. This year, he helped to launch a trial combining chemoprevention and a less effective malaria vaccine in Burkina Faso and Mali. The vaccine was previously shown to reduce the number of malaria cases by less than 36% in children[4], but Greenwood hopes the combined tools, together with bed nets, can suppress malaria enough to stop it from bouncing back once today’s drugs fail. By that time, he says, genetically engineered mosquitoes might be ready to fly.

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Comments

Comments

There are currently no comments.

Physicists shrink plans for next major collider

Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.

09 November 2017

CERN/SPL

The Large Hadron Collider (pictured) collides protons, whereas the proposed linear accelerator would smash together electrons and positrons.

Limited funding and a dearth of newly discovered particles are forcing physicists to cut back plans for their next major accelerator project: a multibillion-dollar facility known as the International Linear Collider (ILC)

in Japan.

On 7 November, the International Committee for Future Accelerators (ICFA), which oversees work on the ILC, endorsed halving the machine's planned energy from 500 to 250 gigaelectronvolts (GeV), and shortening its proposed 33.5-kilometre-long tunnel by as much as 13 kilometres. The scaled-down version would have to forego some of its planned research such as studies of the 'top' flavour of quark, which is produced only at higher energies.

Instead, the collider would focus on studying the particle that endows all others with mass — the Higgs boson, which was detected in 2012 by the Large Hadron Collider (LHC) at CERN, Europe's particle-physics lab near Geneva, Switzerland.

Leading particle physicists nevertheless remain upbeat. A 250-GeV machine still has "a convincing physics case", says Hugh Montgomery at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia. He says that it could be upgraded to higher energies in future.

High-energy physicists have been planning a future linear collider for 25 years, but the ILC is now unlikely to see the light of day until at least 2030. They viewed the linear collider as complementary to the LHC, allowing physicists to scrutinize in detail any particles discovered at CERN.

Linear design

The circular LHC smashes together protons, which allows it to reach very high energies (13 teraelectronvolts). But, as composite particles (made of quarks), protons create messy collisions with clouds of debris.

By contrast, the ILC would collide electrons and positrons head on after accelerating them in thousands of superconducting cavities joined end to end. Although yielding lower energies, its collisions — between fundamental particles — would be cleaner and more precise than those in a proton–proton machine.

The international physics community had hoped that Japan would foot much of the estimated US$10 billion needed to realize the original design, after researchers there put forward a proposal to host the facility in October 2012, just after the Higgs discovery. But the Japanese government — deterred by the project's huge price tag, according to Tatsuya Nakada, a physicist at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland — has not yet made any offer of funding.

That fact, coupled with an absence of any other new particle discoveries at the LHC beyond the Higgs, led the Japan Association of High Energy Physicists in July to propose capping the ILC's energy at 250 GeV.

Aiming for a higher energy, the association explained, made less sense after data collected by the LHC in 2015 and 2016 showed that any particles outside physicists' standard model are unlikely to weigh less than 1,000 GeV, and therefore would be out of reach even for a full-scale version of the ILC. However, 250 GeV is high enough to produce large numbers of Higgs bosons, which, the association said, could yield indirect signs of new physics through measurements of their interactions with other known particles.

Energy debate

This proposed 'Higgs factory' has also been endorsed by an international working group responsible for formulating the ILC's science case, in a paper uploaded to the preprint server arXiv last month[1]. The ICFA then gave the pared-down collider its thumbs up at a meeting held in Ottawa, Canada, this week.

Not all physicists are enthusiastic, however. John Ellis, a theorist at King's College London and CERN, maintains that only when operating at around 1,000 GeV will a linear collider provide "a more complete picture of the Higgs". He acknowledges that costs need to be reined in, but says that in limiting the ILC to 250 GeV, "you are making significant scientific compromises".

A report uploaded to arXiv last week[2] describes three possible layouts for the

250 GeV model (a technical design for the higher-energy ILC was published in 2013). Each requires halving the length of the superconducting electron–positron accelerators, but two of the options retain extra tunnel space to accommodate future upgrades.

Taking into account projected savings from ongoing research into accelerators, the report estimates that the collider's core construction cost could be reduced by as much as 40% — bringing it down to around $5 billion in 2012 prices. Manpower and detectors would then raise the total to about $7 billion, according to Lyn Evans, an accelerator physicist at CERN who is directing research on the ILC.

Michael Peskin, a theoretical partical physicist at the SLAC National Accelerator Laboratory in Menlo Park, California, and a member of the ILC working group, has no doubt about the value of a Higgs factory. He says that theoretical studies of the Higgs boson and the weak nuclear force — one of the four known fundamental forces — done over the past year have strengthened the case for experimental probes of the Higgs' interaction strength (the Higgs is required to give the carriers of the weak force finite mass). "The 250-GeV stage is actually more interesting scientifically than we thought," he says.

The ILC decision now rests with Japan. Evans describes the Japanese government's ongoing assessment of the linear-collider project as "very long and very frustrating". But other countries won't commit money until the host country makes its plans known, he says. "The rest of the world is waiting for the Japanese government to decide," he says.

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Comments

3 comments

1. *Pentcho Valev* • 2017-11-11 04:23 PM

   Peter Woit: "I think the worst thing that has happened to theoretical physics over the past 25 years is this descent into ideology, something that has accelerated with the multiverse mania of the last 10-15 years." http://www.math.columbia.edu/~woit/wordpress/?p=9375 Correct, except for the number 25 - it should be replaced by 112: Peter Hayes: "This paper investigates an alternative possibility: that the critics were right and that the success of Einstein's theory in overcoming them was due to its strengths as an ideology rather than as a science. The clock paradox illustrates how relativity theory does indeed contain inconsistencies that make it scientifically problematic. These same inconsistencies, however, make the theory ideologically powerful. [...] The gatekeepers of professional physics in the universities and research institutes are disinclined to support or employ anyone who raises problems over the elementary inconsistencies of relativity. A winnowing out process has made it very difficult for critics of Einstein to achieve or maintain professional status. Relativists are then able to use the argument of authority to discredit these critics. Were relativists to admit that Einstein may have made a series of elementary logical errors, they would be faced with the embarrassing question of why this had not been noticed earlier. Under these circumstances the marginalisation of antirelativists, unjustified on scientific grounds, is eminently justifiable on grounds of realpolitik. Supporters of relativity theory have protected both the theory and their own reputations by shutting their opponents out of professional discourse. [...] The triumph of relativity theory represents the triumph of ideology not only in the profession of physics bur also in the philosophy of science." The Ideology of Relativity: The Case of the Clock Paradox http://www.informaworld.com/smpp/content~content=a909857880 Joao Magueijo: "Lee [Smolin] and I discussed these paradoxes at great length for many months, starting in January 2001. We would meet in cafés in South Kensington or Holland Park to mull over the problem. THE ROOT OF ALL THE EVIL WAS CLEARLY SPECIAL RELATIVITY. All these paradoxes resulted from well known effects such as length contraction, time dilation, or E=mc^2,

all basic predictions of special relativity. And all denied the possibility of establishing a well-defined border, common to all observers, capable of containing new quantum gravitational effects." Faster Than the Speed of Light, p. 250 http://www.amazon.com/Faster-Than-Speed-Light-Speculation/dp/0738205257 Pentcho Valev

2. *Pentcho Valev* • 2017-11-11 07:32 AM

   Dead (schizophrenic) science - colliders are not necessary: "...Lorenzo Maccone, of the University of Pavia in Italy, Seth Lloyd at MIT in Cambridge, USA, and Vittorio Giovannetti at the Scuola Normale Superiore in Pisa, Italy. [...] They hope their strategy may make it possible to solve one of the biggest problems in physics: the apparent incompatibility of quantum mechanics, which governs the physics of the very small, and general relativity, which describes the motion of stars and planets. [...] In general relativity, space and time are woven together into a pliable thing called spacetime, but quantum mechanics runs on quaintly separate, classical notions of space and time. And when physicists try to apply the equations of general relativity to the realm of quantum mechanics, those equations spit out nonsense." http://fqxi.org/community/articles/display/224 Big Brother replaced 2+2=4 with 2+2=5: "In the end the Party would announce that two and two made five, and you would have to believe it. It was inevitable that they should make that claim sooner or later: the logic of their position demanded it. Not merely the validity of experience, but the very existence of external reality, was tacitly denied by their philosophy. The heresy of heresies was common sense. And what was terrifying was not that they would kill you for thinking otherwise, but that they might be right. For, after all, how do we know that two and two make four? Or that the force of gravity works? Or that the past is unchangeable? If both the past and the external world exist only in the mind, and if the mind itself is controllable what then?" https://ebooks.adelaide.edu.au/o/orwell/george/o79n/chapter1.7.htm Einstein replaced Newton's absolute time with spacetime: "Special relativity is based on the observation that the speed of light is always the same, independently of who measures it, or how fast the

source of the light is moving with respect to the observer. Einstein demonstrated that as an immediate consequence, space and time can no longer be independent, but should rather be considered a new joint entity called "spacetime." http://community.bowdoin.edu/news/2015/04/professor-baumgarte-describes-100-years-of-gravity/ Scientists in Big Brother's world are trying to reconcile 2+2=4 and 2+2=5. Scientists in Einstein's schizophrenic world are trying to reconcile Newton's absolute time and Einstein's spacetime: Natalie Wolchover: "The effort to unify quantum mechanics and general relativity means reconciling totally different notions of time. In quantum mechanics, time is universal and absolute; its steady ticks dictate the evolving entanglements between particles. But in general relativity (Albert Einstein's theory of gravity), time is relative and dynamical, a dimension that's inextricably interwoven with directions X, Y and Z into a four-dimensional "space-time" fabric." https://www.quantamagazine.org/20161201-quantum-gravitys-time-problem/ Perimeter Institute: "Quantum mechanics has one thing, time, which is absolute. But general relativity tells us that space and time are both dynamical so there is a big contradiction there. So the question is, can quantum gravity be formulated in a context where quantum mechanics still has absolute time?" https://www.perimeterinstitute.ca/research/conferences/convergence discussion-questions/what-are-lessons-quantum http://negrjp.fotoblog.uol.com.br/images/photo20150819051851.jpg Pentcho Valev

3. *Pentcho Valev* • 2017-11-09 08:59 PM

   Nowadays the conclusion "Physics is dead" is getting more and more explicit - it has even entered popular culture: Leonard: "I know I said physics is dead, but it is the opposite of dead. If anything, it is undead, like a zombie." https://www.youtube.com/watch?v=GDNP9KOEdh0 The problem is theoretical - experimentalists are just misguided: "The Large Hadron Collider is a particle accelerator currently under construction in the research centre CERN. From the point of view of relativity theory, it has several points of interest: First of all, the protons it accelerates will reach higher energies than ever, allowing

new tests of the relativistic quantum field theories that are at the core of modern particle physics. Secondly, at such high energies, there should be first traces of an as-yet unproven symmetry of nature called supersymmetry, which plays an important role in string theory, one of the candidates for a theory of quantum gravity (the quantum theory version of Einstein's general relativity). Finally, the high energies are interesting because they give information about the very early high temperature universe, and about the physics that should be included in the big bang models of relativistic cosmology." http://www.einstein-online.info/dictionary/large-hadron-collider There is a tenet which, if false, does convert modern physics into a zombie, and this is Einstein's constant-speed-of-light postulate. Here is the original formulation: Albert Einstein, ON THE ELECTRODYNAMICS OF MOVING BODIES, 1905: "...light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body." http://www.fourmilab.ch/etexts/einstein/specrel/www/ If interpreted correctly, the Doppler effect directly refutes the postulated independence from "the state of motion of the emitting body". Here is an incorrect interpretation - the postulate is saved by wrongly assuming that the light pulses bunch up in front of the moving source: Albert Einstein Institute: "We will start with a very simple set-up, which you can see in the following animation. On the right-hand side, drawn in green, there is a sender that emits pulses in regular succession. On the left-hand side there is a receiver, drawn in blue. The pulses themselves are drawn in red, and they all travel at the same speed from right to left. Everytime the sender emits a new pulse, a yellow indicator light flashes once. Likewise, a flashing light indicates when a pulse has reached the receiver: http://www.einstein-online.info/images/spotlights/doppler/doppler_static.gif Next, let us look at a slightly different situation, where the source is moving towards the detector. We assume that the motion of the sender does not influence the speed at which the pulses travel, and that the pulses are sent with the same frequency as before. Still, as we can see in the following animation, the motion influences the pulse

pattern: http://www.einstein-online.info/images/spotlights/doppler/doppler_source_blue.gif The distance between successive pulses is now smaller than when both sender and receiver were at rest. Consequently, the pulses arrive at the receiver in quicker succession. If we compare the rates at which the indicator lights at the receiver and at the sender are flashing, we find that the indicator light at the receiver is flashing faster." [END OF QUOTATION] http://www.einstein-online.info/spotlights/doppler Einsteinians make the following assumption above, which is essentially identical to Einstein's 1905 constant-speed-of-light postulate: Assumption 1: "The motion of the sender does not influence the speed at which the pulses travel." Assumption 1 goes hand in hand with another assumption: Assumption 2: "The distance between successive pulses is now smaller than when both sender and receiver were at rest." Assumption 2 is false - the pulses do not bunch up when the source (sender) is moving. If they did, by measuring the (variable) distance between the pulses, an observer associated with the source would know whether he is moving or at rest, which contradicts the principle of relativity. Since Assumption 2 is false, Assumption 1 is false as well. If the speed of the moving source is v, the speed of the light relative to the receiver is c'=c+v, in violation of Einstein's relativity. The following quotations suggest that, if the speed of light is variable, modern physics is dead: "The speaker Joao Magueijo, is a Reader in Theoretical Physics at Imperial College, London and author of Faster Than the Speed of Light: The Story of a Scientific Speculation. He opened by explaining how Einstein's theory of relativity is the foundation of every other theory in modern physics and that the assumption that the speed of light is constant is the foundation of that theory. Thus a constant speed of light is embedded in all of modern physics and to propose a varying speed of light (VSL) is worse than swearing! It is like proposing a language without vowels." http://www.thegreatdebate.org.uk/VSLRevPrnt.html "But the researchers said they spent a lot of time working on a theory that wouldn't destabilise our understanding of physics. "The whole of physics is predicated on the constancy of the speed of light," Joao

Magueijo told Motherboard. "So we had to find ways to change the speed of light without wrecking the whole thing too much." http://www.telegraph.co.uk/technology/2016/12/06/speed-light-discovered/ Pentcho Valev

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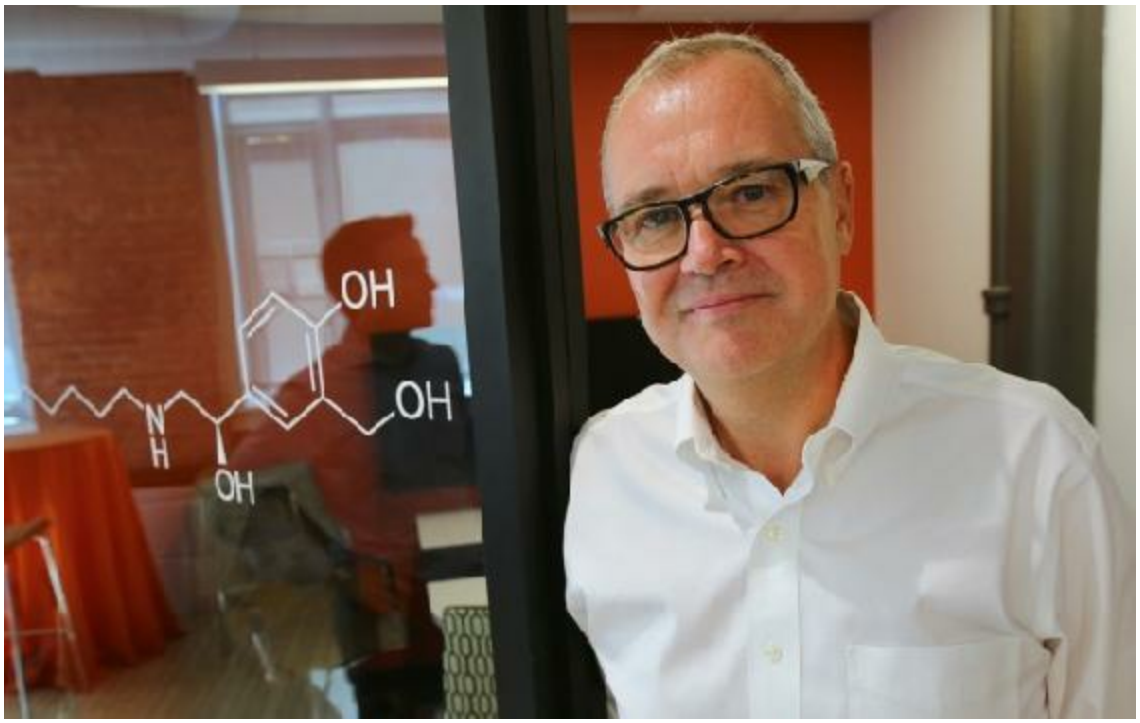
UK government appoints next chief scientific adviser

A former pharmaceutical boss will help navigate the UK's exit from the European Union.

08 November 2017



Pat Greenhouse/Boston Globe/Getty

Patrick Vallance is the third successive biomedial scientist to be appointed chief scientific adviser.

Patrick Vallance, president of research and development at the pharmaceutical giant GlaxoSmithKline, has been appointed as chief scientific adviser, the UK government announced on 8 November.

Vallance, a clinical pharmacologist who previously led the medical division at University College London, will replace Mark Walport in April 2018. Walport has left the government to become head of a powerful new funding body called UK Research and Innovation.

As chief scientific adviser, Vallance will advise the prime minister and her cabinet, the government's most senior decision-making body. He will also lead the Government Office for Science, which promotes the use of scientific evidence in policymaking across government.

A major part of his role will be to ensure that high-quality advice is available across government departments as they deal with the legal and regulatory consequences of the UK's decision to leave the European Union, says Graeme Reid, a science-policy researcher at University College London. The United Kingdom needs to manage the impact of Brexit on the regulation of the nuclear industry and the UK's role in fusion research, as well as on environment policy and other science-related issues. "Patrick Vallance's experience in both business and universities will be of huge value," says Reid.

Brexit is likely to boost the day-to-day importance of chief scientific advisor's role, but Vallance will also have to reinvent other, more informal aspects of the position, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School. The creation of UK Research and Innovation, intended to increase the power of UK research-funding bodies, means Walport will continue to wield great influence over science in government. The chief scientific adviser has traditionally been the voice of science in government, Flanagan says.

The relationship between Vallance and Walport will be an interesting dynamic to watch, says James Wilsdon, a research-policy specialist based at the University of Sheffield, UK. He says he hopes that Vallance will act as a bridge between the science community and policymakers, and will be open to a wide range of people and perspectives. The network of chief scientific advisers is not yet operating at full strength, he says, "so re-energising the collegiality and connectivity of that network though Whitehall is a really important thing".

The role is less well-paid than Vallance's present position. His base salary at GlaxoSmithKline is £780,000 (US$1.02 million), but the science-adviser job was advertised in the salary range of £160,000–£180,000.

Vallance will be the third successive chief scientific adviser to come from the biomedical sciences. He follows Walport, who is a former director of the Wellcome Trust, and John Beddington, a population biologist now at the Oxford Martin School and the University of Oxford, UK.

In a separate announcement, GlaxoSmithKline announced that it had appointed Hal Barron, current president of research and development at Alphabet-funded California Life Sciences, to replace Vallance.

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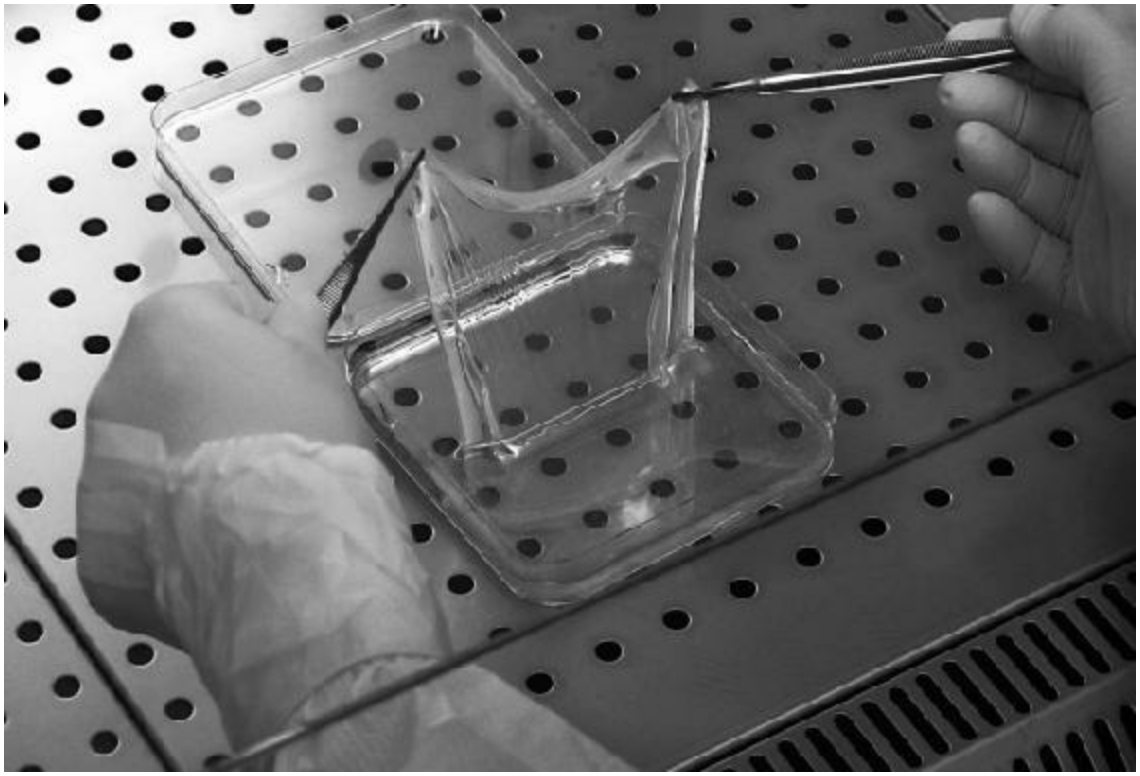
Skin regeneration with insights

A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.

08 November 2017



A sheet of skin cells grown in culture.

Somewhere in Germany’s Ruhr valley, a nine-year-old boy is doing what children do: playing football, joking around with friends and going to school. Two years ago, he was confined to a hospital bed, dying of a rare and cruel genetic skin disease. In a landmark paper online in *Nature* this week, scientists and clinicians present the details of his astonishing recovery (T. Hirsch *et al.* *Nature* http://dx.doi.org/10.1038/nature24487; 2017).

The boy had junctional epidermolysis bullosa, or JEB. He, like other people with the disease, carried a mutation in a gene that controls the integrity of the skin. Doctors could only try to ease his suffering as some 80% of his skin simply fell away.

A team of Italian researchers came to his aid by combining stem-cell techniques with gene therapy. As a young scientist at Harvard Medical School in Boston, Massachusetts, in the 1980s, Michele De Luca — the lead author of the new study — watched pioneers in skin regeneration learn to grow small sheets of skin from cells taken from burns patients, and to use them in grafts. He extended the work in Italy, applying new genetic and stem-cell technologies. He developed ways to generate stem cells from human skin, replace disease-causing genes in them and grow sheets of healthy skin on scaffolds in the lab.

He chose JEB for his first clinical trial, which he registered with the Italian Medicines Agency in 2002. Four years later, he reported his first success, in which he created healthy skin patches from biopsies to replace small areas of sloughed-off skin on the legs of a patient with a form of JEB (F. Mavilio *et al. Nature Med.* **12,** 1397–1402; 2006). New European Commission regulations introduced in 2007 required him to pause the project while he created facilities adhering to ‘good manufacturing practices’ (GMPs) and a spin-off company to meet the demands for strengthened oversight of cell-based therapies.

Having a company refocused his team’s attention on a different type of stem-cell therapy, one likely to yield a product for the market faster. Holoclar, a treatment that replaces the eye’s cornea in a form of blindness, became the world’s first commercial stem-cell therapy in 2015.

A few months later, at the University of Modena, De Luca got a call out of the blue from doctors in Germany who were trying to treat the little boy. Because the therapy had been in a clinical trial, albeit one on hold at the time, and because De Luca could provide GMP services, German regulatory authorities quickly approved the one-off compassionate use of the JEB therapy. Surgeons in Germany sent a skin biopsy to Modena, and two major skin transplants followed. Six months after the initial biopsy, the boy returned to school. During the many months since, he has not had so much as a blister,

and loves to show off his ‘new skin’.

This major clinical development was based on decades of basic research. The clinical data gathered during 21 months of follow-up after the boy’s treatment have also led to major insights into human skin biology, as discussed in an accompanying News & Views (M. Aragona and C. Blanpain *Nature* http://dx.doi.org/10.1038/nature24753; 2017). For example, normal regeneration of the epidermis is directed by only a few stem-cell clones that can self-renew.

By their nature, highly personalized treatments using gene therapies and products derived from an individual’s stem cells are likely to be applicable to only a subset of patients. Although the report presents the treatment of one patient, it is a classic case of researchers standing on the shoulders of others. This project, for example, relied on long-term follow-up of a patient treated in 2006, as well as parallel studies that underpinned the development of tools for *ex vivo* gene therapy and for growing transplantable sheets of epidermis *in vitro*.

The work is both a technical achievement and an example of how translational medicine should be conducted. It involves research informing the clinic and the clinic informing research, with seamless collaboration between doctors, scientists, regulators and technicians at many levels — a particularly important aspect in areas such as stem-cell biology. It requires the highest standards of scientific and ethical diligence. Similar treatments are starting to be rolled out in other labs for other diseases. *Nature* is glad to celebrate and support such an enterprise.

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Too many academics study the same people

Researchers should recognize communities that feel over-researched and under-rewarded.

08 November 2017

Susanna D'Aliesio/SOPA Images/LightRocket/Getty

Two women in Lebanon’s Shatila camp.

In southern Beirut, a temporary shelter has become a permanent home. The Shatila refugee camp was established to house displaced Palestinians in 1949 and now has thousands of families within its walls. Residents have learnt to contend with overcrowding, pollution — and a steady stream of well-funded

foreign researchers who come to study them.

Drawn by its unusual story and convenient position close to the airport, researchers flock to Shatila to track the effects of prolonged refugee status and cultural isolation on the community. Well-meaning researchers are so common in Shatila that locals have learnt how to spot them.

Before she became a social anthropologist at King's College London, Mayssoun Sukarieh did voluntary work in Shatila. Residents who saw her reach for her notebook would ask if she was a social researcher: "They come for a tiny bit, and then they leave," the locals explained.

Sukarieh realized that scholars' repeated visits were affecting the community. Academics were among the few contacts that people in Shatila had with the wider world. Again and again, the outsiders would fly out with what they wanted and offer little or nothing in return. The community started to view the visitors with amusement, then resentment.

Some people in Shatila, Sukarieh feared, were being 'over-researched' — an anecdotal concern that social scientists and biomedical researchers increasingly encounter at 'high-traffic' research sites around the world. Sometimes, it is a point raised by ethical-review committees. Occasionally, the community under study makes its own frustrations heard loud and clear.

How big is the problem? Ironically, the issue of over-research has not been researched much. In a study published last month, scientists in South Africa analysed concerns about over-research at two sites of HIV-prevention studies (J. Koen, D. Wassenaar and N. Mamotte *Soc. Sci. Med.* **194,** 1–9; 2017).

They found that the term 'over-research' is poorly defined and encompasses a range of concerns. For example, some use it to describe how other communities are being neglected in favour of one with a pre-established research structure or proximity to a university. This can lead to skewed data, and misconceptions about a particular phenomenon or place.

Alternatively, the term could be used to describe a local community that bears the burden of research participation without sufficient reward, creating a sense of frustration that leads to dwindling participation. In biomedical

studies, researchers sometimes worry that involvement in multiple clinical trials — and exposure to multiple medications — can increase the risk to participants and cloud results.

Repeated studies can certainly exaggerate the frustration that local people feel when their cooperation produces only data, publications and further research. In the South African study, many locals argued that the research should be more closely linked to developing their communities. Some projects, including certain grants from UNAIDS, a global United Nations effort to tackle HIV/AIDS, do require researchers to invest in infrastructure and education. More funders should look at this model. However, several HIV-prevention studies have done such a good job that their results are inconclusive: too few participants contracted the disease for the data to be statistically meaningful.

It is crucial that efforts to reward research participation are developed in consultation with the community being studied. Sukarieh describes well-intentioned educational courses aimed at Shatila-research participants that were impractically long — one consisted of 20 hourly sessions — and discussed issues irrelevant to the people's needs.

Over-research can bring benefits, though: a heavily studied community can become savvy in making its needs known to researchers and in influencing how a study is done. In Hackney, an ethnically diverse borough of London that underwent a period of rapid gentrification, a sociologist who came to study participants in a creative-writing group, for example, was told that, to do so, she had to join the group and write pieces like everyone else. The researcher reported how this strengthened her involvement and built stronger links to the community that helped the project to succeed (S. Neal *et al. Qual. Res.* **16,** 491–507; 2016).

Forging deep links with a community takes time, and time requires funding. Funders should recognize the need to build resources for such efforts into their grants; institutions should recognize and reward this time and effort, and acknowledge that it can eat into a researcher's publication record. It is not good enough to come in for a tiny bit, and then leave.

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Comments

Comments

There are currently no comments.

Grant recipients can still give objective advice

The US environment agency should not ban researchers it funds from its advisory boards.

08 November 2017

KEENPRESS/Getty

Melting ice caps are raising sea levels.

Scott Pruitt, administrator of the US Environmental Protection Agency (EPA), levelled a damning accusation against scientists on 31 October. In the interests of restoring scientific “integrity”, Pruitt signed a directive stating that the EPA would no longer allow researchers with active grants from the

agency to serve on the EPA's scientific advisory boards. By his tally, an unspecified number of scientists in voluntary positions on those boards had received US$77 million in EPA grants over the past three years — more than enough, Pruitt declared, to raise questions about their ability to provide independent scientific advice.

It was a cynical move — and entirely unnecessary. After all, it is ultimately up to Pruitt and his team to make the appointments to the boards, which advise the agency on everything from basic research programmes to contentious regulatory decisions. If Pruitt wanted to increase the geographical diversity, or include more people from local, state and tribal agencies, as claimed, he could have done so without raising a fuss. Instead, he opted for a public proclamation that singles out active academic scientists as a unique source of bias. He is wrong, on multiple counts.

Scientific enquiry requires money. That's a fact of life. But receiving a research grant is very different from being on the payroll of an institution, advocacy group or company. Those are all very real conflicts of interest that were ignored in Pruitt's directive.

Moreover, winning competitive research grants does not imply fealty to the granting institution. What drives EPA-funded researchers above all is the desire to deliver a public good: discovery and understanding.

Of course, scientific conflicts of interest do exist. So there are established procedures that require scientists to excuse themselves when their own work is under consideration by the boards. These same procedures apply to industry scientists — who are also rightfully represented on the advisory boards — when deliberations involve issues that could affect their companies' bottom lines.

What Pruitt either fails to understand, or has chosen to ignore, is that his advisory boards are designed to focus on science, not policy. Understanding the latest research requires perspectives from the leading scientists. And when it comes to environmental and human-health issues, it is only to be expected that many of those people will have research grants from the EPA.

In the end, Pruitt's directive seems crafted to incite US President Donald

Trump’s political base, and it’s yet another example of researchers being dragged into the political and cultural wars rending the country.

Happily, it is harder to argue with data. This might explain why the first volume of a comprehensive — and congressionally mandated — assessment of climate science released on 3 November (see page 152) sailed through reviews from officials at the EPA and other federal agencies.

That report, which integrates the latest climate research, found that greenhouse-gas emissions caused by human activity are altering the planet in fundamental ways. It lays out what we know about the threat of global warming — from deep in the ocean to the highest mountain peaks. And it stands in direct opposition to the climate scepticism voiced by Pruitt and Trump.

Some scientists had feared political interference, but senior officials at federal agencies gave the report the green light, without major changes. This is as it should be: scientists can assess what’s known and probe what is not. And it is up to policymakers to decide what to do with that information. This should be a lesson for Pruitt: the current administration has the right to create its own priorities, but it should not and cannot override what science reveals.

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Rohingya refugees, Bulgarian protests and a prize for negative results

The week in science: 3–9 November 2017.

08 November 2017

Events | Research | Policy | Climate | People | Publishing | Trend watch

EVENTS

Ice crack to close Antarctic base again For the second time in two years, the British Antarctic Survey (BAS) will close its Halley VI research station for the winter season because of an enormous crack in the floating ice shelf on which it rests. In March, operators finished moving the transportable station 23 kilometres inland from its initial 2012 location because of an ice chasm nearby. Now, another crack in the Brunt Ice Shelf, this one 50 kilometres long, is threatening the station from the other side. Halley VI will close between March and November 2018, the BAS said on 31 October, because it is too difficult to evacuate personnel quickly in winter if the crack develops further.

Michal Krzysztofowicz/BAS

Money for nothing A data organization has launched what it says is the world's first prize for publishing negative scientific results. The European College of Neuropsychopharmacology's Preclinical Data Forum says that the aim of the €10,000 (US$11,600) prize is to encourage researchers to publish data that don't confirm the hypothesis being tested. Such negative studies are much less likely to be published than positive results, meaning that other scientists may waste time trying to repeat the work. The call for entries — initially just for neuroscience research — opened on 8 November.

Bulgarian protest Hundreds of Bulgarian researchers took to the streets of Sofia on 1 November to demand higher wages and an increase in science funding marked out in the government's 2018 budget. Bulgaria has one of the lowest levels of research investment in the European Union. The demonstrators are threatening further protests when Bulgaria takes over the rotating EU presidency next January.

Rohingya refugees A survey of Rohingya refugees in Bangladesh suggests

that 7.5% of the children have life-threatening malnutrition. The United Nations children's charity UNICEF reported the figure on 3 November. More than 2,700 children are being treated for acute malnutrition in refugee camps, where conditions are expected to worsen because of poor sanitation and crowding. Since late August, more than 600,000 Rohingya people have fled from Myanmar to Bangladesh, following attacks by Myanmar's police.

RESEARCH

Weather forecasts Improving forecasts of severe weather is important, but meteorologists should also listen to social scientists to help save lives during storms, says a 1 November report from the US National Academies of Sciences, Engineering, and Medicine. It recommends that federal agencies do more to incorporate social- and behavioural-sciences research into their preparation for weather hazards. These changes might include researching people's processes for deciding how to respond to threats such as tornado or hurricane warnings, and evaluating how weather forecasters communicate with media and emergency-management officials to convey messages more effectively.

POLICY

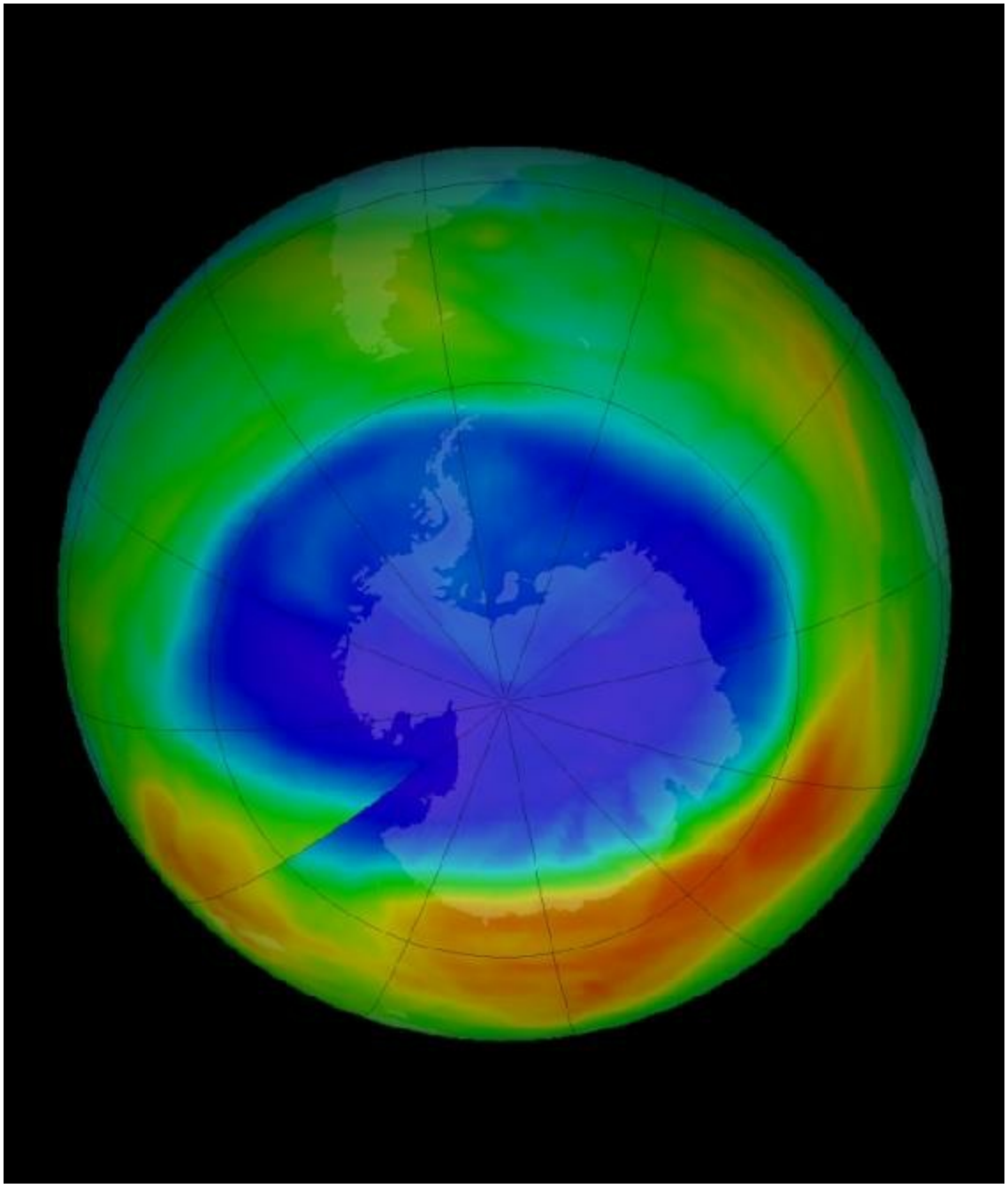
Antibiotic advice The World Health Organization (WHO) has recommended that animal-food industries curb the routine use of antibiotics for growth promotion and disease prevention. Healthy animals should receive the drugs only if others in the same flock or herdare diagnosed with communicable infections, the agency said in guidance published on 7 November. The recommendations were informed by a review of 179 studies; it found that the prevalence of multidrug-resistant bacteria in farmed animals dropped by up to 32% in places that had cut back on antibiotic use (K. L. Tang *et al. Lancet Planet. Health* http://doi.org/cfxh; 2017). The evidence connecting antibiotic restrictions in farm animals to drug resistance in humans was less robust, but hinted at a similar correlation.

Genetic-test rules The US Food and Drug Administration (FDA) is seeking

to loosen its regulation of genetic tests that are marketed directly to consumers, its commissioner, Scott Gottlieb, announced on 6 November. The FDA has proposed a policy that would allow genetic-testing companies to submit a product to the agency for a one-time review; if approved, the company would be allowed to market more tests without further review. The proposal is open for public comment until January. The agency also said that it has decided to exempt from review tests that are used to determine whether potential parents carry disease-causing genetic mutations that could cause an inherited disorder in their children.

CLIMATE

Small ozone hole This year's hole in the ozone layer was the smallest since 1988, NASA said on 2 November. The hole above Antarctica, which opens each September, was unusually small, owing to warm weather in the Southern Hemisphere. At its peak, the area of the hole was almost 2 billion hectares, or roughly two and a half times the size of the contiguous United States. Scientists attribute the shrinkage to natural variation, and not to rapid healing because of human intervention, NASA said. This year, warm air above Antarctica depleted cloud cover, which is where ozone-destroying chemical reactions occur. The hole has been shrinking since the introduction in 1987 of the Montreal Protocol to phase out ozone-depleting chemicals.



Katy Mersmann/NASA Ozone Watch/NASA

PUBLISHING

Censorship in China Springer Nature, one of the world's largest academic

publishers, has stopped readers in China from accessing some of its content. *The Financial Times* reported on 1 November that the publisher had blocked access to more than 1,000 articles from the websites of two of its journals, *The Journal of Chinese Political Science* and*International Politics*. The publishing house, which also owns *Nature*, said that the articles accounted for less than 1% of its content and had been blocked to comply with local Chinese laws. (*Nature*'s news team is editorially independent of its publisher.) The articles included politically sensitive terms such as Tibet, Taiwan and Cultural Revolution. Some in the academic community criticized the decision, which comes two-and-a-half months after UK firm Cambridge University Press blocked access to some articles in China and then swiftly reversed its decision.

Copyright battle The scholarly social network ResearchGate has over the past month disabled public access to 1.7 million papers on its site, according to five scientific publishers who have been tracking its activities. Early last month, the publishers formed a coalition to get ResearchGate to take down papers that breach copyright; two publishers have also filed a lawsuit against the site. The coalition says that the site has since disabled access to around 93% of its copyrighted material, although academics have re-uploaded some papers for public view. The publishers have now sent an undisclosed number of take-down notices to order the removal of remaining infringing content. ResearchGate, which is based in Berlin, declined to comment.

Piracy-site lawsuit The American Chemical Society (ACS) has won a lawsuit against the pirate site Sci-Hub over the website's illicit dissemination of copyrighted research articles. On 3 November, a US court granted the ACS US$4.8 million in damages for copyright infringement and trademark violation. The court also issued an injunction ordering Internet services that are "in active concert or participation" with Sci-Hub, including providers and search engines, to stop facilitating access to the site. Representatives of Sci-Hub, which was launched in 2011, did not appear in court to present their case.

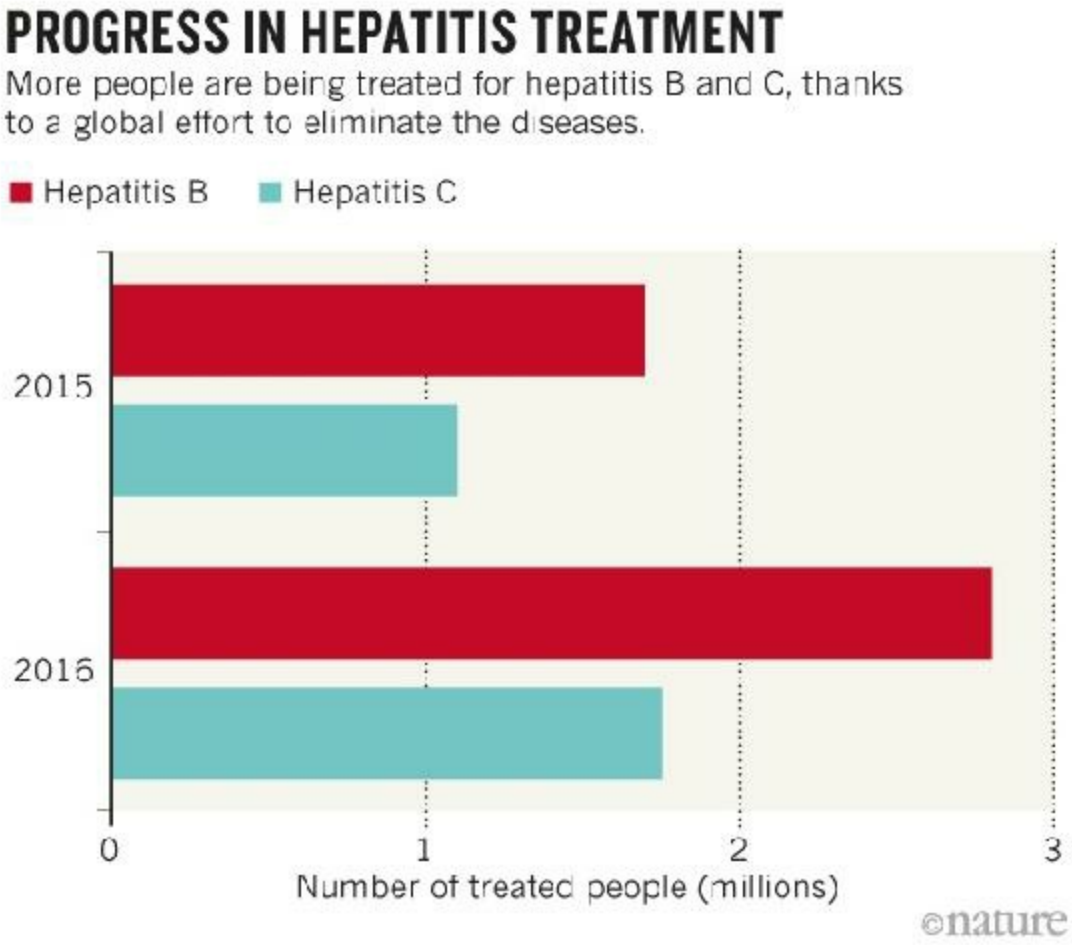
PEOPLE

Nominee withdraws Sam Clovis, the controversial nominee for the post of chief scientist at the US Department of Agriculture, withdrew from consideration on 2 November. The announcement came shortly after Clovis's name surfaced in the ongoing investigation into links between US President Donald Trump's election campaign and Russia. Clovis, a former conservative talk-show host and economics professor, was already a controversial pick for the chief-scientist position, which, by law, must be filled by a distinguished scientist.

Science chair to quit Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, said on 2 November that he will retire when his term expires late next year. The Texas Republican has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. The House of Representatives limits committee chairs to six years in the role, so Smith would have been forced to relinquish his post on the science panel in 2019.

TREND WATCH

The number of people who were able to access treatment for viral hepatitis C grew by some 1.7 million in 2016, a 60% increase over 2015, the World Health Organization (WHO) said on 31 October. A further 2.8 million people were given lifelong treatment for hepatitis B in 2016, a 65% jump over 2015. The WHO estimates that there were between 6 million and 10 million new cases of viral hepatitis B and C in 2015. The agency wants 80% of people diagnosed to be receiving treatment by 2030.



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The bitter battle over the world's most popular insecticides

As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.

08 November 2017

Lucy Hulmes/CEH

Researchers have monitored the health of the red mason bee (*Osmia bicornis-rufa*), which nests in hollow cavities.

Maj Rundlöf remembers the moment she changed her mind about neonicotinoids. In December 2013, in her office at Lund University in Sweden, she and postdoc Georg Andersson were peering at data from their

latest study. It was designed to test what would happen to bees if they fed on crops treated with neonicotinoids — the world's most widely used insecticides. “I didn't expect to see any effect at all, to be honest,” says Rundlöf.

Hives of honeybees (*Apis mellifera*) weren't greatly affected by the chemicals in their pollen and nectar, the study suggested[1]. But the data on bumblebees (*Bombus terrestris*) told a different story. Bumblebee colonies that hadn't fed on the treated crops looked normal: they were packing on weight to survive the winter. But in the colonies exposed to neonicotinoids, the growth chart was a flat line.

When the Swedish study was published in April 2015, it made headlines around the world. It was the first to show that neonicotinoid chemicals — known as neonics — could harm bees in a real-world farming situation.

Bee populations are declining in many parts of the globe, a worrying sign for the crops and wild plants that rely on these pollinators for their survival. Parasites, disease and shrinking food resources are all prime suspects. But a link to neonics has become a major flashpoint.

Even before Rundlöf's results were revealed, the European Union had placed heavy restrictions on the three most widely used neonics in flowering crops — plants that might be attractive to bees — amid rising concerns that the chemicals might harm pollinators. The restricted neonics were imidacloprid and clothianidin, made by agrochemical giant Bayer, and thiamethoxam, made by Syngenta. But farmers, the agrochemical industry and some scientists pointed out that the moratorium was precautionary and based on limited evidence, gathered mostly from lab tests.

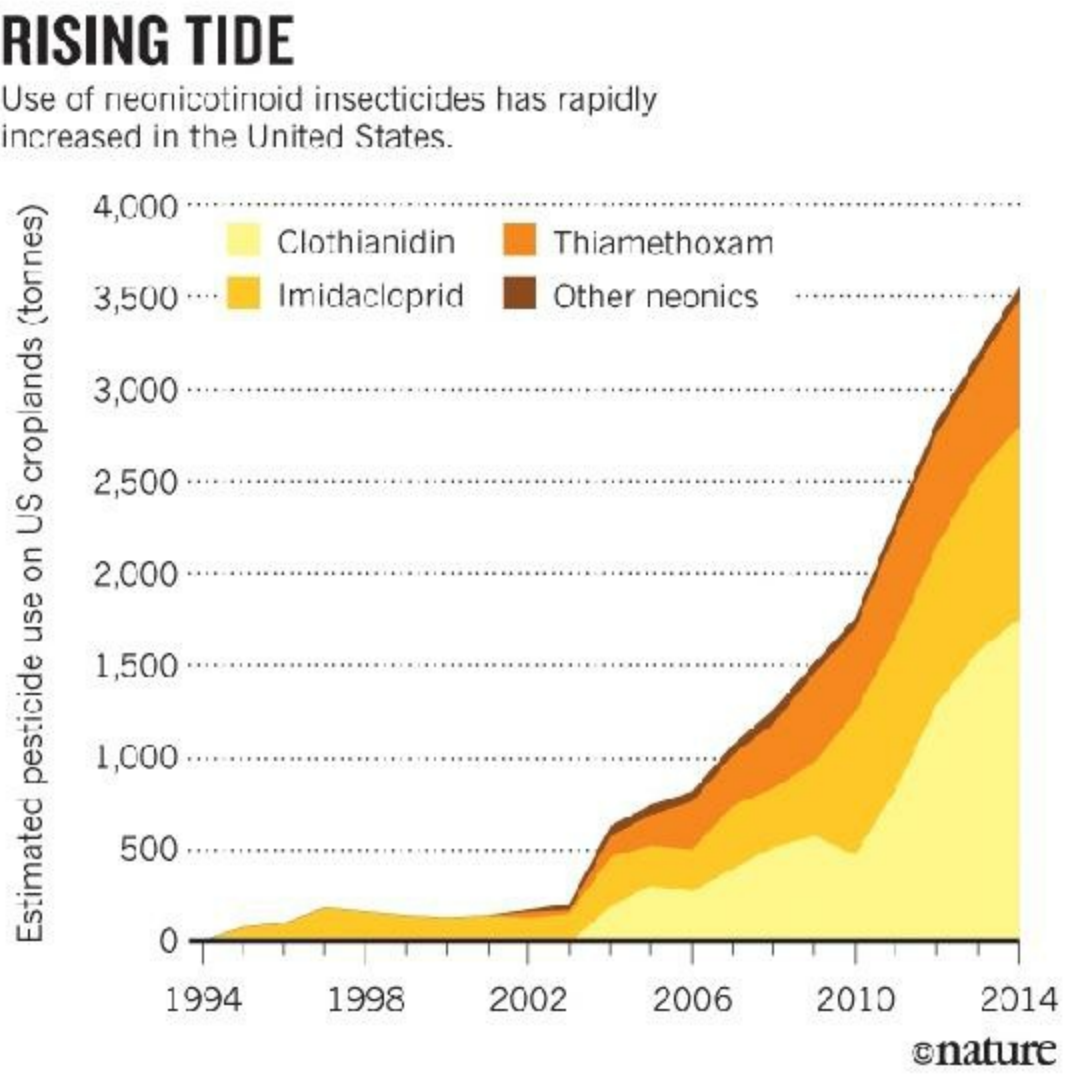
Since Rundlöf's paper, studies showing real-world evidence of harm from pesticides in the field have been mounting — and environmental organizations have demanded wide-ranging bans. Regulatory agencies will soon decide what to do about neonics, which have a global market worth more than US$1.5 billion per year. This month, the EU's European Food Safety Authority is due to complete a re-evaluation of evidence for restricting neonics; the EU will then need to decide what action to take. The US Environmental Protection Agency is expected to complete its own review of

the insecticides next year. France's parliament has passed a law that would ban neonics in 2018, although some exemptions will be allowed.

But industry groups and some scientists say the evidence still isn't conclusive. The picture is complicated: some studies show harm to some bees in some circumstances, whereas others find no harm. The results seem to be affected by many factors, including the species of bee and the kinds of crops involved. Scientists working on the question say the subject has become toxic: any new study is instantly and furiously picked at by entrenched advocates on both sides. Even the results of the largest study on the matter, funded by the agrochemical industry, failed to produce a consensus. Published this year[2], it launched another round of recriminations — including complaints from funders who criticized the paper that they had paid for. Ultimately, it's likely that political or regulatory decisions will settle the matter before opposing parties agree, says Sainath Suryanarayanan, an entomologist and sociologist at the University of Wisconsin–Madison who has studied the bee-health issue. “It is a common pattern for highly contentious and polarized debates,” he says.

The world's favourite insecticide

In the early 1980s, scientists at Nihon Tokushu Noyaku Seizo in Tokyo, an arm of Bayer, started to play around with nithiazine, an insecticide created in California a decade earlier. They discovered a new compound that was more than 100 times as effective at killing crop pests, such as aphids. Named imidacloprid, the chemical was launched onto the market in the 1990s, and it quickly became one of the most widely used insecticides in the world. By the mid-2000s, imidacloprid and similar compounds made up one-quarter of all insecticides (see 'Rising tide'). The compounds damage insects' nervous systems by causing the nerves to fire continually until they fail, eventually leading to death. Many neonics are applied directly to seeds, and are taken up by growing plants. If the plant flowers, the chemicals find their way into pollen and nectar.



Source: USGS/CalPIP

In France, where sunflower seeds coated with imidacloprid came on the market in 1994, beekeepers raised the alarm. They said that their honeybees were failing to make it home after foraging flights, and they pinned the blame on the sunflowers. The concerns triggered a 1999 French ban on imidacloprid-coated sunflower seeds, which continues to this day — although it was based on the precautionary principle, rather than formal proofs of harm, says Axel Decourtye, a researcher at the Institute for Bees in Avignon, France.

Scientists hurried to find those proofs — or evidence that the concern was overblown. Researchers quickly discovered that honeybees fed high doses of neonicotinoids died. And even sub-lethal doses triggered unusual behaviour: exposed honeybees changed their dining habits, foraging less often but for longer periods[3]. Other research showed[4] that neonics act on parts of a bee's brain associated with memory and learning. Honeybees trained to respond to particular scents by sticking out their tongues, for example, performed worse — or failed to learn the task at all — when dosed with a neonic.

At every stage, critics raised new queries about how realistic the experiments were, says Decourtye. “How do we know if the neonicotinoid doses are realistic? Does the effect on the individual have any effect on the colony?”

Out in the field

As work continued in the laboratory, researchers also began to turn to the fields. In 2012, Decourtye and his colleagues published a paper[5] showing that what they called “thiamethoxam intoxication” seemed to interfere with the ability of honeybees to return to their hives after looking for food in a realistic, outdoor setting. Yet that study still dosed bees' food with neonics, rather than allowing them to feed on treated crops.

Around the same time, a UK team found[6] that it was not just honeybees that could be at risk. They reported that colonies of bumblebees exposed to “field-realistic” levels of imidacloprid in the lab and then left to grow in field conditions grew slower than controls. They also produced 85% fewer new queens to carry on their line. That work was led by Dave Goulson, a bee researcher now at the University of Sussex in Brighton, UK. In 2006, Goulson had started a charity dedicated to conserving bumblebees, and people began telling him their concerns about neonics. “To start with, I was pretty dubious,” he says. But by 2014, the Task Force on Systemic Pesticides (TFSP) — a group of 30 scientists, including Goulson — announced that it had analysed 800 peer-reviewed studies on neonics and bees, and found “clear evidence of harm sufficient to trigger regulatory action”[8].

Rundlöf's study set out to be the most realistic yet. Her team sowed eight

Swedish fields with oilseed-rape seeds coated in clothianidin, and eight with untreated seeds. They found[1] not only that bumblebee colonies in treated fields grew less well than the controls, but also that the numbers of wild bees in the treated fields fell. Industry spokespeople noted that honeybee colonies weren't affected, and also quibbled with the study — arguing, for example, that the researchers had only placed a small number of wild bees into fields, so findings might not be statistically robust. Rundlöf, however, points out that the researchers also surveyed wild bees flying around, and had the bumblebee-colony data to draw on. “I know we have robust evidence,” she says.

Maj Rundlöf

Researchers examine the health of honeybees during a field study led by Maj Rundlöf in Sweden.

In mid-2017, the largest field study yet — funded with some $3 million from

industry — reported its long-awaited results[2]. Scientists from the Centre for Ecology and Hydrology (CEH) near Wallingford, UK, had put honeybees, mason bees (*Osmia bicornis*) and bumblebees in 33 oilseed-rape fields in the United Kingdom, Germany and Hungary. This time, the seeds, sown in winter, had been coated with either clothianidin or thiamethoxam, or with a neonicotinoid-free pesticide treatment.

The researchers, led by CEH entomologist Ben Woodcock, found that bumblebees and mason bees fared less well the more neonics they were exposed to. The honeybee picture was more complicated: in some cases, neonics seemed to affect bee health, but in others, they didn't. In the United Kingdom and Hungary, neonic compounds seemed to reduce worker-bee numbers in honeybee hives; in Hungary, researchers also saw fewer egg cells in these hives, an indication of reduced reproductive success. In Germany, however, the honeybee hives exposed to neonics had more egg cells — a puzzling result. Overall, the CEH study concluded that neonicotinoids reduced bees' ability to establish new colonies after winter. The journal editor's summary of the paper came under the headline: “Damage confirmed”.

The agrochemical firms that funded the study don't agree. At a press conference in June, when CEH scientists presented their results — without Woodcock, who was overseas — spokespeople from Syngenta and Bayer told reporters that both the study's analysis and its conclusions were questionable. They noted that Woodcock's team had analysed more than 200 pieces of information about honeybees; 9 showed a negative effect from neonicotinoids, whereas 7 were positive. “The one-line simplistic summary conclusion published does not reflect the data presented in this paper,” argued Peter Campbell, an environmental specialist at Syngenta in Reading, UK, in a separate statement released to the media.

Woodcock was incensed by the criticism. In an interview with environmental group Greenpeace, he said that industry had accused him of being a liar. Now, he says, he regrets that choice of words, but he still thinks industry took a blinkered view of the results. “I do feel that the sentiment of what I implied, while inappropriate, was not an unreasonable reaction,” he says. The negative effects were in key areas related to bee health, he says, adding that for

industrial firms to deny that neonics are having an effect on bees is “probably naive”.

Many of the academics *Nature* talked to agree. “I think the majority of researchers highlight that the weakening of bee populations caused by neonicotinoids is proved,” says Decourtye. But not everyone is so certain. “The question of whether the damage to bees is translated to an effect in fields on whole populations of bees is much harder to show,” says Linda Field, head of the department of Biointeractions and Crop Protection at Rothamsted Research in Harpenden, UK. Mature colonies may survive even if individual bees are impaired, because other worker bees compensate, notes Nigel Raine, a biologist at the University of Guelph in Canada. But solitary bees, such as wild bees and queen bumblebees emerging from hibernation, might be at greater risk.

Campbell thinks that many academics are “neutral” on the matter, but are not vocal about it. Studies showing harm to bees tend to garner media attention, and are published in widely read journals, whereas those showing no impact are relegated to less highly cited publications, he says. But Goulson and Woodcock say some of the studies that industry cites as showing no harm are statistically dubious, and more flawed than the headline-garnering trials that show harm.

Christian Maus, global lead scientist for bee care at Bayer in Monheim am Rhein, Germany, picks his words carefully. “I think it is clear and undebated that neonicotinoids do have some intrinsic toxicity to bees,” he says. “But under realistic conditions, as prevailing in the field and agricultural practice, we have not seen any evidence that they would be harming honeybee colonies, for instance, when they are correctly applied.”

Combinatorial effects

Researchers are looking beyond simple relationships between a single pesticide and bee harm. In a 2012 paper[8], Raine and his colleagues showed that exposing bumblebees to a neonicotinoid in combination with a pesticide called a pyrethroid hampered their ability to collect pollen. Colonies exposed

to both compounds experienced higher losses of worker bees than did controls, or colonies dosed with only one. The study was the first to show combinatorial effects, Raine says — which is important, because bees will be exposed to multiple compounds in the wild. And this year, in a paper[9] published alongside Woodcock's, a Canadian team studying honeybee colonies near maize (corn) plants found that the presence of the fungicide boscalid halved the dose of neonics needed to cause death.

That work also suggested that neonic chemicals can migrate away from the plants that they are supposed to protect: by identifying the sources of pollen grains in the hives, the researchers showed that bees were exposed to neonics mainly through pollen from untreated plants. Neonicotinoids are water-soluble — which is how they move from seeds into growing plant tissues. “But that also means they can be washed off the seed, into the soil, and maybe into other plants,” says Christian Krupke, an entomologist at Purdue University in West Lafayette, Indiana.

In one study[10], Krupke found that just 1.34% of clothianidin applied as seed treatment to maize ended up in the crop’s tissues. Neonics that get into the wider environment might cause other, more indirect problems. A 2014 study[11] in the Netherlands, for instance, reported a fall in populations of insect-eating birds in areas with high concentrations of neonicotinoids in the water. It suggested that the chemicals might have depleted the birds’ food resource.

Some researchers are now questioning whether there is any benefit to using neonicotinoids at all. In another study[12], Krupke’s group found no benefits on maize yield from the use of neonicotinoids in Indiana. In this crop, he says, the prophylactic use of neonicotinoids — which are often part of a bundle of pesticides sold pre-applied to seeds — is foolish.

“The way they’re used doesn’t make any sense,” he says. “It only makes sense from one motive. That is the profit motive for the manufacturer.”

Campbell insists that neonicotinoids do provide yield increases, but much of the evidence is proprietary and unpublished. Since the EU neonicotinoid restrictions, Maus says, research suggests there has been a 4% decline in

oilseed-rape yield. Whether or not the restrictions have had any effect, farmers have furiously protested against losing the ability to use neonics. Anecdotal reports suggest many are attempting to compensate by applying increasing amounts of pyrethroids, which are sprayed over crops, rather than applied to seeds; these chemicals may bring their own health risks if used in large quantities, because they are toxic to fish and aquatic insects.

The B word

Regulators in some countries will soon decide whether to take further action to restrict neonics — and here, researchers are split. Some campaign groups, such as Greenpeace and the Pesticide Action Network, have argued for a ban on the use of neonics on all outdoor crops, not just those that might be attractive to bees, such as the bright-yellow flowers of oilseed rape.

“A lot of farmers do fundamentally rely on neonicotinoids,” says Woodcock. And clamping down severely on one chemical might mean that greater amounts of other damaging substances are used. “If people can't use neonicotinoids and they go to other insecticides, is that any better? There are lots of knock-on effects,” says Field.

That concern points to wider doubts about the regulatory systems that allowed agrichemicals such as neonics onto the market in the first place, says Goulson. Many researchers are hesitant to advocate outright bans. Some, such as Rundlöf, say it isn't their job to make policy recommendations. But Goulson says his view has changed as the evidence has mounted. In 2014 — at the time of the TFSP's first synthesis report — he thought that there might be certain situations in which neonics were the best option. But since then, he says, there's been even stronger evidence of collapsing insect populations — and it is hard to regulate partial bans. “I think now I'd vote for a complete ban,” he says.

Whatever regulators do, Goulson says, he is growing increasingly downbeat about the chances of any consensus forming between industry and academia on the issue. “I'm starting to come to the conclusion there will never be a game-changer,” he says. “There is nothing I think any scientist could do at

this point to make people all sit down and have any answer.”

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Four ethical priorities for neurotechnologies and AI

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Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

BSIP/UIG/Getty

A man with a spinal-cord injury (right) prepares for a virtual cycle race in which competitors steer avatars using brain signals.

Consider the following scenario. A paralysed man participates in a clinical

trial of a brain–computer interface (BCI). A computer connected to a chip in his brain is trained to interpret the neural activity resulting from his mental rehearsals of an action. The computer generates commands that move a robotic arm. One day, the man feels frustrated with the experimental team. Later, his robotic hand crushes a cup after taking it from one of the research assistants, and hurts the assistant. Apologizing for what he says must have been a malfunction of the device, he wonders whether his frustration with the team played a part.

This scenario is hypothetical. But it illustrates some of the challenges that society might be heading towards.

Current BCI technology is mainly focused on therapeutic outcomes, such as helping people with spinal-cord injuries. It already enables users to perform relatively simple motor tasks — moving a computer cursor or controlling a motorized wheelchair, for example. Moreover, researchers can already interpret a person's neural activity from functional magnetic resonance imaging scans at a rudimentary level[1] — that the individual is thinking of a person, say, rather than a car.

It might take years or even decades until BCI and other neurotechnologies are part of our daily lives. But technological developments mean that we are on a path to a world in which it will be possible to decode people's mental processes and directly manipulate the brain mechanisms underlying their intentions, emotions and decisions; where individuals could communicate with others simply by thinking; and where powerful computational systems linked directly to people's brains aid their interactions with the world such that their mental and physical abilities are greatly enhanced.

Such advances could revolutionize the treatment of many conditions, from brain injury and paralysis to epilepsy and schizophrenia, and transform human experience for the better. But the technology could also exacerbate social inequalities and offer corporations, hackers, governments or anyone else new ways to exploit and manipulate people. And it could profoundly alter some core human characteristics: private mental life, individual agency and an understanding of individuals as entities bound by their bodies.

It is crucial to consider the possible ramifications now.

The Morningside Group comprises neuroscientists, neurotechnologists, clinicians, ethicists and machine-intelligence engineers. It includes representatives from Google and Kernel (a neurotechnology start-up in Los Angeles, California); from international brain projects; and from academic and research institutions in the United States, Canada, Europe, Israel, China, Japan and Australia. We gathered at a workshop sponsored by the US National Science Foundation at Columbia University, New York, in May 2017 to discuss the ethics of neurotechnologies and machine intelligence.

We believe that existing ethics guidelines are insufficient for this realm[2]. These include the Declaration of Helsinki, a statement of ethical principles first established in 1964 for medical research involving human subjects (go.nature.com/2z262ag); the Belmont Report, a 1979 statement crafted by the US National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research (go.nature.com/2hrezmb); and the Asilomar artificial intelligence (AI) statement of cautionary principles, published early this year and signed by business leaders and AI researchers, among others (go.nature.com/2ihnqac).

To begin to address this deficit, here we lay out recommendations relating to four areas of concern: privacy and consent; agency and identity; augmentation; and bias. Different nations and people of varying religions, ethnicities and socio-economic backgrounds will have differing needs and outlooks. As such, governments must create their own deliberative bodies to mediate open debate involving representatives from all sectors of society, and to determine how to translate these guidelines into policy, including specific laws and regulations.

Intelligent investments

Some of the world's wealthiest investors are betting on the interplay between neuroscience and AI. More than a dozen companies worldwide, including Kernel and Elon Musk's start-up firm Neuralink, which launched this year, are investing in the creation of devices that can both 'read' human brain activity and 'write' neural information into the brain. We estimate that current spending on neurotechnology by for-profit industry is already US$100

million per year, and growing fast.

BSIP/UIG/Getty

After having electrodes implanted in the brain to stimulate neural activity, some people have reported feeling an altered sense of identity.

Investment from other sectors is also considerable. Since 2013, more than $500 million in federal funds has gone towards the development of neurotechnology under the US BRAIN initiative alone.

Current capabilities are already impressive. A neuroscientist paralysed by amyotrophic lateral sclerosis (ALS; also known as Lou Gehrig's or motor neuron disease) has used a BCI to run his laboratory, write grant applications and send e-mails[3]. Meanwhile, researchers at Duke University in Durham, North Carolina, have shown that three monkeys with electrode implants can operate as a 'brain net' to move an avatar arm collaboratively[4]. These devices can work across thousands of kilometres if the signal is transmitted wirelessly by the Internet.

Soon such coarse devices, which can stimulate and read the activity of a few dozen neurons at most, will be surpassed. Earlier this year, the US Defense Advanced Research Projects Agency (DARPA) launched a project called Neural Engineering System Design. It aims to win approval from the US Food and Drug Administration within 4 years for a wireless human brain device that can monitor brain activity using 1 million electrodes simultaneously and selectively stimulate up to 100,000 neurons.

Meanwhile, Google, IBM, Microsoft, Facebook, Apple and numerous start-ups are building ever-more-sophisticated artificial neural networks that can already outperform humans on tasks with well-defined inputs and outputs.

Last year, for example, researchers at the University of Washington in Seattle demonstrated that Google's FaceNet system could recognize one face from a million others. Another Google system with similar neural-network architecture far outperforms well-travelled humans at guessing where in the world a street scene has been photographed, demonstrating the generality of the technique. In August, Microsoft announced that, in certain metrics, its neural network for recognizing conversational speech has matched the abilities of even trained professionals, who have the option of repeatedly rewinding and listening to words used in context. And using electroencephalogram (EEG) data, researchers at the University of Freiburg in Germany showed in July how neural networks can be used to decode planning-related brain activity and so control robots[5].

Future neural networks derived from a better understanding of how real ones work will almost certainly be much more powerful even than these examples. The artificial networks in current use have been inspired by models of brain circuits that are more than 50 years old, which are based on recording the activity of individual neurons in anaesthetized animals[6]. In today's neuroscience labs, researchers can monitor and manipulate the activity of thousands of neurons in awake, behaving animals, owing to advances in optical methods, computing, molecular engineering and microelectronics.

We are already intimately connected to our machines. Researchers at Google calculated this year that the average user touches their phone nearly one million times annually (unpublished data). The human brain controls auditory

and visual systems to decipher sounds and images, and commands limbs to hold and manipulate our gadgets. Yet the convergence of developments in neurotechnologies and AI would offer something qualitatively different — the direct linking of people's brains to machine intelligence, and the bypassing of the normal sensorimotor functions of brains and bodies.

Four concerns

For neurotechnologies to take off in general consumer markets, the devices would have to be non-invasive, of minimal risk, and require much less expense to deploy than current neurosurgical procedures. Nonetheless, even now, companies that are developing devices must be held accountable for their products, and be guided by certain standards, best practices and ethical norms.

We highlight four areas of concern that call for immediate action. Although we raise these issues in the context of neurotechnology, they also apply to AI.

Privacy and consent. An extraordinary level of personal information can already be obtained from people's data trails. Researchers at the Massachusetts Institute of Technology in Cambridge, for example, discovered in 2015 that fine-grained analysis of people's motor behaviour, revealed through their keyboard typing patterns on personal devices, could enable earlier diagnosis of Parkinson's disease[7]. A 2017 study suggests that measures of mobility patterns, such as those obtained from people carrying smartphones during their normal daily activities, can be used to diagnose early signs of cognitive impairment resulting from Alzheimer's disease[8].

Algorithms that are used to target advertising, calculate insurance premiums or match potential partners will be considerably more powerful if they draw on neural information — for instance, activity patterns from neurons associated with certain states of attention. And neural devices connected to the Internet open up the possibility of individuals or organizations (hackers, corporations or government agencies) tracking or even manipulating an individual's mental experience.

We believe that citizens should have the ability — and right — to keep their neural data private (see also 'Agency and identity'). We propose the following steps to ensure this.

For all neural data, the ability to opt out of sharing should be the default choice, and assiduously protected. People readily give up their privacy rights to commercial providers of services, such as Internet browsing, social media or entertainment, without fully understanding what they are surrendering. A default of opting out would mean that neural data are treated in the same way that organs or tissues are in most countries. Individuals would need to explicitly opt in to share neural data from any device. This would involve a safe and secure process, including a consent procedure that clearly specifies who will use the data, for what purposes and for how long.

Even with this approach, neural data from many willing sharers, combined with massive amounts of non-neural data — from Internet searches, fitness monitors and so on — could be used to draw 'good enough' conclusions about individuals who choose not to share. To limit this problem, we propose that the sale, commercial transfer and use of neural data be strictly regulated. Such regulations — which would also limit the possibility of people giving up their neural data or having neural activity written directly into their brains for financial reward — may be analogous to legislation that prohibits the sale of human organs, such as the 1984 US National Organ Transplant Act.

Another safeguard is to restrict the centralized processing of neural data. We advocate that computational techniques, such as differential privacy or 'federated learning', be deployed to protect user privacy (see 'Protecting privacy'). The use of other technologies specifically designed to protect people's data would help, too. Blockchain-based techniques, for instance, allow data to be tracked and audited, and 'smart contracts' can give transparent control over how data are used, without the need for a centralized authority. Lastly, open-data formats and open-source code would allow for greater transparency about what stays private and what is transmitted.

Protecting privacy: Federated learning

When technology companies use machine learning to improve their software, they typically gather user information on their servers to analyse how a particular service is being used and then train new algorithms on the aggregated data. Researchers at Google are experimenting with an alternative method of artificial-intelligence training called federated learning. Here, the teaching process happens locally on each user's device without the data being centralized: the lessons aggregated from the data (for instance, the knowledge that the word 'weekly' can be used as an adjective and an adverb) are sent back to Google's servers, but the actual e-mails, texts and so on remain on the user's own phone. Other groups are exploring similar ideas. Thus, information systems with improved designs could be used to enhance users' ownership and privacy over their personal data, while still enabling valuable computations to be performed on those data.

Agency and identity. Some people receiving deep-brain stimulation through electrodes implanted in their brains have reported feeling an altered sense of agency and identity. In a 2016 study, a man who had used a brain stimulator to treat his depression for seven years reported in a focus group[9] that he began to wonder whether the way he was interacting with others — for example, saying something that, in retrospect, he thought was inappropriate — was due to the device, his depression or whether it reflected something deeper about himself. He said: “It blurs to the point where I'm not sure ... frankly, who I am.”

Neurotechnologies could clearly disrupt people's sense of identity and agency, and shake core assumptions about the nature of the self and personal responsibility — legal or moral.

People could end up behaving in ways that they struggle to claim as their own, if machine learning and brain-interfacing devices enable faster translation between an intention and an action, perhaps by using an 'auto-complete' or 'auto-correct' function. If people can control devices through their thoughts across great distances, or if several brains are wired to work collaboratively, our understanding of who we are and where we are acting will be disrupted.

As neurotechnologies develop and corporations, governments and others start striving to endow people with new capabilities, individual identity (our

bodily and mental integrity) and agency (our ability to choose our actions) must be protected as basic human rights.

We recommend adding clauses protecting such rights ('neurorights') to international treaties, such as the 1948 Universal Declaration of Human Rights. However, this might not be enough — international declarations and laws are just agreements between states, and even the Universal Declaration is not legally binding. Thus, we advocate the creation of an international convention to define prohibited actions related to neurotechnology and machine intelligence, similar to the prohibitions listed in the 2010 International Convention for the Protection of All Persons from Enforced Disappearance. An associated United Nations working group could review the compliance of signatory states, and recommend sanctions when needed.

Such declarations must also protect people's rights to be educated about the possible cognitive and emotional effects of neurotechnologies. Currently, consent forms typically focus only on the physical risks of surgery, rather than the possible effects of a device on mood, personality or sense of self.

Augmentation. People frequently experience prejudice if their bodies or brains function differently from most[10]. The pressure to adopt enhancing neurotechnologies, such as those that allow people to radically expand their endurance or sensory or mental capacities, is likely to change societal norms, raise issues of equitable access and generate new forms of discrimination.

Moreover, it's easy to imagine an augmentation arms race. In recent years, we have heard staff at DARPA and the US Intelligence Advanced Research Projects Activity discuss plans to provide soldiers and analysts with enhanced mental abilities ('super-intelligent agents'). These would be used for combat settings and to better decipher data streams.

Any lines drawn will inevitably be blurry, given how hard it is to predict which technologies will have negative impacts on human life. But we urge that guidelines are established at both international and national levels to set limits on the augmenting neurotechnologies that can be implemented, and to define the contexts in which they can be used — as is happening for gene editing in humans.

Privacy and individuality are valued more highly in some cultures than in others. Therefore, regulatory decisions must be made within a culture-specific context, while respecting universal rights and global guidelines. Moreover, outright bans of certain technologies could simply push them underground, so efforts to establish specific laws and regulations must include organized forums that enable in-depth and open debate.

Such efforts should draw on the many precedents for building international consensus and incorporating public opinion into scientific decision-making at the national level[11]. For instance, after the First World War, a 1925 conference led to the development and ratification of the Geneva Protocol, a treaty banning the use of chemical and biological weapons. Similarly, after the Second World War, the UN Atomic Energy Commission was established to deal with the use of atomic energy for peaceful purposes and to control the spread of nuclear weapons.

In particular, we recommend that the use of neural technology for military purposes be stringently regulated. For obvious reasons, any moratorium should be global and sponsored by a UN-led commission. Although such commissions and similar efforts might not resolve all enhancement issues, they offer the best-available model for publicly acknowledging the need for restraint, and for wide input into the development and implementation of a technology.

Bias. When scientific or technological decisions are based on a narrow set of systemic, structural or social concepts and norms, the resulting technology can privilege certain groups and harm others. A 2015 study[12] found that postings for jobs displayed to female users by Google's advertising algorithm pay less well than those displayed to men. Similarly, a ProPublica investigation revealed last year that algorithms used by US law-enforcement agencies wrongly predict that black defendants are more likely to reoffend than white defendants with a similar criminal record (go.nature.com/29aznyw). Such biases could become embedded in neural devices. Indeed, researchers who have examined these kinds of cases have shown that defining fairness in a mathematically rigorous manner is very difficult (go.nature.com/2ztfjt9).

Practical steps to counter bias within technologies are already being discussed in industry and academia. Such ongoing public discussions and debate are necessary to shape definitions of problematic biases and, more generally, of normality.

We advocate that countermeasures to combat bias become the norm for machine learning. We also recommend that probable user groups (especially those who are already marginalized) have input into the design of algorithms and devices as another way to ensure that biases are addressed from the first stages of technology development.

Responsible neuroengineering

Underlying many of these recommendations is a call for industry and academic researchers to take on the responsibilities that come with devising devices and systems capable of bringing such change. In doing so, they could draw on frameworks that have already been developed for responsible innovation.

In addition to the guidelines mentioned above, the UK Engineering and Physical Sciences Research Council, for instance, provides a framework to encourage innovators to “anticipate, reflect, engage and act” in ways that “promote ... opportunities for science and innovation that are socially desirable and undertaken in the public interest”. Among the various efforts to address this in AI, the IEEE Standards Association created a global ethics initiative in April 2016, with the aim of embedding ethics into the design of processes for all AI and autonomous systems.

History indicates that profit hunting will often trump social responsibility in the corporate world. And even if, at an individual level, most technologists set out to benefit humanity, they can come up against complex ethical dilemmas for which they aren't prepared. We think that mindsets could be altered and the producers of devices better equipped by embedding an ethical code of conduct into industry and academia.

A first step towards this would be to expose engineers, other tech developers

and academic-research trainees to ethics as part of their standard training on joining a company or laboratory. Employees could be taught to think more deeply about how to pursue advances and deploy strategies that are likely to contribute constructively to society, rather than to fracture it.

This type of approach would essentially follow that used in medicine. Medical students are taught about patient confidentiality, non-harm and their duties of beneficence and justice, and are required to take the Hippocratic Oath to adhere to the highest standards of the profession.

The possible clinical and societal benefits of neurotechnologies are vast. To reap them, we must guide their development in a way that respects, protects and enables what is best in humanity.

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The catalogue that made metrics, and changed science

08 November 2017

As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.

Alamy

Cataloguers of the Royal Society developed the first record of published scientific research.

In 1830, Charles Babbage had an unusual idea. Exasperated by how little recognition science was getting in England, the computer pioneer and scientific provocateur suggested that quantifying authorship might be a way to identify scientific eminence.

Like many of Babbage's radical ideas, this one persuaded almost nobody, but it eventually proved prophetic. Before the end of the century, listing papers and comparing publication counts had become a popular pursuit among scientific authors and other observers. Within a few decades, academic scientists were coming to fear the creed of 'publish or perish' (see 'Catalogues and counts').

This transformation can inform current debates about the value of algorithms for quantifying scientific credibility and importance. History shows how search technologies and metrics are not neutral tools that simply speed up efforts to locate and evaluate scientific work. Metrics transform the very things that they measure. By changing the reward structure, they alter researchers' behaviour — both how results are communicated and which topics receive the most attention.

But there is a second, more subtle, transformation that we must be alert to. The processes by which scientific merit is judged have long been central to the public perception of scientific authority. As these processes change, we must also consider the ways in which broader cultural beliefs about scientific expertise are transformed.

Broken pieces of fact

Babbage's suggestion to count authors' papers was met with various criticisms. One author did the calculation for each fellow in the Royal Society in London, and showed that this was a terrible guide to scientific eminence. Another pointed out[1] that “a far more satisfactory criterion” would have been “the value of those papers”.

Back then, scientific reputations were built not on periodicals but on books and other proofs of genius that demonstrated mastery of a subject. Babbage himself had little respect for most scientific journals, and he limited his proposal to counting papers in the venerable *Philosophical Transactions of the Royal Society of London*. As late as 1867, the British physiologist Michael Foster, in a retrospective written on the life of Karl von Baer, heaped praise on the embryologist's multivolume masterwork, *On the Development*

of Animals, and dismissed his periodical publications. These, Foster claimed[2], were just “specimens of those broken pieces of fact, which every scientific worker throws out to the world, hoping that on them, some time or other, some truth may come to land”.

Alamy

But things were beginning to change. A young engineer working for the US

Coast and Geodetic Survey (now the National Geodetic Survey) had suggested that it would be useful if some catalogue could be devised to keep track of the publications of European scientific societies. Once the idea crossed the Atlantic and percolated up to the Royal Society, its scope grew to become a list of all periodical papers containing original scientific research published since 1800. Some questioned the need to preserve so much insignificant writing. The physicist William Thomson (later Lord Kelvin) warned that the project would lead the society to financial ruin.

The main argument for what would become the *Catalogue of Scientific Papers* was that periodical publishing was a mess. Although many authors published in the journals of scientific societies, vast quantities of valuable information appeared in popular-science magazines, encyclopaedias and general-interest weeklies. Authors distributed huge numbers of offprints that sometimes did not even make clear what journal they had come from.

When the society's indexers got down to work in 1867, they realized that the situation was worse than they'd imagined. For thousands of papers, they couldn't even figure out who the author was. Many who published in periodicals chose to remain anonymous, or signed only their initials. In other cases, it was hard to tell to what extent the writer of a paper was responsible for its contents, or whether another person ought to be credited. Moreover, vast numbers of papers were published in various forms in different periodicals, and it was no easy matter deciding what should count as the same publication. Today, such publishing habits would probably lead to accusations of misconduct; not very long ago this was business as usual.

The Royal Society's cataloguers did what they could, contacting editors and authors to match names to papers. They turned a significant portion of the society's library into a bibliographic workroom, and made their job simpler by excluding all general-interest periodicals from the search, as well as anything that smacked of reading for non-specialists. They compiled lists of which periodicals ought to be included in the count, and circulated them to other experts and academies for feedback. The decision about whether to index some doubtful titles sometimes made it all the way to the society's council for a vote.

As their work progressed, the directors of the project came to realize that

their charge to produce a master list of all 'scientific papers' published since 1800 might actually influence publishing practices in the future. They hoped that authors would be more careful about where they published — or at least sign their contributions[3]. They probably did not anticipate the full consequences of what they were about to unleash.

Counting what counts

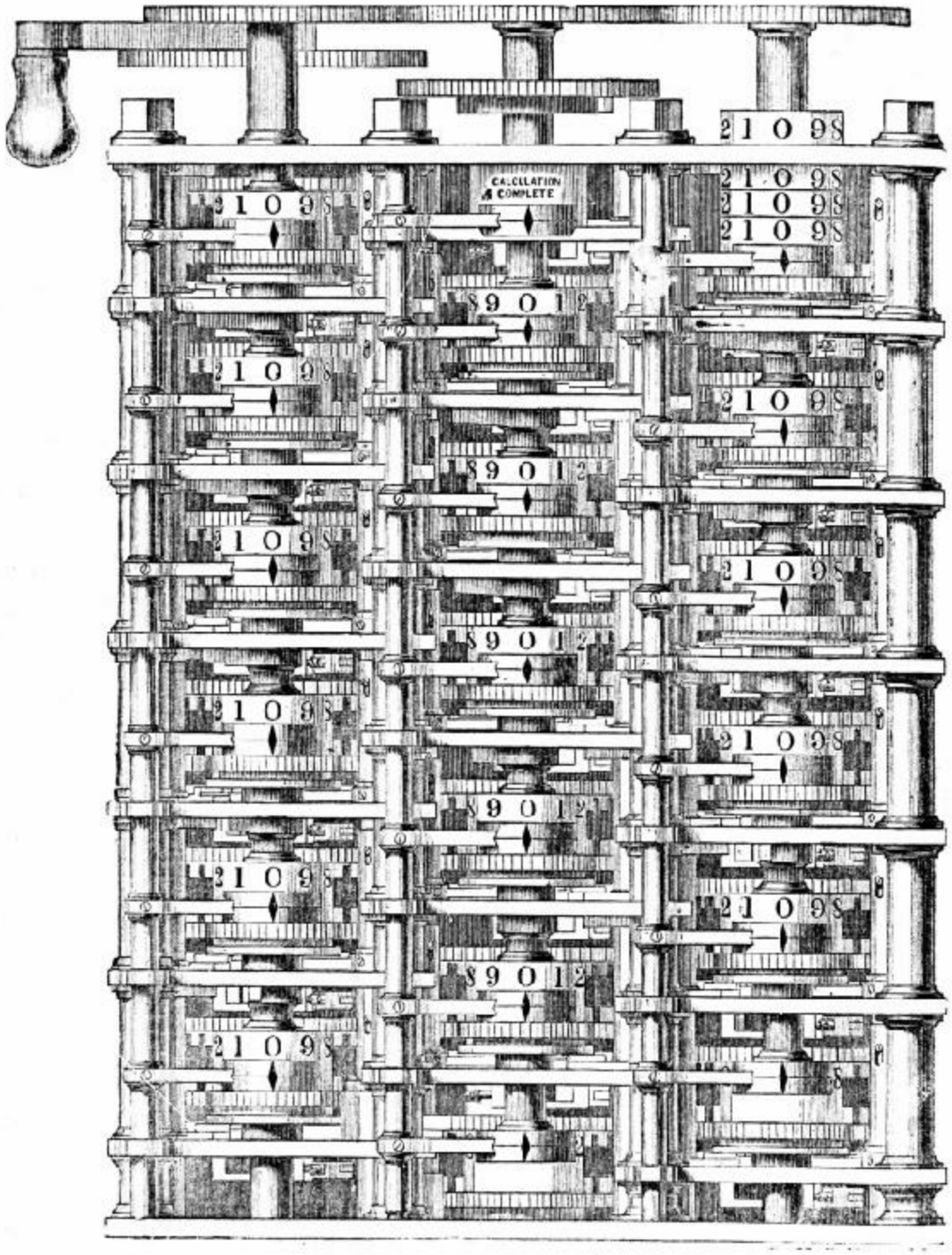
When the first volumes of the *Catalogue of Scientific Papers* appeared at the end of 1867, reaction across Europe and the United States was swift and wide-ranging. One observer wrote in awe that the catalogue made science look like a coral-island, a majestic edifice that grew imperceptibly larger with the addition of each new fact embodied in each paper. Some were less enthusiastic. One Royal Society fellow complained that the editors had distorted “the progress and history of discovery both in Physical and Natural Science” by excluding so many valuable contributions from “journals not professedly scientific”, accounts of scientific voyages, independently published treatises, encyclopaedia articles (which at the time often included original research), and much more[4].

Many observers hurried over the prospect of how helpful the catalogue would be for finding information and began comparing the productivity of individuals. By quantifying the contributions of each author, the catalogue seemed tailor-made for keeping score. A writer in *Nature* got down to business[5]: “Dr. Hooker appears for 58 papers; his late father for 72; and the late W. Hopkins, who did so much in mathematical geology, for 33 .... the indefatigable Isaac Lea, of Philadelphia, for 106, mostly about shells...”. And so forth. In a detailed review in a Viennese newspaper, the mineralogist Wilhelm von Haidinger began by urging prudence, warning that the mere comparison of numbers was no basis on which to make judgements of value[6]. But even he admitted that the numbers were somehow irresistible. Within two years, von Haidinger had taken his numerical analysis further. He published a study based on the catalogue that included a chart that compared the number of highly productive scientific authors in each region of Europe, lamenting the low position of Austria according to this ranking[7].

Such enthusiasm for counting had practical consequences. Within a decade of those first volumes appearing, the forms submitted by candidates for admission to the Royal Society transformed into long lists of papers. By the early 1870s, obituaries and biographical encyclopaedias were routinely noting the number of papers written by a researcher, and even following the chronology sketched out by those papers as guide-posts to a career. By 1900, even Foster, the physiologist once so sceptical of scientific periodicals, had changed his tune. Original science belonged in periodicals, he explained. Putting new findings in books — as Charles Darwin had famously done — was “out of place and even dangerous”[8]. To be an expert on scientific subjects meant being an author of scientific papers.

Publish or perish

There is a direct line from these developments to twentieth-century worries about scientific publishing going off the rails. A letter to *Nature* in 1932 lamented the growing practice of candidates submitting a “list of strictly technical publications” to the Royal Society, leading to the result that “our journals are filled with masses of unreadable trash” published by ambitious scholars hoping to strengthen their applications[9].



Alamy

Charles Babbage, inventor of the difference engine, was an advocate of counting papers.

This was around the same time that the phrase publish or perish began to circulate in academia. It did so first in the United States, where the spread of research universities was turning science into something resembling a profession. The slogan became shorthand for the corrupting influence of narrow, bureaucratic performance measures of research.

In the 1960s, Eugene Garfield launched a radically different search tool, known as the Science Citation Index. He hoped that it might end the harmful culture of publish or perish by showing that some papers were more cited — and hence more valuable — than others.

Immediately, commentators warned that new measures based on citations would only make things worse, leading to a “highly invidious pecking order” of journals that could distort science[10]. The journal impact factor made its public debut in 1972, soon after the US Congress called on the National Science Foundation to produce a better account of the benefits wrought by public funding of science. There is no doubt that the citation index changed practices of scientific publishing, just as the rise of counting papers had followed the introduction of the catalogue before.

Today, advocates of altmetrics argue that well-made algorithms can mimic and aggregate the everyday acts of judgement that researchers make when they read, cite, link or otherwise engage with published research. These algorithms, they claim, will turn out to be as good or better at replicating established processes — such as peer review — that are supposed to delimit what constitutes important and trustworthy research.

Whether or not these claims turn out to be true, they ignore the question of whether we deem the procedures that experts use to evaluate ideas to be intrinsically valuable (that is, independent of the content of those judgements).

Scientific judgement does not happen in a cultural vacuum. The rise of processes such as peer review to organize and evaluate research was never simply about getting scientific judgement right; it was about balancing scientists' expert cultures with public demands for accountability. The *Catalogue of Scientific Papers* was itself part of a cultural moment in which

indexes and card catalogues were celebrated for their potential to set knowledge free and even foster world peace. Interest in altmetrics has grown alongside widespread fascination with the potential of online platforms to make scientific communication both more open and more democratic.

At a time when the public status of the scientific expert is becoming increasingly uncertain, these questions are more important than ever. In a democracy, the procedures by which we decide what constitutes valuable scientific knowledge fundamentally depend on public conceptions of the aims of the scientific enterprise.

The question of whether new metrics might one day replicate the results of peer review (when it is working well) is a red herring. How we choose to judge what constitutes good science is just as important as the end results of those judgements. Even algorithms have politics.

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Further reading

Csiszar, A. *Br. J. Hist. Sci.* **50,** 23–60 (2017).

Comments

Comments

There are currently no comments.

Indian scientists urged to speak out about pseudoscience

Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.

07 November 2017

Pallava Bagla/Corbis/Getty

Scientists taking part in India's march for science in August were protesting against the spread of anti-science beliefs, superstitions and myths.

A leading Indian science-advocacy group is urging the country’s researchers to speak out against pseudoscience, which it fears has gained a foothold in the past few years, partly through support from some agencies of the Indian

government.

The call to arms, made by the non-profit Breakthrough Science Society, comes after some members of an alumni association of the prestigious Indian Institute of Science (IISc), Bangalore, planned a workshop on astrology at the IISc for 25–26 November.

Strong backlash from scientists resulted in the event being cancelled on 28 October. The society's general secretary, Soumitro Banerjee, says that it would be "detrimental to Indian science" for researchers to remain neutral on such issues. "India's scientific community must be proactive in propagating a scientific bent of mind," says Banerjee, a physicist at the Indian Institute of Science Education and Research Kolkata.

Timeline of events

Two days before the alumni association cancelled the workshop, dozens of scientists signed letters to the IISc director, Anurag Kumar, objecting to the workshop. The IISc director and the faculty were not involved in organizing the workshop.

Muthya Ravindra, a computer scientist and president of the alumni association, says that the event, organized by one of its members, was still under discussion when "due to some miscommunications", e-mails promoting the event were sent out.

But Ravindra says that despite criticism from scientists and other academics, people widely believe in astrology and seek its advice in newspapers, magazines and on television. He is unsure what role scientists should play in educating society on the dangers such practices may have. "It is very confusing to me whether we as scientists [should] criticize or take some part in finding a solution," he says.

India's ruling party, the conservative Bharatiya Janata Party (BJP) has shown support for giving astrology a place in universities. In 2001, then-science minister of the BJP-led coalition government Murli Manohar Joshi took steps to allow public universities to include astrology classes in curricula.

However, the Indian government and science ministry did not have a role in the IISc alumni association's planned astrology workshop.

Pseudoscience debate

Alarm in the Indian scientific community over anti-science policies and programmes has been brewing for some time. Several scientists who spoke with *Nature* are reluctant to comment publicly about it for fear of jeopardizing their jobs. Others took part in the March for Science organized by the 7,000-member Breakthrough Science Society in August in around 40 Indian cities, in part to protest the government's support for ideas not yet backed by science. One area of concern, says Banerjee, is the government's push for a national research programme on the health and other benefits of a combination of five cow products, known as panchgavya.

The Indian Institute of Technology (IIT), Delhi, hosted a two-day workshop last December to discuss ways to validate research on panchgavya, which was supported by India's Department of Science and Technology, Department of Biotechnology, and Council of Scientific and Industrial research (CSIR), and inaugurated by India's science minister Harsh Vardhan.

According to IIT Delhi's website, Vardhan, who is a physician, "emphasised that use of panchgavya in practice and in daily routines will help to address the pressing global issues like climate change, resistance development, malnourishment, global health etc".

Following the workshop, India's science ministry formed a national steering committee to initiate a national programme on the topic.

Supporters of this research say that cow products should be considered part of India's vast traditional knowledge base. But critics say that such unverified theories are pseudoscience, and that singling out the benefits of cow products is part of a larger political agenda by Hindus, for whom the cow is a sacred animal.

They also argue that research on topics such as panchgavya should be handled in a neutral manner rather than as a way of promoting traditional

knowledge. Rahul Siddharthan, a computation biologist at the Institute of Mathematical Sciences in Chennai, says that the government must accept that any research involving traditional hypotheses about health could potentially refute those hypotheses. “Refutability is the essence of science,” he says.

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Comments

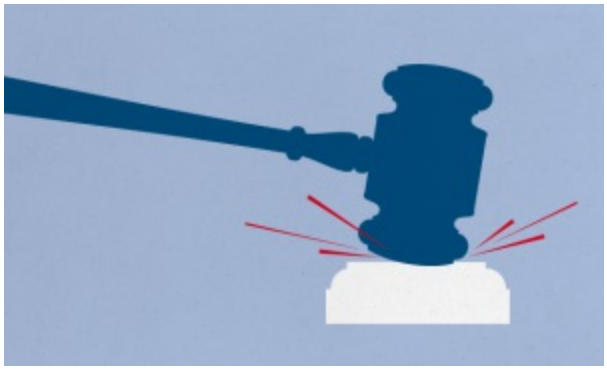
Commenting is currently unavailable.

Pirate paper website Sci-Hub dealt another blow by US courts

American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.

07 November 2017 Updated:

1. 08 November 2017



The American Chemical Society (ACS) has won a lawsuit against the pirate research-paper website Sci-Hub, over the site’s illicit use and dissemination of ACS articles.

On 3 November, a US court ordered Sci-Hub's operators to pay the ACS US$4.8 million in damages for copyright infringement and trademark violation. Sci-Hub’s owners did not appear in court to present their case.

The judge also ordered that any party “in active concert or participation” with Sci-Hub should “cease facilitating” access to the repository. This means that the ACS could request Internet services including web providers, search engines and domain-name registrars to stop linking or to block access to Sci-Hub and the various domains it is hosted under.

Which services might be approached by the ACS isn't yet clear: the meaning of the phrase "in active concert or participation with" is open to legal interpretation, says Michael Carroll, an information-justice and intellectual-property specialist at the American University Washington College of Law in Washington, DC.

There are no clear standards as to when an Internet service is in "active concert" with a pirate website, says Carroll. A user merely resolving a domain-name request to such a site, for example, does not yet qualify as active participation, he adds.

Such an order by a US court is exceptional, Carroll says. "In general, our federal courts do not have the power to issue orders against people or entities that were not part of the lawsuit." But he adds that US federal rules for civil procedures such as this do sometimes allow injunctions against persons who are in 'active participation' with an enjoined party. The current lawsuit is an example of that, he says.

The ruling is another legal blow for Sci-Hub, which provides free access to millions of paywalled research papers and is popular with researchers around the world. In June, a New York court granted the Dutch publisher Elsevier $15 million in damages from the site for large-scale copyright infringement.

But publishers are unlikely to see any money from Sci-Hub because its chief operator lives outside the United States. Alexandra Elbakyan, a former neuroscientist who created the portal in 2011, says the court order is an example of censorship.

The ACS, which filed its lawsuit in June in a Virginia court, said in a statement on 6 November that the ruling was "a victory for copyright law and the entire publishing enterprise". An analysis published in August estimated that as of March 2017, Sci-Hub's database contained 69% of the world's roughly 81.6 million scholarly articles — and 98.8% of the ACS's journal content.

The ACS says that it will now seek to enforce the court's order. Asked for comment, the society referred *Nature*'s news team to its statement. But Internet service providers are expected to resist what they may perceive as

undue censorship.

Attempts to stop people visiting Sci-Hub face another hurdle, too: the site has an alternative address that can be reached by users of the Tor network, a group of servers that encrypts Internet traffic and disguises its origins. No Internet provider can easily block access to such sites.

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Updates

Updated:

The story has been updated with comments from Alexandra Elbakyan.

Comments

Commenting is currently unavailable.

Genetically modified apple reaches US stores, but will consumers bite?

Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.

07 November 2017 Corrected:

1. 10 November 2017

Okanagan Specialty Fruits, Inc.

The apple on the right doesn’t bruise when dropped — it lacks a gene encoding an enzyme that causes plant cells to brown on exposure to oxygen.

This month, bags of sliced apples will hit grocery-store shelves in the midwestern United States for the first time. Shoppers who purchase the

apples can leave the slices out for snacking, because of a feat of genetic engineering that prevents their flesh from browning when exposed to air.

The ‘Arctic apple’ is one of the first foods to be given a trait intended to please consumers rather than farmers, and it joins a small number of genetically modified organisms (GMOs) to be sold as a whole product, not an ingredient. Since Okanagan Specialty Fruits in Summerland, Canada, planted its first test apples in 2003, the array of foods modified in labs has expanded to include meatless burgers, made with soya protein produced by recombinant yeast, fish fillets grown from seafood stem cells, and mushrooms whose genomes have been edited with CRISPR technology. Most of these items have not yet reached the market.

Now, many small biotechnology companies developing such foods are watching the Arctic apple’s launch, eager for clues to how consumers will perceive the fruits of their labour.

“If the apple sells, it will pave the way for others,” says Yinong Yang, a plant pathologist at Pennsylvania State University in University Park, who used CRISPR to engineer a mushroom that resists browning. He hopes one day to license his mushroom to commercial growers.

Mary Maxon, who oversees biosciences programmes at Lawrence Berkeley National Laboratory in California, agrees. “The apple is not the first GMO that people would eat, but it’s the first one that consumers may value,” she says.

When Okanagan co-founder Neal Carter bought an orchard in 1995, he thought hard about how to win over the US snack market. He found his answer in Australia, where researchers at the Commonwealth Scientific and Industrial Research Organisation had figured out how to delete a gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives.

Only later did he realize that if consumers were to be enticed to buy, Americans’ distrust of GMOs would need to be overcome. Okanagan’s subsequent surveys of people in America’s top apple-growing states — New

York and Washington — revealed that about 20% were wary of GMOs. But the company also found that many people changed their minds when told that the apples were engineered to silence browning genes, and then tested for safety.

Mike Seldon, the co-founder of Finless Foods, a firm in New York City that is developing fish fillets from fish stem cells, agrees that providing more information helps to win over consumers. “We’re not going to repeat the mistakes of the GMO industries in the past, and just put foods on the market without public conversation,” he says. “If we do, you can expect a backlash — and that’s warranted.”

Seldon sees a parallel between the Arctic apple and his fillets: both were created with attributes to please consumers. Finless Foods, which has made prototypes of bluefin-tuna fillets, hopes that people will be won over by the idea of eating fish without worrying about overfishing, animal slaughter or environmental pollution.

But others say that Okanagan hasn’t gone far enough in telling consumers how its apple was made. The company does not mention GMOs on the apples’ bags; instead, the bags have a QR code — which links to online information when it is scanned by a smartphone. “Not everyone has a smartphone, and even if you have one, are you going to check every item with it?” says Bill Freese, a science-policy analyst at the Center for Food Safety, an advocacy group in Washington DC. He wants the apples to be clearly labelled as GMOs.

Consumer reaction isn’t the only concern for developers of genetically engineered or other lab-made foods who want to sell their wares in the United States. One major stumbling block is the US regulatory process, which involves a complicated tangle of federal agencies — and, for many companies, an unclear path forward. US regulators assessed the Arctic apple for five years before approving it for sale, but spent just two years reviewing a non-browning GM potato developed by agricultural firm J. R. Simplot of Boise, Idaho.

Then there is the case of the CRISPR mushroom. The US Department of Agriculture (USDA) said in 2016 that it would not evaluate the mushroom,

which was created by using CRISPR to delete a gene. That seemed to clear the fungus's path to the market. But Yang says that, after *Nature*'s news team reported on the USDA's decision, the US Food and Drug Administration contacted him to ask whether it could review the mushroom. "I agreed to that since it would give consumers a peace of mind," he says.

As far as investors are concerned, regulatory uncertainty may be less of a barrier to the success of engineered foods than customer uncertainty. James Hardiman, a partner at the venture-capital fund Data Collective in San Francisco, California, says that companies developing such foods can always build a few extra years into their long-term plans, to account for twists in the regulatory process. "The public narrative is much more difficult to control," he says. "We know the public can be irrational."

Still, Carter is optimistic about how his Arctic apple will be received. "We rarely get e-mails saying we are Satan any more," he says of his company. "Now we have people asking where they can buy the apples."

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Corrections

Corrected:

An earlier version of this story stated that Carter took over his family's orchard.

Comments

Commenting is currently unavailable.

US government approves 'killer' mosquitoes to fight disease

US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.

06 November 2017

Dennis Kunkel Microscopy/SPL

The lab-grown mosquitoes developed by MosquitoMate seek to eliminate the disease-carrying Asian tiger mosquito (*Aedes albopictus*, shown here).

The US Environmental Protection Agency (EPA) has approved the use of a common bacterium to kill wild mosquitoes that transmit viruses such as dengue, yellow fever and Zika, *Nature*'s news team has learned.

On 3 November, the agency told biotechnology start-up MosquitoMate that it could release the bacterium *Wolbachia pipientis* into the environment as a tool against the Asian tiger mosquito (*Aedes albopictus*). Lab-reared mosquitoes will deliver the bacterium to wild mosquito populations.

The decision — which the EPA has not formally announced — allows the company, which is based in Lexington, Kentucky, to release the bacteria-infected mosquitoes in 20 US states and Washington DC.

“It’s a non-chemical way of dealing with mosquitoes, so from that perspective, you’d think it would have a lot of appeal,” says David O’Brochta, an entomologist at the University of Maryland in Rockville.“I’m glad to see it pushed forward, as I think it could be potentially really important.”

MosquitoMate will rear the *Wolbachia*-infected *A. albopictus* mosquitoes in its laboratories, and then sort males from females. Then the laboratory males, which don’t bite, will be released at treatment sites. When these males mate with wild females, which do not carry the same strain of *Wolbachia*, the resulting fertilized eggs don’t hatch because the paternal chromosomes do not form properly.

The company says that over time, as more of the *Wolbachia*-infected males are released and breed with the wild partners, the pest population of *A. albopictus* mosquitoes dwindles. Other insects, including other species of mosquito, are not harmed by the practice, says Stephen Dobson, an entomologist at the University of Kentucky in Lexington and founder of MosquitoMate.

Production challenges

The EPA restricted the release of MosquitoMate’s product, called ZAP males, to 20 states and Washington DC. The agency has previously said that those places “are similar in temperature and precipitation to areas where efficacy of the ZAP males was tested” — Kentucky, New York and California. The EPA decision excludes much of the southeastern United

States, which is home to dense populations of mosquitoes and a long mosquito season, because MosquitoMate did not conduct field trials there.

MosquitoMate plans to begin selling its mosquitoes locally, in Lexington, and will expand from there to nearby cities such as Louisville, Kentucky, and Cincinnati, Ohio. The company will work with homeowners, golf courses, hotels and other customers to deploy its insects, according to Dobson. “Now the work starts,” he says.

The company will have to start small. Suppressing the mosquito population of an entire city is likely to require the weekly production of millions of these mosquitoes. To reach that level, Dobson’s company must find a way to efficiently separate male mosquitoes from females. The company’s technicians now separate them both by hand and mechanically, Dobson says.

Another group that is also developing mosquitoes infected with *Wolbachia* to control wild populations has succeeded in producing large quantities of their insects. Researchers from Sun Yat-sen University in Guangzhou, China, and Michigan State University in East Lansing say they are releasing 5 million *Wolbachia*-infected *A. albopictus* each week in Guangzhou.

The scientists use mechanical sorters to separate males from females, on the basis of size differences at the pupal stage, at more than 99% efficiency, says Zhiyong Xi, a medical entomologist and microbiologist at Michigan State University, who leads the project. They expose the remaining mosquitoes to X-ray radiation at a dose that sterilizes any remaining females, but is too low to affect the males.

Looking ahead

Using lab-grown mosquitoes to kill mosquito pests has been tested extensively in Brazil in recent years. The country has allowed large-scale releases of such mosquitoes in response to an epidemic of the Zika virus that began in 2015. Zika is a mosquito-borne virus that has been linked to severe birth defects, such as abnormally small heads — a condition known as microcephaly. *Aedes aegypti* mosquitoes are thought to be the primary vector

for the virus.

One type of mosquito being tested in Brazil is a genetically modified variety of *A. aegypti* developed by Oxitec in Milton, UK. When the modified male mosquitoes mate with wild females, they pass a lethal gene on to any progeny.

Oxitec has run into challenges when attempting to test its GM mosquitoes in the United States, however. A community in the Florida Keys voted last year against allowing Oxitec to conduct field trials there, although the rest of the county in which the community is located voted in favour of the plans.

By contrast, MosquitoMate has developed and tested a variety of *Wolbachia*-carrying *A. aegypti* mosquitoes in the Florida Keys and Fresno, California, without drawing much public attention. The EPA received only 14 comments during the public-comment period for the Florida trials, and most of them were positive. The company plans to submit an application to the EPA for nationwide release of that species, says Dobson.

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Comments

Commenting is currently unavailable.

Language patterns reveal body's hidden response to stress

Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

06 November 2017

Carlo Allegri/Getty

Listen in: the words people say may reveal the body's biological response to threat.

Subtleties in the language people use may reveal physiological stress.

Psychologists found that tracking certain words used by volunteers in randomly collected audio clips reflected stress-related changes in their gene expression. The speech patterns predicted those physiological changes more

accurately than speakers' own ratings of their stress levels.

The research, which is published on 6 November in *Proceedings of the National Academy of Sciences*[1] suggests that changes in language may track the biological effects of stress better than how we consciously feel. It's a new approach to studying stress, says David Creswell, a psychologist at Carnegie Mellon University in Pittsburgh, Pennsylvania, and one that "holds tremendous promise" for understanding how psychological adversity affects physical health.

Adverse life circumstances — such as poverty, trauma or social isolation — can have devastating effects on health, increasing the risk of a variety of chronic disorders ranging from heart disease to dementia. Researchers trying to pin down the biological mechanisms involved have found that people who experience these circumstances also undergo broad changes in gene expression in the cells of their immune system. Genes involved in inflammation become more active, for example, and antiviral genes are turned down.

These biological changes seem to represent the body's evolutionary response to threat, says Steve Cole, a genomicist at the University of California, Los Angeles, and a co-author on the paper. But he was always troubled by a "nagging observation": they don't tally well with how stressed people say they are.

Cole wondered whether stress biology is triggered instead by an automatic assessment of threat in the brain, which doesn't necessarily reach conscious awareness. To find out, he and his colleagues teamed up with Matthias Mehl, a psychologist at the University of Arizona, Tucson, who studies how stress affects language.

Stress on speech

The researchers asked 143 adult volunteers in the United States to wear audio recorders, which switched on every few minutes for two days, capturing a total of 22,627 clips. Mehl transcribed any words spoken by the volunteers,

and analysed the language they used.

He was particularly interested in what psychologists call 'function' words, such as pronouns and adjectives. “By themselves they don’t have any meaning, but they clarify what’s going on,” says Mehl. Whereas we consciously choose 'meaning' words such as nouns and verbs, researchers believe that function words “are produced more automatically and they betray a bit more about what’s going on with the speaker”. Mehl and others have found, for example, that people’s use of function words changes when they face a personal crisis or following terrorist attacks.

The researchers compared the language used by each volunteer with the expression in their white blood cells of 50 genes known to be influenced by adversity. They found that the volunteers’ use of function words predicted gene expression significantly better than self-reports of stress, depression and anxiety.

People with more stressed-out gene-expression signatures tended to talk less overall. But they used more adverbs such as 'really' or 'incredibly'. These words may act as “emotional intensifiers”, says Mehl, signifying a higher state of arousal. They were also less likely to use third-person plural pronouns, such as 'they' or 'their'. That makes sense too, he says, because when people are under threat, they may focus less on others and the outside world.

He cautions that more research is needed to test these specific effects, and to assess whether stress influences language, or vice versa. But he suggests that the approach could ultimately help to identify people at risk of developing stress-related disease. Doctors may need to “listen beyond the content” of what patients tell them, he says, “to the way it is expressed”.

Cole suggests that assessing language use could help to test whether interventions aimed at reducing stress really work. Perhaps “you could even ditch self-report stress measures”, he says, and instead listen passively to how trial participants speak.

“Language reflects how people connect with their world, but who would ever have thought that gene expression would be related to language?” says James

Pennebaker, a psychologist at the University of Texas, Austin, who has pioneered research on language and social processes (and has previously worked with Mehl). “It’s such an exciting new way of thinking,” he adds. “I was blown away.”

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Comments

Comments

There are currently no comments.

Nature News

周日, 19 11月 2017

Nature News

[周日, 19 11月 2017]

- **Nature News**

Nature News

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Giant telescope’s mobile-phone ‘dead zones’ rile South African residents

Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.

17 November 2017

Mujahid Safodien/AFP/Getty

South Africa has already built prototype dishes that will form part of the Square Kilometre Array, which will be the world’s largest radio telescope.

A map showing how mobile-phone use might be restricted because of a giant

radio telescope in South Africa has angered people who will live near the instrument — deepening a rift between the local farming community and those backing the project.

The row has arisen over the South African portion of the Square Kilometre Array (SKA), which will eventually consist of thousands of radio dishes in Africa and up to a million antennas in Australia. The array, which begins construction in 2019 for completion in the 2030s, will have a total signal-collecting area of more than 1 square kilometre, making it the world's largest radio telescope. The telescope's first phase in South Africa involves 194 radio dishes, to be laid out like a galaxy with three arms spiralling out from a core cluster.

Local residents in the Northern Cape province, where the government has acquired nearly 1,400 square kilometres of land for the initial phase, have already expressed concerns about the telescope. Some are angry that the SKA won't boost the region's economy as much as they had expected; others fear the land acquisition will damage local agricultural activity — in particular, sheep farming.

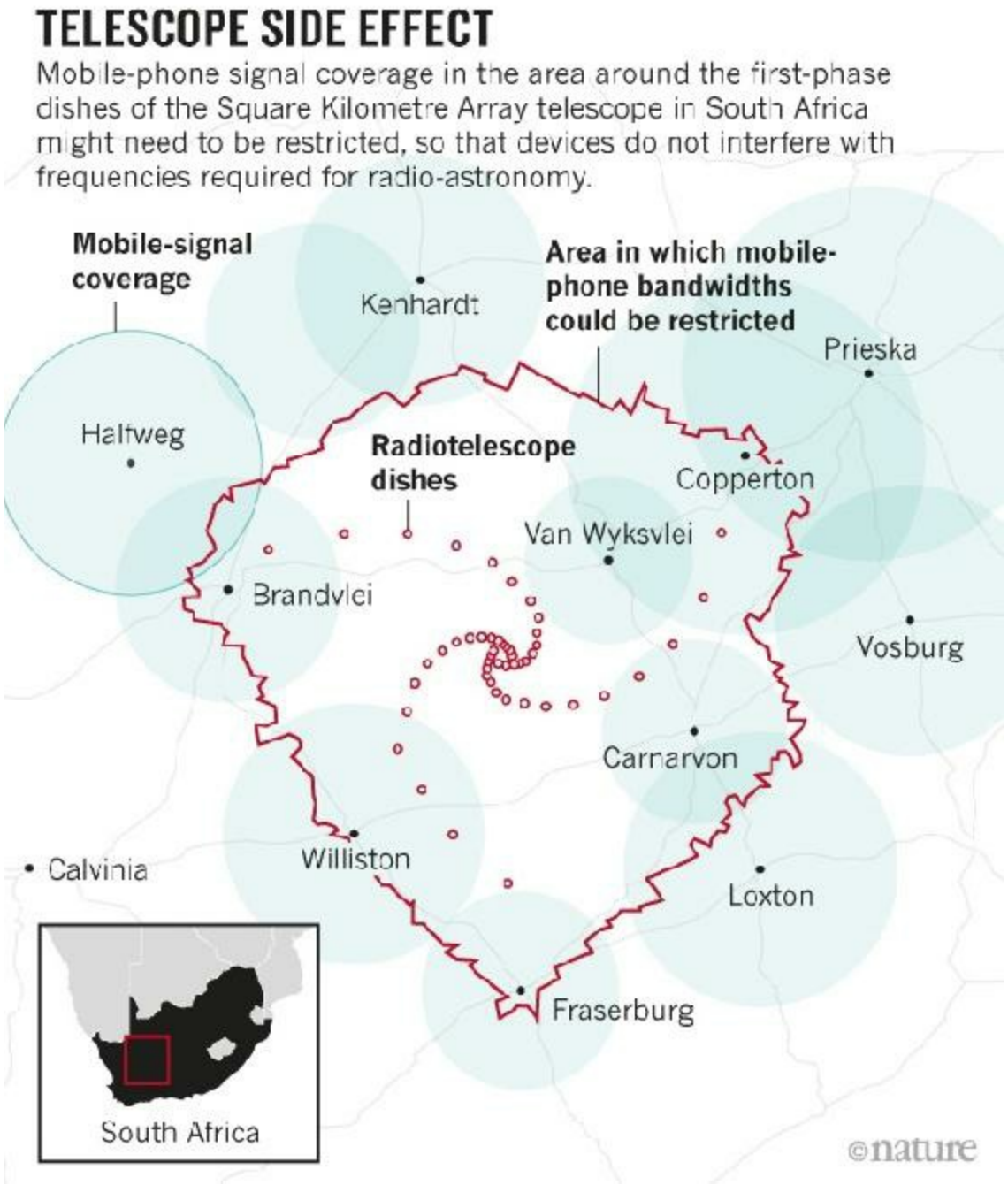
But the map of projected mobile-phone coverage around the project, uploaded to Facebook on 2 November, has brought to light another problem facing the local community. It shows the area around the SKA's radio dishes where the use of electronic devices will eventually be restricted, because their signals would interfere with the relatively weak radio signals that the dishes will try to pick up from the distant Universe.

Communications problem

Nearby residents had been aware that mobile-reception 'dead zones' could be a side effect of the SKA. But Eric Torr, a light-aircraft-business owner who uploaded the map, says it shows the area affected is "larger than we were led to believe". The map suggests that six towns fall into the dead zone, he says, and that this could have serious implications for their farming economies.

The map was produced by the South African Radio Astronomy Observatory

(SARAO), which is leading the SKA project in South Africa. Lorenzo Raynard, head of communications at the SARAO, says it shows areas where mobile-phone coverage could be reduced by 20% or more (see ‘Telescope side effect’). The chart was part of a presentation calling on businesses to submit alternative communications solutions for affected areas, he says.



Adapted from SARAO map

An informal collection of farming organizations has already been working with the observatory to find alternative communications technologies, such as satellite phones, that can be used around the antennas, according to Henning Myburgh, a farmer in the area. “Adequate electronic communications, especially for children, are a basic human right,” he says. Myburgh says that the cooperative’s search has now moved to finding cell-phone technologies that can co-exist with the SKA and replicate the phone facilities the farmers currently have. “This is a major shift and if possible will be a huge step forward,” he says.

Still, says Myburgh, there are farmers who are unhappy. “I don't think that anybody will ever be happy with the situation, taking into account the massively intrusive nature of the project in the region,” he says.

Nicol Jacobs, who farms in the spiral arms, says the SKA was originally going to affect only two farms. He says he found out about the full extent of the telescope when the government began buying more farms. “We’re going to be eaten piece by piece,” he says. Jacobs says he would like the government to return the bought farms to the agricultural community: “I will fight as long as I can,” he adds.

Despite residents’ annoyance, South African law says that the country’s science and technology minister can preserve the area of the SKA’s land for astronomy. The department of science and technology, which oversees astronomy in the country, is responsible for finalizing regulations about areas that will lose mobile-phone coverage, and to define radio-wave frequencies that will be protected for astronomy. Asked when they would be finalized, the department’s astronomy-management authority declined to give a firm date.

Environmental assessment

Although resident’s complaints may not affect the SKA’s layout, an environmental assessment — due to be finalized next year — could change matters.

Earlier this month, the SARAO tasked the South African Environmental Observation Network to implement an environmental assessment of the telescope site, and made 3 million rand (US$209,000) available for the work.

“The relative position of the dishes determines the quality of the telescope beam,” says Robert Braun, science director at SKA Organisation, which is designing the telescope.

The organization has drawn up an ideal map of dish positions, says Braun. But it might have to shift them if the environmental assessment finds that local habitats or biomes are affected, says Casper Crous, an ecologist who is part of the assessment collaboration.

The overarching plan is to turn South Africa’s SKA site into a nature reserve and a site for long-term environmental research once the telescope is operational, says Crous. So a no-go zone for dishes, for example, “would be kokerboom [quiver tree] populations or ephemeral wetlands — areas that if impacted are unlikely to ever recover,” he says.

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Comments

Comments

There are currently no comments.

Sex matters in experiments on party drug — in mice

Ketamine lifts rodents' mood only if administered by male researchers.

17 November 2017

unoL/Getty

When it comes to lab mice and antidepressants, it's complicated.

Mouse experiments with the popular club drug ketamine may be skewed by the sex of the researcher performing them, a study suggests.

The findings, presented on 14 November at the Society for Neuroscience (SfN) meeting in Washington DC, only deepen the mystery of how ketamine,

which has powerful mood-lifting properties, interacts with the brain. They also raise questions about the reproducibility of behavioural experiments in mice.

Ketamine is best known as a psychoactive recreational drug. But it has caught psychiatrists' interest because of its potential to treat depression within hours. It's unclear exactly how the drug works, however, and many researchers are using animal models to suss out the mechanism.

Polymnia Georgiou, a neuroscientist at the University of Maryland in Baltimore, is one of them. In 2015, a male colleague asked her to run some experiments for him while he was out of town, including a standard way of testing antidepressants called the forced-swim test. In this assay, researchers inject healthy mice with a drug, place them into a tank of water and measure how long they swim before they give up and wait for someone to rescue them.

Antidepressants can cause healthy mice to swim for longer than their untreated counterparts, which is what Georgiou's male colleague found during his experiments using ketamine.

Scents and the brain

But although Georgiou followed his protocol exactly, she found that treated mice did not swim for any longer than mice injected with a placebo. When she and three female and four male researchers investigated this disconnect by performing the experiments, they discovered that the ketamine acted as an antidepressant only when it was administered by men.

Suspecting that scent was involved, the researchers put the animals inside a fume hood so that the mice couldn't smell who was injecting them. This completely eliminated the effect of the ketamine, regardless of the experimenter's sex. When Georgiou and her colleagues placed a t-shirt worn by a man next to the mice in the fume hood, mice injected with ketamine swam for longer than those injected with a placebo. This suggested that male odour was necessary for the drug to work.

The head of Georgiou's lab, neuroscientist Todd Gould, learned that antidepressant researcher Ronald Duman at Yale University in New Haven, Connecticut, was seeing similar effects with female researchers in his lab that were working on ketamine experiments. So Gould asked Duman to repeat Georgiou's swim-test experiment in his own lab. When eight male and eight female researchers injected mice with ketamine, they saw the same results: mice injected by women did not respond to the drug.

Georgiou and her colleagues repeated the experiments with other antidepressants, but the researchers' sex didn't seem to matter. She and Gould suspect that the antidepressant effect is the result of a specific interaction between ketamine and the male odour in the mouse brain .

But other evidence suggests that the sex of the researcher can affect other types of behavioural experiment, not just those involving ketamine. A 2014 paper[1] in *Nature Methods* found that mice were more stressed and less likely to respond to pain when handled by a male researcher. And behavioural neuroscientist Silvana Chiavegatto of the University of São Paulo in Brazil, who was at Georgiou's SfN presentation, says that she has seen the same phenomenon in her lab, where she studies depression but doesn't use ketamine.

Rethinking the model

"I think it's really fascinating, with wide implications for our field," says Adrienne Betz, a behavioural neuroscientist at Quinnipiac University in Hamden, Connecticut. But she cautions that the results are preliminary, and it remains to be seen whether the effect is specific to ketamine and to mice.

Others disagree about the potential implications. Hundreds of papers with female experimenters demonstrate the effects of antidepressants — including ketamine — in mice, says Lisa Monteggia, a neuroscientist at the University of Texas Southwestern in Dallas. Other factors, such as whether the researcher is stressed when he or she injects the mice, might affect the animals' behaviour, she says.

Gould and Georgiou say that their results don’t necessarily invalidate previous studies; they simply show that ketamine experiments in their lab work only when men inject the mice. There is overwhelming evidence that ketamine is a powerful antidepressant in humans. Gould doubts that the sex of the person administering the drug affects how well it works in a depressed patient, but it's never been tested.

He adds that the findings suggest that researchers studying drugs' effects on mouse behaviour should report the sex of the experimenter in their publications to ensure that other labs can replicate the results. “There are a number of factors that influence replicability and are unrecognized — this is one of them,” Gould says. “For us, it is an inconvenient truth.”

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Comments

Comments

There are currently no comments.

Arecibo telescope wins reprieve from US government

National Science Foundation will look for partners to provide extra financial support for Puerto Rico facility.

16 November 2017 Updated:

1. 17 November 2017

Xavier Garcia/Bloomberg/Getty

The massive dish of the Arecibo radio telescope measures 305 metres across.

Nearly two months after Hurricane Maria devastated Puerto Rico, the people

who operate one of the world's pre-eminent radio telescopes — at the Arecibo Observatory, on the northwestern part of the island — are still without reliable water, electricity and phone service at their homes. But their jobs seem to be safe.

The US National Science Foundation (NSF), which funds about two-thirds of the observatory's annual US$12-million budget, has decided to continue operating it in collaboration with as-yet-to-be-decided partners. Over the next 5 years, the agency will reduce its annual contribution from $8.2 million to $2 million, with the rest coming from the unspecified partner institutions.

"This is very good news for the Arecibo Observatory and a huge win for the scientific community in general," says Francisco Córdova, the observatory's director. "There is definitely a sense of relief in the air."

The decision comes as part of the NSF's years-long effort to offload several of its astronomical research facilities to free up millions of dollars each year for future projects, such as the Large Synoptic Survey Telescope that is under construction in Chile.

"We have worked very hard to help bring Arecibo to a state where we still have cutting-edge research there, but with NSF not having to make the same investment that we've made historically," says James Ulvestad, acting assistant director for the agency's mathematical- and physical-sciences directorate.

The current management contract at the observatory will expire on 31 March 2018. Earlier this year, the NSF asked potential partners to come forward with ideas and funding offers to keep science operations going. Now, having made its commitment to continue funding the observatory official, the NSF can move forward with negotiating a collaboration agreement and revealing who its partners will be.

"I'm so happy they made the right decision," says Edgard Rivera-Valentín, a planetary scientist who works jointly at the observatory and the Lunar and Planetary Institute in Houston, Texas. "I'm so happy the observatory stays alive."

Slow recovery

The agency's decision is a welcome reprieve for the roughly 120 Arecibo staff who have suffered and rallied in Maria's wake. Hurricane-force winds blasted Puerto Rico on 20 September, downing power lines and damaging buildings across the island. Torrential rains washed out roads and knocked out water supplies.

At the observatory, which is nestled into the limestone mountains above the city of Arecibo, some of the staff sheltered in place during the worst of Maria. The observatory's concrete bunkers, built by the US government in 1963, weathered the storm with little problem. Still, Maria's winds tore down the 29-metre-long 'line feed' antenna that stretched across the observatory's 305-metre-wide dish, puncturing its aluminium skin in places.

Staff went to work helping to clear roads around the region, and government officials used the observatory's helipad as a distribution point for supplies. The facility's deep well supplied hundreds of local residents who had no other source of clean drinking water.

Within weeks, the Arecibo dish was cleaned up and back to doing science. On 29 September, it resumed taking observations, in a low-power mode that lets the sky drift across the field of view; on 7 November, it resumed pointing the dish at specific areas of the sky. The telescope has already observed a fast radio burst, one of a new class of astronomical phenomena that Arecibo is well suited to study with its enormous dish. Last week, the observing schedule expanded to include work at additional radio frequencies, Córdova says.

But telescope operations are still running off generators, and diesel is a precious commodity on the island, says Nicholas White, senior vice-president for science at the Universities Space Research Association in Columbia, Maryland, which helps to manage the observatory. "That's the biggest constraint — just getting back on the grid," he says.

Without a reliable power supply, the observatory cannot restart its planetary radar, which tracks and characterizes near-Earth asteroids. NASA supplies

$3.7 million — about one-third of Arecibo's budget — for this work.

The NSF estimates that it will take between $4 million and $8 million to fix the hurricane damage at the observatory, Ulvestad says. The agency "intends to repair Arecibo to its pre-hurricane condition", he says.

A long history

The NSF decision makes Arecibo the first of the agency's astronomical facilities to have completed a full environmental-impact review of its operations, with an eye towards divestment. The agency is working through a similar process to potentially divorce itself from the Green Bank Observatory in West Virginia, home to the world's premiere single-dish radio telescope, and several other observatories.

Arecibo occupies a unique place in the history of radio astronomy. On 16 November 1974, it beamed the most powerful intentional message ever sent in the hope of contacting extraterrestrial life. In the same year, it was used in the discovery of the first known binary pulsar, whose change in orbital period provided the first indirect evidence for gravitational waves — the ripples in space-time predicted by Albert Einstein.

"People have been telling us for five years: 'You guys are just out to close Arecibo,'" says Ulvestad. "This is a demonstration that that was not what we were ever out to do."

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Updates

Updated:

Added comments from Francisco Córdova.

Comments

Comments

There are currently no comments.

Improved diagnostics fail to halt the rise of tuberculosis

TB remains a big killer despite the development of a better test for detecting the disease.

16 November 2017 Corrected:

1. 17 November 2017

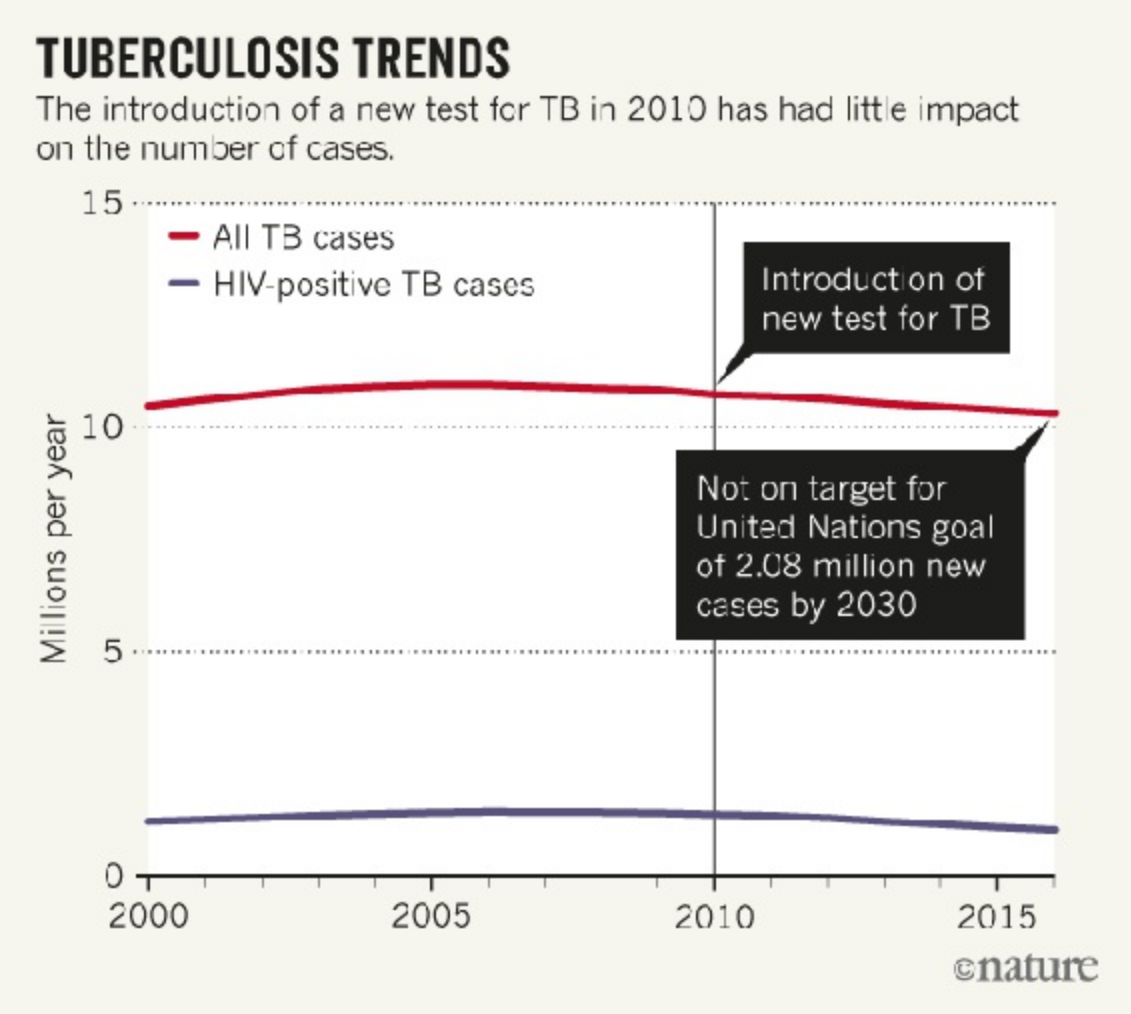
Beawiharta/Reuters

Newly diagnosed tuberculosis patients are treated at a clinic in Jakarta, Indonesia.

Seven years ago, the global community of researchers, health-care workers and activists battling tuberculosis was euphoric. A landmark 2010 trial showed that a new genetic test was highly effective at diagnosing TB, prompting hopes that countries could soon finally control the disease, which killed 1.45 million that year. The World Health Organization (WHO), promptly endorsed the test, called GeneXpert, and promoted its roll-out around the globe to replace a microscope-based test that missed half of all cases.

But the high hopes have since crashed as rates of tuberculosis rates have not fallen dramatically, and nations are now looking to address the problems that cause so many TB cases to be missed and the difficulties in treating those who are diagnosed. In an attempt to turn the tide, health ministers and officials from 100 countries are meeting in Moscow on 16–17 November. And a United Nations General Assembly devoted to TB is scheduled for September 2018. Experts say that the rollout of GeneXpert offers a cautionary lesson — although, in hindsight, an obvious one — in the battle against TB. The tale is a familiar one in global health care: a solution that seems extraordinarily promising in the lab or clinical trials falters when deployed in the struggling health-care systems of developing and middle-income countries.

“What GeneXpert has taught us in TB is that inserting one new tool into a system that isn’t working overall is not going to by itself be a game changer. We need more investment in health systems,” says Erica Lessem, deputy executive director at the Treatment Action Group, an activist organization in New York City.



Source: WHO

No game changer

Some 10.4 million people were infected with TB last year, according to a WHO report published on 30 October. More than half of the cases occurred in China, India, Indonesia, Pakistan and the Philippines. The infection, which causes coughing, weight loss and chest pain, often goes undiagnosed for months or years, spurring transmission. The US government and others spent more than US$100 million developing GeneXpert. Yet despite the WHO's ringing 2010 endorsement of the test, the roll-out of GeneXpert, which is manufactured by Cepheid, a company based in Sunnyvale, California (and

bought by Danaher, headquartered in Washington DC, earlier this year), was initially slow.

The machines cost $17,000 each and require constant electricity and air-conditioning — infrastructure that is not widely available in the TB clinics of countries with a high incidence of the disease, requiring the machines to be placed in central facilities. Until the US government together with the Bill & Melinda Gates Foundation and UNITAID, an international organization that aims to lower drug prices, began subsidizing tests in 2012, each cost $16.86 (the price fell to $9.98), compared with a few dollars for a microscope TB test.

Weak health systems

The WHO says that more than 23 million GeneXpert tests have now been purchased in the public sector in 130 countries that are eligible for the discount. But Madhukar Pai, an epidemiologist at McGill University in Montreal, Canada, says that this still represents a relatively small proportion of people suspected of having TB. Most countries use the tests on selected group of people, Pai says. India, for example, offers the test only to people co-infected with HIV.

Even countries that fully embraced GeneXpert are not seeing the returns they had hoped for. After a countrywide roll-out begun in 2011, the test is available for all suspected TB cases in South Africa. But a randomized clinical trial conducted in 2015 during the roll-out found that people diagnosed using GeneXpert were just as likely to die from TB as those diagnosed at labs still using the microscope test[1]. “Just intuitively one would think that finding TB cases earlier would avert TB deaths. The fact that we didn’t find that was surprising,” says Gavin Churchyard, a physician specializing in TB at the Aurum Institute in Johannesburg, South Africa, who led the study. Similar studies in other countries have come to much the same conclusion about GeneXpert.

Churchyard suspects that doctors have been giving people with TB-like symptoms drugs, even if their microscope test was negative or missing, and

that this helps to explain why his team found no benefit from implementing the GeneXpert test. Others have speculated that, by being involved in a clinical trial, patients in both arms of the trial received better care than they would otherwise have done, obfuscating any differences between the groups.

Either way, Churchyard says, his team's study illustrates how broken South Africa's TB treatment system is, a problem echoed across other countries with high incidences of TB. Even with accurate tests, cases are still being missed. Results from the GeneXpert tests take just as long to deliver as microscope tests, and many people never return to the clinic to get their results and drugs; those who begin antibiotics often do not complete the regimen. "What the study really unmasked was that it's not enough to have new technology and introduce it into a weak health system," Churchyard says.

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Corrections

Corrected:

An earlier version of this story have the wrong citation for the 2015 trial.

Comments

Comments

There are currently no comments.

What countries' constitutions reveal about how societies evolve

Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.

16 November 2017

Bettmann/Getty

The right to form unions usually came before child labour protections in a country's constitution.

Timing can be everything when it comes to successfully expanding constitutional rights. Now, a study[1] looking at how constitutions around the world have evolved has revealed patterns that could help people predict the best moment to introduce such changes.

Amendments are generally introduced into a country's constitution in a certain sequence, the authors report in a paper on the preprint server arXiv, and now under review at a journal. In addition, their computer analyses corroborate previously proposed ideas that the addition of some provisions is heavily influenced by the zeitgeist — the dominant social mores of the time — whereas the adoption of others reflects a country's colonial history.

The study validates computational techniques that could be applied to pressing questions about how constitutions reflect and affect societies, says Mila Versteeg, a legal scholar at the University of Virginia in Charlottesville. "These methods might be able to move the ball if applied to the right questions," she says.

Organizations and advocates could use the results to push for policies in a more strategic way, say the paper's authors. "This can be seen as a road map to help get you to where you want to be," says lead researcher Alex Rutherford, a data scientist who was working at the United Nations children's agency UNICEF in New York City when the study was conducted.

The ties that bind

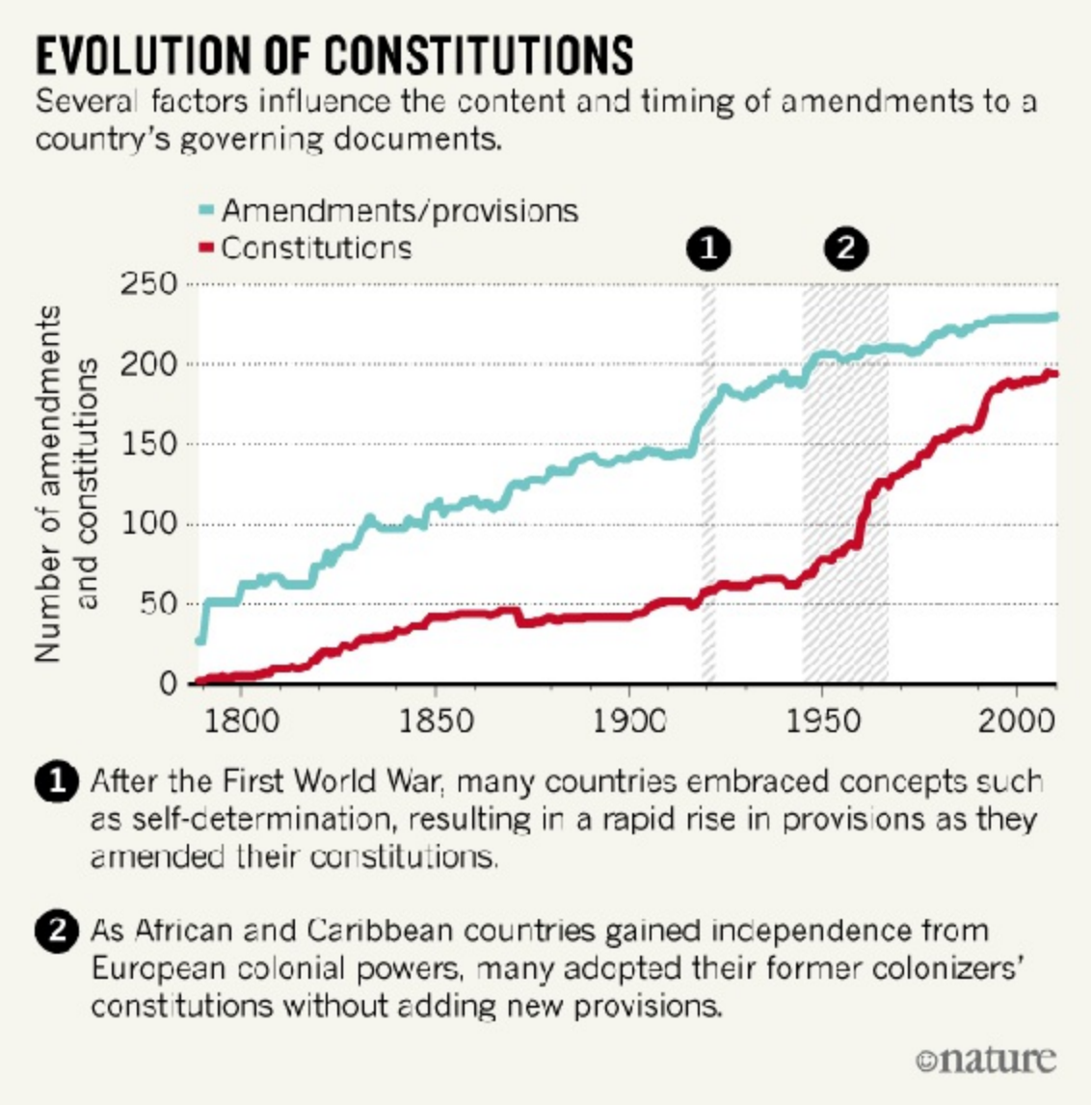
Rutherford and his colleagues used two kinds of computer analyses to look for patterns in provisions from the constitutions of 194 countries. In one, using hand-coded text, they found that the number of provisions increased over time (see 'Evolution of constitutions'). Moreover, the team found that provisions generally appeared in a particular order. Making education compulsory, for example, was usually preceded by the establishment of a right to a free education.

Some of the sequences were less straightforward: the right to form trade unions preceded laws against child labour, for example. This progression

probably reflects the identities of the people who have traditionally scripted constitutions, says Rutherford. Adult men, for instance, seem to have considered their own protections before thinking about others, including those who were unable to push for their own rights, he says. “I think we should protect the most vulnerable first, but this paper says this is not how laws have progressed historically.”

The team then performed a network analysis to identify words that the constitutions had in common and to detect how they grouped together. In some cases, with fundamental provisions such as freedom of religion, clusters included countries that had the same former colonizers.

Meanwhile, amendments such as those prohibiting torture or protecting the environment tended to emerge at specific points in time, regardless of a country’s colonial history. “If you draft a constitution now, you’d be more likely to include a clause on the environment than you would 20 years ago, since we didn’t know much about what was going on back then,” says Rutherford.



Source: REF. 1

Seeds of the future

Constitutional specialists say the team's timeline of provisions seems to be new. "It makes intuitive sense, but I don't think anyone had tried to show it empirically," says David Law, a political scientist at Washington University in St Louis, Missouri. The indexed data that Rutherford and his colleagues used came from the Comparative Constitutions Project, a US-based non-

profit organization partnered with Google. The project hand-codes constitutional texts by turning the words into zeroes and ones.

The credibility of the network approach is boosted by the fact that the analysis of constitutional language came to similar conclusions as previous, less-automated studies. Versteeg suggests that network analysis might next be applied to questions such as what sorts of rights are not well enforced, and whether constitutions can yield subtle clues signalling that a democracy is in decline.

To get at the latter query, Versteeg suggests analysing constitutional texts from democratic countries that have altered their constitutions and become increasingly authoritarian — such as Hungary and Turkey — to find language that gives a ruler more power. Next, researchers could search for these signatures in other countries, such as the United States. “Could we tell when added rights are actually red flags bearing the signs of authoritarianism?” Versteeg asks.

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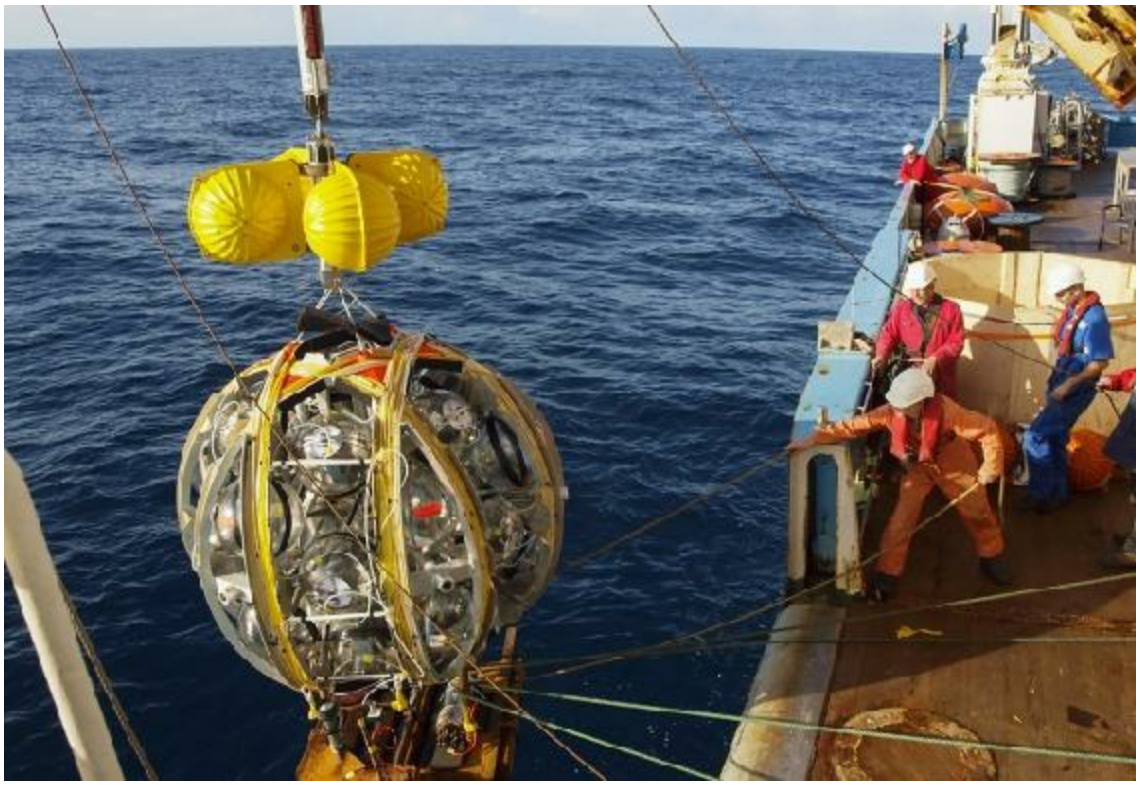
Comments

Commenting is currently unavailable.

Europe sets priorities for hunting cosmic particles

Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.

16 November 2017



KM3NeT

The KM3NeT neutrino telescope is deploying arrays of light sensors deep in the Mediterranean Sea.

Neutrinos, dark matter and γ-rays top European physicists' wish list for the next decade of efforts to catch high-energy particles from space. The

priorities are laid out in a roadmap for 2017–26, posted online last month by a group of funding agencies from fourteen European countries, ahead of being officially unveiled in January.

Twenty years ago, the field of astroparticle physics barely existed. But some of the major discoveries in particle physics — including neutrino research that earned Nobel prizes in 2002 and 2015 — are now coming from space-focused detectors, rather than through the more conventional venue of atom smashers. It's a field that ties together the largest and smallest scales of physics, says Antonio Masiero, a physicist at the University of Padua, Italy, from the expansion of the Universe to exotic types of nuclear decay: “The beauty of astroparticle physics is that it has no borders.”

The roadmap is the second such exercise by the Astroparticle Physics European Consortium (APPEC), which aims to coordinate funding plans for this fast-growing field. (CERN — Europe’s physics lab near Geneva, Switzerland — the European Southern Observatory and the European Space Agency do this for the continent’s particle-physics, astronomy and space-based facilities, respectively.) APPEC requested input from across the community, and held an open ‘town meeting’ in Paris in April 2016 before a panel of experts, chaired by Masiero, compiled the final document.

Infrastructure ideals

The resulting strategy covers huge observatories all the way down to tabletop experiments. At smaller scales, it urges funding agencies to be open to innovative proposals. But when it comes to the largest facilities, the strategy is to be “resource aware”, says Masiero: focusing on only a few projects and requiring only a modest increase over current funding levels. It’s not a “Santa Claus list”, agrees Frank Linde, a particle physicist at the Dutch National Institute for Subatomic Physics in Amsterdam and former APPEC chair.

Among the big projects endorsed by APPEC is the Cubic Kilometre Neutrino Telescope (KM3NeT), a double array of deep-sea light sensors being built by a primarily Dutch, French and Italian collaboration. One site, off the coast of Toulon, France, is designed to detect relatively low-energy neutrinos

produced by cosmic rays hitting the atmosphere, whereas the other, off the southern tip of Sicily, Italy, will aim to catch the signature of the highest-energy neutrinos coming from outer space, after they have travelled through Earth. Researchers hope to figure out where these particles come from.

So far, KM3NeT has received one third of the approximately €150 million (US$177 million) in funding it would need for building the full-size detector, says spokesperson Mauro Taiuti, a physicist at the University of Genoa, Italy. The APPEC stamp of approval could help it to win the rest.

Another major piece of infrastructure that garnered support was the Cherenkov Array Telescope, a €300-million γ-ray observatory to be split between Spain's La Palma Island and Paranal, in Chile's Atacama Desert. The two arrays of optical telescopes will seek flashes of blue light produced in the atmosphere when a high-energy photon collides with a molecule of air, creating a cascade of secondary particles across the sky.

In the nascent field of gravitational-wave astronomy, which APPEC also covers, the big priority is the Einstein Telescope (ET), a next-generation triple interferometer that will have light beams running along three 10-kilometre arms in an equilateral triangle, instead of the two perpendicular arms that current detectors use. Like the Japanese interferometer KAGRA — now under construction — the proposed ET would be built underground, to protect it from vibrations ranging from footsteps to falling leaves, says B. S. Sathyaprakash, a physicist at Pennsylvania State University in University Park, who helped to design it.

Dark-matter dash

APPEC also wants Europe to double-down on existing efforts to spot dark matter, calling for a dramatic scale-up of experiments that use tanks of liquid argon and xenon, to look for traces of collisions between these mysterious particles and atoms of ordinary matter. The largest such detectors now contain more than three tonnes of the noble gases, but according to the roadmap they need to be ten times larger.

These searches bet on the theory that dark matter is composed of weakly interacting massive particles, or WIMPs. Some physicists have called for more investment in ‘alternative’ searches for dark matter, for example, looking for particles known as axions. The road map is a “vanilla document, clearly redacted not to ruffle any feathers”, says Juan Collar, a physicist at the University of Chicago in Illinois. “If European programme managers follow this roadmap to the letter, they will turn the dark-matter field into a desert of ideas.”

But Mario Livio, an astrophysicist at the University of Nevada in Las Vegas who has also called for broadening the search for dark matter, counters that concentrating efforts on WIMPs will allow Europe “to build on existing experience and facilities”. Overall, the roadmap is “very reasonable”, he adds. “The programme, if executed as envisioned, will address some of the most exciting questions in astroparticle physics.”

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Comments

1 comment

1. *Pentcho Valev* • 2017-11-16 09:24 PM
   It seems dark matter is the unfortunate result of theoretical impotence: Cosmologists are unable to calculate the rotational curve for a system ESSENTIALLY different from our solar system, e.g. a spiral galaxy, take the solar-system rotational curve as a paradigm and fill the gap between theory and observation with dark matter. Similarly, cosmologists don't know how to model the local interaction between expansion and gravitational attraction (any such model would produce results incompatible with observations) and implicitly obey the following idiotic slogan: Wherever there is gravitational attraction, forget about expansion! Sabine Hossenfelder: "The solution of general relativity that

describes the expanding universe is a solution on average; it is good only on very large distances. But the solutions that describe galaxies are different - and just don't expand. It's not that galaxies expand unnoticeably, they just don't. The full solution, then, is both stitched together: Expanding space between non-expanding galaxies."
https://www.forbes.com/sites/startswithabang/2017/07/28/most-things-dont-actually-expand-in-an-expanding-universe/ Pentcho Valev

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Hazy skies cool down Pluto

Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.

15 November 2017

NASA/JHU-APL/SwRI

The temperature of Pluto's atmosphere is only about 70 degrees Celsius above absolute zero.

Pluto’s atmosphere is even more bone-chillingly cold than one might expect 5 billion kilometres from the Sun. New research suggests that’s because of the smog that envelops the dwarf planet.

“Haze is responsible for all the atmospheric cooling,” says Xi Zhang, a planetary scientist at the University of California in Santa Cruz. He and his colleagues describe the findings in the 16 November issue of *Nature*[1].

When NASA's New Horizons spacecraft flew past Pluto in July 2015, it discovered that the atmosphere was about -203 ºC, just 70 degrees above absolute zero[2]. That's around 30 degrees colder than predicted — and a big mystery to planetary scientists.

Figuring out how Pluto's atmosphere works is crucial for understanding atmospheres on other large icy worlds in the Solar System and beyond. "Until we know the reason for the cold temperatures, we can't extrapolate to other seasons on Pluto, much less other bodies," says Leslie Young, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, who was not involved in the study.

Smog blanket

Pluto's atmosphere is made mostly of nitrogen, with smaller amounts of compounds such as methane. High in the atmosphere — between 500 and 1,000 kilometres above the surface — sunlight triggers chemical reactions that transform some of these gases into solid hydrocarbon particles.

The particles then drift downward and, at around 350 kilometres above Pluto's surface, clump with others to form long chemical chains. By the time they reach 200 kilometres' altitude, the particles have transformed into thick layers of haze, which the New Horizons spacecraft saw dramatically blanketing Pluto.

Zhang and his colleagues compared the heating and cooling effects of the atmosphere's gas molecules to those of its haze particles. Earlier studies have suggested that the presence of gas molecules, such as hydrogen cyanide, could help explain why Pluto's atmosphere is so cold[3]. But Zhang's team found that including haze was the only way to get their model to match the temperatures that New Horizons measured as it flew by the dwarf planet.

"The fundamental difference is the size," Zhang says. Molecules are typically less than a nanometre across, whereas the haze particles are several hundred nanometres across. That means that the gas and the haze behave very differently in the way they absorb and re-radiate energy from the Sun. Haze

turns out to both heat up and cool down more efficiently than gas, Zhang says.

“It is a neat idea,” says Sarah Hörst, a planetary scientist at Johns Hopkins University in Baltimore, Maryland.

Scientists probably hadn't thought about haze as the cooling culprit before because the haze layers do not block light, says Tanguy Bertrand, a planetary scientist at the Laboratory for Dynamic Meteorology in Paris who has studied Pluto's atmosphere with his colleague François Forget[4]. “I find this study very convincing,” Bertrand says.

Competing ideas

But other researchers have proposed different ideas about why Pluto’s atmosphere is so cold. Roger Yelle, a planetary scientist at the University of Arizona in Tucson, reported one such approach at a conference in Latvia in September. His team’s model suggests that a combination of hydrogen cyanide, acetylene and ethane gas can cool things down. All three gases are known to exist in Pluto’s atmosphere.

Zhang’s team and Yelle’s team have yet to reconcile their contradictory conclusions. But after it launches in 2019, NASA’s James Webb Space Telescope could test Zhang's proposal. If the haze particles are indeed the main factor cooling Pluto’s atmosphere, they would make the dwarf planet appear relatively bright in mid-infrared wavelengths. Zhang hopes to observe Pluto with the Webb telescope to see if his team is right.

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Comments

Comments

There are currently no comments.

African scientists get their own open-access publishing platform

Venture will launch next year and seeks to strengthen continent's science by helping academics share work more quickly.

15 November 2017

Africa's academy of science has announced that it will launch an open-access publishing platform early next year — the first of its kind aimed exclusively at scientists on the continent.

The platform, called *AAS Open Research* and announced by the African Academy of Sciences (AAS) in Nairobi on 15 November, is being created with the London-based open-access publisher F1000, adopting the model of its *F1000Research* publishing platform. *AAS Open Research* will publish articles, research protocols, data sets and code, usually within days of submission and before peer review. F1000 staff will arrange post-publication peer review: the reviews and the names of their authors will be published alongside the papers. The papers will be indexed in abstract databases such as PubMed only after they pass review.

The AAS says that the platform will be especially useful for young African academics, who can face difficulties publishing in overseas journals. Some studies suggest[1] that research from low-income countries is perceived differently from that done in high-income ones, for instance. The portal will cut the time and effort scientists have to put into finding homes for their work, and will make the review process more transparent, the academy says.

Although there are already open-access publishers that focus on Africa, such as AOSIS Publishing, based in South Africa, *AAS Open Research* will be the first to adopt open peer review.

The new platform does carry a caveat, however: it will initially take submissions only from AAS fellows and affiliates (who together number around 400), as well as researchers funded through programmes managed by the Alliance for Accelerating Excellence in Africa. The Nairobi-based body manages grants for African research programmes that come from international funders, mostly targeting health research but also areas such as climate change.

Limiting eligibility to the platform is critical to ensure that submissions are of high quality, says AAS executive director Nelson Torto. Researchers who meet the initial criteria have already been vetted and selected through a rigorous grant-review process, he says. In future, to open up the platform to more researchers, the academy wants to partner with other African research funders whose selection processes are similarly rigorous, Torto adds.

Following a trend

The African venture follows a series of open publishing portals launched with F1000 in the past 18 months, including those set up by the Wellcome Trust in London and the Bill & Melinda Gates Foundation in Seattle, Washington — both large charities that fund scientific research. Research centres including the UCL Great Ormond Street Institute of Child Health and the Montreal Neurological Institute and Hospital in Canada have also teamed up with the firm; the European Commission is considering creating its own open publishing platform for outputs from its main Horizon 2020 research programme.

The AAS will not itself be covering the costs of publishing on the platform. Rather, the academy says, African researchers' grant funders will pay publishing fees directly to F1000: £120–800 (US$160–1,100) per article, depending on length.

Some scientists have raised concerns that publishing on open-research platforms might stop African academics from getting the recognition needed for career advancement that they receive for publishing in conventional journals. In South Africa, for instance, academics are rewarded for publishing

in a list of titles maintained by the country's higher-education department.

"For open publishing to be successful, it will need to be accompanied by changes in the criteria for academic recognition and promotion within African institutions of higher learning," says Salim Abdool Karim, an HIV researcher and AAS fellow in Durban, South Africa.

The risk of publishing on little-known platforms is a concern, agrees Gordon Awandare, a biochemist at the University of Ghana in Accra who will be eligible to publish on *AAS Open Research*. However, the AAS platform will help to chip away at the grip of the big journals, says Awandare, which will be good for African science. "Our approach has always been to spread our research across several platforms, so we will continue to do that."

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Comments

1 comment

1. *PROF CHUKWUEMEKA CH AGBAKWURU* • 2017-11-16 06:15 PM
   The African Scientists Open-Access Publishing Platform is a very welcomed innovation to give African Researcher (International & National) the much needed opportunity of making worthwhile intellectual contributions to African and World Development through publishing of their research studies.
   www.mastercomputeragency.net

Puerto Rico struggles to assess hurricane’s health effects

While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.

15 November 2017

Mario Tama/Getty

Hurricane Maria, which hit Puerto Rico in mid-September, disrupted water supplies in some areas.

Nightfall sets a hard deadline for a team of public-health researchers in Puerto Rico. Since Hurricane Maria hit on 20 September, leaving large swathes of the island without a reliable power supply, the scientists have

rushed home each night to avoid being in the streets after dark. Many lack running water, and most have limited telephone access.

Yet the team —– co-led by José Cordero of the University of Georgia in Athens — has managed to contact several hundred women to begin assessing whether Hurricane Maria has worsened drinking-water contamination, stress and infectious disease that could harm developing fetuses. This wasn't what the researchers set out to study six years ago when they started a project to assess the impact of pollution on pre-term births. But Cordero's team is one of several research groups have scrambled to quantify Hurricane Maria's immediate health impacts, even as team members struggle to fulfil their own basic needs.

The devastation that Cordero saw on a recent visit to Puerto Rico, his birthplace, shocked him. "I thought I was prepared, but I wasn't," he says.

Even before the hurricane, the island's 18 'Superfund' sites — areas so polluted that the US Environmental Protection Agency deems them hazardous to human health or the environment — posed a potential risk to pregnant women, says Ingrid Padilla, an environmental engineer at the University of Puerto Rico at Mayagüez. Twelve of these sites sit on karst, a geological formation made of porous rock that allows toxic chemicals to flow down from the surface into groundwater.

Padilla's previous research suggests that flooding and other disturbances can quickly bring toxic substances in groundwater back to the surface, and carry them into the water supply. Now, she and her colleagues are collecting hair and blood samples from the research cohort to determine whether pregnant women are being exposed to hazardous chemicals, such as phthalates and chloroform. Since the hurricane hit, the researchers have begun to collect and test groundwater from karst regions and tap water from the homes of people living there.

Other research teams are worried that water that has pooled in hurricane debris could provide a breeding ground for disease-carrying mosquitoes. At the height of the Zika epidemic in 2016, experts debated whether a massive hurricane would destroy mosquito habitat or enhance it, says Carmen Zorrilla, an obstetrician and gynaecologist at the University of Puerto Rico in

San Juan. The evidence is still unclear, she says, and logistical problems may make it impossible for researchers to gather enough data to provide answers.

In some areas where hospitals faced extensive storm damage, the only medical care available is emergency treatment. Screening for the Zika virus is a low priority, and infected adults rarely experience severe symptoms and are unlikely to seek medical treatment.

There are also few labs on the island that can test samples for Zika and other mosquito-borne diseases. Like many Puerto Rican facilities, the US Centers for Disease Control and Prevention (CDC) dengue lab in San Juan lost power during the hurricane and was closed for a week. Diesel generators kept its freezers running to preserve blood and other biological samples, but the lab is still running on generator power and is behind on testing some samples. Shipping delays destroyed reagents that the lab had ordered, since the chemicals were not kept consistently cold during transport.

Lab director Stephen Waterman says that the CDC is collecting data on the incidence of mosquito-borne disease and other hurricane impacts. But its priority is to help US government workers and local communities recognize mosquito breeding grounds, and to provide technical help on efforts to control the spread of the insects. Agency staff would also like to verify reports that leptospirosis — a waterborne bacterial disease that is spread by rats — has sickened dozens of people. “We’re focused on preventing disease,” Waterman says.

Yet the ruined facilities and lack of power continue to tax public-health workers’ ability to know where hazards lie. Take the numerous diesel generators running on the island, which produce visible plumes of grey smoke. Benjamin Bolaños, a microbiologist at the University of Puerto Rico in San Juan, worries that these emissions could harm people with respiratory illnesses, but that the effect will be difficult to quantify. “We are blind because probably the [air quality] monitors were destroyed by the hurricane,” he says.

This makes the prospect of more months without reliable power even more frightening. "The kind of work we’re doing is not because it would be interesting to do,” Cordero says. “It has to be done now because a few years

from now, it’s too late.”

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Comments

Comments

There are currently no comments.

China fires up next-generation neutron-science facility

Beam generator puts country in elite company for doing experiments in materials science and other fields.

14 November 2017

Jin Liwang/Xinhua via ZUMAPRESS

Engineers work on an instrument at the China Spallation Neutron Source in Dongguan.

China is revving up its next-generation neutron generator and will soon start experiments there. That will lift the country into a select group of nations with facilities that produce intense neutron beams to study the structure of

materials.

The China Spallation Neutron Source (CSNS) in Dongguan, a 2.2-billion-yuan (US$331-million) centre, will allow the country's growing pool of top-notch physicists and material scientists, along with international collaborators, to compete in multiple physics and engineering fields. Its designers also hope that the facility will lead to commercial products and applications ranging from batteries and bridges to aeroplane engines and cancer therapy.

"It is not only a big step forward for Chinese scientists, but also a significant event for the international scientist community," says Wang Xun-Li, a physicist at the City University of Hong Kong who has been involved in planning the facility.

Beam bombardment

Spallation neutron sources produce neutrons by slamming protons onto a metal target — CSNS uses tungsten. They are more cost effective and safer than other methods, which use nuclear reactors to produce neutron beams. As neutrons have no charge, they can penetrate materials more easily than some other probing methods, and they are more sensitive to light elements such as hydrogen, making them useful for evaluating candidate materials for fuel cells. Similar facilities exist only in the United Kingdom, United States, Japan and Switzerland, and one is under construction in Sweden.

Fujio Maekawa, a specialist in neutron sources at the Japan Proton Accelerator Research Complex in Tokaimura, says that although the CSNS delivers neutrons at a lower density than other spallation sources — which means that experiments will take longer — a planned upgrade will bring it in line with other facilities. And given their scarcity, "neutron users around the world always welcome new sources", he says.

The CSNS will have capacity to host 20 beam lines, supplying as many instruments. Preliminary tests of its first three instruments began on 1 November. "Neutrons arrived at the samples as expected," says Wang

Fangwei, head of the neutron-science division at CSNS. Although debugging might take a couple of years, he expects the instruments to be calibrated and ready for initial experiments by the end of 2017.

Chinese physicists are eager to use the facility to analyse the underlying magnetic properties of materials, an area in which the country has significant experience. Wang Xun-Li says that several planned instruments will give scientists the chance to move to the forefront of fields such as the physics of skyrmions — vortex-like excitations in magnetic materials — and high-temperature superconductivity. “There are a whole bunch of early- to mid-career scientists who are hungry to use the facility for studying magnetism,” says Wang Xun-Li.

Global appeal

Wang Xun-Li thinks that the latest facility will encourage Chinese researchers to remain in the country instead of pursuing careers elsewhere. “In the past, it was common to see Chinese scientists go abroad for these kinds of studies,” he says.

The facility’s first instruments are also attracting international researchers. German material scientist Frank Klose says that the CSNS was a major factor when he and material scientist Christine Rehm, his wife, decided to join the new Guangdong Technion Israel Institute of Technology in Shantou, 400 kilometres east of Dongguan. Klose’s research focuses on designing data-storage devices and sensors that could be used in hydrogen-powered cars. He helped design one of the facility's instruments to investigate the magnetic properties of spintronic devices, which take advantage of the spin of electrons to store data.

But scientists contacted by *Nature* have raised concerns about CSNS’s location, saying that Dongguan lacks services and infrastructure, such as schools and universities, that will persuade top scientists and their families to move there. “I believe CSNS is suffering from a lack of first-grade scientists who actually are based in Dongguan,” says a researcher familiar with the facility, who asked for anonymity because of the sensitivity of the issue.

Potential users have also expressed some frustration that only 3 instruments will be ready this year, despite the facility’s capacity to host 20.

But more instruments are already being built. Shenzhen's government is funding two that are expected to be ready by the end of 2019, including one designed to model high-pressure environments, such as the Earth's core. Mao Ho-Kwang, a geophysicist at the Carnegie Institution for Science in Washington DC, is keen to use it to simulate what happens to materials in high-pressure conditions. “The CSNS instruments will be a great asset for Earth, environmental and energy science, as well as physics, chemistry and material science,” says Mao. “I am very excited, and the whole neutron community is getting very excited too”.

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Comments

Commenting is currently unavailable.

High-jumping beetle inspires agile robots

Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.

13 November 2017

Brian L. Stauffer

Click beetles have a hinged body that can propel them to great heights.

A beetle that can launch itself spectacularly into the air after falling on its back — flipping right side up without having to use its legs — could inspire a new generation of smart robots.

Imagine a rescue robot vaulting its way through a disaster zone riddled with obstacles, or a planetary robot extricating itself from an unexpected tumble on Mars. Each might use a trick or two learnt from the click beetles, a family of insects with the unique ability to catapult themselves out of trouble.

“A lot of robots out there jump using their legs,” says Aimy Wissa, a mechanical engineer at the University of Illinois in Urbana-Champaign. “What’s unique about this is if something breaks, you can still jump without legs and get out of the situation.”

Wissa and her Illinois colleagues, led by mechanical-engineering graduate student Ophelia Bolmin, described the mechanics of jumping click beetles on 7 November at a meeting of the Entomological Society of America in Denver, Colorado. They published early results in the proceedings of a bio-inspired robotics conference in July[1].

So far, the scientists have studied how click beetles manage to store and hold the energy needed to launch themselves into the air. They hope to soon start building prototype machines designed after the beetles.

Snap to it

There are about 10,000 species of click beetles around the world. The insect’s head and body are connected by a hinge that the beetle can slowly arch and then suddenly snap in the opposite direction, jack-knifing its body and sending it into the air with an audible ‘click’. Earlier work has shown that the beetles launch nearly vertically before somersaulting through the air[2].

Ophelia Bolmin/University of Illinois at Urbana-Champaign

Click beetles can launch themselves up with surprising force.

If the beetle lands on its back, it just does the same manoeuvre again. Compare that to an upended ladybird — also known as a ladybug — which has to wiggle around on its back until it manages to roll over far enough and get traction with its legs to flip itself over.

The Illinois team wanted to analyse how the click beetles pull off their acrobatic feat. “We thought we could look at, how do they really jump, how is that energy being released?” says Marianne Alleyne, an entomologist on the team.

Students measured the dimensions of dozens of beetles of four species (*Alaus oculatus*, *Ampedus nigricollis*, *Ampedus linteus* and *Melanotus* spp.), videotaped their jumps with high-speed cameras and analysed the energy required for the beetles to pull the hinge back and then release it. Muscles alone are not enough, because they contract relatively slowly, and so other body parts such as tendons must also be involved, the team says.

How high?

The researchers also measured the force drop as the hinge snapped shut, confirming that it corresponded to the click as the beetle begin to soar skyward. They are now analysing the energies involved as beetles of different sizes make the jump. Click beetles can range from just a few millimetres to a few centimetres long; early results suggest that the bigger the beetle, the higher it can jump, Wissa says.

Other engineers have developed a range of agile robots that can jump using their legs — including one inspired by the Senegal bushbaby (*Galago senegalensis*), which has the highest vertical jumping ability of any animal[3]. Compared with crawling, jumping is a fast and efficient way for small robots to get around obstacles, says Mark Cutkosky, a mechanical engineer at Stanford University in California.

The advantage of the beetle approach is that something could go wrong with the robot's legs, and it could still get out of its predicament, Wissa says. "It simplifies the design a lot."

Any robots inspired by the click beetle would probably have to be quite small — perhaps a few tens of grams, says Gal Ribak, a biomechanics specialist at Tel Aviv University who has studied the beetles' jumps[4]. "Otherwise, the jumping mechanism will require too much energy to lift the body into the air, and the repeated impacts at take-off and landing would result in mechanical damage," he says.

But those constraints might not apply to robots exploring planets other than Earth. On worlds with lower gravity, beetle-like robots could fly high.

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Comments

Comments

There are currently no comments.

Richard
Haughton

Race for quantum supremacy hits theoretical quagmire

It’s far from obvious how to tell whether a quantum computer can outperform a classical one, says Philip Ball.

13 November 2017 Corrected:

1. 14 November 2017

Quantum supremacy might sound ominously like the denouement of the *Terminator* movie franchise, or a misguided political movement. In fact, it denotes the stage at which the capabilities of a quantum computer exceed those of any available classical computer. The term, coined in 2012 by quantum theorist John Preskill at the California Institute of Technology, Pasadena[1], has gained cachet because this point seems imminent. According to various quantum-computing proponents, it could happen before the end of the year.

But does the concept of quantum supremacy make sense? A moment’s thought reveals many problems. By what measure should a quantum computer be judged to outperform a classical one? For solving which

problem? And how would anyone know the quantum computer has succeeded, if they can’t check with a classical one?

Computer scientists and engineers are rather more phlegmatic about the notion of quantum supremacy than excited commentators who foresee an impending quantum takeover of information technology. They see it not as an abrupt boundary but as a symbolic gesture: a conceptual tool on which to peg a discussion of the differences between the two methods of computation. And, perhaps, a neat advertising slogan.

IBM Research

An IBM cryostat wired for a 50-qubit system.

Magic number

Quantum computers manipulate bits of information according to the quantum rules that govern the behaviour of matter on the smallest scales. In this quantum world, information can be coded as quantum bits (qubits), physically composed of objects that represent binary 1s and 0s as quantum states. By keeping the qubits in a coherent quantum superposition of states –

so that in effect their settings are correlated, rather than being independent as in the bits (transistors) of classical computer circuitry – it becomes possible to carry out some computations much more efficiently, and thus faster, with far fewer (qu)bits, than on classical computers.

Both IBM and Google have already developed prototype quantum-computing devices. IBM has made a 5-qubit device available for public use as a cloud-based resource and on 10 November it announced that it had made a 20-qubit device available for commercial users. Its computer scientists also reported on the same day that they had successfully tested a 50-qubit circuit. Google, too, is developing devices with 49–50 qubits on which its researchers hope to demonstrate quantum supremacy by the end of this year[2].

How could anyone know, though, that a quantum computer is genuinely doing something that is impossible for a classical one to do – rather than that they just haven't yet found a classical algorithm that is clever enough to do the job? This is what makes quantum supremacy a theoretically interesting challenge: are there classes of problem for which it can be rigorously shown that quantum computing can do what classical cannot?

Among the favourite candidates are so-called sampling problems, in which in-effect random bits are transformed into bits that come from a predefined distribution. The Google team in Santa Barbara, California, led by John Martinis, has described an experimental procedure for implementing such a sampling scheme on a quantum computer, and has argued that at the 50-qubit level it could show quantum supremacy[2].

Because of this paper, 50 qubits has become something of an iconic number. That's why a recent preprint[3] from Edwin Pednault and co-workers at IBM's Thomas J. Watson Research Center in Yorktown Heights, New York, showing how, with enough ingenuity, some 49-qubit problems can be simulated classically, has been interpreted in some news reports as a challenge to Google's aim to demonstrate quantum supremacy with only 50 qubits.

It's all about depth

But it's not really that. Quantum-computing experts are now finding themselves obliged to repeat a constant refrain: it's not just about the number of qubits. One of the main measures of the power of a quantum circuit is its so-called depth: in effect, how many logical operations ('gates') can be implemented in a system of qubits before their coherence decays, at which point errors proliferate and further computation becomes impossible. How the qubits are connected also matters. So the true measure of the power of a quantum circuit is a combination of factors, which IBM researchers have called the "quantum volume".

This means that the extent to which a quantum-computational task is challenging to perform classically depends also on the algorithmic depth, not just on how many qubits you have to throw at it. Martinis says that the IBM paper is concerned only with small-depth problems, so it's not so surprising that a classical solution still exists at the 49-qubit level. "We at Google are well aware that small-depth circuits are easier to classically compute", he says. "It is an issue we covered in our original paper."

Scott Aaronson, a computer scientist at the Massachusetts Institute of Technology, agrees that the IBM work doesn't obviously put quantum supremacy further out of reach. "It is an excellent paper, which sets a new record for the classical simulation of generic quantum circuits," he writes – but "it does not undercut the rationale for quantum supremacy experiments."

Indeed, he says, the truth is almost the opposite: the paper shows that it's "possible to simulate 49-qubit circuits using a classical computer, [which] is a precondition for Google's planned quantum supremacy experiment, because it's the only way we know to check such an experiment's results." In essence, the IBM paper shows how to verify the quantum result right up to the edge of what is feasible – so computer scientists and engineers can be confident that things are OK when they go beyond it. The goal, Aaronson says, can be likened to "get[ting] as far as you can up the mountain, conditioned on people still being able to see you from the base."

These views seem to sit comfortably with the IBM team's own perspective on their work. "I think the appropriate conclusion to draw from the simulation methods we have developed is that quantum supremacy should properly be viewed as a matter of degree, and not as an absolute threshold,"

says Pednault. “I, along with others, prefer to use the term ‘quantum advantage’ to emphasize this perspective.”

Theorist Jay Gambetta at IBM agrees that for such reasons, quantum supremacy might not mean very much. “I don’t believe that quantum supremacy represents a magical milestone that we will reach and declare victory,” he says. “I see these ‘supremacy’ experiments more as a set of benchmarking experiments to help develop quantum devices.”

In any event, demonstrating quantum supremacy, says Pednault, “should not be misconstrued as the definitive moment when quantum computing will do something useful for economic and societal impact. There is still a lot of science and hard work to do.”

Which, of course, is just applied science as normal. The idea of quantum supremacy sets a nice theoretical puzzle, but says little about what quantum computers might ultimately do for society.

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Corrections

Corrected:

An earlier version of this story erroneously stated that IBM had created a 20-qubit device for public use. It is available only for commercial users, however IBM does have a 5-qubit device for public use.

Comments

Commenting is currently unavailable.

Archaeologists say human-evolution study used stolen bone

Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.

13 November 2017 Updated:

1. 13 November 2017

Marc Steinmetz

The Untermassfeld site in Germany has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago.

Serious concerns have surfaced about three research papers claiming evidence for one of the earliest human occupations of Europe.

In an extraordinary letter posted to the bioRxiv.org preprint server on 31 October[1], archaeologists allege that the papers, published in 2013, 2016 and 2017, included material of questionable provenance, and that results reported in the 2016 paper were based on at least one stolen bone. Editors at the journals concerned have now published expressions of concern about the papers.

There is no suggestion that the authors of those papers were involved in theft, but the researchers behind the letter say they are concerned that appropriate questions regarding the provenance of the material appear not to have been asked. They also reject the authors' conclusion that a German site known for animal remains was also home to hominins, ancient relatives of humans, 1 million years ago. The authors have denied the allegations and say they stand by their conclusion.

The letter was initiated by archaeologist Wil Roebroeks at Leiden University in the Netherlands, and Ralf-Dietrich Kahlke, a palaeontologist and head of the Senckenberg Research Station of Quaternary Palaeontology in Weimar, Germany, who leads excavations at Untermassfeld, a fossil site about 150 kilometres northeast of Frankfurt. Their preprint describes repeated disappearances of bones from Untermassfeld, as well as fossils delivered in anonymous packages. The authors of the disputed papers insist, however, that they analysed independent collections of bones and stones, and reject the suggestion that any of it was stolen.

Untermassfeld, which has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago, holds the most complete record of northern European wildlife from this time period. But since yearly excavations began in the late 1970s, no hominin bones or signs of occupation have been found, says Kahlke. Hominins first settled in southern Europe around 800,000 to 1 million years ago, most archaeologists agree, and expanded farther north only sporadically until around 500,000 years ago.

Uncertain origins

One of the first claims that hominins lived near Untermassfeld more than 1 million years ago appeared in a 2013 paper in the journal *Quaternary International*, which contended that rocks from the site resembled stone tools[2]. In a 2016 *Journal of Human Evolution* paper[3], two of the original paper's authors, Günter Landeck at the North Hessian Society of Prehistory and Archeology of the Medieval in Bad Hersfeld, Germany, and Joan Garcia Garriga at the Universitat Oberta de Catalunya in Barcelona, concluded that marks on animal bones from Untermassfeld were made by humans. In 2017, Landeck and Garcia Garriga published further analysis of the bones in another *Quaternary International* paper[4].

There is no suggestion that the other co-authors of the 2013 paper had any connection with the material from Untermassfeld. And after this article was published, Garcia Garriga contacted *Nature* to say that he, also, did not have connections with the material; he said that Landeck had done the analysis, while he himself helped in discussing data and writing up its archaeological implications.

In their papers, Landeck and Garcia Garriga attributed the material, along with hundreds of rock fragments of limestone and chert, to “the Schleusingen collection”, which they stated was recovered by a biology teacher in the late 1970s and early 1980s.

Kahlke says he is personally unaware of a Schleusingen collection and questions whether the material was collected at this time. Rocks like those described in the papers can be found in the vicinity of the site, but he says that animal fossils are concentrated in a small area that has been under excavation since 1978. No other research teams had permission to excavate the site during that time, Kahlke says. But he says that material was routinely stolen from the site — which he reported to the police, most recently in 2012 — until the site and fossil bed were better secured. There is no suggestion that Landeck and Garcia Garriga were involved in these thefts.

Ralf-Dietrich Kahlke

Researchers excavating at Untermassfeld allege that part of a deer bone protruding from the sediment on 28 May 2009 (in box, left) had disappeared several days later.

One fossil that Kahlke considers suspicious is a right limb-bone fragment from an extinct species of fallow deer, described in Landeck and Garcia Garriga's 2016 *Journal of Human Evolution* paper. Kahlke says that the bone in the paper seems to match a piece of deer bone that thieves broke from a larger chunk of sediment at Untermassfeld, leaving part of the bone behind. The bone fragment is present in a photograph taken on 28 May 2009, and missing in a photograph taken several days later. A rhinoceros limb fragment that disappeared from the site in 2012 also closely resembles a fossil described in the 2016 paper, Kahlke says.

Case unsolved

Deepening the mystery, a deer bone fragment was among a jumble of bones and rocks in two packages sent anonymously to a museum near Untermassfeld in March 2014. Ralf Werneburg, a palaeontologist and director of the Natural History Museum Schloss Bertholdsburg in Schleusingen, Germany, recognized the material as originating from Untermassfeld and contacted Kahlke.

Ralf-Dietrich Kahlke

An anonymous package sent to a museum in Schleusingen contained a deer bone fragment (lower bone), which appears to match a fragment left behind (upper bone) after a theft from the Untermassfeld site in 2009. (The fragments are shown pieced together in the view on the far-right).

In Kahlke's opinion, the returned deer bone fragment is the one described in the 2016 paper, and matches up with the piece left behind after the 2009 theft**.** He says that the sixty-three other bone fragments in the packages also closely resemble some of the fossils described in the 2016 paper (the rhinoceros limb bone was not among them), and 11 rock fragments resemble

artefacts in the 2013 *Quaternary International* paper.

Roebroeks and Kahlke's team analysed the material in the returned packages, and concluded that it does not support a hominin occupation at Untermassfeld. They argue that the claimed cut-marks on the animal bones, including the deer bone, were probably caused by rodents or other natural wear, they say, and the rock fragments lack telltale marks typical of hominin tools. They say that it wasn't possible to analyse other material from Landeck and Garcia Garriga's paper because its location is unclear.

Nature exchanged multiple e-mails with Landeck and Garcia Garriga about this mystery and asking for comment on the contents of this article. The researchers responded that most of the material they examined, including the deer bone fragment, was from two private collections amassed in the 1970s and early 1980s, and that much of it came from the same geological layer as Untermassfeld, but not within the site itself. They said that they presumed that some of this material was returned to the Natural History Museum Schloss Bertholdsburg in 2014 by the individual who had loaned it to them. They would not name the individual, but insisted: "We have nothing to do with a stolen bone". They added that they are planning to publish a detailed response to Roebroeks and Kahlke's allegations.

The regional prosecutor's office in Meiningen that investigated the 2009 theft told *Nature* the case had been closed unsolved later that year. A 5-year statute of limitation prevents it from being reopened. The case involving the 2012 theft of the rhinoceros bone was reopened early this year after the *Journal of Human Evolution* paper was published. The prosecutor's office said that an individual, whom it declined to name because of data protection laws, had been found guilty and fined.

Ongoing inquiry

Expressions of concern published on each of the three papers note that the location of the Untermassfeld material "was not stated accurately in the publication", and that the authors have been unable to adequately clarify where it is now. Landeck and Garcia Garriga declined to comment to *Nature*

on the specific details of the notes but said that they plan to publish a response.

Sarah Elton, an anthropologist at the University of Durham, UK, and an editor at the *Journal of Human Evolution*, says that an investigation into the accusations is ongoing. She adds that, as a result of the case, the journal now asks prospective authors to supply complete information about the location of material included in a study, as well as how it was accessed.

Other experts have been shocked by the revelations. “This paper should be retracted, of course,” says Jean-Jacques Hublin, an anthropologist and a director at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, about the 2016 paper. But the concerns go beyond questions of provenance. Hublin says that, like Roebroeks and Kahlke, he does not accept the claim that Untermassfeld contains signs of hominin presence, and he worries that its appearance in prominent journals will cause others to accept the idea, despite the lack of evidence for it.

The debate around Untermassfeld, Roebroeks and his colleagues say, underscores the importance of providing accurate descriptions of the provenance of published material, which is needed to verify claims. The desire to set the record straight about the arrival of hominins to Europe was the primary motivation for the team’s letter, he says. Based on his analysis, Roebroeks argues: “These bones and stones are not indicative of hominin presence.”

With additional reporting by Alison Abbott

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Updates

Updated:

> This article was updated on 13 November to note that expressions of concern have been published on all three papers, and to include a statement made after publication by Garcia Garriga: that he was not involved in analysing the material from Untermassfeld.

Comments

Commenting is currently unavailable.

Lab mice's ancestral ‘Eve’ gets her genome sequenced

Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.

13 November 2017

Anne Chadwick Williams/Sacramento Bee/ZUMA Press/Alamy

The genomes of lab mice can shift in subtle and unpredictable ways over generations of breeding.

Adam and Eve, a pair of black mice, lived for less than two years and never left their home at the Jackson Laboratory (JAX) in Bar Harbor, Maine. But since they were bred in 2005, their progeny have spread around the globe: the

pair's living descendants, which likely number in the hundreds of thousands. They are members of the most popular strain of mice used in biomedical research, which was created nearly a century ago.

Now, researchers at JAX are reconstructing Eve's genome in the hopes of better understanding — and compensating for — the natural mutations that occur in lab mice over the course of generations. These genetic changes can cause unanticipated physiological effects that can confound experiments. Related substrains of lab mice can differ in their taste for alcohol or their sensitivity to insulin, for example, and researchers suspect that such differences between supposedly identical mice lines have hampered some areas of research.

The scientists who founded JAX created Adam and Eve's breed, which is called C57BL/6, in 1921. To keep the mice as genetically similar as possible, researchers have repeatedly bred brothers with sisters for nearly a century — and sold the resulting offspring to customers around the world. But this strategy created a genetic bottleneck: every generation, between 10 and 30 new mutations pop up and are passed down to offspring. This 'genetic drift' quickly accumulates over the years, says Laura Reinholdt, a geneticist at JAX. The genomes of the C57BL/6 mice that the lab sells today have thousands of genetic differences from the mouse reference genome, which was created in 2002 from three mice from the substrain C57BL/6J. The genome is used as a template for researchers developing genetically modified mice.

Other suppliers have inadvertently created divergent substrains of C57BL/6 mice when they've bought rodents from JAX and bred them over several generations. Although most mutations go unnoticed, some occur in genes that affect a mouse's appearance or physiology. In 2016, mouse supplier Envigo in Somerset, New Jersey, found that C57BL/6 mice at 6 of its 19 breeding facilities around the world had acquired a mutation in a gene related to the immune system. The company notified the researchers that bought these mice, and asked customers to specify which location they preferred to source mice from in the future, given that the company's stocks were no longer identical.

Hidden changes

And although it is easy to spot a mutation that changes fur from black to white, for instance, some changes are discovered only if researchers are investigating a particular trait. A substrain of C57BL/6 mice that the US National Institutes of Health bred for 50 generations are uninterested in alcohol, whereas those bred at JAX's facility display a preference for alcoholic beverages.

In 2005, a team at JAX decided to reset the genetic clock by selling only C57BL/6J mice descended from two chosen mice: Adam and Eve. The researchers froze hundreds of embryos of the duo's grandchildren, enough to last for 25-30 years. Every five generations, the company thaws some of these embryos and raises them to adulthood as new breeding pairs.

"In some ways, the changes that are acquired are insidious and unstoppable," says Michael Wiles, the lab's senior director of technology evaluation and development, who led the project. "We've not stopped general drift, but we've slowed it considerably." Once the stockpiled embryos run out, however, JAX will have to start over with new breeding pairs from a much later generation.

Yet Eve's genome is very different from the 2002 mouse reference genome. In a presentation last month at the American Society for Human Genetics' meeting in Orlando, Florida, JAX computational scientist Anuj Srivastava spoke about the company's effort to reconstruct Eve's genome in high detail, using three different sequencing methods. Wiles says that the genome will be finished by the end of November, and that JAX plans to publish it early in 2018.

Mouse trap

Other mouse breeders have started their own efforts to account for genetic drift. Taconic Biosciences, a mouse distributor in Hudson, New York, restarts its C57BL/6 line every ten generations from its stash of frozen embryos.

Because Taconic has bred its line separately from the JAX line for decades, the Eve genome won't necessarily reflect the genetic make-up of Taconic's mice any more than the current mouse reference genome does.

Ana Perez, Taconic's global director of genetic sciences and compliance, says that the company plans to publish the genome of its own Eve. "From my perspective, each particular breeder should have their own reference genome to follow," she says. Buying mice from different breeders and expecting them to be the same is a fallacy, she adds.

But most researchers don't think about the differences between the various substrains of C57BL/6 mice and how those disparities can affect reproducibility in research, says Cory Brayton, a pathobiologist at Johns Hopkins University in Baltimore, Maryland. "The vendors are pretty good about making the information available, but the awareness is still pretty low," she says. It is impossible to quantify how often experiments or entire research programmes are wasted when researchers realize that their supposedly identical mice have genetically diverged from the ancestor they bought from a vendor, but Brayton suspects it is common.

The Eve genome will be a useful addition for researchers who use animals from JAX, says Brayton, although it won't solve all the reproducibility problems inherent to inbred mouse lines. "If you use [inbred mice] wisely, they can be highly informative," she says. "If you use them stupidly, they may really confound your studies."

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Comments

Comments

There are currently no comments.

World’s carbon emissions set to spike by 2% in 2017

Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.

13 November 2017

Kevin Frayer/Getty

China, the world’s largest emitter of greenhouse gases, is trying to reduce its reliance on coal.

Humanity’s carbon emissions are likely to surge by 2% in 2017, driven mainly by increased coal consumption in China, scientists reported on 13 November[1–3]. The unexpected rise would end a three-year period in which

emissions have remained flat despite a growing global economy.

Researchers with the Global Carbon Project, an international research consortium, presented their findings at the United Nations climate talks in Bonn, Germany. Countries there are ironing out details of how to implement the 2015 Paris climate accord, which calls for limiting global warming to a rise of 1.5–2 °C. The projected jump in the world's greenhouse-gas output underlines the challenges ahead; if the latest analysis proves correct, global carbon dioxide emissions will reach a record-breaking 41 billion tonnes in 2017.

"We were not particularly surprised that emissions are up again, but we were surprised at the size of the growth," says Corinne Le Quéré, a climate scientist at the University of East Anglia in Norwich, UK, and co-author of the work, which was published in the journals *Nature Climate Change*, *Environmental Research Letters* and *Earth System Science Data Discussions*. To Le Quéré, the question now is whether 2017 is a temporary blip or a return to business as usual. "If 2018 is as big as 2017, then I will be very discouraged," she says.

Several factors caused the world's CO_2 emissions to level out from 2014 to 2016, including an economic slowdown in China, the world's largest emitter; a shift from coal to gas in the United States; and global growth in the use of renewable energies such as solar and wind. Many climate scientists and policymakers had hoped that the pause in emissions growth represented a shift in energy use that would eventually cause global greenhouse-gas emissions to peak — and then decline.

The latest analysis projects that CO_2 emissions in the United States and the European Union will continue to decline — by 0.4% and 0.2%, respectively, in 2017 — although at a slower pace than in recent years. And emissions growth in India is set to slow, rising by just 2% this year, compared with an average of 6% per year over the past decade.

But the picture is very different in China, which produces nearly 26% of the world's output of CO_2. This year, the country's emissions of the greenhouse gas are expected to surge by 3.5%, to 10.5 billion tonnes. The main causes

are increased activity at the country's factories and reduced hydroelectric-energy production, the Global Carbon Project analysis finds.

The effort highlights nagging uncertainties about greenhouse-gas emissions trends, particularly in China, India and other countries with economies that are rapidly growing and changing, says David Victor, a political scientist at the University of California, San Diego. He is not convinced that government actions — at the national or international level — have driven the recent levelling of emissions. And although emissions are projected to grow this year, Victor says that China is still on a trajectory that would see its emissions peak well before its 2030 target.

Taken together, the projections for 2017 reinforce the notion that the world has far to go before it solves the climate problem, says Glen Peters, a climate-policy researcher at the CICERO Center for International Climate Research in Oslo and a co-author of the Global Carbon Project's 2017 analysis.

"This is basically saying that we are not safe yet," Peters says. "We can't be complacent."

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Comments

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There are currently no comments.

Nature News

周三, 08 11月 2017

Nature News

[周三, 08 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Indian scientists urged to speak out about pseudoscience** [周二, 07 11月 08:00]
  Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.
- **Pirate paper website Sci-Hub dealt another blow by US courts** [周二, 07 11月 08:00]
  American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.
- **Genetically modified apple reaches US stores, but will consumers bite?** [周二, 07 11月 08:00]
  Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.
- **US government approves 'killer' mosquitoes to fight disease** [周一, 06 11月 08:00]
  US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.
- **Language patterns reveal body's hidden response to stress** [周一, 06 11月 08:00]
  Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.
- **Energy researcher sues the US National Academy of Sciences for millions of dollars** [周五, 03 11月 08:00]
  Rare move stems from a conflict over two journal articles about renewable energy.
- **US government report says that climate change is real — and humans are to blame** [周五, 03 11月 08:00]
  Conclusions of climate-change science analysis are at odds with US President Donald Trump’s policies.
- **Newly discovered orangutan species is also the most endangered** [周四, 02 11月 08:00]
  The first new species of great ape described in more than eight decades faces threats to its habitat.

- **Gut microbes can shape responses to cancer immunotherapy** [周四, 02 11月 08:00]
  Studies find that species diversity and antibiotics influence cutting-edge treaments.
- **Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid** [周四, 02 11月 08:00]
  Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.
- **Controversial chairman of US House science committee to retire** [周四, 02 11月 08:00]
  Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.
- **Infusions of young blood tested in patients with dementia** [周三, 01 11月 08:00]
  The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.
- **Pay for US postdocs varies wildly by institution** [周三, 01 11月 08:00]
  Analysis of universities' salary data suggests major disparities in pay for early-career researchers.
- **Citation is not the only impact** [周三, 01 11月 08:00]
  A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.
- **University systems allow sexual harassers to thrive** [周三, 01 11月 08:00]
  It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen.
- **Interstellar visitor, Arctic shipwrecks and a retraction recommendation** [周三, 01 11月 08:00]
  The week in science: 27 October–2 November 2017.
- **Plans to promote German research excellence come under fire** [周三, 01 11月 08:00]
  Critics say selection process for high-stakes funding programme is flawed.
- **The new thermodynamics: how quantum physics is bending the rules** [周三, 01 11月 08:00]
  Experiments are starting to probe the limits of the classical laws of thermodynamics.
- **Join the disruptors of health science** [周三, 01 11月 08:00]
  Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.
- **Books in brief** [周三, 01 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.

- **Zoology: The joys of spinelessness** [周三, 01 11月 08:00]
  Lisa-ann Gershwin delights in two books on marine invertebrates.
- **Human embryos: Collect reliable data on embryo selection** [周三, 01 11月 08:00]
- **Night shifts: Circadian biology for public health** [周三, 01 11月 08:00]
- **Crime fiction: Sherlock Holmes — a family likeness?** [周三, 01 11月 08:00]
- **Forestry: Sustainability crisis brews in EU forestry** [周三, 01 11月 08:00]
- **Spanish government takes control of Catalonian universities** [周二, 31 10月 08:00]
  Madrid will oversee the finances of the region's research centres and seven public universities.
- **Seeds, sponges and spinal surgery** [周二, 31 10月 08:00]
  October’s sharpest science shots, selected by Nature ’s photo team.
- **Small group scoops international effort to sequence huge wheat genome** [周二, 31 10月 08:00]
  Just six scientists conquer one of the most complicated genomes ever read.
- **Astronomers race to learn from first interstellar asteroid ever seen** [周二, 31 10月 08:00]
  Wonky orbit confirms that this visitor isn’t from around here.
- **How baby bats develop their dialects** [周二, 31 10月 08:00]
  The young animals crowdsource the pitch of their calls from colony members.
- **US environment agency bars scientists it funds from serving on its advisory boards** [周二, 31 10月 08:00]
  The US Environmental Protection Agency says the policy will address potential conflicts of interest, but scientists raise alarms.
- **Frédéric Chopin’s telltale heart** [周二, 31 10月 08:00]
  Scientists have written another chapter in the curious case of the composer’s heart. But it is unlikely to be the end of the story.
- **Lower emissions on the high seas** [周二, 31 10月 08:00]
  Global regulations to limit carbon dioxide from the shipping industry are overdue.
- **Lessons from first campus carbon-pricing scheme** [周二, 31 10月 08:00]
  Putting a value on emissions can lower energy use, write Kenneth Gillingham, Stefano Carattini and Daniel Esty.

Indian scientists urged to speak out about pseudoscience

Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.

07 November 2017

Pallava Bagla/Corbis/Getty

Scientists taking part in India's march for science in August were protesting against the spread of anti-science beliefs, superstitions and myths.

A leading Indian science-advocacy group is urging the country’s researchers to speak out against pseudoscience, which it fears has gained a foothold in the past few years, partly through support from some agencies of the Indian

government.

The call to arms, made by the non-profit Breakthrough Science Society, comes after some members of an alumni association of the prestigious Indian Institute of Science (IISc), Bangalore, planned a workshop on astrology at the IISc for 25–26 November.

Strong backlash from scientists resulted in the event being cancelled on 28 October. The society's general secretary, Soumitro Banerjee, says that it would be "detrimental to Indian science" for researchers to remain neutral on such issues. "India's scientific community must be proactive in propagating a scientific bent of mind," says Banerjee, a physicist at the Indian Institute of Science Education and Research Kolkata.

Timeline of events

Two days before the alumni association cancelled the workshop, dozens of scientists signed letters to the IISc director, Anurag Kumar, objecting to the workshop. The IISc director and the faculty were not involved in organizing the workshop.

Muthya Ravindra, a computer scientist and president of the alumni association, says that the event, organized by one of its members, was still under discussion when "due to some miscommunications", e-mails promoting the event were sent out.

But Ravindra says that despite criticism from scientists and other academics, people widely believe in astrology and seek its advice in newspapers, magazines and on television. He is unsure what role scientists should play in educating society on the dangers such practices may have. "It is very confusing to me whether we as scientists [should] criticize or take some part in finding a solution," he says.

India's ruling party, the conservative Bharatiya Janata Party (BJP) has shown support for giving astrology a place in universities. In 2001, then-science minister of the BJP-led coalition government Murli Manohar Joshi took steps to allow public universities to include astrology classes in curricula.

However, the Indian government and science ministry did not have a role in the IISc alumni association's planned astrology workshop.

Pseudoscience debate

Alarm in the Indian scientific community over anti-science policies and programmes has been brewing for some time. Several scientists who spoke with *Nature* are reluctant to comment publicly about it for fear of jeopardizing their jobs. Others took part in the March for Science organized by the 7,000-member Breakthrough Science Society in August in around 40 Indian cities, in part to protest the government's support for ideas not yet backed by science. One area of concern, says Banerjee, is the government's push for a national research programme on the health and other benefits of a combination of five cow products, known as panchgavya.

The Indian Institute of Technology (IIT), Delhi, hosted a two-day workshop last December to discuss ways to validate research on panchgavya, which was supported by India's Department of Science and Technology, Department of Biotechnology, and Council of Scientific and Industrial research (CSIR), and inaugurated by India's science minister Harsh Vardhan.

According to IIT Delhi's website, Vardhan, who is a physician, "emphasised that use of panchgavya in practice and in daily routines will help to address the pressing global issues like climate change, resistance development, malnourishment, global health etc".

Following the workshop, India's science ministry formed a national steering committee to initiate a national programme on the topic.

Supporters of this research say that cow products should be considered part of India's vast traditional knowledge base. But critics say that such unverified theories are pseudoscience, and that singling out the benefits of cow products is part of a larger political agenda by Hindus, for whom the cow is a sacred animal.

They also argue that research on topics such as panchgavya should be handled in a neutral manner rather than as a way of promoting traditional

knowledge. Rahul Siddharthan, a computation biologist at the Institute of Mathematical Sciences in Chennai, says that the government must accept that any research involving traditional hypotheses about health could potentially refute those hypotheses. “Refutability is the essence of science,” he says.

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Comments

1 comment

1. *Pentcho Valev* • 2017-11-07 06:11 PM
   Astrology, being pseudoscience of course, is still much more scientific than Einstein's relativity: Thibault Damour: "The paradigm of the special relativistic upheaval of the usual concept of time is the twin paradox. Let us emphasize that this striking example of time dilation proves that time travel (towards the future) is possible. As a gedanken experiment (if we neglect practicalities such as the technology needed for reaching velocities comparable to the velocity of light, the cost of the fuel and the capacity of the traveller to sustain high accelerations), it shows that a sentient being can jump, "within a minute" (of his experienced time) arbitrarily far in the future, say sixty million years ahead, and see, and be part of, what (will) happen then on Earth. This is a clear way of realizing that the future "already exists" (as we can experience it "in a minute")."
   http://www.bourbaphy.fr/damourtemps.pdf The time-travel hoax was devised by Einstein in 1905: Albert Einstein, On the Electrodynamics of Moving Bodies, 1905: "From this there ensues the following peculiar consequence. If at the points A and B of K there are stationary clocks which, viewed in the stationary system, are synchronous; and if the clock at A is moved with the velocity v along the line AB to B, then on its arrival at B the two clocks no

longer synchronize, but the clock moved from A to B lags behind the other which has remained at B by tv^2/2c^2 (up to magnitudes of fourth and higher order), t being the time occupied in the journey from A to B."
http://www.fourmilab.ch/etexts/einstein/specrel/www/ The conclusion "the clock moved from A to B lags behind the other which has remained at B" does not follow from Einstein's 1905 postulates - the argument is INVALID. This means that the conclusion is unacceptable, no matter whether the postulates are true or false. The following two conclusions, in contrast, VALIDLY follow from the postulates (they will be true if the postulates are true): Conclusion 1: The clock moved from A to B lags behind the other which has remained at B, as judged from the stationary system. Conclusion 2: The clock which has remained at B lags behind the clock moved from A to B, as judged from the moving system. Conclusions 1 and 2 (symmetrical time dilation) in their combination give no prediction for the readings of the two clocks as they meet at B. In contrast, the INVALIDLY deduced conclusion provides a straightforward prediction - the moving clock is SLOW, the stationary one is FAST (asymmetrical time dilation). The famous "travel into the future" is a direct implication - the slowness of the moving clock means that its (moving) owner can remain virtually unchanged while sixty million years are passing for the stationary system. Pentcho Valev

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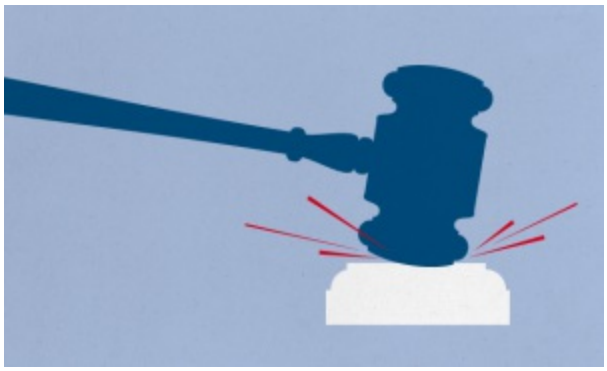
Pirate paper website Sci-Hub dealt another blow by US courts

American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.

07 November 2017



The American Chemical Society (ACS) has won a lawsuit against the pirate research-paper website Sci-Hub, over the site’s illicit use and dissemination of ACS articles.

On 3 November, a US court ordered Sci-Hub's operators to pay the ACS US$4.8 million in damages for copyright infringement and trademark violation. Sci-Hub’s owners did not appear in court to present their case.

The judge also ordered that any party “in active concert or participation” with Sci-Hub should “cease facilitating” access to the repository. This means that the ACS could request Internet services including web providers, search engines and domain-name registrars to stop linking or block access to Sci-Hub and the various domains it is hosted under.

Which services might be approached by the ACS isn’t yet clear: the meaning of the phrase “in active concert or participation with” is open to legal interpretation, says Michael Carroll, an information-justice and intellectual-

property specialist at the American University Washington College of Law in Washington, DC.

There are no clear standards as to when an Internet service is in “active concert” with a pirate website, says Carroll. A user merely resolving a domain-name request to such a site, for example, does not yet qualify as active participation, he adds.

Such an order by a US court is exceptional, Carroll says. “In general, our federal courts do not have the power to issue orders against people or entities that were not part of the lawsuit.” But he adds that US federal rules for civil procedures such as this do sometimes allow injunctions against persons who are in ‘active participation’ with an enjoined party. The current lawsuit is an example of that, he says.

The ruling is another legal blow for Sci-Hub, which provides free access to millions of paywalled research papers and is popular with researchers around the world. In June, a New York court had granted the Dutch publisher Elsevier $15 million in damages from the site for large-scale copyright infringement.

But publishers are unlikely to see any money from Sci-Hub because its chief operator lives outside the United States. Alexandra Elbakyan, a former neuroscientist who created the portal in 2011, did not respond to a request for comment from *Nature*'s news team.

The ACS, which filed its lawsuit in June in a Virginia court, said in a statement on 6 November that the ruling was “a victory for copyright law and the entire publishing enterprise”. An analysis published in August estimated that as of March 2017, Sci-Hub’s database contained 69% of the world’s roughly 81.6 million scholarly articles — and 98.8% of the ACS’s journal content.

The ACS says that it will now seek to enforce the court’s order. Asked for comment, the society referred *Nature*’s news team to its statement. But Internet service providers are expected to resist what they may perceive as undue censorship.

Attempts to stop people visiting Sci-Hub face another hurdle, too: the site has an alternative address that can be reached by users of the Tor network, a group of servers that encrypts Internet traffic and disguises its origins. No Internet provider can easily block access to such sites.

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Comments

Comments

There are currently no comments.

Genetically modified apple reaches US stores, but will consumers bite?

Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.

07 November 2017

Okanagan Specialty Fruits, Inc.

The apple on the right doesn’t bruise when dropped — it lacks a gene encoding an enzyme that causes plant cells to brown on exposure to oxygen.

This month, bags of sliced apples will hit grocery-store shelves in the midwestern United States for the first time. Shoppers who purchase the apples can leave the slices out for snacking, because of a feat of genetic engineering that prevents their flesh from browning when exposed to air.

The ‘Arctic apple’ is one of the first foods to be given a trait intended to please consumers rather than farmers, and it joins a small number of genetically modified organisms (GMOs) to be sold as a whole product, not an ingredient. Since Okanagan Specialty Fruits in Summerland, Canada, planted its first test apples in 2003, the array of foods modified in labs has expanded to include meatless burgers, made with soya protein produced by recombinant yeast, fish fillets grown from seafood stem cells, and mushrooms whose genomes have been edited with CRISPR technology. Most of these items have not yet reached the market.

Now, many small biotechnology companies developing such foods are watching the Arctic apple’s launch, eager for clues to how consumers will perceive the fruits of their labour.

“If the apple sells, it will pave the way for others,” says Yinong Yang, a plant pathologist at Pennsylvania State University in University Park, who used CRISPR to engineer a mushroom that resists browning. He hopes one day to license his mushroom to commercial growers.

Mary Maxon, who oversees biosciences programmes at Lawrence Berkeley National Laboratory in California, agrees. “The apple is not the first GMO that people would eat, but it’s the first one that consumers may value,” she says.

When Okanagan co-founder Neal Carter took over his family’s orchard in 1995, he thought hard about how to win over the US snack market. He found his answer in Australia, where researchers at the Commonwealth Scientific and Industrial Research Organisation had figured out how to delete a gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives.

Only later did he realize that if consumers were to be enticed to buy, Americans’ distrust of GMOs would need to be overcome. Okanagan’s subsequent surveys of people in America’s top apple-growing states — New York and Washington — revealed that about 20% were wary of GMOs. But the company also found that many people changed their minds when told that the apples were engineered to silence browning genes, and then tested for

safety.

Mike Seldon, the co-founder of Finless Foods, a firm in New York City that is developing fish fillets from fish stem cells, agrees that providing more information helps to win over consumers. “We’re not going to repeat the mistakes of the GMO industries in the past, and just put foods on the market without public conversation,” he says. “If we do, you can expect a backlash — and that’s warranted.”

Seldon sees a parallel between the Arctic apple and his fillets: both were created with attributes to please consumers. Finless Foods, which has made prototypes of bluefin-tuna fillets, hopes that people will be won over by the idea of eating fish without worrying about overfishing, animal slaughter or environmental pollution.

But others say that Okanagan hasn’t gone far enough in telling consumers how its apple was made. The company does not mention GMOs on the apples’ bags; instead, the bags have a QR code — which links to online information when it is scanned by a smartphone. “Not everyone has a smartphone, and even if you have one, are you going to check every item with it?” says Bill Freese, a science-policy analyst at the Center for Food Safety, an advocacy group in Washington DC. He wants the apples to be clearly labelled as GMOs.

Consumer reaction isn’t the only concern for developers of genetically engineered or other lab-made foods who want to sell their wares in the United States. One major stumbling block is the US regulatory process, which involves a complicated tangle of federal agencies — and, for many companies, an unclear path forward. US regulators assessed the Arctic apple for five years before approving it for sale, but spent just two years reviewing a non-browning GM potato developed by agricultural firm J. R. Simplot of Boise, Idaho.

Then there is the case of the CRISPR mushroom. The US Department of Agriculture (USDA) said in 2016 that it would not evaluate the mushroom, which was created by using CRISPR to delete a gene. That seemed to clear the fungus’s path to the market. But Yang says that, after *Nature*’s news team reported on the USDA’s decision, the US Food and Drug Administration

contacted him to ask whether it could review the mushroom. “I agreed to that since it would give consumers a peace of mind,” he says.

As far as investors are concerned, regulatory uncertainty may be less of a barrier to the success of engineered foods than customer uncertainty. James Hardiman, a partner at the venture-capital fund Data Collective in San Francisco, California, says that companies developing such foods can always build a few extra years into their long-term plans, to account for twists in the regulatory process. “The public narrative is much more difficult to control,” he says. “We know the public can be irrational.”

Still, Carter is optimistic about how his Arctic apple will be received. “We rarely get e-mails saying we are Satan any more,” he says of his company. “Now we have people asking where they can buy the apples.”

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Comments

Comments

There are currently no comments.

US government approves 'killer' mosquitoes to fight disease

US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.

06 November 2017

Dennis Kunkel Microscopy/SPL

The lab-grown mosquitoes developed by MosquitoMate seek to eliminate the disease-carrying Asian tiger mosquito (*Aedes albopictus*, shown here).

The US Environmental Protection Agency (EPA) has approved the use of a common bacterium to kill wild mosquitoes that transmit viruses such as dengue, yellow fever and Zika, *Nature*'s news team has learned.

On 3 November, the agency told biotechnology start-up MosquitoMate that it could release the bacterium *Wolbachia pipientis* into the environment as a tool against the Asian tiger mosquito (*Aedes albopictus*). Lab-reared mosquitoes will deliver the bacterium to wild mosquito populations.

The decision — which the EPA has not formally announced — allows the company, which is based in Lexington, Kentucky, to release the bacteria-infected mosquitoes in 20 US states and Washington DC.

“It’s a non-chemical way of dealing with mosquitoes, so from that perspective, you’d think it would have a lot of appeal,” says David O’Brochta, an entomologist at the University of Maryland in Rockville.“I’m glad to see it pushed forward, as I think it could be potentially really important.”

MosquitoMate will rear the *Wolbachia*-infected *A. albopictus* mosquitoes in its laboratories, and then sort males from females. Then the laboratory males, which don’t bite, will be released at treatment sites. When these males mate with wild females, which do not carry the same strain of *Wolbachia*, the resulting fertilized eggs don’t hatch because the paternal chromosomes do not form properly.

The company says that over time, as more of the *Wolbachia*-infected males are released and breed with the wild partners, the pest population of *A. albopictus* mosquitoes dwindles. Other insects, including other species of mosquito, are not harmed by the practice, says Stephen Dobson, an entomologist at the University of Kentucky in Lexington and founder of MosquitoMate.

Production challenges

The EPA restricted the release of MosquitoMate’s product, called ZAP males, to 20 states and Washington DC. The agency has previously said that those places “are similar in temperature and precipitation to areas where efficacy of the ZAP males was tested” — Kentucky, New York and California. The EPA decision excludes much of the southeastern United

States, which is home to dense populations of mosquitoes and a long mosquito season, because MosquitoMate did not conduct field trials there.

MosquitoMate plans to begin selling its mosquitoes locally, in Lexington, and will expand from there to nearby cities such as Louisville, Kentucky, and Cincinnati, Ohio. The company will work with homeowners, golf courses, hotels and other customers to deploy its insects, according to Dobson. “Now the work starts,” he says.

The company will have to start small. Suppressing the mosquito population of an entire city is likely to require the weekly production of millions of these mosquitoes. To reach that level, Dobson’s company must find a way to efficiently separate male mosquitoes from females. The company’s technicians now separate them both by hand and mechanically, Dobson says.

Another group that is also developing mosquitoes infected with *Wolbachia* to control wild populations has succeeded in producing large quantities of their insects. Researchers from Sun Yat-sen University in Guangzhou, China, and Michigan State University in East Lansing say they are releasing 5 million *Wolbachia*-infected *A. albopictus* each week in Guangzhou.

The scientists use mechanical sorters to separate males from females, on the basis of size differences at the pupal stage, at more than 99% efficiency, says Zhiyong Xi, a medical entomologist and microbiologist at Michigan State University, who leads the project. They expose the remaining mosquitoes to X-ray radiation at a dose that sterilizes any remaining females, but is too low to affect the males.

Looking ahead

Using lab-grown mosquitoes to kill mosquito pests has been tested extensively in Brazil in recent years. The country has allowed large-scale releases of such mosquitoes in response to an epidemic of the Zika virus that began in 2015. Zika is a mosquito-borne virus that has been linked to severe birth defects, such as abnormally small heads — a condition known as microcephaly. *Aedes aegypti* mosquitoes are thought to be the primary vector

for the virus.

One type of mosquito being tested in Brazil is a genetically modified variety of *A. aegypti* developed by Oxitec in Milton, UK. When the modified male mosquitoes mate with wild females, they pass a lethal gene on to any progeny.

Oxitec has run into challenges when attempting to test its GM mosquitoes in the United States, however. A community in the Florida Keys voted last year against allowing Oxitec to conduct field trials there, although the rest of the county in which the community is located voted in favour of the plans.

By contrast, MosquitoMate has developed and tested a variety of *Wolbachia*-carrying *A. aegypti* mosquitoes in the Florida Keys and Fresno, California, without drawing much public attention. The EPA received only 14 comments during the public-comment period for the Florida trials, and most of them were positive. The company plans to submit an application to the EPA for nationwide release of that species, says Dobson.

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Comments

Commenting is currently unavailable.

Language patterns reveal body's hidden response to stress

Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

06 November 2017

Carlo Allegri/Getty

Listen in: the words people say may reveal the body's biological response to threat.

Subtleties in the language people use may reveal physiological stress.

Psychologists found that tracking certain words used by volunteers in randomly collected audio clips reflected stress-related changes in their gene expression. The speech patterns predicted those physiological changes more

accurately than speakers' own ratings of their stress levels.

The research, which is published on 6 November in *Proceedings of the National Academy of Sciences*[1] suggests that changes in language may track the biological effects of stress better than how we consciously feel. It's a new approach to studying stress, says David Creswell, a psychologist at Carnegie Mellon University in Pittsburgh, Pennsylvania, and one that "holds tremendous promise" for understanding how psychological adversity affects physical health.

Adverse life circumstances — such as poverty, trauma or social isolation — can have devastating effects on health, increasing the risk of a variety of chronic disorders ranging from heart disease to dementia. Researchers trying to pin down the biological mechanisms involved have found that people who experience these circumstances also undergo broad changes in gene expression in the cells of their immune system. Genes involved in inflammation become more active, for example, and antiviral genes are turned down.

These biological changes seem to represent the body's evolutionary response to threat, says Steve Cole, a genomicist at the University of California, Los Angeles, and a co-author on the paper. But he was always troubled by a "nagging observation": they don't tally well with how stressed people say they are.

Cole wondered whether stress biology is triggered instead by an automatic assessment of threat in the brain, which doesn't necessarily reach conscious awareness. To find out, he and his colleagues teamed up with Matthias Mehl, a psychologist at the University of Arizona, Tucson, who studies how stress affects language.

Stress on speech

The researchers asked 143 adult volunteers in the United States to wear audio recorders, which switched on every few minutes for two days, capturing a total of 22,627 clips. Mehl transcribed any words spoken by the volunteers,

and analysed the language they used.

He was particularly interested in what psychologists call 'function' words, such as pronouns and adjectives. “By themselves they don’t have any meaning, but they clarify what’s going on,” says Mehl. Whereas we consciously choose 'meaning' words such as nouns and verbs, researchers believe that function words “are produced more automatically and they betray a bit more about what’s going on with the speaker”. Mehl and others have found, for example, that people’s use of function words changes when they face a personal crisis or following terrorist attacks.

The researchers compared the language used by each volunteer with the expression in their white blood cells of 50 genes known to be influenced by adversity. They found that the volunteers’ use of function words predicted gene expression significantly better than self-reports of stress, depression and anxiety.

People with more stressed-out gene-expression signatures tended to talk less overall. But they used more adverbs such as 'really' or 'incredibly'. These words may act as “emotional intensifiers”, says Mehl, signifying a higher state of arousal. They were also less likely to use third-person plural pronouns, such as 'they' or 'their'. That makes sense too, he says, because when people are under threat, they may focus less on others and the outside world.

He cautions that more research is needed to test these specific effects, and to assess whether stress influences language, or vice versa. But he suggests that the approach could ultimately help to identify people at risk of developing stress-related disease. Doctors may need to “listen beyond the content” of what patients tell them, he says, “to the way it is expressed”.

Cole suggests that assessing language use could help to test whether interventions aimed at reducing stress really work. Perhaps “you could even ditch self-report stress measures”, he says, and instead listen passively to how trial participants speak.

“Language reflects how people connect with their world, but who would ever have thought that gene expression would be related to language?” says James

Pennebaker, a psychologist at the University of Texas, Austin, who has pioneered research on language and social processes (and has previously worked with Mehl). “It’s such an exciting new way of thinking,” he adds. “I was blown away.”

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Comments

Comments

There are currently no comments.

Energy researcher sues the US National Academy of Sciences for millions of dollars

Rare move stems from a conflict over two journal articles about renewable energy.

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1. 07 November 2017

Eric Thayer/Bloomberg/Getty

Renewable energy, including from wind, is at the heart of a multi-million dollar lawsuit.

A scientific dispute about the future of alternative energy has landed in a US court. Mark Jacobson, an environmental and civil engineer at Stanford University in California, has filed a libel lawsuit against the US National Academy of Sciences (NAS) and a researcher who published a study in the academy's journal that criticized Jacobson's work.

Jacobson, who filed suit in superior court in Washington DC in late September, is seeking damages of US$10 million. He also wants the *Proceedings of the National Academy of Sciences* (*PNAS*) to retract the article it published by mathematician Christopher Clack this year. The NAS and Clack have until late November to respond, according to court documents. Some experts are worried that the lawsuit could dampen scientific progress on renewable energies. But others defend the move, saying researchers should be able to take advantage of all civil avenues in defense of their work.

Jacobson was the lead author of a high-profile *PNAS* paper[1] published in December 2015 making the case that the continental United States could meet nearly 100% of its energy needs using wind, water and solar sources as early as 2050. A rebuttal[2] written by Clack — then at the University of Colorado Boulder — and 20 co-authors, and published in *PNAS* in June 2017, questioned Jacobson's methodology and challenged his conclusions. The authors argued, among other things, that Jacobson's paper overestimated the maximum outputs from hydroelectric facilities and the nation's capacity to store energy produced by renewable sources.

In the lawsuit, Jacobson says that he had alerted *PNAS* to 30 falsehoods and five "materially misleading statements" in Clack's paper before its publication. The complaint states that almost all of those inaccuracies remained in the published version. Jacobson also argues that "the decision by NAS to publish the Clack Paper in PNAS has had grave ramifications" for his reputation and career.

In a letter[3] accompanying Clack's paper in *PNAS*, Jacobson and three co-authors wrote that Clack's criticisms are "demonstrably false". They maintained that their projections regarding hydroelectric power were based

on an assumed increase in the number of turbines and were not a “modeling mistake”.

Conflict resolution

Some observers are disappointed to see the conflict play out in court. The diversity of engineering models that form the basis of long-term energy projections should be celebrated, not litigated, says chemical engineer Daniel Schwartz, director of the Clean Energy Institute at the University of Washington in Seattle. “Bringing this dispute into the court of law, regardless of outcome, is a step towards devaluing the debate of underlying engineering assumptions,” he says.

“This dispute is likely to be most harmful to the scientific community, which has already been subject to lawsuits from groups sceptical of climate change,” says David Adelman, who studies environmental law at the University of Texas in Austin.

Suing a journal over a scientific disagreement is a rare move, says Adil Shamoo, a biochemist at the University of Maryland School of Medicine in Baltimore and editor-in-chief of the journal *Accountability in Research*, which is published by Taylor & Francis. But Shamoo thinks that scientists should be able to sue if they feel that a paper is “reckless” or “malicious”. “I’m a great believer in using all of the avenues of a civil society,” he says.

Shamoo does think that Clack’s paper was “unduly harsh and personal”. He says that “it was not written as if it was part of a scientific dialogue”.

Clack declined to respond to Shamoo’s characterization of his paper, but says that he is disappointed that Jacobson filed the lawsuit. Clack — now chief executive of Vibrant Clean Energy LLC in Boulder — says that his rebuttal paper “underwent very vigorous peer review”, and that the *PNAS* editors had considered Jacobson’s criticisms but found them to be “without merit”.

Jacobson says that he “cannot comment” on the lawsuit. And a spokesperson for the NAS says that “we do not comment on pending litigation”.

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Corrections

Corrected:

A previous version of this story stated that *PNAS* published Clack's article in 2015.

Comments

Commenting is currently unavailable.

US government report says that climate change is real — and humans are to blame

Conclusions of climate-change science analysis are at odds with US President Donald Trump’s policies.

03 November 2017

Drew Angerer/Getty

Heat waves are growing more common in many parts of the United States.

From warmer temperatures to more extreme weather, melting glaciers and rising sea levels, humanity is fundamentally changing the planet by pumping

greenhouse gases into the atmosphere, US government scientists said on 3 November in their latest assessment of climate science.

The average global temperature has increased by 1 °C since the pre-industrial era, the 477-page report says — adding that the past 115 years comprise the warmest period "in the history of modern civilization". The analysis warns that temperatures could increase by another 4 °C by the end of the century, with dramatic consequences for humans and natural ecosystems.

The findings are at odds with the policies of US President Donald Trump, who has questioned well-established tenets of climate science and vowed to protect and promote the US fossil-fuel industry. Trump's stances led many scientists to worry that his administration would try to block or tamper with the climate-change assessment, but several scientists who helped to write the document reported no problems.

"We weren't interfered with, and we ended up producing something that I think is of tremendous value," says David Fahey, an atmospheric scientist with the National Oceanic and Atmospheric Administration in Boulder, Colorado, and a coordinating lead author of the analysis.

The climate-science report is the first volume of the fourth National Climate Assessment, a legally mandated analysis of the causes and impacts of global warming that is due in 2018. The second volume focuses on how climate change is affecting life in the United States, from crop yields to property damage from extreme weather. That document was released in draft form, along with a report on the carbon cycle. The US National Academy of Sciences is set to review the latter two documents.

"The science speaks for itself," says Don Wuebbles, a climate scientist at the University of Illinois at Urbana-Champaign and a coordinating lead author of the climate-science report. "It's hard to counteract the basic observations and the truth of the science with any kind of political playing around."

The trio of documents paints a dramatic picture of how global warming is affecting people and communities across the United States. Tidal flooding is accelerating in more than 25 cities along the coasts of the Atlantic Ocean and the Gulf of Mexico. Large forest fires have become more frequent in the

western part of the country, and warmer spring temperatures combined with shrinking mountain snowpack are reducing the amount of water available to the region's cities and farms. As a result, the draft climate-impacts report warns, "chronic, long-duration hydrological drought is increasingly possible before the end of the century".

The climate-science report was released just days before the latest United Nations climate talks kick off in Bonn, Germany. The summit will be the first major meeting of its kind since Trump vowed to pull the United States out of the 2015 Paris climate pact.

Few observers expect the US government's latest set of climate-change analyses to affect how the Trump administration approaches energy and environmental issues. In August, the National Oceanic and Atmospheric Administration disbanded an advisory committee that was intended to help the nation prepare for a warmer climate by translating the findings of the coming climate assessment into guidance for cities, states and industry.

Nor is it clear whether senior Trump administration officials will accept the reports' core scientific conclusions. As recently as March, US Environmental Protection Agency administrator Scott Pruitt said he did not believe that carbon dioxide is a major driver of global warming.

Nonetheless, many scientists and environmentalists lauded the new reports for bolstering the case for more-aggressive action against climate change.

"The full assessment, when it gets published, is going to show that there are palpable impacts that are going to hit every part of the country," says Andrew Light, a senior fellow at the World Resources Institute, an environmental think-tank based in Washington DC. "It's the responsibility of leaders to take note of that and act accordingly."

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Comments

Commenting is currently unavailable.

Newly discovered orangutan species is also the most endangered

The first new species of great ape described in more than eight decades faces threats to its habitat.

02 November 2017

Maxime Aliaga/SOCP-Batang Toru Programme

Orangutans in Sumatra's Batang Toru forest are now officially a new species: *Pongo tapanuliensis.*

Almost a century after scientists first heard rumours of its existence, an isolated population of orangutans on the Indonesian island of Sumatra has

been confirmed as a new species — just as its habitat faces imminent threats.

The population, estimated at fewer than 800 individuals, inhabits the Batang Toru forest in western Sumatra. A researcher exploring the area in the 1930s wrote of reports of an isolated orangutan population. But it wasn't until biological anthropologist Erik Meijaard, the founder of conservation group Borneo Futures in Jakarta, discovered the paper in the mid-1990s that scientists went looking for the Batang Toru group. Local villagers showed researchers the remains of a female orangutan, and nests in the area confirmed the presence of a population. A male orangutan killed by locals in 2013 provided key evidence: intact tissue and bone.

From the start, scientists noticed that these apes looked different from other orangutans. They had smaller heads, with flatter faces, and their hair was frizzier than that of their cousins living farther north on Sumatra or on the nearby island of Borneo.

Gene gap

Now, genetic tests, field observations and a comparison of the male skeleton against 33 orangutan specimens in museums have revealed that the Batang Toru group is, in fact, a distinct species. Named *Pongo tapanuliensis*, the newly identified great ape is described in *Current Biology*[1] on 2 November by a team that included most of the world's orangutan experts. "It's taken 20 years to come to the realization of what this is," Meijaard says.

Although the genetic analysis of *P. tapanuliensis* relies on a single skeleton, Meijaard says that's not unusual in taxonomy. Many studies, including others he's contributed to, rely on a single piece of evidence, and typically consider only morphology. The latest study shows that the group is distinct not only in morphology, but also in genetics and behaviour, he says.

Matthew G. Nowak

P. tapanuliensis orangutans have smaller heads and flatter faces than their cousins elsewhere on Sumatra and on Borneo.

Russ Mittermeier, executive vice-chair of Washington, DC-based Conservation International and chair of the primate-specialist group at the International Union for Conservation of Nature (IUCN), describes the evidence as “unquestionably” sufficient to support the new species designation. “Although we have had 87 new species of primates described since 2000, this is the first new great ape species since 1929.”

Biruté Mary Galdikas, an orangutan specialist in Los Angeles who founded Orangutan Foundation International, says that the study confirms what she and other orangutan researchers have suspected for decades. “I am not surprised that there is a new species or subspecies of orangutan described from Sumatra,” she says.

Ancestral ties

Key to the determination was tracing the population’s ancestry. Surprisingly, Meijaard says, genetic testing of the Batang Toru skeleton revealed that the population is more closely related to Bornean orangutans, despite living on the same island as the other Sumatran group. That’s probably because of how

orangutans migrated to the region, he says.

All orangutans trace their origins to ancestors that lived on the Asian mainland about 8 million years ago. Those great apes migrated to what is now Sumatra, when sea levels were lower and the lands were connected. Genetic data suggest the Batang Toru species is the closest descendant of those first arrivals.

The other Sumatran orangutans, which live in the island's far north, split off from the Batang Toru group about 3.4 million years ago, modelling based on genetic data suggests. The Bornean orangutans also split from the Batang Toru group, but much later — about 674,000 years ago — which explains why those two populations are more similar, Meijaard says.

Even as Batang Toru's orangutans are named a new species, the animals' long-term survival is uncertain. Previous population analyses suggest there are fewer than 800 individuals, making it the most endangered of the great apes. Although much of its habitat is protected by the Indonesian government, a proposed hydroelectric dam on the Batang Toru river would flood part of the area and divide the population into two, isolating the groups on either side of the river. That's likely to further shrink the gene pool in the already inbred population, Meijaard says. The dam would also bring more people to the area, potentially increasing hunting pressure.

Conservation groups are working with government officials to find an alternative site for the project, says Meijaard. "There is no doubt that conservation efforts are needed immediately," Mittermeier says.

The IUCN primate-specialist group has recently recommended that the species be included on the IUCN Red List of Threatened Species. A decision is expected in December. "It would be bitterly ironic if it goes extinct as a biologically viable population just as it is described as a new species," says Galdikas.

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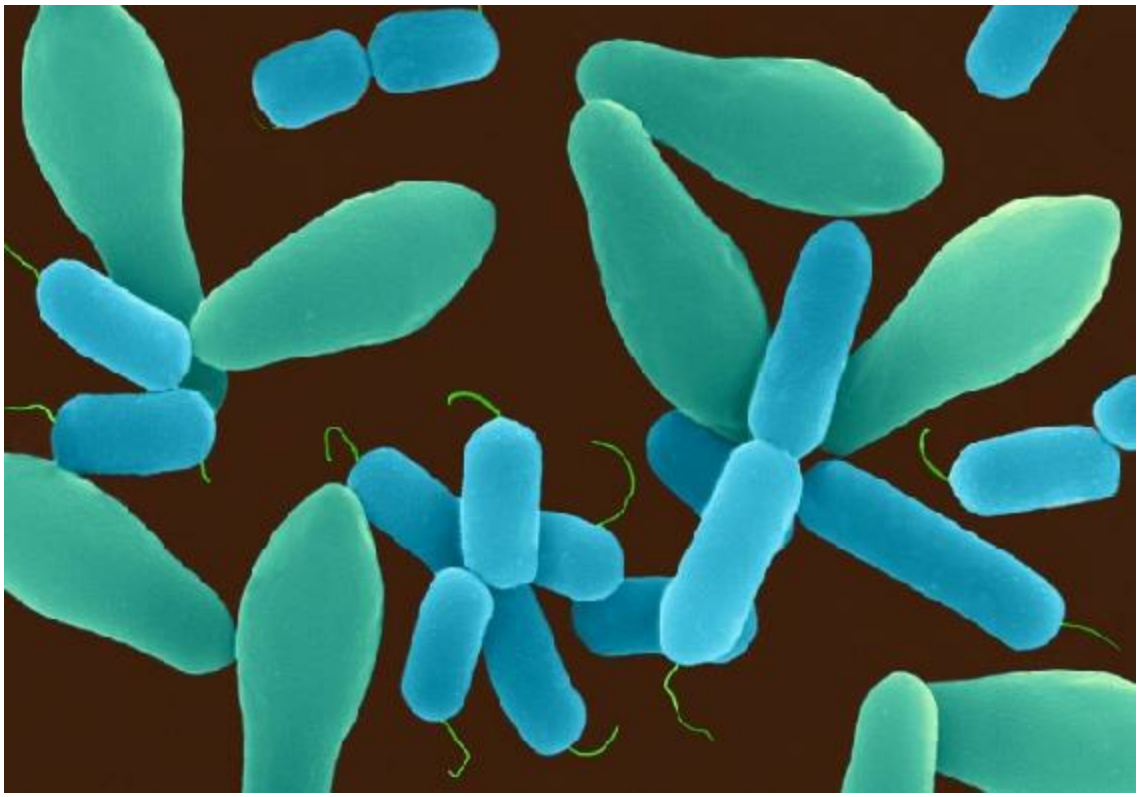
Comments

There are currently no comments.

Gut microbes can shape responses to cancer immunotherapy

Studies find that species diversity and antibiotics influence cutting-edge treaments.

02 November 2017



Dennis Kunkel Microscopy/SPL

Gut bacteria such as these *Clostridium* could improve a patient's reponse to cancer immunotherapies.

Cancer immunotherapies unleash the body’s immune system to fight cancer, but microbes living in a patient’s gut can affect the outcome of those

treatments, two research teams have found.

Their studies, published on 2 November in *Science*[1, 2], are the latest in a wave of results linking two of the hottest fields in biomedical research: cancer immunotherapy and the role of the body's resident microbes, referred to collectively as the microbiome, in disease.

They also highlight the impact of antibiotics on cancer immunotherapies, particularly drugs that block either of two related proteins called PD-1 and PD-L1. One of the studies found that people treated with antibiotics for unrelated infections had a reduced response to these immunotherapies.

“It raises important questions,” says cancer researcher Jennifer Wargo of the University of Texas MD Anderson Cancer Center in Houston, and an author of one of the studies. “Should we be limiting or tightly monitoring antibiotic use in these patients? And can we actually change the microbiome to enhance responses to therapy?”

The composition and diversity of the microbiome has been linked to everything from mental-health disorders to some side effects of cancer chemotherapy. In 2015, researchers working on mice reported that a specific genus of bacterium in the gut enhanced anti-tumour responses to drugs that target PD-L1[3].

Wargo saw a presentation about the work at a cancer meeting several years ago. “I was floored,” she says. Wargo saw an opportunity to expand the work to humans through her access to clinical samples at MD Anderson.

Exerting influence

Wargo teamed up with epidemiologist Vancheswaran Gopalakrishnan and other researchers to collect faecal samples from more than 100 people with advanced melanoma before they began treatment with anti-PD-1 immunotherapy drugs. The scientists found that those who had the most diverse gut microbes were most likely to respond to the immunotherapy[1]. And tumour growth was reduced in mice that received faecal transplants from

people who responded to immunotherapy.

The type of microbe was also linked to differences in responses to treatment, the researchers discovered. For example, people whose guts contained a lot of bacteria from a group called Clostridiales were more likely to respond to treatment, whereas those who had more Bacteroidales bacteria were less likely to respond.

A second study[2] showed that people who received antibiotics to treat infections shortly before or after starting immunotherapy did not respond as well to PD-1-blocking therapies. The researchers — led by cancer immunologist Laurence Zitvogel and cancer biologist Guido Kroemer, both of the Gustave Roussy Cancer Campus in Villejuif, France — also found that the presence of the bacterium *Akkermansia muciniphila* in both humans and mice was linked to better responses to immunotherapy.

Although it's too early for clinicians to change how they use antibiotics in people with cancer, the work is a step beyond previous studies that relied mainly on mouse models of cancer, says immunologist Romina Goldszmid of the National Cancer Institute in Bethesda, Maryland.

Now, she says, researchers need to learn more about how those microbes exert their influence on the immune system. "What's really missing in the field, rather than knowing who is there and who isn't there, is knowing what the bugs are doing," she says. "We need more information about that."

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Nature
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Comments

Comments

There are currently no comments.

Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid

Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.

02 November 2017 Corrected:

1. 06 November 2017

Tomasz Tomaszewski/VISUM creativ/eyevine

A previously unknown chamber has been found in the largest of the pyramids in Giza, Egypt.

Physicists have used the by-products of cosmic rays to reveal a large, previously unidentified chamber inside the 4,500-year-old Great Pyramid in Giza, Egypt. The find is the first discovery since the nineteenth century of a major new space inside the pyramid.

Egyptologists have been quick to dismiss any idea of finding lost treasure in the 30-metre-long void. “There’s zero chance of hidden burial chambers,” says Aidan Dodson, an Egyptologist at the University of Bristol, UK, who studies ancient Egyptian tombs. But experts hope that the finding will lead to significant insights into how this spectacular pyramid was built.

The Great Pyramid was constructed by the pharaoh Khufu (also known as Cheops), who reigned from 2509–2483 BC. Constructed from limestone and granite blocks, and rising to 139 metres, it is the oldest and largest of the Giza pyramids and one of the most impressive structures to survive from the ancient world.

Chamber layout

Whereas other pyramids from this period sit above underground burial chambers, Khufu’s Pyramid contains several large rooms inside the body of the structure itself. These include the King’s chamber, which still holds a stone sarcophagus, the smaller Queen’s chamber and a sloping passageway known as the Grand Gallery.

These large chambers were discovered in the ninth century AD and explored extensively by Western archaeologists in the nineteenth century. But enthusiasts have wondered ever since whether there might be more hidden chambers inside the pyramid, or even whether the king’s real burial chamber is yet to be found.

“There are so many theories — nice ones but also crazy ones,” says Mehdi Tayoubi, president of the Heritage Innovation Preservation institute in Paris. So, he co-founded an international collaboration called Scan Pyramids to find out; the project was supervised by the Egyptian Ministry of Antiquities. The

group is “agnostic” about particular theories, he says, but is using non-invasive technologies to search for hidden chambers.

ScanPyramids

Researchers placed muons detectors inside and outside the pyramid to find ou whether theories of a hidden space in the Great Pyramid were true.

To see through the Great Pyramid, the researchers used a technique developed in high-energy particle physics: they tracked particles called muons, which are produced when cosmic rays strike atoms in the upper atmosphere. Around 10,000 muons rain down on each square metre of Earth’s surface every minute. Sensitive muon detectors have been developed for use in particle accelerators, but they have also been used in the past decade or so to determine the inner structures of volcanoes and to study the damaged nuclear reactor at Fukushima, Japan.

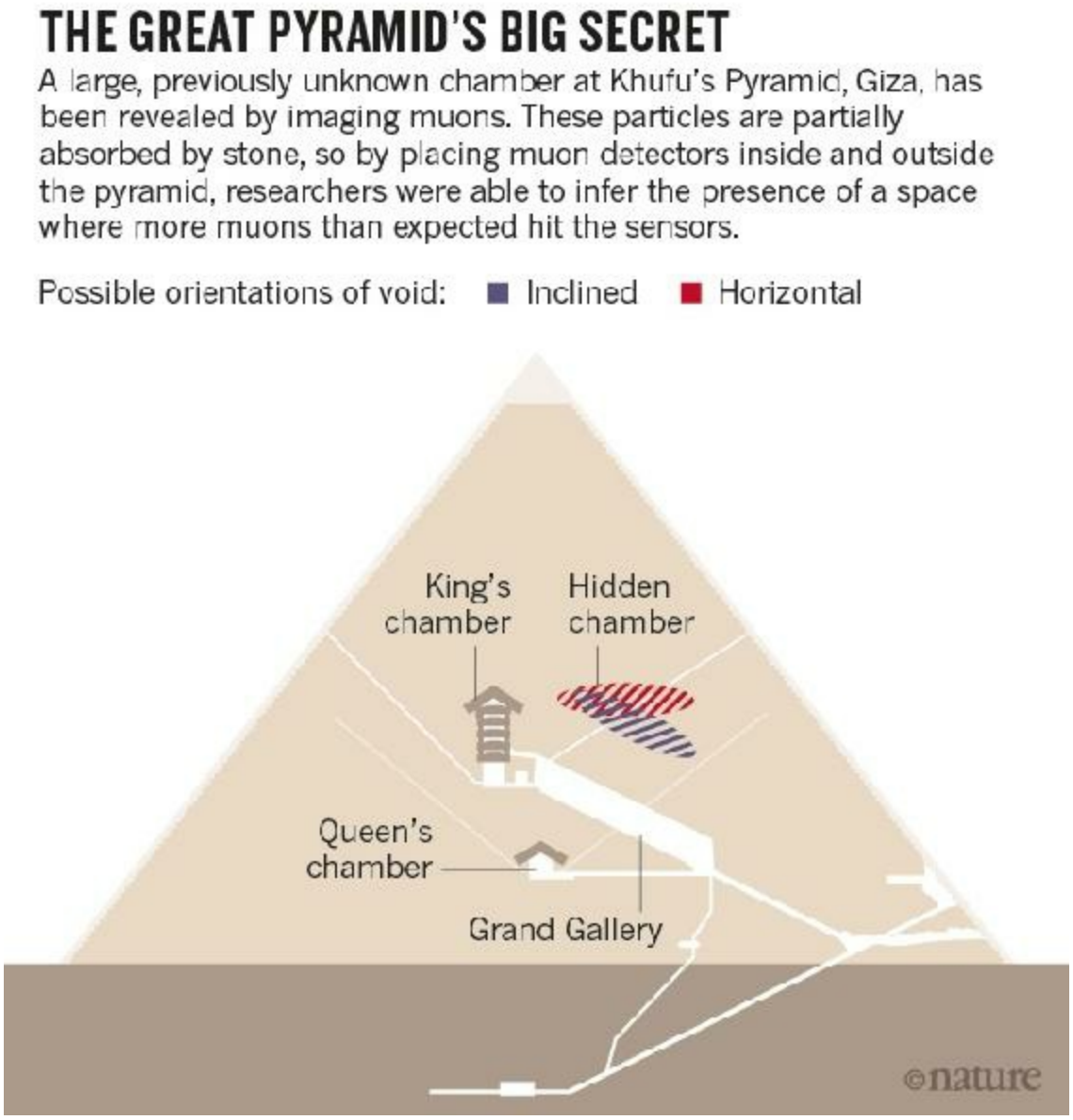
Muon maps

In December 2015, physicist Kunihiro Morishima of Nagoya University, Japan, and his colleagues placed a series of detectors inside the Queen's chamber, where they would detect muons passing through the pyramid from above. The particles are partially absorbed by stone, so any large holes in the pyramid would result in more muons than expected hitting the detectors.

After several months, "we had an unexpected line", says Tayoubi. To check the result, two other teams of physicists, from the Japanese High Energy Accelerator Research Organization in Tsukuba and the French Alternative Energies and Atomic Energy Commision in Paris, then used different types of muon detector placed in other locations both inside and outside the pyramid.

All three teams observed a large, unexpected void in the same location above the Grand Gallery (see 'The Great Pyramid's big secret'). Their results were reported in *Nature*[1] on 2 November. The space is at least 30 metres long, with a similar cross section to the Grand Gallery. "It was a big surprise," says Tayoubi. "We're really excited."

The chamber could be either horizontal or inclined, the researchers say, and might be made up of two or more smaller spaces. The purpose of the space is unknown, but Tayoubi suggests that it could be "a second Grand Gallery".



With high, corbelled — or stepped — ceilings and mysterious stone benches, the Grand Gallery is “one of the most fantastic rooms constructed in the ancient world”, says Bob Brier, an Egyptologist at Long Island University in Brookville, New York, who co-wrote the 2008 book *The Secret of the Great Pyramid* (Smithsonian). “If there’s another one, that’s real news.”

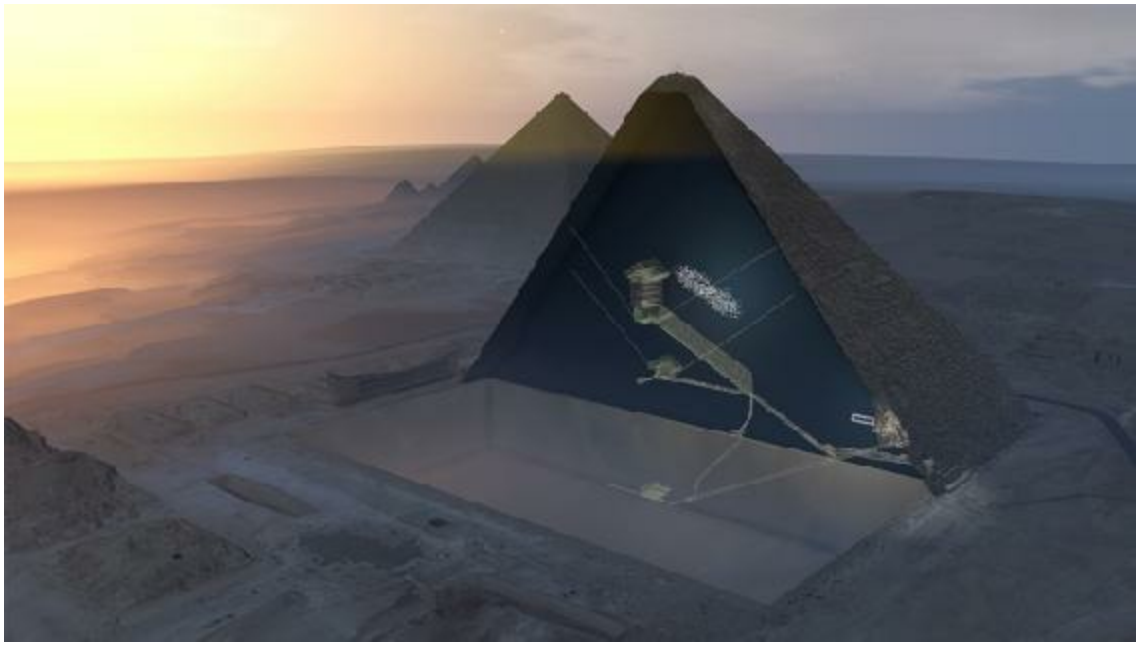
Theories abound

The newly discovered space is unlikely to contain any artefacts relating to the

king’s burial, says Dodson, because there’s already a burial chamber with a sarcophagus in it. Instead he speculates that the space might be a “relieving chamber”, intended to reduce the weight of masonry pressing down on the Grand Gallery. Similar relieving chambers are seen above the King’s chamber and in the pyramid of Khufu’s father, Sneferu, at Meidum, another pyramid site in Egypt.

But Colin Reader, an independent geologist and engineer based in Liverpool, UK, who has studied Egyptian pyramids, suggests that the new chamber is too far from the Grand Gallery to serve this purpose. He wonders whether, just as the Grand Gallery leads to the King’s chamber, the void might lead to another, higher chamber. “You would want to investigate and rule that out,” he says.

Brier has a third theory. In 2007, he and French architect Jean-Pierre Houdin suggested that the Grand Gallery formed part of a huge counterweight system. Weights sliding down the floor of the Grand Gallery could have raised the hefty, granite blocks that comprise the King’s chamber, he says. He speculates that the new space could be part of a second counterweight system higher up.



ScanPyramids

A 3D visualization of the Great Pyramid and its hidden chamber (white dots).

The results also seem to reject the theory, put forward by Houdin and Brier, that the builders of the Great Pyramid used an internal ramp to raise blocks up to the highest levels. “These data suggest that the ramp is not there,” says Brier. “I think we’ve lost.”

Tayoubi says that he next wants to scan Khafre’s (also known as Chephren’s) Pyramid, Egypt’s second largest pyramid. A team led by Nobel-prizewinning physicist Luis Alvarez carried out muon imaging in this pyramid in the late 1960s, using spark chambers as detectors and recording the cosmic-ray data on magnetic tape.

They reported no new chambers in the areas scanned[2]. But technology has improved dramatically since then, points out Tayoubi.

“I think Alvarez was a real visionary guy,” says Tayoubi. “He had the right idea, maybe too early. Our dream would be to give a tribute to Alvarez and redo the Khafre experiment, to see if he was right.”

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Corrections

Corrected:

An earlier version of this story erroneously stated that the Great Pyramid is the oldest of the Egyptian pyramids.

Comments

Commenting is currently unavailable.

Controversial chairman of US House science committee to retire

Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.

02 November 2017

Bill Clark/CQ Roll Call/Getty

Representative Lamar Smith was first elected to the US Congress in 1987.

Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, will retire when his term expires late next year.

Smith, a Texas Republican, has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation (NSF) and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. Since taking the helm of the science committee in 2013, he has transformed it from a relatively deliberative panel into an investigative weapon.

Under the rules of the House of Representatives, which limit committee chairs to six years in the role, Smith would have been forced to relinquish his post on the science panel in 2019. That is one of the reasons he decided against running for re-election, according to news reports; the other is the upcoming birth of his second grandchild. As the news of his retirement made the rounds, many scientists and environmentalists celebrated.

“It is a relief,” says Katharine Hayhoe, director of the Climate Science Center at Texas Tech University in Lubbock. Although many politicians have rejected the conclusions of climate science out of political expediency, she says, Smith has been more aggressive than most.

The congressman has repeatedly tried to reshape the NSF, sponsoring multiple pieces of legislation that would require the agency to justify its grants and explain how they serve the “national interest”. He has also pushed unsuccessfully to scale back programmes in geoscience and social sciences, among other fields.

Smith has notably scrutinized the work of climate scientists. In 2015, he attempted to compel the US National Oceanic and Atmospheric Administration (NOAA) to hand over internal documents related to a climate-change study. The research, published in *Science* in 2015[1], sought to dispel the idea that the rate of global warming had slowed down around the turn of the century. Smith went so far as to accuse a NOAA official — Thomas Karl, who has since retired — of manipulating data to advance an “extreme climate change agenda”.

In 2016, Smith came to the defence of oil giant Exxon Mobil when it was being investigated by the attorneys-general of New York and Massachusetts, who wanted to know whether the firm had misled investors about the

financial implications of global warming. Smith issued subpoenas to the attorneys-general as part of a broader probe, which also targeted environmental groups that have accused Exxon Mobil of suppressing internal research and spreading false information about climate change.

“I think [Smith’s] position on peer review, on the NSF and climate science put him at odds with the science community,” says physicist Neal Lane, a former NSF director who served as science adviser to former president Bill Clinton. “But it was consistent with that of the leadership in the House, which can hardly be described as pro-science.”

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Comments

Comments

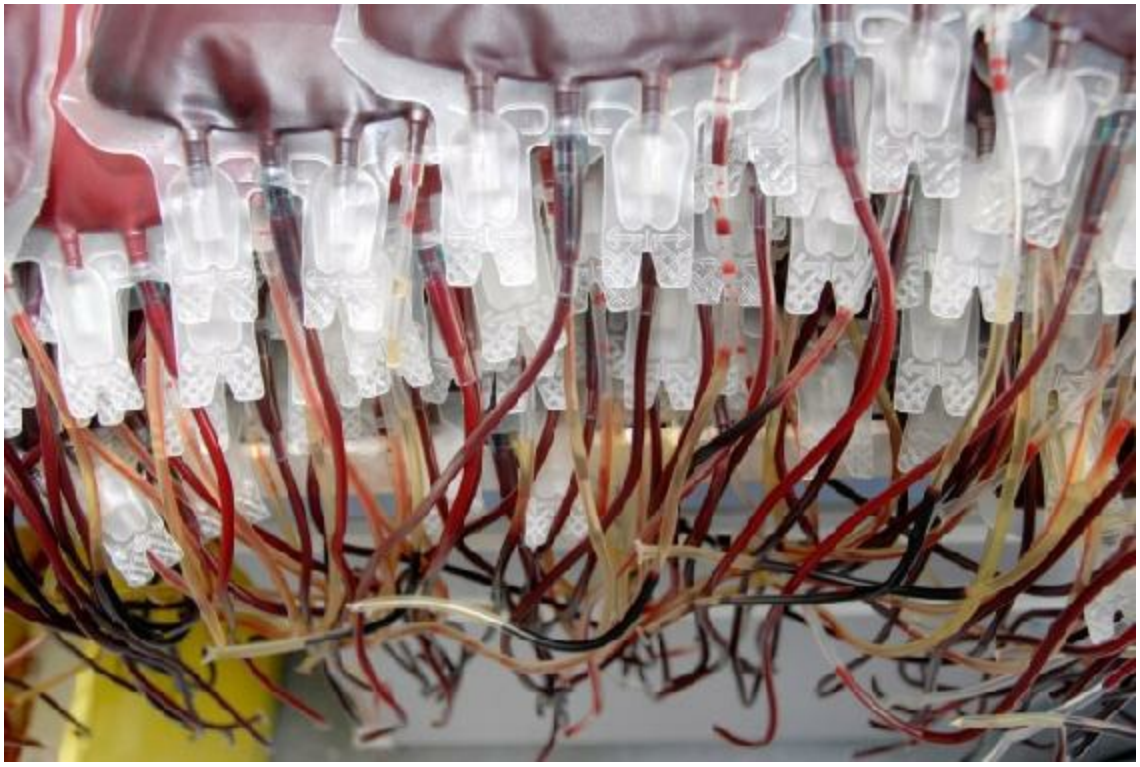
There are currently no comments.

Infusions of young blood tested in patients with dementia

The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.

01 November 2017 Corrected:

1. 03 November 2017



AJ Photo/SPL

Donor blood from young people has been transfused into people with dementia.

The first controlled, but controversial and small, clinical trial of giving young blood to people with dementia has reported that the procedure appears safe. It has also hinted that it may even produce modest improvements in the daily lives of people who have Alzheimer's disease.

Researchers who conducted the trial and others caution that the results are based on just 18 people and therefore are only a first step in exploring this type of treatment. "This is a really very small trial and the results should not be over-interpreted," says Tony Wyss-Coray, a neuroscientist at Stanford University in California. The trial was conducted by his start-up company Alkahest, which is based in San Carlos, California, and was led by Stanford neurologist Sharon Sha.

The results suggest the procedure is safe and hint that it could even boost the ability of people with dementia to undertake everyday skills, such as shopping or preparing a meal. The team announced the results on 1 November and plans to present them on 4 November at the 10th Clinical Trials on Alzheimer's Disease conference in Boston, Massachusetts.

The team tested people aged between 54 and 86 with mild to moderate Alzheimer's disease. The team gave the 18 subjects weekly infusions for four weeks. They received either a saline placebo or plasma — blood from which the red cells have been removed — from blood donors aged 18–30. During the study, the team monitored the patients to assess their cognitive skills, mood and general abilities to manage their lives independently.

The study detected no serious adverse reactions. It saw no significant effect on cognition, but two different batteries of tests assessing daily living skills both showed significant improvement.

The human trial grew out of earlier 'parabiosis' experiments, in which the blood systems of two rodents are surgically joined together to see what happens when molecules circulating in one animal enter another animal.

Alkahest now plans to conduct a second, larger trial using plasma from which many proteins and other molecules have been removed. Wyss-Coray, whose group did most of the mouse studies that inspired the clinical trial[1] told *Nature* that his experiments suggest that such a treatment could be more

effective than using whole plasma.

Transfusion confusion

Blood-transfusion trials are controversial because the active molecules in plasma that seem to lead to the purported effects are unknown.

Irina Conboy, a neurologist at the University of California, Berkeley, and her colleagues have performed extensive parabiosis experiments stitching together young and old mice that have been genetically matched. She has found that young blood clearly rejuvenates mouse tissues such as the heart and the brain[2]. But she says that the effects are probably coordinated by a complex orchestration of factors in the blood that needs to be understood more fully before moving to the clinic.

“The scientific basis for the trial is simply not there,” she says. “The effects of young blood on cognition have not been replicated by an independent group, and there has never been a test with a mouse model of Alzheimer’s.” She says that frequently exposing older people to foreign plasma may be unsafe, because hyperactivation of their immune systems could lead to autoimmune or inflammatory disease.

But, Wyss-Coray says, “Alzheimer’s patients don’t want to wait until the exact mode of action is discovered.”

He says that it is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain, which has so far failed to result in any treatments.

Blood transfusions used for this purpose do not require approval by the US Food and Drug Administration, and some American companies are already charging hefty fees for transfusions of blood from young people.

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Corrections

Corrected:

An earlier version of this story wrongly identified Tony Wyss-Coray as leading the clinical trial. In fact, the trial was led by neurologist Sharon Sha of Stanford University and doctors working for Alkahest. Alkahest, not Wyss-Coray, will conduct the second, larger trial. Wyss-Coray was also wrongly identified as a neurologist.

Comments

1 comment

1. *Chris Exley* • 2017-11-02 03:10 PM

   Wyss-Coray is clearly wrong to suggest that this 'is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain'. We showed that silicon-rich mineral waters provided some cognitive improvements in individuals with AD over only 12 weeks (https://content.iospress.com/articles/journal-of-alzheimers-disease-reports/adr170010) and similar research published today has suggested benefits in individuals with multiple sclerosis (http://www.ebiomedicine.com/article/S2352-3964(17)30428-0/fulltext). Unfortunately we do not have the resources of Wyss-Coray to take these prospective therapies further.

Pay for US postdocs varies wildly by institution

Analysis of universities' salary data suggests major disparities in pay for early-career researchers.

01 November 2017

Some postdoctoral researchers at public universities in the United States apparently work for fast-food wages whereas others make more than US$100,000 a year, an analysis of postdoc pay has revealed.

The salary data, which a science-advocacy group released on 1 November after a year-long investigation, are incomplete and — in some cases — appear to be incorrect. Some researchers are listed as earning nothing, and another study underway suggests a higher overall rate of pay for US postdocs. But the latest analysis underscores the challenges of getting basic information about an under-recognized and misunderstood segment of the

academic workforce.

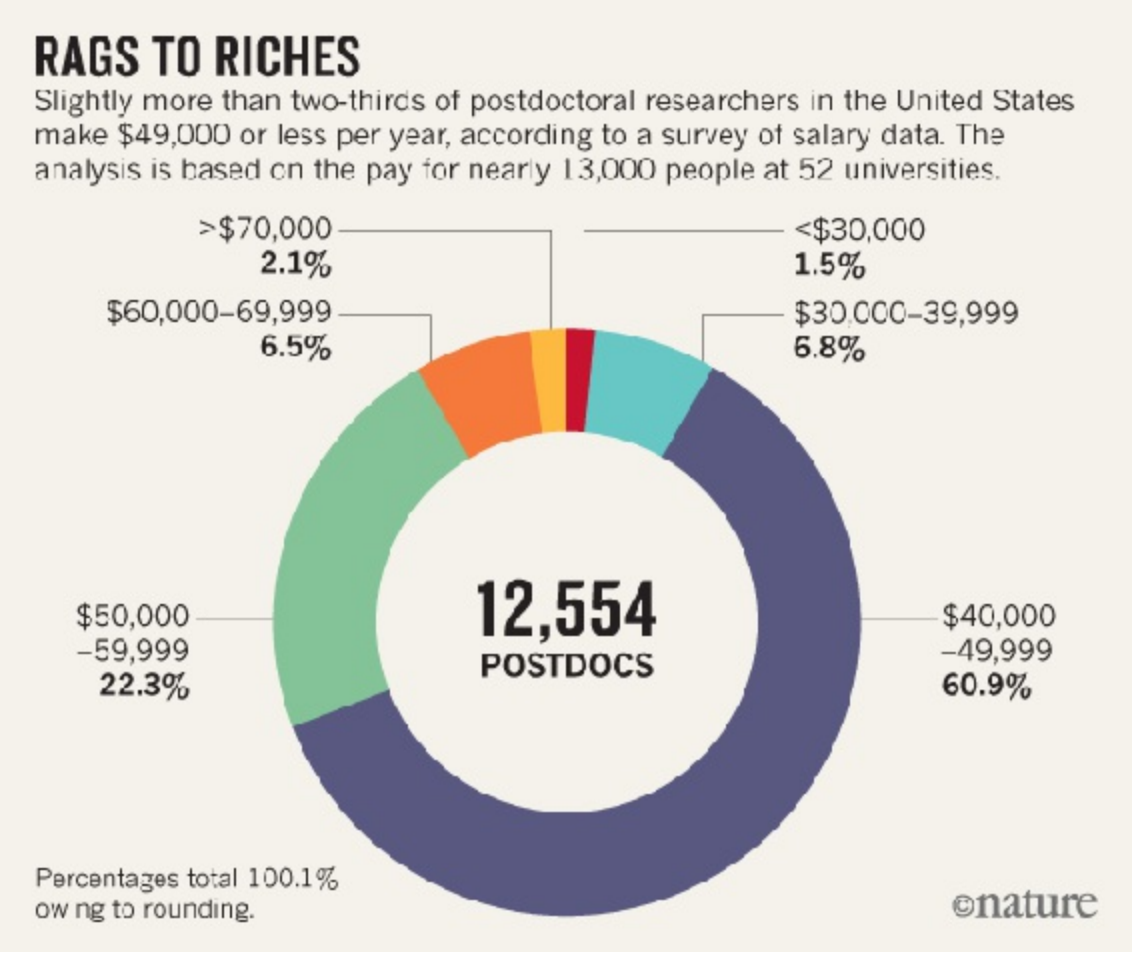
Gary McDowell, a former developmental biologist and executive director of Future of Research, an advocacy group in Boston, Massachusetts, used the US Freedom of Information Act to gather salary reports for nearly 13,000 postdocs at 51 public universities. Through personal connections, he also received salary information from one private institution, Boston University in Massachusetts.

Most universities made a good-faith effort to provide salary information, McDowell says, but few had the numbers at hand when he contacted them. McDowell says that he had to spend considerable time on the phone explaining to university employees what 'postdoc' means. “I asked a basic question — 'How much do your postdocs get paid?' — but there was a lot of confusion,” he says. “It points to how much interest there is in postdocs at these institutions.”

Multiply by zero?

Some universities still provided improbable numbers. They include the University of Utah in Salt Lake City, which reported that 50 postdocs each made $0 per year. McDowell says it is unlikely that these researchers were unpaid volunteers. Instead, he suspects that some institutions — including the University of Utah — reported only the money that postdocs received from the institution's payroll, and overlooked fellowships and other external sources of income. “University of Utah postdoctoral scholars are being paid for their work,” a university spokesman said.

While compiling data, McDowell opted to disregard the 411 reported salaries that were less than $23,660 a year. That is the threshold below which many postdocs would be eligible for overtime pay under a federal law called the Fair Labor Standards Act. “I gave them the benefit of the doubt,” McDowell says of those entries. “Those are likely reporting errors.”



Gary McDowell/Future of Research

The remaining 12,554 salary reports ranged from $23,660 to $114,600 a year (see 'Rags to riches'). McDowell suspects that some institutions mistakenly included pay data for staff scientists or other employees in their reports, which could explain some of the highest salaries. Even with that caveat, his survey suggests that postdoc salaries range widely. At any given institution, McDowell says, “It’s not uncommon for there to be fourfold differences between the highest and the lowest paid.”

Overall, 61% of reported salaries were between $40,000 and $49,999, and about 31% were reported at $50,000 or more. (The $50,000 figure is the minimum postdoctoral salary recommended in 2014 by the US National Academies of Sciences, Engineering, and Medicine.) The University of Illinois at Urbana-Champaign reported the lowest median salary at $27,515.

The University of Maryland at College Park reported the highest median figure — $56,000.

Emerging trends

McDowell notes that the data set is still incomplete. Some institutions reported salaries for only a small fraction of their workforce, and the University of California (UC) system denied his request outright. The university system's public-records office told *Nature* in a statement that it lacks the capacity to do "the programming required to create the custom data report that Mr McDowell requested". The University of California, Santa Barbara, had already provided numbers to McDowell when the broader UC system denied his request for data.

Other attempts to gather information on postdoctoral salaries have met with less resistance. The National Postdoctoral Association (NPA) in Rockville, Maryland, solicited salary information from its more than 200 member institutions for a forthcoming report. "We've worked with these institutions for over a decade, and when we ask for information they readily give it," says Kate Sleeth, chairwoman of the NPA's board of directors. "We didn't have to explain to anyone what a postdoc is."

Of the 127 NPA member institutions that participated in the survey, 85% reported paying all postdocs at least $47,484 — the minimum salary established by the US National Institutes of Health for the 2017 fiscal year. The NPA is set to publish the full results of its poll in January 2018.

In the meantime, McDowell is still combing through his data set. Throughout November, he plans to publish daily analyses on the Future of Research website, futureofresearch.org, that will examine salaries at individual institutions and university systems. In doing so, he hopes to promote conversation about the treatment of early-career researchers.

"In academia, we're not supposed to talk about money and we're not supposed to aspire to having money," McDowell says. "I think scientists should value scientists."

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Comments

Commenting is currently unavailable.

Citation is not the only impact

A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.

01 November 2017

Getty

A research paper on drying coffee stains had unusual and unexpected applications.

What makes good science? And how do *Nature*'s editors select papers to publish? The answers to both questions are many and varied. But they have one thing in common: neither is necessarily reflected in citations.

Nature publishes about 800 papers each year. Over, say, two years following

publication, the pattern of citations typically ranges from a few papers with citations in the hundreds, to a large number with tens of citations, and a tail with single figures.

We are pleased when our papers make an impact. But there is much more to scientific impact than citations. For example, last week, in an 'In Retrospect' article in News & Views, Ronald Larson described a remarkable story (R. Larson *Nature* **550,** 466–467; 2017). In 1997, *Nature* published a paper by Robert Deegan and his colleagues that provided an explanation of the 'coffee-ring effect' in spilt liquids, based on considerations of evaporation and surface interactions (R. D. Deegan *et al. Nature* **389,** 827–829; 1997). For several years, the paper sat proudly in our pages, typically gathering about 20 citations per year. In 2006, as new implications and applications became clear, the rate picked up to well over 100 a year. So far, it has attracted about 4,000 citations. The paper is worth highlighting as an example of the varied types of judgement that *Nature* editors use to select papers.

Our most highly cited papers are indeed often key landmarks in their fields. But there are papers that turn out to have low citations that we are equally happy to have published. The work by Deegan *et al.* was selected not because of any editorial ability to anticipate advances years in the future, but because, at the time, we considered it to be a noteworthy and pleasing piece of insight. Nothing more, nothing less. The developments celebrated by Larson are an editor's unexpected bonus.

Most papers that we publish, with the invaluable help of our reviewers, are selected with a view to their scientific significance, whether as a powerful insight or an unusually empowering resource. And often that will correlate closely with citations (although citation patterns differ across disciplines). But it's important also, for editors in all the disciplines from which we publish, sometimes to appreciate the interest in a paper using quite different criteria. It may be compelling for its sheer creativity or logical elegance, for making the reader stop and think very differently about a question, or for a stimulating and even mysterious observation. Many of these may be slow burners citation-wise — or simply be textbook examples that never get taken up in abundance. Here are other examples, drawn from the physical sciences,

that, despite low citations, we like to celebrate.

One such paper illustrated how images could be taken using X-rays radiated when sticky tape was peeled (C. G. Camara *et al. Nature* **455,** 1089–1092; 2008). The citations are not huge by physics standards (165 since 2008) but we still love it, and we did not fully anticipate how it would go viral on social media. Another (11 citations) reported an actual sample of Cretaceous seawater from 145 million years ago. (W. E. Sanford *et al. Nature* **503,** 252–256; 2013). And finally, a theoretical paper providing an exact textbook solution for the capacity of noisy quantum communication channels has been cited just six times since 2013 (G. Smith and J. A. Smolin *Nature* **504,** 263–267; 2013), but we value it for what it is and anticipate that its take-up could increase as research moves from idealized 'noise-free' systems to more realistic noisy ones.

There are examples in other disciplines too. Why highlight such papers? Because we are glad to have published them. And because it's perhaps salutary to appreciate just how unrelated scientific interest (at least, as we at *Nature* see it) and citation numbers can be.

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Comments

Commenting is currently unavailable.

Urban Vibe
Studios
London

University systems allow sexual harassers to thrive

It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen[1].

01 November 2017

Harvey Weinstein, Roger Ailes, Geoff Marcy. From entertainment to academia, accusations of these people's abuses of power have helped to create a sea change in the numbers of people willing to discuss sexual harassment in the workplace. Much of the conversation has concerned condemnation of harassers and praise for those who come forward to talk about what they have seen and experienced. This puts an interpersonal frame on a systemic problem. Attention must also be paid to systems that allow harassers to thrive.

In 2006, I joined the Brain and Cognitive Sciences Department at the University of Rochester, New York, as a PhD student. This August, I joined other female graduate students and postdocs who contributed testimony to a complaint to the US Equal Employment Opportunity Commission over

sexual harassment, poor handling of investigations of our claims and discrimination. We described how we actively avoided Florian Jaeger, a professor in our department, because of his frequent sexual innuendos, pressure to have intimate relationships and other unprofessional behaviour. We were faced with the unfair and unreasonable choice of losing professional opportunities or exposing ourselves to profoundly disturbing encounters. (According to *The New York Times*, Jaeger has since taken a leave of absence but said this was not an admission of guilt.)

I knew this behaviour was not acceptable. I was also convinced that if I came forward alone, I risked retribution and the university would not take my claims seriously. I felt my best option was to warn other students privately and make it known that I would come forward if we reached a critical mass.

After I chose to move away to finish my dissertation, I learnt that in 2013 two colleagues had complained to the department chair about Jaeger's behaviour and given my name as someone who should be interviewed. I was not contacted. In 2016, other senior faculty members learnt of these claims and filed a second complaint to the university to investigate. This time the university first contacted me during an appeal, after issuing a report that cleared Jaeger. The first person to secure testimony from me was from McAllister Olivarius, a London-based legal firm hired by the plaintiffs. My former colleagues had found a powerful ally in getting their complaints taken seriously.

It should not have taken such heroic efforts.

In this regard, Hollywood and academia have troubling similarities. Both rely too much on mentor–protégé relationships, with few checks on individual power. In academia, there is scant protection for lab members. Graduate students and postdocs are viewed more as part of their supervisor's lab than part of the university community. By contrast, institutions have many incentives to protect their powerful, permanent and often lucrative faculty members.

Administrators can reasonably assume that, if they ignore claims for long enough, they will never be held to account. People like me graduate or leave without a degree, the statute of limitations passes, and the harassers get

promoted. Sometimes universities don't interview suggested witnesses or collect other evidence; in my view, this allows them to claim that they investigated complaints but found insufficient reasons for further action. (The University of Rochester has said it took the allegations seriously and that its investigation was thorough.)

Since completing my PhD, I've taken a position at a large company. There are still power differentials in such settings, and sexual harassment can occur unpunished anywhere. However, I've seen several practices that I think academia could learn from.

In my first week of employment, the company explained my rights to a safe workplace and gave me options for reporting concerns. As a graduate student, I had mistakenly believed that the only instances of sexual harassment that could be brought forward were the most egregious: assault or quid-pro-quo propositions. I was unaware of legal precedents involving pervasive harassment creating a hostile and unequal environment. I was also unaware of the standard of preponderance of evidence, and thought that every instance had to be recorded and irrefutable. Graduate students and employees should not have to be legal scholars to win protections.

Another problem is how much the fate of a graduate student or postdoc depends on a supervisor who controls funding for their position, when they can submit a dissertation or paper and what other opportunities they can apply for. Power is less likely to be abused when it is more distributed.

My current company holds drop-in conference calls throughout the year, some of which are reserved for women only. We can discuss concerns off the record or even anonymously; topics range from standardizing the promotion process and improving diversity in recruitment, to discussing comments that have made us feel undermined or uncomfortable. People bringing concerns have options about whether and how they are reported outside the call. At the same time, leaders can become aware of even minor problems and address them (through discussion with staff and line managers, or through memos) before they become patterns that lead to a toxic work environment.

We used to consider those in leadership positions blameless simply by virtue of not being harassers themselves. We now expect better.

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Comments

Comments

There are currently no comments.

Interstellar visitor, Arctic shipwrecks and a retraction recommendation

The week in science: 27 October–2 November 2017.

01 November 2017

History | Universities | People | Medicines | Research | Space | Events | Facilities | Climate | Trend watch | Awards

HISTORY

Arctic explorer's wrecks given to Canada The UK government is giving Canada two historic shipwrecks: those of HMS *Erebus* and HMS *Terror*. The vessels were part of British explorer Sir John Franklin's ill-fated 1845 expedition to find the Northwest Passage, a long-sought shipping route that connects the Atlantic and Pacific oceans through the Canadian Arctic. Franklin died, along with his entire crew, after the ships became ice-bound and the team abandoned them. Marine archaeologists discovered *Erebus* and *Terror* in 2014 and 2016, respectively, off King William Island. In 1997, an agreement had granted custody of the yet-to-be located wrecks to Canada, although they remained property of the United Kingdom. On 23 October, the UK government said that it would transfer ownership of the ships to Parks Canada, a government agency.

Parks Canada

Part of the wreck of the HMS *Terror*.

UNIVERSITIES

Institute dissolved The Swiss Federal Institute of Technology in Zurich (ETH Zurich), one of Europe's leading universities, has launched an investigation into allegations that PhD students were regularly bullied in its Institute for Astronomy. ETH Zurich released a statement on 25 October saying that it had closed the institute in August in response to the accusations, which were made earlier this year. Newspaper reports say students had complained that astrophysicist Marcella Carollo — a professor, and wife of the institute's director Simon Lilly — had been inappropriately and personally critical, and overly demanding of their time. The university did not publicly name the couple, but said that it had transferred their professorships to the university's physics department. It moved other Institute for Astronomy staff to a newly created Institute for Particle Physics and

Astronomy, and assigned the students new supervisors.

Science cluster French President Emmanuel Macron has announced a plan to save the troubled Paris-Saclay project, an attempt to create a single science 'super-campus' southwest of the city. During a visit to the site on 25 October, Macron said that the project would now proceed in two clusters, one made up of elite institutions called *grandes écoles*, and one made up largely of universities. The project, which initially aimed to bring together nearly 20 research and teaching institutions under one umbrella university, had been mired by the *grandes écoles*' refusal to give up their names and autonomy. A previous effort this year to find a compromise solution had failed. "The time of procrastination is behind us," Macron said.

PEOPLE

Surgeon's papers Six research papers co-written by disgraced thoracic surgeon Paolo Macchiarini should be retracted because they contain evidence of scientific misconduct, the Swedish Central Ethical Review Board said in a statement dated 27 October. The papers had been central to Macchiarini's claims about a radical stem-cell-based tracheal transplant, which he developed partly during his employment by the Karolinska Institute in Stockholm. The institute had asked the ethics board to examine the papers. Earlier last month, Swedish public prosecutors dropped their investigations into charges of manslaughter and grievous bodily harm by the surgeon. The charges involved four people on whom Macchiarini had performed operations at the Karolinska University Hospital between 2011 and 2013. Three have since died, but the prosecutors said there was a lack of conclusive evidence that the surgery caused the deaths. They noted negligent procedures in some of the operations.

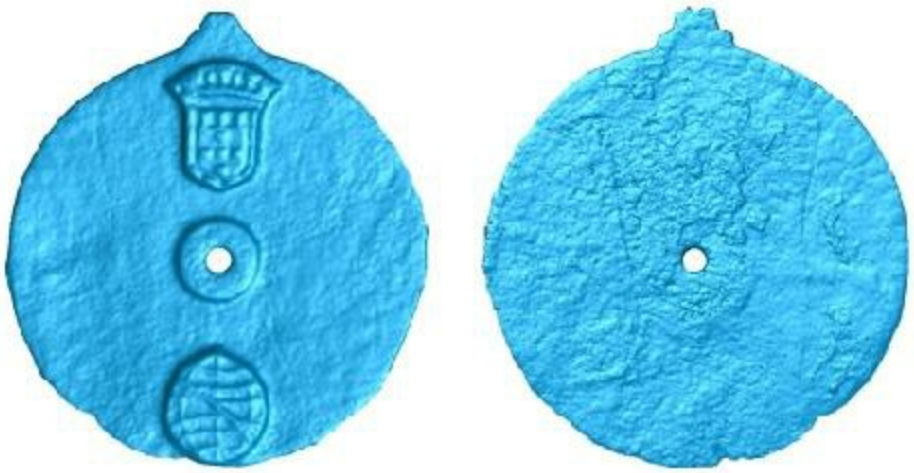
MEDICINES

Hepatitis C drugs On 25 October, a US non-profit organization filed challenges against six core patents for sofosbuvir, a key component of three hepatitis C drugs. The medicines — Sovaldi, Harvoni and Epclusa — belong

to Gilead Sciences in Foster City, California. The Initiative for Medicines, Access and Knowledge (I-MAK) in New York City argues that Gilead's patents are unmerited because the drug is not different enough to warrant a US patent, saying that the company developed the compound by tweaking existing HIV and cancer drugs. The patents prevent cheaper, generic drugs from entering the US market. Using a similar argument, I-MAK had a sofosbuvir patent removed in China in 2015.

RESEARCH

Old astrolabe A 500-year-old bronze disc recovered from a shipwreck in 2014 might be the oldest-known example of a technology that changed world history. The artefact was retrieved from the wreck of the *Esmeralda*, part of the fleet of the Portuguese explorer Vasco da Gama. On 24 October, researchers at the University of Warwick in Coventry, UK, said that laser scanning has now revealed markings at 5-degree intervals around its circumference, suggesting that the 17.5-centimetre-diameter object is a mariner's astrolabe. Developed by Portuguese navigators in the late fifteenth century, these devices determine latitude by measuring the Sun's altitude, and helped sailors to explore the oceans and map the world. The *Esmeralda* sank in the Indian Ocean in 1503, making this mariner's astrolabe several decades older than any of the hundred or so others that survive.



WMG/University of Warwick

Composite image of scans of a 500-year-old bronze astrolabe.

SPACE

Foreign object Astronomers have spotted a space rock that might have come from outside the Solar System. The small asteroid or comet, named A/2017 U1, swooped towards and then past the Sun from an angle almost perpendicular to the plane in which most of the planets orbit. Its trajectory — a hyperbolic orbit — suggests that it came from interstellar space, NASA said on 26 October, a week after the object's discovery. If further observations confirm its orbit, it would be the first such interstellar object known.

Earth mission ends The paired satellites of the US–German Gravity Recovery and Climate Experiment (GRACE), which have been making fundamental observations of Earth since their 2002 launch, have ceased science operations. Mission controllers realized on 12 October that the

batteries in one of the satellites had failed because of its age, a long-expected outcome. NASA and the German space agency DLR announced the mission's end on 27 October, and said the other satellite will be decommissioned next year. GRACE has provided crucial measurements of melting ice sheets and groundwater storage, among other things.

EVENTS

Weedkiller dispute The European Union postponed a decisive vote on 25 October on proposals to renew its licence for the controversial weedkiller glyphosate. The current EU authorization expires on 15 December. But member states were unable to settle on a compromise for how long the licence should be extended by. The World Health Organization says that glyphosate is "probably" carcinogenic to humans, but key EU safety agencies say it is not. Member states will be asked to vote on a five-year extension on 9 November. More than 1.3 million Europeans have signed a petition calling for the substance to be banned.

Harassment probe The US House Committee on Science, Space, and Technology is investigating allegations of sexual harassment against geologist David Marchant of Boston University, Massachusetts. Marchant has received about US$5.4 million in funding since the 1990s from federal agencies, including the National Science Foundation (NSF) and NASA. In letters sent to the NSF, NASA and Boston University on 26 October, the committee asked for all documents and communications involving federal grants awarded to Marchant, as well as complaints of alleged assault and harassment and any actions taken by each institution. Two of Marchant's former graduate students filed complaints with Boston University, in October 2016 and May 2017, for behaviour that allegedly occurred while they were on research trips with him in Antarctica in the 1990s.

FACILITIES

Genome database A Chinese province is building a large sequencing centre that will create a database of genetic information from Chinese people. The

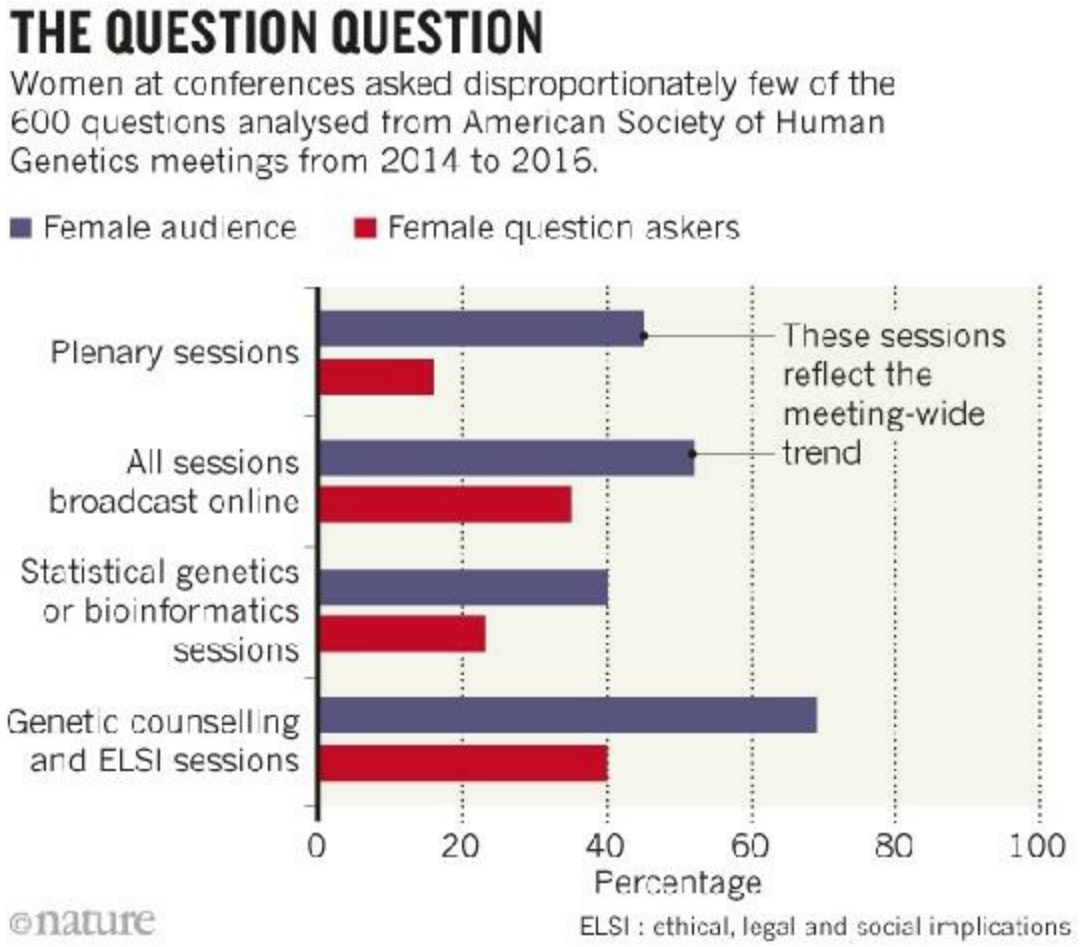
National Health & Medicine Big Data Center is being built in Nanjing, the capital of Jiangsu province, as part of a 6-billion-yuan (US$905-million) genome project announced by the local government on 29 October. The centre will house multiple firms that will together sequence up to 500,000 samples a year. Data will be used to look for mutations related to disease, as well as environmental factors that might trigger illness. Researchers will also use the data to tailor treatments to individual patients.

CLIMATE

Record CO_2 levels Atmospheric concentrations of carbon dioxide surged at a record pace and to a record high in 2016 because of human emissions and an El Niño warming event, the World Meteorological Organization said on 30 October. Average global CO_2 concentrations rose from 400 to 403.3 parts per million, roughly 45% above pre-industrial levels. The last time Earth had comparable CO_2 levels was during the mid-Pliocene epoch around 4 million years ago, when temperatures were 2–3 °C warmer than those today and sea levels were 10–20 metres higher. Concentrations of the greenhouse gases methane and nitrous oxide also increased, to 157% and 22% above pre-industrial levels, respectively.

TREND WATCH

Women ask fewer questions than men at conferences, even if there are more women in the room, according to an analysis of talks at American Society of Human Genetics (ASHG) meetings in 2014–16. Natalie Telis of Stanford University in California and her colleagues looked at 600 questions asked at 222 conference talks. To reach parity in question-asking, the audience would have to be at least 85% women, they say. Women are most likely to question female speakers, but still speak up less often than men.



Source: Natalie Telis

AWARDS

Space pioneers The first woman and the first Chinese national in space were among four recipients of the inaugural medal for space science from the United Nations Educational, Scientific and Cultural Organization (UNESCO). Awards for Chinese astronaut Yang Liwei, who completed the country's first crewed space mission in October 2003, and Russian cosmonaut Valentina Tereshkova were announced at a ceremony in Paris on 27 October. Also honoured were Koichi Wakata, the first Japanese commander of the International Space Station, and Arnaldo Tamayo Mendez, the first Cuban in space. The medal, established in June, recognizes

prominent researchers or public figures who have contributed to space science.

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Comments

There are currently no comments.

Plans to promote German research excellence come under fire

Critics say selection process for high-stakes funding programme is flawed.

01 November 2017

Bern Lauter/vario images GmbH/Alamy

Peter Strohschneider, president of the DFG.

Germany’s latest programme to boost research at its universities and make them more competitive internationally risks missing its goals, according to

observers.

The Excellence Initiative was launched in 2005 with €4.6 billion (US$5.4 billion) in funding and the aim of creating a handful of elite universities. Researchers across Germany are now preparing for the programme's next round, dubbed the Excellence Strategy, which starts in 2019.

Earlier this year, almost 200 groups of scientists submitted proposals to form Clusters of Excellence — large collaborations of research groups at one or more universities that form the core element of the strategy. And last month, an international committee invited 88 of the groups to submit full project proposals by late February. Up to 50 such clusters will from 2019 receive top-up funding of about €8 million per year for seven years.

But observers question whether the 88 selected projects represent Germany's best science, particularly because the focus for selection has shifted away from basic science and towards applied research. Unsuccessful applicants say that the rules for submitting proposals for the initiative were not clearly defined and communicated. Several high-profile groups came away empty-handed, including biology teams in Frankfurt, Heidelberg and Munich involving dozens of scientists funded by the prestigious European Research Council.

"The Excellence Initiative has brought German science some welcome structural change," says Dieter Imboden, a Swiss environmental physicist who chaired a 2016 review of the initiative. "But its achievements must not obscure the view of its flaws."

The competition to form clusters should be run independently of that for elite-university status, he says. Otherwise, second-tier universities could outperform those with a much stronger overall research portfolio and gain the sought-after title, which is currently held by 11 universities.

Critics also say that the geographic spread of positively reviewed applications for future excellence clusters — across 41 universities in 13 of Germany's 16 states — hints at a political desire to distribute the funds more evenly across the country.

But Peter Strohschneider, president of Germany's main research-funding agency, the DFG, which runs the programme, says the selection panels chose the projects strictly on the basis of scientific quality, without any regional or political considerations. Scientists will figure strongly on the Excellence Commission, which will make the final selection in September 2018 and will also include federal and state science ministers, he says.

Until 2005, responsibility for funding universities in Germany lay exclusively with the states. The Excellence Initiative was created to allow central government to inject federal money into research, a move now guaranteed by a change to the German constitution. But many say the changes have not gone far enough.

"The initiative has quite lost sight of its goal," says a former president of a large German university, speaking on condition of anonymity. "Universities here remain trapped in a federal political system that is unable to create a powerhouse like Yale or Harvard."

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The new thermodynamics: how quantum physics is bending the rules

Experiments are starting to probe the limits of the classical laws of thermodynamics.

01 November 2017

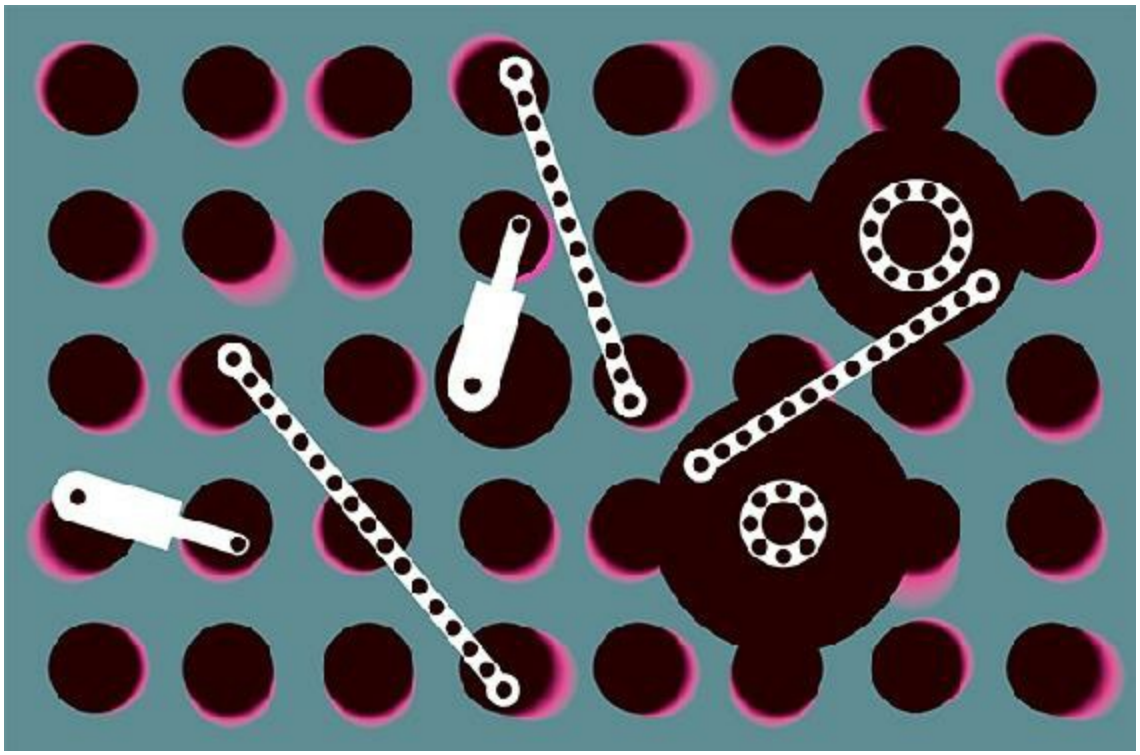


Illustration by Edgar Bąk

It would take a foolhardy physicist to dare attempt to break the laws of thermodynamics. But it turns out that there may be ways to bend them. At a lab at the University of Oxford, UK, quantum physicists are trying to do so with a small lump of synthetic diamond. At first, the diamond is barely

visible, nestled inside a chaotic mess of optical fibres and mirrors. But when they switch on a green laser, defects in the diamond are illuminated, and the crystal begins to glow red.

In that light, the team has found preliminary evidence of an effect that was theorized only a few years ago[1]: a quantum boost that would push the diamond's power output above the level prescribed by classical thermodynamics. If the results hold up, they will be a tangible boon for the study of quantum thermodynamics, a relatively new field that aims to uncover the rules that govern heat and energy flow at the atomic scale.

There is reason to suspect that the laws of thermodynamics, which are based on how large numbers of particles behave, are different in the quantum realm. Over the past five years or so, a quantum-thermodynamics community has grown around that idea. What was once the domain of a handful of theoreticians now includes a few hundred theoretical and experimental physicists around the globe. “The field is moving so fast I can barely keep up,” says Ronnie Kosloff, an early pioneer of the field at the Hebrew University of Jerusalem in Israel.

A number of quantum thermodynamicists hope to find behaviour outside the remit of conventional thermodynamics that could be adapted for practical purposes, including improving lab-based refrigeration techniques, creating batteries with enhanced capabilities and refining technology for quantum computing.

But the field is still in its infancy. Experiments such as the one taking place at Oxford are just starting to put theoretical predictions to the test. And physicists working at the periphery are watching such tests closely for evidence of the useful applications that theorists have predicted. “Quantum thermodynamics is clearly hot — pardon the pun,” says Ronald Walsworth, a physicist at Harvard University in Cambridge, Massachusetts, who specializes in developing precision atomic-scale tools. “But for those of us looking in from the outside, the question is: can it really shed new light on the development of technologies?”

Breaking the law

The development of the classical laws of thermodynamics stretches back to the nineteenth century. They emerged from the effort to understand steam engines and other macroscopic systems. Thermodynamic quantities such as temperature and heat are statistical in nature and defined in reference to the average motion of large ensembles of particles. But back in the 1980s, Kosloff began pondering whether this picture would continue to make sense for much smaller systems.

It wasn't a popular line of research at the time, says Kosloff, because the questions being asked were largely abstract, with little hope of connection to experiments. “The field developed very slowly,” he says. “I was alone for years.”

That changed dramatically around a decade ago, as questions about the limits of technological miniaturization became more pressing and experimental techniques advanced. A flurry of attempts were made to calculate how thermodynamics and quantum theory might combine. But the resulting proposals created more confusion than clarity, Kosloff says. Some claimed that quantum devices could violate classical thermodynamic constraints with impunity and so act as perpetual-motion machines, capable of performing work without needing any energy input. Others, suggesting that the laws of thermodynamics should hold unmodified at very small scales, were equally perplexing. “In some sense, you can use the same equations to work out the performance of a single atom engine and your car engine,” says Kosloff. “But that seems shocking, too — surely as you get smaller and smaller you should hit some quantum limit.” In classical thermodynamics, a single particle doesn't have a temperature. So as both the system generating work and its environment approach that limit, it becomes increasingly absurd to imagine that they would obey standard thermodynamic rules, says Tobias Schaetz, a quantum physicist at the University of Freiburg in Germany.

The preponderance of conflicting theoretical claims and predictions initially undermined the burgeoning field's credibility. “I have been very critical of the field because there is far too much theory and not enough experiment,” says quantum physicist Peter Hänggi, at the University of Augsburg in Germany. But the community is beginning to coalesce more formally around core questions in an effort to cut through the chaos. One goal has been to use

experiments to uncover the point at which the classical laws of thermodynamics no longer perfectly predict the thermal behaviour of quantum systems.

Experiments are starting to pin down that quantum–classical boundary. Last year, for example, Schaetz and his colleagues showed that, under certain conditions, strings of five or fewer magnesium ions in a crystal do not reach and remain in thermal equilibrium with their surroundings like larger systems do[2]. In their test, each ion started in a high-energy state and its spin oscillated between two states corresponding to the direction of its magnetism — 'up' and 'down'. Standard thermodynamics predicts that such spin oscillations should die down as the ions cool by interacting with the other atoms in the crystal around them, just as hot coffee cools when its molecules collide with molecules in the colder surrounding air.

Such collisions transfer energy from the coffee molecules to the air molecules. A similar cooling mechanism is at play in the crystal, where quantized vibrations in the lattice called phonons carry heat away from the oscillating spins. Schaetz and his colleagues found that their small ion systems did stop oscillating, suggesting that they had cooled. But after a few milliseconds, the ions began oscillating vigorously again. This resurgence has a quantum origin, says Schaetz. Rather than dissipating away entirely, the phonons rebounded at the edges of the crystal and returned, in phase, to their source ions, reinstating the original spin oscillations.

Schaetz says that his experiment sends a warning to engineers attempting to reduce the size of existing electronics. “You may have a wire that is only 10 or 15 atoms wide, and you may think that it has successfully carried the heat away from your chip, but then boop — suddenly this quantum revival happens,” Schaetz says. “It is very disturbing.”

Rebounding phonons could present a challenge in some applications, but other quantum phenomena could turn out to be useful. Efforts to identify such phenomena had been stalled by the difficulty in defining basic quantities, such as heat and temperature, in quantum systems. But the solution to a famous thought experiment, laid out 150 years ago by Scottish physicist James Clerk Maxwell, provided a clue about where to turn, posing an intriguing link between information and energy. Maxwell imagined an entity

that could sort slow- and fast-moving molecules, creating a temperature difference between two chambers simply by opening and closing a door between them.

Such a 'demon', as it was later called, thus generates a hot and a cold chamber that can be harnessed to produce useful energy. The problem is that by sorting particles in this way, the demon reduces the system's entropy — a measure of the disorder of the particles' arrangements — without having done any work on the particles themselves. This seemingly violates the second law of thermodynamics.

But physicists eventually realized that the demon would pay a thermodynamic price to process the information about the molecules' speeds. It would need to store, erase and rewrite that information in its brain. That process consumes energy and creates an overall increase in entropy[3]. Information was once thought to be immaterial, “but Maxwell's demon shows that it can have objective physical consequences”, says quantum physicist Arnau Riera, at the Institute of Photonic Sciences in Barcelona, Spain.

Finding the limit

Inspired by the idea that information is a physical quantity — and that it is intimately linked to thermodynamics — researchers have attempted to recast the laws of thermodynamics so that they work in the quantum regime.

Perpetual-motion machines may be impossible. But an early hope was that limits prescribed by quantum thermodynamics might be less stringent than those that hold in the classical realm. “This was the train of thought we had learned from quantum computing — that quantum effects help you beat classical bounds,” says Raam Uzdin, a quantum physicist at the Technion–Israel Institute of Technology in Haifa.

Disappointingly, Uzdin says, this is not the case. Recent analyses suggest that quantum versions of the second law, which governs efficiency, and the third law, which prohibits systems from reaching absolute zero, retain similar and, in some cases, more-stringent constraints than their classical incarnations.

Some differences arise because the macroscopic thermodynamic quantity 'free energy'— the energy a system has available to do work — doesn't have just one counterpart at the microscale, but many, says Jonathan Oppenheim, a quantum physicist at University College London. Classically, the free energy is calculated by assuming that all states of the system, determined by the arrangement of particles at a given energy, are equally likely. But that assumption isn't true on tiny scales, says Oppenheim; certain states might be much more probable than others. To account for this, additional free energies need to be defined in order to accurately describe the system and how it will evolve. Oppenheim and his colleagues propose that individual second laws exist for each type of free energy, and that quantum devices must obey all of them[4]. “Since the second law tells you what you aren't allowed to do, in some ways, it seems that having more laws on the microscale leaves you worse off,” says Oppenheim.

Much of the work done to calculate equivalents of the second and third laws remains, for now, theoretical. But proponents argue that it can help to illuminate how thermodynamic bounds are physically enforced at small scales. For instance, a theoretical analysis carried out by a pair of quantum physicists based in Argentina showed that as a quantum refrigerator nears absolute zero, photons will spontaneously appear in the vicinity of the device[5]. “This dumps energy into the surroundings, causing a heating effect that counters the cooling and stops you ever reaching absolute zero,” explains team member Nahuel Freitas of Ciudad University in Buenos Aires.

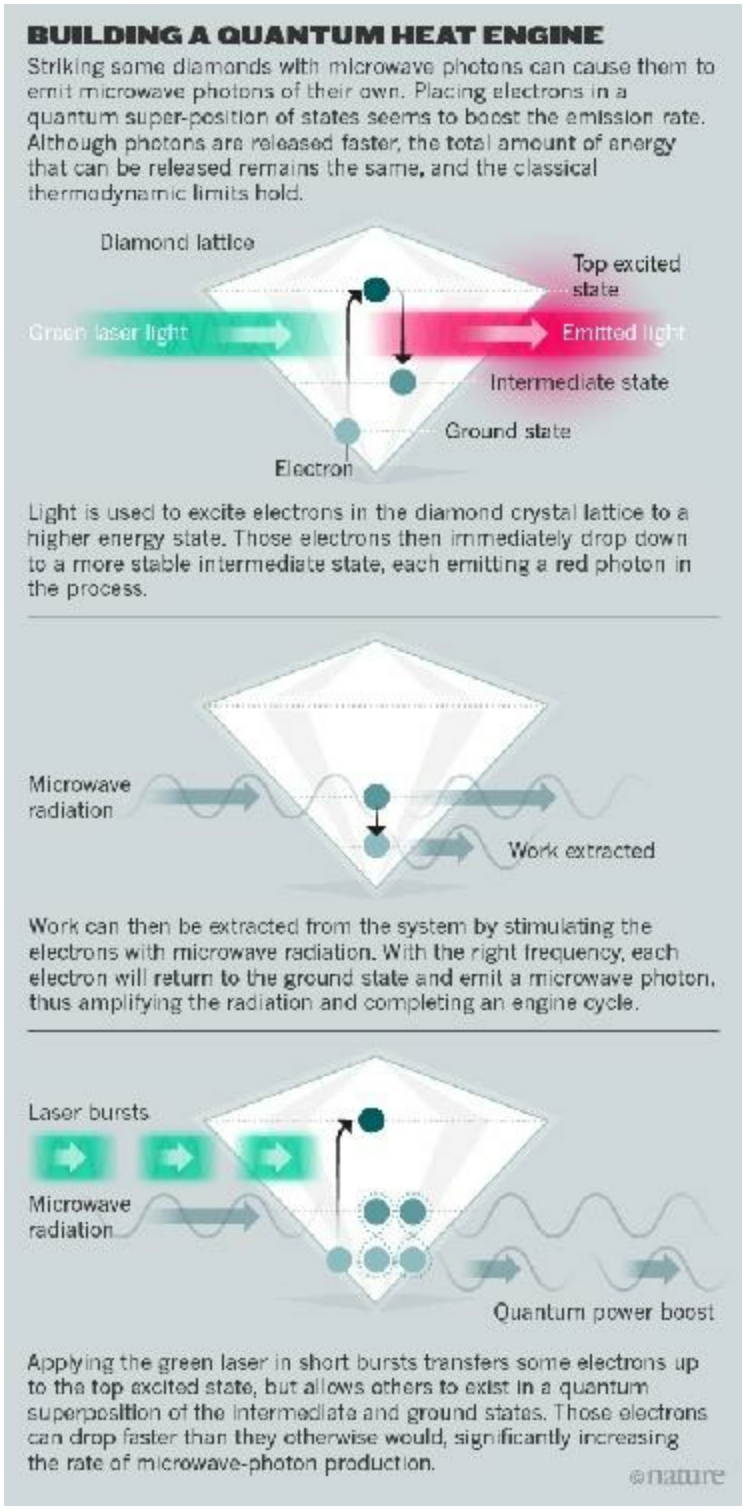
Theory has also revealed some potential wiggle room. In a theoretical analysis examining information flow between hot and cold chambers, or 'baths', of particles, a team based in Barcelona that included Riera and quantum physicist Manabendra Nath Bera discovered a strange scenario in which the hot bath seemed to spontaneously get hotter, while the cold bath became colder[6]. “At first, this looks crazy, like we can violate thermodynamics,” says Bera. But the researchers soon realized that they had overlooked the quantum twist: the particles in the baths can become entangled. In theory, making and breaking these correlations provides a way to store and release energy. Once this quantum resource was budgeted for, the laws of thermodynamics fell into place.

A number of independent groups have proposed using such entanglement to store energy in a 'quantum battery', and a group at the Italian Institute of Technology in Genoa is attempting to confirm the Barcelona team's predictions with batteries built from superconducting quantum bits, or 'qubits'[7]. In principle, such quantum batteries could charge considerably faster than their classical equivalents. “You won't be able to extract and store more energy than the classical bound allows — that's set by the second law,” says Riera. “But you may be able to speed things up.”

Some researchers are looking for easier ways to manipulate qubits for quantum-computing applications. Quantum physicist Nayeli Azucena Rodríguez Briones at the University of Waterloo in Canada and her colleagues have devised[8] an operation that might enhance the cooling needed for quantum-computing operations by manipulating pairs of qubit energy levels. They are currently planning to test this idea in the lab using superconducting qubits.

A small spark

The concept that quantum effects could be exploited to improve thermodynamic performance also inspired the diamond experiment under way at Oxford, which was first proposed by Kosloff, Uzdin and Amikam Levy, also at the Hebrew University[1]. Defects created by nitrogen atoms scattered through the diamond can serve as an engine — a machine that performs an operation after being brought into contact with first a hot reservoir (in this case a laser) and then a cold one. But Kosloff and his colleagues expect that such an engine can be operated in an enhanced mode, by exploiting a quantum effect that enables some of the electrons to exist in two energy states simultaneously. Maintaining these superpositions by pulsing the laser light rather than using a continuous beam should enable the crystal to emit microwave photons more rapidly than it otherwise would (see 'Building a quantum heat engine').



Last week, the Oxford-based team posted a preliminary analysis[9] showing evidence of the predicted quantum boost. The paper has yet to be peer reviewed, but if the work holds up, then “it is a groundbreaking result,” says

Janet Anders, a quantum physicist at Exeter University, UK. But, she adds, it's still not clear exactly what enables this feat. “It seems to be a magic fuel, not so much adding energy, but enabling the engine to extract energy faster,” Anders says. “Theoretical physicists will need to examine just how it does this.”

Focusing on experiments is a major step in the right direction for revitalizing the field, says Hänggi. But, for him, the experiments are not yet bold enough to give truly ground-breaking insights. There is also the challenge that quantum systems can be irrevocably disturbed by measurement and interaction with the environment. These effects are rarely sufficiently accounted for in theoretical proposals for new experiments, he says. “That is difficult to calculate, and much more difficult to implement in an experiment,” he says.

Ian Walmsley, who heads the Oxford lab where the diamond experiment was conducted, is also circumspect about the future of the field. Although he and other experimenters have been drawn to quantum thermodynamics research in recent years, he says that their interest has been largely “opportunistic”. They have spotted the chance to carry out relatively quick and easy experiments by piggybacking on set-ups already in place for other uses; the diamond-defect set-up, for instance, is already being widely studied for quantum computing and sensor applications. Today, quantum thermodynamics is fizzing with energy, Walmsley says. “But whether it will continue to sparkle, or just explode into nothing, well, we will have to wait and see.”

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Comments

8 comments

1. *Pentcho Valev* • 2017-11-03 08:02 AM

   Clifford Truesdell, The Tragicomical History of Thermodynamics, 1822-1854, p. 6: "Finally, I confess to a heartfelt hope - very slender but tough - that even some thermodynamicists of the old tribe will study this book, master the contents, and so share in my discovery: Thermodynamics need never have been the Dismal Swamp of Obscurity that from the first it was and that today in common instruction it is; in consequence, it need not so remain." [...] p. 333: "Clausius' verbal statement of the "Second Law" makes no sense, for "some other change connected therewith" introduces two new and unexplained concepts: "other change" and "connection" of changes. Neither of these finds any place in Clausius' formal structure. All that remains is a Mosaic prohibition. A century of philosophers and journalists have acclaimed this commandment; a century of mathematicians have shuddered and averted their eyes from the unclean."
   https://www.amazon.com/Tragicomical-Thermodynamics-1822-1854-Mathematics-Physical/dp/1461394465 Jos Uffink, Bluff your way in the Second Law of Thermodynamics: "Before one can claim that acquaintance with the Second Law is as indispensable to a cultural education as Macbeth or Hamlet, it should obviously be clear what this law states. This question is surprisingly difficult. The Second Law made its appearance in physics around 1850, but a half century later it was already surrounded by so much confusion that the British Association for the Advancement of Science decided to appoint a special committee with the task of providing clarity about the meaning of this law. However, its final report (Bryan 1891) did not settle the issue. Half a century later, the physicist/philosopher Bridgman still complained that there are almost as many formulations of the second law as there have been discussions of it. And even today, the Second Law remains so obscure that it continues to attract new efforts at clarification."

http://philsci-archive.pitt.edu/313/1/engtot.pdf As Clifford Truesdell suggests, the confusion started with Clausius's 1850 idiotic argument - later formulations of the second law of thermodynamics have all been defective. However previous formulations - those of Carnot - were both clear and correct. The simplest one is this: "A cold body is necessary" That is, heat cannot be cyclically converted into work unless a hot body, source of heat, and a cold body, receiver of heat, are available. The problem is that in 1824 Carnot deduced "A cold body is necessary" from a postulate that eventually turned out to be false: Carnot's (false) postulate: Heat is an indestructible substance (caloric) that cannot be converted into work by the heat engine. Unpublished notes written in the period 1824-1832 reveal that, after realizing that his postulate was false (and discovering the first law of thermodynamics), Carnot found "A cold body is necessary" implausible: Sadi Carnot, REFLECTIONS ON THE MOTIVE POWER OF HEAT, p. 225: "Heat is simply motive power, or rather motion which has changed form. It is a movement among the particles of bodies. Wherever there is destruction of motive power there is, at the same time, production of heat in quantity exactly proportional to the quantity of motive power destroyed. Reciprocally, wherever there is destruction of heat, there is production of motive power." p. 222: "Could a motion (that of radiating heat) produce matter (caloric)? No, undoubtedly; it can only produce a motion. Heat is then the result of a motion. Then it is plain that it could be produced by the consumption of motive power, and that it could produce this power. All the other phenomena - composition and decomposition of bodies, passage to the gaseous state, specific heat, equilibrium of heat, its more or less easy transmission, its constancy in experiments with the calorimeter - could be explained by this hypothesis. But it would be DIFFICULT TO EXPLAIN WHY, IN THE DEVELOPMENT OF MOTIVE POWER BY HEAT, A COLD BODY IS NECESSARY; why, in consuming the heat of a warm body, motion cannot be produced." http://www.nd.edu/~powers/ame.20231/carnot1897.pdf Generally, a cold body is not necessary, that is, the second law of thermodynamics is false. The cold body is only

TECHNOLOGICALLY necessary – non-isothermal heat engines are fast-working and powerful. Heat engines working under isothermal conditions (in the absence of a cold body) are commonplace but are too slow and impuissant to be of any technological importance. Except, perhaps, for the case where water is placed in an electric field - the non-conservative force (pressure) that emerges seems to be able to convert ambient heat into work quite vigorously: Wolfgang K. H. Panofsky, Melba Phillips, Classical Electricity and Magnetism, pp.115-116: "Thus the decrease in force that is experienced between two charges when they are immersed in a dielectric liquid can be understood only by considering the effect of the PRESSURE OF THE LIQUID ON THE CHARGES themselves." http://www.amazon.com/Classical-Electricity-Magnetism-Second-Physics/dp/0486439240?tag=viglink21401-20 "However, in experiments in which a capacitor is submerged in a dielectric liquid the force per unit area exerted by one plate on another is observed to decrease... [...] This apparent paradox can be explained by taking into account the DIFFERENCE IN LIQUID PRESSURE in the field filled space between the plates and the field free region outside the capacitor." http://farside.ph.utexas.edu/teaching/jk1/lectures/node46.html Tai Chow, Introduction to Electromagnetic Theory: A Modern Perspective, p. 267: "The strictly electric forces between charges on the conductors are not influenced by the presence of the dielectric medium. The medium is polarized, however, and the interaction of the electric field with the polarized medium results in an INCREASED FLUID PRESSURE ON THE CONDUCTORS that reduces the net forces acting on them." http://www.amazon.com/Introduction-To-Electromagnetic-Theory-Perspective/dp/0763738271 "Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ Pentcho Valev

2. *Vyacheslav Somsikov* • 2017-11-03 04:34 AM

   For the verification of the deterministic mechanism of irreversibility, which obtained within the framework of the classical mechanics laws [Somsikov V.M. Non-Linearity of Dynamics of the

Non-Equilibrium Systems. World Journal of Mechanics, 2017, Vol.7 No.2, 11-23], we was performed the numerical calculations of the change of D-entropy for the system with different number of the potentially interacting material points (MP) when it moves through a potential barrier. D – entropy is a relation of the value of change of the systems internal energy to its full value. [Somsikov V. M. and Andreev A. B. On criteria of transition to a thermodynamic description of system dynamics. Russian Physics Journal, Vol. 58, No. 11, March, 2016; http://www.ijSciences.com Volume 4 – May 2015 (05)]. The calculations were carried 400 times for a given number of particles for different initial states of the system, but for the same predetermined amount of energy. This made it possible to determine the change of the D-entropy for different states of the system for a given value of its energy and a given number of MP. It was found that the fluctuations of internal energy decreasing with increasing number of particles in the system for different initial conditions. When number of particles less 64, the D –entropy can be as positive as negative.When number of particles more 64 then none of the 400 numerical experiments gave a negative value change of the internal energy. This means that when number of particles more 64 the dynamics of the system becomes irreversible. Therefore, the number 64 can be called as a first critical number of the system, beyond which the system becomes irreversible. When number of particles more than 1000, the dispersion of the internal energy reaches to the minimum. With further increase in the number of MP the increment of the internal energy is not changed. This number can be called as a second critical number. Thus if the system consist from number of particles more than 1000, the thermodynamic description is a correct. Obviously, in the general case, these critical numbers will depend on the parameters of the task, for example, the width and height of the barrier.

3. *Pentcho Valev* • 2017-11-02 07:25 PM

   "Entropy was discovered when it was noticed to be a quantity that behaves as a function of state, as a consequence of the second law of thermodynamics." https://en.wikipedia.org/wiki/Entropy It was Clausius who "noticed" that the entropy is a state function, but was

he correct? Here is the story: If you define the entropy S as a quantity that obeys the equation dS=dQrev/T, you will find that, so defined, the entropy is a state function FOR AN IDEAL GAS. Clausius was very impressed by this statefunctionness and decided to prove that the entropy (so defined) is a state function for ANY system. So "Entropy is a state function" became a fundamental theorem in thermodynamics. Clausius deduced it from the assumption that any cycle can be disintegrated into small Carnot cycles, and nowadays this deduction remains the only justification of "Entropy is a state function": "Carnot Cycles: S is a State Function. Any reversible cycle can be thought of as a collection of Carnot cycles - this approximation becomes exact as cycles become infinitesimal. Entropy change around an individual cycle is zero. Sum of entropy changes over all cycles is zero." http://mutuslab.cs.uwindsor.ca/schurko/introphyschem/lectures/240 "Entropy Changes in Arbitrary Cycles. What if we have a process which occurs in a cycle other than the Carnot cycle, e.g., the cycle depicted in Fig. 3. If entropy is a state function, cyclic integral of dS = 0, no matter what the nature of the cycle. In order to see that this is true, break up the cycle into sub-cycles, each of which is a Carnot cycle, as shown in Fig. 3. If we apply Eq. (7) to each piece, and add the results, we get zero for the sum." http://ronispc.chem.mcgill.ca/ronis/chem213/hnd8.pdf The assumption on which "Entropy is a state function" is based - that any cycle can be subdivided into small Carnot cycles - is obviously false. An isothermal cycle CANNOT be subdivided into small Carnot cycles. A cycle involving the action of conservative forces CANNOT be subdivided into small Carnot cycles. Conclusion: The belief that the entropy is a state function is totally unjustified. Any time scientists use the term "entropy", they don't know what they are talking about. "My greatest concern was what to call it. I thought of calling it 'information', but the word was overly used, so I decided to call it 'uncertainty'. When I discussed it with John von Neumann, he had a better idea. Von Neumann told me, 'You should call it entropy, for two reasons: In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important,

nobody knows what entropy really is, so in a debate you will always have the advantage."
https://en.wikipedia.org/wiki/History_of_entropy Pentcho Valev

4. *Pentcho Valev* • 2017-11-02 10:05 PM
   The version of the second law of thermodynamics known as "Entropy always increases" (a version which, according to A. Eddington, holds "the supreme position among the laws of Nature") is in fact a theorem deduced by Clausius in 1865: Jos Uffink, Bluff your Way in the Second Law of Thermodynamics, p. 37: "Hence we obtain: THE ENTROPY PRINCIPLE (Clausius' version) For every nicht umkehrbar [irreversible] process in an adiabatically isolated system which begins and ends in an equilibrium state, the entropy of the final state is greater than or equal to that of the initial state. For every umkehrbar [reversible] process in an adiabatical system, the entropy of the final state is equal to that of the initial state." http://philsci-archive.pitt.edu/archive/00000313/ Clausius' deduction was based on three postulates: Postulate 1 (implicit): The entropy is a state function. Postulate 2: Clausius' inequality (formula 10 on p. 33 in Uffink's paper) is correct. Postulate 3: Any irreversible process can be closed by a reversible process to become a cycle. All the three postulates remain totally unjustified even nowadays. Postulate 1 can easily be disproved by considering cycles (heat engines) converting heat into work in ISOTHERMAL conditions. Postulate 3 is also false: Uffink, p.39: "A more important objection, it seems to me, is that Clausius bases his conclusion that the entropy increases in a nicht umkehrbar [irreversible] process on the assumption that such a process can be closed by an umkehrbar [reversible] process to become a cycle. This is essential for the definition of the entropy difference between the initial and final states. But the assumption is far from obvious for a system more complex than an ideal gas, or for states far from equilibrium, or for processes other than the simple exchange of heat and work. Thus, the generalisation to all transformations occurring in Nature is somewhat rash." Note that, even if Clausius's theorem were true (it is not), it only holds for "an adiabatically isolated system which begins and ends in an equilibrium state". This means that (even if Clausius's theorem were true) applications of "Entropy

always increases" to processes which do not begin and end in equilibrium, that is, to processes in Nature, not in a cylinder with a piston, would still be incorrect: Jos Uffink, in the same article: "I therefore argue for the view that the second law has nothing to do with the arrow of time. [...] This summary leads to the question whether it is fruitful to see irreversibility or time-asymmetry as the essence of the second law. Is it not more straightforward, in view of the unargued statements of Kelvin, the bold claims of Clausius and the strained attempts of Planck, to give up this idea? I believe that Ehrenfest-Afanassjewa was right in her verdict that the discussion about the arrow of time as expressed in the second law of the thermodynamics is actually a RED HERRING." Pentcho Valev

5. *Raji Heyrovska* • 2017-11-02 02:45 PM

   I just saw the interesting article by Merali [1]. In this context, I wish to draw attention to the First International Conference [2] on Quantum Limits to the Second Law. In her contribution [3] to this conference, she points out that thermodynamic functions and laws were developed over the years to "bridge" the gap between the equations of state and thermal properties of matter. In [3] the author has incorporated the thermodynamic properties into the equation of state thereby forming one simple composite equation. The heat capacity difference is introduced in place of the gas constant in her earlier concise equation of state for gases, based on free volume and molecular association/dissociation. This provides a new and simple relation between the P, V, T properties, internal energy (E), enthalpy (H), Gibbs (G) and Helmholtz (A) free energies, heat energy (Q), entropy (S), partition function (f) and the thermodynamic laws. Since a proper definition of "heat" is essential for the discussion of the second law, Q for a gas at the given P, V, T, S is defined as TS = PVflnW, where W is the thermodynamic probability related to f. The latter is expressed as the ratio of free volume to volume corresponding to the de Broglie wave length. Also, for the first time experimental heat capacities at various P, V and T are correlated with the extent of molecular association. The available data for nitrogen have been used to demonstrate the validity of the new equation of state. References: 1. Merali, Z., Nature 551, 20–22 (02 November 2017) doi:10.1038/551020a 2.

“QUANTUM LIMITS TO THE SECOND LAW: First International Conference on Quantum Limits to the Second Law”: 29-31 July 2002, San Diego, California (USA), ISBN: 0-7354-0098-9, Editors: Daniel P. Sheehan, Volume number: 643, Published: Nov 20, 2002, http://aip.scitation.org/toc/apc/643/1?expanded=643 3. Heyrovska, R., AIP Conference Proceedings 643, 157-162 (2002); http://aip.scitation.org/doi/10.1063/1.1523797

6. *Pentcho Valev* • 2017-11-02 09:37 AM

The second law of thermodynamics has an absurd implication that proves its falsehood: If we have a reversible chemical reaction and a catalyst increases the rate of the forward reaction by a factor of, say, 745492, it obligatorily increases the rate of the reverse reaction by exactly the same factor, 745492, despite the fact that the two reactions - forward and reverse - may be entirely different (e.g. the diffusion factor is crucial for one but not important for the other) and accordingly require entirely different catalytic mechanisms. The absurd implication is usually referred to as "Catalysts do not shift chemical equilibrium": "A catalyst reduces the time taken to reach equilibrium, but does not change the position of the equilibrium. This is because the catalyst increases the rates of the forward and reverse reactions BY THE SAME AMOUNT." http://www.bbc.co.uk/bitesize/higher/chemistry/reactions/equilibriu "In the presence of a catalyst, both the forward and reverse reaction rates will speed up EQUALLY... [...] If the addition of catalysts could possibly alter the equilibrium state of the reaction, this would violate the second rule of thermodynamics..." https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/chemical-equilibrium-14/factors-that-affect-chemical-equilibrium-106/the-effect-of-a-catalyst-447-3459/ The absurd implication is not obeyed by chemical reactions of course. Here is a publication in Nature describing a catalyst accelerating the forward and SUPPRESSING the reverse reaction: http://images.nature.com/m685/nature-assets/ncomms/2013/130917/ncomms3500/images_hires/ncomms35 f1.jpg Yu Hang Li et al. Unidirectional suppression of hydrogen oxidation on oxidized platinum clusters. https://www.nature.com/articles/ncomms3500 Another example of

disobedience: Perpetual (limited only by the deterioration of the system) motion of dimer A_2 and monomer A between two catalytic surfaces, S1 and S2 (a time crystal par excellence): http://upload.wikimedia.org/wikipedia/commons/c/ce/NatureSLTD-Fig1c.jpg See the explanations here: https://en.wikipedia.org/wiki/Duncan%27s_Paradox That catalysts can violate the second law of thermodynamics by shifting chemical equilibrium is presented by Wikipedia as a fact: "Epicatalysis is a newly identified class of gas-surface heterogeneous catalysis in which specific gas-surface reactions shift gas phase species concentrations away from those normally associated with gas-phase equilibrium. [...] A traditional catalyst adheres to three general principles, namely: 1) it speeds up a chemical reaction; 2) it participates in, but is not consumed by, the reaction; and 3) it does not change the chemical equilibrium of the reaction. Epicatalysts overcome the third principle..." https://en.wikipedia.org/wiki/Epicatalysis Pentcho Valev

7. *Pentcho Valev* • 2017-11-01 07:17 PM

   The second law of thermodynamics has long been under attack but only for small, microscopic, quantum etc. systems: Nature 2002: "Second law broken. Researchers have shown for the first time that, on the level of thousands of atoms and molecules, fleeting energy increases violate the second law of thermodynamics." http://www.nature.com/news/2002/020722/full/news020722-2.html The truth is that MACROSCOPIC systems violating the second law of thermodynamics are COMMONPLACE. The problem is that misleading education diverts the attention from relevant examples: "A necessary component of a heat engine, then, is that two temperatures are involved. At one stage the system is heated, at another it is cooled." http://physics.bu.edu/~duffy/py105/Heatengines.html So educators present the two temperatures as NECESSARY and deal with non-isothermal heat engines only: http://readingpenrose.files.wordpress.com/2015/07/rubber-band-engine.gif "All materials react to heat in some way. But this new shape-changing polymer reacts to temperatures as small as the touch of human skin to contract - in the process lifting as much as

1,000 times its own weight." http://gizmodo.com/this-new-shape-changing-polymer-can-lift-1-000-times-it-1759165438 "Stretchy Science: A Rubber Band Heat Engine. Learn how a rubber band can turn heat into mechanical work with this simple activity. [...] Your blow dryer essentially turned your rubber band into a heat engine - a machine that turns thermal energy into mechanical work." https://www.scientificamerican.com/article/bring-science-home-rubber-band-heat/ The second law of thermodynamics would be long forgotten if isothermal analogs which almost obviously violate the second law of thermodynamics had been analyzed (one should only evaluate the work involved in a quasi-static cycle): http://www.gsjournal.net/old/valev/val3.gif "When the pH is lowered (that is, on raising the chemical potential, μ, of the protons present) at the isothermal condition of 37°C, these matrices can exert forces, f, sufficient to lift weights that are a thousand times their dry weight." http://www.google.com/patents/US5520672 A. KATCHALSKY, POLYELECTROLYTES AND THEIR BIOLOGICAL INTERACTIONS, p. 15, Figure 4: "Polyacid gel in sodium hydroxide solution: expanded. Polyacid gel in acid solution: contracted; weight is lifted." https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1367611/pdf/bioph0017.pdf The following four-step isothermal cycle, if carried out quasi-statically (reversibly), clearly violates the second law of thermodynamics: 1. The polymer is initially stretched. The operator adds hydrogen ions (H+) to the system. The force of contraction increases. 2. The polymers contracts and lifts a weight. 3. The operator removes the same amount of H+ from the system. The force of contraction decreases. 4. The operator stretches the polymer and restores the initial state of the system. The net work extracted from the cycle is positive unless the following is the case: The operator, as he decreases and then increases the pH of the system (steps 1 and 3), does (loses; wastes) more work than the work he gains from weight-lifting. However electrochemists know that, if both adding hydrogen ions to the system and then removing them are performed quasi-statically, the net work involved is virtually zero (the operator gains work if the hydrogen ions are transported from a high to a low concentration and then loses the

same amount of work in the backward transport). That is, the net work involved in steps 1 and 3 is zero, and the net work extracted from steps 2 and 4 is positive, in violation of the second law of thermodynamics. Pentcho Valev

8. *Pentcho Valev* • 2017-11-01 06:36 PM

    Philip Ball explains why Frank Wilczek's time crystals are bogus: "But to make that happen, the researchers must deliver kicks to the spins, provided by a laser or pulses of microwaves, to keep them out of equilibrium. The time crystals are sustained only by constant kicking, even though - crucially - their oscillation doesn't match the rhythm of the kicking. The experiments are ingenious and the results show that this modified version of Wilczek's vision is feasible. But are we right to award the new findings this eye-catching new label, or are they really just a new example of a phenomenon that has been going on since the first primeval heart started beating? If these fancy arrangements of quantum spins deserve to be called time crystals, can we then say that we each already have a time crystal pulsing inside of us, keeping us alive?" http://www.prospectmagazine.co.uk/blogs/philip-ball/time-crystals-could-they-exist-science-physics That is, Frank Wilczek's time crystals are regularly "kicked" by the experimentalist. However, there are genuine time crystals "kicked" by ambient heat and breathtakingly violating the second law of thermodynamics. Here is perpetual (limited only by the deterioration of the system) motion of water in an electric field, obviously able to produce work - e.g. by rotating a waterwheel: "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ "The water movement is bidirectional, i.e., it simultaneously flows in both directions." https://www.wetsus.nl/home/wetsus-news/more-than-just-a-party-trick-the-floating-water-bridge-holds-insight-into-nature-and-human-innovation/1 The work will be done at the expense of what energy? The first hypothesis that comes to mind is: At the expense of electric energy. The system is, essentially, an electric motor. However, close inspection would suggest that the hypothesis is untenable. Scientists use triply distilled water to reduce the conductivity and the electric current passing through the

system to minimum. If, for some reason, the current is increased, the motion stops - the system cannot be an electric motor. If the system is not an electric motor, then it is ... a perpetual-motion machine of the second kind! Here arguments describing perpetual-motion machines as impossible, idiotic, etc. are irrelevant - the following conditional is valid: IF THE SYSTEM IS NOT AN ELECTRIC MOTOR, then it is a perpetual-motion machine of the second kind. In other words, if the work is not done at the expense of electric energy, then it is done at the expense of ambient heat, in violation of the second law of thermodynamics. No third source of energy is conceivable. In the electric field between the plates of a capacitor, the same perpetual motion of water can be seen (we have a time crystal again): " Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg In the capacitor system the rising water can repeatedly do work, e.g. by lifting floating weights. The crucial question is: The work (lifting floating weights) will be done at the expense of what energy? Obviously "electric energy" is not the correct answer - the capacitor is not an electric motor. Then the only possible answer remains "ambient heat". The system is a heat engine violating the second law of thermodynamics! Pentcho Valev

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Join the disruptors of health science

01 November 2017

Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.

Gabriela Hasbun for *Nature*

Thomas Insel left Verily, a health-science spin-off formed by Google's parent company, to co-found a start-up called Mindstrong Health this year.

In early 2015, I testified with several other National Institutes of Health (NIH) directors at an annual hearing held by the US Senate. It was my 13th and final year as director of the US National Institute of Mental Health

(NIMH) in Bethesda, Maryland. What struck me most was how the harsh fiscal reality tempered the passionate bipartisan support for the NIH. As one senator noted, with a federal deficit of nearly US$500 billion, there was little hope of any significant increase in funding.

Six months after that hearing, I left the NIH for Silicon Valley, first working at Verily in South San Francisco, California, a health-science spin-off formed by Google's parent company Alphabet. Since May, I've been president and co-founder of a start-up called Mindstrong Health in Palo Alto, California. I've witnessed the tremendous possibilities that immense resources, massive computing power and the application of data science can bring to biomedical research. I've watched some of today's best junior faculty members and postdocs launch their careers in Silicon Valley instead of in academic departments. And I've wondered how technology giants and start-ups will change biomedical and health-care research.

These companies have transformed the worlds of information, entertainment and commerce. But by moving into health care, they face some formidable challenges. In my view, solving them will require deep partnerships between technology companies, clinical experts, patient advocates and academic scientists.

A financial frontier

In the United States, public funding for science has not kept up with inflation over the past decade. The proposed 2018 budget from the White House recommends funding cuts for the NIH and the National Science Foundation of more than 10% each. Appropriations may ultimately be more generous, but no one is expecting Congress to repair a decade's loss of purchasing power.

Meanwhile, private-sector investment has become a bigger piece of the research-funding pie — increasing from 46% in 1994 to 58% in 2012 for biomedical research[1]. Tech companies, in particular, have been ploughing more funds into research, and moving into areas such as health and life sciences that have typically been the domain of the NIH, pharmaceutical and

biotechnology companies. By any measure, tech companies have enormous sums to spend. The collective cash reserves of Apple, Microsoft, Alphabet and Facebook — roughly $500 billion — exceed by tenfold the annual federal investment in biomedical research.

So what does this changing ecosystem mean for US biomedical science? Has the locus of innovation shifted from academia to Google and Facebook?

In some areas, such as artificial intelligence (AI), tech companies already dominate. According to a 2017 report, the tech giants invested between US$20 billion and $30 billion in AI in 2016, with 90% of this going towards research and development. Some, such as Google and the Chinese web-services company Baidu, are rebranding themselves as AI or deep-learning companies, with a focus on both expanding the science of machine learning and applying the approach to big-data problems[2].

In health research, the landscape is still evolving. Three years ago, IBM began selling a software suite called Watson for Oncology to cancer-treatment centres around the world. The program is built around what IBM call cognitive computing and is designed to help clinicians to select the best treatment. The company claimed that by using its cloud-based data on cancer, Watson could recommend interventions for individual patients, although some say the effort was premature and oversold[3].

Over the past 12 months, Fitbit, the developer of several fitness trackers, has expanded into a health-care and health-research company. With more than 50 million registered users, it is involved in 400 research projects, including studies of diabetes and heart disease. In fact, Fitbit has just been listed as one of nine digital health companies to be considered by the US Food and Drug Administration (FDA) in its precertification pilot programme — a new, supposedly more agile, approach to regulation that will focus on the software developer rather than on individual products.

Since March 2015, Apple's ResearchKit has made it easier for developers to create health apps for the iPhone or Apple Watch. It has also provided a platform for enrolling thousands of participants remotely in clinical projects, for instance in diabetes, cancer and diseases of the central nervous system. A study at Johns Hopkins University in Baltimore, Maryland, for instance, has

used ResearchKit to capture data just before and throughout seizures in nearly 1,000 people with epilepsy[4].

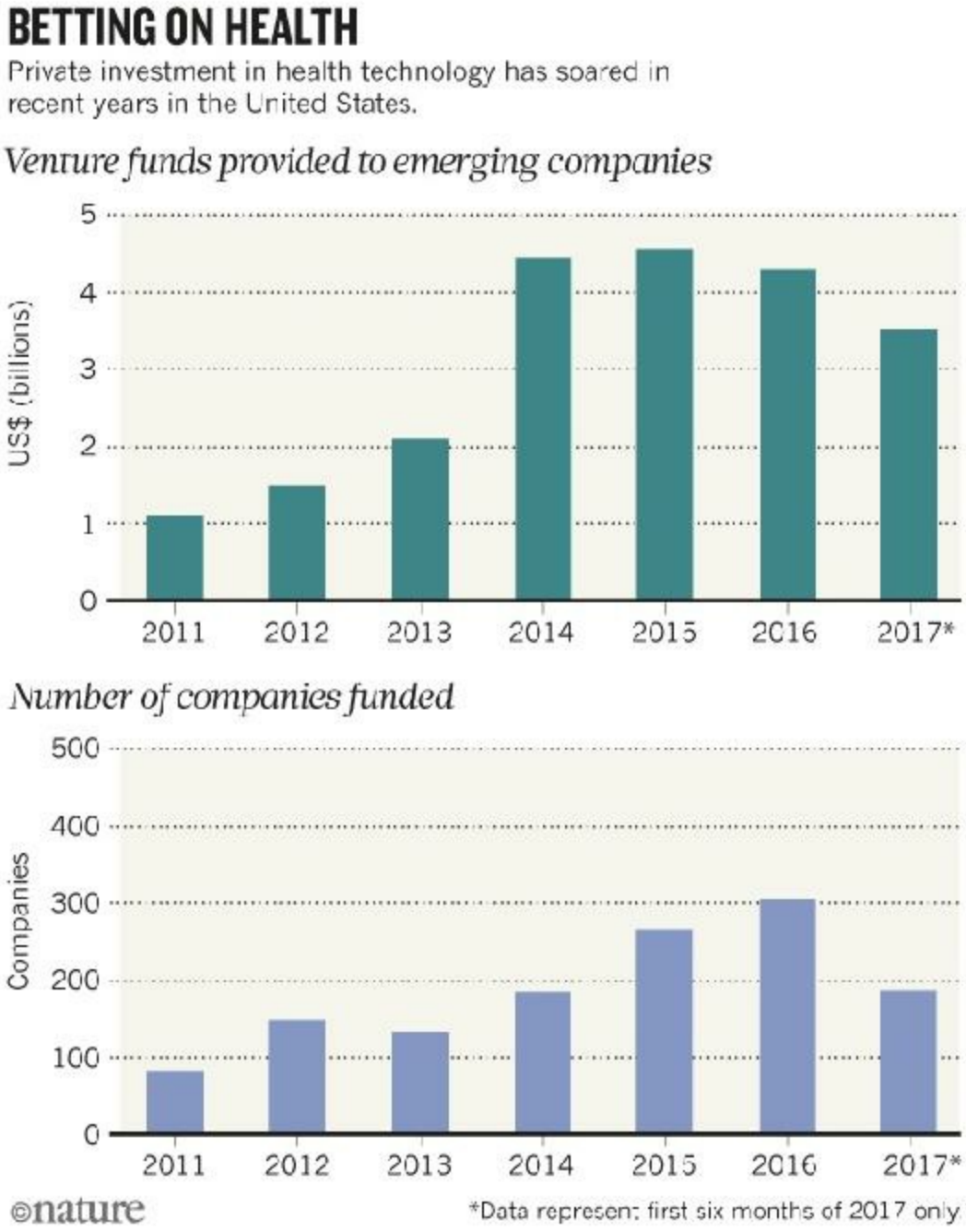
Kiyoshi Ota/Bloomberg/Getty

Fitbit, the developer of these sleep-monitoring wristbands, is currently involved in 400 research projects.

Also in 2015, Alphabet launched Verily — a company focused on creating software and hardware to transform health care. After growing to more than 500 employees in just over 2 years, Verily seeks to address diabetes, heart disease, cancer and diseases of the central nervous system using miniaturized sensors in smart devices — such as a contact lens that estimates blood sugar levels.

Just six months ago, Facebook revealed the existence of Building 8, a division focused on delivering consumer “hardware products that are social first”, including brain–computer interfaces designed to aid people with disabilities.

Meanwhile, health tech has become one of the hottest areas for venture investment in the United States: more than 1,000 new digital-health companies have started up since 2012. A report from Rock Health, a US venture-capital fund headquartered in San Francisco that invests in digital-health start-ups, estimates[5] that $15 billion has poured in to the sector over the past 5 years, up from $1.5 billion in 2012 and $1.1 billion in 2011 (see 'Betting on health').



Source: Rock Health

Like pharma and biotech, big and small tech companies are product-focused and team-based. This contrasts with academia, where scientists are rewarded for publishing papers and incentives are built around individual promotion

within a departmental structure.

But what struck me most on moving from the Beltway to the Bay Area was that, unlike pharma and biotech, tech companies enter biomedical and health research with a pedigree of software research and development, and a confident, even cocky, spirit of disruption and innovation. They have grown by learning how to move quickly from concept to execution. Software development may generate a minimally viable product within weeks. That product can be refined through 'dogfooding' (testing it on a few hundred employees, families or friends) in a month, then released to thousands of users for rapid iterative improvement.

During my first month working at Verily, I returned to Bethesda for the winter holidays; when I went back to work in early January, I found that a group of engineers had developed an entirely new product between Christmas and New Year's Day. Contrast that with the NIH-funded world of research, where it usually takes at least 18 months to go from proposing an idea to getting a project funded, or the years it can take to transform the discovery of a molecule into a marketable drug.

This intense focus on the rapid development of consumer products is very different from the pursuit of fundamental knowledge that has been a hallmark of academic research. And as a newcomer (what Google calls a noogler), I found the language of product development and the drive towards 'quarterly OKRs' (objectives and key results) a bit off-putting. But the truly disruptive impact of tech companies is not the rapid-fire push for consumer products or their deep pockets; it's their focus on AI and data resources.

Mining data

It is not surprising that companies that are dependent on information processing for their main revenue would be at the vanguard of developing the tools for collecting, storing and analysing data. A by-product of this is that tech companies are transforming data science — much as pharma and biotech transformed medicinal chemistry and molecular biology in the last decades of the twentieth century. In an era when biology is increasingly an information

science, the tools being created by tech companies can provide insights that will almost certainly be translated into advances for health.

The potential is awesome — for discovery as well as for product development.

Three examples illustrate what can be achieved through having extraordinary access to population data as well as massive data-storage and data-processing capacity. Importantly, none connects in an obvious way to a primary business of the company.

First, in 2016 a team at Google used a version of machine learning called convolutional neural nets to create an algorithm to detect diabetic retinopathy[6]. The researchers started by having 54 ophthalmologists rate 128,175 retinal images. Once the algorithm had been trained on this data set, the team used two new sets of retinal images to test against eight board-certified ophthalmologists. The results were striking: depending on how the researchers set its parameters, the algorithm performed better than seven of the eight clinical experts, in terms of sensitivity and specificity. This approach is not markedly different from previous efforts to identify cats and faces with machine learning, but the potential impact on diagnostics and clinical care is profound.

Second, a team in Facebook's Building 8 is seeking to develop new brain–computer interfaces that (with the use of non-invasive optical sensors) will enable people to type simply by thinking — what is now called 'silent speech'. Although several universities have teams working on brain–computer interactions, the number of engineers and the computational resources that Facebook can muster would be difficult for any academic investigator to fund using federal grants. Importantly, Facebook is supporting some of these academic scientists (as well as recruiting many) to expedite this project.

Third, a team at Microsoft has used anonymous Bing search histories from 9.2 million users to predict cases of pancreatic cancer several months before people are usually diagnosed with the disease[7]. The team identified characteristic patterns of historical symptom searches in more than 3,000 anonymous users who subsequently indicated a probable diagnosis of

pancreatic cancer — indicated by searches such as 'just diagnosed with pancreatic cancer'. This approach lacks the corroboration of a pathological diagnosis and the sensitivity is poor (only 5–15% of cases can be identified). But false-positive rates are extremely low (less than 0.0001).

In short, tech companies have scale and speed: an experiment can involve millions of people and be completed in months. But scale and speed aren't everything.

Sticking points

In moving from software or hardware development to biomedical research and health care, tech companies large and small face formidable challenges. They usually do not have the regulatory expertise needed to develop medical products, they rarely have access to clinical samples and they often lack a deep understanding of the clinical problem to be solved.

Gabriela Hasbun for *Nature*

At its California office, Mindstrong Health is developing digital phenotyping as a diagnostic tool.

Various moves are being made to try to address these issues. In May, Verily hired Robert Califf, former chief of the FDA, to help with its personalized-medicine effort called Project Baseline. In 2015, 23andMe, a personal-genomics company based in Mountain View, California, recruited Richard Scheller, former head of research at the biotech company Genentech in San Francisco, to lead its research programme. And in 2016, Apple brought Stephen Friend, an open-science advocate from the non-profit research organization Sage Bionetworks in Seattle, Washington, to assist with its health projects.

How a culture built around engineers and designers will incorporate people from different sectors remains to be seen, and whether companies that build consumer products will be able to work with health-care payers and providers is unclear. But the willingness of tech companies to hire national experts on health, regulation and health data to aid in discoveries that will have clinical utility is a hopeful sign.

Yet there are at least four further major areas of uncertainty.

Open science increasingly drives innovation in the public sector. It is unclear to what degree the drive for intellectual property and profits will limit the transparency of research in the tech sector[8]. The stereotype is that for-profit companies will focus only on commercial end points. But there are notable counter-examples from AI research, in addition to the biomedical examples above. In 2015, Google made its machine-learning software library, TensorFlow, open source, and AI researchers across the board quickly adopted this powerful tool. Likewise, the *Apple Machine Learning Journal* launched in July to provide more transparency about the company's current projects (see go.nature.com/2yckpi9).

It's too early to say whether big or small tech companies will favour open source for their biomedical scientific initiatives. The success of ResearchKit gives some indication of what could be accomplished if they do.

Another uncertainty is whether the business model in tech, which is often based on advertising revenue or the sales of devices, will limit the rigour, generalizability and validity of the science carried out. Especially in start-ups that are dependent on rapid returns for their investors, the financial runway may be too short for lengthy or large clinical trials.

And then there's the issue of trust. It has become the norm for tech companies to use personal shopping or geolocation data for commerce. It's unclear whether the public will be as accepting about the use of personal health data, especially by behemoths such as Google or Facebook.

The recent commitments of big and small tech companies to discovery and clinical research are exciting. But during an economic downturn, these projects could be the first to be axed to protect the company's bottom line.

Science needs commitment. Bell Labs — at its peak, the premier research and development company of the United States — is an example of extraordinary scientific success in a for-profit organization. But as author Jon Gertner pointed out[9] in *The New York Times* in 2012: “Mark Zuckerberg noted that one of his firm's mottoes was 'move fast and break things'; that of Bell Labs' might just as well have been 'move deliberately and build things'.”

Partners, In time

The practical questions are these. What will each of the sectors in the evolving ecosystem do best? What can be done across sectors? How can bridges be built between companies with unprecedented access to data and massive computational resources, and academic scientists who may have a deep understanding of a clinical problem or access to unique clinical populations?

It seems likely that the academic sector will continue to lead on those aspects of fundamental biology and clinical research that do not require big data or machine learning — the purification of an enzyme, perhaps, or the development of a mouse model for a rare disease. Pharma and biotech will continue to be the source of new medicines. The domain of the tech industry

will be research that is data-intensive, and product development that requires a legion of software engineers working with designers.

Transformative medical products that require clinical testing, regulatory standards and insights about the health-care marketplace, including the practical constraints faced by providers in the clinic, will almost certainly require partnerships between public research entities and private companies. These must include precompetitive partnerships across tech, pharma–biotech, academia and patient-advocacy groups. Developing these partnerships will not be easy, given the different stakeholders, cultures and incentives.

Yet there are successful public–private partnerships to learn from.

Since 2006, the Biomarkers Consortium, managed by the US charitable organization the Foundation for the NIH, has brought academics and private companies together to develop biomarkers across a range of diseases. The Alzheimer's Disease Neuroimaging Initiative, which since 2004 has worked to establish standards for imaging biomarkers in dementia, is among the studies it has supported. As is I-SPY2, which since 2010 has created treatment pathways based on biomarkers for breast cancer. Another Foundation for the NIH initiative is the Accelerating Medicines Partnership. This has paired the NIH and the FDA with 10 pharma and biotech companies as well as 12 non-profit patient-advocacy foundations to define new targets for drug development for rheumatoid arthritis, type 2 diabetes and Alzheimer's disease.

A new sector in the research ecosystem means that health problems, even those that do not present an obvious commercial opportunity, can be approached from a fresh angle. Data science could integrate the full stack of patient information, from genomics to socio-economic factors, to guide clinical care. Sensors and big data could transform our description of phenomics — each person's set of behavioural, physical and biochemical traits. For example, digital phenotyping through the use of smartphone sensors, keyboard performance and voice or speech features can provide, for the first time, an objective, continuous, passive measure of behaviour and cognition at the global scale. Mindstrong Health is using this approach to detect the earliest phases of dementia, mental illness and possibly a range of medical disorders[10].

As just one example of an urgent opportunity, attempts to prevent suicide worldwide have been remarkably ineffective — including public-health measures to reduce stigma, raise awareness and reduce access to guns. Social media, just-in-time interventions and new analytical tools for prediction could change our understanding of risk and yield new strategies for prevention[11]. Tech companies, paired with other players, could start to solve this and many other historically intractable problems.

There is an old African proverb: “To go fast, go alone; to go far, go together.” Science to improve health has proved frustratingly slow. Perhaps, with a new fast partner, all of us in research can go farther.

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doi:10.1038/551023a

Comments

Comments

There are currently no comments.

Spanish government takes control of Catalonian universities

Madrid will oversee the finances of the region's research centres and seven public universities.

31 October 2017

Alain Pitton/NurPhoto/Getty

Supporters of independence for Catalonia.

The Spanish government has taken over responsibility for higher education and research in Catalonia, following the region’s unilateral declaration of independence on 27 October. It will retain control of spending on research centres and universities, which the League of European Research Universities

says threatens institutional autonomy.

The Catalonia region of north-east Spain has been in political turmoil ever since a highly controversial vote on independence was taken on 1 October. For the past 32 years the Catalan government has set and financed the budgets of universities, which were allocated €700 million (US$814 million) of the nearly €1-billion Catalan budget for science and universities in 2017. The region is strong in science: between 2007 and 2015, its universities won a 210 grants from the European Research Council, totalling €334 million. In the most recent round, 10 of the 22 ERC starting grants awarded to researchers in Spain were won by researchers based at Catalan institutions.

The Ministry of Education, Culture and Sport in Madrid will run Catalan universities and the Ministry of Economy, Industry and Competitiveness will oversee the region's research policy with immediate effect.

The changes mean that the Spanish government will be able to make decisions affecting research centres and universities in Catalonia, after it dismissed all the members of the Catalan government.

Carmen Vela, Spain's secretary of state for research, development and innovation, says that the government hopes the difficulties will be resolved shortly. "Today's situation is a bit different, but it has a very clear goal: restoring normality and tranquility. We are going to work to ensure that there are no negative impacts on research and innovation in Catalonia." She says that the Spanish government will manage but not devise science policy in Catalonia ahead of regional elections due in December.

University connections

Santi Vila, minister of business and knowledge in the Catalan government, stepped down a day before the independence declaration. Arcadi Navarro, secretary of state for universities and research in the Catalan government and a geneticist at Pompeu Fabra University in Barcelona, who used to report to Vila, might yet remain in his job. Vela says that she would like him to continue. "Arcadi is an excellent researcher and someone with whom we

have always had an excellent relationship," Vela says. "We want to keep working with him."

Jaume Casals, rector of Pompeu Fabra University, says that he does not expect the Spanish government to interfere directly in universities' affairs. "The relationship between Madrid and Barcelona when it comes to science and universities has always been fluid, and I hope that will not change," says Casals, who also leads the Alliance 4 Universities, a group of research-intensive universities consisting of two based in Madrid and another two in Catalonia.

Enric Banda, senior adviser at the Barcelona Supercomputing Centre and former president of the grass-roots association EuroScience, agrees. "This is the first time these type of measures, stipulated in the Spanish constitution, are applied. The uncertainty is high because nobody knows exactly how they will be implemented. But I don't expect any additional disruption in the daily activities of the Catalan universities," he says.

Financial ties

The League of European Research Universities, headquartered in Leuven, Belgium, has criticized the financial arrangements on the grounds that they undermine institutional autonomy. In a statement issued on 23 October, the group's secretary-general, Kurt Deketelaere, wrote: "Just like academic freedom, institutional autonomy is key for the academic world and society at large. It cannot be limited on the basis of political considerations, or to serve political goals."

Ahead of the Catalan elections in December, both Casals and Banda are calling on the Spanish government to lift the financial controls and to minimise the impact of the political upheaval on the region's international image. "Catalonia has done very well at attracting international researchers and students and we would like that to continue," says Casals.

Journal name:
Nature

DOI:
doi:10.1038/nature.2017.22922

Comments

Commenting is currently unavailable.

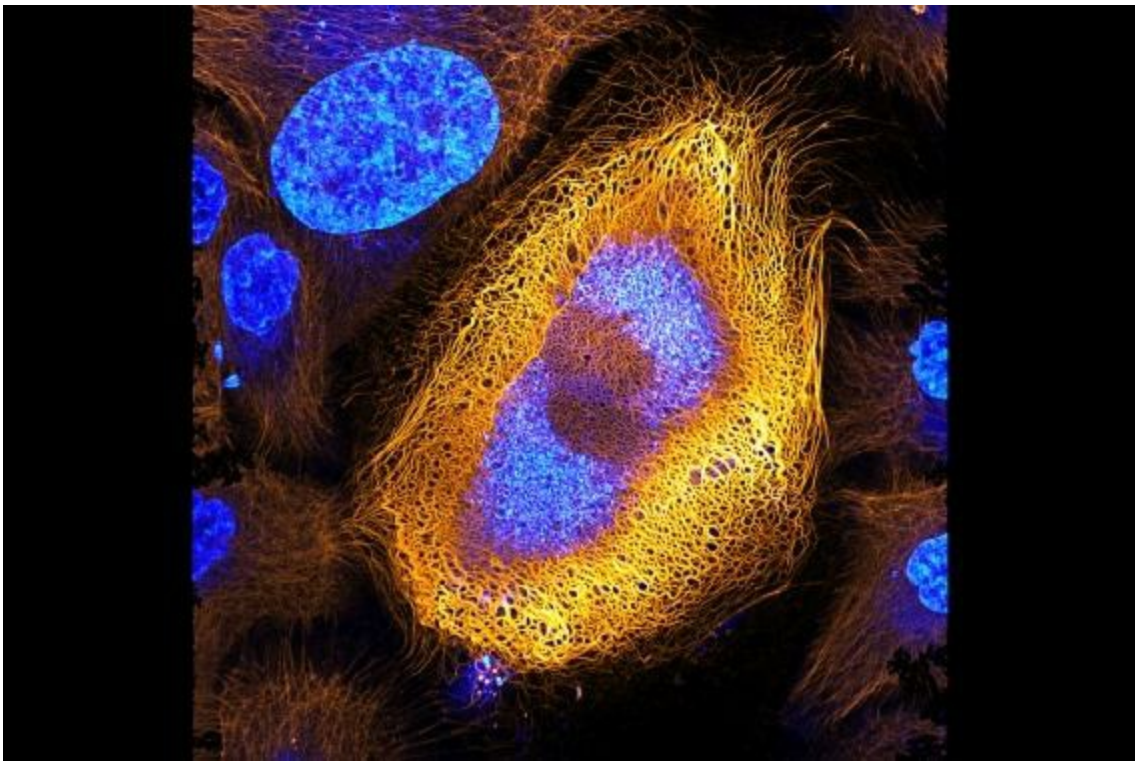
Seeds, sponges and spinal surgery

October’s sharpest science shots, selected by *Nature*’s photo team.

31 October 2017

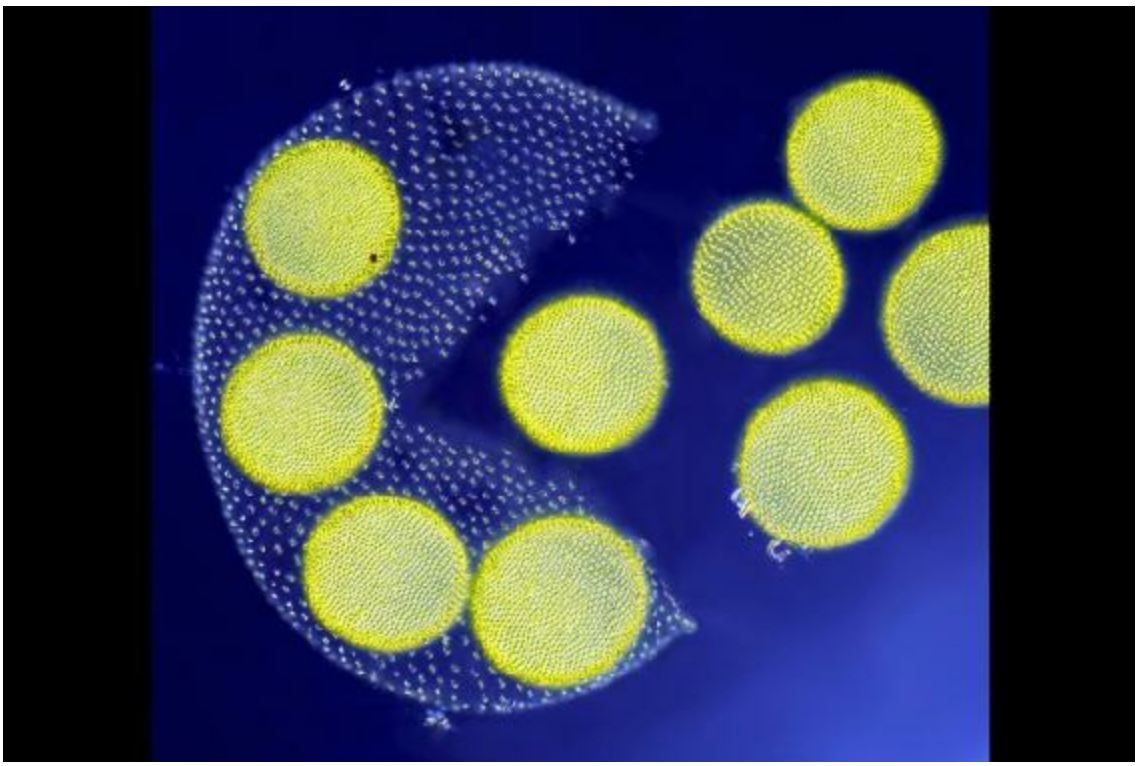
Small beauties

Image Slideshow

1. 

   This image of an immortalized human skin cell won first place in the Nikon Small World Photomicrography Competition. It was taken by Bram van den Broek, a biophysicist at the Netherlands Cancer Institute in Amsterdam.

B. van den Broek, A. Volkov, K. Jalink, N. Schwartz, R. Windoffer/Nikon Small World 2017

2. 

This might look like computer-game character Pac-Man, but it is actually a type of alga called Volvox releasing daughter colonies to continue its line.

Jean-Marc Babalian/Nikon Small World 2017

3. 

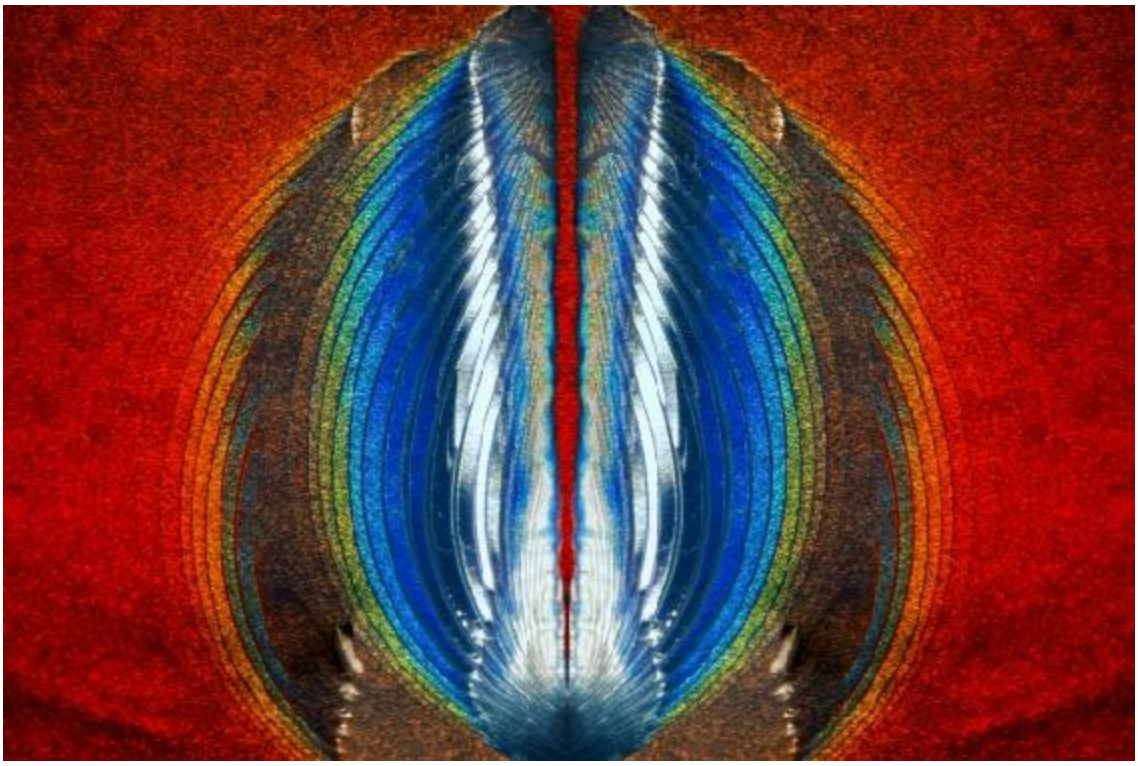
This portrait of a tropical weevil (*Rhigus nigrosparsus*) was given an ‘image of distinction’ award.

M. Clemens/Nikon Small World 2017

4. 

An eerie green crystal of the mineral pyromorphite featured in another shot that received an image of distinction.

E. C. Márquez/Nikon Small World 2017

5. 

This butterfly-like shape is in fact the fractured plastic of a credit-card hologram, seen at ten times its real size.

S. Simon/Nikon Small World 2017

6. 

   This startlingly alien shape is a cross-section through something very common: a needle from a Scots pine tree (*Pinus sylvestris*).

   A. Klepnev/Nikon Small World 2017

From tragic to touching

Image Slideshow

1. 

   The grand-title winner of this year's Wildlife Photographer of the Year competition features a black rhino (*Diceros bicornis*) in Hluhluwe Imfolozi Game Reserve in South Africa, after it was butchered by poachers who were after its horns. Brent Stirton has seen more than 30 such tragic scenes.

   Brent Stirton/Wildlife Photographer of the Year

2. 

This Maori octopus (*Macroctopus maorum*) was spoilt for choice when it came across a huge congregation of giant spider crabs off Tasmania, Australia. The photograph won the invertebrate-behaviour category of the Wildlife Photographer of the Year competition, which is developed and produced by the Natural History Museum, London.

Justin Gilligan/Wildlife Photographer of the Year

3. 

Divers from the Dumont d’Urville scientific base in East Antarctica worked for 3 days in the frigid waters off the continent to capture this image of an ice berg, which was stitched together from 147 separate shots. It won the Earth’s environments category.

Laurent Ballesta/Wildlife Photographer of the Year

4. 

These polar bears (*Ursus maritimus*) near Norway's Arctic island of Svalbard were photographed feeding on waste from a ship's kitchen. The image won the black-and-white category in this year's awards.

Eilo Elvinger/Wildlife Photographer of the Year

5. 

Controversial oil drilling is an increasing threat to the residents of Yasuní National Park in Ecuador. Among the animals imperilled is this toad, the star of this finalist in the animal-portraits category.

Jaime Culebras/Wildlife Photographer of the Year

6. 

The Sonoran Desert in the United States and Mexico hosts many saguaro cacti (*Carnegiea gigantea*), including this example that has suffered frost damage, causing its limbs to fall to the ground. The image is a finalist in the plants and fungi category.

Jack Dykinga/Wildlife Photographer of the Year

Syrian seeds

Diego Ibarra Sanchez/The New York Times/eyevine

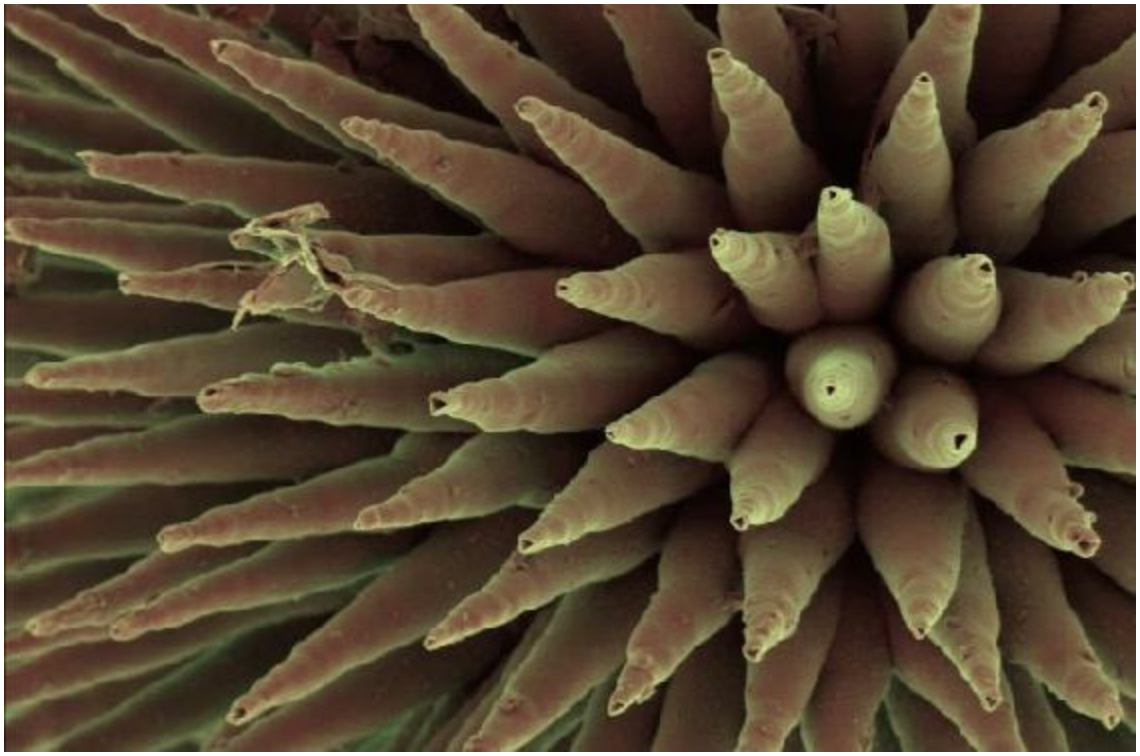
Among the people forced out of their country by the war in Syria are researchers from the nation's seed bank, who are now rebuilding their lives in locations around the world. Ali Shehadeh (pictured) is one of them. A researcher who was based at a International Center for Agricultural Research in the Dry Areas seed bank in Aleppo, he now works in Terbol, Lebanon.

Capturing sunlight

Xu Haijing/Xinhua/ZUMA Wire

The 2017 World Solar Challenge this month saw strange vehicles racing 3,00(kilometres across Australia, powered only by sunlight. Here, the Dutch-built vehicle RED Shift passes a rock formation known as the Devil's Marbles, near Tennant Creek in the Northern Territory.

Sponge spikes



Zlotnikov Group, B CUBE, TU Dresden

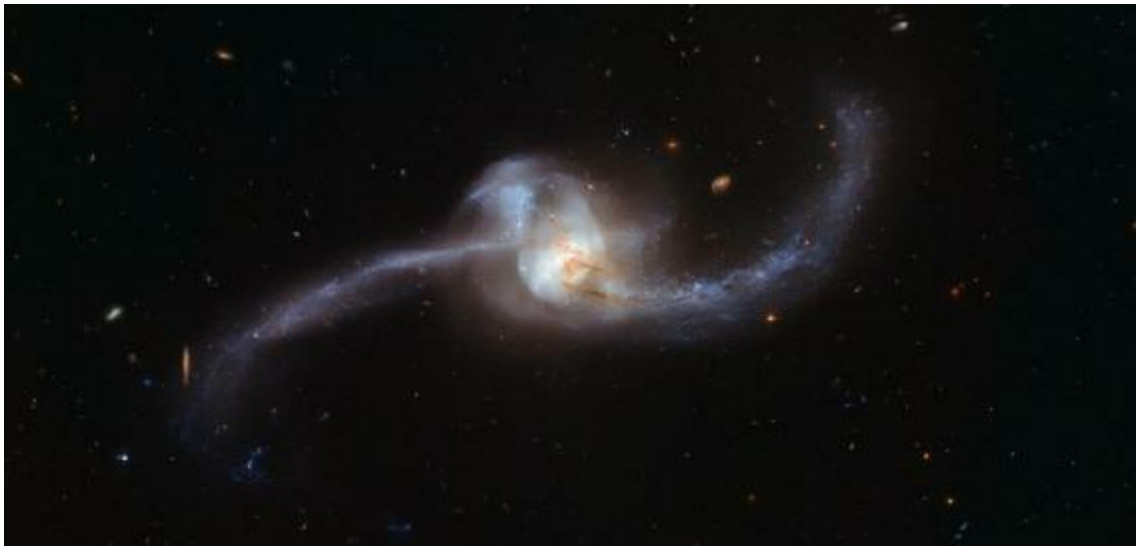
Marine sponges called demospongiae make their skeletons out of silica-glass structures called spicules. Using this image and others, researchers have been unpicking what they call the “half-a-billion-year-old fabrication concept” that produces these structures.

Spinal surgery

Beatrice de Gea/The New York Times/Redux/eyevine

Physicians at Texas Children’s Hospital in Houston now operate on fetuses with spina bifida while they are still in the womb using a new, experimental technique. This technique involves lifting the mother’s uterus out of her body to operate on the spine of the baby inside it.

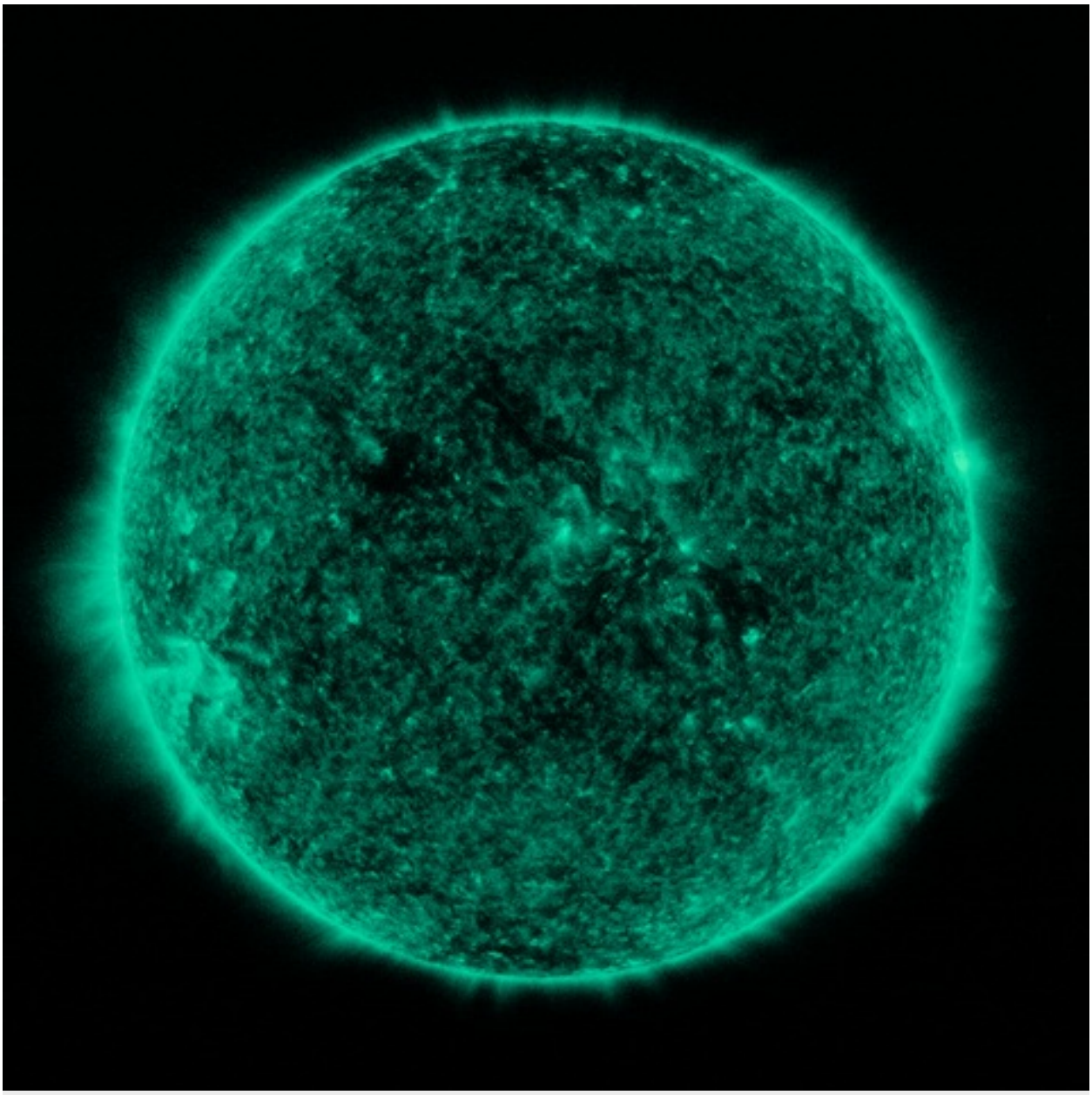
A cosmic collision’s aftermath



ESA/Hubble & NASA

Two galaxies smashed together into one to form this cluster of stars, with tails some 15,000 parsecs (50,000 light years) long. NASA released the image this month, and cheerfully pointed out that this is what our Milky Way will look like in 4 billion years' time, after it collides with neighbouring galaxy Andromeda.

Sun block



NASA’s Goddard Space Flight Center/SDO/Joy Ng

NASA’s Solar Dynamics Observatory was launched into space in 2010 to supply researchers back on Earth with an uninterrupted view of the Sun. Uninterrupted, that is, except when the Moon gets in the way, as shown in this ultraviolet spectrum from 19 October.

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Nature

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Comments

Comments

There are currently no comments.

Small group scoops international effort to sequence huge wheat genome

Just six scientists conquer one of the most complicated genomes ever read.

31 October 2017

Nico van Kappel/Minden Pictures/Getty

The genome of wheat (*Triticum aestivum*) is huge, and full of repetitive sequences.

The wheat genome is finally complete. A giant international consortium of academics and companies has been trying to finish the challenging DNA

sequence for more than a decade, but in the end, it was a small US-led team that scooped the prize. Researchers hope that the genome of bread wheat (*Triticum aestivum*) — described in the journal *GigaScience* this month[1] — will aid efforts to study and improve a staple crop on which around 2 billion people rely.

The wheat genome is crop geneticists' Mount Everest. It is huge — more than five times the size of a single copy of the human genome — and harbours six copies of each chromosome, adding up to between 16 billion and 17 billion letters of DNA. And more than 80% of it is made of repetitive sequences. These stretches are especially vexing for scientists trying to assemble the short DNA segments generated by sequencing machines into much longer chromosome sequences.

It’s like putting together a jigsaw puzzle filled with pieces of blue sky, says Steven Salzberg, a genomicist at Johns Hopkins University in Baltimore, Maryland, who led the latest sequencing effort. “The wheat genome is full of blue sky. All these pieces look like a lot of other pieces, but they’re not exactly alike.”

As a result, previous wheat-genome sequences contained gaps that made it hard for scientists to locate and examine any particular gene, says Klaus Mayer, a plant genomicist at the Helmholtz Center in Munich, Germany, and one of 1,800 members of the International Wheat Genome Sequencing Consortium (IWGSC) that have been tackling the genome since 2005.

A sequence released by the consortium in 2014 covered about two-thirds of the genome, but it was highly fragmented and lacked details about the sequences between genes[2]. Improved versions were released in 2016 and 2017, but the use of these data is restricted until the IWGSC publishes its analysis (Mayer says the team is preparing to submit its report to a journal). The sequence was also produced using proprietary software from a company called NRGene, preventing other scientists from reproducing the effort.

Puzzle pieces

Salzberg, who specializes in assembling genome sequences, and his five colleagues decided to tackle the problem themselves. To overcome the challenge of ordering repetitive DNA — the puzzle pieces of blue sky — the researchers used a sequencing technology that generates very long DNA stretches (often in excess of 10,000 DNA letters). They also created much shorter, but highly accurate sequences, using another technology.

Stitching these ‘reads’ together — which amounted to 1.5 trillion DNA letters and consumed 880,000 hours of processor time on a cluster of parallel computers — resulted in nearly continuous chromosome sequences that encompassed 15.3 billion letters of the wheat genome.

Mayer calls the new sequence “a major leap forward”. Postdocs can spend whole fellowships locating a single wheat gene of interest, he says. “Those genes which took 10 man- or woman-years to clone, this will melt down to a couple of months, hopefully.” The results of such research should help breeders to develop strains of wheat that are better able to tolerate climate change, disease and other stresses.

Some scientists are already using the new wheat genome — including, Salzberg says, members of the IWGSC working on one particular chromosome. But if it is to be of widespread use, all of the genes and sequences will need to be identified and labelled, a laborious process known as annotation. Salzberg says that a collaborator of his is planning to do this, “unless someone does it sooner”.

Neil Hall, a genomicist and director of the Earlham Institute, a genomics research centre in Norwich, UK, sees Salzberg’s approach as a sign of the times. If the wheat genome — considered one of the most complicated to be tackled by scientists — can be sequenced by a small team using the latest technology, almost any genome could.

“I think we’ve moved beyond the era where genome projects have to be these monolithic international cooperations,” Hall says. “Genomics is more like the gig economy now.”

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Nature

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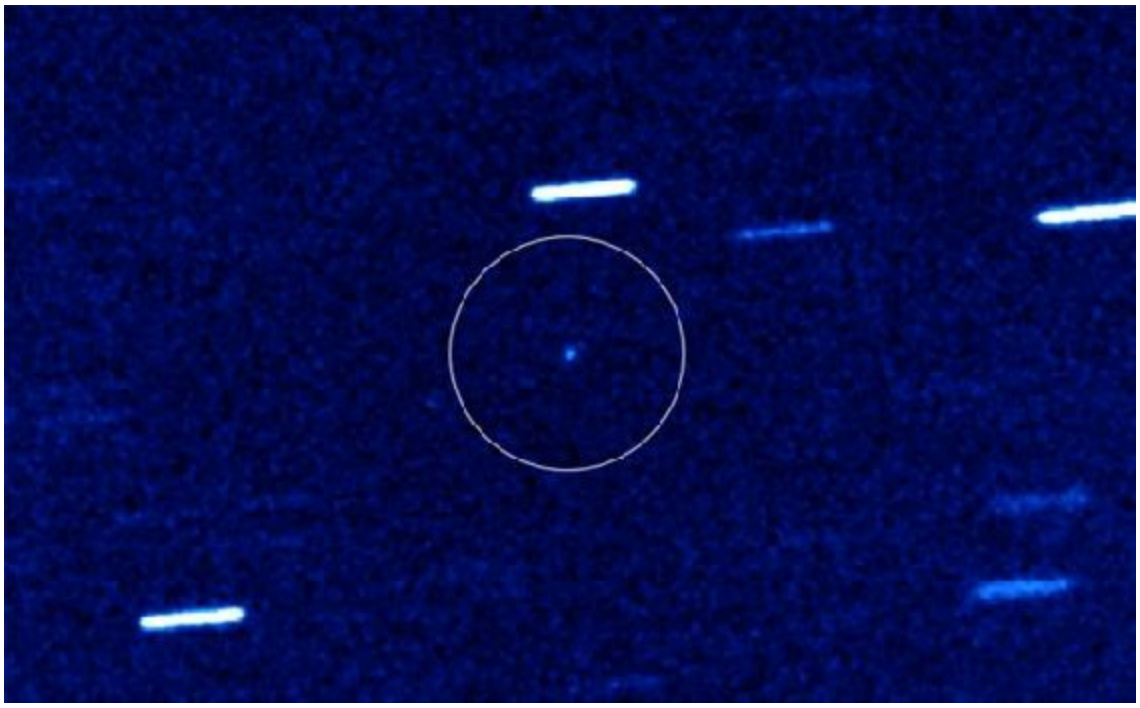
Comments

Commenting is currently unavailable.

Astronomers race to learn from first interstellar asteroid ever seen

Wonky orbit confirms that this visitor isn’t from around here.

31 October 2017



Alan Fitzsimmons, Queen’s University Belfast/Isaac Newton Group, La Palma.

The interstellar asteroid A/2017 U1 (circled) is rushing away from Earth and is currently traversing the Pisces constellation.

Scientists are trying to learn everything that they can from the first interstellar asteroid they have ever observed crossing into our Solar System. Spotted less than two weeks ago, the object is now whizzing across the constellation Pisces and, in a couple of months, will be too faint and far away for even the

largest telescopes to see.

“It’s fascinating,” says astronomer David Jewitt of the University of California, Los Angeles. “We are seeing a body from elsewhere in the Galaxy passing through our Solar System. It’s the first time we’ve seen such a thing.”

Unfortunately, the asteroid, dubbed A/2017 U1, is dashing away, never to return. “It’s going really fast,” says Jewitt. “So we have a limited time to get any measurements at all.” Astronomers would love to know what it’s made of, but it’s so dim that spectra — light that observers use to determine the compositions of celestial objects — have so far revealed little information[1]. Nor can anyone say what solar system it came from, or how old it is.

A curious path

Researchers with the Pan-STARRS1 telescope atop Haleakala in Maui, Hawaii, spied the first images of the intruder, made during the new Moon, in mid-October. “It didn’t move like comets or asteroids normally do,” says astronomer Rob Weryk at the University of Hawaii at Manoa, who first noticed the object on the morning of 19 October.

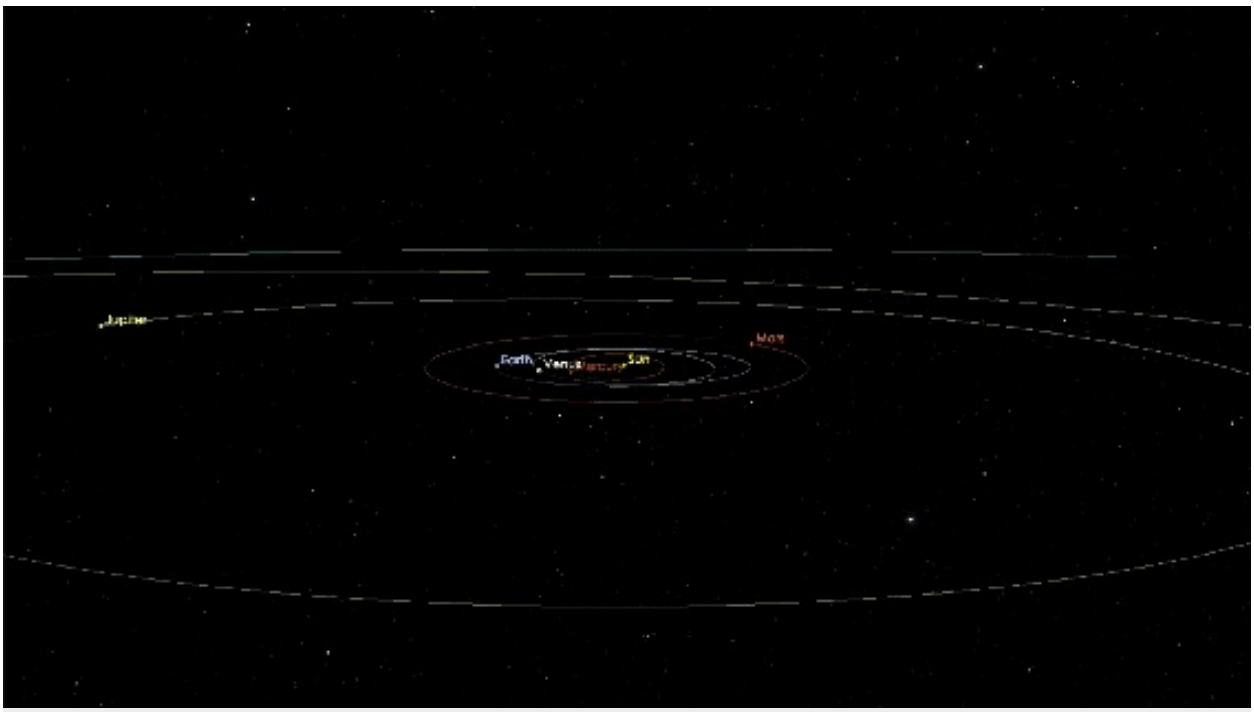
Comets and asteroids usually move on elliptical orbits around the Sun. These orbits have an eccentricity — a measure used to describe orbital shape — of less than 1. But an object zipping through the Solar System from beyond should instead follow a hyperbolic orbit, whose eccentricity exceeds 1.

The latest observations of the asteroid’s changing position indicate that its orbital eccentricity is a whopping 1.20. “It is virtually certain that the object moves in a hyperbolic trajectory,” says Carlos de la Fuente Marcos, an astronomer at the Complutense University of Madrid.

The asteroid skirted the Sun on 9 September, when it was inside Mercury’s orbit, and then passed by Earth at a distance of 24 million kilometres on 14 October.

On the lookout

Astronomers know little else about the exotic visitor. It’s faint, which means that it’s small: fewer than 400 metres across. And despite its excursion near the Sun, it did not develop a tail — as a comet would — and so astronomers are currently classifying it as an asteroid.



NASA/JPL-Caltech

The path of A/2017 U1, an interstellar object that swung through our Solar System.

Researchers have anticipated interstellar visitors for years. “We have waited a long time,” says planetary scientist Alan Stern at the Southwest Research Institute in Boulder, Colorado, who studied the matter in the 1990s.

That expectation is based on the knowledge that the gravitational pulls of the giant planets Jupiter, Saturn, Uranus and Neptune catapulted trillions of comets and asteroids from the young Solar System into interstellar

space. Planets in other solar systems presumably did the same, littering interstellar space with rogue objects. “By measuring how many there are sweeping through our Solar System, we can get a gauge of how many are in the entire Galaxy, and how many solar systems have contributed to that population,” says Stern.

“If one hadn’t been discovered fairly soon, that would start to worry me a bit,” says astronomer David Hughes, emeritus professor at the University of Sheffield, UK.

The asteroid came from the direction of the constellation Lyra, which is roughly where our Solar System is heading. Given this trajectory, researchers are expecting to see more objects coming from this direction than from elsewhere, just as runners heading into the rain encounter more drops on their chests than their backs.

A/2017 U1 is the first of many such objects, predicts Jewitt.

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Comments

Comments

There are currently no comments.

How baby bats develop their dialects

The young animals crowdsource the pitch of their calls from colony members.

31 October 2017

Joel Sartore/National Geographic Creative

Adult Egyptian fruit bats have a hand in what young bats learn.

It takes a village to teach a bat how to communicate. Baby Egyptian fruit bats learn calls from their mothers, but research now shows that they can learn new dialects, or the pitch of their vocalizations, from the colony members around them.

Learning to communicate by repeating the noises that others make is something only a few mammal groups — including humans, whales and dolphins — are known to do. Researchers call this vocal learning, and it's something that they're starting to study in bats. Findings published on 31 October in *PLOS Biology*[1] show that bats can also pick things up from the group around them, a process that the authors dub crowd vocal learning.

Bats are becoming the best organism to use in studies of how mammals learn to vocalize, because they’re more easily manipulated in the lab than whales or dolphins. The latest research underscores their importance, says neuroscientist Michael Yartsev of the University of California, Berkeley, who was not involved with the work.

Songbirds demonstrate vocal learning beautifully, but their brains are organized differently from human brains. Pinning down a mammalian model to explore how this function develops is important for neurologists studying vocal learning, says Yartsev.

The call of the colony

Egyptian fruit bats (*Rousettus aegyptiacus*) are highly social and live in colonies with dozens to thousands of other bats. To see how the pups learn dialects, researchers caught 15 pregnant Egyptian fruit bats and took them into the lab. To control for potential genetic effects, they ensured that the mothers weren't closely related. The team then split the mothers into three groups of five and put each group into one of three chambers, where the mothers gave birth to their young. The scientists used recordings of wild Egyptian fruit bat colonies that were low in frequency, high or a mix of both frequencies, and then piped one pitch into each chamber.

The team released the mothers back into the wild after 14 weeks, around the time the young would naturally be weaned. After another 17 weeks in the enclosures, the young bats were mimicking the pitch of the recordings they had grown up with: bats in the high-frequency chamber made more high-frequency calls than the bats that grew up hearing the other two frequency soundscapes.

The findings make sense, says Yossi Yovel, a neuroecologist at Tel Aviv University in Israel and a study co-author. Baby bats grow up in the dark, surrounded by noisy neighbours, so it would be odd if they didn't pick things up from the animals around them. "It's perhaps not surprising, but it was never demonstrated before now."

Yovel and his team plan to release the young bats into the wild and observe whether their dialect changes to match that of the wild bats, or whether the colony members pick up the experimental bats' dialect.

Studying how this process works in mammalian brains could provide insight into how humans learn language, too, says Sonja Vernes, a neurogeneticist at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands. "If we can understand how bats do it, I think we can learn something about how humans do it."

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Nature
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doi:10.1038/nature.2017.22926

Comments

Comments

There are currently no comments.

US environment agency bars scientists it funds from serving on its advisory boards

The US Environmental Protection Agency says the policy will address potential conflicts of interest, but scientists raise alarms.

31 October 2017 Updated:

1. 31 October 2017

Andrew Harrer/Bloomberg/Getty

EPA administrator Scott Pruitt is poised to reshape the mix of experts that advise his agency.

The US Environmental Protection Agency (EPA) moved today to ban researchers who receive agency grants from serving on EPA advisory boards.

In crafting the policy, EPA administrator Scott Pruitt sided with his agency's most vociferous critics, who claim that EPA science panels are stacked with scientists who are biased in favour of the agency's regulatory agenda. The policy does not extend to scientists who work for local, state and tribal agencies that receive EPA grants, instead focusing on academic researchers. At a press conference, Pruitt said that scientists on three major EPA advisory panels have received US$77 million in grants over the past three years.

"When you receive that much money, there's a question that arises about independence," Pruitt said. Moving forward, he said, scientists "will have to choose — either the grant, or service, but not both."

Scientists and environmentalists blasted the policy as hypocritical and dangerous, saying it will exclude many top researchers while rendering the volunteer posts less attractive for those who remain eligible. The EPA's multitude of science advisory boards provide input on everything from proposed regulations to the agency's long-term research agenda.

"It's a disturbing and short-sighted action," says Peter Thorne, who chaired the agency's main science advisory board until the end of September. Thorne, a toxicologist at the University of Iowa in Iowa City, says that the board already has policies in place to deal with conflicts of interest — such as those related to research by a board member or financial interests among industry scientists. "I'm really baffled as to why this is necessary," he says.

The EPA's new policy borrows from legislation backed by Republican lawmakers that has been circulating in the US Congress for several years. In March, the US House of Representatives passed the latest version, which would restrict scientists with EPA grants from serving on the Science Advisory Board and loosen rules that seek to address any conflicts of interest related to industry scientists who serve on the panel. The fate of that bill is uncertain, however, since the Senate — which would have to give its approval before the legislation could become law — has not taken action on

the matter.

“The reason it couldn’t get through Congress is that it doesn’t make any sense,” says Andrew Rosenberg, who heads the Center for Science and Democracy at the Union of Concerned Scientists (UCS), an advocacy group in Cambridge, Massachusetts. “It turns the idea of conflict of interest on its head.”

Competing interests

Rosenberg’s group analysed the current membership of the EPA’s main science advisory board and found that 5 of the 47 members could be barred by the new policy. But the EPA restrictions on advisory-board members could soon affect a much larger swathe of panel appointments. The terms of 15 people on the agency’s main science advisory board expired at the end of September. EPA watchers are also expecting to soon see appointments to the Board of Scientific Counselors, which advises the EPA’s main research arm, and a third panel that advises the agency on air regulations.

All three of those boards have new leaders, Pruitt announced today. Michael Honeycutt, a toxicologist at the Texas Commission on Environmental Quality, will lead the agency’s main science advisory board. Honeycutt has long opposed EPA proposals to enact stricter air-quality standards. Tony Cox, an independent consultant, will lead the Clean Air Safety Advisory Committee, while Paul Gilman, chief sustainability officer at the energy firm Covanta in Morristown, New Jersey, will lead the Board of Scientific Counselors.

One senior EPA official, who declined to be named for fear of retaliation, says that agency leadership initially considered barring any scientist who had ever received an EPA grant from serving on any agency advisory panel. Ultimately, the agency decided to focus on researchers with active grants — in part because EPA officials discovered that it was hard to find qualified scientists who had never received EPA grants.

The agency’s overhaul of its advisory boards has been in the works for

months. The EPA sparked an uproar in May and June by dismissing dozens of scientists who had served a single three-year term on the Board of Scientific Counselors. In the past, the agency has appointed many scientists for a second term to provide more continuity for programme managers who are seeking input on the vast array of research efforts at the agency.

For Thorne, the question is how the administration is going to engage with its new science advisers. In September, the main science advisory board issued a letter describing its activities and inviting Pruitt to attend one of its meetings. Whether Pruitt will take the committee up on its invitation remains to be seen, but Thorne says one thing is clear: if the agency chooses to marginalize or ignore the board, it will do so “at its own peril”.

Journal name:
Nature
DOI:
doi:10.1038/nature.2017.22929

Updates

Updated:

The story has been updated with information from the EPA press conference.

Comments

1 comment

1. *Rainald Koch* • 2017-11-01 12:58 PM
   "Tony Cox, an independent consultant, will lead the Clean Air Safety Advisory Committee" -- reminds me to Richard Anthony (Tony) Cox www-tonycox.ch.cam.ac.uk -- would be a better fit.

http://www.nature.com/doifinder/10.1038/nature.2017.22929

| 章节菜单 | 主菜单 |

Frédéric Chopin’s telltale heart

Scientists have written another chapter in the curious case of the composer’s heart. But it is unlikely to be the end of the story.

31 October 2017

De Agostini/A. Dagli Orti/Getty

The composer Frédéric Chopin died in 1849, but the debate about what killed him continues.

Edgar Allen Poe was a master of the macabre. His 1843 *The Tell-Tale Heart*

is a classic gothic tale for Halloween with its roots in guilt and fear: a murderer is haunted by the imagined beating of the excised heart of his victim.

The piano works of Frédéric Chopin — one of the greatest composers of the same period — tend more towards the uplifting. But events after his death have puzzled experts for more than a century and are worthy of any horror story. Scientists in Poland now claim to have solved the mystery. As the researchers conclude in a long-awaited report, he almost certainly died of complications caused by tuberculosis (M. Witt *et al. Am. J. Med.*; in the press; available at http://doi.org/cfpt). The evidence? The scientists have examined Chopin's own telltale heart.

The macabre afterlife of Chopin began with his recorded last words: "Swear to make them cut me open, so that I won't be buried alive." Taphephobia, as this fear is called, was a nineteenth-century obsession (shared by Alfred Nobel, among others), and saw some coffins made with alarm systems to be rung from within. Chopin's sister had an autopsy performed on him, during which his heart was removed. So although most of her brother lies in the famous Père Lachaise Cemetery in Paris, the city in which he died, she sealed his heart in a jar of (probably) brandy and took it back to Warsaw, the city closest to where he was born.

This wasn't too unusual. Remote burial of the heart was a fairly common practice, partly because it was too difficult to repatriate the bodies of kings and nobles who fell in foreign fields. (The heart of the English writer Thomas Hardy is said to be buried in his beloved Dorset, UK, although a more gruesome version of the story has the precious organ being eaten by a cat, and that of the offending animal interred instead.) But Chopin's status as a Polish national hero has helped to make sure that his heart never really rested in peace. His sister smuggled it into Poland past Russian border guards and it was later sealed inside a church pillar. Decades afterwards, during the Second World War, it was retrieved and protected by a Nazi SS commander who claimed to love Chopin's music. After the war, the heart was returned to rest in the church — but only until 2014.

Then, scientists were invited to join an official inspection of the jar and its contents. Their examination — and brief comments to journalists months

later — focused on how he died. The original autopsy notes are lost, and an entire academic subfield across many disciplines has emerged to discuss whether Chopin had tuberculosis or something much rarer, perhaps an early known case of cystic fibrosis. Those academics now have a Halloween treat: a draft of a paper to appear in *The American Journal of Medicine* offers more details on the state of the heart.

The original autopsy caused significant damage to both atria, but the paper claims "with high probability" that the remains show that Chopin had chronic tuberculosis, and that the immediate cause of death was a life-threatening complication called pericarditis — inflammation of the membrane enclosing the heart.

Chopin is not the only ghost from the past to offer their secrets to scientists. The artist Salvador Dalí was exhumed in July, moustache reportedly intact, to provide samples to decide a paternity case (he was not the father); and 2015 tests on bones of the Communist poet and winner of the Nobel Prize in Literature, Pablo Neruda, have fuelled theories that he was poisoned in Chile after Augusto Pinochet seized power in 1973.

There could yet be a twist in Chopin's tale. Some scholars are unsure that the heart is the composer's, and DNA tests to check for cystic fibrosis have so far been refused. The scientists were not allowed to open the jar in 2014, and Michał Witt at the Polish Academy of Sciences' Institute of Human Genetics in Poznan, who worked on the project, says that they didn't want to. The next opportunity will be in 50 years, when the heart is again scheduled for inspection. Witt does not expect to be around to see it. Still, he does have something more planned: the team was allowed to take photographs of the embalmed heart, and although none is yet public, he does plan to include them in the final manuscript. The full tale, after all, has not yet been told.

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Comments

There are currently no comments.

Lower emissions on the high seas

Global regulations to limit carbon dioxide from the shipping industry are overdue.

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Getty

Voluntary efforts to tackle carbon pollution from the shipping industry have failed.

In Herman Melville’s novel *Moby-Dick*, seafaring is the occupation of adventure-lovers. But since the maritime classic was published in 1851, the act of ‘sailing about a little’ has become a huge commercial undertaking. Today, a massive fleet of cargo ships transports 90% of global consumer goods. Shipping is efficient — but comes with an environmental cost that has

not been adequately accounted for.

Worldwide, there are about half a million ships in operation, together producing almost one billion tonnes of carbon dioxide each year. That's between 2% and 3% of the global total, and more CO_2 than Germany emits annually. But unlike greenhouse-gas emissions from Germany and other nations, shipping emissions are not subject to the reduction pledges made by individual nations under the Paris climate agreement. (The Paris deal does, however, include shipping emissions in its global carbon-budget calculations.)

After years of inaction, the great white whale of greenhouse-gas pollution is now in the cross hairs of the International Maritime Organization (IMO), the specialized United Nations agency that sets safety and environmental standards for the global shipping industry. The IMO is under pressure from campaigners and representatives of other, regulated sectors to agree a global cap on shipping emissions.

Following sharp increases in the early 2000s, the sector's emissions have remained more or less stable since the global financial crisis of 2008. But that is unlikely to continue. The current overcapacity in the maritime cargo market means that ship traffic (and emissions) can increase quickly to meet demand. Moreover, the shipping industry at large — including the cruise sector — has potential to grow, and rapidly.

The IMO has a specialist greenhouse-gas working group that is grappling with the idea of a cap. But its latest meeting, held last week in London, closed without declaring much progress. Overall, the IMO is committed to tightening environmental standards for new ships. Yet its technology-oriented strategy — including an Energy Efficiency Design Index that requires the engines of vessels to burn less fuel — is unlikely to be enough. Cleaning up the industry will require adequate market instruments and economic incentives to encourage owners and operators of both ships and ports to adopt climate-friendly practices, such as enforcing lower speeds.

Owing to the peculiarities of this volatile business, the routes, speed and fuel consumption of tens of thousands of container ships are hard to monitor and verify. An emissions-trading system, for example, would be difficult to

implement and even harder to manage. The IMO agreed last year to set up a global CO_2 data-collection system that will yield welcome knowledge, as will improvements in tracking the positions and movements of ships from space. But a tax by national governments on fossil fuels used by ships — incurred at refinery level — might be a more effective economic mechanism.

Voluntary efforts alone will not do. The industry has set up a series of half-hearted and overlapping eco-ratings schemes since the 2000s. But an analysis published online on 16 October shows that these have had no notable effect on the environmental performance of ships (R. T. Poulsen *et al. Mar. Policy* **87,** 94–103; 2018). Whereas eco-ratings can steer companies to make more-efficient refrigerators and washing machines in line with the preferences of consumers and regulators, maritime transport is different. The pressure of end-users is too distant to influence ship owners and operators. And price remains the dominant factor for builders and buyers of cargo ships.

As a global business, shipping must be tackled by global regulations, and not through a patchwork of voluntary efforts and regional laws. It is true that some regional efforts, such as the European Union's scheme to monitor, report and verify CO_2 emissions from large ships using its ports, might be a step towards global regulations.

The IMO has already shown that it can tackle other environmental issues. Measures it introduced in the wake of the *Exxon Valdez* oil spill in 1989 ensure that oil tankers are now much safer. An international convention for ballast-water management, which aims to control the spread of harmful invasive species, came into force in September after years of preparation (although it does not address biofouling on ships' hulls, which is potentially more harmful to local ecology). The IMO has also agreed measures to encourage environmentally responsible ship recycling and minimize uncontrolled shipbreaking, much of which occurs on South Asian beaches. However, this 2009 Hong Kong convention is still not implemented and is awaiting ratification by most member parties.

When it comes to the impact on climate, there is no excuse for delay. Emissions from shipping largely escape the public scrutiny and criticism attracted by those from aviation. Parties to the IMO should step up and hasten

the implementation of the necessary standards.

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Commenting is currently unavailable.

Lessons from first campus carbon-pricing scheme

31 October 2017

Putting a value on emissions can lower energy use, write Kenneth Gillingham, Stefano Carattini and Daniel Esty.

Enzo Figueres/Getty

Kroon Hall, home to Yale University's environment school in New Haven, Connecticut, reduced emissions substantially in the face of the carbon charge.

In July, Yale became the first university to launch a carbon-price programme across its campus. More than 250 buildings, together accounting for nearly

70% of the institution's emissions, will be charged US$40 per tonne of carbon dioxide that they emit as a result of energy use. Buildings that reduce their emissions more than the average will receive a share of the funds collected.

More than 500 firms around the world — three times more than a year ago — consider a carbon price of some kind when judging where to invest their money. Hundreds more are expected to start doing so in the coming months. Faced with higher prices, these organizations are shifting to forms of energy that generate less emissions and are more efficient.

Although some large companies have tried internal carbon pricing over the past two decades — BP was the first, in 1998 — little has been published about the value of such programmes. Here, we share initial insights and ideas for future research from a pilot scheme tried in 2015–16 at Yale — a prelude to the university's decision to roll out carbon pricing more broadly this year.

Price signals

Carbon pricing offers a direct incentive to reduce energy consumption and thus mitigate global climate change. In 2015, 13% of global greenhouse-gas emissions were subject to some form of carbon price, and this percentage is rising[1], despite the challenges currently facing government-backed schemes (see 'Faltering policies').

Faltering policies

Governments are struggling to put an appropriate price on carbon dioxide. In 2016, voters in the state of Washington rejected an initiative that would have set a tax on carbon emissions, despite broad support in polls for policy action on climate change. US President Donald Trump has backed away from the previous administration's Clean Power Plan. South Africa has delayed implementing a carbon tax. The United Kingdom has frozen its price floor for trading carbon at £18 (US$24) per tonne of CO_2 until 2021, rather than gradually raising it, as intended. According to the International Monetary Fund, most developed countries should price carbon at at least US$100 per

tonne of CO_2 equivalent to reach their emissions-reduction targets for the 2015 Paris climate -change agreement. The longer they wait, the higher these prices will need to be.

A company or institution can implement a carbon price through an internal emissions-trading programme, a carbon charge or a 'proxy price' (or 'shadow price') on greenhouse-gas emissions.

In the first case, the firm caps its emissions at a given level for a fixed period and divides its allowances between its organizational units — in a similar way to the European Union Emissions Trading Scheme. Units then trade their allowances with each other. Buying allowances from units with lower pollution-reduction costs minimizes the overall cost to the company. BP used this approach to reduce its company emissions, quickly achieving its goal of a 10% cut from 1990 levels by 2010[2].

An internal charge increases the price of carbon-intensive goods and services exchanged within the organization. The higher the price, the greater the incentive for the firm to decarbonize.

Companies can redistribute the revenue raised, or invest it in emissions-abatement schemes, as the luxury-goods conglomerate LVMH does. Ice-cream manufacturer Ben & Jerry's invests its revenue in programmes to reduce emissions across its supply chain, on the basis of a “cow-to-cone” life-cycle analysis.

For the past five years, Microsoft has charged its business groups a carbon fee that appears quarterly in their profit-and-loss statements. The fee covers energy consumption (adjusted for employee count) from data centres, offices and software-development labs, as well as from business air travel[3]. The revenue raised goes towards buying renewable energy or improving the treatment of electronic waste or the energy efficiency of lighting, heating, ventilation and air-conditioning systems[4]. In 2015, this fee was about $4 per tonne of CO_2 (ref. 5); this is much less than the US government estimate of the 'social cost of carbon', which is $44 per tonne. Low fees are common, with most internal carbon charges below $30 per tonne of carbon dioxide.

Proxy prices — which involve no financial transactions but are taken into account when weighing up business decisions — are often higher. No revenue is raised, but the carbon price shapes long-term investment choices. When deciding what sorts of buildings to construct or equipment to buy, the proxy price favours low-carbon solutions.

Ben & Jerry's

A solar-energy installation under construction next to the Ben & Jerry's ice-cream factory in Vermont.

For example, ExxonMobil, the Texas-based oil-and-gas multinational, is using a proxy price of $10 per tonne of CO_2; that will rise to $80 per tonne by 2040 (ref. 5). Proxy pricing drove Bristol Water, a British public utility company, to install more energy-efficient water pumps[6]. Saint-Gobain, a building-materials manufacturer based in Paris, uses a carbon price to drive investments in research and development for breakthrough technologies[6]. Some companies, such as the Dutch multinational Royal DSM in Heerlen, present two business cases for investments: one with and one without carbon

pricing[6].

Getting ahead

Organizations are implementing internal carbon pricing for many reasons. By aligning investment decisions now, firms are preparing for more-stringent domestic climate policies and for future mandatory carbon pricing. They are also avoiding becoming locked into unprofitable investments and 'stranded assets', which are a concern for investors and others, and are preparing for changed future circumstances. For example, more than 80% of current coal reserves might need to remain untouched if countries are to limit warming to 2° C (ref. 7). Committing to carbon pricing sends a signal to rating agencies and regulators that an enterprise is forward-looking and attentive to emerging climate risks[8].

Internal carbon pricing is part of broader corporate or organizational social-responsibility efforts[4]. By using a carbon price rather than targets for renewable-energy procurement, or internal energy-efficiency standards, organizations achieve those goals in the most cost-effective way. Innovations may result from directing managerial attention to cheaper projects that improve operations or that reduce energy expenditure[2]. Managers do not need to know the exact costs of abatement to achieve progress.

Organizations can also pilot internal carbon-pricing schemes to shape future governmental decisions. Policy leadership was one of the motivations behind BP's internal carbon pricing[9].

Lessons from Yale

Yale University's carbon-charge pilot was launched as part of the university's broader sustainability initiative and ran from December 2015 to May 2016. The charges covered direct and indirect emissions from consuming energy sources such as electricity, gas, steam and chilled water. The price was set at $40 per tonne of CO_2, which was close to the US government's estimated social cost.

Each of the 20 buildings selected for the pilot received a monthly report that detailed energy consumption and carbon use. They were all randomly allocated to one of four approaches: no carbon price; carbon pricing with 20% of the revenue earmarked for energy-efficiency actions; pricing with the revenue redistributed to buildings that reduced their emissions by at least 1% relative to their historic level of emissions; and pricing with revenue that was returned to buildings whose percentage reduction in emissions exceeded the average. This last approach is revenue-neutral: a net charge applied if emissions reductions were below average, and a net rebate if cuts were above average. Campus buildings outside the scheme served as a control group. Emissions were estimated in proportion to the amount of energy used, with different factors for different sources.

By the end of the trial, buildings that had faced carbon charges had used less energy than those that had not (see 'Energy savings'). Reasons for this included increased awareness of energy use, competition between buildings and the higher price of energy.

Building managers were mainly responsible for responding to the charge. Some favoured cheap options, such as turning down the heat by 1° C. Behavioural or operational changes, such as turning off lights and unused electrical equipment, also cost little. Others, including the departments of economics, environmental studies, public health and the boathouse, took more expensive measures such as installing occupancy sensors, thermal window shades or bulbs that use light-emitting diodes.

At the end of the pilot, the university selected the revenue-neutral pricing structure to implement campus-wide, because of its financial stability. The structure is not subject to potentially large outflows of funds if buildings exceed a target, saving energy because of an unusually mild winter, for example, or if energy needs rise unexpectedly owing to a cold snap or other reasons.

Of course, there are caveats. The scheme's novelty might have boosted engagement. Academics might be more interested than others in adopting challenging and original innovations. The sample size is small and the findings might not generalize to other situations.

Nonetheless, we feel that Yale's experience highlights important ingredients and challenges for internal carbon pricing.

First, information and incentives must be conveyed clearly for carbon charges to change behaviour.

After the pilot, more than half of the staff involved reported an improved understanding of energy use. The flow of information began with the energy reports to managers and spread through meetings with the staff and faculty, and through posters that explained energy savings. Students carried out energy audits. Actions were often collectively identified and followed up by monthly e-mail updates.

Second, the details of the scheme matter. How energy information is presented and carbon-charge revenue is redistributed influence the effectiveness of the scheme. For example, exit surveys of managers indicated that they responded more to the 'net' carbon charge, calculated after they had received a rebate, than to the higher 'gross' charge. Thus, many perceived the price signal as smaller. To increase managers' response to the price signal, one of them suggested a “bump in pay” for good performance on the carbon charge.

Third, carbon pricing is more effective when participants consider the rules to be fair. Perceived fairness increases engagement and encourages competition. The baseline from which emissions reductions are compared is a crucial design factor because it influences winners and losers. Yale's carbon-pricing system recognizes that buildings vary in size, age and energy efficiency, and that research in some disciplines is more energy-intensive than in others. Hence, only emissions above the historic baseline count towards the carbon charge. Emissions in the divinity school might be 100 times lower than those in the medical school, which hosts magnetic-resonance equipment.

For the pilot, the average emissions in the previous three fiscal years, 2013–15, were used as the baseline. In the campus-wide scheme, fiscal years 2011–15 are being used, with adjustments for a few buildings with large renovations, additions, construction or directed growth. For example, emissions at Ezra Stiles College were exceptionally low in 2011–12. during a period of major renovation. Brand new buildings will require projections.

Future research

Four areas of research could improve the design of internal carbon-pricing schemes. First, scientists, engineers and economists need to identify and test design options using rigorous pilot projects, similar to Yale's. These should span organizations of many different sizes and complexities. Such tests would provide insights for policymakers.

Second, no evidence exists on how internal carbon charges interact with non-carbon-pricing policies, such as tax credits or other incentives for renewable energy or energy efficiency. Economists should explore these interactions through data analysis and natural experiments, such as from regulatory changes, including effects on consumers.

Third, building scientists and other metrics experts must develop methods to assure high-quality benchmarking and data analytics for emissions inventories and baseline calculations. Ideally, these metrics should cover a wide range of energy uses before an internal carbon price is set up.

Fourth, accounting and managerial expertise is required to define the tax and financial implications of internal carbon pricing, in particular for multinational and transnational organizations.

We are only beginning to understand internal carbon pricing, but it seems to hold great promise as a way to sharpen incentives and reduce greenhouse-gas emissions.

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Supplementary information

PDF files

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Nature News

周三, 15 11月 2017

Nature News

[周三, 15 11月 2017]

- **Nature News**

Nature News

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- **China fires up next-generation neutron-science facility** [周二, 14 11月 08:00]
  Beam generator puts country in elite company for doing experiments in materials science and other fields.
- **High-jumping beetle inspires agile robots** [周一, 13 11月 08:00]
  Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.
- **Archaeologists say human-evolution study used stolen bone** [周一, 13 11月 08:00]
  Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.
- **Lab mice's ancestral ‘Eve’ gets her genome sequenced** [周一, 13 11月 08:00]
  Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.
- **World’s carbon emissions set to spike by 2% in 2017** [周一, 13 11月 08:00]
  Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.
- **South Africa tackles crime at sea with ship-spotting satellites** [周五, 10 11月 08:00]
  Automated vessel-tracking system aims to spy poachers and smugglers.
- **Resurrected malaria strategy saves thousands of lives in Africa** [周五, 10 11月 08:00]
  Pre-emptively treating kids for malaria is working, despite logistical challenges.
- **Physicists shrink plans for next major collider** [周四, 09 11月 08:00]
  Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.
- **Skin regeneration with insights** [周三, 08 11月 08:00]
  A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.

- **Too many academics study the same people** [周三, 08 11月 08:00]
  Researchers should recognize communities that feel over-researched and under-rewarded.
- **Grant recipients can still give objective advice** [周三, 08 11月 08:00]
  The US environment agency should not ban researchers it funds from its advisory boards.
- **Rohingya refugees, Bulgarian protests and a prize for negative results** [周三, 08 11月 08:00]
  The week in science: 3–9 November 2017.
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  Physicists begin to embrace alternative explanations for the missing material.
- **The bitter battle over the world's most popular insecticides** [周三, 08 11月 08:00]
  As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.
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  Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.
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  As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.
- **Polar exploration: The forgotten journey** [周三, 08 11月 08:00]
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- **Books in brief** [周三, 08 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.
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  A former pharmaceutical boss will help navigate the UK's exit from the European Union.
- **Indian scientists urged to speak out about pseudoscience** [周二, 07 11月 08:00]
  Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.
- **Pirate paper website Sci-Hub dealt another blow by US courts** [周二, 07 11月 08:00]
  American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.
- **Genetically modified apple reaches US stores, but will consumers bite?** [周二, 07 11月 08:00]
  Success for the 'Arctic apple' could herald a new wave of lab-grown foods.

China fires up next-generation neutron-science facility

Beam generator puts country in elite company for doing experiments in materials science and other fields.

14 November 2017

Jin Liwang/Xinhua via ZUMAPRESS

Engineers work on an instrument at the China Spallation Neutron Source in Dongguan.

China is revving up its next-generation neutron generator and will soon start experiments there. That will lift the country into a select group of nations with facilities that produce intense neutron beams to study the structure of

materials.

The China Spallation Neutron Source (CSNS) in Dongguan, a 2.2-billion-yuan (US$331-million) centre, will allow the country's growing pool of top-notch physicists and material scientists, along with international collaborators, to compete in multiple physics and engineering fields. Its designers also hope that the facility will lead to commercial products and applications ranging from batteries and bridges to aeroplane engines and cancer therapy.

"It is not only a big step forward for Chinese scientists, but also a significant event for the international scientist community," says Wang Xun-Li, a physicist at the City University of Hong Kong who has been involved in planning the facility.

Beam bombardment

Spallation neutron sources produce neutrons by slamming protons onto a metal target — CSNS uses tungsten. They are more cost effective and safer than other methods, which use nuclear reactors to produce neutron beams. As neutrons have no charge, they can penetrate materials more easily than some other probing methods, and they are more senstive to light elements such as hydrogen, making them useful for evaluating candidate materials for fuel cells. Similar facilities exist only in the United Kingdom, United States, Japan and Switzerland, and one is under construction in Sweden.

Fujio Maekawa, a specialist in neutron sources at the Japan Proton Accelerator Research Complex in Tokaimura, says that although the CSNS delivers neutrons at a lower density than other spallation sources — which means that experiments will take longer — a planned upgrade will bring it in line with other facilities. And given their scarcity, "neutron users around the world always welcome new sources", he says.

The CSNS will have capacity to host 20 beam lines, supplying as many instruments. Preliminary tests of its first three instruments began on 1 November. "Neutrons arrived at the samples as expected," says Wang

Fangwei, head of the neutron-science division at CSNS. Although debugging might take a couple of years, he expects the instruments to be calibrated and ready for initial experiments by the end of 2017.

Chinese physicists are eager to use the facility to analyse the underlying magnetic properties of materials, an area in which the country has significant experience. Wang Xun-Li says that several planned instruments will give scientists the chance to move to the forefront of fields such as the physics of skyrmions — vortex-like excitations in magnetic materials — and high-temperature superconductivity. “There are a whole bunch of early- to mid-career scientists who are hungry to use the facility for studying magnetism,” says Wang Xun-Li.

Global appeal

Wang Xun-Li thinks that the latest facility will encourage Chinese researchers to remain in the country instead of pursuing careers elsewhere. “In the past, it was common to see Chinese scientists go abroad for these kinds of studies,” he says.

The facility’s first instruments are also attracting international researchers. German material scientist Frank Klose says that the CSNS was a major factor when he and material scientist Christine Rehm, his wife, decided to join the new Guangdong Technion Israel Institute of Technology in Shantou, 400 kilometres east of Dongguan. Klose’s research focuses on designing data-storage devices and sensors that could be used in hydrogen-powered cars. He helped design one of the facility's instruments to investigate the magnetic properties of spintronic devices, which take advantage of the spin of electrons to store data.

But scientists contacted by *Nature* have raised concerns about CSNS’s location, saying that Dongguan lacks services and infrastructure, such as schools and universities, that will persuade top scientists and their families to move there. “I believe CSNS is suffering from a lack of first-grade scientists who actually are based in Dongguan,” says a researcher familiar with the facility, who asked for anonymity because of the sensitivity of the issue.

Potential users have also expressed some frustration that only 3 instruments will be ready this year, despite the facility's capacity to host 20.

But more instruments are already being built. Shenzhen's government is funding two that are expected to be ready by the end of 2019, including one designed to model high-pressure environments, such as the Earth's core. Mao Ho-Kwang, a geophysicist at the Carnegie Institution for Science in Washington DC, is keen to use it to simulate what happens to materials in high-pressure conditions. "The CSNS instruments will be a great asset for Earth, environmental and energy science, as well as physics, chemistry and material science," says Mao. "I am very excited, and the whole neutron community is getting very excited too".

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Comments

Comments

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High-jumping beetle inspires agile robots

Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.

13 November 2017

Brian L. Stauffer

Click beetles have a hinged body that can propel them to great heights.

A beetle that can launch itself spectacularly into the air after falling on its back — flipping right side up without having to use its legs — could inspire a new generation of smart robots.

Imagine a rescue robot vaulting its way through a disaster zone riddled with obstacles, or a planetary robot extricating itself from an unexpected tumble on Mars. Each might use a trick or two learnt from the click beetles, a family of insects with the unique ability to catapult themselves out of trouble.

“A lot of robots out there jump using their legs,” says Aimy Wissa, a mechanical engineer at the University of Illinois in Urbana-Champaign. “What’s unique about this is if something breaks, you can still jump without legs and get out of the situation.”

Wissa and her Illinois colleagues, led by mechanical-engineering graduate student Ophelia Bolmin, described the mechanics of jumping click beetles on 7 November at a meeting of the Entomological Society of America in Denver, Colorado. They published early results in the proceedings of a bio-inspired robotics conference in July[1].

So far, the scientists have studied how click beetles manage to store and hold the energy needed to launch themselves into the air. They hope to soon start building prototype machines designed after the beetles.

Snap to it

There are about 10,000 species of click beetles around the world. The insect’s head and body are connected by a hinge that the beetle can slowly arch and then suddenly snap in the opposite direction, jack-knifing its body and sending it into the air with an audible ‘click’. Earlier work has shown that the beetles launch nearly vertically before somersaulting through the air[2].

Ophelia Bolmin/University of Illinois at Urbana-Champaign

Click beetles can launch themselves up with surprising force.

If the beetle lands on its back, it just does the same manoeuvre again. Compare that to an upended ladybird — also known as a ladybug — which has to wiggle around on its back until it manages to roll over far enough and get traction with its legs to flip itself over.

The Illinois team wanted to analyse how the click beetles pull off their acrobatic feat. “We thought we could look at, how do they really jump, how is that energy being released?” says Marianne Alleyne, an entomologist on the team.

Students measured the dimensions of dozens of beetles of four species (*Alaus oculatus*, *Ampedus nigricollis*, *Ampedus linteus* and *Melanotus* spp.), videotaped their jumps with high-speed cameras and analysed the energy required for the beetles to pull the hinge back and then release it. Muscles alone are not enough, because they contract relatively slowly, and so other body parts such as tendons must also be involved, the team says.

How high?

The researchers also measured the force drop as the hinge snapped shut, confirming that it corresponded to the click as the beetle begin to soar skyward. They are now analysing the energies involved as beetles of different sizes make the jump. Click beetles can range from just a few millimetres to a few centimetres long; early results suggest that the bigger the beetle, the higher it can jump, Wissa says.

Other engineers have developed a range of agile robots that can jump using their legs — including one inspired by the Senegal bushbaby (*Galago senegalensis*), which has the highest vertical jumping ability of any animal[3]. Compared with crawling, jumping is a fast and efficient way for small robots to get around obstacles, says Mark Cutkosky, a mechanical engineer at Stanford University in California.

The advantage of the beetle approach is that something could go wrong with the robot's legs, and it could still get out of its predicament, Wissa says. "It simplifies the design a lot."

Any robots inspired by the click beetle would probably have to be quite small — perhaps a few tens of grams, says Gal Ribak, a biomechanics specialist at Tel Aviv University who has studied the beetles' jumps[4]. "Otherwise, the jumping mechanism will require too much energy to lift the body into the air, and the repeated impacts at take-off and landing would result in mechanical damage," he says.

But those constraints might not apply to robots exploring planets other than Earth. On worlds with lower gravity, beetle-like robots could fly high.

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Comments

Comments

There are currently no comments.

Archaeologists say human-evolution study used stolen bone

Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.

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1. 13 November 2017

Marc Steinmetz

The Untermassfeld site in Germany has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago.

Serious concerns have surfaced about three research papers claiming evidence for one of the earliest human occupations of Europe.

In an extraordinary letter posted to the bioRxiv.org preprint server on 31 October[1], archaeologists allege that the papers, published in 2013, 2016 and 2017, included material of questionable provenance, and that results reported in the 2016 paper were based on at least one stolen bone. Editors at the journals concerned have now published expressions of concern about the papers.

There is no suggestion that the authors of those papers were involved in theft, but the researchers behind the letter say they are concerned that appropriate questions regarding the provenance of the material appear not to have been asked. They also reject the authors' conclusion that a German site known for animal remains was also home to hominins, ancient relatives of humans, 1 million years ago. The authors have denied the allegations and say they stand by their conclusion.

The letter was initiated by archaeologist Wil Roebroeks at Leiden University in the Netherlands, and Ralf-Dietrich Kahlke, a palaeontologist and head of the Senckenberg Research Station of Quaternary Palaeontology in Weimar, Germany, who leads excavations at Untermassfeld, a fossil site about 150 kilometres northeast of Frankfurt. Their preprint describes repeated disappearances of bones from Untermassfeld, as well as fossils delivered in anonymous packages. The authors of the disputed papers insist, however, that they analysed independent collections of bones and stones, and reject the suggestion that any of it was stolen.

Untermassfeld, which has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago, holds the most complete record of northern European wildlife from this time period. But since yearly excavations began in the late 1970s, no hominin bones or signs of occupation have been found, says Kahlke. Hominins first settled in southern Europe around 800,000 to 1 million years ago, most archaeologists agree, and expanded farther north only sporadically until around 500,000 years ago.

Uncertain origins

One of the first claims that hominins lived near Untermassfeld more than 1 million years ago appeared in a 2013 paper in the journal *Quaternary International*, which contended that rocks from the site resembled stone tools[2]. In a 2016 *Journal of Human Evolution* paper[3], two of the original paper's authors, Günter Landeck at the North Hessian Society of Prehistory and Archeology of the Medieval in Bad Hersfeld, Germany, and Joan Garcia Garriga at the Universitat Oberta de Catalunya in Barcelona, concluded that marks on animal bones from Untermassfeld were made by humans. In 2017, Landeck and Garcia Garriga published further analysis of the bones in another *Quaternary International* paper[4].

There is no suggestion that the other co-authors of the 2013 paper had any connection with the material from Untermassfeld. And after this article was published, Garcia Garriga contacted *Nature* to say that he, also, did not have connections with the material; he said that Landeck had done the analysis, while he himself helped in discussing data and writing up its archaeological implications.

In their papers, Landeck and Garcia Garriga attributed the material, along with hundreds of rock fragments of limestone and chert, to “the Schleusingen collection”, which they stated was recovered by a biology teacher in the late 1970s and early 1980s.

Kahlke says he is personally unaware of a Schleusingen collection and questions whether the material was collected at this time. Rocks like those described in the papers can be found in the vicinity of the site, but he says that animal fossils are concentrated in a small area that has been under excavation since 1978. No other research teams had permission to excavate the site during that time, Kahlke says. But he says that material was routinely stolen from the site — which he reported to the police, most recently in 2012 — until the site and fossil bed were better secured. There is no suggestion that Landeck and Garcia Garriga were involved in these thefts.

Ralf-Dietrich Kahlke

Researchers excavating at Untermassfeld allege that part of a deer bone protruding from the sediment on 28 May 2009 (in box, left) had disappeared several days later.

One fossil that Kahlke considers suspicious is a right limb-bone fragment from an extinct species of fallow deer, described in Landeck and Garcia Garriga's 2016 *Journal of Human Evolution* paper. Kahlke says that the bone in the paper seems to match a piece of deer bone that thieves broke from a larger chunk of sediment at Untermassfeld, leaving part of the bone behind. The bone fragment is present in a photograph taken on 28 May 2009, and missing in a photograph taken several days later. A rhinoceros limb fragment that disappeared from the site in 2012 also closely resembles a fossil described in the 2016 paper, Kahlke says.

Case unsolved

Deepening the mystery, a deer bone fragment was among a jumble of bones and rocks in two packages sent anonymously to a museum near Untermassfeld in March 2014. Ralf Werneburg, a palaeontologist and director of the Natural History Museum Schloss Bertholdsburg in Schleusingen, Germany, recognized the material as originating from Untermassfeld and contacted Kahlke.

Ralf-Dietrich Kahlke

An anonymous package sent to a museum in Schleusingen contained a deer bone fragment (lower bone), which appears to match a fragment left behind (upper bone) after a theft from the Untermassfeld site in 2009. (The fragments are shown pieced together in the view on the far-right).

In Kahlke's opinion, the returned deer bone fragment is the one described in the 2016 paper, and matches up with the piece left behind after the 2009 theft**.** He says that the sixty-three other bone fragments in the packages also closely resemble some of the fossils described in the 2016 paper (the rhinoceros limb bone was not among them), and 11 rock fragments resemble

artefacts in the 2013 *Quaternary International* paper.

Roebroeks and Kahlke's team analysed the material in the returned packages, and concluded that it does not support a hominin occupation at Untermassfeld. They argue that the claimed cut-marks on the animal bones, including the deer bone, were probably caused by rodents or other natural wear, they say, and the rock fragments lack telltale marks typical of hominin tools. They say that it wasn't possible to analyse other material from Landeck and Garcia Garriga's paper because its location is unclear.

Nature exchanged multiple e-mails with Landeck and Garcia Garriga about this mystery and asking for comment on the contents of this article. The researchers responded that most of the material they examined, including the deer bone fragment, was from two private collections amassed in the 1970s and early 1980s, and that much of it came from the same geological layer as Untermassfeld, but not within the site itself. They said that they presumed that some of this material was returned to the Natural History Museum Schloss Bertholdsburg in 2014 by the individual who had loaned it to them. They would not name the individual, but insisted: "We have nothing to do with a stolen bone". They added that they are planning to publish a detailed response to Roebroeks and Kahlke's allegations.

The regional prosecutor's office in Meiningen that investigated the 2009 theft told *Nature* the case had been closed unsolved later that year. A 5-year statute of limitation prevents it from being reopened. The case involving the 2012 theft of the rhinoceros bone was reopened early this year after the *Journal of Human Evolution* paper was published. The prosecutor's office said that an individual, whom it declined to name because of data protection laws, had been found guilty and fined.

Ongoing inquiry

Expressions of concern published on each of the three papers note that the location of the Untermassfeld material "was not stated accurately in the publication", and that the authors have been unable to adequately clarify where it is now. Landeck and Garcia Garriga declined to comment to *Nature*

on the specific details of the notes but said that they plan to publish a response.

Sarah Elton, an anthropologist at the University of Durham, UK, and an editor at the *Journal of Human Evolution*, says that an investigation into the accusations is ongoing. She adds that, as a result of the case, the journal now asks prospective authors to supply complete information about the location of material included in a study, as well as how it was accessed.

Other experts have been shocked by the revelations. “This paper should be retracted, of course,” says Jean-Jacques Hublin, an anthropologist and a director at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, about the 2016 paper. But the concerns go beyond questions of provenance. Hublin says that, like Roebroeks and Kahlke, he does not accept the claim that Untermassfeld contains signs of hominin presence, and he worries that its appearance in prominent journals will cause others to accept the idea, despite the lack of evidence for it.

The debate around Untermassfeld, Roebroeks and his colleagues say, underscores the importance of providing accurate descriptions of the provenance of published material, which is needed to verify claims. The desire to set the record straight about the arrival of hominins to Europe was the primary motivation for the team’s letter, he says. Based on his analysis, Roebroeks argues: “These bones and stones are not indicative of hominin presence.”

With additional reporting by Alison Abbott

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Updates

Updated:

> This article was updated on 13 November to note that expressions of concern have been published on all three papers, and to include a statement made after publication by Garcia Garriga: that he was not involved in analysing the material from Untermassfeld.

Comments

Commenting is currently unavailable.

Lab mice's ancestral ‘Eve’ gets her genome sequenced

Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.

13 November 2017

Anne Chadwick Williams/Sacramento Bee/ZUMA Press/Alamy

The genomes of lab mice can shift in subtle and unpredictable ways over generations of breeding.

Adam and Eve, a pair of black mice, lived for less than two years and never left their home at the Jackson Laboratory (JAX) in Bar Harbor, Maine. But since they were bred in 2005, their progeny have spread around the globe: the

pair's living descendants, which likely number in the hundreds of thousands. They are members of the most popular strain of mice used in biomedical research, which was created nearly a century ago.

Now, researchers at JAX are reconstructing Eve's genome in the hopes of better understanding — and compensating for — the natural mutations that occur in lab mice over the course of generations. These genetic changes can cause unanticipated physiological effects that can confound experiments. Related substrains of lab mice can differ in their taste for alcohol or their sensitivity to insulin, for example, and researchers suspect that such differences between supposedly identical mice lines have hampered some areas of research.

The scientists who founded JAX created Adam and Eve's breed, which is called C57BL/6, in 1921. To keep the mice as genetically similar as possible, researchers have repeatedly bred brothers with sisters for nearly a century — and sold the resulting offspring to customers around the world. But this strategy created a genetic bottleneck: every generation, between 10 and 30 new mutations pop up and are passed down to offspring. This 'genetic drift' quickly accumulates over the years, says Laura Reinholdt, a geneticist at JAX. The genomes of the C57BL/6 mice that the lab sells today have thousands of genetic differences from the mouse reference genome, which was created in 2002 from three mice from the substrain C57BL/6J. The genome is used as a template for researchers developing genetically modified mice.

Other suppliers have inadvertently created divergent substrains of C57BL/6 mice when they've bought rodents from JAX and bred them over several generations. Although most mutations go unnoticed, some occur in genes that affect a mouse's appearance or physiology. In 2016, mouse supplier Envigo in Somerset, New Jersey, found that C57BL/6 mice at 6 of its 19 breeding facilities around the world had acquired a mutation in a gene related to the immune system. The company notified the researchers that bought these mice, and asked customers to specify which location they preferred to source mice from in the future, given that the company's stocks were no longer identical.

Hidden changes

And although it is easy to spot a mutation that changes fur from black to white, for instance, some changes are discovered only if researchers are investigating a particular trait. A substrain of C57BL/6 mice that the US National Institutes of Health bred for 50 generations are uninterested in alcohol, whereas those bred at JAX's facility display a preference for alcoholic beverages.

In 2005, a team at JAX decided to reset the genetic clock by selling only C57BL/6J mice descended from two chosen mice: Adam and Eve. The researchers froze hundreds of embryos of the duo's grandchildren, enough to last for 25-30 years. Every five generations, the company thaws some of these embryos and raises them to adulthood as new breeding pairs.

"In some ways, the changes that are acquired are insidious and unstoppable," says Michael Wiles, the lab's senior director of technology evaluation and development, who led the project. "We've not stopped general drift, but we've slowed it considerably." Once the stockpiled embryos run out, however, JAX will have to start over with new breeding pairs from a much later generation.

Yet Eve's genome is very different from the 2002 mouse reference genome. In a presentation last month at the American Society for Human Genetics' meeting in Orlando, Florida, JAX computational scientist Anuj Srivastava spoke about the company's effort to reconstruct Eve's genome in high detail, using three different sequencing methods. Wiles says that the genome will be finished by the end of November, and that JAX plans to publish it early in 2018.

Mouse trap

Other mouse breeders have started their own efforts to account for genetic drift. Taconic Biosciences, a mouse distributor in Hudson, New York, restarts its C57BL/6 line every ten generations from its stash of frozen embryos.

Because Taconic has bred its line separately from the JAX line for decades, the Eve genome won't necessarily reflect the genetic make-up of Taconic's mice any more than the current mouse reference genome does.

Ana Perez, Taconic's global director of genetic sciences and compliance, says that the company plans to publish the genome of its own Eve. "From my perspective, each particular breeder should have their own reference genome to follow," she says. Buying mice from different breeders and expecting them to be the same is a fallacy, she adds.

But most researchers don't think about the differences between the various substrains of C57BL/6 mice and how those disparities can affect reproducibility in research, says Cory Brayton, a pathobiologist at Johns Hopkins University in Baltimore, Maryland. "The vendors are pretty good about making the information available, but the awareness is still pretty low," she says. It is impossible to quantify how often experiments or entire research programmes are wasted when researchers realize that their supposedly identical mice have genetically diverged from the ancestor they bought from a vendor, but Brayton suspects it is common.

The Eve genome will be a useful addition for researchers who use animals from JAX, says Brayton, although it won't solve all the reproducibility problems inherent to inbred mouse lines. "If you use [inbred mice] wisely, they can be highly informative," she says. "If you use them stupidly, they may really confound your studies."

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Comments

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World’s carbon emissions set to spike by 2% in 2017

Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.

13 November 2017

Kevin Frayer/Getty

China, the world’s largest emitter of greenhouse gases, is trying to reduce its reliance on coal.

Humanity’s carbon emissions are likely to surge by 2% in 2017, driven mainly by increased coal consumption in China, scientists reported on 13 November[1–3]. The unexpected rise would end a three-year period in which

emissions have remained flat despite a growing global economy.

Researchers with the Global Carbon Project, an international research consortium, presented their findings at the United Nations climate talks in Bonn, Germany. Countries there are ironing out details of how to implement the 2015 Paris climate accord, which calls for limiting global warming to a rise of 1.5–2 °C. The projected jump in the world's greenhouse-gas output underlines the challenges ahead; if the latest analysis proves correct, global carbon dioxide emissions will reach a record-breaking 41 billion tonnes in 2017.

"We were not particularly surprised that emissions are up again, but we were surprised at the size of the growth," says Corinne Le Quéré, a climate scientist at the University of East Anglia in Norwich, UK, and co-author of the work, which was published in the journals *Nature Climate Change*, *Environmental Research Letters* and *Earth System Science Data Discussions*. To Le Quéré, the question now is whether 2017 is a temporary blip or a return to business as usual. "If 2018 is as big as 2017, then I will be very discouraged," she says.

Several factors caused the world's CO_2 emissions to level out from 2014 to 2016, including an economic slowdown in China, the world's largest emitter; a shift from coal to gas in the United States; and global growth in the use of renewable energies such as solar and wind. Many climate scientists and policymakers had hoped that the pause in emissions growth represented a shift in energy use that would eventually cause global greenhouse-gas emissions to peak — and then decline.

The latest analysis projects that CO_2 emissions in the United States and the European Union will continue to decline — by 0.4% and 0.2%, respectively, in 2017 — although at a slower pace than in recent years. And emissions growth in India is set to slow, rising by just 2% this year, compared with an average of 6% per year over the past decade.

But the picture is very different in China, which produces nearly 26% of the world's output of CO_2. This year, the country's emissions of the greenhouse gas are expected to surge by 3.5%, to 10.5 billion tonnes. The main causes

are increased activity at the country's factories and reduced hydroelectric-energy production, the Global Carbon Project analysis finds.

The effort highlights nagging uncertainties about greenhouse-gas emissions trends, particularly in China, India and other countries with economies that are rapidly growing and changing, says David Victor, a political scientist at the University of California, San Diego. He is not convinced that government actions — at the national or international level — have driven the recent levelling of emissions. And although emissions are projected to grow this year, Victor says that China is still on a trajectory that would see its emissions peak well before its 2030 target.

Taken together, the projections for 2017 reinforce the notion that the world has far to go before it solves the climate problem, says Glen Peters, a climate-policy researcher at the CICERO Center for International Climate Research in Oslo and a co-author of the Global Carbon Project's 2017 analysis.

"This is basically saying that we are not safe yet," Peters says. "We can't be complacent."

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South Africa tackles crime at sea with ship-spotting satellites

Automated vessel-tracking system aims to spy poachers and smugglers.

10 November 2017

Leeman/Getty

South Africa has started to combine data from satellites, vessel transponders and radar to monitor ships in its waters in real time.

In October last year, a fishing boat set out from Velddrif, a small town on South Africa’s west coast. It sailed northwest for about 25 nautical miles (46 kilometres), then turned sharply and headed back the way it had come. Staying clear of coastal settlements, it entered the West Coast National Park

marine protected area — a strictly no-fishing zone — where it slowed down and began to sail in a zigzag pattern.

“It was obvious what they were doing,” says Niel Malan, a marine biologist who works in South Africa’s Department of Environmental Affairs in Cape Town. “They were poaching.”

On any other day, the transgression would probably have passed undetected. But Malan and his colleagues were testing a new vessel-tracking system that — when fully operational — will send out alerts when ships are acting suspiciously anywhere in South African waters.

A test version of the Integrated Vessel Tracking Decision Support Tool was launched on 7 November by the South African Oceans and Coastal Information Management System (OCIMS), at its annual meeting in Cape Town. The tracking system, which has taken US$1 million and 5 years to develop, combines data from satellites, vessel transponders and radar to monitor ships in real time and spot any that might be engaged in criminal activities, such as illegal fishing or smuggling.

Similar remote-sensing systems have been developed over the last decade or so by countries including the United States, Australia and India. But South Africa is a particularly crucial area for maritime crime-fighting, because of its geographical location at the joining of three oceans — the Atlantic, Indian and Southern — and because of the sheer extent of its waters. The country’s Exclusive Economic Zone, which extends 200 miles off the coastline and includes an additional 400-mile-diameter circle around the Prince Edward Islands, exceeds its land area by 25%. “Because of the vastness of our EEZ, we see this as a critical technology,” says Waldo Kleynhans, the system’s lead developer based in Pretoria.

South Africa's coast is also a busy shipping lane and an area rich in natural resources. Cold, nutrient-rich waters sustain extensive commercial fishing on South Africa's west coast and to the south, while every year billions of sardines migrate down the east coast, attracting flocks of birds, as well as dolphins, sharks and whales.

South Africa has a well-documented problem with coastal poaching of high-

value species such as abalone and rock lobster, whereas the extent of illegal fishing in its open oceans is largely unknown. The area around the Prince Edward Islands — home to the prized Patagonian toothfish (*Dissostichus eleginoides*) — is particularly vulnerable, says Timothy Walker, a researcher focusing on maritime and water security at the Institute for Security Studies in Pretoria. South African authorities are also concerned about human trafficking and the smuggling of drugs or banned wildlife items, such as rhino horn and ivory.

Yet the navy has scant physical resources to monitor illegal activities, says Mark Blaine, a captain in the South African Navy and a part-time researcher in nautical science at Stellenbosch University — four frigates, three submarines and a handful of patrol vessels and aircraft — which he describes as equivalent to "a country the size of Algeria using around six police cars to patrol the entire country".

Satellite spotting

The satellite data used by the new system includes information from automated identification system (AIS) trackers, which all ships above a certain size are required to carry. South Africa currently buys this data from third-party suppliers, but plans to launch its own constellation of AIS nano-satellites in 2018 to collect the information. Meanwhile, satellites using synthetic-aperture radar, which can spot vessels in the dark or through thick cloud, will help to detect 'dark targets' that are not carrying trackers or that have turned them off.

Malan says that the tracking system can be set to flag up different suspicious behaviours. Users such as the fisheries department or the South African navy might create a digital fence around a marine reserve or other sensitive area, for example, and ask to receive alerts when ships enter it. Or they could request to be alerted if two ships meet in the open ocean for an extended time.

Ultimately, Malan says, the system's success will depend on the end-users, who will have to monitor incoming data, set up appropriate alerts and decide

how to respond. Enforcement will also be a challenge. Malan says that details of the suspicious boat he spotted in October 2016 were relayed to the fisheries department. “But we're not sure if they finished the investigation,” he says.

He hopes that once a few miscreants have been caught using the tracking system, however, its existence will act as a deterrent: “I think once we start prosecuting a few people, then the word will spread quickly — and we hope that will lead to better behaviour.”

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Commenting is currently unavailable.

Resurrected malaria strategy saves thousands of lives in Africa

Pre-emptively treating kids for malaria is working, despite logistical challenges.

10 November 2017

Amy Maxmen

A healthworker in Mali prepares a dose of malaria chemoprevention.

In a sea of high-tech malaria fixes — everything from drug-delivery by drone to gene-edited mosquitoes — an old-fashioned approach is saving thousands of children in West Africa, according to studies presented this week at the American Society of Tropical Medicine and Hygiene (ASTMH) meeting in

Baltimore, Maryland.

The measure, called seasonal malaria chemoprevention, involves giving children a dose of antimalarial drugs once each month in the rainy season to prevent the disease in hard-hit regions. Researchers have previously demonstrated this strategy in large clinical trials but they had feared that their positive results wouldn't be replicated in the messy, real world, because chemoprevention requires thousands of local health workers to deliver drugs to children in villages far from hospitals, pharmacies and paved roads.

"People were doubtful this intervention would work, because it's so demanding," says Brian Greenwood, an infectious disease specialist at the London School of Hygiene and Tropical Medicine who helped to conduct trials that showed reductions in malaria prevalence up to 84%[1]. As a result of those studies, more than 6.4 million children in nine countries in sub-Saharan Africa (Burkina Faso, Cameroon, Chad, Gambia, Guinea, Mali, Niger, Nigeria, Senegal) received the drugs in 2016.

It seems to be working, according to data presented at the ASTMH meeting. "They are seeing the same level of efficacy against malaria that we saw in clinical trials and reducing hospital admissions," says Greenwood. "I am very happy." But researchers are also finding signs that this approach may not work for long.

Data driven

Malaria researchers deployed chemoprevention in the 1950s, but it fell out of favour when the widespread use of malaria drugs led to drug resistance. Yet by 2000, more than 830,000 people were dying of the disease each year — mainly children in Africa — and there were no blockbuster vaccines on the horizon. So malariologists revisited the approach. Between 2002 and 2012, clinical trials conducted in West Africa suggested that combinations of older malaria drugs had the power to prevent 8.8 million cases and 80,000 deaths every year if implemented solely during the rainy season, when the disease spikes.

Amy Maxmen

Children in Mali receive a dose of malaria drugs, to reduce their risk of becoming infected with the disease.

In 2012, the World Health Organization recommended the strategy with three old drugs — sulphadoxine, pyrimethamine and amodiaquine — so that the only sure-fire cure for malaria, artemisinin, would remain effective. Alassane Dicko, a malariologist at the University of Bamako in Mali, says that he did not take the intervention for granted when it launched in Mali in 2013, because he knew that funds were limited and drug resistance inevitable. “Research is essential,” he says. His lab began assessing chemoprevention’s efficacy, cost and effects on drug resistance.

In August, Dicko and his colleagues reported[2] that malaria prevalence was reduced by 65% in children under age 5 who were treated with chemoprevention in the Malian district of Kita, compared to a similar number of children in a neighbouring district that lacked the funds to roll out the intervention.

Race against resistance

On the basis of results such as these, malaria researchers at the meeting estimate that chemoprevention has averted roughly 6 million cases and 40,000 deaths in 2015 and 2016 in the countries where it is practised. “This intervention has been extremely well documented over three or four years,” says Erin Eckert, an epidemiologist at the US Agency for International Development’s President’s Malaria Initiative, based in Washington DC. As a result, the agency plans to help fund chemoprevention in eight countries next year.

Also at the ASTMH meeting, Dicko reported a 80-person trial showing that adding another old malaria drug, primaquine, to the regimen combo blocks the transfer of the malaria parasite, *Plasmodium falciparum*, from humans into mosquitoes. This would further reduce the amount of the parasite in circulation. Dicko aims to hit the disease hard and fast — with multiple drugs, as soon as possible — because he and his colleagues are already detecting genetic signs of drug resistance in parasites[3].

New chemoprevention drugs in the pipeline might not be ready before existing drugs fail because of resistance, Greenwood says. This year, he helped to launch a trial combining chemoprevention and a less effective malaria vaccine in Burkina Faso and Mali. The vaccine was previously shown to reduce the number of malaria cases by less than 36% in children[4], but Greenwood hopes the combined tools, together with bed nets, can suppress malaria enough to stop it from bouncing back once today’s drugs fail. By that time, he says, genetically engineered mosquitoes might be ready to fly.

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Comments

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Physicists shrink plans for next major collider

Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.

09 November 2017

CERN/SPL

The Large Hadron Collider (pictured) collides protons, whereas the proposed linear accelerator would smash together electrons and positrons.

Limited funding and a dearth of newly discovered particles are forcing physicists to cut back plans for their next major accelerator project: a multibillion-dollar facility known as the International Linear Collider (ILC)

in Japan.

On 7 November, the International Committee for Future Accelerators (ICFA), which oversees work on the ILC, endorsed halving the machine's planned energy from 500 to 250 gigaelectronvolts (GeV), and shortening its proposed 33.5-kilometre-long tunnel by as much as 13 kilometres. The scaled-down version would have to forego some of its planned research such as studies of the 'top' flavour of quark, which is produced only at higher energies.

Instead, the collider would focus on studying the particle that endows all others with mass — the Higgs boson, which was detected in 2012 by the Large Hadron Collider (LHC) at CERN, Europe's particle-physics lab near Geneva, Switzerland.

Leading particle physicists nevertheless remain upbeat. A 250-GeV machine still has "a convincing physics case", says Hugh Montgomery at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia. He says that it could be upgraded to higher energies in future.

High-energy physicists have been planning a future linear collider for 25 years, but the ILC is now unlikely to see the light of day until at least 2030. They viewed the linear collider as complementary to the LHC, allowing physicists to scrutinize in detail any particles discovered at CERN.

Linear design

The circular LHC smashes together protons, which allows it to reach very high energies (13 teraelectronvolts). But, as composite particles (made of quarks), protons create messy collisions with clouds of debris.

By contrast, the ILC would collide electrons and positrons head on after accelerating them in thousands of superconducting cavities joined end to end. Although yielding lower energies, its collisions — between fundamental particles — would be cleaner and more precise than those in a proton–proton machine.

The international physics community had hoped that Japan would foot much of the estimated US$10 billion needed to realize the original design, after researchers there put forward a proposal to host the facility in October 2012, just after the Higgs discovery. But the Japanese government — deterred by the project's huge price tag, according to Tatsuya Nakada, a physicist at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland — has not yet made any offer of funding.

That fact, coupled with an absence of any other new particle discoveries at the LHC beyond the Higgs, led the Japan Association of High Energy Physicists in July to propose capping the ILC's energy at 250 GeV.

Aiming for a higher energy, the association explained, made less sense after data collected by the LHC in 2015 and 2016 showed that any particles outside physicists' standard model are unlikely to weigh less than 1,000 GeV, and therefore would be out of reach even for a full-scale version of the ILC. However, 250 GeV is high enough to produce large numbers of Higgs bosons, which, the association said, could yield indirect signs of new physics through measurements of their interactions with other known particles.

Energy debate

This proposed 'Higgs factory' has also been endorsed by an international working group responsible for formulating the ILC's science case, in a paper uploaded to the preprint server arXiv last month[1]. The ICFA then gave the pared-down collider its thumbs up at a meeting held in Ottawa, Canada, this week.

Not all physicists are enthusiastic, however. John Ellis, a theorist at King's College London and CERN, maintains that only when operating at around 1,000 GeV will a linear collider provide "a more complete picture of the Higgs". He acknowledges that costs need to be reined in, but says that in limiting the ILC to 250 GeV, "you are making significant scientific compromises".

A report uploaded to arXiv last week[2] describes three possible layouts for the

250 GeV model (a technical design for the higher-energy ILC was published in 2013). Each requires halving the length of the superconducting electron–positron accelerators, but two of the options retain extra tunnel space to accommodate future upgrades.

Taking into account projected savings from ongoing research into accelerators, the report estimates that the collider's core construction cost could be reduced by as much as 40% — bringing it down to around $5 billion in 2012 prices. Manpower and detectors would then raise the total to about $7 billion, according to Lyn Evans, an accelerator physicist at CERN who is directing research on the ILC.

Michael Peskin, a theoretical partical physicist at the SLAC National Accelerator Laboratory in Menlo Park, California, and a member of the ILC working group, has no doubt about the value of a Higgs factory. He says that theoretical studies of the Higgs boson and the weak nuclear force — one of the four known fundamental forces — done over the past year have strengthened the case for experimental probes of the Higgs' interaction strength (the Higgs is required to give the carriers of the weak force finite mass). "The 250-GeV stage is actually more interesting scientifically than we thought," he says.

The ILC decision now rests with Japan. Evans describes the Japanese government's ongoing assessment of the linear-collider project as "very long and very frustrating". But other countries won't commit money until the host country makes its plans known, he says. "The rest of the world is waiting for the Japanese government to decide," he says.

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Comments

3 comments

1. *Pentcho Valev* • 2017-11-11 04:23 PM

   Peter Woit: "I think the worst thing that has happened to theoretical physics over the past 25 years is this descent into ideology, something that has accelerated with the multiverse mania of the last 10-15 years." http://www.math.columbia.edu/~woit/wordpress/?p=9375 Correct, except for the number 25 - it should be replaced by 112: Peter Hayes: "This paper investigates an alternative possibility: that the critics were right and that the success of Einstein's theory in overcoming them was due to its strengths as an ideology rather than as a science. The clock paradox illustrates how relativity theory does indeed contain inconsistencies that make it scientifically problematic. These same inconsistencies, however, make the theory ideologically powerful. [...] The gatekeepers of professional physics in the universities and research institutes are disinclined to support or employ anyone who raises problems over the elementary inconsistencies of relativity. A winnowing out process has made it very difficult for critics of Einstein to achieve or maintain professional status. Relativists are then able to use the argument of authority to discredit these critics. Were relativists to admit that Einstein may have made a series of elementary logical errors, they would be faced with the embarrassing question of why this had not been noticed earlier. Under these circumstances the marginalisation of antirelativists, unjustified on scientific grounds, is eminently justifiable on grounds of realpolitik. Supporters of relativity theory have protected both the theory and their own reputations by shutting their opponents out of professional discourse. [...] The triumph of relativity theory represents the triumph of ideology not only in the profession of physics bur also in the philosophy of science." The Ideology of Relativity: The Case of the Clock Paradox http://www.informaworld.com/smpp/content~content=a909857880 Joao Magueijo: "Lee [Smolin] and I discussed these paradoxes at great length for many months, starting in January 2001. We would meet in cafés in South Kensington or Holland Park to mull over the problem. THE ROOT OF ALL THE EVIL WAS CLEARLY SPECIAL RELATIVITY. All these paradoxes resulted from well known effects such as length contraction, time dilation, or E=mc^2,

all basic predictions of special relativity. And all denied the possibility of establishing a well-defined border, common to all observers, capable of containing new quantum gravitational effects." Faster Than the Speed of Light, p. 250 http://www.amazon.com/Faster-Than-Speed-Light-Speculation/dp/0738205257 Pentcho Valev

2. *Pentcho Valev* • 2017-11-11 07:32 AM

   Dead (schizophrenic) science - colliders are not necessary: "...Lorenzo Maccone, of the University of Pavia in Italy, Seth Lloyd at MIT in Cambridge, USA, and Vittorio Giovannetti at the Scuola Normale Superiore in Pisa, Italy. [...] They hope their strategy may make it possible to solve one of the biggest problems in physics: the apparent incompatibility of quantum mechanics, which governs the physics of the very small, and general relativity, which describes the motion of stars and planets. [...] In general relativity, space and time are woven together into a pliable thing called spacetime, but quantum mechanics runs on quaintly separate, classical notions of space and time. And when physicists try to apply the equations of general relativity to the realm of quantum mechanics, those equations spit out nonsense." http://fqxi.org/community/articles/display/224 Big Brother replaced 2+2=4 with 2+2=5: "In the end the Party would announce that two and two made five, and you would have to believe it. It was inevitable that they should make that claim sooner or later: the logic of their position demanded it. Not merely the validity of experience, but the very existence of external reality, was tacitly denied by their philosophy. The heresy of heresies was common sense. And what was terrifying was not that they would kill you for thinking otherwise, but that they might be right. For, after all, how do we know that two and two make four? Or that the force of gravity works? Or that the past is unchangeable? If both the past and the external world exist only in the mind, and if the mind itself is controllable what then?" https://ebooks.adelaide.edu.au/o/orwell/george/o79n/chapter1.7.htm Einstein replaced Newton's absolute time with spacetime: "Special relativity is based on the observation that the speed of light is always the same, independently of who measures it, or how fast the

source of the light is moving with respect to the observer. Einstein demonstrated that as an immediate consequence, space and time can no longer be independent, but should rather be considered a new joint entity called "spacetime." http://community.bowdoin.edu/news/2015/04/professor-baumgarte-describes-100-years-of-gravity/ Scientists in Big Brother's world are trying to reconcile 2+2=4 and 2+2=5. Scientists in Einstein's schizophrenic world are trying to reconcile Newton's absolute time and Einstein's spacetime: Natalie Wolchover: "The effort to unify quantum mechanics and general relativity means reconciling totally different notions of time. In quantum mechanics, time is universal and absolute; its steady ticks dictate the evolving entanglements between particles. But in general relativity (Albert Einstein's theory of gravity), time is relative and dynamical, a dimension that's inextricably interwoven with directions X, Y and Z into a four-dimensional "space-time" fabric." https://www.quantamagazine.org/20161201-quantum-gravitys-time-problem/ Perimeter Institute: "Quantum mechanics has one thing, time, which is absolute. But general relativity tells us that space and time are both dynamical so there is a big contradiction there. So the question is, can quantum gravity be formulated in a context where quantum mechanics still has absolute time?" https://www.perimeterinstitute.ca/research/conferences/convergence discussion-questions/what-are-lessons-quantum http://negrjp.fotoblog.uol.com.br/images/photo20150819051851.jpg Pentcho Valev

3. *Pentcho Valev* • 2017-11-09 08:59 PM

   Nowadays the conclusion "Physics is dead" is getting more and more explicit - it has even entered popular culture: Leonard: "I know I said physics is dead, but it is the opposite of dead. If anything, it is undead, like a zombie." https://www.youtube.com/watch?v=GDNP9KOEdh0 The problem is theoretical - experimentalists are just misguided: "The Large Hadron Collider is a particle accelerator currently under construction in the research centre CERN. From the point of view of relativity theory, it has several points of interest: First of all, the protons it accelerates will reach higher energies than ever, allowing

new tests of the relativistic quantum field theories that are at the core of modern particle physics. Secondly, at such high energies, there should be first traces of an as-yet unproven symmetry of nature called supersymmetry, which plays an important role in string theory, one of the candidates for a theory of quantum gravity (the quantum theory version of Einstein's general relativity). Finally, the high energies are interesting because they give information about the very early high temperature universe, and about the physics that should be included in the big bang models of relativistic cosmology." http://www.einstein-online.info/dictionary/large-hadron-collider There is a tenet which, if false, does convert modern physics into a zombie, and this is Einstein's constant-speed-of-light postulate. Here is the original formulation: Albert Einstein, ON THE ELECTRODYNAMICS OF MOVING BODIES, 1905: "...light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body." http://www.fourmilab.ch/etexts/einstein/specrel/www/ If interpreted correctly, the Doppler effect directly refutes the postulated independence from "the state of motion of the emitting body". Here is an incorrect interpretation - the postulate is saved by wrongly assuming that the light pulses bunch up in front of the moving source: Albert Einstein Institute: "We will start with a very simple set-up, which you can see in the following animation. On the right-hand side, drawn in green, there is a sender that emits pulses in regular succession. On the left-hand side there is a receiver, drawn in blue. The pulses themselves are drawn in red, and they all travel at the same speed from right to left. Everytime the sender emits a new pulse, a yellow indicator light flashes once. Likewise, a flashing light indicates when a pulse has reached the receiver: http://www.einstein-online.info/images/spotlights/doppler/doppler_static.gif Next, let us look at a slightly different situation, where the source is moving towards the detector. We assume that the motion of the sender does not influence the speed at which the pulses travel, and that the pulses are sent with the same frequency as before. Still, as we can see in the following animation, the motion influences the pulse

pattern: http://www.einstein-online.info/images/spotlights/doppler/doppler_source_blue.gif The distance between successive pulses is now smaller than when both sender and receiver were at rest. Consequently, the pulses arrive at the receiver in quicker succession. If we compare the rates at which the indicator lights at the receiver and at the sender are flashing, we find that the indicator light at the receiver is flashing faster." [END OF QUOTATION] http://www.einstein-online.info/spotlights/doppler Einsteinians make the following assumption above, which is essentially identical to Einstein's 1905 constant-speed-of-light postulate: Assumption 1: "The motion of the sender does not influence the speed at which the pulses travel." Assumption 1 goes hand in hand with another assumption: Assumption 2: "The distance between successive pulses is now smaller than when both sender and receiver were at rest." Assumption 2 is false - the pulses do not bunch up when the source (sender) is moving. If they did, by measuring the (variable) distance between the pulses, an observer associated with the source would know whether he is moving or at rest, which contradicts the principle of relativity. Since Assumption 2 is false, Assumption 1 is false as well. If the speed of the moving source is v, the speed of the light relative to the receiver is c'=c+v, in violation of Einstein's relativity. The following quotations suggest that, if the speed of light is variable, modern physics is dead: "The speaker Joao Magueijo, is a Reader in Theoretical Physics at Imperial College, London and author of Faster Than the Speed of Light: The Story of a Scientific Speculation. He opened by explaining how Einstein's theory of relativity is the foundation of every other theory in modern physics and that the assumption that the speed of light is constant is the foundation of that theory. Thus a constant speed of light is embedded in all of modern physics and to propose a varying speed of light (VSL) is worse than swearing! It is like proposing a language without vowels." http://www.thegreatdebate.org.uk/VSLRevPrnt.html "But the researchers said they spent a lot of time working on a theory that wouldn't destabilise our understanding of physics. "The whole of physics is predicated on the constancy of the speed of light," Joao

Magueijo told Motherboard. "So we had to find ways to change the speed of light without wrecking the whole thing too much." http://www.telegraph.co.uk/technology/2016/12/06/speed-light-discovered/ Pentcho Valev

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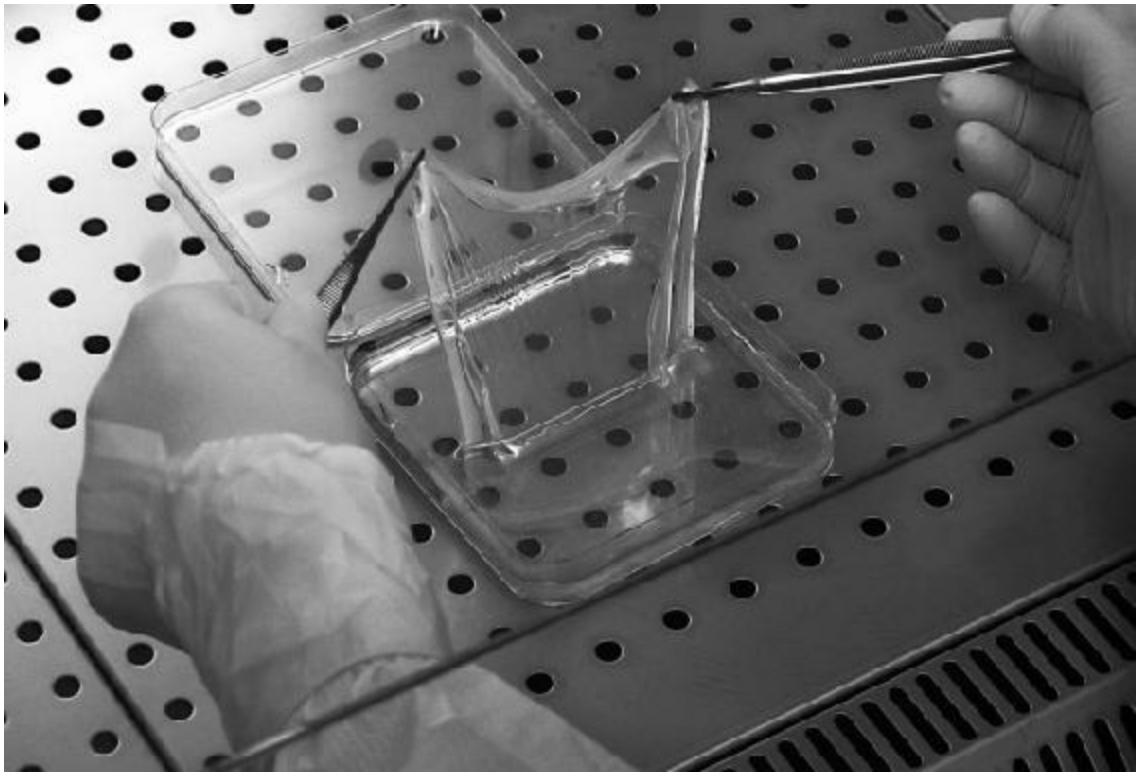
Skin regeneration with insights

A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.

08 November 2017



A sheet of skin cells grown in culture.

Somewhere in Germany’s Ruhr valley, a nine-year-old boy is doing what children do: playing football, joking around with friends and going to school. Two years ago, he was confined to a hospital bed, dying of a rare and cruel genetic skin disease. In a landmark paper online in *Nature* this week, scientists and clinicians present the details of his astonishing recovery (T. Hirsch *et al.* *Nature* http://dx.doi.org/10.1038/nature24487; 2017).

The boy had junctional epidermolysis bullosa, or JEB. He, like other people with the disease, carried a mutation in a gene that controls the integrity of the skin. Doctors could only try to ease his suffering as some 80% of his skin simply fell away.

A team of Italian researchers came to his aid by combining stem-cell techniques with gene therapy. As a young scientist at Harvard Medical School in Boston, Massachusetts, in the 1980s, Michele De Luca — the lead author of the new study — watched pioneers in skin regeneration learn to grow small sheets of skin from cells taken from burns patients, and to use them in grafts. He extended the work in Italy, applying new genetic and stem-cell technologies. He developed ways to generate stem cells from human skin, replace disease-causing genes in them and grow sheets of healthy skin on scaffolds in the lab.

He chose JEB for his first clinical trial, which he registered with the Italian Medicines Agency in 2002. Four years later, he reported his first success, in which he created healthy skin patches from biopsies to replace small areas of sloughed-off skin on the legs of a patient with a form of JEB (F. Mavilio *et al. Nature Med.* **12,** 1397–1402; 2006). New European Commission regulations introduced in 2007 required him to pause the project while he created facilities adhering to ‘good manufacturing practices’ (GMPs) and a spin-off company to meet the demands for strengthened oversight of cell-based therapies.

Having a company refocused his team’s attention on a different type of stem-cell therapy, one likely to yield a product for the market faster. Holoclar, a treatment that replaces the eye’s cornea in a form of blindness, became the world’s first commercial stem-cell therapy in 2015.

A few months later, at the University of Modena, De Luca got a call out of the blue from doctors in Germany who were trying to treat the little boy. Because the therapy had been in a clinical trial, albeit one on hold at the time, and because De Luca could provide GMP services, German regulatory authorities quickly approved the one-off compassionate use of the JEB therapy. Surgeons in Germany sent a skin biopsy to Modena, and two major skin transplants followed. Six months after the initial biopsy, the boy returned to school. During the many months since, he has not had so much as a blister,

and loves to show off his ‘new skin’.

This major clinical development was based on decades of basic research. The clinical data gathered during 21 months of follow-up after the boy’s treatment have also led to major insights into human skin biology, as discussed in an accompanying News & Views (M. Aragona and C. Blanpain *Nature* http://dx.doi.org/10.1038/nature24753; 2017). For example, normal regeneration of the epidermis is directed by only a few stem-cell clones that can self-renew.

By their nature, highly personalized treatments using gene therapies and products derived from an individual’s stem cells are likely to be applicable to only a subset of patients. Although the report presents the treatment of one patient, it is a classic case of researchers standing on the shoulders of others. This project, for example, relied on long-term follow-up of a patient treated in 2006, as well as parallel studies that underpinned the development of tools for *ex vivo* gene therapy and for growing transplantable sheets of epidermis *in vitro*.

The work is both a technical achievement and an example of how translational medicine should be conducted. It involves research informing the clinic and the clinic informing research, with seamless collaboration between doctors, scientists, regulators and technicians at many levels — a particularly important aspect in areas such as stem-cell biology. It requires the highest standards of scientific and ethical diligence. Similar treatments are starting to be rolled out in other labs for other diseases. *Nature* is glad to celebrate and support such an enterprise.

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Too many academics study the same people

Researchers should recognize communities that feel over-researched and under-rewarded.

08 November 2017

Susanna D'Aliesio/SOPA Images/LightRocket/Getty

Two women in Lebanon’s Shatila camp.

In southern Beirut, a temporary shelter has become a permanent home. The Shatila refugee camp was established to house displaced Palestinians in 1949 and now has thousands of families within its walls. Residents have learnt to contend with overcrowding, pollution — and a steady stream of well-funded

foreign researchers who come to study them.

Drawn by its unusual story and convenient position close to the airport, researchers flock to Shatila to track the effects of prolonged refugee status and cultural isolation on the community. Well-meaning researchers are so common in Shatila that locals have learnt how to spot them.

Before she became a social anthropologist at King's College London, Mayssoun Sukarieh did voluntary work in Shatila. Residents who saw her reach for her notebook would ask if she was a social researcher: "They come for a tiny bit, and then they leave," the locals explained.

Sukarieh realized that scholars' repeated visits were affecting the community. Academics were among the few contacts that people in Shatila had with the wider world. Again and again, the outsiders would fly out with what they wanted and offer little or nothing in return. The community started to view the visitors with amusement, then resentment.

Some people in Shatila, Sukarieh feared, were being 'over-researched' — an anecdotal concern that social scientists and biomedical researchers increasingly encounter at 'high-traffic' research sites around the world. Sometimes, it is a point raised by ethical-review committees. Occasionally, the community under study makes its own frustrations heard loud and clear.

How big is the problem? Ironically, the issue of over-research has not been researched much. In a study published last month, scientists in South Africa analysed concerns about over-research at two sites of HIV-prevention studies (J. Koen, D. Wassenaar and N. Mamotte *Soc. Sci. Med.* **194,** 1–9; 2017).

They found that the term 'over-research' is poorly defined and encompasses a range of concerns. For example, some use it to describe how other communities are being neglected in favour of one with a pre-established research structure or proximity to a university. This can lead to skewed data, and misconceptions about a particular phenomenon or place.

Alternatively, the term could be used to describe a local community that bears the burden of research participation without sufficient reward, creating a sense of frustration that leads to dwindling participation. In biomedical

studies, researchers sometimes worry that involvement in multiple clinical trials — and exposure to multiple medications — can increase the risk to participants and cloud results.

Repeated studies can certainly exaggerate the frustration that local people feel when their cooperation produces only data, publications and further research. In the South African study, many locals argued that the research should be more closely linked to developing their communities. Some projects, including certain grants from UNAIDS, a global United Nations effort to tackle HIV/AIDS, do require researchers to invest in infrastructure and education. More funders should look at this model. However, several HIV-prevention studies have done such a good job that their results are inconclusive: too few participants contracted the disease for the data to be statistically meaningful.

It is crucial that efforts to reward research participation are developed in consultation with the community being studied. Sukarieh describes well-intentioned educational courses aimed at Shatila-research participants that were impractically long — one consisted of 20 hourly sessions — and discussed issues irrelevant to the people's needs.

Over-research can bring benefits, though: a heavily studied community can become savvy in making its needs known to researchers and in influencing how a study is done. In Hackney, an ethnically diverse borough of London that underwent a period of rapid gentrification, a sociologist who came to study participants in a creative-writing group, for example, was told that, to do so, she had to join the group and write pieces like everyone else. The researcher reported how this strengthened her involvement and built stronger links to the community that helped the project to succeed (S. Neal *et al. Qual. Res.* **16,** 491–507; 2016).

Forging deep links with a community takes time, and time requires funding. Funders should recognize the need to build resources for such efforts into their grants; institutions should recognize and reward this time and effort, and acknowledge that it can eat into a researcher's publication record. It is not good enough to come in for a tiny bit, and then leave.

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Comments

There are currently no comments.

Grant recipients can still give objective advice

The US environment agency should not ban researchers it funds from its advisory boards.

08 November 2017

KEENPRESS/Getty

Melting ice caps are raising sea levels.

Scott Pruitt, administrator of the US Environmental Protection Agency (EPA), levelled a damning accusation against scientists on 31 October. In the interests of restoring scientific “integrity”, Pruitt signed a directive stating that the EPA would no longer allow researchers with active grants from the

agency to serve on the EPA's scientific advisory boards. By his tally, an unspecified number of scientists in voluntary positions on those boards had received US$77 million in EPA grants over the past three years — more than enough, Pruitt declared, to raise questions about their ability to provide independent scientific advice.

It was a cynical move — and entirely unnecessary. After all, it is ultimately up to Pruitt and his team to make the appointments to the boards, which advise the agency on everything from basic research programmes to contentious regulatory decisions. If Pruitt wanted to increase the geographical diversity, or include more people from local, state and tribal agencies, as claimed, he could have done so without raising a fuss. Instead, he opted for a public proclamation that singles out active academic scientists as a unique source of bias. He is wrong, on multiple counts.

Scientific enquiry requires money. That's a fact of life. But receiving a research grant is very different from being on the payroll of an institution, advocacy group or company. Those are all very real conflicts of interest that were ignored in Pruitt's directive.

Moreover, winning competitive research grants does not imply fealty to the granting institution. What drives EPA-funded researchers above all is the desire to deliver a public good: discovery and understanding.

Of course, scientific conflicts of interest do exist. So there are established procedures that require scientists to excuse themselves when their own work is under consideration by the boards. These same procedures apply to industry scientists — who are also rightfully represented on the advisory boards — when deliberations involve issues that could affect their companies' bottom lines.

What Pruitt either fails to understand, or has chosen to ignore, is that his advisory boards are designed to focus on science, not policy. Understanding the latest research requires perspectives from the leading scientists. And when it comes to environmental and human-health issues, it is only to be expected that many of those people will have research grants from the EPA.

In the end, Pruitt's directive seems crafted to incite US President Donald

Trump’s political base, and it’s yet another example of researchers being dragged into the political and cultural wars rending the country.

Happily, it is harder to argue with data. This might explain why the first volume of a comprehensive — and congressionally mandated — assessment of climate science released on 3 November (see page 152) sailed through reviews from officials at the EPA and other federal agencies.

That report, which integrates the latest climate research, found that greenhouse-gas emissions caused by human activity are altering the planet in fundamental ways. It lays out what we know about the threat of global warming — from deep in the ocean to the highest mountain peaks. And it stands in direct opposition to the climate scepticism voiced by Pruitt and Trump.

Some scientists had feared political interference, but senior officials at federal agencies gave the report the green light, without major changes. This is as it should be: scientists can assess what’s known and probe what is not. And it is up to policymakers to decide what to do with that information. This should be a lesson for Pruitt: the current administration has the right to create its own priorities, but it should not and cannot override what science reveals.

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Rohingya refugees, Bulgarian protests and a prize for negative results

The week in science: 3–9 November 2017.

08 November 2017

Events | Research | Policy | Climate | People | Publishing | Trend watch

EVENTS

Ice crack to close Antarctic base again For the second time in two years, the British Antarctic Survey (BAS) will close its Halley VI research station for the winter season because of an enormous crack in the floating ice shelf on which it rests. In March, operators finished moving the transportable station 23 kilometres inland from its initial 2012 location because of an ice chasm nearby. Now, another crack in the Brunt Ice Shelf, this one 50 kilometres long, is threatening the station from the other side. Halley VI will close between March and November 2018, the BAS said on 31 October, because it is too difficult to evacuate personnel quickly in winter if the crack develops further.

Michal Krzysztofowicz/BAS

Money for nothing A data organization has launched what it says is the world's first prize for publishing negative scientific results. The European College of Neuropsychopharmacology's Preclinical Data Forum says that the aim of the €10,000 (US$11,600) prize is to encourage researchers to publish data that don't confirm the hypothesis being tested. Such negative studies are much less likely to be published than positive results, meaning that other scientists may waste time trying to repeat the work. The call for entries — initially just for neuroscience research — opened on 8 November.

Bulgarian protest Hundreds of Bulgarian researchers took to the streets of Sofia on 1 November to demand higher wages and an increase in science funding marked out in the government's 2018 budget. Bulgaria has one of the lowest levels of research investment in the European Union. The demonstrators are threatening further protests when Bulgaria takes over the rotating EU presidency next January.

Rohingya refugees A survey of Rohingya refugees in Bangladesh suggests

that 7.5% of the children have life-threatening malnutrition. The United Nations children's charity UNICEF reported the figure on 3 November. More than 2,700 children are being treated for acute malnutrition in refugee camps, where conditions are expected to worsen because of poor sanitation and crowding. Since late August, more than 600,000 Rohingya people have fled from Myanmar to Bangladesh, following attacks by Myanmar's police.

RESEARCH

Weather forecasts Improving forecasts of severe weather is important, but meteorologists should also listen to social scientists to help save lives during storms, says a 1 November report from the US National Academies of Sciences, Engineering, and Medicine. It recommends that federal agencies do more to incorporate social- and behavioural-sciences research into their preparation for weather hazards. These changes might include researching people's processes for deciding how to respond to threats such as tornado or hurricane warnings, and evaluating how weather forecasters communicate with media and emergency-management officials to convey messages more effectively.

POLICY

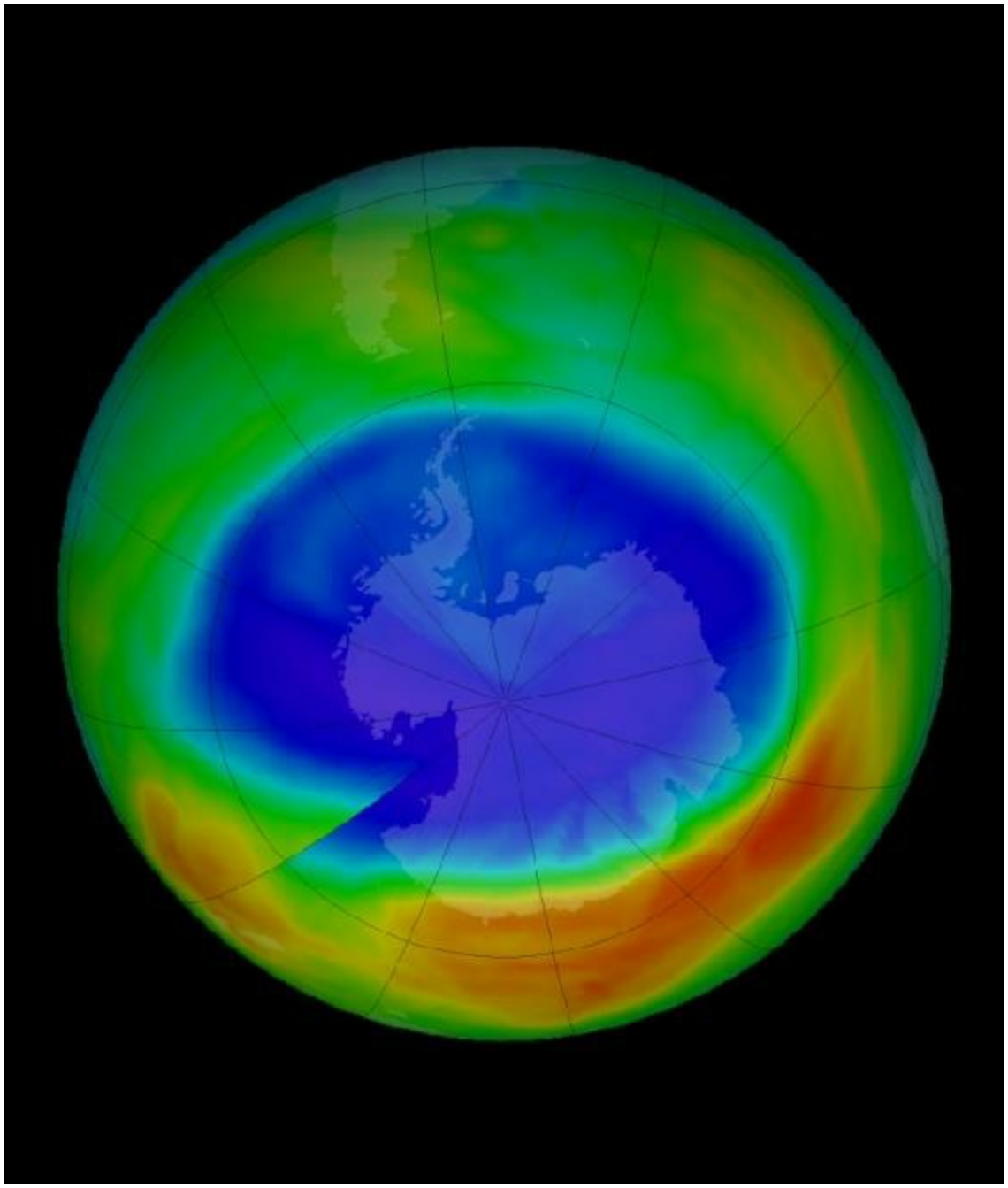
Antibiotic advice The World Health Organization (WHO) has recommended that animal-food industries curb the routine use of antibiotics for growth promotion and disease prevention. Healthy animals should receive the drugs only if others in the same flock or herdare diagnosed with communicable infections, the agency said in guidance published on 7 November. The recommendations were informed by a review of 179 studies; it found that the prevalence of multidrug-resistant bacteria in farmed animals dropped by up to 32% in places that had cut back on antibiotic use (K. L. Tang *et al. Lancet Planet. Health* http://doi.org/cfxh; 2017). The evidence connecting antibiotic restrictions in farm animals to drug resistance in humans was less robust, but hinted at a similar correlation.

Genetic-test rules The US Food and Drug Administration (FDA) is seeking

to loosen its regulation of genetic tests that are marketed directly to consumers, its commissioner, Scott Gottlieb, announced on 6 November. The FDA has proposed a policy that would allow genetic-testing companies to submit a product to the agency for a one-time review; if approved, the company would be allowed to market more tests without further review. The proposal is open for public comment until January. The agency also said that it has decided to exempt from review tests that are used to determine whether potential parents carry disease-causing genetic mutations that could cause an inherited disorder in their children.

CLIMATE

Small ozone hole This year's hole in the ozone layer was the smallest since 1988, NASA said on 2 November. The hole above Antarctica, which opens each September, was unusually small, owing to warm weather in the Southern Hemisphere. At its peak, the area of the hole was almost 2 billion hectares, or roughly two and a half times the size of the contiguous United States. Scientists attribute the shrinkage to natural variation, and not to rapid healing because of human intervention, NASA said. This year, warm air above Antarctica depleted cloud cover, which is where ozone-destroying chemical reactions occur. The hole has been shrinking since the introduction in 1987 of the Montreal Protocol to phase out ozone-depleting chemicals.



Katy Mersmann/NASA Ozone Watch/NASA

PUBLISHING

Censorship in China Springer Nature, one of the world's largest academic

publishers, has stopped readers in China from accessing some of its content. *The Financial Times* reported on 1 November that the publisher had blocked access to more than 1,000 articles from the websites of two of its journals, *The Journal of Chinese Political Science* and*International Politics*. The publishing house, which also owns *Nature*, said that the articles accounted for less than 1% of its content and had been blocked to comply with local Chinese laws. (*Nature*'s news team is editorially independent of its publisher.) The articles included politically sensitive terms such as Tibet, Taiwan and Cultural Revolution. Some in the academic community criticized the decision, which comes two-and-a-half months after UK firm Cambridge University Press blocked access to some articles in China and then swiftly reversed its decision.

Copyright battle The scholarly social network ResearchGate has over the past month disabled public access to 1.7 million papers on its site, according to five scientific publishers who have been tracking its activities. Early last month, the publishers formed a coalition to get ResearchGate to take down papers that breach copyright; two publishers have also filed a lawsuit against the site. The coalition says that the site has since disabled access to around 93% of its copyrighted material, although academics have re-uploaded some papers for public view. The publishers have now sent an undisclosed number of take-down notices to order the removal of remaining infringing content. ResearchGate, which is based in Berlin, declined to comment.

Piracy-site lawsuit The American Chemical Society (ACS) has won a lawsuit against the pirate site Sci-Hub over the website's illicit dissemination of copyrighted research articles. On 3 November, a US court granted the ACS US$4.8 million in damages for copyright infringement and trademark violation. The court also issued an injunction ordering Internet services that are "in active concert or participation" with Sci-Hub, including providers and search engines, to stop facilitating access to the site. Representatives of Sci-Hub, which was launched in 2011, did not appear in court to present their case.

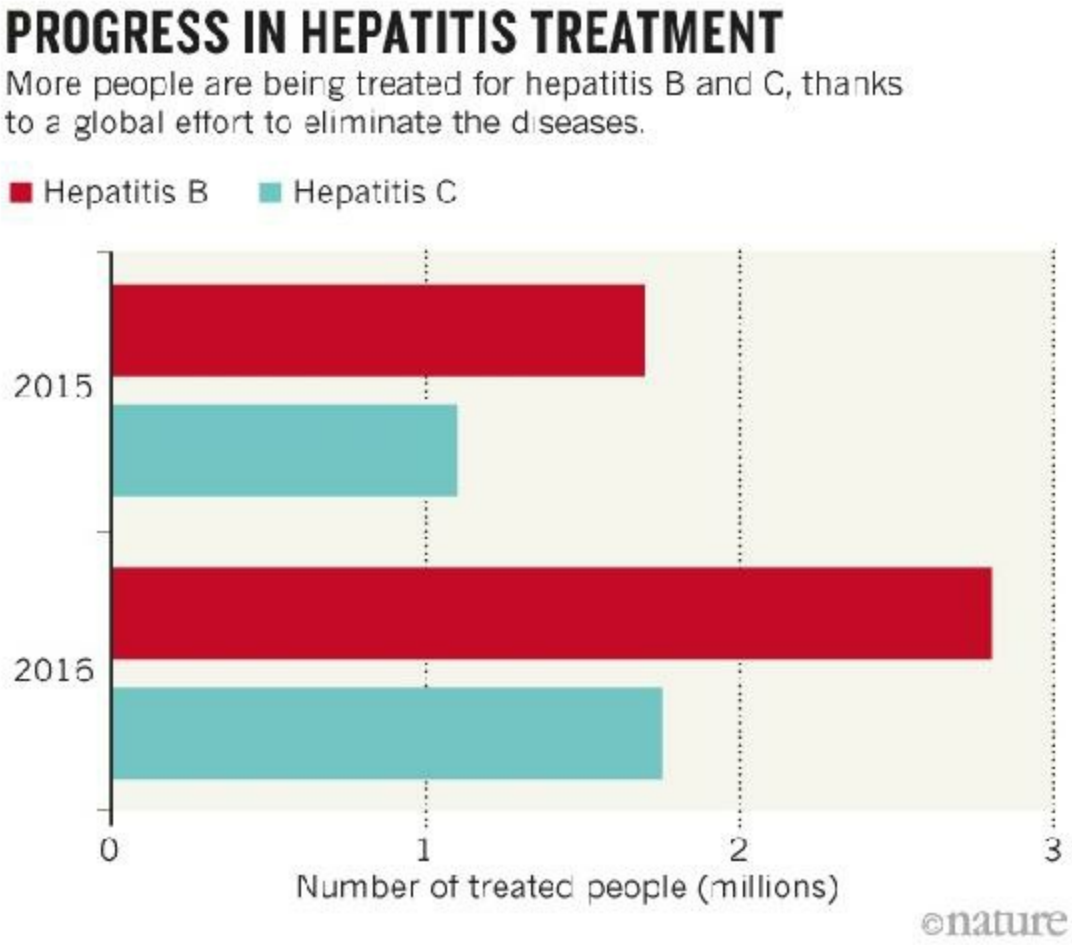
PEOPLE

Nominee withdraws Sam Clovis, the controversial nominee for the post of chief scientist at the US Department of Agriculture, withdrew from consideration on 2 November. The announcement came shortly after Clovis's name surfaced in the ongoing investigation into links between US President Donald Trump's election campaign and Russia. Clovis, a former conservative talk-show host and economics professor, was already a controversial pick for the chief-scientist position, which, by law, must be filled by a distinguished scientist.

Science chair to quit Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, said on 2 November that he will retire when his term expires late next year. The Texas Republican has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. The House of Representatives limits committee chairs to six years in the role, so Smith would have been forced to relinquish his post on the science panel in 2019.

TREND WATCH

The number of people who were able to access treatment for viral hepatitis C grew by some 1.7 million in 2016, a 60% increase over 2015, the World Health Organization (WHO) said on 31 October. A further 2.8 million people were given lifelong treatment for hepatitis B in 2016, a 65% jump over 2015. The WHO estimates that there were between 6 million and 10 million new cases of viral hepatitis B and C in 2015. The agency wants 80% of people diagnosed to be receiving treatment by 2030.



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Dark-matter hunt fails to find the elusive particles

Physicists begin to embrace alternative explanations for the missing material.

08 November 2017

XENON Collab.

Scientists working on the XENON1T experiment are searching for signs of dark matter.

Physicists are growing ever more frustrated in their hunt for dark matter — the massive but hard-to-detect substance that is thought to comprise 85% of the material Universe. Teams working with the world's most sensitive dark-matter detectors report that they have failed to find the

particles, and that the ongoing drought has challenged theorists' prevailing views.

The latest results from an experiment called XENON1T at the Gran Sasso National Laboratory in Italy, published on 30 October[1], continue a dry spell stretching back 30 years in the quest to nab dark-matter particles. An attempt by a Chinese team to detect the elusive stuff, the results of which were published on the same day[2], also came up empty-handed. Ongoing attempts by space-based telescopes, as well as at CERN, the European particle-physics laboratory near Geneva, Switzerland, have also not spotted any hints of dark-matter particles.

The findings have left researchers struggling for answers. "We do not understand how the Universe works at a deeper and more profound level than most of us care to admit," says Stacy McGaugh, an astrophysicist at Case Western Reserve University in Cleveland, Ohio.

Physicists have widely accepted the existence of dark matter since the 1980s as an explanation for why galaxies remain intact rather than flying apart, which would be expected given the amount of observable mass they contain and how fast they rotate. Researchers surmised that halos of invisible dark matter surround galaxies and stabilize them. Physicists grew more confident when dark-matter models successfully predicted the fluctuations detected in an observable echo of the Big Bang, known as the cosmic microwave background.

These observations became the most dramatic evidence for a proposal in the 1980s that dark matter might be formed of weakly interacting massive particles, known as WIMPs. The existence of such particles fits with how physicists think that the Universe evolved, and with the relative abundance of matter. Moreover, the properties of WIMPs would match those predicted by a branch of particle physics called supersymmetry.

The latest round of results seems to rule out the simplest and most elegant supersymmetry theories, casting doubt on the idea that the still-undetected particles are the missing dark matter. If simple supersymmetry theories are no longer viable, scientists say, any WIMP particle has to interact with matter much more feebly than physicists once thought. "It's not a wholesale retreat

from the WIMP paradigm, but it is definitely a change in emphasis," says Dan Hooper, a physicist at the Fermi National Accelerator Laboratory in Batavia, Illinois.

Attitudes are shifting, and physicists are increasingly embracing other possible explanations for dark matter, says David Spergel, a theoretical astrophysicist at Princeton University in New Jersey, who was an early proponent of WIMP models. "These experiments haven't completely closed the window. However, we also need to be thinking about other types of dark matter and new experiments," he says.

Dedicated detectors

It has taken decades to build experiments capable of detecting the minuscule rate at which WIMPs were thought to interact with matter. Only in the past ten years have experiments, carried out at about a dozen laboratories, reached the level of sensitivity needed to detect them. The most sensitive detector in the world is Gran Sasso's XENON1T, which looks for flashes of light created when dark matter interacts with atoms in its 3.5-tonne tank of extremely pure liquid xenon. But the team reported no dark matter from its first run. Neither was there any signal in data collected over two years during the second iteration of China's PandaX experiment, based in Jinping in Sichuan province. Hunts in space have also failed to find WIMPs, and hopes are fading that a once-promising γ-ray signal detected by NASA's Fermi telescope from the centre of the Milky Way was due to dark matter — more-conventional sources seem to explain the observation. There has been only one major report[3] of a dark-matter detection, made by the DAMA collaboration at Gran Sasso, but no group has succeeded in replicating that highly controversial result; renewed attempts to match it are under way.

Future generations of detectors based on the same principle as XENON1T are already in the works, and will be needed if physicists are to finally close the window on WIMPs. But the particles' continuing no-show is making theorists more open-minded and has allowed other theories to gain prominence, says Hooper. Perhaps dark matter consists of exotic axion particles, which are akin to strange, massive photons. Theorists are also

looking at whether dark matter might not interact with known particles at all, but exist in a “hidden sector”, he says.

The looming rejection of the WIMP hypothesis is encouraging for the few physicists who claim that dark matter itself is a red herring. “I hope people will become even more open-minded,” says McGaugh, who has studied modified versions of gravity that negate the need for dark matter. However, Hooper stresses that the fading support for WIMPs does not weaken the case for dark matter, which he thinks will eventually be found. “I’m not worried about the never possibility, but it could be very, very difficult,” he says.

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The bitter battle over the world's most popular insecticides

As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.

08 November 2017

Lucy Hulmes/CEH

Researchers have monitored the health of the red mason bee (*Osmia bicornis-rufa*), which nests in hollow cavities.

Maj Rundlöf remembers the moment she changed her mind about neonicotinoids. In December 2013, in her office at Lund University in Sweden, she and postdoc Georg Andersson were peering at data from their

latest study. It was designed to test what would happen to bees if they fed on crops treated with neonicotinoids — the world's most widely used insecticides. “I didn't expect to see any effect at all, to be honest,” says Rundlöf.

Hives of honeybees (*Apis mellifera*) weren't greatly affected by the chemicals in their pollen and nectar, the study suggested[1]. But the data on bumblebees (*Bombus terrestris*) told a different story. Bumblebee colonies that hadn't fed on the treated crops looked normal: they were packing on weight to survive the winter. But in the colonies exposed to neonicotinoids, the growth chart was a flat line.

When the Swedish study was published in April 2015, it made headlines around the world. It was the first to show that neonicotinoid chemicals — known as neonics — could harm bees in a real-world farming situation.

Bee populations are declining in many parts of the globe, a worrying sign for the crops and wild plants that rely on these pollinators for their survival. Parasites, disease and shrinking food resources are all prime suspects. But a link to neonics has become a major flashpoint.

Even before Rundlöf's results were revealed, the European Union had placed heavy restrictions on the three most widely used neonics in flowering crops — plants that might be attractive to bees — amid rising concerns that the chemicals might harm pollinators. The restricted neonics were imidacloprid and clothianidin, made by agrochemical giant Bayer, and thiamethoxam, made by Syngenta. But farmers, the agrochemical industry and some scientists pointed out that the moratorium was precautionary and based on limited evidence, gathered mostly from lab tests.

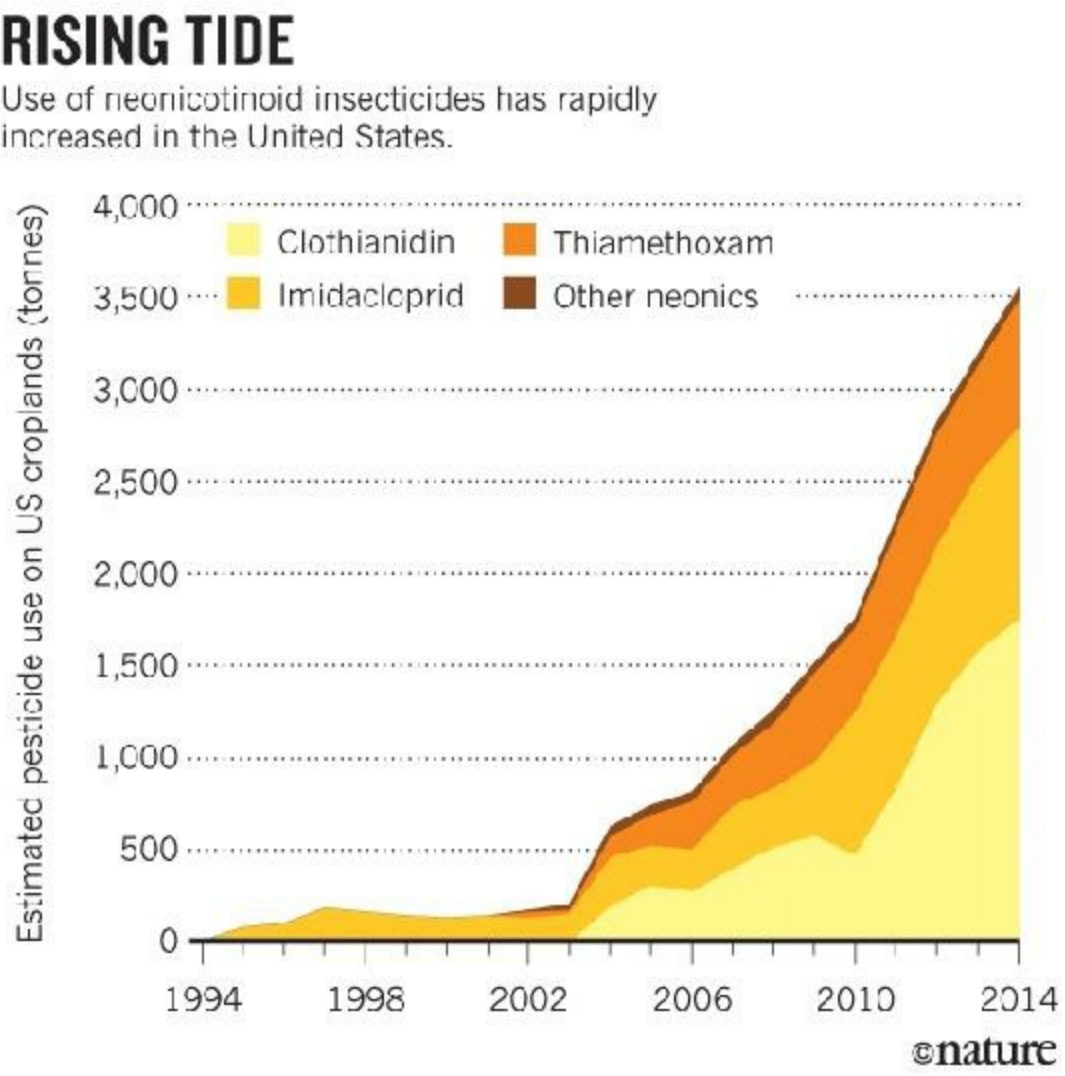
Since Rundlöf's paper, studies showing real-world evidence of harm from pesticides in the field have been mounting — and environmental organizations have demanded wide-ranging bans. Regulatory agencies will soon decide what to do about neonics, which have a global market worth more than US$1.5 billion per year. This month, the EU's European Food Safety Authority is due to complete a re-evaluation of evidence for restricting neonics; the EU will then need to decide what action to take. The US Environmental Protection Agency is expected to complete its own review of

the insecticides next year. France's parliament has passed a law that would ban neonics in 2018, although some exemptions will be allowed.

But industry groups and some scientists say the evidence still isn't conclusive. The picture is complicated: some studies show harm to some bees in some circumstances, whereas others find no harm. The results seem to be affected by many factors, including the species of bee and the kinds of crops involved. Scientists working on the question say the subject has become toxic: any new study is instantly and furiously picked at by entrenched advocates on both sides. Even the results of the largest study on the matter, funded by the agrochemical industry, failed to produce a consensus. Published this year[2], it launched another round of recriminations — including complaints from funders who criticized the paper that they had paid for. Ultimately, it's likely that political or regulatory decisions will settle the matter before opposing parties agree, says Sainath Suryanarayanan, an entomologist and sociologist at the University of Wisconsin–Madison who has studied the bee-health issue. “It is a common pattern for highly contentious and polarized debates,” he says.

The world's favourite insecticide

In the early 1980s, scientists at Nihon Tokushu Noyaku Seizo in Tokyo, an arm of Bayer, started to play around with nithiazine, an insecticide created in California a decade earlier. They discovered a new compound that was more than 100 times as effective at killing crop pests, such as aphids. Named imidacloprid, the chemical was launched onto the market in the 1990s, and it quickly became one of the most widely used insecticides in the world. By the mid-2000s, imidacloprid and similar compounds made up one-quarter of all insecticides (see 'Rising tide'). The compounds damage insects' nervous systems by causing the nerves to fire continually until they fail, eventually leading to death. Many neonics are applied directly to seeds, and are taken up by growing plants. If the plant flowers, the chemicals find their way into pollen and nectar.



Source: USGS/CalPIP

In France, where sunflower seeds coated with imidacloprid came on the market in 1994, beekeepers raised the alarm. They said that their honeybees were failing to make it home after foraging flights, and they pinned the blame on the sunflowers. The concerns triggered a 1999 French ban on imidacloprid-coated sunflower seeds, which continues to this day — although it was based on the precautionary principle, rather than formal proofs of harm, says Axel Decourtye, a researcher at the Institute for Bees in Avignon, France.

Scientists hurried to find those proofs — or evidence that the concern was overblown. Researchers quickly discovered that honeybees fed high doses of neonicotinoids died. And even sub-lethal doses triggered unusual behaviour: exposed honeybees changed their dining habits, foraging less often but for longer periods[3]. Other research showed[4] that neonics act on parts of a bee's brain associated with memory and learning. Honeybees trained to respond to particular scents by sticking out their tongues, for example, performed worse — or failed to learn the task at all — when dosed with a neonic.

At every stage, critics raised new queries about how realistic the experiments were, says Decourtye. “How do we know if the neonicotinoid doses are realistic? Does the effect on the individual have any effect on the colony?”

Out in the field

As work continued in the laboratory, researchers also began to turn to the fields. In 2012, Decourtye and his colleagues published a paper[5] showing that what they called “thiamethoxam intoxication” seemed to interfere with the ability of honeybees to return to their hives after looking for food in a realistic, outdoor setting. Yet that study still dosed bees' food with neonics, rather than allowing them to feed on treated crops.

Around the same time, a UK team found[6] that it was not just honeybees that could be at risk. They reported that colonies of bumblebees exposed to “field-realistic” levels of imidacloprid in the lab and then left to grow in field conditions grew slower than controls. They also produced 85% fewer new queens to carry on their line. That work was led by Dave Goulson, a bee researcher now at the University of Sussex in Brighton, UK. In 2006, Goulson had started a charity dedicated to conserving bumblebees, and people began telling him their concerns about neonics. “To start with, I was pretty dubious,” he says. But by 2014, the Task Force on Systemic Pesticides (TFSP) — a group of 30 scientists, including Goulson — announced that it had analysed 800 peer-reviewed studies on neonics and bees, and found “clear evidence of harm sufficient to trigger regulatory action”[8].

Rundlöf's study set out to be the most realistic yet. Her team sowed eight

Swedish fields with oilseed-rape seeds coated in clothianidin, and eight with untreated seeds. They found[1] not only that bumblebee colonies in treated fields grew less well than the controls, but also that the numbers of wild bees in the treated fields fell. Industry spokespeople noted that honeybee colonies weren't affected, and also quibbled with the study — arguing, for example, that the researchers had only placed a small number of wild bees into fields, so findings might not be statistically robust. Rundlöf, however, points out that the researchers also surveyed wild bees flying around, and had the bumblebee-colony data to draw on. “I know we have robust evidence,” she says.

Maj Rundlöf

Researchers examine the health of honeybees during a field study led by Maj Rundlöf in Sweden.

In mid-2017, the largest field study yet — funded with some $3 million from

industry — reported its long-awaited results[2]. Scientists from the Centre for Ecology and Hydrology (CEH) near Wallingford, UK, had put honeybees, mason bees (*Osmia bicornis*) and bumblebees in 33 oilseed-rape fields in the United Kingdom, Germany and Hungary. This time, the seeds, sown in winter, had been coated with either clothianidin or thiamethoxam, or with a neonicotinoid-free pesticide treatment.

The researchers, led by CEH entomologist Ben Woodcock, found that bumblebees and mason bees fared less well the more neonics they were exposed to. The honeybee picture was more complicated: in some cases, neonics seemed to affect bee health, but in others, they didn't. In the United Kingdom and Hungary, neonic compounds seemed to reduce worker-bee numbers in honeybee hives; in Hungary, researchers also saw fewer egg cells in these hives, an indication of reduced reproductive success. In Germany, however, the honeybee hives exposed to neonics had more egg cells — a puzzling result. Overall, the CEH study concluded that neonicotinoids reduced bees' ability to establish new colonies after winter. The journal editor's summary of the paper came under the headline: “Damage confirmed”.

The agrochemical firms that funded the study don't agree. At a press conference in June, when CEH scientists presented their results — without Woodcock, who was overseas — spokespeople from Syngenta and Bayer told reporters that both the study's analysis and its conclusions were questionable. They noted that Woodcock's team had analysed more than 200 pieces of information about honeybees; 9 showed a negative effect from neonicotinoids, whereas 7 were positive. “The one-line simplistic summary conclusion published does not reflect the data presented in this paper,” argued Peter Campbell, an environmental specialist at Syngenta in Reading, UK, in a separate statement released to the media.

Woodcock was incensed by the criticism. In an interview with environmental group Greenpeace, he said that industry had accused him of being a liar. Now, he says, he regrets that choice of words, but he still thinks industry took a blinkered view of the results. “I do feel that the sentiment of what I implied, while inappropriate, was not an unreasonable reaction,” he says. The negative effects were in key areas related to bee health, he says, adding that for

industrial firms to deny that neonics are having an effect on bees is “probably naive”.

Many of the academics *Nature* talked to agree. “I think the majority of researchers highlight that the weakening of bee populations caused by neonicotinoids is proved,” says Decourtye. But not everyone is so certain. “The question of whether the damage to bees is translated to an effect in fields on whole populations of bees is much harder to show,” says Linda Field, head of the department of Biointeractions and Crop Protection at Rothamsted Research in Harpenden, UK. Mature colonies may survive even if individual bees are impaired, because other worker bees compensate, notes Nigel Raine, a biologist at the University of Guelph in Canada. But solitary bees, such as wild bees and queen bumblebees emerging from hibernation, might be at greater risk.

Campbell thinks that many academics are “neutral” on the matter, but are not vocal about it. Studies showing harm to bees tend to garner media attention, and are published in widely read journals, whereas those showing no impact are relegated to less highly cited publications, he says. But Goulson and Woodcock say some of the studies that industry cites as showing no harm are statistically dubious, and more flawed than the headline-garnering trials that show harm.

Christian Maus, global lead scientist for bee care at Bayer in Monheim am Rhein, Germany, picks his words carefully. “I think it is clear and undebated that neonicotinoids do have some intrinsic toxicity to bees,” he says. “But under realistic conditions, as prevailing in the field and agricultural practice, we have not seen any evidence that they would be harming honeybee colonies, for instance, when they are correctly applied.”

Combinatorial effects

Researchers are looking beyond simple relationships between a single pesticide and bee harm. In a 2012 paper[8], Raine and his colleagues showed that exposing bumblebees to a neonicotinoid in combination with a pesticide called a pyrethroid hampered their ability to collect pollen. Colonies exposed

to both compounds experienced higher losses of worker bees than did controls, or colonies dosed with only one. The study was the first to show combinatorial effects, Raine says — which is important, because bees will be exposed to multiple compounds in the wild. And this year, in a paper[9] published alongside Woodcock's, a Canadian team studying honeybee colonies near maize (corn) plants found that the presence of the fungicide boscalid halved the dose of neonics needed to cause death.

That work also suggested that neonic chemicals can migrate away from the plants that they are supposed to protect: by identifying the sources of pollen grains in the hives, the researchers showed that bees were exposed to neonics mainly through pollen from untreated plants. Neonicotinoids are water-soluble — which is how they move from seeds into growing plant tissues. “But that also means they can be washed off the seed, into the soil, and maybe into other plants,” says Christian Krupke, an entomologist at Purdue University in West Lafayette, Indiana.

In one study[10], Krupke found that just 1.34% of clothianidin applied as seed treatment to maize ended up in the crop’s tissues. Neonics that get into the wider environment might cause other, more indirect problems. A 2014 study[11] in the Netherlands, for instance, reported a fall in populations of insect-eating birds in areas with high concentrations of neonicotinoids in the water. It suggested that the chemicals might have depleted the birds’ food resource.

Some researchers are now questioning whether there is any benefit to using neonicotinoids at all. In another study[12], Krupke’s group found no benefits on maize yield from the use of neonicotinoids in Indiana. In this crop, he says, the prophylactic use of neonicotinoids — which are often part of a bundle of pesticides sold pre-applied to seeds — is foolish.

“The way they’re used doesn’t make any sense,” he says. “It only makes sense from one motive. That is the profit motive for the manufacturer.”

Campbell insists that neonicotinoids do provide yield increases, but much of the evidence is proprietary and unpublished. Since the EU neonicotinoid restrictions, Maus says, research suggests there has been a 4% decline in

oilseed-rape yield. Whether or not the restrictions have had any effect, farmers have furiously protested against losing the ability to use neonics. Anecdotal reports suggest many are attempting to compensate by applying increasing amounts of pyrethroids, which are sprayed over crops, rather than applied to seeds; these chemicals may bring their own health risks if used in large quantities, because they are toxic to fish and aquatic insects.

The B word

Regulators in some countries will soon decide whether to take further action to restrict neonics — and here, researchers are split. Some campaign groups, such as Greenpeace and the Pesticide Action Network, have argued for a ban on the use of neonics on all outdoor crops, not just those that might be attractive to bees, such as the bright-yellow flowers of oilseed rape.

“A lot of farmers do fundamentally rely on neonicotinoids,” says Woodcock. And clamping down severely on one chemical might mean that greater amounts of other damaging substances are used. “If people can't use neonicotinoids and they go to other insecticides, is that any better? There are lots of knock-on effects,” says Field.

That concern points to wider doubts about the regulatory systems that allowed agrichemicals such as neonics onto the market in the first place, says Goulson. Many researchers are hesitant to advocate outright bans. Some, such as Rundlöf, say it isn't their job to make policy recommendations. But Goulson says his view has changed as the evidence has mounted. In 2014 — at the time of the TFSP's first synthesis report — he thought that there might be certain situations in which neonics were the best option. But since then, he says, there's been even stronger evidence of collapsing insect populations — and it is hard to regulate partial bans. “I think now I'd vote for a complete ban,” he says.

Whatever regulators do, Goulson says, he is growing increasingly downbeat about the chances of any consensus forming between industry and academia on the issue. “I'm starting to come to the conclusion there will never be a game-changer,” he says. “There is nothing I think any scientist could do at

this point to make people all sit down and have any answer.”

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Four ethical priorities for neurotechnologies and AI

08 November 2017

Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

BSIP/UIG/Getty

A man with a spinal-cord injury (right) prepares for a virtual cycle race in which competitors steer avatars using brain signals.

Consider the following scenario. A paralysed man participates in a clinical

trial of a brain–computer interface (BCI). A computer connected to a chip in his brain is trained to interpret the neural activity resulting from his mental rehearsals of an action. The computer generates commands that move a robotic arm. One day, the man feels frustrated with the experimental team. Later, his robotic hand crushes a cup after taking it from one of the research assistants, and hurts the assistant. Apologizing for what he says must have been a malfunction of the device, he wonders whether his frustration with the team played a part.

This scenario is hypothetical. But it illustrates some of the challenges that society might be heading towards.

Current BCI technology is mainly focused on therapeutic outcomes, such as helping people with spinal-cord injuries. It already enables users to perform relatively simple motor tasks — moving a computer cursor or controlling a motorized wheelchair, for example. Moreover, researchers can already interpret a person's neural activity from functional magnetic resonance imaging scans at a rudimentary level[1] — that the individual is thinking of a person, say, rather than a car.

It might take years or even decades until BCI and other neurotechnologies are part of our daily lives. But technological developments mean that we are on a path to a world in which it will be possible to decode people's mental processes and directly manipulate the brain mechanisms underlying their intentions, emotions and decisions; where individuals could communicate with others simply by thinking; and where powerful computational systems linked directly to people's brains aid their interactions with the world such that their mental and physical abilities are greatly enhanced.

Such advances could revolutionize the treatment of many conditions, from brain injury and paralysis to epilepsy and schizophrenia, and transform human experience for the better. But the technology could also exacerbate social inequalities and offer corporations, hackers, governments or anyone else new ways to exploit and manipulate people. And it could profoundly alter some core human characteristics: private mental life, individual agency and an understanding of individuals as entities bound by their bodies.

It is crucial to consider the possible ramifications now.

The Morningside Group comprises neuroscientists, neurotechnologists, clinicians, ethicists and machine-intelligence engineers. It includes representatives from Google and Kernel (a neurotechnology start-up in Los Angeles, California); from international brain projects; and from academic and research institutions in the United States, Canada, Europe, Israel, China, Japan and Australia. We gathered at a workshop sponsored by the US National Science Foundation at Columbia University, New York, in May 2017 to discuss the ethics of neurotechnologies and machine intelligence.

We believe that existing ethics guidelines are insufficient for this realm[2]. These include the Declaration of Helsinki, a statement of ethical principles first established in 1964 for medical research involving human subjects (go.nature.com/2z262ag); the Belmont Report, a 1979 statement crafted by the US National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research (go.nature.com/2hrezmb); and the Asilomar artificial intelligence (AI) statement of cautionary principles, published early this year and signed by business leaders and AI researchers, among others (go.nature.com/2ihnqac).

To begin to address this deficit, here we lay out recommendations relating to four areas of concern: privacy and consent; agency and identity; augmentation; and bias. Different nations and people of varying religions, ethnicities and socio-economic backgrounds will have differing needs and outlooks. As such, governments must create their own deliberative bodies to mediate open debate involving representatives from all sectors of society, and to determine how to translate these guidelines into policy, including specific laws and regulations.

Intelligent investments

Some of the world's wealthiest investors are betting on the interplay between neuroscience and AI. More than a dozen companies worldwide, including Kernel and Elon Musk's start-up firm Neuralink, which launched this year, are investing in the creation of devices that can both 'read' human brain activity and 'write' neural information into the brain. We estimate that current spending on neurotechnology by for-profit industry is already US$100

million per year, and growing fast.

BSIP/UIG/Getty

After having electrodes implanted in the brain to stimulate neural activity, some people have reported feeling an altered sense of identity.

Investment from other sectors is also considerable. Since 2013, more than $500 million in federal funds has gone towards the development of neurotechnology under the US BRAIN initiative alone.

Current capabilities are already impressive. A neuroscientist paralysed by amyotrophic lateral sclerosis (ALS; also known as Lou Gehrig's or motor neuron disease) has used a BCI to run his laboratory, write grant applications and send e-mails[3]. Meanwhile, researchers at Duke University in Durham, North Carolina, have shown that three monkeys with electrode implants can operate as a 'brain net' to move an avatar arm collaboratively[4]. These devices can work across thousands of kilometres if the signal is transmitted wirelessly by the Internet.

Soon such coarse devices, which can stimulate and read the activity of a few dozen neurons at most, will be surpassed. Earlier this year, the US Defense Advanced Research Projects Agency (DARPA) launched a project called Neural Engineering System Design. It aims to win approval from the US Food and Drug Administration within 4 years for a wireless human brain device that can monitor brain activity using 1 million electrodes simultaneously and selectively stimulate up to 100,000 neurons.

Meanwhile, Google, IBM, Microsoft, Facebook, Apple and numerous start-ups are building ever-more-sophisticated artificial neural networks that can already outperform humans on tasks with well-defined inputs and outputs.

Last year, for example, researchers at the University of Washington in Seattle demonstrated that Google's FaceNet system could recognize one face from a million others. Another Google system with similar neural-network architecture far outperforms well-travelled humans at guessing where in the world a street scene has been photographed, demonstrating the generality of the technique. In August, Microsoft announced that, in certain metrics, its neural network for recognizing conversational speech has matched the abilities of even trained professionals, who have the option of repeatedly rewinding and listening to words used in context. And using electroencephalogram (EEG) data, researchers at the University of Freiburg in Germany showed in July how neural networks can be used to decode planning-related brain activity and so control robots[5].

Future neural networks derived from a better understanding of how real ones work will almost certainly be much more powerful even than these examples. The artificial networks in current use have been inspired by models of brain circuits that are more than 50 years old, which are based on recording the activity of individual neurons in anaesthetized animals[6]. In today's neuroscience labs, researchers can monitor and manipulate the activity of thousands of neurons in awake, behaving animals, owing to advances in optical methods, computing, molecular engineering and microelectronics.

We are already intimately connected to our machines. Researchers at Google calculated this year that the average user touches their phone nearly one million times annually (unpublished data). The human brain controls auditory

and visual systems to decipher sounds and images, and commands limbs to hold and manipulate our gadgets. Yet the convergence of developments in neurotechnologies and AI would offer something qualitatively different — the direct linking of people's brains to machine intelligence, and the bypassing of the normal sensorimotor functions of brains and bodies.

Four concerns

For neurotechnologies to take off in general consumer markets, the devices would have to be non-invasive, of minimal risk, and require much less expense to deploy than current neurosurgical procedures. Nonetheless, even now, companies that are developing devices must be held accountable for their products, and be guided by certain standards, best practices and ethical norms.

We highlight four areas of concern that call for immediate action. Although we raise these issues in the context of neurotechnology, they also apply to AI.

Privacy and consent. An extraordinary level of personal information can already be obtained from people's data trails. Researchers at the Massachusetts Institute of Technology in Cambridge, for example, discovered in 2015 that fine-grained analysis of people's motor behaviour, revealed through their keyboard typing patterns on personal devices, could enable earlier diagnosis of Parkinson's disease[7]. A 2017 study suggests that measures of mobility patterns, such as those obtained from people carrying smartphones during their normal daily activities, can be used to diagnose early signs of cognitive impairment resulting from Alzheimer's disease[8].

Algorithms that are used to target advertising, calculate insurance premiums or match potential partners will be considerably more powerful if they draw on neural information — for instance, activity patterns from neurons associated with certain states of attention. And neural devices connected to the Internet open up the possibility of individuals or organizations (hackers, corporations or government agencies) tracking or even manipulating an individual's mental experience.

We believe that citizens should have the ability — and right — to keep their neural data private (see also 'Agency and identity'). We propose the following steps to ensure this.

For all neural data, the ability to opt out of sharing should be the default choice, and assiduously protected. People readily give up their privacy rights to commercial providers of services, such as Internet browsing, social media or entertainment, without fully understanding what they are surrendering. A default of opting out would mean that neural data are treated in the same way that organs or tissues are in most countries. Individuals would need to explicitly opt in to share neural data from any device. This would involve a safe and secure process, including a consent procedure that clearly specifies who will use the data, for what purposes and for how long.

Even with this approach, neural data from many willing sharers, combined with massive amounts of non-neural data — from Internet searches, fitness monitors and so on — could be used to draw 'good enough' conclusions about individuals who choose not to share. To limit this problem, we propose that the sale, commercial transfer and use of neural data be strictly regulated. Such regulations — which would also limit the possibility of people giving up their neural data or having neural activity written directly into their brains for financial reward — may be analogous to legislation that prohibits the sale of human organs, such as the 1984 US National Organ Transplant Act.

Another safeguard is to restrict the centralized processing of neural data. We advocate that computational techniques, such as differential privacy or 'federated learning', be deployed to protect user privacy (see 'Protecting privacy'). The use of other technologies specifically designed to protect people's data would help, too. Blockchain-based techniques, for instance, allow data to be tracked and audited, and 'smart contracts' can give transparent control over how data are used, without the need for a centralized authority. Lastly, open-data formats and open-source code would allow for greater transparency about what stays private and what is transmitted.

Protecting privacy: Federated learning

When technology companies use machine learning to improve their software, they typically gather user information on their servers to analyse how a particular service is being used and then train new algorithms on the aggregated data. Researchers at Google are experimenting with an alternative method of artificial-intelligence training called federated learning. Here, the teaching process happens locally on each user's device without the data being centralized: the lessons aggregated from the data (for instance, the knowledge that the word 'weekly' can be used as an adjective and an adverb) are sent back to Google's servers, but the actual e-mails, texts and so on remain on the user's own phone. Other groups are exploring similar ideas. Thus, information systems with improved designs could be used to enhance users' ownership and privacy over their personal data, while still enabling valuable computations to be performed on those data.

Agency and identity. Some people receiving deep-brain stimulation through electrodes implanted in their brains have reported feeling an altered sense of agency and identity. In a 2016 study, a man who had used a brain stimulator to treat his depression for seven years reported in a focus group[9] that he began to wonder whether the way he was interacting with others — for example, saying something that, in retrospect, he thought was inappropriate — was due to the device, his depression or whether it reflected something deeper about himself. He said: “It blurs to the point where I'm not sure ... frankly, who I am.”

Neurotechnologies could clearly disrupt people's sense of identity and agency, and shake core assumptions about the nature of the self and personal responsibility — legal or moral.

People could end up behaving in ways that they struggle to claim as their own, if machine learning and brain-interfacing devices enable faster translation between an intention and an action, perhaps by using an 'auto-complete' or 'auto-correct' function. If people can control devices through their thoughts across great distances, or if several brains are wired to work collaboratively, our understanding of who we are and where we are acting will be disrupted.

As neurotechnologies develop and corporations, governments and others start striving to endow people with new capabilities, individual identity (our

bodily and mental integrity) and agency (our ability to choose our actions) must be protected as basic human rights.

We recommend adding clauses protecting such rights ('neurorights') to international treaties, such as the 1948 Universal Declaration of Human Rights. However, this might not be enough — international declarations and laws are just agreements between states, and even the Universal Declaration is not legally binding. Thus, we advocate the creation of an international convention to define prohibited actions related to neurotechnology and machine intelligence, similar to the prohibitions listed in the 2010 International Convention for the Protection of All Persons from Enforced Disappearance. An associated United Nations working group could review the compliance of signatory states, and recommend sanctions when needed.

Such declarations must also protect people's rights to be educated about the possible cognitive and emotional effects of neurotechnologies. Currently, consent forms typically focus only on the physical risks of surgery, rather than the possible effects of a device on mood, personality or sense of self.

Augmentation. People frequently experience prejudice if their bodies or brains function differently from most[10]. The pressure to adopt enhancing neurotechnologies, such as those that allow people to radically expand their endurance or sensory or mental capacities, is likely to change societal norms, raise issues of equitable access and generate new forms of discrimination.

Moreover, it's easy to imagine an augmentation arms race. In recent years, we have heard staff at DARPA and the US Intelligence Advanced Research Projects Activity discuss plans to provide soldiers and analysts with enhanced mental abilities ('super-intelligent agents'). These would be used for combat settings and to better decipher data streams.

Any lines drawn will inevitably be blurry, given how hard it is to predict which technologies will have negative impacts on human life. But we urge that guidelines are established at both international and national levels to set limits on the augmenting neurotechnologies that can be implemented, and to define the contexts in which they can be used — as is happening for gene editing in humans.

Privacy and individuality are valued more highly in some cultures than in others. Therefore, regulatory decisions must be made within a culture-specific context, while respecting universal rights and global guidelines. Moreover, outright bans of certain technologies could simply push them underground, so efforts to establish specific laws and regulations must include organized forums that enable in-depth and open debate.

Such efforts should draw on the many precedents for building international consensus and incorporating public opinion into scientific decision-making at the national level[11]. For instance, after the First World War, a 1925 conference led to the development and ratification of the Geneva Protocol, a treaty banning the use of chemical and biological weapons. Similarly, after the Second World War, the UN Atomic Energy Commission was established to deal with the use of atomic energy for peaceful purposes and to control the spread of nuclear weapons.

In particular, we recommend that the use of neural technology for military purposes be stringently regulated. For obvious reasons, any moratorium should be global and sponsored by a UN-led commission. Although such commissions and similar efforts might not resolve all enhancement issues, they offer the best-available model for publicly acknowledging the need for restraint, and for wide input into the development and implementation of a technology.

Bias. When scientific or technological decisions are based on a narrow set of systemic, structural or social concepts and norms, the resulting technology can privilege certain groups and harm others. A 2015 study[12] found that postings for jobs displayed to female users by Google's advertising algorithm pay less well than those displayed to men. Similarly, a ProPublica investigation revealed last year that algorithms used by US law-enforcement agencies wrongly predict that black defendants are more likely to reoffend than white defendants with a similar criminal record (go.nature.com/29aznyw). Such biases could become embedded in neural devices. Indeed, researchers who have examined these kinds of cases have shown that defining fairness in a mathematically rigorous manner is very difficult (go.nature.com/2ztfjt9).

Practical steps to counter bias within technologies are already being discussed in industry and academia. Such ongoing public discussions and debate are necessary to shape definitions of problematic biases and, more generally, of normality.

We advocate that countermeasures to combat bias become the norm for machine learning. We also recommend that probable user groups (especially those who are already marginalized) have input into the design of algorithms and devices as another way to ensure that biases are addressed from the first stages of technology development.

Responsible neuroengineering

Underlying many of these recommendations is a call for industry and academic researchers to take on the responsibilities that come with devising devices and systems capable of bringing such change. In doing so, they could draw on frameworks that have already been developed for responsible innovation.

In addition to the guidelines mentioned above, the UK Engineering and Physical Sciences Research Council, for instance, provides a framework to encourage innovators to “anticipate, reflect, engage and act” in ways that “promote ... opportunities for science and innovation that are socially desirable and undertaken in the public interest”. Among the various efforts to address this in AI, the IEEE Standards Association created a global ethics initiative in April 2016, with the aim of embedding ethics into the design of processes for all AI and autonomous systems.

History indicates that profit hunting will often trump social responsibility in the corporate world. And even if, at an individual level, most technologists set out to benefit humanity, they can come up against complex ethical dilemmas for which they aren't prepared. We think that mindsets could be altered and the producers of devices better equipped by embedding an ethical code of conduct into industry and academia.

A first step towards this would be to expose engineers, other tech developers

and academic-research trainees to ethics as part of their standard training on joining a company or laboratory. Employees could be taught to think more deeply about how to pursue advances and deploy strategies that are likely to contribute constructively to society, rather than to fracture it.

This type of approach would essentially follow that used in medicine. Medical students are taught about patient confidentiality, non-harm and their duties of beneficence and justice, and are required to take the Hippocratic Oath to adhere to the highest standards of the profession.

The possible clinical and societal benefits of neurotechnologies are vast. To reap them, we must guide their development in a way that respects, protects and enables what is best in humanity.

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Comments

Comments

There are currently no comments.

The catalogue that made metrics, and changed science

08 November 2017

As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.

Alamy

Cataloguers of the Royal Society developed the first record of published scientific research.

In 1830, Charles Babbage had an unusual idea. Exasperated by how little recognition science was getting in England, the computer pioneer and scientific provocateur suggested that quantifying authorship might be a way to identify scientific eminence.

Like many of Babbage's radical ideas, this one persuaded almost nobody, but it eventually proved prophetic. Before the end of the century, listing papers and comparing publication counts had become a popular pursuit among scientific authors and other observers. Within a few decades, academic scientists were coming to fear the creed of 'publish or perish' (see 'Catalogues and counts').

This transformation can inform current debates about the value of algorithms for quantifying scientific credibility and importance. History shows how search technologies and metrics are not neutral tools that simply speed up efforts to locate and evaluate scientific work. Metrics transform the very things that they measure. By changing the reward structure, they alter researchers' behaviour — both how results are communicated and which topics receive the most attention.

But there is a second, more subtle, transformation that we must be alert to. The processes by which scientific merit is judged have long been central to the public perception of scientific authority. As these processes change, we must also consider the ways in which broader cultural beliefs about scientific expertise are transformed.

Broken pieces of fact

Babbage's suggestion to count authors' papers was met with various criticisms. One author did the calculation for each fellow in the Royal Society in London, and showed that this was a terrible guide to scientific eminence. Another pointed out[1] that “a far more satisfactory criterion” would have been “the value of those papers”.

Back then, scientific reputations were built not on periodicals but on books and other proofs of genius that demonstrated mastery of a subject. Babbage himself had little respect for most scientific journals, and he limited his proposal to counting papers in the venerable *Philosophical Transactions of the Royal Society of London*. As late as 1867, the British physiologist Michael Foster, in a retrospective written on the life of Karl von Baer, heaped praise on the embryologist's multivolume masterwork, *On the Development*

of Animals, and dismissed his periodical publications. These, Foster claimed[2], were just “specimens of those broken pieces of fact, which every scientific worker throws out to the world, hoping that on them, some time or other, some truth may come to land”.

Alamy

But things were beginning to change. A young engineer working for the US

Coast and Geodetic Survey (now the National Geodetic Survey) had suggested that it would be useful if some catalogue could be devised to keep track of the publications of European scientific societies. Once the idea crossed the Atlantic and percolated up to the Royal Society, its scope grew to become a list of all periodical papers containing original scientific research published since 1800. Some questioned the need to preserve so much insignificant writing. The physicist William Thomson (later Lord Kelvin) warned that the project would lead the society to financial ruin.

The main argument for what would become the *Catalogue of Scientific Papers* was that periodical publishing was a mess. Although many authors published in the journals of scientific societies, vast quantities of valuable information appeared in popular-science magazines, encyclopaedias and general-interest weeklies. Authors distributed huge numbers of offprints that sometimes did not even make clear what journal they had come from.

When the society's indexers got down to work in 1867, they realized that the situation was worse than they'd imagined. For thousands of papers, they couldn't even figure out who the author was. Many who published in periodicals chose to remain anonymous, or signed only their initials. In other cases, it was hard to tell to what extent the writer of a paper was responsible for its contents, or whether another person ought to be credited. Moreover, vast numbers of papers were published in various forms in different periodicals, and it was no easy matter deciding what should count as the same publication. Today, such publishing habits would probably lead to accusations of misconduct; not very long ago this was business as usual.

The Royal Society's cataloguers did what they could, contacting editors and authors to match names to papers. They turned a significant portion of the society's library into a bibliographic workroom, and made their job simpler by excluding all general-interest periodicals from the search, as well as anything that smacked of reading for non-specialists. They compiled lists of which periodicals ought to be included in the count, and circulated them to other experts and academies for feedback. The decision about whether to index some doubtful titles sometimes made it all the way to the society's council for a vote.

As their work progressed, the directors of the project came to realize that

their charge to produce a master list of all 'scientific papers' published since 1800 might actually influence publishing practices in the future. They hoped that authors would be more careful about where they published — or at least sign their contributions[3]. They probably did not anticipate the full consequences of what they were about to unleash.

Counting what counts

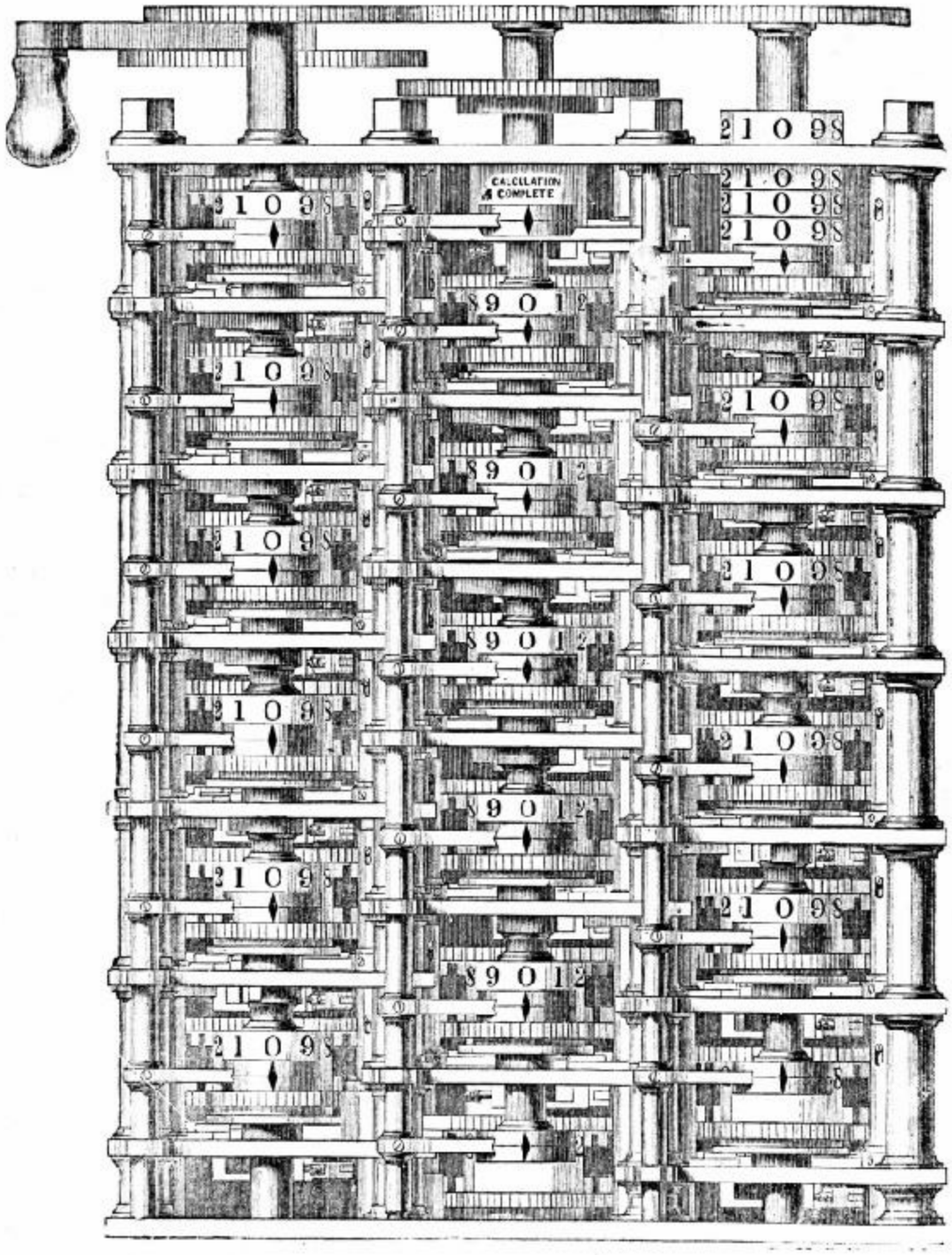
When the first volumes of the *Catalogue of Scientific Papers* appeared at the end of 1867, reaction across Europe and the United States was swift and wide-ranging. One observer wrote in awe that the catalogue made science look like a coral-island, a majestic edifice that grew imperceptibly larger with the addition of each new fact embodied in each paper. Some were less enthusiastic. One Royal Society fellow complained that the editors had distorted “the progress and history of discovery both in Physical and Natural Science” by excluding so many valuable contributions from “journals not professedly scientific”, accounts of scientific voyages, independently published treatises, encyclopaedia articles (which at the time often included original research), and much more[4].

Many observers hurried over the prospect of how helpful the catalogue would be for finding information and began comparing the productivity of individuals. By quantifying the contributions of each author, the catalogue seemed tailor-made for keeping score. A writer in *Nature* got down to business[5]: “Dr. Hooker appears for 58 papers; his late father for 72; and the late W. Hopkins, who did so much in mathematical geology, for 33 .... the indefatigable Isaac Lea, of Philadelphia, for 106, mostly about shells...”. And so forth. In a detailed review in a Viennese newspaper, the mineralogist Wilhelm von Haidinger began by urging prudence, warning that the mere comparison of numbers was no basis on which to make judgements of value[6]. But even he admitted that the numbers were somehow irresistible. Within two years, von Haidinger had taken his numerical analysis further. He published a study based on the catalogue that included a chart that compared the number of highly productive scientific authors in each region of Europe, lamenting the low position of Austria according to this ranking[7].

Such enthusiasm for counting had practical consequences. Within a decade of those first volumes appearing, the forms submitted by candidates for admission to the Royal Society transformed into long lists of papers. By the early 1870s, obituaries and biographical encyclopaedias were routinely noting the number of papers written by a researcher, and even following the chronology sketched out by those papers as guide-posts to a career. By 1900, even Foster, the physiologist once so sceptical of scientific periodicals, had changed his tune. Original science belonged in periodicals, he explained. Putting new findings in books — as Charles Darwin had famously done — was “out of place and even dangerous”[8]. To be an expert on scientific subjects meant being an author of scientific papers.

Publish or perish

There is a direct line from these developments to twentieth-century worries about scientific publishing going off the rails. A letter to *Nature* in 1932 lamented the growing practice of candidates submitting a “list of strictly technical publications” to the Royal Society, leading to the result that “our journals are filled with masses of unreadable trash” published by ambitious scholars hoping to strengthen their applications[9].



Alamy

Charles Babbage, inventor of the difference engine, was an advocate of counting papers.

This was around the same time that the phrase publish or perish began to circulate in academia. It did so first in the United States, where the spread of research universities was turning science into something resembling a profession. The slogan became shorthand for the corrupting influence of narrow, bureaucratic performance measures of research.

In the 1960s, Eugene Garfield launched a radically different search tool, known as the Science Citation Index. He hoped that it might end the harmful culture of publish or perish by showing that some papers were more cited — and hence more valuable — than others.

Immediately, commentators warned that new measures based on citations would only make things worse, leading to a “highly invidious pecking order” of journals that could distort science[10]. The journal impact factor made its public debut in 1972, soon after the US Congress called on the National Science Foundation to produce a better account of the benefits wrought by public funding of science. There is no doubt that the citation index changed practices of scientific publishing, just as the rise of counting papers had followed the introduction of the catalogue before.

Today, advocates of altmetrics argue that well-made algorithms can mimic and aggregate the everyday acts of judgement that researchers make when they read, cite, link or otherwise engage with published research. These algorithms, they claim, will turn out to be as good or better at replicating established processes — such as peer review — that are supposed to delimit what constitutes important and trustworthy research.

Whether or not these claims turn out to be true, they ignore the question of whether we deem the procedures that experts use to evaluate ideas to be intrinsically valuable (that is, independent of the content of those judgements).

Scientific judgement does not happen in a cultural vacuum. The rise of processes such as peer review to organize and evaluate research was never simply about getting scientific judgement right; it was about balancing scientists' expert cultures with public demands for accountability. The *Catalogue of Scientific Papers* was itself part of a cultural moment in which

indexes and card catalogues were celebrated for their potential to set knowledge free and even foster world peace. Interest in altmetrics has grown alongside widespread fascination with the potential of online platforms to make scientific communication both more open and more democratic.

At a time when the public status of the scientific expert is becoming increasingly uncertain, these questions are more important than ever. In a democracy, the procedures by which we decide what constitutes valuable scientific knowledge fundamentally depend on public conceptions of the aims of the scientific enterprise.

The question of whether new metrics might one day replicate the results of peer review (when it is working well) is a red herring. How we choose to judge what constitutes good science is just as important as the end results of those judgements. Even algorithms have politics.

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Further reading

Csiszar, A. *Br. J. Hist. Sci.* **50,** 23–60 (2017).

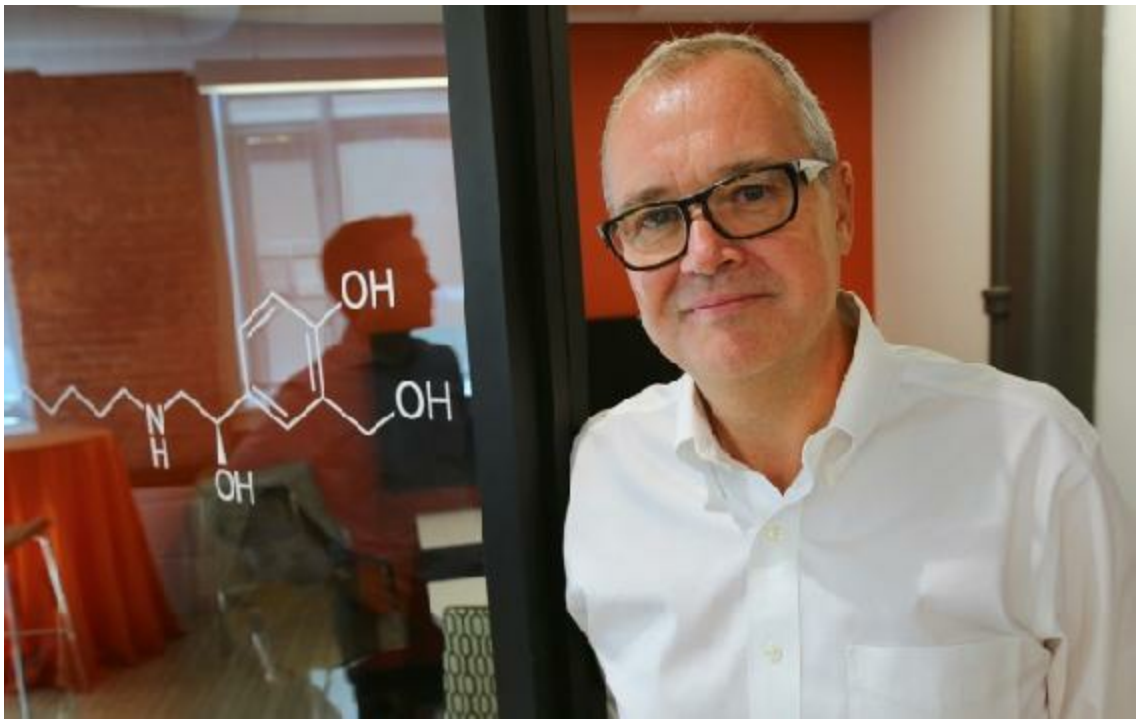
Comments

Commenting is currently unavailable.

UK government appoints next chief scientific adviser

A former pharmaceutical boss will help navigate the UK's exit from the European Union.

08 November 2017



Pat Greenhouse/Boston Globe/Getty

Patrick Vallance is the third successive biomedial scientist to be appointed chief scientific adviser.

Patrick Vallance, president of research and development at the pharmaceutical giant GlaxoSmithKline, has been appointed as chief scientific adviser, the UK government announced on 8 November.

Vallance, a clinical pharmacologist who previously led the medical division at University College London, will replace Mark Walport in April 2018. Walport has left the government to become head of a powerful new funding body called UK Research and Innovation.

As chief scientific adviser, Vallance will advise the prime minister and her cabinet, the government's most senior decision-making body. He will also lead the Government Office for Science, which promotes the use of scientific evidence in policymaking across government.

A major part of his role will be to ensure that high-quality advice is available across government departments as they deal with the legal and regulatory consequences of the UK's decision to leave the European Union, says Graeme Reid, a science-policy researcher at University College London. The United Kingdom needs to manage the impact of Brexit on the regulation of the nuclear industry and the UK's role in fusion research, as well as on environment policy and other science-related issues. "Patrick Vallance's experience in both business and universities will be of huge value," says Reid.

Brexit is likely to boost the day-to-day importance of chief scientific advisor's role, but Vallance will also have to reinvent other, more informal aspects of the position, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School. The creation of UK Research and Innovation, intended to increase the power of UK research-funding bodies, means Walport will continue to wield great influence over science in government. The chief scientific adviser has traditionally been the voice of science in government, Flanagan says.

The relationship between Vallance and Walport will be an interesting dynamic to watch, says James Wilsdon, a research-policy specialist based at the University of Sheffield, UK. He says he hopes that Vallance will act as a bridge between the science community and policymakers, and will be open to a wide range of people and perspectives. The network of chief scientific advisers is not yet operating at full strength, he says, "so re-energising the collegiality and connectivity of that network though Whitehall is a really important thing".

The role is less well-paid than Vallance's present position. His base salary at GlaxoSmithKline is £780,000 (US$1.02 million), but the science-adviser job was advertised in the salary range of £160,000–£180,000.

Vallance will be the third successive chief scientific adviser to come from the biomedical sciences. He follows Walport, who is a former director of the Wellcome Trust, and John Beddington, a population biologist now at the Oxford Martin School and the University of Oxford, UK.

In a separate announcement, GlaxoSmithKline announced that it had appointed Hal Barron, current president of research and development at Alphabet-funded California Life Sciences, to replace Vallance.

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Indian scientists urged to speak out about pseudoscience

Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.

07 November 2017

Pallava Bagla/Corbis/Getty

Scientists taking part in India's march for science in August were protesting against the spread of anti-science beliefs, superstitions and myths.

A leading Indian science-advocacy group is urging the country’s researchers to speak out against pseudoscience, which it fears has gained a foothold in the past few years, partly through support from some agencies of the Indian

government.

The call to arms, made by the non-profit Breakthrough Science Society, comes after some members of an alumni association of the prestigious Indian Institute of Science (IISc), Bangalore, planned a workshop on astrology at the IISc for 25–26 November.

Strong backlash from scientists resulted in the event being cancelled on 28 October. The society's general secretary, Soumitro Banerjee, says that it would be "detrimental to Indian science" for researchers to remain neutral on such issues. "India's scientific community must be proactive in propagating a scientific bent of mind," says Banerjee, a physicist at the Indian Institute of Science Education and Research Kolkata.

Timeline of events

Two days before the alumni association cancelled the workshop, dozens of scientists signed letters to the IISc director, Anurag Kumar, objecting to the workshop. The IISc director and the faculty were not involved in organizing the workshop.

Muthya Ravindra, a computer scientist and president of the alumni association, says that the event, organized by one of its members, was still under discussion when "due to some miscommunications", e-mails promoting the event were sent out.

But Ravindra says that despite criticism from scientists and other academics, people widely believe in astrology and seek its advice in newspapers, magazines and on television. He is unsure what role scientists should play in educating society on the dangers such practices may have. "It is very confusing to me whether we as scientists [should] criticize or take some part in finding a solution," he says.

India's ruling party, the conservative Bharatiya Janata Party (BJP) has shown support for giving astrology a place in universities. In 2001, then-science minister of the BJP-led coalition government Murli Manohar Joshi took steps to allow public universities to include astrology classes in curricula.

However, the Indian government and science ministry did not have a role in the IISc alumni association's planned astrology workshop.

Pseudoscience debate

Alarm in the Indian scientific community over anti-science policies and programmes has been brewing for some time. Several scientists who spoke with *Nature* are reluctant to comment publicly about it for fear of jeopardizing their jobs. Others took part in the March for Science organized by the 7,000-member Breakthrough Science Society in August in around 40 Indian cities, in part to protest the government's support for ideas not yet backed by science. One area of concern, says Banerjee, is the government's push for a national research programme on the health and other benefits of a combination of five cow products, known as panchgavya.

The Indian Institute of Technology (IIT), Delhi, hosted a two-day workshop last December to discuss ways to validate research on panchgavya, which was supported by India's Department of Science and Technology, Department of Biotechnology, and Council of Scientific and Industrial research (CSIR), and inaugurated by India's science minister Harsh Vardhan.

According to IIT Delhi's website, Vardhan, who is a physician, "emphasised that use of panchgavya in practice and in daily routines will help to address the pressing global issues like climate change, resistance development, malnourishment, global health etc".

Following the workshop, India's science ministry formed a national steering committee to initiate a national programme on the topic.

Supporters of this research say that cow products should be considered part of India's vast traditional knowledge base. But critics say that such unverified theories are pseudoscience, and that singling out the benefits of cow products is part of a larger political agenda by Hindus, for whom the cow is a sacred animal.

They also argue that research on topics such as panchgavya should be handled in a neutral manner rather than as a way of promoting traditional

knowledge. Rahul Siddharthan, a computation biologist at the Institute of Mathematical Sciences in Chennai, says that the government must accept that any research involving traditional hypotheses about health could potentially refute those hypotheses. “Refutability is the essence of science,” he says.

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Comments

Commenting is currently unavailable.

Pirate paper website Sci-Hub dealt another blow by US courts

American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.

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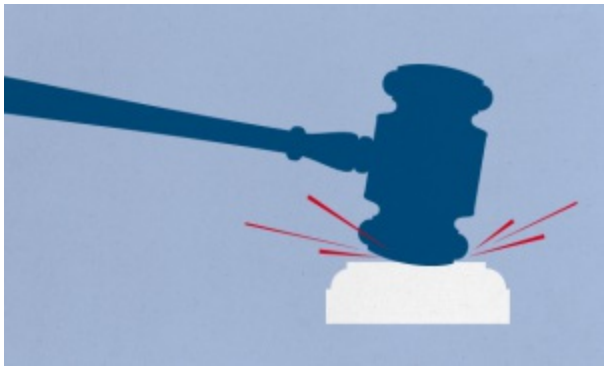
1. 08 November 2017



The American Chemical Society (ACS) has won a lawsuit against the pirate research-paper website Sci-Hub, over the site’s illicit use and dissemination of ACS articles.

On 3 November, a US court ordered Sci-Hub's operators to pay the ACS US$4.8 million in damages for copyright infringement and trademark violation. Sci-Hub’s owners did not appear in court to present their case.

The judge also ordered that any party “in active concert or participation” with Sci-Hub should “cease facilitating” access to the repository. This means that the ACS could request Internet services including web providers, search engines and domain-name registrars to stop linking or to block access to Sci-Hub and the various domains it is hosted under.

Which services might be approached by the ACS isn't yet clear: the meaning of the phrase "in active concert or participation with" is open to legal interpretation, says Michael Carroll, an information-justice and intellectual-property specialist at the American University Washington College of Law in Washington, DC.

There are no clear standards as to when an Internet service is in "active concert" with a pirate website, says Carroll. A user merely resolving a domain-name request to such a site, for example, does not yet qualify as active participation, he adds.

Such an order by a US court is exceptional, Carroll says. "In general, our federal courts do not have the power to issue orders against people or entities that were not part of the lawsuit." But he adds that US federal rules for civil procedures such as this do sometimes allow injunctions against persons who are in 'active participation' with an enjoined party. The current lawsuit is an example of that, he says.

The ruling is another legal blow for Sci-Hub, which provides free access to millions of paywalled research papers and is popular with researchers around the world. In June, a New York court granted the Dutch publisher Elsevier $15 million in damages from the site for large-scale copyright infringement.

But publishers are unlikely to see any money from Sci-Hub because its chief operator lives outside the United States. Alexandra Elbakyan, a former neuroscientist who created the portal in 2011, says the court order is an example of censorship.

The ACS, which filed its lawsuit in June in a Virginia court, said in a statement on 6 November that the ruling was "a victory for copyright law and the entire publishing enterprise". An analysis published in August estimated that as of March 2017, Sci-Hub's database contained 69% of the world's roughly 81.6 million scholarly articles — and 98.8% of the ACS's journal content.

The ACS says that it will now seek to enforce the court's order. Asked for comment, the society referred *Nature*'s news team to its statement. But Internet service providers are expected to resist what they may perceive as

undue censorship.

Attempts to stop people visiting Sci-Hub face another hurdle, too: the site has an alternative address that can be reached by users of the Tor network, a group of servers that encrypts Internet traffic and disguises its origins. No Internet provider can easily block access to such sites.

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Updates

Updated:

The story has been updated with comments from Alexandra Elbakyan.

Comments

Commenting is currently unavailable.

Genetically modified apple reaches US stores, but will consumers bite?

Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.

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1. 10 November 2017,
2. 14 November 2017

Okanagan Specialty Fruits, Inc.

The apple on the right doesn’t bruise when dropped — it lacks a gene encoding an enzyme that causes plant cells to brown on exposure to oxygen.

This month, bags of sliced apples will hit grocery-store shelves in the

midwestern United States for the first time. Shoppers who purchase the apples can leave the slices out for snacking, because of a feat of genetic engineering that prevents their flesh from browning when exposed to air.

The ‘Arctic apple’ is one of the first foods to be given a trait intended to please consumers rather than farmers, and it joins a small number of genetically modified organisms (GMOs) to be sold as a whole product, not an ingredient. Since Okanagan Specialty Fruits in Summerland, Canada, planted its first test apples in 2003, the array of foods modified in labs has expanded to include meatless burgers, made with soya protein produced by recombinant yeast, fish fillets grown from seafood stem cells, and mushrooms whose genomes have been edited with CRISPR technology. Most of these items have not yet reached the market.

Now, many small biotechnology companies developing such foods are watching the Arctic apple’s launch, eager for clues to how consumers will perceive the fruits of their labour.

“If the apple sells, it will pave the way for others,” says Yinong Yang, a plant pathologist at Pennsylvania State University in University Park, who used CRISPR to engineer a mushroom that resists browning. He hopes one day to license his mushroom to commercial growers.

Mary Maxon, who oversees biosciences programmes at Lawrence Berkeley National Laboratory in California, agrees. “The apple is not the first GMO that people would eat, but it’s the first one that consumers may value,” she says.

When Okanagan co-founder Neal Carter bought an orchard in 1995, he thought hard about how to win over the US snack market. He found his answer in Australia, where researchers at the Commonwealth Scientific and Industrial Research Organisation had figured out how to delete a gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives.

Only later did he realize that if consumers were to be enticed to buy, Americans’ distrust of GMOs would need to be overcome. Okanagan’s

subsequent surveys of people in America's top apple-growing states — New York and Washington — revealed that about 20% were wary of GMOs. But the company also found that many people changed their minds when told that the apples were engineered to silence browning genes, and then tested for safety.

Mike Selden, the co-founder of Finless Foods, a firm in San Francisco, California, that is developing fish fillets from fish stem cells, agrees that providing more information helps to win over consumers. "We're not going to repeat the mistakes of the GMO industries in the past, and just put foods on the market without public conversation," he says. "If we do, you can expect a backlash — and that's warranted."

Selden sees a parallel between the Arctic apple and his fillets: both were created with attributes to please consumers. Finless Foods, which has made prototypes of bluefin-tuna fillets, hopes that people will be won over by the idea of eating fish without worrying about overfishing, animal slaughter or environmental pollution.

But others say that Okanagan hasn't gone far enough in telling consumers how its apple was made. The company does not mention GMOs on the apples' bags; instead, the bags have a QR code — which links to online information when it is scanned by a smartphone. "Not everyone has a smartphone, and even if you have one, are you going to check every item with it?" says Bill Freese, a science-policy analyst at the Center for Food Safety, an advocacy group in Washington DC. He wants the apples to be clearly labelled as GMOs.

Consumer reaction isn't the only concern for developers of genetically engineered or other lab-made foods who want to sell their wares in the United States. One major stumbling block is the US regulatory process, which involves a complicated tangle of federal agencies — and, for many companies, an unclear path forward. US regulators assessed the Arctic apple for five years before approving it for sale, but spent just two years reviewing a non-browning GM potato developed by agricultural firm J. R. Simplot of Boise, Idaho.

Then there is the case of the CRISPR mushroom. The US Department of

Agriculture (USDA) said in 2016 that it would not evaluate the mushroom, which was created by using CRISPR to delete a gene. That seemed to clear the fungus's path to the market. But Yang says that, after *Nature*'s news team reported on the USDA's decision, the US Food and Drug Administration contacted him to ask whether it could review the mushroom. "I agreed to that since it would give consumers a peace of mind," he says.

As far as investors are concerned, regulatory uncertainty may be less of a barrier to the success of engineered foods than customer uncertainty. James Hardiman, a partner at the venture-capital fund Data Collective in San Francisco, California, says that companies developing such foods can always build a few extra years into their long-term plans, to account for twists in the regulatory process. "The public narrative is much more difficult to control," he says. "We know the public can be irrational."

Still, Carter is optimistic about how his Arctic apple will be received. "We rarely get e-mails saying we are Satan any more," he says of his company. "Now we have people asking where they can buy the apples."

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Corrections

Corrected:

An earlier version of this story stated that Carter took over his family's orchard.

Corrected:

> An earlier version of this story erroneously located Finless Foods in New York City.

Comments

Commenting is currently unavailable.

Nature News

周三, 22 11月 2017

Nature News

[周三, 22 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Black academics soon to outnumber white researchers in South Africa** [周二, 21 11月 08:00]
  Legacy of apartheid means academia has remained largely white.
- **Hungary rewards highly cited scientists with bonus grants** [周二, 21 11月 08:00]
  Some top researchers prosper in Hungary as country tries to improve its international standing in science.
- **Online software spots genetic errors in cancer papers** [周一, 20 11月 08:00]
  Tool to scrutinize research papers identifies mistakes in gene sequences.
- **Sex matters in experiments on party drug — in mice** [周五, 17 11月 08:00]
  Ketamine lifts rodents' mood only if administered by male researchers.
- **Improved diagnostics fail to halt the rise of tuberculosis** [周四, 16 11月 08:00]
  TB remains a big killer despite the development of a better test for detecting the disease.
- **Hazy skies cool down Pluto** [周三, 15 11月 08:00]
  Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.
- **African scientists get their own open-access publishing platform** [周三, 15 11月 08:00]
  Venture will launch next year and seeks to strengthen continent’s science by helping academics share work more quickly.
- **Puerto Rico struggles to assess hurricane’s health effects** [周三, 15 11月 08:00]
  While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.
- **Economics: How science got a golden ticket** [周三, 15 11月 08:00]
  Ehsan Masood hails an account of the mixed implications of governments valuing research as an investment.
- **Computer science: Visionary of virtual reality** [周三, 15 11月 08:00]
  Aldo Faisal explores the immersive journey of technology pioneer Jaron Lanier.

- **China fires up next-generation neutron-science facility** [周二, 14 11月 08:00]
  Beam generator puts country in elite company for doing experiments in materials science and other fields.

Black academics soon to outnumber white researchers in South Africa

Legacy of apartheid means academia has remained largely white.

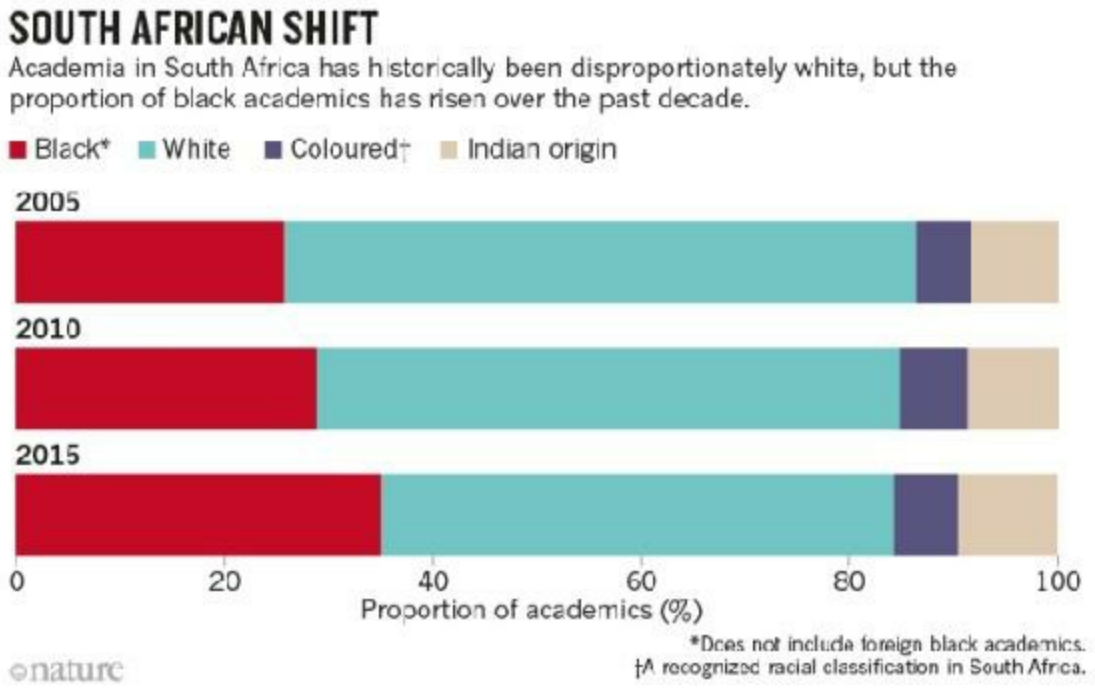
21 November 2017

There will soon be more black academics in South Africa than white ones, a study of demographic data suggests.

Although more than 80% of the country's population is black, its academic sector has remained disproportionately white — a legacy of the apartheid era.

But over the past decade, the proportion of black South African researchers has risen steadily: from 26% in 2005 to 35% in 2015, according to the study, which was published[1] in *Higher Education* last month. The proportion of white academics decreased by more than 10 percentage points over the same period, to 49% in 2015 (see 'South African shift').

"Our research shows that transformation is taking place and there are strong indications that it will accelerate in the future, particularly in the next decade," says David Hedding, a geomorphologist at the University of South Africa in Florida, Johannesburg, and co-author of the paper.



The authors suggest that in the next decade, more than 4,000 researchers — about 27% of the country's academics, and most of them white men — will retire, which should create opportunities for younger researchers. Black researchers could outnumber white ones some time between 2020 and 2025, they say.

Hedding says that it's not possible to attribute the change to a specific policy, but that the government should keep doing what it is currently doing. However, he thinks the country should focus more on nurturing PhD candidates and enticing them into academia. He and his co-author, geoinformatics specialist Greg Breetzke at the University of Pretoria, also note that black women, the country's largest demographic, remain significantly under-represented in universities, accounting for just 14% of academics in 2015.

Charles Sheppard, director of management information at Nelson Mandela University in Port Elizabeth, agrees that South Africa must focus on generating local PhDs. At the moment, it produces more doctorate-holders who hail from other African countries than from the home nation, he says. "We need to work harder on getting this right," he adds.

The latest study is the most well thought out, most evidenced-based and least anecdotal to address this complex problem yet, says Zeblon Vilakazi, deputy vice-chancellor at the University of the Witwatersrand in Johannesburg. “This is a step in the right direction,” says Vilakazi.

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Comments

Comments

There are currently no comments.

Hungary rewards highly cited scientists with bonus grants

Some top researchers prosper in Hungary as country tries to improve its international standing in science.

21 November 2017

Richard Wareham Fotografie/Alamy

Hungarian commissioner for research and innovation József Pálinkás has designed grants that reward research excellence.

Earlier this year, cell biologist Attila Reményi was facing his toughest decision since returning to his native Hungary a decade ago. With his

generous start-up funding about to run out, should he downsize his lab?

Then, in June, the government's National Research, Development and Innovation Office (NRDNI) put out a call for five-year basic-research grants of up to 300 million Hungarian forints (US$1.18 million) each for highly cited scientists such as Reményi. "It came out of the blue," says Reményi at the Hungarian Academy of Sciences (HAS) Research Centre for Natural Sciences, Budapest, who learnt on 13 November that he was among 12 winners.

But for NRDNI president József Pálinkás, the Frontline Research Excellence grants are the result of years of work. They are part of a plan to create a long-term, systematic plan of grants and rewards to encourage researchers in all fields to strive for world-class publications and to tempt Hungarian scientists working abroad to return. In a country whose leaders are coming under increasing criticism for autocratic and xenophobic tendencies, scientists say that the situation for science has never been rosier.

Under Viktor Orbán's nationalist government, this small, post-communist country has been steadily falling on *The Economist* magazine's Democracy Index. Last year, several foreign members of the HAS resigned, citing the failure of the academy to protest against what they saw as anti-democratic moves by the government. HAS president, mathematician László Lovász, responded that the academy is not a political organization. Scientists in the country are noticeably reluctant to comment publicly on politics, and several young researchers told *Nature* they fear that criticizing the government might compromise their careers.

Yet within this troubled political environment, Pálinkás, a physicist, has spent the past few years quietly persuading the government that basic science matters as much as product-focused research. Shortly after becoming president of the HAS in 2008, he created the Momentum system of start-up funding — one-time, five-year grants of up to 50 million forints per year — to encourage Hungarian scientists to set up independent labs back home. Reményi was a Momentum recipient in 2013.

In 2015, Pálinkás left HAS to become the founding director of the NRDNI, where he designed a system of regular grants to help ensure that returnees

stay after the start-up money runs out. The frontline grants are a key part of this, giving the recipients salaries equivalent to the European Union average, which is two-and-a-half times higher than the salary that a scientist would normally earn in Hungary. Around 50 of these grants will eventually run each year. The programme is modelled on European Research Council grants, but with a twist: only those who have published a paper in the past five years that counted among the top 10% most-cited papers in their discipline are eligible to apply. This approach “creates a lot of tension in the community, but without such serious selection science won’t work well,” says Pálinkás. To further encourage scientists to aim for quality over quantity, last year he introduced another reward for high-impact publication: researchers who within two years have a paper among the top 5% most highly cited in their field automatically receive a one-off payment of 20 million forints.

Hungary has a long tradition of research and outperforms other former communist countries in the EU on many measures. It has won more European Research Council grants and was the only country this year to win two Teaming grants: prestigious EU awards to create centres of excellence in 15 mostly eastern European countries in partnership with a western European research organization. It has also made some large investments, most generously in the Hungarian Brain Research Programme, launched in 2014, which has received 18.5 million forints up to 2021 and enabled many principal investigators to start their own labs. A 3-billion-forints programme has just been agreed in quantum technology. Five new programmes in areas including artificial intelligence and water research will be added next year, thanks to a 3% increase in the NRDNI budget, agreed in principle this month.

Hungary’s research performance still lags behind that of science-strong western European countries, however, and at 1.2% of gross domestic product, its research investment is well below the EU average of 2%. To support its scientific ambitions, Hungary has heavily invested its EU structural funds — subsidies to poorer regions — in expanding research infrastructure. The country’s scientists fear that when the current round of these funds runs out in 2019, these major investments may go to waste.

Pálinkás says that to avoid this, he will request a doubling of the national research budget in 2019. And despite the political challenges, Hungarian

scientists seem optimistic: “The situation for science is better than it has been before,” says Reményi. Immunologist Adam Dénes returned from the United Kingdom in 2012 to start his own lab at the HAS Institute of Experimental Medicine in Budapest, a move he describes as a “political, philosophical and career challenge”. But for now, he says, “the pluses are more than the minuses.”

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There are currently no comments.

Online software spots genetic errors in cancer papers

Tool to scrutinize research papers identifies mistakes in gene sequences.

20 November 2017

Two scientists have rolled out a program that spots incorrect gene sequences reported in experiments — and have used it to identify flaws in more than 60 papers, almost all of them studies of cancer.

Jennifer Byrne, a cancer researcher at the Kids Research Institute of the Children's Hospital at Westmead in Sydney, Australia, and Cyril Labbé, a computer scientist at the University of Grenoble Alpes in Grenoble, France, made public an early version of the program, called Seek & Blastn, in October and now they want other researchers to test the program and help to improve it. They then plan to offer it to journal editors and publishers as an addition to the tools that most already use to check papers, such as software

to detect plagiarism.

Byrne has been working on identifying errors in human cancer papers since 2015, when she noticed problems with five papers on gene function in cancer cells. The authors of the papers described performing a common experiment in which they inactivated a gene using a short targeted nucleotide sequence, to observe its effects on tumour cells. Byrne was familiar with the gene because she was part of the team that reported it in 1998. And she realized that the papers reported using the wrong nucleotide sequences for the experiment they claimed to conduct. Two of these papers have since been retracted. Another two are expected to be retracted on 21 November.

Experimental errors

After noticing similar errors in another 25 papers, Byrne and Labbé developed the Seek & Blastn tool to discover more papers with incorrectly identified nucleotide fragments. The software extracts nucleotide sequences from uploaded papers and cross-checks them against a public database of nucleotides, called the Nucleotide Basic Local Alignment Search Tool (Blastn).

“Seek & Blastn tries to find mismatches between the claimed status of a sequence — what the paper says it does — and what the sequence actually is,” says Byrne. A mismatch is flagged, for instance, when a sequence described as targeting a human gene doesn’t find a match in the Blastn database. Sequences described as non-targeting that do have a match in the Blastn database are also detected.

So far, the program detects only misidentified human sequences, says Labbé, but the pair hope to develop it to check sequences from other species, such as mice. The program also struggles to pick up misidentified sequences if the description is unclear in the original paper. This can cause the program to miss some mistakes and to flag papers that have no errors, so all papers put through the software should also be checked manually, he says.

The pair say that they used Seek & Blastn to detect mismatched sequences in

another 60 papers. Many of these manuscripts have other problems, such as poor-quality images, graphs and large chunks of overlapping text, all of which make some of the papers “strikingly similar” to each other, says Byrne. With the help of colleagues, they are now manually checking the papers.

Although some errors are minor or accidental, Byrne says the majority of the mismatches they have detected in papers may invalidate the results and conclusions. When you see these incorrectly identified sequences, she says, “you do get concerned about how the results were produced and whether the results in the paper actually reflect the experiments that were done”.

In a 2016 study[1] in *Scientometrics*, Byrne and Labbé reported 48 problematic papers, including the 30 papers that had incorrectly identified nucleotide fragments. These were all written by authors from China. The duo did not publicly identify the papers, apart from the five papers from 2015, but privately contacted journal editors, Byrne says. Many of the editors have not responded, she says. But three more papers have been retracted. In total, the pair have identified incorrect sequences in more than 90 papers.

Automated tools such as Seek & Blastn are most valuable if they are used to promote good scientific practice and encourage scientists to avoid errors in the first place, rather than just catch people out, says statistician David Allison at Indiana University in Bloomington, who has spotted many papers with substantial errors. Such tools could also help to quantify error rates in particular journals and fields, he says.

Matt Hodgkinson, head of research integrity for open-access publisher Hindawi in London, which retracted two of the papers from its journal *BioMed Research International*, says he could see publishers using Seek & Blastn as part of the article-screening process. “It would depend on the cost and ease of use, whether it can be used and interpreted at scale,” says Hodgkinson. Staff or academic editors would also need to check the output, given the risk for false positives, he says.

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Comments

Commenting is currently unavailable.

Sex matters in experiments on party drug — in mice

Ketamine lifts rodents' mood only if administered by male researchers.

17 November 2017

unoL/Getty

When it comes to lab mice and antidepressants, it's complicated.

Mouse experiments with the popular club drug ketamine may be skewed by the sex of the researcher performing them, a study suggests.

The findings, presented on 14 November at the Society for Neuroscience (SfN) meeting in Washington DC, only deepen the mystery of how ketamine,

which has powerful mood-lifting properties, interacts with the brain. They also raise questions about the reproducibility of behavioural experiments in mice.

Ketamine is best known as a psychoactive recreational drug. But it has caught psychiatrists' interest because of its potential to treat depression within hours. It's unclear exactly how the drug works, however, and many researchers are using animal models to suss out the mechanism.

Polymnia Georgiou, a neuroscientist at the University of Maryland in Baltimore, is one of them. In 2015, a male colleague asked her to run some experiments for him while he was out of town, including a standard way of testing antidepressants called the forced-swim test. In this assay, researchers inject healthy mice with a drug, place them into a tank of water and measure how long they swim before they give up and wait for someone to rescue them.

Antidepressants can cause healthy mice to swim for longer than their untreated counterparts, which is what Georgiou's male colleague found during his experiments using ketamine.

Scents and the brain

But although Georgiou followed his protocol exactly, she found that treated mice did not swim for any longer than mice injected with a placebo. When she and three female and four male researchers investigated this disconnect by performing the experiments, they discovered that the ketamine acted as an antidepressant only when it was administered by men.

Suspecting that scent was involved, the researchers put the animals inside a fume hood so that the mice couldn't smell who was injecting them. This completely eliminated the effect of the ketamine, regardless of the experimenter's sex. When Georgiou and her colleagues placed a t-shirt worn by a man next to the mice in the fume hood, mice injected with ketamine swam for longer than those injected with a placebo. This suggested that male odour was necessary for the drug to work.

The head of Georgiou's lab, neuroscientist Todd Gould, learned that antidepressant researcher Ronald Duman at Yale University in New Haven, Connecticut, was seeing similar effects with female researchers in his lab that were working on ketamine experiments. So Gould asked Duman to repeat Georgiou's swim-test experiment in his own lab. When eight male and eight female researchers injected mice with ketamine, they saw the same results: mice injected by women did not respond to the drug.

Georgiou and her colleagues repeated the experiments with other antidepressants, but the researchers' sex didn't seem to matter. She and Gould suspect that the antidepressant effect is the result of a specific interaction between ketamine and the male odour in the mouse brain .

But other evidence suggests that the sex of the researcher can affect other types of behavioural experiment, not just those involving ketamine. A 2014 paper[1] in *Nature Methods* found that mice were more stressed and less likely to respond to pain when handled by a male researcher. And behavioural neuroscientist Silvana Chiavegatto of the University of São Paulo in Brazil, who was at Georgiou's SfN presentation, says that she has seen the same phenomenon in her lab, where she studies depression but doesn't use ketamine.

Rethinking the model

"I think it's really fascinating, with wide implications for our field," says Adrienne Betz, a behavioural neuroscientist at Quinnipiac University in Hamden, Connecticut. But she cautions that the results are preliminary, and it remains to be seen whether the effect is specific to ketamine and to mice.

Others disagree about the potential implications. Hundreds of papers with female experimenters demonstrate the effects of antidepressants — including ketamine — in mice, says Lisa Monteggia, a neuroscientist at the University of Texas Southwestern in Dallas. Other factors, such as whether the researcher is stressed when he or she injects the mice, might affect the animals' behaviour, she says.

Gould and Georgiou say that their results don’t necessarily invalidate previous studies; they simply show that ketamine experiments in their lab work only when men inject the mice. There is overwhelming evidence that ketamine is a powerful antidepressant in humans. Gould doubts that the sex of the person administering the drug affects how well it works in a depressed patient, but it's never been tested.

He adds that the findings suggest that researchers studying drugs' effects on mouse behaviour should report the sex of the experimenter in their publications to ensure that other labs can replicate the results. “There are a number of factors that influence replicability and are unrecognized — this is one of them,” Gould says. “For us, it is an inconvenient truth.”

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Comments

Comments

There are currently no comments.

Improved diagnostics fail to halt the rise of tuberculosis

TB remains a big killer despite the development of a better test for detecting the disease.

16 November 2017 Corrected:

1. 17 November 2017

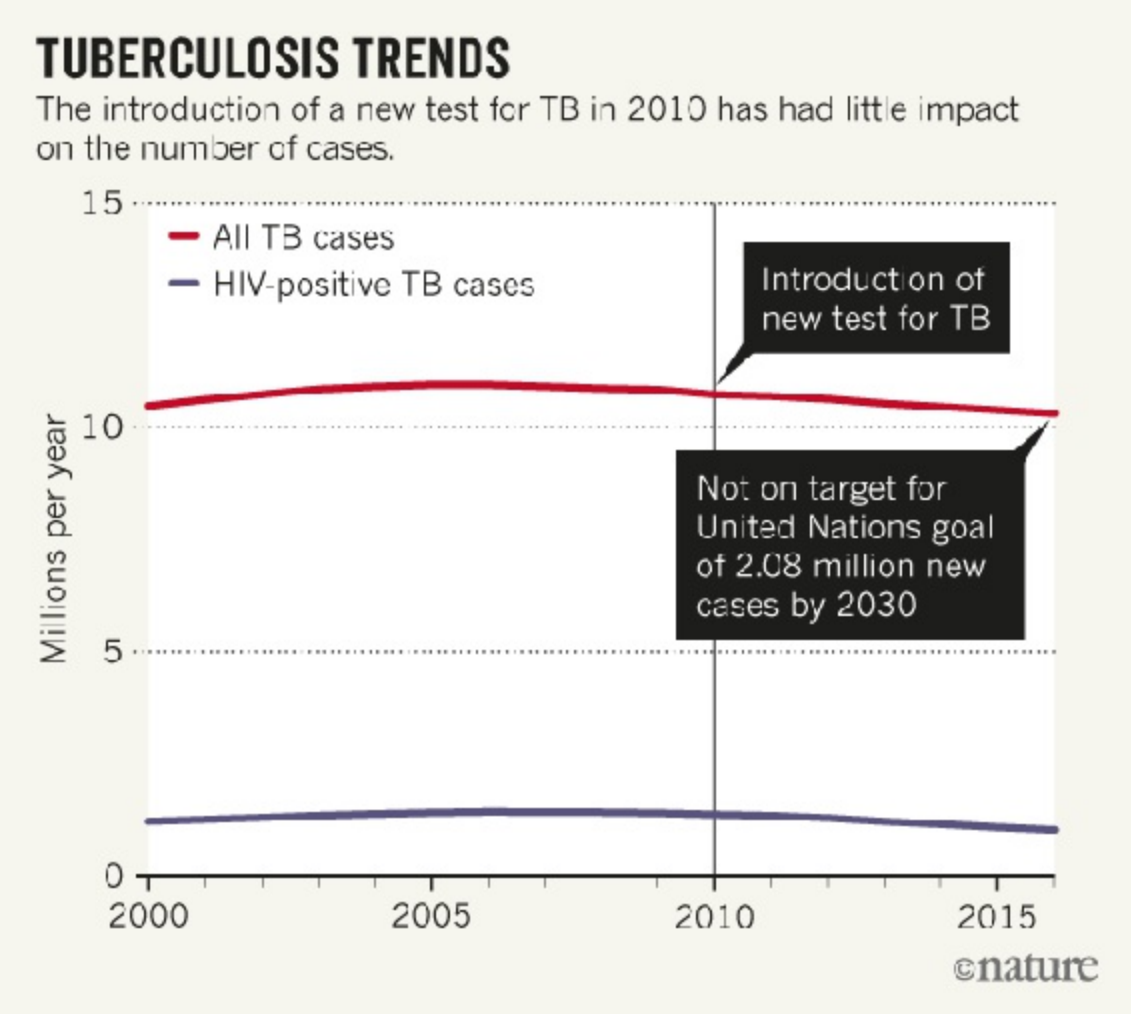
Beawiharta/Reuters

Newly diagnosed tuberculosis patients are treated at a clinic in Jakarta, Indonesia.

Seven years ago, the global community of researchers, health-care workers and activists battling tuberculosis was euphoric. A landmark 2010 trial showed that a new genetic test was highly effective at diagnosing TB, prompting hopes that countries could soon finally control the disease, which killed 1.45 million that year. The World Health Organization (WHO), promptly endorsed the test, called GeneXpert, and promoted its roll-out around the globe to replace a microscope-based test that missed half of all cases.

But the high hopes have since crashed as rates of tuberculosis rates have not fallen dramatically, and nations are now looking to address the problems that cause so many TB cases to be missed and the difficulties in treating those who are diagnosed. In an attempt to turn the tide, health ministers and officials from 100 countries are meeting in Moscow on 16–17 November. And a United Nations General Assembly devoted to TB is scheduled for September 2018. Experts say that the rollout of GeneXpert offers a cautionary lesson — although, in hindsight, an obvious one — in the battle against TB. The tale is a familiar one in global health care: a solution that seems extraordinarily promising in the lab or clinical trials falters when deployed in the struggling health-care systems of developing and middle-income countries.

“What GeneXpert has taught us in TB is that inserting one new tool into a system that isn’t working overall is not going to by itself be a game changer. We need more investment in health systems,” says Erica Lessem, deputy executive director at the Treatment Action Group, an activist organization in New York City.



Source: WHO

No game changer

Some 10.4 million people were infected with TB last year, according to a WHO report published on 30 October. More than half of the cases occurred in China, India, Indonesia, Pakistan and the Philippines. The infection, which causes coughing, weight loss and chest pain, often goes undiagnosed for months or years, spurring transmission. The US government and others spent more than US$100 million developing GeneXpert. Yet despite the WHO's ringing 2010 endorsement of the test, the roll-out of GeneXpert, which is manufactured by Cepheid, a company based in Sunnyvale, California (and

bought by Danaher, headquartered in Washington DC, earlier this year), was initially slow.

The machines cost $17,000 each and require constant electricity and air-conditioning — infrastructure that is not widely available in the TB clinics of countries with a high incidence of the disease, requiring the machines to be placed in central facilities. Until the US government together with the Bill & Melinda Gates Foundation and UNITAID, an international organization that aims to lower drug prices, began subsidizing tests in 2012, each cost $16.86 (the price fell to $9.98), compared with a few dollars for a microscope TB test.

Weak health systems

The WHO says that more than 23 million GeneXpert tests have now been purchased in the public sector in 130 countries that are eligible for the discount. But Madhukar Pai, an epidemiologist at McGill University in Montreal, Canada, says that this still represents a relatively small proportion of people suspected of having TB. Most countries use the tests on selected group of people, Pai says. India, for example, offers the test only to people co-infected with HIV.

Even countries that fully embraced GeneXpert are not seeing the returns they had hoped for. After a countrywide roll-out begun in 2011, the test is available for all suspected TB cases in South Africa. But a randomized clinical trial conducted in 2015 during the roll-out found that people diagnosed using GeneXpert were just as likely to die from TB as those diagnosed at labs still using the microscope test[1]. “Just intuitively one would think that finding TB cases earlier would avert TB deaths. The fact that we didn’t find that was surprising,” says Gavin Churchyard, a physician specializing in TB at the Aurum Institute in Johannesburg, South Africa, who led the study. Similar studies in other countries have come to much the same conclusion about GeneXpert.

Churchyard suspects that doctors have been giving people with TB-like symptoms drugs, even if their microscope test was negative or missing, and

that this helps to explain why his team found no benefit from implementing the GeneXpert test. Others have speculated that, by being involved in a clinical trial, patients in both arms of the trial received better care than they would otherwise have done, obfuscating any differences between the groups.

Either way, Churchyard says, his team's study illustrates how broken South Africa's TB treatment system is, a problem echoed across other countries with high incidences of TB. Even with accurate tests, cases are still being missed. Results from the GeneXpert tests take just as long to deliver as microscope tests, and many people never return to the clinic to get their results and drugs; those who begin antibiotics often do not complete the regimen. "What the study really unmasked was that it's not enough to have new technology and introduce it into a weak health system," Churchyard says.

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Corrections

Corrected:

An earlier version of this story gave the wrong citation for the 2015 trial.

Comments

Commenting is currently unavailable.

Hazy skies cool down Pluto

Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.

15 November 2017

NASA/JHU-APL/SwRI

The temperature of Pluto's atmosphere is only about 70 degrees Celsius above absolute zero.

Pluto’s atmosphere is even more bone-chillingly cold than one might expect 5 billion kilometres from the Sun. New research suggests that’s because of the smog that envelops the dwarf planet.

“Haze is responsible for all the atmospheric cooling,” says Xi Zhang, a planetary scientist at the University of California in Santa Cruz. He and his colleagues describe the findings in the 16 November issue of *Nature*[1].

When NASA's New Horizons spacecraft flew past Pluto in July 2015, it discovered that the atmosphere was about -203 ºC, just 70 degrees above absolute zero[2]. That's around 30 degrees colder than predicted — and a big mystery to planetary scientists.

Figuring out how Pluto's atmosphere works is crucial for understanding atmospheres on other large icy worlds in the Solar System and beyond. "Until we know the reason for the cold temperatures, we can't extrapolate to other seasons on Pluto, much less other bodies," says Leslie Young, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, who was not involved in the study.

Smog blanket

Pluto's atmosphere is made mostly of nitrogen, with smaller amounts of compounds such as methane. High in the atmosphere — between 500 and 1,000 kilometres above the surface — sunlight triggers chemical reactions that transform some of these gases into solid hydrocarbon particles.

The particles then drift downward and, at around 350 kilometres above Pluto's surface, clump with others to form long chemical chains. By the time they reach 200 kilometres' altitude, the particles have transformed into thick layers of haze, which the New Horizons spacecraft saw dramatically blanketing Pluto.

Zhang and his colleagues compared the heating and cooling effects of the atmosphere's gas molecules to those of its haze particles. Earlier studies have suggested that the presence of gas molecules, such as hydrogen cyanide, could help explain why Pluto's atmosphere is so cold[3]. But Zhang's team found that including haze was the only way to get their model to match the temperatures that New Horizons measured as it flew by the dwarf planet.

"The fundamental difference is the size," Zhang says. Molecules are typically less than a nanometre across, whereas the haze particles are several hundred nanometres across. That means that the gas and the haze behave very differently in the way they absorb and re-radiate energy from the Sun. Haze

turns out to both heat up and cool down more efficiently than gas, Zhang says.

“It is a neat idea,” says Sarah Hörst, a planetary scientist at Johns Hopkins University in Baltimore, Maryland.

Scientists probably hadn't thought about haze as the cooling culprit before because the haze layers do not block light, says Tanguy Bertrand, a planetary scientist at the Laboratory for Dynamic Meteorology in Paris who has studied Pluto's atmosphere with his colleague François Forget[4]. “I find this study very convincing,” Bertrand says.

Competing ideas

But other researchers have proposed different ideas about why Pluto’s atmosphere is so cold. Roger Yelle, a planetary scientist at the University of Arizona in Tucson, reported one such approach at a conference in Latvia in September. His team’s model suggests that a combination of hydrogen cyanide, acetylene and ethane gas can cool things down. All three gases are known to exist in Pluto’s atmosphere.

Zhang’s team and Yelle’s team have yet to reconcile their contradictory conclusions. But after it launches in 2019, NASA’s James Webb Space Telescope could test Zhang's proposal. If the haze particles are indeed the main factor cooling Pluto’s atmosphere, they would make the dwarf planet appear relatively bright in mid-infrared wavelengths. Zhang hopes to observe Pluto with the Webb telescope to see if his team is right.

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Comments

Comments

There are currently no comments.

African scientists get their own open-access publishing platform

Venture will launch next year and seeks to strengthen continent's science by helping academics share work more quickly.

15 November 2017

Africa's academy of science has announced that it will launch an open-access publishing platform early next year — the first of its kind aimed exclusively at scientists on the continent.

The platform, called *AAS Open Research* and announced by the African Academy of Sciences (AAS) in Nairobi on 15 November, is being created with the London-based open-access publisher F1000, adopting the model of its *F1000Research* publishing platform. *AAS Open Research* will publish articles, research protocols, data sets and code, usually within days of submission and before peer review. F1000 staff will arrange post-publication peer review: the reviews and the names of their authors will be published alongside the papers. The papers will be indexed in abstract databases such as PubMed only after they pass review.

The AAS says that the platform will be especially useful for young African academics, who can face difficulties publishing in overseas journals. Some studies suggest[1] that research from low-income countries is perceived differently from that done in high-income ones, for instance. The portal will cut the time and effort scientists have to put into finding homes for their work, and will make the review process more transparent, the academy says.

Although there are already open-access publishers that focus on Africa, such as AOSIS Publishing, based in South Africa, *AAS Open Research* will be the first to adopt open peer review.

The new platform does carry a caveat, however: it will initially take submissions only from AAS fellows and affiliates (who together number around 400), as well as researchers funded through programmes managed by the Alliance for Accelerating Excellence in Africa. The Nairobi-based body manages grants for African research programmes that come from international funders, mostly targeting health research but also areas such as climate change.

Limiting eligibility to the platform is critical to ensure that submissions are of high quality, says AAS executive director Nelson Torto. Researchers who meet the initial criteria have already been vetted and selected through a rigorous grant-review process, he says. In future, to open up the platform to more researchers, the academy wants to partner with other African research funders whose selection processes are similarly rigorous, Torto adds.

Following a trend

The African venture follows a series of open publishing portals launched with F1000 in the past 18 months, including those set up by the Wellcome Trust in London and the Bill & Melinda Gates Foundation in Seattle, Washington — both large charities that fund scientific research. Research centres including the UCL Great Ormond Street Institute of Child Health and the Montreal Neurological Institute and Hospital in Canada have also teamed up with the firm; the European Commission is considering creating its own open publishing platform for outputs from its main Horizon 2020 research programme.

The AAS will not itself be covering the costs of publishing on the platform. Rather, the academy says, African researchers' grant funders will pay publishing fees directly to F1000: £120–800 (US$160–1,100) per article, depending on length.

Some scientists have raised concerns that publishing on open-research platforms might stop African academics from getting the recognition needed for career advancement that they receive for publishing in conventional journals. In South Africa, for instance, academics are rewarded for publishing

in a list of titles maintained by the country's higher-education department.

"For open publishing to be successful, it will need to be accompanied by changes in the criteria for academic recognition and promotion within African institutions of higher learning," says Salim Abdool Karim, an HIV researcher and AAS fellow in Durban, South Africa.

The risk of publishing on little-known platforms is a concern, agrees Gordon Awandare, a biochemist at the University of Ghana in Accra who will be eligible to publish on *AAS Open Research*. However, the AAS platform will help to chip away at the grip of the big journals, says Awandare, which will be good for African science. "Our approach has always been to spread our research across several platforms, so we will continue to do that."

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Comments

1 comment

1. *PROF CHUKWUEMEKA CH AGBAKWURU* • 2017-11-16 06:15 PM
   The African Scientists Open-Access Publishing Platform is a very welcomed innovation to give African Researcher (International & National) the much needed opportunity of making worthwhile intellectual contributions to African and World Development through publishing of their research studies.
   www.mastercomputeragency.net

Puerto Rico struggles to assess hurricane’s health effects

While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.

15 November 2017

Mario Tama/Getty

Hurricane Maria, which hit Puerto Rico in mid-September, disrupted water supplies in some areas.

Nightfall sets a hard deadline for a team of public-health researchers in Puerto Rico. Since Hurricane Maria hit on 20 September, leaving large swathes of the island without a reliable power supply, the scientists have

rushed home each night to avoid being in the streets after dark. Many lack running water, and most have limited telephone access.

Yet the team —– co-led by José Cordero of the University of Georgia in Athens — has managed to contact several hundred women to begin assessing whether Hurricane Maria has worsened drinking-water contamination, stress and infectious disease that could harm developing fetuses. This wasn't what the researchers set out to study six years ago when they started a project to assess the impact of pollution on pre-term births. But Cordero's team is one of several research groups have scrambled to quantify Hurricane Maria's immediate health impacts, even as team members struggle to fulfil their own basic needs.

The devastation that Cordero saw on a recent visit to Puerto Rico, his birthplace, shocked him. "I thought I was prepared, but I wasn't," he says.

Even before the hurricane, the island's 18 'Superfund' sites — areas so polluted that the US Environmental Protection Agency deems them hazardous to human health or the environment — posed a potential risk to pregnant women, says Ingrid Padilla, an environmental engineer at the University of Puerto Rico at Mayagüez. Twelve of these sites sit on karst, a geological formation made of porous rock that allows toxic chemicals to flow down from the surface into groundwater.

Padilla's previous research suggests that flooding and other disturbances can quickly bring toxic substances in groundwater back to the surface, and carry them into the water supply. Now, she and her colleagues are collecting hair and blood samples from the research cohort to determine whether pregnant women are being exposed to hazardous chemicals, such as phthalates and chloroform. Since the hurricane hit, the researchers have begun to collect and test groundwater from karst regions and tap water from the homes of people living there.

Other research teams are worried that water that has pooled in hurricane debris could provide a breeding ground for disease-carrying mosquitoes. At the height of the Zika epidemic in 2016, experts debated whether a massive hurricane would destroy mosquito habitat or enhance it, says Carmen Zorrilla, an obstetrician and gynaecologist at the University of Puerto Rico in

San Juan. The evidence is still unclear, she says, and logistical problems may make it impossible for researchers to gather enough data to provide answers.

In some areas where hospitals faced extensive storm damage, the only medical care available is emergency treatment. Screening for the Zika virus is a low priority, and infected adults rarely experience severe symptoms and are unlikely to seek medical treatment.

There are also few labs on the island that can test samples for Zika and other mosquito-borne diseases. Like many Puerto Rican facilities, the US Centers for Disease Control and Prevention (CDC) dengue lab in San Juan lost power during the hurricane and was closed for a week. Diesel generators kept its freezers running to preserve blood and other biological samples, but the lab is still running on generator power and is behind on testing some samples. Shipping delays destroyed reagents that the lab had ordered, since the chemicals were not kept consistently cold during transport.

Lab director Stephen Waterman says that the CDC is collecting data on the incidence of mosquito-borne disease and other hurricane impacts. But its priority is to help US government workers and local communities recognize mosquito breeding grounds, and to provide technical help on efforts to control the spread of the insects. Agency staff would also like to verify reports that leptospirosis — a waterborne bacterial disease that is spread by rats — has sickened dozens of people. “We’re focused on preventing disease,” Waterman says.

Yet the ruined facilities and lack of power continue to tax public-health workers’ ability to know where hazards lie. Take the numerous diesel generators running on the island, which produce visible plumes of grey smoke. Benjamin Bolaños, a microbiologist at the University of Puerto Rico in San Juan, worries that these emissions could harm people with respiratory illnesses, but that the effect will be difficult to quantify. “We are blind because probably the [air quality] monitors were destroyed by the hurricane,” he says.

This makes the prospect of more months without reliable power even more frightening. "The kind of work we’re doing is not because it would be interesting to do,” Cordero says. “It has to be done now because a few years

from now, it’s too late.”

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Comments

There are currently no comments.

China fires up next-generation neutron-science facility

Beam generator puts country in elite company for doing experiments in materials science and other fields.

14 November 2017

Jin Liwang/Xinhua via ZUMAPRESS

Engineers work on an instrument at the China Spallation Neutron Source in Dongguan.

China is revving up its next-generation neutron generator and will soon start experiments there. That will lift the country into a select group of nations with facilities that produce intense neutron beams to study the structure of

materials.

The China Spallation Neutron Source (CSNS) in Dongguan, a 2.2-billion-yuan (US$331-million) centre, will allow the country's growing pool of top-notch physicists and material scientists, along with international collaborators, to compete in multiple physics and engineering fields. Its designers also hope that the facility will lead to commercial products and applications ranging from batteries and bridges to aeroplane engines and cancer therapy.

"It is not only a big step forward for Chinese scientists, but also a significant event for the international scientist community," says Wang Xun-Li, a physicist at the City University of Hong Kong who has been involved in planning the facility.

Beam bombardment

Spallation neutron sources produce neutrons by slamming protons onto a metal target — CSNS uses tungsten. They are more cost effective and safer than other methods, which use nuclear reactors to produce neutron beams. As neutrons have no charge, they can penetrate materials more easily than some other probing methods, and they are more sensitive to light elements such as hydrogen, making them useful for evaluating candidate materials for fuel cells. Similar facilities exist only in the United Kingdom, United States, Japan and Switzerland, and one is under construction in Sweden.

Fujio Maekawa, a specialist in neutron sources at the Japan Proton Accelerator Research Complex in Tokaimura, says that although the CSNS delivers neutrons at a lower density than other spallation sources — which means that experiments will take longer — a planned upgrade will bring it in line with other facilities. And given their scarcity, "neutron users around the world always welcome new sources", he says.

The CSNS will have capacity to host 20 beam lines, supplying as many instruments. Preliminary tests of its first three instruments began on 1 November. "Neutrons arrived at the samples as expected," says Wang

Fangwei, head of the neutron-science division at CSNS. Although debugging might take a couple of years, he expects the instruments to be calibrated and ready for initial experiments by the end of 2017.

Chinese physicists are eager to use the facility to analyse the underlying magnetic properties of materials, an area in which the country has significant experience. Wang Xun-Li says that several planned instruments will give scientists the chance to move to the forefront of fields such as the physics of skyrmions — vortex-like excitations in magnetic materials — and high-temperature superconductivity. “There are a whole bunch of early- to mid-career scientists who are hungry to use the facility for studying magnetism,” says Wang Xun-Li.

Global appeal

Wang Xun-Li thinks that the latest facility will encourage Chinese researchers to remain in the country instead of pursuing careers elsewhere. “In the past, it was common to see Chinese scientists go abroad for these kinds of studies,” he says.

The facility’s first instruments are also attracting international researchers. German material scientist Frank Klose says that the CSNS was a major factor when he and material scientist Christine Rehm, his wife, decided to join the new Guangdong Technion Israel Institute of Technology in Shantou, 400 kilometres east of Dongguan. Klose’s research focuses on designing data-storage devices and sensors that could be used in hydrogen-powered cars. He helped design one of the facility's instruments to investigate the magnetic properties of spintronic devices, which take advantage of the spin of electrons to store data.

But scientists contacted by *Nature* have raised concerns about CSNS’s location, saying that Dongguan lacks services and infrastructure, such as schools and universities, that will persuade top scientists and their families to move there. “I believe CSNS is suffering from a lack of first-grade scientists who actually are based in Dongguan,” says a researcher familiar with the facility, who asked for anonymity because of the sensitivity of the issue.

Potential users have also expressed some frustration that only 3 instruments will be ready this year, despite the facility’s capacity to host 20.

But more instruments are already being built. Shenzhen's government is funding two that are expected to be ready by the end of 2019, including one designed to model high-pressure environments, such as the Earth's core. Mao Ho-Kwang, a geophysicist at the Carnegie Institution for Science in Washington DC, is keen to use it to simulate what happens to materials in high-pressure conditions. “The CSNS instruments will be a great asset for Earth, environmental and energy science, as well as physics, chemistry and material science,” says Mao. “I am very excited, and the whole neutron community is getting very excited too”.

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Nature News

周四, 09 11月 2017

Nature News

[周四, 09 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **UK government appoints next chief scientific adviser** [周三, 08 11月 08:00]
  A former pharmaceutical boss will help navigate the UK's exit from the European Union.
- **Skin regeneration with insights** [周三, 08 11月 08:00]
  A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.
- **Too many academics study the same people** [周三, 08 11月 08:00]
  Researchers should recognize communities that feel over-researched and under-rewarded.
- **Grant recipients can still give objective advice** [周三, 08 11月 08:00]
  The US environment agency should not ban researchers it funds from its advisory boards.
- **Rohingya refugees, Bulgarian protests and a prize for negative results** [周三, 08 11月 08:00]
  The week in science: 3–9 November 2017.
- **Dark-matter hunt fails to find the elusive particles** [周三, 08 11月 08:00]
  Physicists begin to embrace alternative explanations for the missing material.
- **The bitter battle over the world’s most popular insecticides** [周三, 08 11月 08:00]
  As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.
- **Four ethical priorities for neurotechnologies and AI** [周三, 08 11月 08:00]
  Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.
- **The catalogue that made metrics, and changed science** [周三, 08 11月 08:00]
  As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.
- **Polar exploration: The forgotten journey** [周三, 08 11月 08:00]
  Huw Lewis-Jones revisits a pioneering, ill-fated expedition to map the Arctic.
- **Books in brief** [周三, 08 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.

- **Indian scientists urged to speak out about pseudoscience** [周二, 07 11月 08:00]
  Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.
- **Pirate paper website Sci-Hub dealt another blow by US courts** [周二, 07 11月 08:00]
  American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.
- **Genetically modified apple reaches US stores, but will consumers bite?** [周二, 07 11月 08:00]
  Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.
- **US government approves 'killer' mosquitoes to fight disease** [周一, 06 11月 08:00]
  US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.
- **Language patterns reveal body's hidden response to stress** [周一, 06 11月 08:00]
  Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.
- **US government report says that climate change is real — and humans are to blame** [周五, 03 11月 08:00]
  Conclusions of climate-change science analysis are at odds with US President Donald Trump’s policies.
- **Energy researcher sues the US National Academy of Sciences for millions of dollars** [周五, 03 11月 08:00]
  Rare move stems from a conflict over two journal articles about renewable energy.
- **Gut microbes can shape responses to cancer immunotherapy** [周四, 02 11月 08:00]
  Studies find that species diversity and antibiotics influence cutting-edge treaments.
- **Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid** [周四, 02 11月 08:00]
  Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.
- **Controversial chairman of US House science committee to retire** [周四, 02 11月 08:00]
  Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.
- **Newly discovered orangutan species is also the most**

endangered [周四, 02 11月 08:00]

The first new species of great ape described in more than eight decades faces threats to its habitat.

- ## Infusions of young blood tested in patients with dementia [周三, 01 11月 08:00]

  The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.

- ## Citation is not the only impact [周三, 01 11月 08:00]

  A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.

- ## University systems allow sexual harassers to thrive [周三, 01 11月 08:00]

  It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen.

- ## Interstellar visitor, Arctic shipwrecks and a retraction recommendation [周三, 01 11月 08:00]

  The week in science: 27 October–2 November 2017.

- ## Plans to promote German research excellence come under fire [周三, 01 11月 08:00]

  Critics say selection process for high-stakes funding programme is flawed.

- ## The new thermodynamics: how quantum physics is bending the rules [周三, 01 11月 08:00]

  Experiments are starting to probe the limits of the classical laws of thermodynamics.

- ## Join the disruptors of health science [周三, 01 11月 08:00]

  Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.

- ## Astrophysics: Chasing ghosts in Antarctica [周三, 01 11月 08:00]

  Alexandra Witze welcomes a history of IceCube, an ambitious neutrino observatory.

- ## Books in brief [周三, 01 11月 08:00]

  Barbara Kiser reviews five of the week's best science picks.

- ## Zoology: The joys of spinelessness [周三, 01 11月 08:00]

  Lisa-ann Gershwin delights in two books on marine invertebrates.

- ## Human embryos: Collect reliable data on embryo selection [周三, 01 11月 08:00]

- ## Night shifts: Circadian biology for public health [周三, 01 11月 08:00]

- ## Crime fiction: Sherlock Holmes — a family likeness? [周三, 01 11月 08:00]

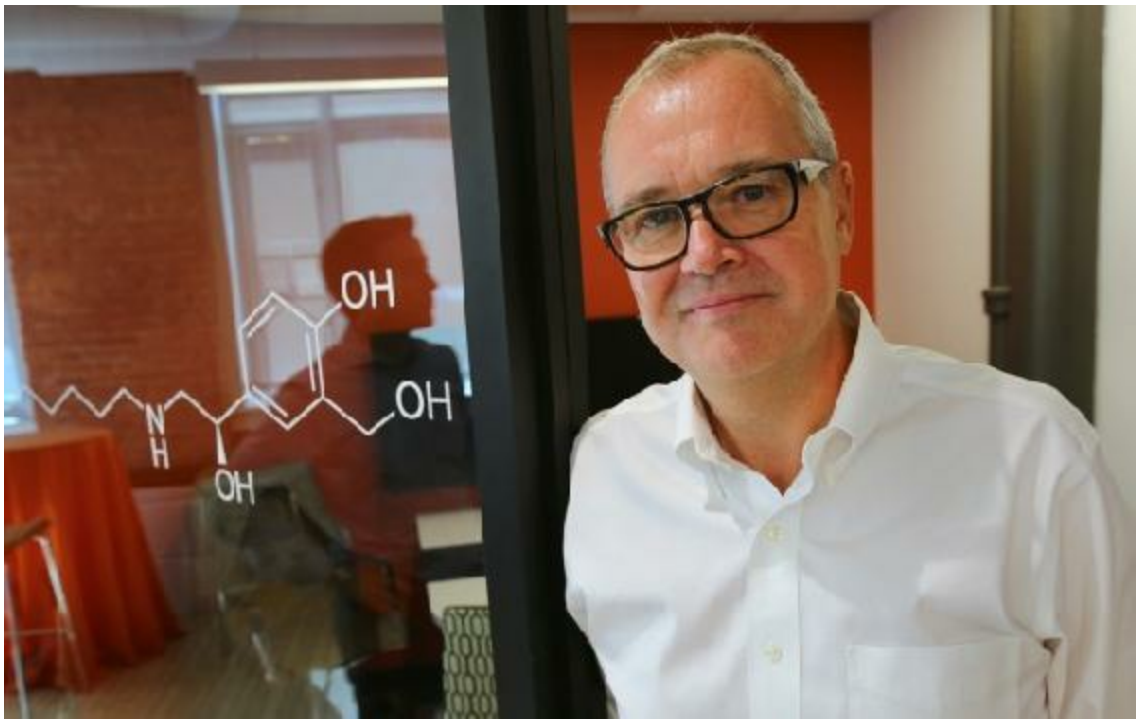
- ## Forestry: Sustainability crisis brews in EU forestry [周三, 01 11月 08:00]

- **Pay for US postdocs varies wildly by institution** [周三, 01 11月 08:00]
  Analysis of universities' salary data suggests major disparities in pay for early-career researchers.

UK government appoints next chief scientific adviser

A former pharmaceutical boss will help navigate the UK's exit from the European Union.

08 November 2017



Pat Greenhouse/Boston Globe/Getty

Patrick Vallance, president of research and development at the pharmaceutical giant GlaxoSmithKline, has been appointed as chief scientific adviser, the UK government announced on 8 November.

Vallance, a clinical pharmacologist who previously led the medical division at University College London, will replace Mark Walport in April 2018. Walport has left the government to become head of a powerful new funding

body called UK Research and Innovation.

As chief scientific adviser Vallance will advise the prime minister and cabinet, the government's most senior decision-making body. He will also lead the Government Office for Science, which promotes the use of scientific evidence in policymaking across government.

A major part of his role will be to ensure that high-quality advice is available across government departments as they deal with the legal and regulatory consequences of the UK's decision to leave the European Union, says Graeme Reid, a science-policy researcher at University College London. The UK needs to manage the impact of Brexit on the regulation of the nuclear industry and the UK's role in fusion research, as well as environment policy and other things. “Patrick Vallance's experience in both business and universities will be of huge value,” says Reid.

Brexit is likely to boost the importance of the day-to-day role, but Vallance will also have to reinvent other, more informal aspects of the position, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School. The creation of UK Research and Innovation, intended to increase the power of UK research funding bodies, means Walport will continue to wield great influence over science in government. The chief scientific adviser has traditionally been the voice of science in government, he says.

The relationship between Vallance and Walport will be an interesting dynamic to watch, says James Wilsdon, a research policy specialist based at the University of Sheffield, UK. He says he hopes Vallance will act as a bridge between the science community and policymakers, and will be open to a wide range of people and perspectives. The network of chief scientific advisers is not yet operating at full strength, he says, “so re-energising the collegiality and connectivity of that network though Whitehall is a really important thing.”

The role is less well-paid than Vallance's present position. His base salary at GlaxoSmithKline is £780,000 (US$1.02 million), but the science-adviser job was advertised in the salary range of £160,000–£180,000.

Vallance will be the third successive chief scientific adviser to come from the biomedical sciences. He follows Walport, who is a former director of the Wellcome Trust, and John Beddington, a population biologist now at the Oxford Martin School and the University of Oxford, UK.

In a separate announcement, GlaxoSmithKline announced that it had apopinted Hal Barron, current president of research and development at Alphabet-funded California Life Sciences, to replace Vallance.

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Comments

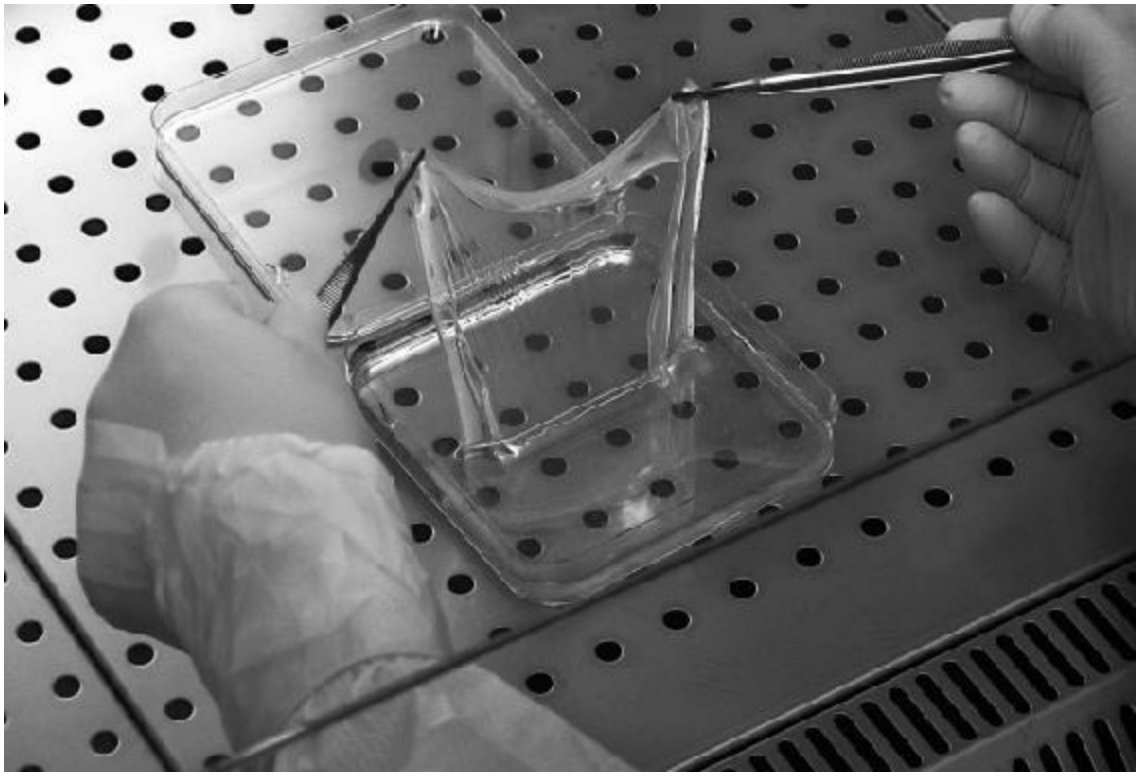
Comments

There are currently no comments.

Skin regeneration with insights

A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.

08 November 2017



A sheet of skin cells grown in culture.

Somewhere in Germany’s Ruhr valley, a nine-year-old boy is doing what children do: playing football, joking around with friends and going to school. Two years ago, he was confined to a hospital bed, dying of a rare and cruel genetic skin disease. In a landmark paper online in *Nature* this week, scientists and clinicians present the details of his astonishing recovery (T. Hirsch *et al.* *Nature* http://dx.doi.org/10.1038/nature24487; 2017).

The boy had junctional epidermolysis bullosa, or JEB. He, like other people with the disease, carried a mutation in a gene that controls the integrity of the skin. Doctors could only try to ease his suffering as some 80% of his skin simply fell away.

A team of Italian researchers came to his aid by combining stem-cell techniques with gene therapy. As a young scientist at Harvard Medical School in Boston, Massachusetts, in the 1980s, Michele De Luca — the lead author of the new study — watched pioneers in skin regeneration learn to grow small sheets of skin from cells taken from burns patients, and to use them in grafts. He extended the work in Italy, applying new genetic and stem-cell technologies. He developed ways to generate stem cells from human skin, replace disease-causing genes in them and grow sheets of healthy skin on scaffolds in the lab.

He chose JEB for his first clinical trial, which he registered with the Italian Medicines Agency in 2002. Four years later, he reported his first success, in which he created healthy skin patches from biopsies to replace small areas of sloughed-off skin on the legs of a patient with a form of JEB (F. Mavilio *et al. Nature Med.* **12,** 1397–1402; 2006). New European Commission regulations introduced in 2007 required him to pause the project while he created facilities adhering to ‘good manufacturing practices’ (GMPs) and a spin-off company to meet the demands for strengthened oversight of cell-based therapies.

Having a company refocused his team’s attention on a different type of stem-cell therapy, one likely to yield a product for the market faster. Holoclar, a treatment that replaces the eye’s cornea in a form of blindness, became the world’s first commercial stem-cell therapy in 2015.

A few months later, at the University of Modena, De Luca got a call out of the blue from doctors in Germany who were trying to treat the little boy. Because the therapy had been in a clinical trial, albeit one on hold at the time, and because De Luca could provide GMP services, German regulatory authorities quickly approved the one-off compassionate use of the JEB therapy. Surgeons in Germany sent a skin biopsy to Modena, and two major skin transplants followed. Six months after the initial biopsy, the boy returned to school. During the many months since, he has not had so much as a blister,

and loves to show off his ‘new skin’.

This major clinical development was based on decades of basic research. The clinical data gathered during 21 months of follow-up after the boy’s treatment have also led to major insights into human skin biology, as discussed in an accompanying News & Views (M. Aragona and C. Blanpain *Nature* http://dx.doi.org/10.1038/nature24753; 2017). For example, normal regeneration of the epidermis is directed by only a few stem-cell clones that can self-renew.

By their nature, highly personalized treatments using gene therapies and products derived from an individual’s stem cells are likely to be applicable to only a subset of patients. Although the report presents the treatment of one patient, it is a classic case of researchers standing on the shoulders of others. This project, for example, relied on long-term follow-up of a patient treated in 2006, as well as parallel studies that underpinned the development of tools for *ex vivo* gene therapy and for growing transplantable sheets of epidermis *in vitro*.

The work is both a technical achievement and an example of how translational medicine should be conducted. It involves research informing the clinic and the clinic informing research, with seamless collaboration between doctors, scientists, regulators and technicians at many levels — a particularly important aspect in areas such as stem-cell biology. It requires the highest standards of scientific and ethical diligence. Similar treatments are starting to be rolled out in other labs for other diseases. *Nature* is glad to celebrate and support such an enterprise.

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Comments

There are currently no comments.

Too many academics study the same people

Researchers should recognize communities that feel over-researched and under-rewarded.

08 November 2017

Susanna D'Aliesio/SOPA Images/LightRocket/Getty

Two women in Lebanon’s Shatila camp.

In southern Beirut, a temporary shelter has become a permanent home. The Shatila refugee camp was established to house displaced Palestinians in 1949 and now has thousands of families within its walls. Residents have learnt to contend with overcrowding, pollution — and a steady stream of well-funded

foreign researchers who come to study them.

Drawn by its unusual story and convenient position close to the airport, researchers flock to Shatila to track the effects of prolonged refugee status and cultural isolation on the community. Well-meaning researchers are so common in Shatila that locals have learnt how to spot them.

Before she became a social anthropologist at King's College London, Mayssoun Sukarieh did voluntary work in Shatila. Residents who saw her reach for her notebook would ask if she was a social researcher: "They come for a tiny bit, and then they leave," the locals explained.

Sukarieh realized that scholars' repeated visits were affecting the community. Academics were among the few contacts that people in Shatila had with the wider world. Again and again, the outsiders would fly out with what they wanted and offer little or nothing in return. The community started to view the visitors with amusement, then resentment.

Some people in Shatila, Sukarieh feared, were being 'over-researched' — an anecdotal concern that social scientists and biomedical researchers increasingly encounter at 'high-traffic' research sites around the world. Sometimes, it is a point raised by ethical-review committees. Occasionally, the community under study makes its own frustrations heard loud and clear.

How big is the problem? Ironically, the issue of over-research has not been researched much. In a study published last month, scientists in South Africa analysed concerns about over-research at two sites of HIV-prevention studies (J. Koen, D. Wassenaar and N. Mamotte *Soc. Sci. Med.* **194,** 1–9; 2017).

They found that the term 'over-research' is poorly defined and encompasses a range of concerns. For example, some use it to describe how other communities are being neglected in favour of one with a pre-established research structure or proximity to a university. This can lead to skewed data, and misconceptions about a particular phenomenon or place.

Alternatively, the term could be used to describe a local community that bears the burden of research participation without sufficient reward, creating a sense of frustration that leads to dwindling participation. In biomedical

studies, researchers sometimes worry that involvement in multiple clinical trials — and exposure to multiple medications — can increase the risk to participants and cloud results.

Repeated studies can certainly exaggerate the frustration that local people feel when their cooperation produces only data, publications and further research. In the South African study, many locals argued that the research should be more closely linked to developing their communities. Some projects, including certain grants from UNAIDS, a global United Nations effort to tackle HIV/AIDS, do require researchers to invest in infrastructure and education. More funders should look at this model. However, several HIV-prevention studies have done such a good job that their results are inconclusive: too few participants contracted the disease for the data to be statistically meaningful.

It is crucial that efforts to reward research participation are developed in consultation with the community being studied. Sukarieh describes well-intentioned educational courses aimed at Shatila-research participants that were impractically long — one consisted of 20 hourly sessions — and discussed issues irrelevant to the people's needs.

Over-research can bring benefits, though: a heavily studied community can become savvy in making its needs known to researchers and in influencing how a study is done. In Hackney, an ethnically diverse borough of London that underwent a period of rapid gentrification, a sociologist who came to study participants in a creative-writing group, for example, was told that, to do so, she had to join the group and write pieces like everyone else. The researcher reported how this strengthened her involvement and built stronger links to the community that helped the project to succeed (S. Neal *et al. Qual. Res.* **16,** 491–507; 2016).

Forging deep links with a community takes time, and time requires funding. Funders should recognize the need to build resources for such efforts into their grants; institutions should recognize and reward this time and effort, and acknowledge that it can eat into a researcher's publication record. It is not good enough to come in for a tiny bit, and then leave.

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Grant recipients can still give objective advice

The US environment agency should not ban researchers it funds from its advisory boards.

08 November 2017

KEENPRESS/Getty

Melting ice caps are raising sea levels.

Scott Pruitt, administrator of the US Environmental Protection Agency (EPA), levelled a damning accusation against scientists on 31 October. In the interests of restoring scientific “integrity”, Pruitt signed a directive stating that the EPA would no longer allow researchers with active grants from the

agency to serve on the EPA's scientific advisory boards. By his tally, an unspecified number of scientists in voluntary positions on those boards had received US$77 million in EPA grants over the past three years — more than enough, Pruitt declared, to raise questions about their ability to provide independent scientific advice.

It was a cynical move — and entirely unnecessary. After all, it is ultimately up to Pruitt and his team to make the appointments to the boards, which advise the agency on everything from basic research programmes to contentious regulatory decisions. If Pruitt wanted to increase the geographical diversity, or include more people from local, state and tribal agencies, as claimed, he could have done so without raising a fuss. Instead, he opted for a public proclamation that singles out active academic scientists as a unique source of bias. He is wrong, on multiple counts.

Scientific enquiry requires money. That's a fact of life. But receiving a research grant is very different from being on the payroll of an institution, advocacy group or company. Those are all very real conflicts of interest that were ignored in Pruitt's directive.

Moreover, winning competitive research grants does not imply fealty to the granting institution. What drives EPA-funded researchers above all is the desire to deliver a public good: discovery and understanding.

Of course, scientific conflicts of interest do exist. So there are established procedures that require scientists to excuse themselves when their own work is under consideration by the boards. These same procedures apply to industry scientists — who are also rightfully represented on the advisory boards — when deliberations involve issues that could affect their companies' bottom lines.

What Pruitt either fails to understand, or has chosen to ignore, is that his advisory boards are designed to focus on science, not policy. Understanding the latest research requires perspectives from the leading scientists. And when it comes to environmental and human-health issues, it is only to be expected that many of those people will have research grants from the EPA.

In the end, Pruitt's directive seems crafted to incite US President Donald

Trump’s political base, and it’s yet another example of researchers being dragged into the political and cultural wars rending the country.

Happily, it is harder to argue with data. This might explain why the first volume of a comprehensive — and congressionally mandated — assessment of climate science released on 3 November (see page 152) sailed through reviews from officials at the EPA and other federal agencies.

That report, which integrates the latest climate research, found that greenhouse-gas emissions caused by human activity are altering the planet in fundamental ways. It lays out what we know about the threat of global warming — from deep in the ocean to the highest mountain peaks. And it stands in direct opposition to the climate scepticism voiced by Pruitt and Trump.

Some scientists had feared political interference, but senior officials at federal agencies gave the report the green light, without major changes. This is as it should be: scientists can assess what’s known and probe what is not. And it is up to policymakers to decide what to do with that information. This should be a lesson for Pruitt: the current administration has the right to create its own priorities, but it should not and cannot override what science reveals.

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Rohingya refugees, Bulgarian protests and a prize for negative results

The week in science: 3–9 November 2017.

08 November 2017

Events | Research | Policy | Climate | People | Publishing | Trend watch

EVENTS

Ice crack to close Antarctic base again For the second time in two years, the British Antarctic Survey (BAS) will close its Halley VI research station for the winter season because of an enormous crack in the floating ice shelf on which it rests. In March, operators finished moving the transportable station 23 kilometres inland from its initial 2012 location because of an ice chasm nearby. Now, another crack in the Brunt Ice Shelf, this one 50 kilometres long, is threatening the station from the other side. Halley VI will close between March and November 2018, the BAS said on 31 October, because it is too difficult to evacuate personnel quickly in winter if the crack develops further.

Michal Krzysztofowicz/BAS

Money for nothing A data organization has launched what it says is the world's first prize for publishing negative scientific results. The European College of Neuropsychopharmacology's Preclinical Data Forum says that the aim of the €10,000 (US$11,600) prize is to encourage researchers to publish data that don't confirm the hypothesis being tested. Such negative studies are much less likely to be published than positive results, meaning that other scientists may waste time trying to repeat the work. The call for entries — initially just for neuroscience research — opened on 8 November.

Bulgarian protest Hundreds of Bulgarian researchers took to the streets of Sofia on 1 November to demand higher wages and an increase in science funding marked out in the government's 2018 budget. Bulgaria has one of the lowest levels of research investment in the European Union. The demonstrators are threatening further protests when Bulgaria takes over the rotating EU presidency next January.

Rohingya refugees A survey of Rohingya refugees in Bangladesh suggests

that 7.5% of the children have life-threatening malnutrition. The United Nations children's charity UNICEF reported the figure on 3 November. More than 2,700 children are being treated for acute malnutrition in refugee camps, where conditions are expected to worsen because of poor sanitation and crowding. Since late August, more than 600,000 Rohingya people have fled from Myanmar to Bangladesh, following attacks by Myanmar's police.

RESEARCH

Weather forecasts Improving forecasts of severe weather is important, but meteorologists should also listen to social scientists to help save lives during storms, says a 1 November report from the US National Academies of Sciences, Engineering, and Medicine. It recommends that federal agencies do more to incorporate social- and behavioural-sciences research into their preparation for weather hazards. These changes might include researching people's processes for deciding how to respond to threats such as tornado or hurricane warnings, and evaluating how weather forecasters communicate with media and emergency-management officials to convey messages more effectively.

POLICY

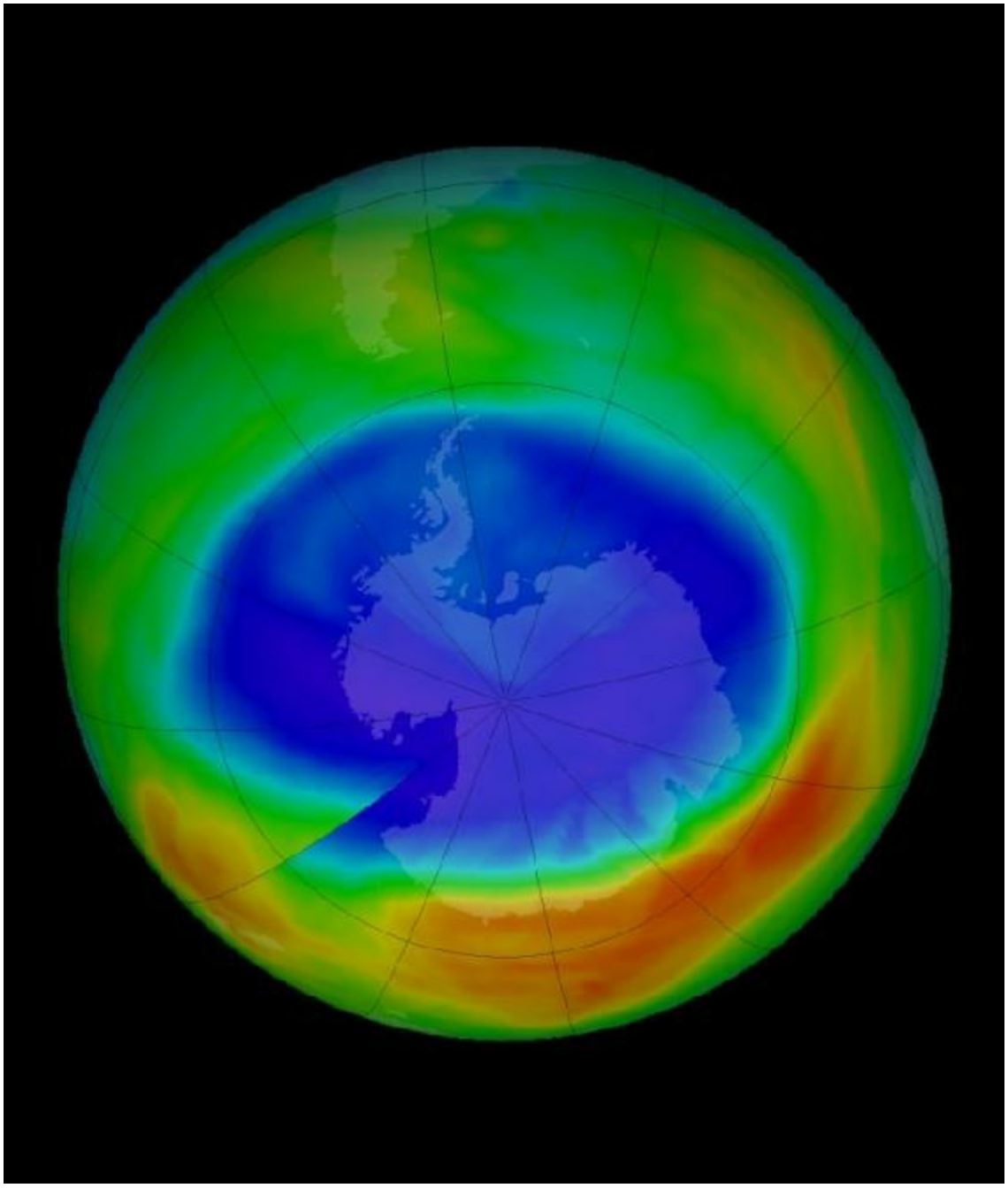
Antibiotic advice The World Health Organization (WHO) has recommended that animal-food industries curb the routine use of antibiotics for growth promotion and disease prevention. Healthy animals should receive the drugs only if others in the same flock or herdare diagnosed with communicable infections, the agency said in guidance published on 7 November. The recommendations were informed by a review of 179 studies; it found that the prevalence of multidrug-resistant bacteria in farmed animals dropped by up to 32% in places that had cut back on antibiotic use (K. L. Tang *et al. Lancet Planet. Health* http://doi.org/cfxh; 2017). The evidence connecting antibiotic restrictions in farm animals to drug resistance in humans was less robust, but hinted at a similar correlation.

Genetic-test rules The US Food and Drug Administration (FDA) is seeking

to loosen its regulation of genetic tests that are marketed directly to consumers, its commissioner, Scott Gottlieb, announced on 6 November. The FDA has proposed a policy that would allow genetic-testing companies to submit a product to the agency for a one-time review; if approved, the company would be allowed to market more tests without further review. The proposal is open for public comment until January. The agency also said that it has decided to exempt from review tests that are used to determine whether potential parents carry disease-causing genetic mutations that could cause an inherited disorder in their children.

CLIMATE

Small ozone hole This year's hole in the ozone layer was the smallest since 1988, NASA said on 2 November. The hole above Antarctica, which opens each September, was unusually small, owing to warm weather in the Southern Hemisphere. At its peak, the area of the hole was almost 2 billion hectares, or roughly two and a half times the size of the contiguous United States. Scientists attribute the shrinkage to natural variation, and not to rapid healing because of human intervention, NASA said. This year, warm air above Antarctica depleted cloud cover, which is where ozone-destroying chemical reactions occur. The hole has been shrinking since the introduction in 1987 of the Montreal Protocol to phase out ozone-depleting chemicals.



Katy Mersmann/NASA Ozone Watch/NASA

PUBLISHING

Censorship in China Springer Nature, one of the world's largest academic

publishers, has stopped readers in China from accessing some of its content. *The Financial Times* reported on 1 November that the publisher had blocked access to more than 1,000 articles from the websites of two of its journals, *The Journal of Chinese Political Science* and*International Politics*. The publishing house, which also owns *Nature*, said that the articles accounted for less than 1% of its content and had been blocked to comply with local Chinese laws. (*Nature*'s news team is editorially independent of its publisher.) The articles included politically sensitive terms such as Tibet, Taiwan and Cultural Revolution. Some in the academic community criticized the decision, which comes two-and-a-half months after UK firm Cambridge University Press blocked access to some articles in China and then swiftly reversed its decision.

Copyright battle The scholarly social network ResearchGate has over the past month disabled public access to 1.7 million papers on its site, according to five scientific publishers who have been tracking its activities. Early last month, the publishers formed a coalition to get ResearchGate to take down papers that breach copyright; two publishers have also filed a lawsuit against the site. The coalition says that the site has since disabled access to around 93% of its copyrighted material, although academics have re-uploaded some papers for public view. The publishers have now sent an undisclosed number of take-down notices to order the removal of remaining infringing content. ResearchGate, which is based in Berlin, declined to comment.

Piracy-site lawsuit The American Chemical Society (ACS) has won a lawsuit against the pirate site Sci-Hub over the website's illicit dissemination of copyrighted research articles. On 3 November, a US court granted the ACS US$4.8 million in damages for copyright infringement and trademark violation. The court also issued an injunction ordering Internet services that are "in active concert or participation" with Sci-Hub, including providers and search engines, to stop facilitating access to the site. Representatives of Sci-Hub, which was launched in 2011, did not appear in court to present their case.

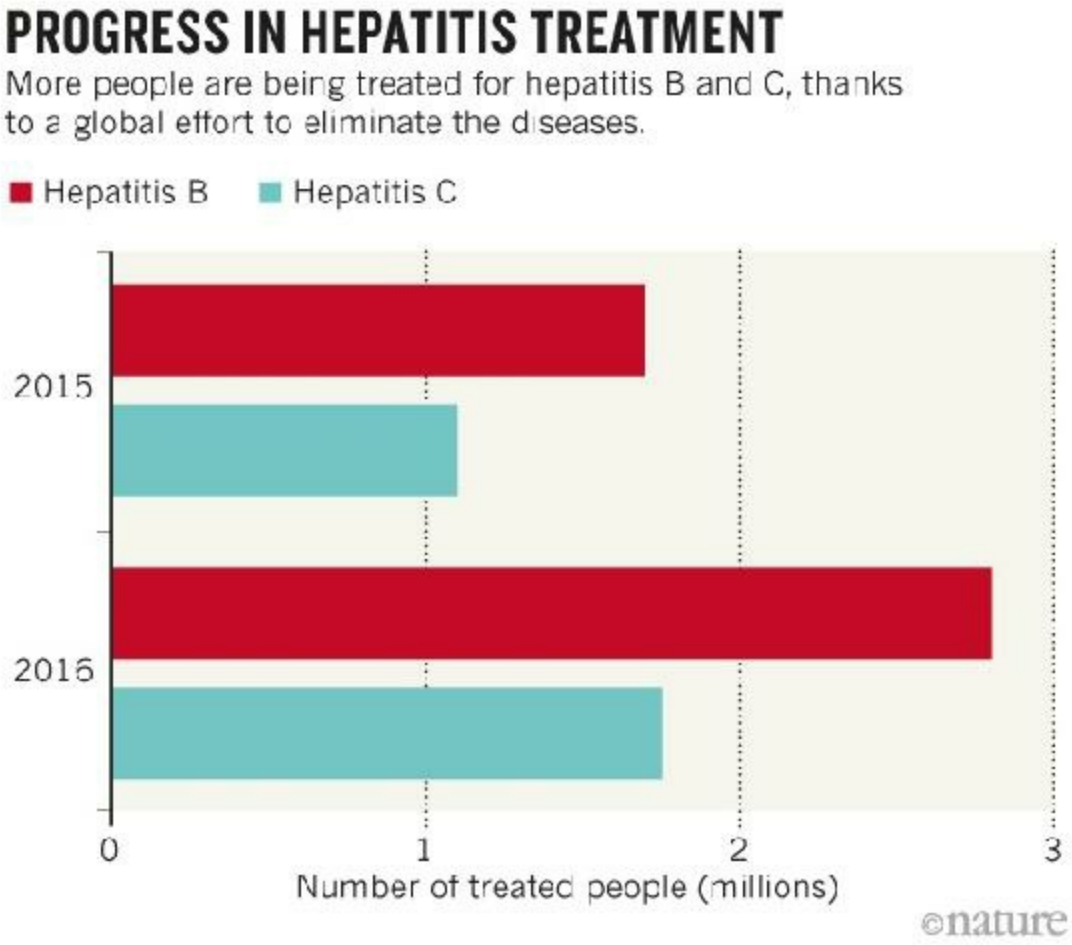
PEOPLE

Nominee withdraws Sam Clovis, the controversial nominee for the post of chief scientist at the US Department of Agriculture, withdrew from consideration on 2 November. The announcement came shortly after Clovis's name surfaced in the ongoing investigation into links between US President Donald Trump's election campaign and Russia. Clovis, a former conservative talk-show host and economics professor, was already a controversial pick for the chief-scientist position, which, by law, must be filled by a distinguished scientist.

Science chair to quit Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, said on 2 November that he will retire when his term expires late next year. The Texas Republican has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. The House of Representatives limits committee chairs to six years in the role, so Smith would have been forced to relinquish his post on the science panel in 2019.

TREND WATCH

The number of people who were able to access treatment for viral hepatitis C grew by some 1.7 million in 2016, a 60% increase over 2015, the World Health Organization (WHO) said on 31 October. A further 2.8 million people were given lifelong treatment for hepatitis B in 2016, a 65% jump over 2015. The WHO estimates that there were between 6 million and 10 million new cases of viral hepatitis B and C in 2015. The agency wants 80% of people diagnosed to be receiving treatment by 2030.



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Comments

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Dark-matter hunt fails to find the elusive particles

Physicists begin to embrace alternative explanations for the missing material.

08 November 2017

XENON Collab.

Scientists working on the XENON1T experiment are searching for signs of dark matter.

Physicists are growing ever more frustrated in their hunt for dark matter — the massive but hard-to-detect substance that is thought to comprise 85% of the material Universe. Teams working with the world's most sensitive dark-matter detectors report that they have failed to find the

particles, and that the ongoing drought has challenged theorists' prevailing views.

The latest results from an experiment called XENON1T at the Gran Sasso National Laboratory in Italy, published on 30 October[1], continue a dry spell stretching back 30 years in the quest to nab dark-matter particles. An attempt by a Chinese team to detect the elusive stuff, the results of which were published on the same day[2], also came up empty-handed. Ongoing attempts by space-based telescopes, as well as at CERN, the European particle-physics laboratory near Geneva, Switzerland, have also not spotted any hints of dark-matter particles.

The findings have left researchers struggling for answers. "We do not understand how the Universe works at a deeper and more profound level than most of us care to admit," says Stacy McGaugh, an astrophysicist at Case Western Reserve University in Cleveland, Ohio.

Physicists have widely accepted the existence of dark matter since the 1980s as an explanation for why galaxies remain intact rather than flying apart, which would be expected given the amount of observable mass they contain and how fast they rotate. Researchers surmised that halos of invisible dark matter surround galaxies and stabilize them. Physicists grew more confident when dark-matter models successfully predicted the fluctuations detected in an observable echo of the Big Bang, known as the cosmic microwave background.

These observations became the most dramatic evidence for a proposal in the 1980s that dark matter might be formed of weakly interacting massive particles, known as WIMPs. The existence of such particles fits with how physicists think that the Universe evolved, and with the relative abundance of matter. Moreover, the properties of WIMPs would match those predicted by a branch of particle physics called supersymmetry.

The latest round of results seems to rule out the simplest and most elegant supersymmetry theories, casting doubt on the idea that the still-undetected particles are the missing dark matter. If simple supersymmetry theories are no longer viable, scientists say, any WIMP particle has to interact with matter much more feebly than physicists once thought. "It's not a wholesale retreat

from the WIMP paradigm, but it is definitely a change in emphasis," says Dan Hooper, a physicist at the Fermi National Accelerator Laboratory in Batavia, Illinois.

Attitudes are shifting, and physicists are increasingly embracing other possible explanations for dark matter, says David Spergel, a theoretical astrophysicist at Princeton University in New Jersey, who was an early proponent of WIMP models. "These experiments haven't completely closed the window. However, we also need to be thinking about other types of dark matter and new experiments," he says.

Dedicated detectors

It has taken decades to build experiments capable of detecting the minuscule rate at which WIMPs were thought to interact with matter. Only in the past ten years have experiments, carried out at about a dozen laboratories, reached the level of sensitivity needed to detect them. The most sensitive detector in the world is Gran Sasso's XENON1T, which looks for flashes of light created when dark matter interacts with atoms in its 3.5-tonne tank of extremely pure liquid xenon. But the team reported no dark matter from its first run. Neither was there any signal in data collected over two years during the second iteration of China's PandaX experiment, based in Jinping in Sichuan province. Hunts in space have also failed to find WIMPs, and hopes are fading that a once-promising γ-ray signal detected by NASA's Fermi telescope from the centre of the Milky Way was due to dark matter — more-conventional sources seem to explain the observation. There has been only one major report[3] of a dark-matter detection, made by the DAMA collaboration at Gran Sasso, but no group has succeeded in replicating that highly controversial result; renewed attempts to match it are under way.

Future generations of detectors based on the same principle as XENON1T are already in the works, and will be needed if physicists are to finally close the window on WIMPs. But the particles' continuing no-show is making theorists more open-minded and has allowed other theories to gain prominence, says Hooper. Perhaps dark matter consists of exotic axion particles, which are akin to strange, massive photons. Theorists are also

looking at whether dark matter might not interact with known particles at all, but exist in a “hidden sector”, he says.

The looming rejection of the WIMP hypothesis is encouraging for the few physicists who claim that dark matter itself is a red herring. “I hope people will become even more open-minded,” says McGaugh, who has studied modified versions of gravity that negate the need for dark matter. However, Hooper stresses that the fading support for WIMPs does not weaken the case for dark matter, which he thinks will eventually be found. “I’m not worried about the never possibility, but it could be very, very difficult,” he says.

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The bitter battle over the world's most popular insecticides

As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.

08 November 2017

Lucy Hulmes/CEH

Researchers have monitored the health of the red mason bee (*Osmia bicornis-rufa*), which nests in hollow cavities.

Maj Rundlöf remembers the moment she changed her mind about neonicotinoids. In December 2013, in her office at Lund University in Sweden, she and postdoc Georg Andersson were peering at data from their

latest study. It was designed to test what would happen to bees if they fed on crops treated with neonicotinoids — the world's most widely used insecticides. “I didn't expect to see any effect at all, to be honest,” says Rundlöf.

Hives of honeybees (*Apis mellifera*) weren't greatly affected by the chemicals in their pollen and nectar, the study suggested[1]. But the data on bumblebees (*Bombus terrestris*) told a different story. Bumblebee colonies that hadn't fed on the treated crops looked normal: they were packing on weight to survive the winter. But in the colonies exposed to neonicotinoids, the growth chart was a flat line.

When the Swedish study was published in April 2015, it made headlines around the world. It was the first to show that neonicotinoid chemicals — known as neonics — could harm bees in a real-world farming situation.

Bee populations are declining in many parts of the globe, a worrying sign for the crops and wild plants that rely on these pollinators for their survival. Parasites, disease and shrinking food resources are all prime suspects. But a link to neonics has become a major flashpoint.

Even before Rundlöf's results were revealed, the European Union had placed heavy restrictions on the three most widely used neonics in flowering crops — plants that might be attractive to bees — amid rising concerns that the chemicals might harm pollinators. The restricted neonics were imidacloprid and clothianidin, made by agrochemical giant Bayer, and thiamethoxam, made by Syngenta. But farmers, the agrochemical industry and some scientists pointed out that the moratorium was precautionary and based on limited evidence, gathered mostly from lab tests.

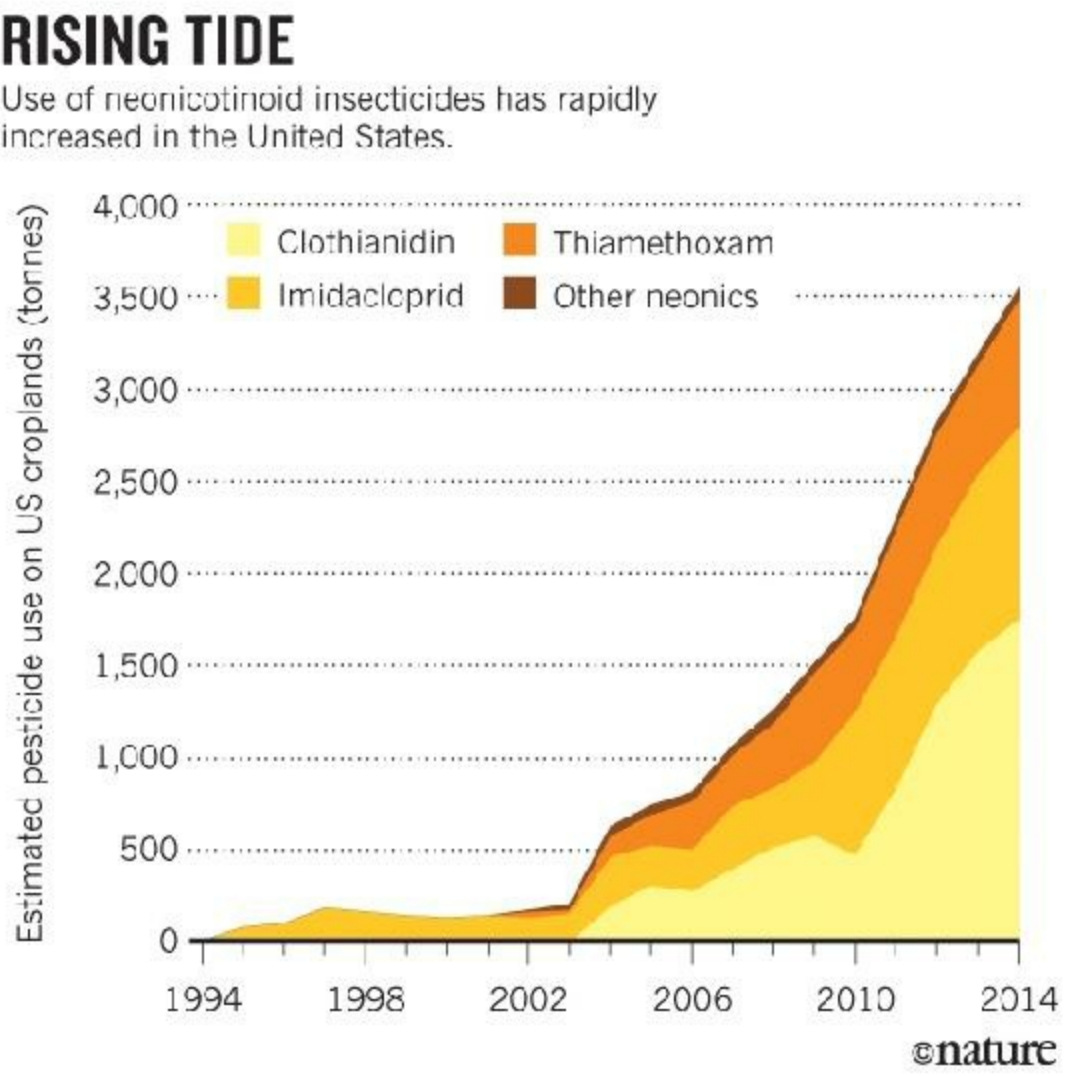
Since Rundlöf's paper, studies showing real-world evidence of harm from pesticides in the field have been mounting — and environmental organizations have demanded wide-ranging bans. Regulatory agencies will soon decide what to do about neonics, which have a global market worth more than US$1.5 billion per year. This month, the EU's European Food Safety Authority is due to complete a re-evaluation of evidence for restricting neonics; the EU will then need to decide what action to take. The US Environmental Protection Agency is expected to complete its own review of

the insecticides next year. France's parliament has passed a law that would ban neonics in 2018, although some exemptions will be allowed.

But industry groups and some scientists say the evidence still isn't conclusive. The picture is complicated: some studies show harm to some bees in some circumstances, whereas others find no harm. The results seem to be affected by many factors, including the species of bee and the kinds of crops involved. Scientists working on the question say the subject has become toxic: any new study is instantly and furiously picked at by entrenched advocates on both sides. Even the results of the largest study on the matter, funded by the agrochemical industry, failed to produce a consensus. Published this year[2], it launched another round of recriminations — including complaints from funders who criticized the paper that they had paid for. Ultimately, it's likely that political or regulatory decisions will settle the matter before opposing parties agree, says Sainath Suryanarayanan, an entomologist and sociologist at the University of Wisconsin–Madison who has studied the bee-health issue. “It is a common pattern for highly contentious and polarized debates,” he says.

The world's favourite insecticide

In the early 1980s, scientists at Nihon Tokushu Noyaku Seizo in Tokyo, an arm of Bayer, started to play around with nithiazine, an insecticide created in California a decade earlier. They discovered a new compound that was more than 100 times as effective at killing crop pests, such as aphids. Named imidacloprid, the chemical was launched onto the market in the 1990s, and it quickly became one of the most widely used insecticides in the world. By the mid-2000s, imidacloprid and similar compounds made up one-quarter of all insecticides (see 'Rising tide'). The compounds damage insects' nervous systems by causing the nerves to fire continually until they fail, eventually leading to death. Many neonics are applied directly to seeds, and are taken up by growing plants. If the plant flowers, the chemicals find their way into pollen and nectar.



Source: USGS/CalPIP

In France, where sunflower seeds coated with imidacloprid came on the market in 1994, beekeepers raised the alarm. They said that their honeybees were failing to make it home after foraging flights, and they pinned the blame on the sunflowers. The concerns triggered a 1999 French ban on imidacloprid-coated sunflower seeds, which continues to this day — although it was based on the precautionary principle, rather than formal proofs of harm, says Axel Decourtye, a researcher at the Institute for Bees in Avignon, France.

Scientists hurried to find those proofs — or evidence that the concern was overblown. Researchers quickly discovered that honeybees fed high doses of neonicotinoids died. And even sub-lethal doses triggered unusual behaviour: exposed honeybees changed their dining habits, foraging less often but for longer periods[3]. Other research showed[4] that neonics act on parts of a bee's brain associated with memory and learning. Honeybees trained to respond to particular scents by sticking out their tongues, for example, performed worse — or failed to learn the task at all — when dosed with a neonic.

At every stage, critics raised new queries about how realistic the experiments were, says Decourtye. “How do we know if the neonicotinoid doses are realistic? Does the effect on the individual have any effect on the colony?”

Out in the field

As work continued in the laboratory, researchers also began to turn to the fields. In 2012, Decourtye and his colleagues published a paper[5] showing that what they called “thiamethoxam intoxication” seemed to interfere with the ability of honeybees to return to their hives after looking for food in a realistic, outdoor setting. Yet that study still dosed bees' food with neonics, rather than allowing them to feed on treated crops.

Around the same time, a UK team found[6] that it was not just honeybees that could be at risk. They reported that colonies of bumblebees exposed to “field-realistic” levels of imidacloprid in the lab and then left to grow in field conditions grew slower than controls. They also produced 85% fewer new queens to carry on their line. That work was led by Dave Goulson, a bee researcher now at the University of Sussex in Brighton, UK. In 2006, Goulson had started a charity dedicated to conserving bumblebees, and people began telling him their concerns about neonics. “To start with, I was pretty dubious,” he says. But by 2014, the Task Force on Systemic Pesticides (TFSP) — a group of 30 scientists, including Goulson — announced that it had analysed 800 peer-reviewed studies on neonics and bees, and found “clear evidence of harm sufficient to trigger regulatory action”[8].

Rundlöf's study set out to be the most realistic yet. Her team sowed eight

Swedish fields with oilseed-rape seeds coated in clothianidin, and eight with untreated seeds. They found[1] not only that bumblebee colonies in treated fields grew less well than the controls, but also that the numbers of wild bees in the treated fields fell. Industry spokespeople noted that honeybee colonies weren't affected, and also quibbled with the study — arguing, for example, that the researchers had only placed a small number of wild bees into fields, so findings might not be statistically robust. Rundlöf, however, points out that the researchers also surveyed wild bees flying around, and had the bumblebee-colony data to draw on. “I know we have robust evidence,” she says.

Maj Rundlöf

Researchers examine the health of honeybees during a field study led by Maj Rundlöf in Sweden.

In mid-2017, the largest field study yet — funded with some $3 million from

industry — reported its long-awaited results[2]. Scientists from the Centre for Ecology and Hydrology (CEH) near Wallingford, UK, had put honeybees, mason bees (*Osmia bicornis*) and bumblebees in 33 oilseed-rape fields in the United Kingdom, Germany and Hungary. This time, the seeds, sown in winter, had been coated with either clothianidin or thiamethoxam, or with a neonicotinoid-free pesticide treatment.

The researchers, led by CEH entomologist Ben Woodcock, found that bumblebees and mason bees fared less well the more neonics they were exposed to. The honeybee picture was more complicated: in some cases, neonics seemed to affect bee health, but in others, they didn't. In the United Kingdom and Hungary, neonic compounds seemed to reduce worker-bee numbers in honeybee hives; in Hungary, researchers also saw fewer egg cells in these hives, an indication of reduced reproductive success. In Germany, however, the honeybee hives exposed to neonics had more egg cells — a puzzling result. Overall, the CEH study concluded that neonicotinoids reduced bees' ability to establish new colonies after winter. The journal editor's summary of the paper came under the headline: “Damage confirmed”.

The agrochemical firms that funded the study don't agree. At a press conference in June, when CEH scientists presented their results — without Woodcock, who was overseas — spokespeople from Syngenta and Bayer told reporters that both the study's analysis and its conclusions were questionable. They noted that Woodcock's team had analysed more than 200 pieces of information about honeybees; 9 showed a negative effect from neonicotinoids, whereas 7 were positive. “The one-line simplistic summary conclusion published does not reflect the data presented in this paper,” argued Peter Campbell, an environmental specialist at Syngenta in Reading, UK, in a separate statement released to the media.

Woodcock was incensed by the criticism. In an interview with environmental group Greenpeace, he said that industry had accused him of being a liar. Now, he says, he regrets that choice of words, but he still thinks industry took a blinkered view of the results. “I do feel that the sentiment of what I implied, while inappropriate, was not an unreasonable reaction,” he says. The negative effects were in key areas related to bee health, he says, adding that for

industrial firms to deny that neonics are having an effect on bees is “probably naive”.

Many of the academics *Nature* talked to agree. “I think the majority of researchers highlight that the weakening of bee populations caused by neonicotinoids is proved,” says Decourtye. But not everyone is so certain. “The question of whether the damage to bees is translated to an effect in fields on whole populations of bees is much harder to show,” says Linda Field, head of the department of Biointeractions and Crop Protection at Rothamsted Research in Harpenden, UK. Mature colonies may survive even if individual bees are impaired, because other worker bees compensate, notes Nigel Raine, a biologist at the University of Guelph in Canada. But solitary bees, such as wild bees and queen bumblebees emerging from hibernation, might be at greater risk.

Campbell thinks that many academics are “neutral” on the matter, but are not vocal about it. Studies showing harm to bees tend to garner media attention, and are published in widely read journals, whereas those showing no impact are relegated to less highly cited publications, he says. But Goulson and Woodcock say some of the studies that industry cites as showing no harm are statistically dubious, and more flawed than the headline-garnering trials that show harm.

Christian Maus, global lead scientist for bee care at Bayer in Monheim am Rhein, Germany, picks his words carefully. “I think it is clear and undebated that neonicotinoids do have some intrinsic toxicity to bees,” he says. “But under realistic conditions, as prevailing in the field and agricultural practice, we have not seen any evidence that they would be harming honeybee colonies, for instance, when they are correctly applied.”

Combinatorial effects

Researchers are looking beyond simple relationships between a single pesticide and bee harm. In a 2012 paper[8], Raine and his colleagues showed that exposing bumblebees to a neonicotinoid in combination with a pesticide called a pyrethroid hampered their ability to collect pollen. Colonies exposed

to both compounds experienced higher losses of worker bees than did controls, or colonies dosed with only one. The study was the first to show combinatorial effects, Raine says — which is important, because bees will be exposed to multiple compounds in the wild. And this year, in a paper[9] published alongside Woodcock's, a Canadian team studying honeybee colonies near maize (corn) plants found that the presence of the fungicide boscalid halved the dose of neonics needed to cause death.

That work also suggested that neonic chemicals can migrate away from the plants that they are supposed to protect: by identifying the sources of pollen grains in the hives, the researchers showed that bees were exposed to neonics mainly through pollen from untreated plants. Neonicotinoids are water-soluble — which is how they move from seeds into growing plant tissues. “But that also means they can be washed off the seed, into the soil, and maybe into other plants,” says Christian Krupke, an entomologist at Purdue University in West Lafayette, Indiana.

In one study[10], Krupke found that just 1.34% of clothianidin applied as seed treatment to maize ended up in the crop’s tissues. Neonics that get into the wider environment might cause other, more indirect problems. A 2014 study[11] in the Netherlands, for instance, reported a fall in populations of insect-eating birds in areas with high concentrations of neonicotinoids in the water. It suggested that the chemicals might have depleted the birds’ food resource.

Some researchers are now questioning whether there is any benefit to using neonicotinoids at all. In another study[12], Krupke’s group found no benefits on maize yield from the use of neonicotinoids in Indiana. In this crop, he says, the prophylactic use of neonicotinoids — which are often part of a bundle of pesticides sold pre-applied to seeds — is foolish.

“The way they’re used doesn’t make any sense,” he says. “It only makes sense from one motive. That is the profit motive for the manufacturer.”

Campbell insists that neonicotinoids do provide yield increases, but much of the evidence is proprietary and unpublished. Since the EU neonicotinoid restrictions, Maus says, research suggests there has been a 4% decline in

oilseed-rape yield. Whether or not the restrictions have had any effect, farmers have furiously protested against losing the ability to use neonics. Anecdotal reports suggest many are attempting to compensate by applying increasing amounts of pyrethroids, which are sprayed over crops, rather than applied to seeds; these chemicals may bring their own health risks if used in large quantities, because they are toxic to fish and aquatic insects.

The B word

Regulators in some countries will soon decide whether to take further action to restrict neonics — and here, researchers are split. Some campaign groups, such as Greenpeace and the Pesticide Action Network, have argued for a ban on the use of neonics on all outdoor crops, not just those that might be attractive to bees, such as the bright-yellow flowers of oilseed rape.

“A lot of farmers do fundamentally rely on neonicotinoids,” says Woodcock. And clamping down severely on one chemical might mean that greater amounts of other damaging substances are used. “If people can't use neonicotinoids and they go to other insecticides, is that any better? There are lots of knock-on effects,” says Field.

That concern points to wider doubts about the regulatory systems that allowed agrichemicals such as neonics onto the market in the first place, says Goulson. Many researchers are hesitant to advocate outright bans. Some, such as Rundlöf, say it isn't their job to make policy recommendations. But Goulson says his view has changed as the evidence has mounted. In 2014 — at the time of the TFSP's first synthesis report — he thought that there might be certain situations in which neonics were the best option. But since then, he says, there's been even stronger evidence of collapsing insect populations — and it is hard to regulate partial bans. “I think now I'd vote for a complete ban,” he says.

Whatever regulators do, Goulson says, he is growing increasingly downbeat about the chances of any consensus forming between industry and academia on the issue. “I'm starting to come to the conclusion there will never be a game-changer,” he says. “There is nothing I think any scientist could do at

this point to make people all sit down and have any answer.”

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Four ethical priorities for neurotechnologies and AI

08 November 2017

Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

BSIP/UIG/Getty

A man with a spinal-cord injury (right) prepares for a virtual cycle race in which competitors steer avatars using brain signals.

Consider the following scenario. A paralysed man participates in a clinical

trial of a brain–computer interface (BCI). A computer connected to a chip in his brain is trained to interpret the neural activity resulting from his mental rehearsals of an action. The computer generates commands that move a robotic arm. One day, the man feels frustrated with the experimental team. Later, his robotic hand crushes a cup after taking it from one of the research assistants, and hurts the assistant. Apologizing for what he says must have been a malfunction of the device, he wonders whether his frustration with the team played a part.

This scenario is hypothetical. But it illustrates some of the challenges that society might be heading towards.

Current BCI technology is mainly focused on therapeutic outcomes, such as helping people with spinal-cord injuries. It already enables users to perform relatively simple motor tasks — moving a computer cursor or controlling a motorized wheelchair, for example. Moreover, researchers can already interpret a person's neural activity from functional magnetic resonance imaging scans at a rudimentary level[1] — that the individual is thinking of a person, say, rather than a car.

It might take years or even decades until BCI and other neurotechnologies are part of our daily lives. But technological developments mean that we are on a path to a world in which it will be possible to decode people's mental processes and directly manipulate the brain mechanisms underlying their intentions, emotions and decisions; where individuals could communicate with others simply by thinking; and where powerful computational systems linked directly to people's brains aid their interactions with the world such that their mental and physical abilities are greatly enhanced.

Such advances could revolutionize the treatment of many conditions, from brain injury and paralysis to epilepsy and schizophrenia, and transform human experience for the better. But the technology could also exacerbate social inequalities and offer corporations, hackers, governments or anyone else new ways to exploit and manipulate people. And it could profoundly alter some core human characteristics: private mental life, individual agency and an understanding of individuals as entities bound by their bodies.

It is crucial to consider the possible ramifications now.

The Morningside Group comprises neuroscientists, neurotechnologists, clinicians, ethicists and machine-intelligence engineers. It includes representatives from Google and Kernel (a neurotechnology start-up in Los Angeles, California); from international brain projects; and from academic and research institutions in the United States, Canada, Europe, Israel, China, Japan and Australia. We gathered at a workshop sponsored by the US National Science Foundation at Columbia University, New York, in May 2017 to discuss the ethics of neurotechnologies and machine intelligence.

We believe that existing ethics guidelines are insufficient for this realm[2]. These include the Declaration of Helsinki, a statement of ethical principles first established in 1964 for medical research involving human subjects (go.nature.com/2z262ag); the Belmont Report, a 1979 statement crafted by the US National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research (go.nature.com/2hrezmb); and the Asilomar artificial intelligence (AI) statement of cautionary principles, published early this year and signed by business leaders and AI researchers, among others (go.nature.com/2ihnqac).

To begin to address this deficit, here we lay out recommendations relating to four areas of concern: privacy and consent; agency and identity; augmentation; and bias. Different nations and people of varying religions, ethnicities and socio-economic backgrounds will have differing needs and outlooks. As such, governments must create their own deliberative bodies to mediate open debate involving representatives from all sectors of society, and to determine how to translate these guidelines into policy, including specific laws and regulations.

Intelligent investments

Some of the world's wealthiest investors are betting on the interplay between neuroscience and AI. More than a dozen companies worldwide, including Kernel and Elon Musk's start-up firm Neuralink, which launched this year, are investing in the creation of devices that can both 'read' human brain activity and 'write' neural information into the brain. We estimate that current spending on neurotechnology by for-profit industry is already US$100

million per year, and growing fast.

BSIP/UIG/Getty

After having electrodes implanted in the brain to stimulate neural activity, some people have reported feeling an altered sense of identity.

Investment from other sectors is also considerable. Since 2013, more than $500 million in federal funds has gone towards the development of neurotechnology under the US BRAIN initiative alone.

Current capabilities are already impressive. A neuroscientist paralysed by amyotrophic lateral sclerosis (ALS; also known as Lou Gehrig's or motor neuron disease) has used a BCI to run his laboratory, write grant applications and send e-mails[3]. Meanwhile, researchers at Duke University in Durham, North Carolina, have shown that three monkeys with electrode implants can operate as a 'brain net' to move an avatar arm collaboratively[4]. These devices can work across thousands of kilometres if the signal is transmitted wirelessly by the Internet.

Soon such coarse devices, which can stimulate and read the activity of a few dozen neurons at most, will be surpassed. Earlier this year, the US Defense Advanced Research Projects Agency (DARPA) launched a project called Neural Engineering System Design. It aims to win approval from the US Food and Drug Administration within 4 years for a wireless human brain device that can monitor brain activity using 1 million electrodes simultaneously and selectively stimulate up to 100,000 neurons.

Meanwhile, Google, IBM, Microsoft, Facebook, Apple and numerous start-ups are building ever-more-sophisticated artificial neural networks that can already outperform humans on tasks with well-defined inputs and outputs.

Last year, for example, researchers at the University of Washington in Seattle demonstrated that Google's FaceNet system could recognize one face from a million others. Another Google system with similar neural-network architecture far outperforms well-travelled humans at guessing where in the world a street scene has been photographed, demonstrating the generality of the technique. In August, Microsoft announced that, in certain metrics, its neural network for recognizing conversational speech has matched the abilities of even trained professionals, who have the option of repeatedly rewinding and listening to words used in context. And using electroencephalogram (EEG) data, researchers at the University of Freiburg in Germany showed in July how neural networks can be used to decode planning-related brain activity and so control robots[5].

Future neural networks derived from a better understanding of how real ones work will almost certainly be much more powerful even than these examples. The artificial networks in current use have been inspired by models of brain circuits that are more than 50 years old, which are based on recording the activity of individual neurons in anaesthetized animals[6]. In today's neuroscience labs, researchers can monitor and manipulate the activity of thousands of neurons in awake, behaving animals, owing to advances in optical methods, computing, molecular engineering and microelectronics.

We are already intimately connected to our machines. Researchers at Google calculated this year that the average user touches their phone nearly one million times annually (unpublished data). The human brain controls auditory

and visual systems to decipher sounds and images, and commands limbs to hold and manipulate our gadgets. Yet the convergence of developments in neurotechnologies and AI would offer something qualitatively different — the direct linking of people's brains to machine intelligence, and the bypassing of the normal sensorimotor functions of brains and bodies.

Four concerns

For neurotechnologies to take off in general consumer markets, the devices would have to be non-invasive, of minimal risk, and require much less expense to deploy than current neurosurgical procedures. Nonetheless, even now, companies that are developing devices must be held accountable for their products, and be guided by certain standards, best practices and ethical norms.

We highlight four areas of concern that call for immediate action. Although we raise these issues in the context of neurotechnology, they also apply to AI.

Privacy and consent. An extraordinary level of personal information can already be obtained from people's data trails. Researchers at the Massachusetts Institute of Technology in Cambridge, for example, discovered in 2015 that fine-grained analysis of people's motor behaviour, revealed through their keyboard typing patterns on personal devices, could enable earlier diagnosis of Parkinson's disease[7]. A 2017 study suggests that measures of mobility patterns, such as those obtained from people carrying smartphones during their normal daily activities, can be used to diagnose early signs of cognitive impairment resulting from Alzheimer's disease[8].

Algorithms that are used to target advertising, calculate insurance premiums or match potential partners will be considerably more powerful if they draw on neural information — for instance, activity patterns from neurons associated with certain states of attention. And neural devices connected to the Internet open up the possibility of individuals or organizations (hackers, corporations or government agencies) tracking or even manipulating an individual's mental experience.

We believe that citizens should have the ability — and right — to keep their neural data private (see also 'Agency and identity'). We propose the following steps to ensure this.

For all neural data, the ability to opt out of sharing should be the default choice, and assiduously protected. People readily give up their privacy rights to commercial providers of services, such as Internet browsing, social media or entertainment, without fully understanding what they are surrendering. A default of opting out would mean that neural data are treated in the same way that organs or tissues are in most countries. Individuals would need to explicitly opt in to share neural data from any device. This would involve a safe and secure process, including a consent procedure that clearly specifies who will use the data, for what purposes and for how long.

Even with this approach, neural data from many willing sharers, combined with massive amounts of non-neural data — from Internet searches, fitness monitors and so on — could be used to draw 'good enough' conclusions about individuals who choose not to share. To limit this problem, we propose that the sale, commercial transfer and use of neural data be strictly regulated. Such regulations — which would also limit the possibility of people giving up their neural data or having neural activity written directly into their brains for financial reward — may be analogous to legislation that prohibits the sale of human organs, such as the 1984 US National Organ Transplant Act.

Another safeguard is to restrict the centralized processing of neural data. We advocate that computational techniques, such as differential privacy or 'federated learning', be deployed to protect user privacy (see 'Protecting privacy'). The use of other technologies specifically designed to protect people's data would help, too. Blockchain-based techniques, for instance, allow data to be tracked and audited, and 'smart contracts' can give transparent control over how data are used, without the need for a centralized authority. Lastly, open-data formats and open-source code would allow for greater transparency about what stays private and what is transmitted.

Protecting privacy: Federated learning

When technology companies use machine learning to improve their software, they typically gather user information on their servers to analyse how a particular service is being used and then train new algorithms on the aggregated data. Researchers at Google are experimenting with an alternative method of artificial-intelligence training called federated learning. Here, the teaching process happens locally on each user's device without the data being centralized: the lessons aggregated from the data (for instance, the knowledge that the word 'weekly' can be used as an adjective and an adverb) are sent back to Google's servers, but the actual e-mails, texts and so on remain on the user's own phone. Other groups are exploring similar ideas. Thus, information systems with improved designs could be used to enhance users' ownership and privacy over their personal data, while still enabling valuable computations to be performed on those data.

Agency and identity. Some people receiving deep-brain stimulation through electrodes implanted in their brains have reported feeling an altered sense of agency and identity. In a 2016 study, a man who had used a brain stimulator to treat his depression for seven years reported in a focus group[9] that he began to wonder whether the way he was interacting with others — for example, saying something that, in retrospect, he thought was inappropriate — was due to the device, his depression or whether it reflected something deeper about himself. He said: “It blurs to the point where I'm not sure ... frankly, who I am.”

Neurotechnologies could clearly disrupt people's sense of identity and agency, and shake core assumptions about the nature of the self and personal responsibility — legal or moral.

People could end up behaving in ways that they struggle to claim as their own, if machine learning and brain-interfacing devices enable faster translation between an intention and an action, perhaps by using an 'auto-complete' or 'auto-correct' function. If people can control devices through their thoughts across great distances, or if several brains are wired to work collaboratively, our understanding of who we are and where we are acting will be disrupted.

As neurotechnologies develop and corporations, governments and others start striving to endow people with new capabilities, individual identity (our

bodily and mental integrity) and agency (our ability to choose our actions) must be protected as basic human rights.

We recommend adding clauses protecting such rights ('neurorights') to international treaties, such as the 1948 Universal Declaration of Human Rights. However, this might not be enough — international declarations and laws are just agreements between states, and even the Universal Declaration is not legally binding. Thus, we advocate the creation of an international convention to define prohibited actions related to neurotechnology and machine intelligence, similar to the prohibitions listed in the 2010 International Convention for the Protection of All Persons from Enforced Disappearance. An associated United Nations working group could review the compliance of signatory states, and recommend sanctions when needed.

Such declarations must also protect people's rights to be educated about the possible cognitive and emotional effects of neurotechnologies. Currently, consent forms typically focus only on the physical risks of surgery, rather than the possible effects of a device on mood, personality or sense of self.

Augmentation. People frequently experience prejudice if their bodies or brains function differently from most[10]. The pressure to adopt enhancing neurotechnologies, such as those that allow people to radically expand their endurance or sensory or mental capacities, is likely to change societal norms, raise issues of equitable access and generate new forms of discrimination.

Moreover, it's easy to imagine an augmentation arms race. In recent years, we have heard staff at DARPA and the US Intelligence Advanced Research Projects Activity discuss plans to provide soldiers and analysts with enhanced mental abilities ('super-intelligent agents'). These would be used for combat settings and to better decipher data streams.

Any lines drawn will inevitably be blurry, given how hard it is to predict which technologies will have negative impacts on human life. But we urge that guidelines are established at both international and national levels to set limits on the augmenting neurotechnologies that can be implemented, and to define the contexts in which they can be used — as is happening for gene editing in humans.

Privacy and individuality are valued more highly in some cultures than in others. Therefore, regulatory decisions must be made within a culture-specific context, while respecting universal rights and global guidelines. Moreover, outright bans of certain technologies could simply push them underground, so efforts to establish specific laws and regulations must include organized forums that enable in-depth and open debate.

Such efforts should draw on the many precedents for building international consensus and incorporating public opinion into scientific decision-making at the national level[11]. For instance, after the First World War, a 1925 conference led to the development and ratification of the Geneva Protocol, a treaty banning the use of chemical and biological weapons. Similarly, after the Second World War, the UN Atomic Energy Commission was established to deal with the use of atomic energy for peaceful purposes and to control the spread of nuclear weapons.

In particular, we recommend that the use of neural technology for military purposes be stringently regulated. For obvious reasons, any moratorium should be global and sponsored by a UN-led commission. Although such commissions and similar efforts might not resolve all enhancement issues, they offer the best-available model for publicly acknowledging the need for restraint, and for wide input into the development and implementation of a technology.

Bias. When scientific or technological decisions are based on a narrow set of systemic, structural or social concepts and norms, the resulting technology can privilege certain groups and harm others. A 2015 study[12] found that postings for jobs displayed to female users by Google's advertising algorithm pay less well than those displayed to men. Similarly, a ProPublica investigation revealed last year that algorithms used by US law-enforcement agencies wrongly predict that black defendants are more likely to reoffend than white defendants with a similar criminal record (go.nature.com/29aznyw). Such biases could become embedded in neural devices. Indeed, researchers who have examined these kinds of cases have shown that defining fairness in a mathematically rigorous manner is very difficult (go.nature.com/2ztfjt9).

Practical steps to counter bias within technologies are already being discussed in industry and academia. Such ongoing public discussions and debate are necessary to shape definitions of problematic biases and, more generally, of normality.

We advocate that countermeasures to combat bias become the norm for machine learning. We also recommend that probable user groups (especially those who are already marginalized) have input into the design of algorithms and devices as another way to ensure that biases are addressed from the first stages of technology development.

Responsible neuroengineering

Underlying many of these recommendations is a call for industry and academic researchers to take on the responsibilities that come with devising devices and systems capable of bringing such change. In doing so, they could draw on frameworks that have already been developed for responsible innovation.

In addition to the guidelines mentioned above, the UK Engineering and Physical Sciences Research Council, for instance, provides a framework to encourage innovators to “anticipate, reflect, engage and act” in ways that “promote ... opportunities for science and innovation that are socially desirable and undertaken in the public interest”. Among the various efforts to address this in AI, the IEEE Standards Association created a global ethics initiative in April 2016, with the aim of embedding ethics into the design of processes for all AI and autonomous systems.

History indicates that profit hunting will often trump social responsibility in the corporate world. And even if, at an individual level, most technologists set out to benefit humanity, they can come up against complex ethical dilemmas for which they aren't prepared. We think that mindsets could be altered and the producers of devices better equipped by embedding an ethical code of conduct into industry and academia.

A first step towards this would be to expose engineers, other tech developers

and academic-research trainees to ethics as part of their standard training on joining a company or laboratory. Employees could be taught to think more deeply about how to pursue advances and deploy strategies that are likely to contribute constructively to society, rather than to fracture it.

This type of approach would essentially follow that used in medicine. Medical students are taught about patient confidentiality, non-harm and their duties of beneficence and justice, and are required to take the Hippocratic Oath to adhere to the highest standards of the profession.

The possible clinical and societal benefits of neurotechnologies are vast. To reap them, we must guide their development in a way that respects, protects and enables what is best in humanity.

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The catalogue that made metrics, and changed science

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As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.

Alamy

Cataloguers of the Royal Society developed the first record of published scientific research.

In 1830, Charles Babbage had an unusual idea. Exasperated by how little recognition science was getting in England, the computer pioneer and scientific provocateur suggested that quantifying authorship might be a way to identify scientific eminence.

Like many of Babbage's radical ideas, this one persuaded almost nobody, but it eventually proved prophetic. Before the end of the century, listing papers and comparing publication counts had become a popular pursuit among scientific authors and other observers. Within a few decades, academic scientists were coming to fear the creed of 'publish or perish' (see 'Catalogues and counts').

This transformation can inform current debates about the value of algorithms for quantifying scientific credibility and importance. History shows how search technologies and metrics are not neutral tools that simply speed up efforts to locate and evaluate scientific work. Metrics transform the very things that they measure. By changing the reward structure, they alter researchers' behaviour — both how results are communicated and which topics receive the most attention.

But there is a second, more subtle, transformation that we must be alert to. The processes by which scientific merit is judged have long been central to the public perception of scientific authority. As these processes change, we must also consider the ways in which broader cultural beliefs about scientific expertise are transformed.

Broken pieces of fact

Babbage's suggestion to count authors' papers was met with various criticisms. One author did the calculation for each fellow in the Royal Society in London, and showed that this was a terrible guide to scientific eminence. Another pointed out[1] that “a far more satisfactory criterion” would have been “the value of those papers”.

Back then, scientific reputations were built not on periodicals but on books and other proofs of genius that demonstrated mastery of a subject. Babbage himself had little respect for most scientific journals, and he limited his proposal to counting papers in the venerable *Philosophical Transactions of the Royal Society of London*. As late as 1867, the British physiologist Michael Foster, in a retrospective written on the life of Karl von Baer, heaped praise on the embryologist's multivolume masterwork, *On the Development*

of Animals, and dismissed his periodical publications. These, Foster claimed[2], were just “specimens of those broken pieces of fact, which every scientific worker throws out to the world, hoping that on them, some time or other, some truth may come to land”.

Alamy

But things were beginning to change. A young engineer working for the US

Coast and Geodetic Survey (now the National Geodetic Survey) had suggested that it would be useful if some catalogue could be devised to keep track of the publications of European scientific societies. Once the idea crossed the Atlantic and percolated up to the Royal Society, its scope grew to become a list of all periodical papers containing original scientific research published since 1800. Some questioned the need to preserve so much insignificant writing. The physicist William Thomson (later Lord Kelvin) warned that the project would lead the society to financial ruin.

The main argument for what would become the *Catalogue of Scientific Papers* was that periodical publishing was a mess. Although many authors published in the journals of scientific societies, vast quantities of valuable information appeared in popular-science magazines, encyclopaedias and general-interest weeklies. Authors distributed huge numbers of offprints that sometimes did not even make clear what journal they had come from.

When the society's indexers got down to work in 1867, they realized that the situation was worse than they'd imagined. For thousands of papers, they couldn't even figure out who the author was. Many who published in periodicals chose to remain anonymous, or signed only their initials. In other cases, it was hard to tell to what extent the writer of a paper was responsible for its contents, or whether another person ought to be credited. Moreover, vast numbers of papers were published in various forms in different periodicals, and it was no easy matter deciding what should count as the same publication. Today, such publishing habits would probably lead to accusations of misconduct; not very long ago this was business as usual.

The Royal Society's cataloguers did what they could, contacting editors and authors to match names to papers. They turned a significant portion of the society's library into a bibliographic workroom, and made their job simpler by excluding all general-interest periodicals from the search, as well as anything that smacked of reading for non-specialists. They compiled lists of which periodicals ought to be included in the count, and circulated them to other experts and academies for feedback. The decision about whether to index some doubtful titles sometimes made it all the way to the society's council for a vote.

As their work progressed, the directors of the project came to realize that

their charge to produce a master list of all 'scientific papers' published since 1800 might actually influence publishing practices in the future. They hoped that authors would be more careful about where they published — or at least sign their contributions[3]. They probably did not anticipate the full consequences of what they were about to unleash.

Counting what counts

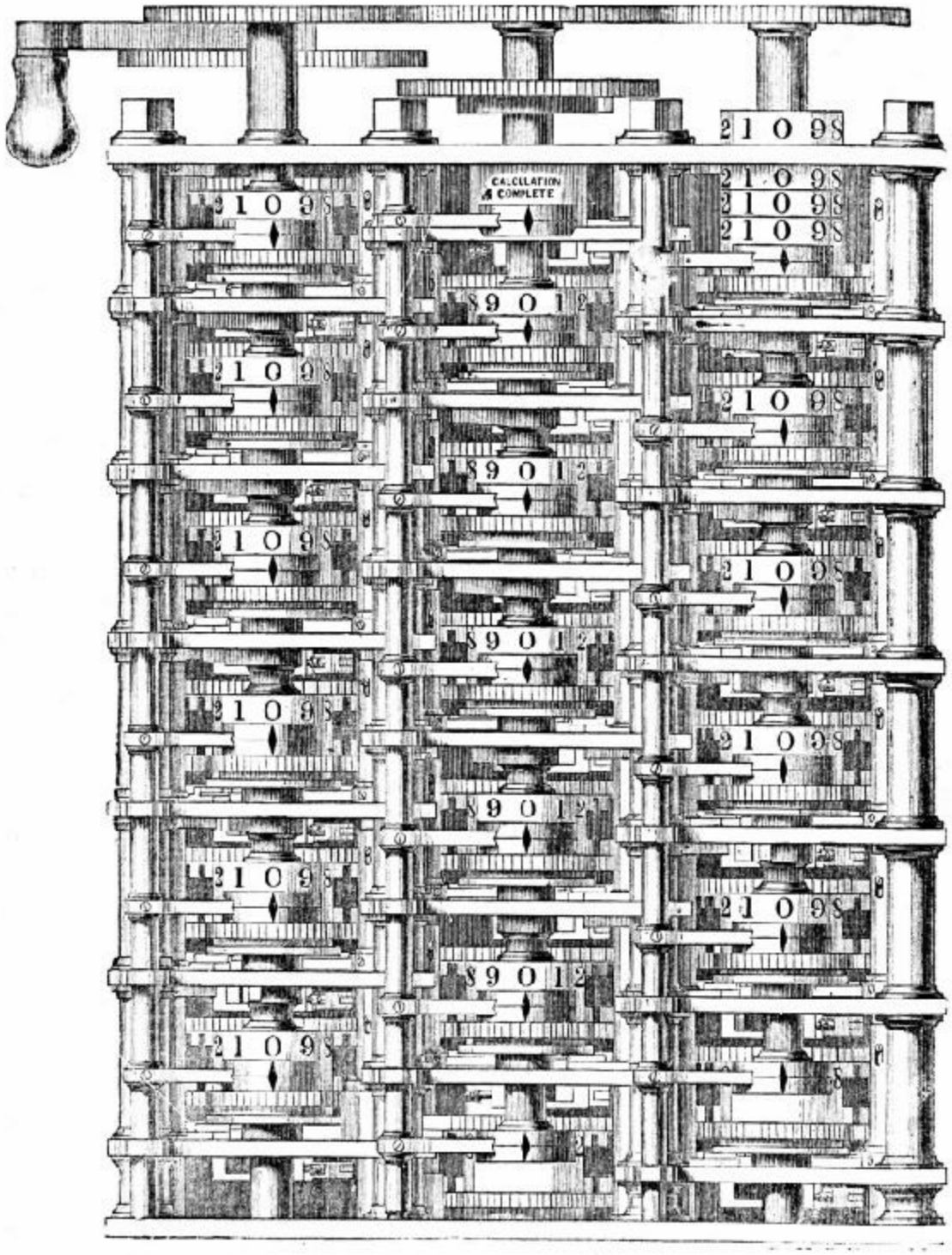
When the first volumes of the *Catalogue of Scientific Papers* appeared at the end of 1867, reaction across Europe and the United States was swift and wide-ranging. One observer wrote in awe that the catalogue made science look like a coral-island, a majestic edifice that grew imperceptibly larger with the addition of each new fact embodied in each paper. Some were less enthusiastic. One Royal Society fellow complained that the editors had distorted “the progress and history of discovery both in Physical and Natural Science” by excluding so many valuable contributions from “journals not professedly scientific”, accounts of scientific voyages, independently published treatises, encyclopaedia articles (which at the time often included original research), and much more[4].

Many observers hurried over the prospect of how helpful the catalogue would be for finding information and began comparing the productivity of individuals. By quantifying the contributions of each author, the catalogue seemed tailor-made for keeping score. A writer in *Nature* got down to business[5]: “Dr. Hooker appears for 58 papers; his late father for 72; and the late W. Hopkins, who did so much in mathematical geology, for 33 .... the indefatigable Isaac Lea, of Philadelphia, for 106, mostly about shells...”. And so forth. In a detailed review in a Viennese newspaper, the mineralogist Wilhelm von Haidinger began by urging prudence, warning that the mere comparison of numbers was no basis on which to make judgements of value[6]. But even he admitted that the numbers were somehow irresistible. Within two years, von Haidinger had taken his numerical analysis further. He published a study based on the catalogue that included a chart that compared the number of highly productive scientific authors in each region of Europe, lamenting the low position of Austria according to this ranking[7].

Such enthusiasm for counting had practical consequences. Within a decade of those first volumes appearing, the forms submitted by candidates for admission to the Royal Society transformed into long lists of papers. By the early 1870s, obituaries and biographical encyclopaedias were routinely noting the number of papers written by a researcher, and even following the chronology sketched out by those papers as guide-posts to a career. By 1900, even Foster, the physiologist once so sceptical of scientific periodicals, had changed his tune. Original science belonged in periodicals, he explained. Putting new findings in books — as Charles Darwin had famously done — was “out of place and even dangerous”[8]. To be an expert on scientific subjects meant being an author of scientific papers.

Publish or perish

There is a direct line from these developments to twentieth-century worries about scientific publishing going off the rails. A letter to *Nature* in 1932 lamented the growing practice of candidates submitting a “list of strictly technical publications” to the Royal Society, leading to the result that “our journals are filled with masses of unreadable trash” published by ambitious scholars hoping to strengthen their applications[9].



Alamy

Charles Babbage, inventor of the difference engine, was an advocate of counting papers.

This was around the same time that the phrase publish or perish began to circulate in academia. It did so first in the United States, where the spread of research universities was turning science into something resembling a profession. The slogan became shorthand for the corrupting influence of narrow, bureaucratic performance measures of research.

In the 1960s, Eugene Garfield launched a radically different search tool, known as the Science Citation Index. He hoped that it might end the harmful culture of publish or perish by showing that some papers were more cited — and hence more valuable — than others.

Immediately, commentators warned that new measures based on citations would only make things worse, leading to a “highly invidious pecking order” of journals that could distort science[10]. The journal impact factor made its public debut in 1972, soon after the US Congress called on the National Science Foundation to produce a better account of the benefits wrought by public funding of science. There is no doubt that the citation index changed practices of scientific publishing, just as the rise of counting papers had followed the introduction of the catalogue before.

Today, advocates of altmetrics argue that well-made algorithms can mimic and aggregate the everyday acts of judgement that researchers make when they read, cite, link or otherwise engage with published research. These algorithms, they claim, will turn out to be as good or better at replicating established processes — such as peer review — that are supposed to delimit what constitutes important and trustworthy research.

Whether or not these claims turn out to be true, they ignore the question of whether we deem the procedures that experts use to evaluate ideas to be intrinsically valuable (that is, independent of the content of those judgements).

Scientific judgement does not happen in a cultural vacuum. The rise of processes such as peer review to organize and evaluate research was never simply about getting scientific judgement right; it was about balancing scientists' expert cultures with public demands for accountability. The *Catalogue of Scientific Papers* was itself part of a cultural moment in which

indexes and card catalogues were celebrated for their potential to set knowledge free and even foster world peace. Interest in altmetrics has grown alongside widespread fascination with the potential of online platforms to make scientific communication both more open and more democratic.

At a time when the public status of the scientific expert is becoming increasingly uncertain, these questions are more important than ever. In a democracy, the procedures by which we decide what constitutes valuable scientific knowledge fundamentally depend on public conceptions of the aims of the scientific enterprise.

The question of whether new metrics might one day replicate the results of peer review (when it is working well) is a red herring. How we choose to judge what constitutes good science is just as important as the end results of those judgements. Even algorithms have politics.

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Further reading

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Comments

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Indian scientists urged to speak out about pseudoscience

Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.

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Pallava Bagla/Corbis/Getty

Scientists taking part in India's march for science in August were protesting against the spread of anti-science beliefs, superstitions and myths.

A leading Indian science-advocacy group is urging the country’s researchers to speak out against pseudoscience, which it fears has gained a foothold in the past few years, partly through support from some agencies of the Indian

government.

The call to arms, made by the non-profit Breakthrough Science Society, comes after some members of an alumni association of the prestigious Indian Institute of Science (IISc), Bangalore, planned a workshop on astrology at the IISc for 25–26 November.

Strong backlash from scientists resulted in the event being cancelled on 28 October. The society's general secretary, Soumitro Banerjee, says that it would be "detrimental to Indian science" for researchers to remain neutral on such issues. "India's scientific community must be proactive in propagating a scientific bent of mind," says Banerjee, a physicist at the Indian Institute of Science Education and Research Kolkata.

Timeline of events

Two days before the alumni association cancelled the workshop, dozens of scientists signed letters to the IISc director, Anurag Kumar, objecting to the workshop. The IISc director and the faculty were not involved in organizing the workshop.

Muthya Ravindra, a computer scientist and president of the alumni association, says that the event, organized by one of its members, was still under discussion when "due to some miscommunications", e-mails promoting the event were sent out.

But Ravindra says that despite criticism from scientists and other academics, people widely believe in astrology and seek its advice in newspapers, magazines and on television. He is unsure what role scientists should play in educating society on the dangers such practices may have. "It is very confusing to me whether we as scientists [should] criticize or take some part in finding a solution," he says.

India's ruling party, the conservative Bharatiya Janata Party (BJP) has shown support for giving astrology a place in universities. In 2001, then-science minister of the BJP-led coalition government Murli Manohar Joshi took steps to allow public universities to include astrology classes in curricula.

However, the Indian government and science ministry did not have a role in the IISc alumni association's planned astrology workshop.

Pseudoscience debate

Alarm in the Indian scientific community over anti-science policies and programmes has been brewing for some time. Several scientists who spoke with *Nature* are reluctant to comment publicly about it for fear of jeopardizing their jobs. Others took part in the March for Science organized by the 7,000-member Breakthrough Science Society in August in around 40 Indian cities, in part to protest the government's support for ideas not yet backed by science. One area of concern, says Banerjee, is the government's push for a national research programme on the health and other benefits of a combination of five cow products, known as panchgavya.

The Indian Institute of Technology (IIT), Delhi, hosted a two-day workshop last December to discuss ways to validate research on panchgavya, which was supported by India's Department of Science and Technology, Department of Biotechnology, and Council of Scientific and Industrial research (CSIR), and inaugurated by India's science minister Harsh Vardhan.

According to IIT Delhi's website, Vardhan, who is a physician, "emphasised that use of panchgavya in practice and in daily routines will help to address the pressing global issues like climate change, resistance development, malnourishment, global health etc".

Following the workshop, India's science ministry formed a national steering committee to initiate a national programme on the topic.

Supporters of this research say that cow products should be considered part of India's vast traditional knowledge base. But critics say that such unverified theories are pseudoscience, and that singling out the benefits of cow products is part of a larger political agenda by Hindus, for whom the cow is a sacred animal.

They also argue that research on topics such as panchgavya should be handled in a neutral manner rather than as a way of promoting traditional

knowledge. Rahul Siddharthan, a computation biologist at the Institute of Mathematical Sciences in Chennai, says that the government must accept that any research involving traditional hypotheses about health could potentially refute those hypotheses. “Refutability is the essence of science,” he says.

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Comments

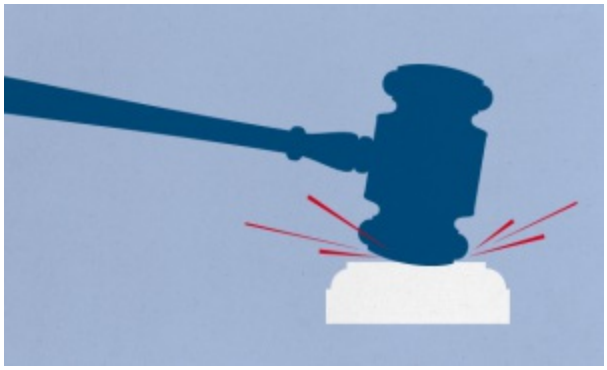
Commenting is currently unavailable.

Pirate paper website Sci-Hub dealt another blow by US courts

American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.

07 November 2017 Updated:

1. 08 November 2017



The American Chemical Society (ACS) has won a lawsuit against the pirate research-paper website Sci-Hub, over the site’s illicit use and dissemination of ACS articles.

On 3 November, a US court ordered Sci-Hub's operators to pay the ACS US$4.8 million in damages for copyright infringement and trademark violation. Sci-Hub’s owners did not appear in court to present their case.

The judge also ordered that any party “in active concert or participation” with Sci-Hub should “cease facilitating” access to the repository. This means that the ACS could request Internet services including web providers, search engines and domain-name registrars to stop linking or to block access to Sci-Hub and the various domains it is hosted under.

Which services might be approached by the ACS isn't yet clear: the meaning of the phrase "in active concert or participation with" is open to legal interpretation, says Michael Carroll, an information-justice and intellectual-property specialist at the American University Washington College of Law in Washington, DC.

There are no clear standards as to when an Internet service is in "active concert" with a pirate website, says Carroll. A user merely resolving a domain-name request to such a site, for example, does not yet qualify as active participation, he adds.

Such an order by a US court is exceptional, Carroll says. "In general, our federal courts do not have the power to issue orders against people or entities that were not part of the lawsuit." But he adds that US federal rules for civil procedures such as this do sometimes allow injunctions against persons who are in 'active participation' with an enjoined party. The current lawsuit is an example of that, he says.

The ruling is another legal blow for Sci-Hub, which provides free access to millions of paywalled research papers and is popular with researchers around the world. In June, a New York court granted the Dutch publisher Elsevier $15 million in damages from the site for large-scale copyright infringement.

But publishers are unlikely to see any money from Sci-Hub because its chief operator lives outside the United States. Alexandra Elbakyan, a former neuroscientist who created the portal in 2011, says the court order is an example of censorship.

The ACS, which filed its lawsuit in June in a Virginia court, said in a statement on 6 November that the ruling was "a victory for copyright law and the entire publishing enterprise". An analysis published in August estimated that as of March 2017, Sci-Hub's database contained 69% of the world's roughly 81.6 million scholarly articles — and 98.8% of the ACS's journal content.

The ACS says that it will now seek to enforce the court's order. Asked for comment, the society referred *Nature*'s news team to its statement. But Internet service providers are expected to resist what they may perceive as

undue censorship.

Attempts to stop people visiting Sci-Hub face another hurdle, too: the site has an alternative address that can be reached by users of the Tor network, a group of servers that encrypts Internet traffic and disguises its origins. No Internet provider can easily block access to such sites.

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Updates

Updated:

The story has been updated with comments from Alexandra Elbakyan.

Comments

Commenting is currently unavailable.

Genetically modified apple reaches US stores, but will consumers bite?

Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.

07 November 2017

Okanagan Specialty Fruits, Inc.

The apple on the right doesn’t bruise when dropped — it lacks a gene encoding an enzyme that causes plant cells to brown on exposure to oxygen.

This month, bags of sliced apples will hit grocery-store shelves in the midwestern United States for the first time. Shoppers who purchase the apples can leave the slices out for snacking, because of a feat of genetic engineering that prevents their flesh from browning when exposed to air.

The ‘Arctic apple’ is one of the first foods to be given a trait intended to please consumers rather than farmers, and it joins a small number of genetically modified organisms (GMOs) to be sold as a whole product, not an ingredient. Since Okanagan Specialty Fruits in Summerland, Canada, planted its first test apples in 2003, the array of foods modified in labs has expanded to include meatless burgers, made with soya protein produced by recombinant yeast, fish fillets grown from seafood stem cells, and mushrooms whose genomes have been edited with CRISPR technology. Most of these items have not yet reached the market.

Now, many small biotechnology companies developing such foods are watching the Arctic apple’s launch, eager for clues to how consumers will perceive the fruits of their labour.

“If the apple sells, it will pave the way for others,” says Yinong Yang, a plant pathologist at Pennsylvania State University in University Park, who used CRISPR to engineer a mushroom that resists browning. He hopes one day to license his mushroom to commercial growers.

Mary Maxon, who oversees biosciences programmes at Lawrence Berkeley National Laboratory in California, agrees. “The apple is not the first GMO that people would eat, but it’s the first one that consumers may value,” she says.

When Okanagan co-founder Neal Carter took over his family’s orchard in 1995, he thought hard about how to win over the US snack market. He found his answer in Australia, where researchers at the Commonwealth Scientific and Industrial Research Organisation had figured out how to delete a gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives.

Only later did he realize that if consumers were to be enticed to buy, Americans’ distrust of GMOs would need to be overcome. Okanagan’s subsequent surveys of people in America’s top apple-growing states — New York and Washington — revealed that about 20% were wary of GMOs. But the company also found that many people changed their minds when told that the apples were engineered to silence browning genes, and then tested for

safety.

Mike Seldon, the co-founder of Finless Foods, a firm in New York City that is developing fish fillets from fish stem cells, agrees that providing more information helps to win over consumers. “We’re not going to repeat the mistakes of the GMO industries in the past, and just put foods on the market without public conversation,” he says. “If we do, you can expect a backlash — and that’s warranted.”

Seldon sees a parallel between the Arctic apple and his fillets: both were created with attributes to please consumers. Finless Foods, which has made prototypes of bluefin-tuna fillets, hopes that people will be won over by the idea of eating fish without worrying about overfishing, animal slaughter or environmental pollution.

But others say that Okanagan hasn’t gone far enough in telling consumers how its apple was made. The company does not mention GMOs on the apples’ bags; instead, the bags have a QR code — which links to online information when it is scanned by a smartphone. “Not everyone has a smartphone, and even if you have one, are you going to check every item with it?” says Bill Freese, a science-policy analyst at the Center for Food Safety, an advocacy group in Washington DC. He wants the apples to be clearly labelled as GMOs.

Consumer reaction isn’t the only concern for developers of genetically engineered or other lab-made foods who want to sell their wares in the United States. One major stumbling block is the US regulatory process, which involves a complicated tangle of federal agencies — and, for many companies, an unclear path forward. US regulators assessed the Arctic apple for five years before approving it for sale, but spent just two years reviewing a non-browning GM potato developed by agricultural firm J. R. Simplot of Boise, Idaho.

Then there is the case of the CRISPR mushroom. The US Department of Agriculture (USDA) said in 2016 that it would not evaluate the mushroom, which was created by using CRISPR to delete a gene. That seemed to clear the fungus’s path to the market. But Yang says that, after *Nature*’s news team reported on the USDA’s decision, the US Food and Drug Administration

contacted him to ask whether it could review the mushroom. “I agreed to that since it would give consumers a peace of mind,” he says.

As far as investors are concerned, regulatory uncertainty may be less of a barrier to the success of engineered foods than customer uncertainty. James Hardiman, a partner at the venture-capital fund Data Collective in San Francisco, California, says that companies developing such foods can always build a few extra years into their long-term plans, to account for twists in the regulatory process. “The public narrative is much more difficult to control,” he says. “We know the public can be irrational.”

Still, Carter is optimistic about how his Arctic apple will be received. “We rarely get e-mails saying we are Satan any more,” he says of his company. “Now we have people asking where they can buy the apples.”

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Comments

Comments

There are currently no comments.

US government approves 'killer' mosquitoes to fight disease

US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.

06 November 2017

Dennis Kunkel Microscopy/SPL

The lab-grown mosquitoes developed by MosquitoMate seek to eliminate the disease-carrying Asian tiger mosquito (*Aedes albopictus*, shown here).

The US Environmental Protection Agency (EPA) has approved the use of a common bacterium to kill wild mosquitoes that transmit viruses such as dengue, yellow fever and Zika, *Nature*'s news team has learned.

On 3 November, the agency told biotechnology start-up MosquitoMate that it could release the bacterium *Wolbachia pipientis* into the environment as a tool against the Asian tiger mosquito (*Aedes albopictus*). Lab-reared mosquitoes will deliver the bacterium to wild mosquito populations.

The decision — which the EPA has not formally announced — allows the company, which is based in Lexington, Kentucky, to release the bacteria-infected mosquitoes in 20 US states and Washington DC.

“It’s a non-chemical way of dealing with mosquitoes, so from that perspective, you’d think it would have a lot of appeal,” says David O’Brochta, an entomologist at the University of Maryland in Rockville.“I’m glad to see it pushed forward, as I think it could be potentially really important.”

MosquitoMate will rear the *Wolbachia*-infected *A. albopictus* mosquitoes in its laboratories, and then sort males from females. Then the laboratory males, which don’t bite, will be released at treatment sites. When these males mate with wild females, which do not carry the same strain of *Wolbachia*, the resulting fertilized eggs don’t hatch because the paternal chromosomes do not form properly.

The company says that over time, as more of the *Wolbachia*-infected males are released and breed with the wild partners, the pest population of *A. albopictus* mosquitoes dwindles. Other insects, including other species of mosquito, are not harmed by the practice, says Stephen Dobson, an entomologist at the University of Kentucky in Lexington and founder of MosquitoMate.

Production challenges

The EPA restricted the release of MosquitoMate’s product, called ZAP males, to 20 states and Washington DC. The agency has previously said that those places “are similar in temperature and precipitation to areas where efficacy of the ZAP males was tested” — Kentucky, New York and California. The EPA decision excludes much of the southeastern United

States, which is home to dense populations of mosquitoes and a long mosquito season, because MosquitoMate did not conduct field trials there.

MosquitoMate plans to begin selling its mosquitoes locally, in Lexington, and will expand from there to nearby cities such as Louisville, Kentucky, and Cincinnati, Ohio. The company will work with homeowners, golf courses, hotels and other customers to deploy its insects, according to Dobson. “Now the work starts,” he says.

The company will have to start small. Suppressing the mosquito population of an entire city is likely to require the weekly production of millions of these mosquitoes. To reach that level, Dobson’s company must find a way to efficiently separate male mosquitoes from females. The company’s technicians now separate them both by hand and mechanically, Dobson says.

Another group that is also developing mosquitoes infected with *Wolbachia* to control wild populations has succeeded in producing large quantities of their insects. Researchers from Sun Yat-sen University in Guangzhou, China, and Michigan State University in East Lansing say they are releasing 5 million *Wolbachia*-infected *A. albopictus* each week in Guangzhou.

The scientists use mechanical sorters to separate males from females, on the basis of size differences at the pupal stage, at more than 99% efficiency, says Zhiyong Xi, a medical entomologist and microbiologist at Michigan State University, who leads the project. They expose the remaining mosquitoes to X-ray radiation at a dose that sterilizes any remaining females, but is too low to affect the males.

Looking ahead

Using lab-grown mosquitoes to kill mosquito pests has been tested extensively in Brazil in recent years. The country has allowed large-scale releases of such mosquitoes in response to an epidemic of the Zika virus that began in 2015. Zika is a mosquito-borne virus that has been linked to severe birth defects, such as abnormally small heads — a condition known as microcephaly. *Aedes aegypti* mosquitoes are thought to be the primary vector

for the virus.

One type of mosquito being tested in Brazil is a genetically modified variety of *A. aegypti* developed by Oxitec in Milton, UK. When the modified male mosquitoes mate with wild females, they pass a lethal gene on to any progeny.

Oxitec has run into challenges when attempting to test its GM mosquitoes in the United States, however. A community in the Florida Keys voted last year against allowing Oxitec to conduct field trials there, although the rest of the county in which the community is located voted in favour of the plans.

By contrast, MosquitoMate has developed and tested a variety of *Wolbachia*-carrying *A. aegypti* mosquitoes in the Florida Keys and Fresno, California, without drawing much public attention. The EPA received only 14 comments during the public-comment period for the Florida trials, and most of them were positive. The company plans to submit an application to the EPA for nationwide release of that species, says Dobson.

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Comments

Commenting is currently unavailable.

Language patterns reveal body's hidden response to stress

Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

06 November 2017

Carlo Allegri/Getty

Listen in: the words people say may reveal the body's biological response to threat.

Subtleties in the language people use may reveal physiological stress.

Psychologists found that tracking certain words used by volunteers in randomly collected audio clips reflected stress-related changes in their gene expression. The speech patterns predicted those physiological changes more

accurately than speakers' own ratings of their stress levels.

The research, which is published on 6 November in *Proceedings of the National Academy of Sciences*[1] suggests that changes in language may track the biological effects of stress better than how we consciously feel. It's a new approach to studying stress, says David Creswell, a psychologist at Carnegie Mellon University in Pittsburgh, Pennsylvania, and one that "holds tremendous promise" for understanding how psychological adversity affects physical health.

Adverse life circumstances — such as poverty, trauma or social isolation — can have devastating effects on health, increasing the risk of a variety of chronic disorders ranging from heart disease to dementia. Researchers trying to pin down the biological mechanisms involved have found that people who experience these circumstances also undergo broad changes in gene expression in the cells of their immune system. Genes involved in inflammation become more active, for example, and antiviral genes are turned down.

These biological changes seem to represent the body's evolutionary response to threat, says Steve Cole, a genomicist at the University of California, Los Angeles, and a co-author on the paper. But he was always troubled by a "nagging observation": they don't tally well with how stressed people say they are.

Cole wondered whether stress biology is triggered instead by an automatic assessment of threat in the brain, which doesn't necessarily reach conscious awareness. To find out, he and his colleagues teamed up with Matthias Mehl, a psychologist at the University of Arizona, Tucson, who studies how stress affects language.

Stress on speech

The researchers asked 143 adult volunteers in the United States to wear audio recorders, which switched on every few minutes for two days, capturing a total of 22,627 clips. Mehl transcribed any words spoken by the volunteers,

and analysed the language they used.

He was particularly interested in what psychologists call 'function' words, such as pronouns and adjectives. “By themselves they don’t have any meaning, but they clarify what’s going on,” says Mehl. Whereas we consciously choose 'meaning' words such as nouns and verbs, researchers believe that function words “are produced more automatically and they betray a bit more about what’s going on with the speaker”. Mehl and others have found, for example, that people’s use of function words changes when they face a personal crisis or following terrorist attacks.

The researchers compared the language used by each volunteer with the expression in their white blood cells of 50 genes known to be influenced by adversity. They found that the volunteers’ use of function words predicted gene expression significantly better than self-reports of stress, depression and anxiety.

People with more stressed-out gene-expression signatures tended to talk less overall. But they used more adverbs such as 'really' or 'incredibly'. These words may act as “emotional intensifiers”, says Mehl, signifying a higher state of arousal. They were also less likely to use third-person plural pronouns, such as 'they' or 'their'. That makes sense too, he says, because when people are under threat, they may focus less on others and the outside world.

He cautions that more research is needed to test these specific effects, and to assess whether stress influences language, or vice versa. But he suggests that the approach could ultimately help to identify people at risk of developing stress-related disease. Doctors may need to “listen beyond the content” of what patients tell them, he says, “to the way it is expressed”.

Cole suggests that assessing language use could help to test whether interventions aimed at reducing stress really work. Perhaps “you could even ditch self-report stress measures”, he says, and instead listen passively to how trial participants speak.

“Language reflects how people connect with their world, but who would ever have thought that gene expression would be related to language?” says James

Pennebaker, a psychologist at the University of Texas, Austin, who has pioneered research on language and social processes (and has previously worked with Mehl). “It’s such an exciting new way of thinking,” he adds. “I was blown away.”

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Comments

Comments

There are currently no comments.

US government report says that climate change is real — and humans are to blame

Conclusions of climate-change science analysis are at odds with US President Donald Trump’s policies.

03 November 2017

Drew Angerer/Getty

Heat waves are growing more common in many parts of the United States.

From warmer temperatures to more extreme weather, melting glaciers and rising sea levels, humanity is fundamentally changing the planet by pumping

greenhouse gases into the atmosphere, US government scientists said on 3 November in their latest assessment of climate science.

The average global temperature has increased by 1 °C since the pre-industrial era, the 477-page report says — adding that the past 115 years comprise the warmest period "in the history of modern civilization". The analysis warns that temperatures could increase by another 4 °C by the end of the century, with dramatic consequences for humans and natural ecosystems.

The findings are at odds with the policies of US President Donald Trump, who has questioned well-established tenets of climate science and vowed to protect and promote the US fossil-fuel industry. Trump's stances led many scientists to worry that his administration would try to block or tamper with the climate-change assessment, but several scientists who helped to write the document reported no problems.

"We weren't interfered with, and we ended up producing something that I think is of tremendous value," says David Fahey, an atmospheric scientist with the National Oceanic and Atmospheric Administration in Boulder, Colorado, and a coordinating lead author of the analysis.

The climate-science report is the first volume of the fourth National Climate Assessment, a legally mandated analysis of the causes and impacts of global warming that is due in 2018. The second volume focuses on how climate change is affecting life in the United States, from crop yields to property damage from extreme weather. That document was released in draft form, along with a report on the carbon cycle. The US National Academy of Sciences is set to review the latter two documents.

"The science speaks for itself," says Don Wuebbles, a climate scientist at the University of Illinois at Urbana-Champaign and a coordinating lead author of the climate-science report. "It's hard to counteract the basic observations and the truth of the science with any kind of political playing around."

The trio of documents paints a dramatic picture of how global warming is affecting people and communities across the United States. Tidal flooding is accelerating in more than 25 cities along the coasts of the Atlantic Ocean and the Gulf of Mexico. Large forest fires have become more frequent in the

western part of the country, and warmer spring temperatures combined with shrinking mountain snowpack are reducing the amount of water available to the region's cities and farms. As a result, the draft climate-impacts report warns, "chronic, long-duration hydrological drought is increasingly possible before the end of the century".

The climate-science report was released just days before the latest United Nations climate talks kick off in Bonn, Germany. The summit will be the first major meeting of its kind since Trump vowed to pull the United States out of the 2015 Paris climate pact.

Few observers expect the US government's latest set of climate-change analyses to affect how the Trump administration approaches energy and environmental issues. In August, the National Oceanic and Atmospheric Administration disbanded an advisory committee that was intended to help the nation prepare for a warmer climate by translating the findings of the coming climate assessment into guidance for cities, states and industry.

Nor is it clear whether senior Trump administration officials will accept the reports' core scientific conclusions. As recently as March, US Environmental Protection Agency administrator Scott Pruitt said he did not believe that carbon dioxide is a major driver of global warming.

Nonetheless, many scientists and environmentalists lauded the new reports for bolstering the case for more-aggressive action against climate change.

"The full assessment, when it gets published, is going to show that there are palpable impacts that are going to hit every part of the country," says Andrew Light, a senior fellow at the World Resources Institute, an environmental think-tank based in Washington DC. "It's the responsibility of leaders to take note of that and act accordingly."

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Comments

Commenting is currently unavailable.

Energy researcher sues the US National Academy of Sciences for millions of dollars

Rare move stems from a conflict over two journal articles about renewable energy.

03 November 2017 Corrected:

1. 07 November 2017

Eric Thayer/Bloomberg/Getty

Renewable energy, including from wind, is at the heart of a multi-million dollar lawsuit.

A scientific dispute about the future of alternative energy has landed in a US court. Mark Jacobson, an environmental and civil engineer at Stanford University in California, has filed a libel lawsuit against the US National Academy of Sciences (NAS) and a researcher who published a study in the academy's journal that criticized Jacobson's work.

Jacobson, who filed suit in superior court in Washington DC in late September, is seeking damages of US$10 million. He also wants the *Proceedings of the National Academy of Sciences* (*PNAS*) to retract the article it published by mathematician Christopher Clack this year. The NAS and Clack have until late November to respond, according to court documents. Some experts are worried that the lawsuit could dampen scientific progress on renewable energies. But others defend the move, saying researchers should be able to take advantage of all civil avenues in defense of their work.

Jacobson was the lead author of a high-profile *PNAS* paper[1] published in December 2015 making the case that the continental United States could meet nearly 100% of its energy needs using wind, water and solar sources as early as 2050. A rebuttal[2] written by Clack — then at the University of Colorado Boulder — and 20 co-authors, and published in *PNAS* in June 2017, questioned Jacobson's methodology and challenged his conclusions. The authors argued, among other things, that Jacobson's paper overestimated the maximum outputs from hydroelectric facilities and the nation's capacity to store energy produced by renewable sources.

In the lawsuit, Jacobson says that he had alerted *PNAS* to 30 falsehoods and five "materially misleading statements" in Clack's paper before its publication. The complaint states that almost all of those inaccuracies remained in the published version. Jacobson also argues that "the decision by NAS to publish the Clack Paper in PNAS has had grave ramifications" for his reputation and career.

In a letter[3] accompanying Clack's paper in *PNAS*, Jacobson and three co-authors wrote that Clack's criticisms are "demonstrably false". They maintained that their projections regarding hydroelectric power were based

on an assumed increase in the number of turbines and were not a “modeling mistake”.

Conflict resolution

Some observers are disappointed to see the conflict play out in court. The diversity of engineering models that form the basis of long-term energy projections should be celebrated, not litigated, says chemical engineer Daniel Schwartz, director of the Clean Energy Institute at the University of Washington in Seattle. “Bringing this dispute into the court of law, regardless of outcome, is a step towards devaluing the debate of underlying engineering assumptions,” he says.

“This dispute is likely to be most harmful to the scientific community, which has already been subject to lawsuits from groups sceptical of climate change,” says David Adelman, who studies environmental law at the University of Texas in Austin.

Suing a journal over a scientific disagreement is a rare move, says Adil Shamoo, a biochemist at the University of Maryland School of Medicine in Baltimore and editor-in-chief of the journal *Accountability in Research*, which is published by Taylor & Francis. But Shamoo thinks that scientists should be able to sue if they feel that a paper is “reckless” or “malicious”. “I’m a great believer in using all of the avenues of a civil society,” he says.

Shamoo does think that Clack’s paper was “unduly harsh and personal”. He says that “it was not written as if it was part of a scientific dialogue”.

Clack declined to respond to Shamoo’s characterization of his paper, but says that he is disappointed that Jacobson filed the lawsuit. Clack — now chief executive of Vibrant Clean Energy LLC in Boulder — says that his rebuttal paper “underwent very vigorous peer review”, and that the *PNAS* editors had considered Jacobson’s criticisms but found them to be “without merit”.

Jacobson says that he “cannot comment” on the lawsuit. And a spokesperson for the NAS says that “we do not comment on pending litigation”.

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Corrections

Corrected:

A previous version of this story stated that *PNAS* published Clack's article in 2015.

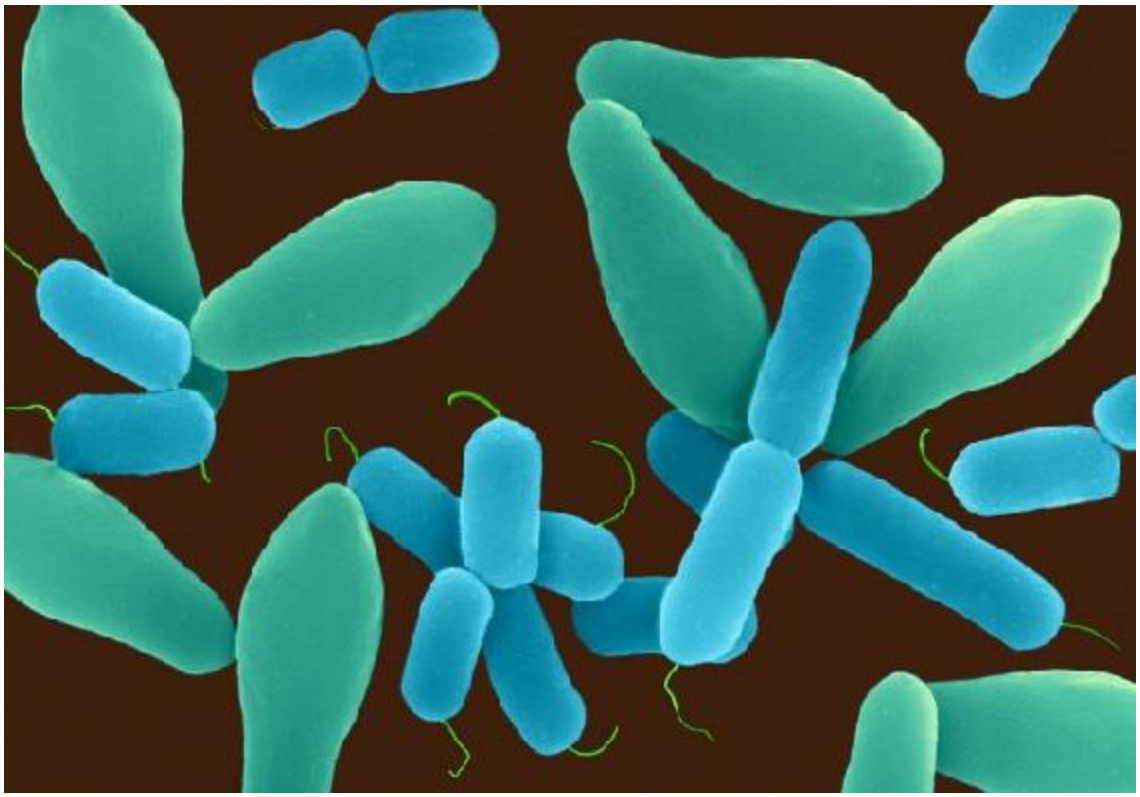
Comments

Commenting is currently unavailable.

Gut microbes can shape responses to cancer immunotherapy

Studies find that species diversity and antibiotics influence cutting-edge treaments.

02 November 2017



Dennis Kunkel Microscopy/SPL

Gut bacteria such as these *Clostridium* could improve a patient's reponse to cancer immunotherapies.

Cancer immunotherapies unleash the body’s immune system to fight cancer, but microbes living in a patient’s gut can affect the outcome of those

treatments, two research teams have found.

Their studies, published on 2 November in *Science*[1, 2], are the latest in a wave of results linking two of the hottest fields in biomedical research: cancer immunotherapy and the role of the body's resident microbes, referred to collectively as the microbiome, in disease.

They also highlight the impact of antibiotics on cancer immunotherapies, particularly drugs that block either of two related proteins called PD-1 and PD-L1. One of the studies found that people treated with antibiotics for unrelated infections had a reduced response to these immunotherapies.

“It raises important questions,” says cancer researcher Jennifer Wargo of the University of Texas MD Anderson Cancer Center in Houston, and an author of one of the studies. “Should we be limiting or tightly monitoring antibiotic use in these patients? And can we actually change the microbiome to enhance responses to therapy?”

The composition and diversity of the microbiome has been linked to everything from mental-health disorders to some side effects of cancer chemotherapy. In 2015, researchers working on mice reported that a specific genus of bacterium in the gut enhanced anti-tumour responses to drugs that target PD-L1[3].

Wargo saw a presentation about the work at a cancer meeting several years ago. “I was floored,” she says. Wargo saw an opportunity to expand the work to humans through her access to clinical samples at MD Anderson.

Exerting influence

Wargo teamed up with epidemiologist Vancheswaran Gopalakrishnan and other researchers to collect faecal samples from more than 100 people with advanced melanoma before they began treatment with anti-PD-1 immunotherapy drugs. The scientists found that those who had the most diverse gut microbes were most likely to respond to the immunotherapy[1]. And tumour growth was reduced in mice that received faecal transplants from

people who responded to immunotherapy.

The type of microbe was also linked to differences in responses to treatment, the researchers discovered. For example, people whose guts contained a lot of bacteria from a group called Clostridiales were more likely to respond to treatment, whereas those who had more Bacteroidales bacteria were less likely to respond.

A second study[2] showed that people who received antibiotics to treat infections shortly before or after starting immunotherapy did not respond as well to PD-1-blocking therapies. The researchers — led by cancer immunologist Laurence Zitvogel and cancer biologist Guido Kroemer, both of the Gustave Roussy Cancer Campus in Villejuif, France — also found that the presence of the bacterium *Akkermansia muciniphila* in both humans and mice was linked to better responses to immunotherapy.

Although it's too early for clinicians to change how they use antibiotics in people with cancer, the work is a step beyond previous studies that relied mainly on mouse models of cancer, says immunologist Romina Goldszmid of the National Cancer Institute in Bethesda, Maryland.

Now, she says, researchers need to learn more about how those microbes exert their influence on the immune system. "What's really missing in the field, rather than knowing who is there and who isn't there, is knowing what the bugs are doing," she says. "We need more information about that."

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Comments

Comments

There are currently no comments.

Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid

Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.

02 November 2017 Corrected:

1. 06 November 2017

Tomasz Tomaszewski/VISUM creativ/eyevine

A previously unknown chamber has been found in the largest of the pyramids in Giza, Egypt.

Physicists have used the by-products of cosmic rays to reveal a large, previously unidentified chamber inside the 4,500-year-old Great Pyramid in Giza, Egypt. The find is the first discovery since the nineteenth century of a major new space inside the pyramid.

Egyptologists have been quick to dismiss any idea of finding lost treasure in the 30-metre-long void. “There’s zero chance of hidden burial chambers,” says Aidan Dodson, an Egyptologist at the University of Bristol, UK, who studies ancient Egyptian tombs. But experts hope that the finding will lead to significant insights into how this spectacular pyramid was built.

The Great Pyramid was constructed by the pharaoh Khufu (also known as Cheops), who reigned from 2509–2483 BC. Constructed from limestone and granite blocks, and rising to 139 metres, it is the oldest and largest of the Giza pyramids and one of the most impressive structures to survive from the ancient world.

Chamber layout

Whereas other pyramids from this period sit above underground burial chambers, Khufu’s Pyramid contains several large rooms inside the body of the structure itself. These include the King’s chamber, which still holds a stone sarcophagus, the smaller Queen’s chamber and a sloping passageway known as the Grand Gallery.

These large chambers were discovered in the ninth century AD and explored extensively by Western archaeologists in the nineteenth century. But enthusiasts have wondered ever since whether there might be more hidden chambers inside the pyramid, or even whether the king’s real burial chamber is yet to be found.

“There are so many theories — nice ones but also crazy ones,” says Mehdi Tayoubi, president of the Heritage Innovation Preservation institute in Paris. So, he co-founded an international collaboration called Scan Pyramids to find out; the project was supervised by the Egyptian Ministry of Antiquities. The

group is “agnostic” about particular theories, he says, but is using non-invasive technologies to search for hidden chambers.

ScanPyramids

Researchers placed muons detectors inside and outside the pyramid to find ou whether theories of a hidden space in the Great Pyramid were true.

To see through the Great Pyramid, the researchers used a technique developed in high-energy particle physics: they tracked particles called muons, which are produced when cosmic rays strike atoms in the upper atmosphere. Around 10,000 muons rain down on each square metre of Earth’s surface every minute. Sensitive muon detectors have been developed for use in particle accelerators, but they have also been used in the past decade or so to determine the inner structures of volcanoes and to study the damaged nuclear reactor at Fukushima, Japan.

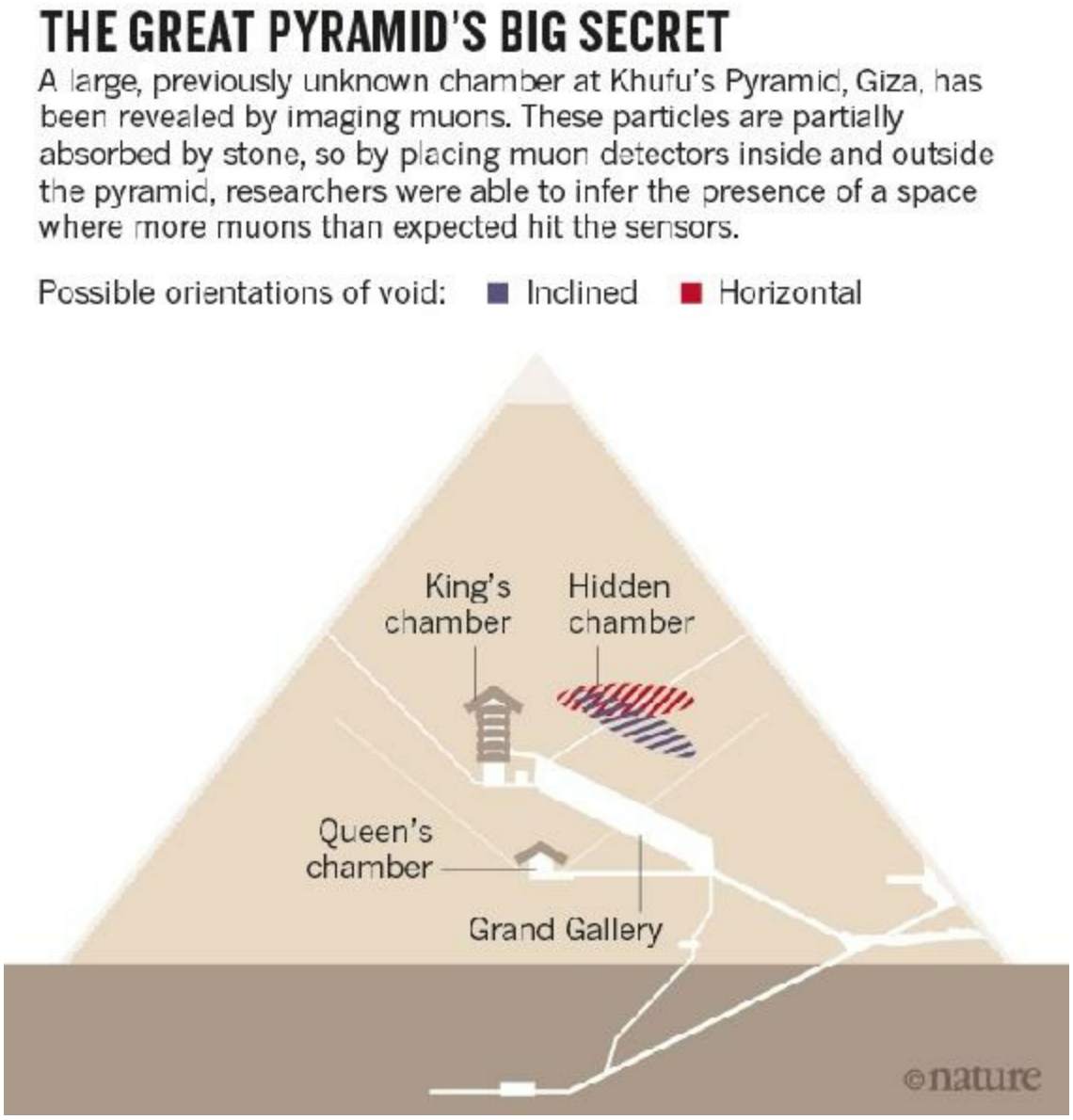
Muon maps

In December 2015, physicist Kunihiro Morishima of Nagoya University, Japan, and his colleagues placed a series of detectors inside the Queen's chamber, where they would detect muons passing through the pyramid from above. The particles are partially absorbed by stone, so any large holes in the pyramid would result in more muons than expected hitting the detectors.

After several months, "we had an unexpected line", says Tayoubi. To check the result, two other teams of physicists, from the Japanese High Energy Accelerator Research Organization in Tsukuba and the French Alternative Energies and Atomic Energy Commision in Paris, then used different types of muon detector placed in other locations both inside and outside the pyramid.

All three teams observed a large, unexpected void in the same location above the Grand Gallery (see 'The Great Pyramid's big secret'). Their results were reported in *Nature*[1] on 2 November. The space is at least 30 metres long, with a similar cross section to the Grand Gallery. "It was a big surprise," says Tayoubi. "We're really excited."

The chamber could be either horizontal or inclined, the researchers say, and might be made up of two or more smaller spaces. The purpose of the space is unknown, but Tayoubi suggests that it could be "a second Grand Gallery".



With high, corbelled — or stepped — ceilings and mysterious stone benches, the Grand Gallery is “one of the most fantastic rooms constructed in the ancient world”, says Bob Brier, an Egyptologist at Long Island University in Brookville, New York, who co-wrote the 2008 book *The Secret of the Great Pyramid* (Smithsonian). “If there’s another one, that’s real news.”

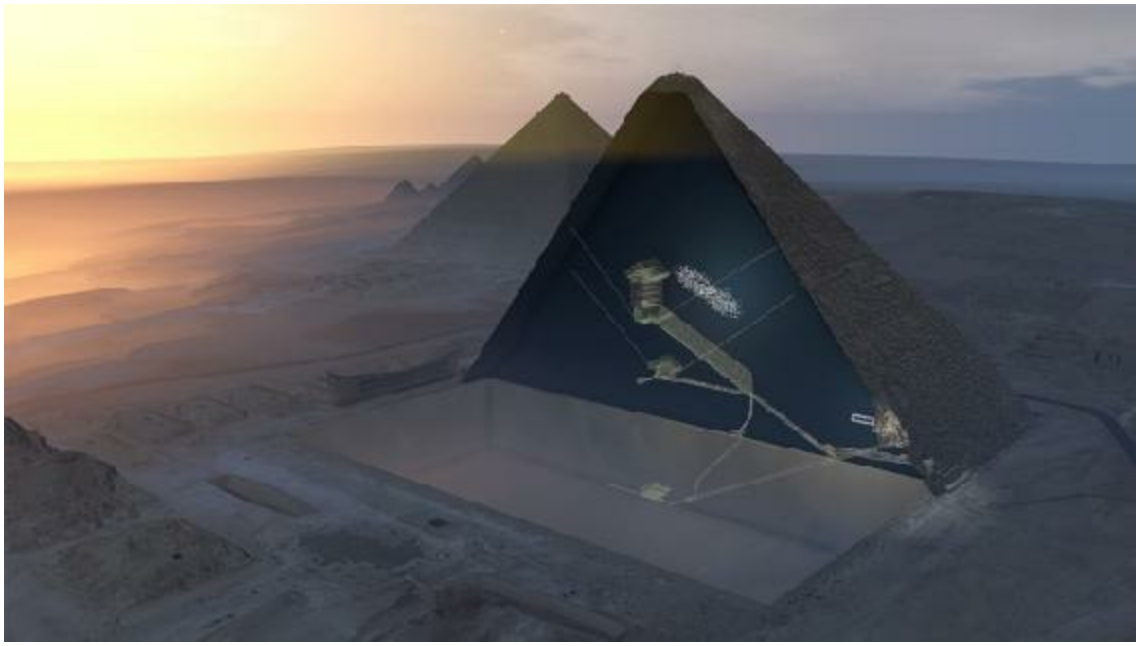
Theories abound

The newly discovered space is unlikely to contain any artefacts relating to the

king’s burial, says Dodson, because there’s already a burial chamber with a sarcophagus in it. Instead he speculates that the space might be a “relieving chamber”, intended to reduce the weight of masonry pressing down on the Grand Gallery. Similar relieving chambers are seen above the King’s chamber and in the pyramid of Khufu’s father, Sneferu, at Meidum, another pyramid site in Egypt.

But Colin Reader, an independent geologist and engineer based in Liverpool, UK, who has studied Egyptian pyramids, suggests that the new chamber is too far from the Grand Gallery to serve this purpose. He wonders whether, just as the Grand Gallery leads to the King’s chamber, the void might lead to another, higher chamber. “You would want to investigate and rule that out,” he says.

Brier has a third theory. In 2007, he and French architect Jean-Pierre Houdin suggested that the Grand Gallery formed part of a huge counterweight system. Weights sliding down the floor of the Grand Gallery could have raised the hefty, granite blocks that comprise the King’s chamber, he says. He speculates that the new space could be part of a second counterweight system higher up.



ScanPyramids

A 3D visualization of the Great Pyramid and its hidden chamber (white dots).

The results also seem to reject the theory, put forward by Houdin and Brier, that the builders of the Great Pyramid used an internal ramp to raise blocks up to the highest levels. “These data suggest that the ramp is not there,” says Brier. “I think we’ve lost.”

Tayoubi says that he next wants to scan Khafre’s (also known as Chephren’s) Pyramid, Egypt’s second largest pyramid. A team led by Nobel-prizewinning physicist Luis Alvarez carried out muon imaging in this pyramid in the late 1960s, using spark chambers as detectors and recording the cosmic-ray data on magnetic tape.

They reported no new chambers in the areas scanned[2]. But technology has improved dramatically since then, points out Tayoubi.

“I think Alvarez was a real visionary guy,” says Tayoubi. “He had the right idea, maybe too early. Our dream would be to give a tribute to Alvarez and redo the Khafre experiment, to see if he was right.”

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Corrections

Corrected:

An earlier version of this story erroneously stated that the Great Pyramid is the oldest of the Egyptian pyramids.

Comments

Commenting is currently unavailable.

Controversial chairman of US House science committee to retire

Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.

02 November 2017

Bill Clark/CQ Roll Call/Getty

Representative Lamar Smith was first elected to the US Congress in 1987.

Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, will retire when his term expires late next year.

Smith, a Texas Republican, has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation (NSF) and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. Since taking the helm of the science committee in 2013, he has transformed it from a relatively deliberative panel into an investigative weapon.

Under the rules of the House of Representatives, which limit committee chairs to six years in the role, Smith would have been forced to relinquish his post on the science panel in 2019. That is one of the reasons he decided against running for re-election, according to news reports; the other is the upcoming birth of his second grandchild. As the news of his retirement made the rounds, many scientists and environmentalists celebrated.

“It is a relief,” says Katharine Hayhoe, director of the Climate Science Center at Texas Tech University in Lubbock. Although many politicians have rejected the conclusions of climate science out of political expediency, she says, Smith has been more aggressive than most.

The congressman has repeatedly tried to reshape the NSF, sponsoring multiple pieces of legislation that would require the agency to justify its grants and explain how they serve the “national interest”. He has also pushed unsuccessfully to scale back programmes in geoscience and social sciences, among other fields.

Smith has notably scrutinized the work of climate scientists. In 2015, he attempted to compel the US National Oceanic and Atmospheric Administration (NOAA) to hand over internal documents related to a climate-change study. The research, published in *Science* in 2015[1], sought to dispel the idea that the rate of global warming had slowed down around the turn of the century. Smith went so far as to accuse a NOAA official — Thomas Karl, who has since retired — of manipulating data to advance an “extreme climate change agenda”.

In 2016, Smith came to the defence of oil giant Exxon Mobil when it was being investigated by the attorneys-general of New York and Massachusetts, who wanted to know whether the firm had misled investors about the

financial implications of global warming. Smith issued subpoenas to the attorneys-general as part of a broader probe, which also targeted environmental groups that have accused Exxon Mobil of suppressing internal research and spreading false information about climate change.

“I think [Smith’s] position on peer review, on the NSF and climate science put him at odds with the science community,” says physicist Neal Lane, a former NSF director who served as science adviser to former president Bill Clinton. “But it was consistent with that of the leadership in the House, which can hardly be described as pro-science.”

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Comments

Comments

There are currently no comments.

Newly discovered orangutan species is also the most endangered

The first new species of great ape described in more than eight decades faces threats to its habitat.

02 November 2017

Maxime Aliaga/SOCP-Batang Toru Programme

Orangutans in Sumatra's Batang Toru forest are now officially a new species: *Pongo tapanuliensis.*

Almost a century after scientists first heard rumours of its existence, an isolated population of orangutans on the Indonesian island of Sumatra has

been confirmed as a new species — just as its habitat faces imminent threats.

The population, estimated at fewer than 800 individuals, inhabits the Batang Toru forest in western Sumatra. A researcher exploring the area in the 1930s wrote of reports of an isolated orangutan population. But it wasn't until biological anthropologist Erik Meijaard, the founder of conservation group Borneo Futures in Jakarta, discovered the paper in the mid-1990s that scientists went looking for the Batang Toru group. Local villagers showed researchers the remains of a female orangutan, and nests in the area confirmed the presence of a population. A male orangutan killed by locals in 2013 provided key evidence: intact tissue and bone.

From the start, scientists noticed that these apes looked different from other orangutans. They had smaller heads, with flatter faces, and their hair was frizzier than that of their cousins living farther north on Sumatra or on the nearby island of Borneo.

Gene gap

Now, genetic tests, field observations and a comparison of the male skeleton against 33 orangutan specimens in museums have revealed that the Batang Toru group is, in fact, a distinct species. Named *Pongo tapanuliensis*, the newly identified great ape is described in *Current Biology*[1] on 2 November by a team that included most of the world's orangutan experts. "It's taken 20 years to come to the realization of what this is," Meijaard says.

Although the genetic analysis of *P. tapanuliensis* relies on a single skeleton, Meijaard says that's not unusual in taxonomy. Many studies, including others he's contributed to, rely on a single piece of evidence, and typically consider only morphology. The latest study shows that the group is distinct not only in morphology, but also in genetics and behaviour, he says.

Matthew G. Nowak

P. tapanuliensis orangutans have smaller heads and flatter faces than their cousins elsewhere on Sumatra and on Borneo.

Russ Mittermeier, executive vice-chair of Washington, DC-based Conservation International and chair of the primate-specialist group at the International Union for Conservation of Nature (IUCN), describes the evidence as “unquestionably” sufficient to support the new species designation. “Although we have had 87 new species of primates described since 2000, this is the first new great ape species since 1929.”

Biruté Mary Galdikas, an orangutan specialist in Los Angeles who founded Orangutan Foundation International, says that the study confirms what she and other orangutan researchers have suspected for decades. “I am not surprised that there is a new species or subspecies of orangutan described from Sumatra,” she says.

Ancestral ties

Key to the determination was tracing the population’s ancestry. Surprisingly, Meijaard says, genetic testing of the Batang Toru skeleton revealed that the population is more closely related to Bornean orangutans, despite living on the same island as the other Sumatran group. That’s probably because of how

orangutans migrated to the region, he says.

All orangutans trace their origins to ancestors that lived on the Asian mainland about 8 million years ago. Those great apes migrated to what is now Sumatra, when sea levels were lower and the lands were connected. Genetic data suggest the Batang Toru species is the closest descendant of those first arrivals.

The other Sumatran orangutans, which live in the island's far north, split off from the Batang Toru group about 3.4 million years ago, modelling based on genetic data suggests. The Bornean orangutans also split from the Batang Toru group, but much later — about 674,000 years ago — which explains why those two populations are more similar, Meijaard says.

Even as Batang Toru's orangutans are named a new species, the animals' long-term survival is uncertain. Previous population analyses suggest there are fewer than 800 individuals, making it the most endangered of the great apes. Although much of its habitat is protected by the Indonesian government, a proposed hydroelectric dam on the Batang Toru river would flood part of the area and divide the population into two, isolating the groups on either side of the river. That's likely to further shrink the gene pool in the already inbred population, Meijaard says. The dam would also bring more people to the area, potentially increasing hunting pressure.

Conservation groups are working with government officials to find an alternative site for the project, says Meijaard. "There is no doubt that conservation efforts are needed immediately," Mittermeier says.

The IUCN primate-specialist group has recently recommended that the species be included on the IUCN Red List of Threatened Species. A decision is expected in December. "It would be bitterly ironic if it goes extinct as a biologically viable population just as it is described as a new species," says Galdikas.

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Comments

Comments

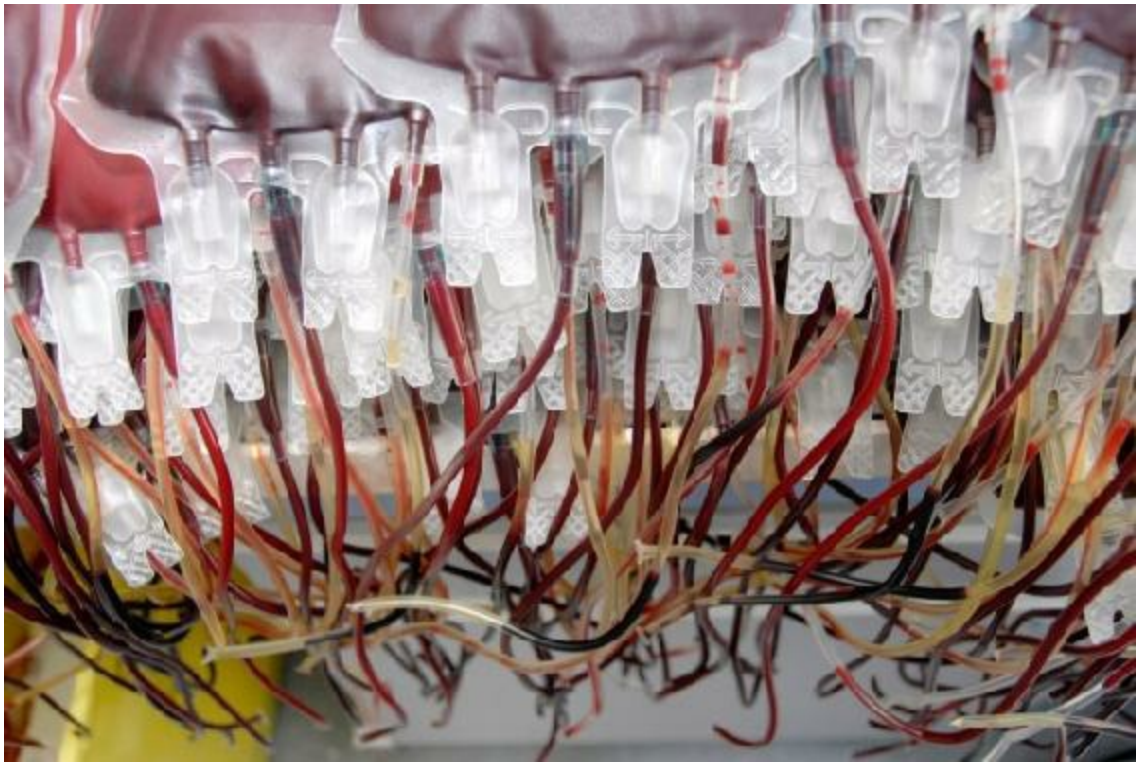
There are currently no comments.

Infusions of young blood tested in patients with dementia

The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.

01 November 2017 Corrected:

1. 03 November 2017



AJ Photo/SPL

Donor blood from young people has been transfused into people with dementia.

The first controlled, but controversial and small, clinical trial of giving young blood to people with dementia has reported that the procedure appears safe. It has also hinted that it may even produce modest improvements in the daily lives of people who have Alzheimer's disease.

Researchers who conducted the trial and others caution that the results are based on just 18 people and therefore are only a first step in exploring this type of treatment. "This is a really very small trial and the results should not be over-interpreted," says Tony Wyss-Coray, a neuroscientist at Stanford University in California. The trial was conducted by his start-up company Alkahest, which is based in San Carlos, California, and was led by Stanford neurologist Sharon Sha.

The results suggest the procedure is safe and hint that it could even boost the ability of people with dementia to undertake everyday skills, such as shopping or preparing a meal. The team announced the results on 1 November and plans to present them on 4 November at the 10th Clinical Trials on Alzheimer's Disease conference in Boston, Massachusetts.

The team tested people aged between 54 and 86 with mild to moderate Alzheimer's disease. The team gave the 18 subjects weekly infusions for four weeks. They received either a saline placebo or plasma — blood from which the red cells have been removed — from blood donors aged 18–30. During the study, the team monitored the patients to assess their cognitive skills, mood and general abilities to manage their lives independently.

The study detected no serious adverse reactions. It saw no significant effect on cognition, but two different batteries of tests assessing daily living skills both showed significant improvement.

The human trial grew out of earlier 'parabiosis' experiments, in which the blood systems of two rodents are surgically joined together to see what happens when molecules circulating in one animal enter another animal.

Alkahest now plans to conduct a second, larger trial using plasma from which many proteins and other molecules have been removed. Wyss-Coray, whose group did most of the mouse studies that inspired the clinical trial[1] told *Nature* that his experiments suggest that such a treatment could be more

effective than using whole plasma.

Transfusion confusion

Blood-transfusion trials are controversial because the active molecules in plasma that seem to lead to the purported effects are unknown.

Irina Conboy, a neurologist at the University of California, Berkeley, and her colleagues have performed extensive parabiosis experiments stitching together young and old mice that have been genetically matched. She has found that young blood clearly rejuvenates mouse tissues such as the heart and the brain[2]. But she says that the effects are probably coordinated by a complex orchestration of factors in the blood that needs to be understood more fully before moving to the clinic.

“The scientific basis for the trial is simply not there,” she says. “The effects of young blood on cognition have not been replicated by an independent group, and there has never been a test with a mouse model of Alzheimer’s.” She says that frequently exposing older people to foreign plasma may be unsafe, because hyperactivation of their immune systems could lead to autoimmune or inflammatory disease.

But, Wyss-Coray says, “Alzheimer’s patients don’t want to wait until the exact mode of action is discovered.”

He says that it is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain, which has so far failed to result in any treatments.

Blood transfusions used for this purpose do not require approval by the US Food and Drug Administration, and some American companies are already charging hefty fees for transfusions of blood from young people.

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Corrections

Corrected:

An earlier version of this story wrongly identified Tony Wyss-Coray as leading the clinical trial. In fact, the trial was led by neurologist Sharon Sha of Stanford University and doctors working for Alkahest. Alkahest, not Wyss-Coray, will conduct the second, larger trial. Wyss-Coray was also wrongly identified as a neurologist.

Comments

1 comment

1. *Chris Exley* • 2017-11-02 03:10 PM

   Wyss-Coray is clearly wrong to suggest that this 'is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain'. We showed that silicon-rich mineral waters provided some cognitive improvements in individuals with AD over only 12 weeks (https://content.iospress.com/articles/journal-of-alzheimers-disease-reports/adr170010) and similar research published today has suggested benefits in individuals with multiple sclerosis (http://www.ebiomedicine.com/article/S2352-3964(17)30428-0/fulltext). Unfortunately we do not have the resources of Wyss-Coray to take these prospective therapies further.

Citation is not the only impact

A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.

01 November 2017

Getty

A research paper on drying coffee stains had unusual and unexpected applications.

What makes good science? And how do *Nature*'s editors select papers to publish? The answers to both questions are many and varied. But they have one thing in common: neither is necessarily reflected in citations.

Nature publishes about 800 papers each year. Over, say, two years following

publication, the pattern of citations typically ranges from a few papers with citations in the hundreds, to a large number with tens of citations, and a tail with single figures.

We are pleased when our papers make an impact. But there is much more to scientific impact than citations. For example, last week, in an 'In Retrospect' article in News & Views, Ronald Larson described a remarkable story (R. Larson *Nature* **550,** 466–467; 2017). In 1997, *Nature* published a paper by Robert Deegan and his colleagues that provided an explanation of the 'coffee-ring effect' in spilt liquids, based on considerations of evaporation and surface interactions (R. D. Deegan *et al. Nature* **389,** 827–829; 1997). For several years, the paper sat proudly in our pages, typically gathering about 20 citations per year. In 2006, as new implications and applications became clear, the rate picked up to well over 100 a year. So far, it has attracted about 4,000 citations. The paper is worth highlighting as an example of the varied types of judgement that *Nature* editors use to select papers.

Our most highly cited papers are indeed often key landmarks in their fields. But there are papers that turn out to have low citations that we are equally happy to have published. The work by Deegan *et al.* was selected not because of any editorial ability to anticipate advances years in the future, but because, at the time, we considered it to be a noteworthy and pleasing piece of insight. Nothing more, nothing less. The developments celebrated by Larson are an editor's unexpected bonus.

Most papers that we publish, with the invaluable help of our reviewers, are selected with a view to their scientific significance, whether as a powerful insight or an unusually empowering resource. And often that will correlate closely with citations (although citation patterns differ across disciplines). But it's important also, for editors in all the disciplines from which we publish, sometimes to appreciate the interest in a paper using quite different criteria. It may be compelling for its sheer creativity or logical elegance, for making the reader stop and think very differently about a question, or for a stimulating and even mysterious observation. Many of these may be slow burners citation-wise — or simply be textbook examples that never get taken up in abundance. Here are other examples, drawn from the physical sciences,

that, despite low citations, we like to celebrate.

One such paper illustrated how images could be taken using X-rays radiated when sticky tape was peeled (C. G. Camara *et al. Nature* **455,** 1089–1092; 2008). The citations are not huge by physics standards (165 since 2008) but we still love it, and we did not fully anticipate how it would go viral on social media. Another (11 citations) reported an actual sample of Cretaceous seawater from 145 million years ago. (W. E. Sanford *et al. Nature* **503,** 252–256; 2013). And finally, a theoretical paper providing an exact textbook solution for the capacity of noisy quantum communication channels has been cited just six times since 2013 (G. Smith and J. A. Smolin *Nature* **504,** 263–267; 2013), but we value it for what it is and anticipate that its take-up could increase as research moves from idealized 'noise-free' systems to more realistic noisy ones.

There are examples in other disciplines too. Why highlight such papers? Because we are glad to have published them. And because it's perhaps salutary to appreciate just how unrelated scientific interest (at least, as we at *Nature* see it) and citation numbers can be.

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Comments

Commenting is currently unavailable.

Urban Vibe
Studios
London

University systems allow sexual harassers to thrive

It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen[1].

01 November 2017

Harvey Weinstein, Roger Ailes, Geoff Marcy. From entertainment to academia, accusations of these people's abuses of power have helped to create a sea change in the numbers of people willing to discuss sexual harassment in the workplace. Much of the conversation has concerned condemnation of harassers and praise for those who come forward to talk about what they have seen and experienced. This puts an interpersonal frame on a systemic problem. Attention must also be paid to systems that allow harassers to thrive.

In 2006, I joined the Brain and Cognitive Sciences Department at the University of Rochester, New York, as a PhD student. This August, I joined other female graduate students and postdocs who contributed testimony to a complaint to the US Equal Employment Opportunity Commission over

sexual harassment, poor handling of investigations of our claims and discrimination. We described how we actively avoided Florian Jaeger, a professor in our department, because of his frequent sexual innuendos, pressure to have intimate relationships and other unprofessional behaviour. We were faced with the unfair and unreasonable choice of losing professional opportunities or exposing ourselves to profoundly disturbing encounters. (According to *The New York Times*, Jaeger has since taken a leave of absence but said this was not an admission of guilt.)

I knew this behaviour was not acceptable. I was also convinced that if I came forward alone, I risked retribution and the university would not take my claims seriously. I felt my best option was to warn other students privately and make it known that I would come forward if we reached a critical mass.

After I chose to move away to finish my dissertation, I learnt that in 2013 two colleagues had complained to the department chair about Jaeger's behaviour and given my name as someone who should be interviewed. I was not contacted. In 2016, other senior faculty members learnt of these claims and filed a second complaint to the university to investigate. This time the university first contacted me during an appeal, after issuing a report that cleared Jaeger. The first person to secure testimony from me was from McAllister Olivarius, a London-based legal firm hired by the plaintiffs. My former colleagues had found a powerful ally in getting their complaints taken seriously.

It should not have taken such heroic efforts.

In this regard, Hollywood and academia have troubling similarities. Both rely too much on mentor–protégé relationships, with few checks on individual power. In academia, there is scant protection for lab members. Graduate students and postdocs are viewed more as part of their supervisor's lab than part of the university community. By contrast, institutions have many incentives to protect their powerful, permanent and often lucrative faculty members.

Administrators can reasonably assume that, if they ignore claims for long enough, they will never be held to account. People like me graduate or leave without a degree, the statute of limitations passes, and the harassers get

promoted. Sometimes universities don't interview suggested witnesses or collect other evidence; in my view, this allows them to claim that they investigated complaints but found insufficient reasons for further action. (The University of Rochester has said it took the allegations seriously and that its investigation was thorough.)

Since completing my PhD, I've taken a position at a large company. There are still power differentials in such settings, and sexual harassment can occur unpunished anywhere. However, I've seen several practices that I think academia could learn from.

In my first week of employment, the company explained my rights to a safe workplace and gave me options for reporting concerns. As a graduate student, I had mistakenly believed that the only instances of sexual harassment that could be brought forward were the most egregious: assault or quid-pro-quo propositions. I was unaware of legal precedents involving pervasive harassment creating a hostile and unequal environment. I was also unaware of the standard of preponderance of evidence, and thought that every instance had to be recorded and irrefutable. Graduate students and employees should not have to be legal scholars to win protections.

Another problem is how much the fate of a graduate student or postdoc depends on a supervisor who controls funding for their position, when they can submit a dissertation or paper and what other opportunities they can apply for. Power is less likely to be abused when it is more distributed.

My current company holds drop-in conference calls throughout the year, some of which are reserved for women only. We can discuss concerns off the record or even anonymously; topics range from standardizing the promotion process and improving diversity in recruitment, to discussing comments that have made us feel undermined or uncomfortable. People bringing concerns have options about whether and how they are reported outside the call. At the same time, leaders can become aware of even minor problems and address them (through discussion with staff and line managers, or through memos) before they become patterns that lead to a toxic work environment.

We used to consider those in leadership positions blameless simply by virtue of not being harassers themselves. We now expect better.

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7
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Comments

Comments

There are currently no comments.

Interstellar visitor, Arctic shipwrecks and a retraction recommendation

The week in science: 27 October–2 November 2017.

01 November 2017

History | Universities | People | Medicines | Research | Space | Events | Facilities | Climate | Trend watch | Awards

HISTORY

Arctic explorer's wrecks given to Canada The UK government is giving Canada two historic shipwrecks: those of HMS *Erebus* and HMS *Terror*. The vessels were part of British explorer Sir John Franklin's ill-fated 1845 expedition to find the Northwest Passage, a long-sought shipping route that connects the Atlantic and Pacific oceans through the Canadian Arctic. Franklin died, along with his entire crew, after the ships became ice-bound and the team abandoned them. Marine archaeologists discovered *Erebus* and *Terror* in 2014 and 2016, respectively, off King William Island. In 1997, an agreement had granted custody of the yet-to-be located wrecks to Canada, although they remained property of the United Kingdom. On 23 October, the UK government said that it would transfer ownership of the ships to Parks Canada, a government agency.

Parks Canada

Part of the wreck of the HMS *Terror*.

UNIVERSITIES

Institute dissolved The Swiss Federal Institute of Technology in Zurich (ETH Zurich), one of Europe's leading universities, has launched an investigation into allegations that PhD students were regularly bullied in its Institute for Astronomy. ETH Zurich released a statement on 25 October saying that it had closed the institute in August in response to the accusations, which were made earlier this year. Newspaper reports say students had complained that astrophysicist Marcella Carollo — a professor, and wife of the institute's director Simon Lilly — had been inappropriately and personally critical, and overly demanding of their time. The university did not publicly name the couple, but said that it had transferred their professorships to the university's physics department. It moved other Institute for Astronomy staff to a newly created Institute for Particle Physics and

Astronomy, and assigned the students new supervisors.

Science cluster French President Emmanuel Macron has announced a plan to save the troubled Paris-Saclay project, an attempt to create a single science 'super-campus' southwest of the city. During a visit to the site on 25 October, Macron said that the project would now proceed in two clusters, one made up of elite institutions called *grandes écoles*, and one made up largely of universities. The project, which initially aimed to bring together nearly 20 research and teaching institutions under one umbrella university, had been mired by the *grandes écoles*' refusal to give up their names and autonomy. A previous effort this year to find a compromise solution had failed. "The time of procrastination is behind us," Macron said.

PEOPLE

Surgeon's papers Six research papers co-written by disgraced thoracic surgeon Paolo Macchiarini should be retracted because they contain evidence of scientific misconduct, the Swedish Central Ethical Review Board said in a statement dated 27 October. The papers had been central to Macchiarini's claims about a radical stem-cell-based tracheal transplant, which he developed partly during his employment by the Karolinska Institute in Stockholm. The institute had asked the ethics board to examine the papers. Earlier last month, Swedish public prosecutors dropped their investigations into charges of manslaughter and grievous bodily harm by the surgeon. The charges involved four people on whom Macchiarini had performed operations at the Karolinska University Hospital between 2011 and 2013. Three have since died, but the prosecutors said there was a lack of conclusive evidence that the surgery caused the deaths. They noted negligent procedures in some of the operations.

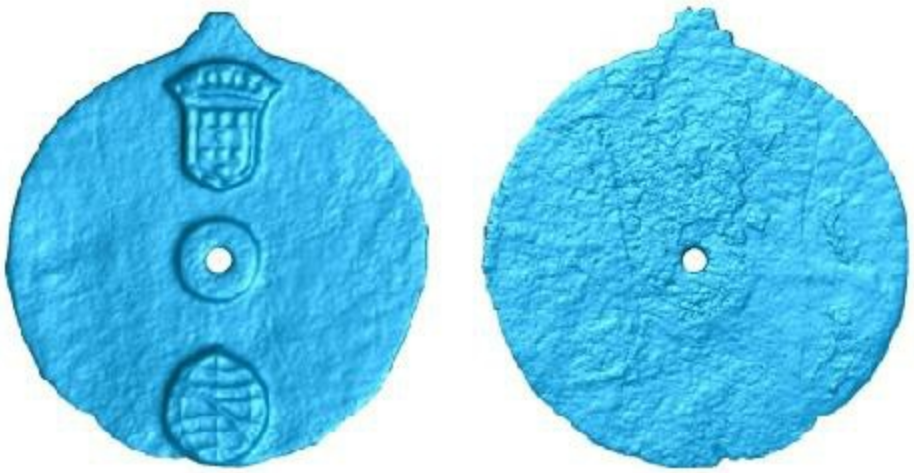
MEDICINES

Hepatitis C drugs On 25 October, a US non-profit organization filed challenges against six core patents for sofosbuvir, a key component of three hepatitis C drugs. The medicines — Sovaldi, Harvoni and Epclusa — belong

to Gilead Sciences in Foster City, California. The Initiative for Medicines, Access and Knowledge (I-MAK) in New York City argues that Gilead's patents are unmerited because the drug is not different enough to warrant a US patent, saying that the company developed the compound by tweaking existing HIV and cancer drugs. The patents prevent cheaper, generic drugs from entering the US market. Using a similar argument, I-MAK had a sofosbuvir patent removed in China in 2015.

RESEARCH

Old astrolabe A 500-year-old bronze disc recovered from a shipwreck in 2014 might be the oldest-known example of a technology that changed world history. The artefact was retrieved from the wreck of the *Esmeralda*, part of the fleet of the Portuguese explorer Vasco da Gama. On 24 October, researchers at the University of Warwick in Coventry, UK, said that laser scanning has now revealed markings at 5-degree intervals around its circumference, suggesting that the 17.5-centimetre-diameter object is a mariner's astrolabe. Developed by Portuguese navigators in the late fifteenth century, these devices determine latitude by measuring the Sun's altitude, and helped sailors to explore the oceans and map the world. The *Esmeralda* sank in the Indian Ocean in 1503, making this mariner's astrolabe several decades older than any of the hundred or so others that survive.



WMG/University of Warwick

Composite image of scans of a 500-year-old bronze astrolabe.

SPACE

Foreign object Astronomers have spotted a space rock that might have come from outside the Solar System. The small asteroid or comet, named A/2017 U1, swooped towards and then past the Sun from an angle almost perpendicular to the plane in which most of the planets orbit. Its trajectory — a hyperbolic orbit — suggests that it came from interstellar space, NASA said on 26 October, a week after the object's discovery. If further observations confirm its orbit, it would be the first such interstellar object known.

Earth mission ends The paired satellites of the US–German Gravity Recovery and Climate Experiment (GRACE), which have been making fundamental observations of Earth since their 2002 launch, have ceased science operations. Mission controllers realized on 12 October that the

batteries in one of the satellites had failed because of its age, a long-expected outcome. NASA and the German space agency DLR announced the mission's end on 27 October, and said the other satellite will be decommissioned next year. GRACE has provided crucial measurements of melting ice sheets and groundwater storage, among other things.

EVENTS

Weedkiller dispute The European Union postponed a decisive vote on 25 October on proposals to renew its licence for the controversial weedkiller glyphosate. The current EU authorization expires on 15 December. But member states were unable to settle on a compromise for how long the licence should be extended by. The World Health Organization says that glyphosate is "probably" carcinogenic to humans, but key EU safety agencies say it is not. Member states will be asked to vote on a five-year extension on 9 November. More than 1.3 million Europeans have signed a petition calling for the substance to be banned.

Harassment probe The US House Committee on Science, Space, and Technology is investigating allegations of sexual harassment against geologist David Marchant of Boston University, Massachusetts. Marchant has received about US$5.4 million in funding since the 1990s from federal agencies, including the National Science Foundation (NSF) and NASA. In letters sent to the NSF, NASA and Boston University on 26 October, the committee asked for all documents and communications involving federal grants awarded to Marchant, as well as complaints of alleged assault and harassment and any actions taken by each institution. Two of Marchant's former graduate students filed complaints with Boston University, in October 2016 and May 2017, for behaviour that allegedly occurred while they were on research trips with him in Antarctica in the 1990s.

FACILITIES

Genome database A Chinese province is building a large sequencing centre that will create a database of genetic information from Chinese people. The

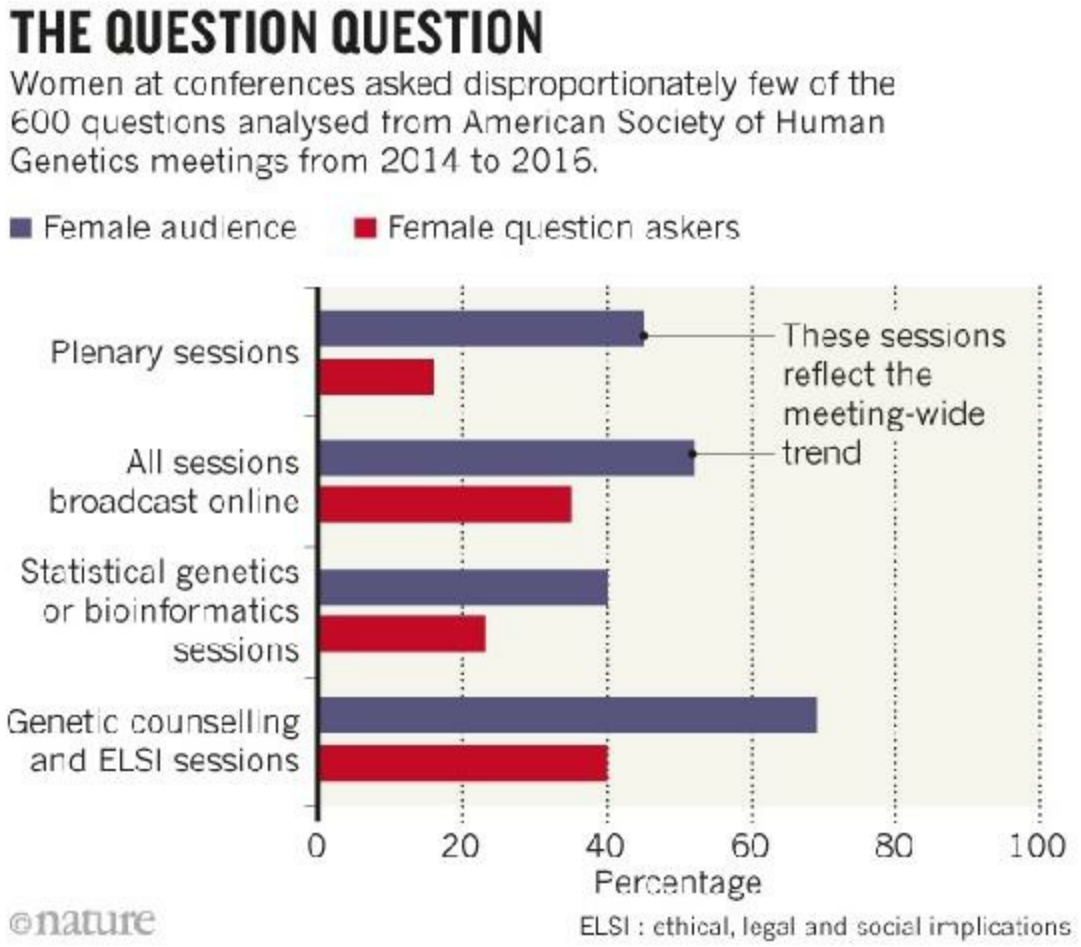
National Health & Medicine Big Data Center is being built in Nanjing, the capital of Jiangsu province, as part of a 6-billion-yuan (US$905-million) genome project announced by the local government on 29 October. The centre will house multiple firms that will together sequence up to 500,000 samples a year. Data will be used to look for mutations related to disease, as well as environmental factors that might trigger illness. Researchers will also use the data to tailor treatments to individual patients.

CLIMATE

Record CO_2 levels Atmospheric concentrations of carbon dioxide surged at a record pace and to a record high in 2016 because of human emissions and an El Niño warming event, the World Meteorological Organization said on 30 October. Average global CO_2 concentrations rose from 400 to 403.3 parts per million, roughly 45% above pre-industrial levels. The last time Earth had comparable CO_2 levels was during the mid-Pliocene epoch around 4 million years ago, when temperatures were 2–3 °C warmer than those today and sea levels were 10–20 metres higher. Concentrations of the greenhouse gases methane and nitrous oxide also increased, to 157% and 22% above pre-industrial levels, respectively.

TREND WATCH

Women ask fewer questions than men at conferences, even if there are more women in the room, according to an analysis of talks at American Society of Human Genetics (ASHG) meetings in 2014–16. Natalie Telis of Stanford University in California and her colleagues looked at 600 questions asked at 222 conference talks. To reach parity in question-asking, the audience would have to be at least 85% women, they say. Women are most likely to question female speakers, but still speak up less often than men.



Source: Natalie Telis

AWARDS

Space pioneers The first woman and the first Chinese national in space were among four recipients of the inaugural medal for space science from the United Nations Educational, Scientific and Cultural Organization (UNESCO). Awards for Chinese astronaut Yang Liwei, who completed the country's first crewed space mission in October 2003, and Russian cosmonaut Valentina Tereshkova were announced at a ceremony in Paris on 27 October. Also honoured were Koichi Wakata, the first Japanese commander of the International Space Station, and Arnaldo Tamayo Mendez, the first Cuban in space. The medal, established in June, recognizes

prominent researchers or public figures who have contributed to space science.

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Comments

There are currently no comments.

Plans to promote German research excellence come under fire

Critics say selection process for high-stakes funding programme is flawed.

01 November 2017

Bern Lauter/vario images GmbH/Alamy

Peter Strohschneider, president of the DFG.

Germany’s latest programme to boost research at its universities and make them more competitive internationally risks missing its goals, according to

observers.

The Excellence Initiative was launched in 2005 with €4.6 billion (US$5.4 billion) in funding and the aim of creating a handful of elite universities. Researchers across Germany are now preparing for the programme's next round, dubbed the Excellence Strategy, which starts in 2019.

Earlier this year, almost 200 groups of scientists submitted proposals to form Clusters of Excellence — large collaborations of research groups at one or more universities that form the core element of the strategy. And last month, an international committee invited 88 of the groups to submit full project proposals by late February. Up to 50 such clusters will from 2019 receive top-up funding of about €8 million per year for seven years.

But observers question whether the 88 selected projects represent Germany's best science, particularly because the focus for selection has shifted away from basic science and towards applied research. Unsuccessful applicants say that the rules for submitting proposals for the initiative were not clearly defined and communicated. Several high-profile groups came away empty-handed, including biology teams in Frankfurt, Heidelberg and Munich involving dozens of scientists funded by the prestigious European Research Council.

"The Excellence Initiative has brought German science some welcome structural change," says Dieter Imboden, a Swiss environmental physicist who chaired a 2016 review of the initiative. "But its achievements must not obscure the view of its flaws."

The competition to form clusters should be run independently of that for elite-university status, he says. Otherwise, second-tier universities could outperform those with a much stronger overall research portfolio and gain the sought-after title, which is currently held by 11 universities.

Critics also say that the geographic spread of positively reviewed applications for future excellence clusters — across 41 universities in 13 of Germany's 16 states — hints at a political desire to distribute the funds more evenly across the country.

But Peter Strohschneider, president of Germany's main research-funding agency, the DFG, which runs the programme, says the selection panels chose the projects strictly on the basis of scientific quality, without any regional or political considerations. Scientists will figure strongly on the Excellence Commission, which will make the final selection in September 2018 and will also include federal and state science ministers, he says.

Until 2005, responsibility for funding universities in Germany lay exclusively with the states. The Excellence Initiative was created to allow central government to inject federal money into research, a move now guaranteed by a change to the German constitution. But many say the changes have not gone far enough.

"The initiative has quite lost sight of its goal," says a former president of a large German university, speaking on condition of anonymity. "Universities here remain trapped in a federal political system that is unable to create a powerhouse like Yale or Harvard."

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The new thermodynamics: how quantum physics is bending the rules

Experiments are starting to probe the limits of the classical laws of thermodynamics.

01 November 2017

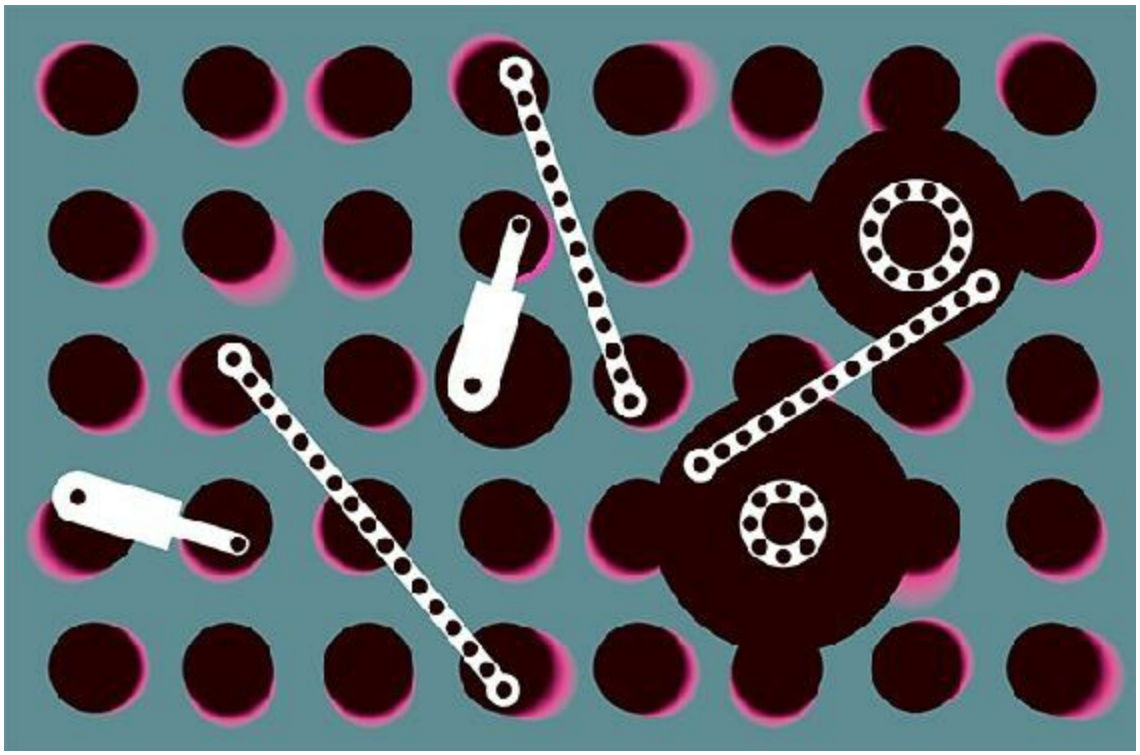


Illustration by Edgar Bąk

It would take a foolhardy physicist to dare attempt to break the laws of thermodynamics. But it turns out that there may be ways to bend them. At a lab at the University of Oxford, UK, quantum physicists are trying to do so with a small lump of synthetic diamond. At first, the diamond is barely

visible, nestled inside a chaotic mess of optical fibres and mirrors. But when they switch on a green laser, defects in the diamond are illuminated, and the crystal begins to glow red.

In that light, the team has found preliminary evidence of an effect that was theorized only a few years ago[1]: a quantum boost that would push the diamond's power output above the level prescribed by classical thermodynamics. If the results hold up, they will be a tangible boon for the study of quantum thermodynamics, a relatively new field that aims to uncover the rules that govern heat and energy flow at the atomic scale.

There is reason to suspect that the laws of thermodynamics, which are based on how large numbers of particles behave, are different in the quantum realm. Over the past five years or so, a quantum-thermodynamics community has grown around that idea. What was once the domain of a handful of theoreticians now includes a few hundred theoretical and experimental physicists around the globe. “The field is moving so fast I can barely keep up,” says Ronnie Kosloff, an early pioneer of the field at the Hebrew University of Jerusalem in Israel.

A number of quantum thermodynamicists hope to find behaviour outside the remit of conventional thermodynamics that could be adapted for practical purposes, including improving lab-based refrigeration techniques, creating batteries with enhanced capabilities and refining technology for quantum computing.

But the field is still in its infancy. Experiments such as the one taking place at Oxford are just starting to put theoretical predictions to the test. And physicists working at the periphery are watching such tests closely for evidence of the useful applications that theorists have predicted. “Quantum thermodynamics is clearly hot — pardon the pun,” says Ronald Walsworth, a physicist at Harvard University in Cambridge, Massachusetts, who specializes in developing precision atomic-scale tools. “But for those of us looking in from the outside, the question is: can it really shed new light on the development of technologies?”

Breaking the law

The development of the classical laws of thermodynamics stretches back to the nineteenth century. They emerged from the effort to understand steam engines and other macroscopic systems. Thermodynamic quantities such as temperature and heat are statistical in nature and defined in reference to the average motion of large ensembles of particles. But back in the 1980s, Kosloff began pondering whether this picture would continue to make sense for much smaller systems.

It wasn't a popular line of research at the time, says Kosloff, because the questions being asked were largely abstract, with little hope of connection to experiments. “The field developed very slowly,” he says. “I was alone for years.”

That changed dramatically around a decade ago, as questions about the limits of technological miniaturization became more pressing and experimental techniques advanced. A flurry of attempts were made to calculate how thermodynamics and quantum theory might combine. But the resulting proposals created more confusion than clarity, Kosloff says. Some claimed that quantum devices could violate classical thermodynamic constraints with impunity and so act as perpetual-motion machines, capable of performing work without needing any energy input. Others, suggesting that the laws of thermodynamics should hold unmodified at very small scales, were equally perplexing. “In some sense, you can use the same equations to work out the performance of a single atom engine and your car engine,” says Kosloff. “But that seems shocking, too — surely as you get smaller and smaller you should hit some quantum limit.” In classical thermodynamics, a single particle doesn't have a temperature. So as both the system generating work and its environment approach that limit, it becomes increasingly absurd to imagine that they would obey standard thermodynamic rules, says Tobias Schaetz, a quantum physicist at the University of Freiburg in Germany.

The preponderance of conflicting theoretical claims and predictions initially undermined the burgeoning field's credibility. “I have been very critical of the field because there is far too much theory and not enough experiment,” says quantum physicist Peter Hänggi, at the University of Augsburg in Germany. But the community is beginning to coalesce more formally around core questions in an effort to cut through the chaos. One goal has been to use

experiments to uncover the point at which the classical laws of thermodynamics no longer perfectly predict the thermal behaviour of quantum systems.

Experiments are starting to pin down that quantum–classical boundary. Last year, for example, Schaetz and his colleagues showed that, under certain conditions, strings of five or fewer magnesium ions in a crystal do not reach and remain in thermal equilibrium with their surroundings like larger systems do[2]. In their test, each ion started in a high-energy state and its spin oscillated between two states corresponding to the direction of its magnetism — 'up' and 'down'. Standard thermodynamics predicts that such spin oscillations should die down as the ions cool by interacting with the other atoms in the crystal around them, just as hot coffee cools when its molecules collide with molecules in the colder surrounding air.

Such collisions transfer energy from the coffee molecules to the air molecules. A similar cooling mechanism is at play in the crystal, where quantized vibrations in the lattice called phonons carry heat away from the oscillating spins. Schaetz and his colleagues found that their small ion systems did stop oscillating, suggesting that they had cooled. But after a few milliseconds, the ions began oscillating vigorously again. This resurgence has a quantum origin, says Schaetz. Rather than dissipating away entirely, the phonons rebounded at the edges of the crystal and returned, in phase, to their source ions, reinstating the original spin oscillations.

Schaetz says that his experiment sends a warning to engineers attempting to reduce the size of existing electronics. “You may have a wire that is only 10 or 15 atoms wide, and you may think that it has successfully carried the heat away from your chip, but then boop — suddenly this quantum revival happens,” Schaetz says. “It is very disturbing.”

Rebounding phonons could present a challenge in some applications, but other quantum phenomena could turn out to be useful. Efforts to identify such phenomena had been stalled by the difficulty in defining basic quantities, such as heat and temperature, in quantum systems. But the solution to a famous thought experiment, laid out 150 years ago by Scottish physicist James Clerk Maxwell, provided a clue about where to turn, posing an intriguing link between information and energy. Maxwell imagined an entity

that could sort slow- and fast-moving molecules, creating a temperature difference between two chambers simply by opening and closing a door between them.

Such a 'demon', as it was later called, thus generates a hot and a cold chamber that can be harnessed to produce useful energy. The problem is that by sorting particles in this way, the demon reduces the system's entropy — a measure of the disorder of the particles' arrangements — without having done any work on the particles themselves. This seemingly violates the second law of thermodynamics.

But physicists eventually realized that the demon would pay a thermodynamic price to process the information about the molecules' speeds. It would need to store, erase and rewrite that information in its brain. That process consumes energy and creates an overall increase in entropy[3]. Information was once thought to be immaterial, “but Maxwell's demon shows that it can have objective physical consequences”, says quantum physicist Arnau Riera, at the Institute of Photonic Sciences in Barcelona, Spain.

Finding the limit

Inspired by the idea that information is a physical quantity — and that it is intimately linked to thermodynamics — researchers have attempted to recast the laws of thermodynamics so that they work in the quantum regime.

Perpetual-motion machines may be impossible. But an early hope was that limits prescribed by quantum thermodynamics might be less stringent than those that hold in the classical realm. “This was the train of thought we had learned from quantum computing — that quantum effects help you beat classical bounds,” says Raam Uzdin, a quantum physicist at the Technion–Israel Institute of Technology in Haifa.

Disappointingly, Uzdin says, this is not the case. Recent analyses suggest that quantum versions of the second law, which governs efficiency, and the third law, which prohibits systems from reaching absolute zero, retain similar and, in some cases, more-stringent constraints than their classical incarnations.

Some differences arise because the macroscopic thermodynamic quantity 'free energy'— the energy a system has available to do work — doesn't have just one counterpart at the microscale, but many, says Jonathan Oppenheim, a quantum physicist at University College London. Classically, the free energy is calculated by assuming that all states of the system, determined by the arrangement of particles at a given energy, are equally likely. But that assumption isn't true on tiny scales, says Oppenheim; certain states might be much more probable than others. To account for this, additional free energies need to be defined in order to accurately describe the system and how it will evolve. Oppenheim and his colleagues propose that individual second laws exist for each type of free energy, and that quantum devices must obey all of them[4]. “Since the second law tells you what you aren't allowed to do, in some ways, it seems that having more laws on the microscale leaves you worse off,” says Oppenheim.

Much of the work done to calculate equivalents of the second and third laws remains, for now, theoretical. But proponents argue that it can help to illuminate how thermodynamic bounds are physically enforced at small scales. For instance, a theoretical analysis carried out by a pair of quantum physicists based in Argentina showed that as a quantum refrigerator nears absolute zero, photons will spontaneously appear in the vicinity of the device[5]. “This dumps energy into the surroundings, causing a heating effect that counters the cooling and stops you ever reaching absolute zero,” explains team member Nahuel Freitas of Ciudad University in Buenos Aires.

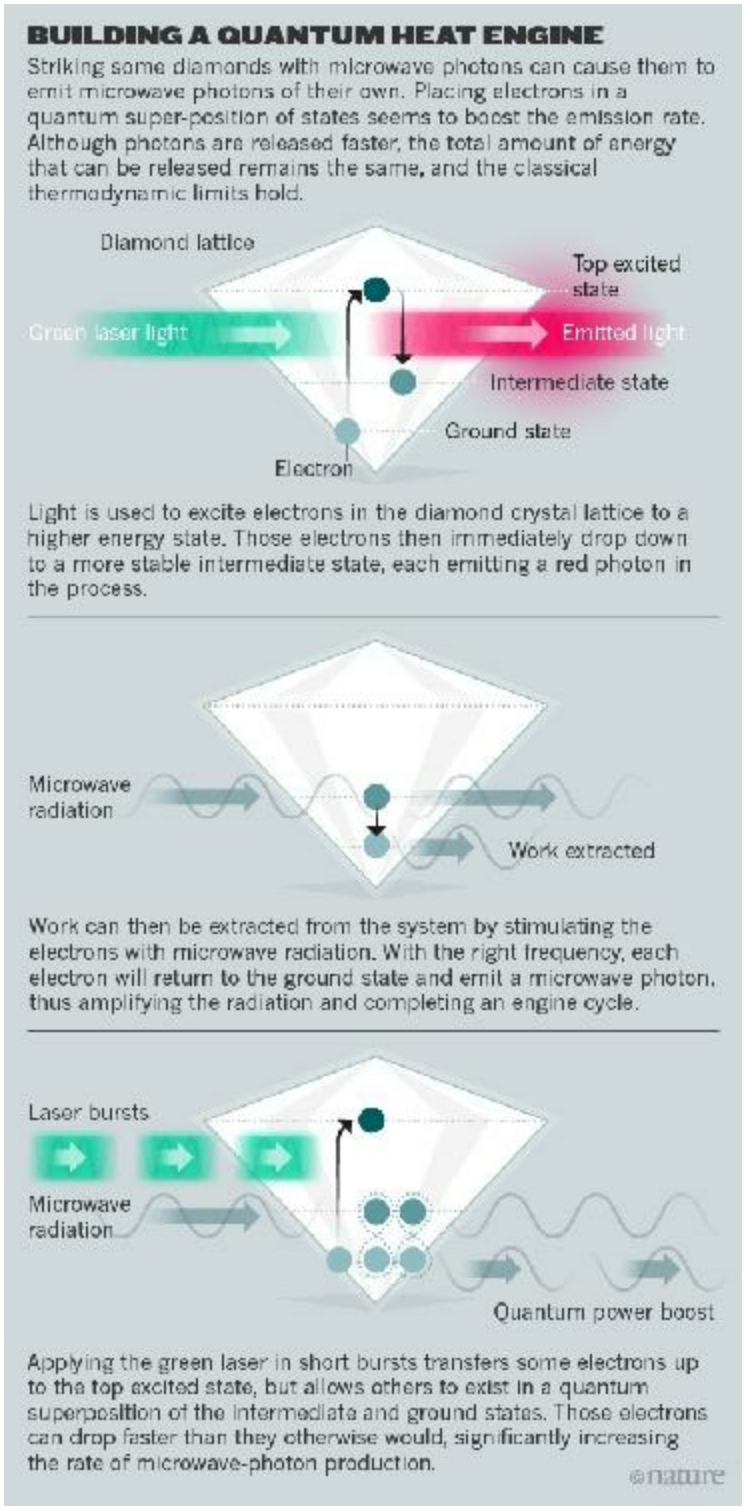
Theory has also revealed some potential wiggle room. In a theoretical analysis examining information flow between hot and cold chambers, or 'baths', of particles, a team based in Barcelona that included Riera and quantum physicist Manabendra Nath Bera discovered a strange scenario in which the hot bath seemed to spontaneously get hotter, while the cold bath became colder[6]. “At first, this looks crazy, like we can violate thermodynamics,” says Bera. But the researchers soon realized that they had overlooked the quantum twist: the particles in the baths can become entangled. In theory, making and breaking these correlations provides a way to store and release energy. Once this quantum resource was budgeted for, the laws of thermodynamics fell into place.

A number of independent groups have proposed using such entanglement to store energy in a 'quantum battery', and a group at the Italian Institute of Technology in Genoa is attempting to confirm the Barcelona team's predictions with batteries built from superconducting quantum bits, or 'qubits'[7]. In principle, such quantum batteries could charge considerably faster than their classical equivalents. “You won't be able to extract and store more energy than the classical bound allows — that's set by the second law,” says Riera. “But you may be able to speed things up.”

Some researchers are looking for easier ways to manipulate qubits for quantum-computing applications. Quantum physicist Nayeli Azucena Rodríguez Briones at the University of Waterloo in Canada and her colleagues have devised[8] an operation that might enhance the cooling needed for quantum-computing operations by manipulating pairs of qubit energy levels. They are currently planning to test this idea in the lab using superconducting qubits.

A small spark

The concept that quantum effects could be exploited to improve thermodynamic performance also inspired the diamond experiment under way at Oxford, which was first proposed by Kosloff, Uzdin and Amikam Levy, also at the Hebrew University[1]. Defects created by nitrogen atoms scattered through the diamond can serve as an engine — a machine that performs an operation after being brought into contact with first a hot reservoir (in this case a laser) and then a cold one. But Kosloff and his colleagues expect that such an engine can be operated in an enhanced mode, by exploiting a quantum effect that enables some of the electrons to exist in two energy states simultaneously. Maintaining these superpositions by pulsing the laser light rather than using a continuous beam should enable the crystal to emit microwave photons more rapidly than it otherwise would (see 'Building a quantum heat engine').



Last week, the Oxford-based team posted a preliminary analysis[9] showing evidence of the predicted quantum boost. The paper has yet to be peer reviewed, but if the work holds up, then “it is a groundbreaking result,” says

Janet Anders, a quantum physicist at Exeter University, UK. But, she adds, it's still not clear exactly what enables this feat. “It seems to be a magic fuel, not so much adding energy, but enabling the engine to extract energy faster,” Anders says. “Theoretical physicists will need to examine just how it does this.”

Focusing on experiments is a major step in the right direction for revitalizing the field, says Hänggi. But, for him, the experiments are not yet bold enough to give truly ground-breaking insights. There is also the challenge that quantum systems can be irrevocably disturbed by measurement and interaction with the environment. These effects are rarely sufficiently accounted for in theoretical proposals for new experiments, he says. “That is difficult to calculate, and much more difficult to implement in an experiment,” he says.

Ian Walmsley, who heads the Oxford lab where the diamond experiment was conducted, is also circumspect about the future of the field. Although he and other experimenters have been drawn to quantum thermodynamics research in recent years, he says that their interest has been largely “opportunistic”. They have spotted the chance to carry out relatively quick and easy experiments by piggybacking on set-ups already in place for other uses; the diamond-defect set-up, for instance, is already being widely studied for quantum computing and sensor applications. Today, quantum thermodynamics is fizzing with energy, Walmsley says. “But whether it will continue to sparkle, or just explode into nothing, well, we will have to wait and see.”

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Comments

8 comments

1. *Pentcho Valev* • 2017-11-03 08:02 AM

   Clifford Truesdell, The Tragicomical History of Thermodynamics, 1822-1854, p. 6: "Finally, I confess to a heartfelt hope - very slender but tough - that even some thermodynamicists of the old tribe will study this book, master the contents, and so share in my discovery: Thermodynamics need never have been the Dismal Swamp of Obscurity that from the first it was and that today in common instruction it is; in consequence, it need not so remain." [...] p. 333: "Clausius' verbal statement of the "Second Law" makes no sense, for "some other change connected therewith" introduces two new and unexplained concepts: "other change" and "connection" of changes. Neither of these finds any place in Clausius' formal structure. All that remains is a Mosaic prohibition. A century of philosophers and journalists have acclaimed this commandment; a century of mathematicians have shuddered and averted their eyes from the unclean."
   https://www.amazon.com/Tragicomical-Thermodynamics-1822-1854-Mathematics-Physical/dp/1461394465 Jos Uffink, Bluff your way in the Second Law of Thermodynamics: "Before one can claim that acquaintance with the Second Law is as indispensable to a cultural education as Macbeth or Hamlet, it should obviously be clear what this law states. This question is surprisingly difficult. The Second Law made its appearance in physics around 1850, but a half century later it was already surrounded by so much confusion that the British Association for the Advancement of Science decided to appoint a special committee with the task of providing clarity about the meaning of this law. However, its final report (Bryan 1891) did not settle the issue. Half a century later, the physicist/philosopher Bridgman still complained that there are almost as many formulations of the second law as there have been discussions of it. And even today, the Second Law remains so obscure that it continues to attract new efforts at clarification."

http://philsci-archive.pitt.edu/313/1/engtot.pdf As Clifford Truesdell suggests, the confusion started with Clausius's 1850 idiotic argument - later formulations of the second law of thermodynamics have all been defective. However previous formulations - those of Carnot - were both clear and correct. The simplest one is this: "A cold body is necessary" That is, heat cannot be cyclically converted into work unless a hot body, source of heat, and a cold body, receiver of heat, are available. The problem is that in 1824 Carnot deduced "A cold body is necessary" from a postulate that eventually turned out to be false: Carnot's (false) postulate: Heat is an indestructible substance (caloric) that cannot be converted into work by the heat engine. Unpublished notes written in the period 1824-1832 reveal that, after realizing that his postulate was false (and discovering the first law of thermodynamics), Carnot found "A cold body is necessary" implausible: Sadi Carnot, REFLECTIONS ON THE MOTIVE POWER OF HEAT, p. 225: "Heat is simply motive power, or rather motion which has changed form. It is a movement among the particles of bodies. Wherever there is destruction of motive power there is, at the same time, production of heat in quantity exactly proportional to the quantity of motive power destroyed. Reciprocally, wherever there is destruction of heat, there is production of motive power." p. 222: "Could a motion (that of radiating heat) produce matter (caloric)? No, undoubtedly; it can only produce a motion. Heat is then the result of a motion. Then it is plain that it could be produced by the consumption of motive power, and that it could produce this power. All the other phenomena - composition and decomposition of bodies, passage to the gaseous state, specific heat, equilibrium of heat, its more or less easy transmission, its constancy in experiments with the calorimeter - could be explained by this hypothesis. But it would be DIFFICULT TO EXPLAIN WHY, IN THE DEVELOPMENT OF MOTIVE POWER BY HEAT, A COLD BODY IS NECESSARY; why, in consuming the heat of a warm body, motion cannot be produced." http://www.nd.edu/~powers/ame.20231/carnot1897.pdf Generally, a cold body is not necessary, that is, the second law of thermodynamics is false. The cold body is only

TECHNOLOGICALLY necessary – non-isothermal heat engines are fast-working and powerful. Heat engines working under isothermal conditions (in the absence of a cold body) are commonplace but are too slow and impuissant to be of any technological importance. Except, perhaps, for the case where water is placed in an electric field - the non-conservative force (pressure) that emerges seems to be able to convert ambient heat into work quite vigorously: Wolfgang K. H. Panofsky, Melba Phillips, Classical Electricity and Magnetism, pp.115-116: "Thus the decrease in force that is experienced between two charges when they are immersed in a dielectric liquid can be understood only by considering the effect of the PRESSURE OF THE LIQUID ON THE CHARGES themselves." http://www.amazon.com/Classical-Electricity-Magnetism-Second-Physics/dp/0486439240?tag=viglink21401-20 "However, in experiments in which a capacitor is submerged in a dielectric liquid the force per unit area exerted by one plate on another is observed to decrease... [...] This apparent paradox can be explained by taking into account the DIFFERENCE IN LIQUID PRESSURE in the field filled space between the plates and the field free region outside the capacitor." http://farside.ph.utexas.edu/teaching/jk1/lectures/node46.html Tai Chow, Introduction to Electromagnetic Theory: A Modern Perspective, p. 267: "The strictly electric forces between charges on the conductors are not influenced by the presence of the dielectric medium. The medium is polarized, however, and the interaction of the electric field with the polarized medium results in an INCREASED FLUID PRESSURE ON THE CONDUCTORS that reduces the net forces acting on them." http://www.amazon.com/Introduction-To-Electromagnetic-Theory-Perspective/dp/0763738271 "Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ Pentcho Valev

2. *Vyacheslav Somsikov* • 2017-11-03 04:34 AM

   For the verification of the deterministic mechanism of irreversibility, which obtained within the framework of the classical mechanics laws [Somsikov V.M. Non-Linearity of Dynamics of the

Non-Equilibrium Systems. World Journal of Mechanics, 2017, Vol.7 No.2, 11-23], we was performed the numerical calculations of the change of D-entropy for the system with different number of the potentially interacting material points (MP) when it moves through a potential barrier. D – entropy is a relation of the value of change of the systems internal energy to its full value. [Somsikov V. M. and Andreev A. B. On criteria of transition to a thermodynamic description of system dynamics. Russian Physics Journal, Vol. 58, No. 11, March, 2016; http://www.ijSciences.com Volume 4 – May 2015 (05)]. The calculations were carried 400 times for a given number of particles for different initial states of the system, but for the same predetermined amount of energy. This made it possible to determine the change of the D-entropy for different states of the system for a given value of its energy and a given number of MP. It was found that the fluctuations of internal energy decreasing with increasing number of particles in the system for different initial conditions. When number of particles less 64, the D –entropy can be as positive as negative.When number of particles more 64 then none of the 400 numerical experiments gave a negative value change of the internal energy. This means that when number of particles more 64 the dynamics of the system becomes irreversible. Therefore, the number 64 can be called as a first critical number of the system, beyond which the system becomes irreversible. When number of particles more than 1000, the dispersion of the internal energy reaches to the minimum. With further increase in the number of MP the increment of the internal energy is not changed. This number can be called as a second critical number. Thus if the system consist from number of particles more than 1000, the thermodynamic description is a correct. Obviously, in the general case, these critical numbers will depend on the parameters of the task, for example, the width and height of the barrier.

3. *Pentcho Valev* • 2017-11-02 07:25 PM

   "Entropy was discovered when it was noticed to be a quantity that behaves as a function of state, as a consequence of the second law of thermodynamics." https://en.wikipedia.org/wiki/Entropy It was Clausius who "noticed" that the entropy is a state function, but was

he correct? Here is the story: If you define the entropy S as a quantity that obeys the equation dS=dQrev/T, you will find that, so defined, the entropy is a state function FOR AN IDEAL GAS. Clausius was very impressed by this statefunctionness and decided to prove that the entropy (so defined) is a state function for ANY system. So "Entropy is a state function" became a fundamental theorem in thermodynamics. Clausius deduced it from the assumption that any cycle can be disintegrated into small Carnot cycles, and nowadays this deduction remains the only justification of "Entropy is a state function": "Carnot Cycles: S is a State Function. Any reversible cycle can be thought of as a collection of Carnot cycles - this approximation becomes exact as cycles become infinitesimal. Entropy change around an individual cycle is zero. Sum of entropy changes over all cycles is zero." http://mutuslab.cs.uwindsor.ca/schurko/introphyschem/lectures/240 "Entropy Changes in Arbitrary Cycles. What if we have a process which occurs in a cycle other than the Carnot cycle, e.g., the cycle depicted in Fig. 3. If entropy is a state function, cyclic integral of dS = 0, no matter what the nature of the cycle. In order to see that this is true, break up the cycle into sub-cycles, each of which is a Carnot cycle, as shown in Fig. 3. If we apply Eq. (7) to each piece, and add the results, we get zero for the sum." http://ronispc.chem.mcgill.ca/ronis/chem213/hnd8.pdf The assumption on which "Entropy is a state function" is based - that any cycle can be subdivided into small Carnot cycles - is obviously false. An isothermal cycle CANNOT be subdivided into small Carnot cycles. A cycle involving the action of conservative forces CANNOT be subdivided into small Carnot cycles. Conclusion: The belief that the entropy is a state function is totally unjustified. Any time scientists use the term "entropy", they don't know what they are talking about. "My greatest concern was what to call it. I thought of calling it 'information', but the word was overly used, so I decided to call it 'uncertainty'. When I discussed it with John von Neumann, he had a better idea. Von Neumann told me, 'You should call it entropy, for two reasons: In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important,

nobody knows what entropy really is, so in a debate you will always have the advantage."
https://en.wikipedia.org/wiki/History_of_entropy Pentcho Valev

4. *Pentcho Valev* • 2017-11-02 10:05 PM
   The version of the second law of thermodynamics known as "Entropy always increases" (a version which, according to A. Eddington, holds "the supreme position among the laws of Nature") is in fact a theorem deduced by Clausius in 1865: Jos Uffink, Bluff your Way in the Second Law of Thermodynamics, p. 37: "Hence we obtain: THE ENTROPY PRINCIPLE (Clausius' version) For every nicht umkehrbar [irreversible] process in an adiabatically isolated system which begins and ends in an equilibrium state, the entropy of the final state is greater than or equal to that of the initial state. For every umkehrbar [reversible] process in an adiabatical system, the entropy of the final state is equal to that of the initial state." http://philsci-archive.pitt.edu/archive/00000313/ Clausius' deduction was based on three postulates: Postulate 1 (implicit): The entropy is a state function. Postulate 2: Clausius' inequality (formula 10 on p. 33 in Uffink's paper) is correct. Postulate 3: Any irreversible process can be closed by a reversible process to become a cycle. All the three postulates remain totally unjustified even nowadays. Postulate 1 can easily be disproved by considering cycles (heat engines) converting heat into work in ISOTHERMAL conditions. Postulate 3 is also false: Uffink, p.39: "A more important objection, it seems to me, is that Clausius bases his conclusion that the entropy increases in a nicht umkehrbar [irreversible] process on the assumption that such a process can be closed by an umkehrbar [reversible] process to become a cycle. This is essential for the definition of the entropy difference between the initial and final states. But the assumption is far from obvious for a system more complex than an ideal gas, or for states far from equilibrium, or for processes other than the simple exchange of heat and work. Thus, the generalisation to all transformations occurring in Nature is somewhat rash." Note that, even if Clausius's theorem were true (it is not), it only holds for "an adiabatically isolated system which begins and ends in an equilibrium state". This means that (even if Clausius's theorem were true) applications of "Entropy

always increases" to processes which do not begin and end in equilibrium, that is, to processes in Nature, not in a cylinder with a piston, would still be incorrect: Jos Uffink, in the same article: "I therefore argue for the view that the second law has nothing to do with the arrow of time. [...] This summary leads to the question whether it is fruitful to see irreversibility or time-asymmetry as the essence of the second law. Is it not more straightforward, in view of the unargued statements of Kelvin, the bold claims of Clausius and the strained attempts of Planck, to give up this idea? I believe that Ehrenfest-Afanassjewa was right in her verdict that the discussion about the arrow of time as expressed in the second law of the thermodynamics is actually a RED HERRING." Pentcho Valev

5. *Raji Heyrovska* • 2017-11-02 02:45 PM

   I just saw the interesting article by Merali [1]. In this context, I wish to draw attention to the First International Conference [2] on Quantum Limits to the Second Law. In her contribution [3] to this conference, she points out that thermodynamic functions and laws were developed over the years to "bridge" the gap between the equations of state and thermal properties of matter. In [3] the author has incorporated the thermodynamic properties into the equation of state thereby forming one simple composite equation. The heat capacity difference is introduced in place of the gas constant in her earlier concise equation of state for gases, based on free volume and molecular association/dissociation. This provides a new and simple relation between the P, V, T properties, internal energy (E), enthalpy (H), Gibbs (G) and Helmholtz (A) free energies, heat energy (Q), entropy (S), partition function (f) and the thermodynamic laws. Since a proper definition of "heat" is essential for the discussion of the second law, Q for a gas at the given P, V, T, S is defined as TS = PVflnW, where W is the thermodynamic probability related to f. The latter is expressed as the ratio of free volume to volume corresponding to the de Broglie wave length. Also, for the first time experimental heat capacities at various P, V and T are correlated with the extent of molecular association. The available data for nitrogen have been used to demonstrate the validity of the new equation of state. References: 1. Merali, Z., Nature 551, 20–22 (02 November 2017) doi:10.1038/551020a 2.

“QUANTUM LIMITS TO THE SECOND LAW: First International Conference on Quantum Limits to the Second Law”: 29-31 July 2002, San Diego, California (USA), ISBN: 0-7354-0098-9, Editors: Daniel P. Sheehan, Volume number: 643, Published: Nov 20, 2002, http://aip.scitation.org/toc/apc/643/1?expanded=643 3. Heyrovska, R., AIP Conference Proceedings 643, 157-162 (2002); http://aip.scitation.org/doi/10.1063/1.1523797

6. *Pentcho Valev* • 2017-11-02 09:37 AM

The second law of thermodynamics has an absurd implication that proves its falsehood: If we have a reversible chemical reaction and a catalyst increases the rate of the forward reaction by a factor of, say, 745492, it obligatorily increases the rate of the reverse reaction by exactly the same factor, 745492, despite the fact that the two reactions - forward and reverse - may be entirely different (e.g. the diffusion factor is crucial for one but not important for the other) and accordingly require entirely different catalytic mechanisms. The absurd implication is usually referred to as "Catalysts do not shift chemical equilibrium": "A catalyst reduces the time taken to reach equilibrium, but does not change the position of the equilibrium. This is because the catalyst increases the rates of the forward and reverse reactions BY THE SAME AMOUNT." http://www.bbc.co.uk/bitesize/higher/chemistry/reactions/equilibriu "In the presence of a catalyst, both the forward and reverse reaction rates will speed up EQUALLY... [...] If the addition of catalysts could possibly alter the equilibrium state of the reaction, this would violate the second rule of thermodynamics..." https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/chemical-equilibrium-14/factors-that-affect-chemical-equilibrium-106/the-effect-of-a-catalyst-447-3459/ The absurd implication is not obeyed by chemical reactions of course. Here is a publication in Nature describing a catalyst accelerating the forward and SUPPRESSING the reverse reaction: http://images.nature.com/m685/nature-assets/ncomms/2013/130917/ncomms3500/images_hires/ncomms35 f1.jpg Yu Hang Li et al. Unidirectional suppression of hydrogen oxidation on oxidized platinum clusters. https://www.nature.com/articles/ncomms3500 Another example of

disobedience: Perpetual (limited only by the deterioration of the system) motion of dimer A_2 and monomer A between two catalytic surfaces, S1 and S2 (a time crystal par excellence): http://upload.wikimedia.org/wikipedia/commons/c/ce/NatureSLTD-Fig1c.jpg See the explanations here: https://en.wikipedia.org/wiki/Duncan%27s_Paradox That catalysts can violate the second law of thermodynamics by shifting chemical equilibrium is presented by Wikipedia as a fact: "Epicatalysis is a newly identified class of gas-surface heterogeneous catalysis in which specific gas-surface reactions shift gas phase species concentrations away from those normally associated with gas-phase equilibrium. [...] A traditional catalyst adheres to three general principles, namely: 1) it speeds up a chemical reaction; 2) it participates in, but is not consumed by, the reaction; and 3) it does not change the chemical equilibrium of the reaction. Epicatalysts overcome the third principle..." https://en.wikipedia.org/wiki/Epicatalysis Pentcho Valev

7. *Pentcho Valev* • 2017-11-01 07:17 PM

   The second law of thermodynamics has long been under attack but only for small, microscopic, quantum etc. systems: Nature 2002: "Second law broken. Researchers have shown for the first time that, on the level of thousands of atoms and molecules, fleeting energy increases violate the second law of thermodynamics." http://www.nature.com/news/2002/020722/full/news020722-2.html The truth is that MACROSCOPIC systems violating the second law of thermodynamics are COMMONPLACE. The problem is that misleading education diverts the attention from relevant examples: "A necessary component of a heat engine, then, is that two temperatures are involved. At one stage the system is heated, at another it is cooled." http://physics.bu.edu/~duffy/py105/Heatengines.html So educators present the two temperatures as NECESSARY and deal with non-isothermal heat engines only: http://readingpenrose.files.wordpress.com/2015/07/rubber-band-engine.gif "All materials react to heat in some way. But this new shape-changing polymer reacts to temperatures as small as the touch of human skin to contract - in the process lifting as much as

1,000 times its own weight." http://gizmodo.com/this-new-shape-changing-polymer-can-lift-1-000-times-it-1759165438 "Stretchy Science: A Rubber Band Heat Engine. Learn how a rubber band can turn heat into mechanical work with this simple activity. [...] Your blow dryer essentially turned your rubber band into a heat engine - a machine that turns thermal energy into mechanical work." https://www.scientificamerican.com/article/bring-science-home-rubber-band-heat/ The second law of thermodynamics would be long forgotten if isothermal analogs which almost obviously violate the second law of thermodynamics had been analyzed (one should only evaluate the work involved in a quasi-static cycle): http://www.gsjournal.net/old/valev/val3.gif "When the pH is lowered (that is, on raising the chemical potential, μ, of the protons present) at the isothermal condition of 37°C, these matrices can exert forces, f, sufficient to lift weights that are a thousand times their dry weight." http://www.google.com/patents/US5520672 A. KATCHALSKY, POLYELECTROLYTES AND THEIR BIOLOGICAL INTERACTIONS, p. 15, Figure 4: "Polyacid gel in sodium hydroxide solution: expanded. Polyacid gel in acid solution: contracted; weight is lifted." https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1367611/pdf/bioph0017.pdf The following four-step isothermal cycle, if carried out quasi-statically (reversibly), clearly violates the second law of thermodynamics: 1. The polymer is initially stretched. The operator adds hydrogen ions (H+) to the system. The force of contraction increases. 2. The polymers contracts and lifts a weight. 3. The operator removes the same amount of H+ from the system. The force of contraction decreases. 4. The operator stretches the polymer and restores the initial state of the system. The net work extracted from the cycle is positive unless the following is the case: The operator, as he decreases and then increases the pH of the system (steps 1 and 3), does (loses; wastes) more work than the work he gains from weight-lifting. However electrochemists know that, if both adding hydrogen ions to the system and then removing them are performed quasi-statically, the net work involved is virtually zero (the operator gains work if the hydrogen ions are transported from a high to a low concentration and then loses the

same amount of work in the backward transport). That is, the net work involved in steps 1 and 3 is zero, and the net work extracted from steps 2 and 4 is positive, in violation of the second law of thermodynamics. Pentcho Valev

8. *Pentcho Valev* • 2017-11-01 06:36 PM

    Philip Ball explains why Frank Wilczek's time crystals are bogus: "But to make that happen, the researchers must deliver kicks to the spins, provided by a laser or pulses of microwaves, to keep them out of equilibrium. The time crystals are sustained only by constant kicking, even though - crucially - their oscillation doesn't match the rhythm of the kicking. The experiments are ingenious and the results show that this modified version of Wilczek's vision is feasible. But are we right to award the new findings this eye-catching new label, or are they really just a new example of a phenomenon that has been going on since the first primeval heart started beating? If these fancy arrangements of quantum spins deserve to be called time crystals, can we then say that we each already have a time crystal pulsing inside of us, keeping us alive?" http://www.prospectmagazine.co.uk/blogs/philip-ball/time-crystals-could-they-exist-science-physics That is, Frank Wilczek's time crystals are regularly "kicked" by the experimentalist. However, there are genuine time crystals "kicked" by ambient heat and breathtakingly violating the second law of thermodynamics. Here is perpetual (limited only by the deterioration of the system) motion of water in an electric field, obviously able to produce work - e.g. by rotating a waterwheel: "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ "The water movement is bidirectional, i.e., it simultaneously flows in both directions." https://www.wetsus.nl/home/wetsus-news/more-than-just-a-party-trick-the-floating-water-bridge-holds-insight-into-nature-and-human-innovation/1 The work will be done at the expense of what energy? The first hypothesis that comes to mind is: At the expense of electric energy. The system is, essentially, an electric motor. However, close inspection would suggest that the hypothesis is untenable. Scientists use triply distilled water to reduce the conductivity and the electric current passing through the

system to minimum. If, for some reason, the current is increased, the motion stops - the system cannot be an electric motor. If the system is not an electric motor, then it is ... a perpetual-motion machine of the second kind! Here arguments describing perpetual-motion machines as impossible, idiotic, etc. are irrelevant - the following conditional is valid: IF THE SYSTEM IS NOT AN ELECTRIC MOTOR, then it is a perpetual-motion machine of the second kind. In other words, if the work is not done at the expense of electric energy, then it is done at the expense of ambient heat, in violation of the second law of thermodynamics. No third source of energy is conceivable. In the electric field between the plates of a capacitor, the same perpetual motion of water can be seen (we have a time crystal again): " Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg In the capacitor system the rising water can repeatedly do work, e.g. by lifting floating weights. The crucial question is: The work (lifting floating weights) will be done at the expense of what energy? Obviously "electric energy" is not the correct answer - the capacitor is not an electric motor. Then the only possible answer remains "ambient heat". The system is a heat engine violating the second law of thermodynamics! Pentcho Valev

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Join the disruptors of health science

01 November 2017

Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.

Gabriela Hasbun for *Nature*

Thomas Insel left Verily, a health-science spin-off formed by Google's parent company, to co-found a start-up called Mindstrong Health this year.

In early 2015, I testified with several other National Institutes of Health (NIH) directors at an annual hearing held by the US Senate. It was my 13th and final year as director of the US National Institute of Mental Health

(NIMH) in Bethesda, Maryland. What struck me most was how the harsh fiscal reality tempered the passionate bipartisan support for the NIH. As one senator noted, with a federal deficit of nearly US$500 billion, there was little hope of any significant increase in funding.

Six months after that hearing, I left the NIH for Silicon Valley, first working at Verily in South San Francisco, California, a health-science spin-off formed by Google's parent company Alphabet. Since May, I've been president and co-founder of a start-up called Mindstrong Health in Palo Alto, California. I've witnessed the tremendous possibilities that immense resources, massive computing power and the application of data science can bring to biomedical research. I've watched some of today's best junior faculty members and postdocs launch their careers in Silicon Valley instead of in academic departments. And I've wondered how technology giants and start-ups will change biomedical and health-care research.

These companies have transformed the worlds of information, entertainment and commerce. But by moving into health care, they face some formidable challenges. In my view, solving them will require deep partnerships between technology companies, clinical experts, patient advocates and academic scientists.

A financial frontier

In the United States, public funding for science has not kept up with inflation over the past decade. The proposed 2018 budget from the White House recommends funding cuts for the NIH and the National Science Foundation of more than 10% each. Appropriations may ultimately be more generous, but no one is expecting Congress to repair a decade's loss of purchasing power.

Meanwhile, private-sector investment has become a bigger piece of the research-funding pie — increasing from 46% in 1994 to 58% in 2012 for biomedical research[1]. Tech companies, in particular, have been ploughing more funds into research, and moving into areas such as health and life sciences that have typically been the domain of the NIH, pharmaceutical and

biotechnology companies. By any measure, tech companies have enormous sums to spend. The collective cash reserves of Apple, Microsoft, Alphabet and Facebook — roughly $500 billion — exceed by tenfold the annual federal investment in biomedical research.

So what does this changing ecosystem mean for US biomedical science? Has the locus of innovation shifted from academia to Google and Facebook?

In some areas, such as artificial intelligence (AI), tech companies already dominate. According to a 2017 report, the tech giants invested between US$20 billion and $30 billion in AI in 2016, with 90% of this going towards research and development. Some, such as Google and the Chinese web-services company Baidu, are rebranding themselves as AI or deep-learning companies, with a focus on both expanding the science of machine learning and applying the approach to big-data problems[2].

In health research, the landscape is still evolving. Three years ago, IBM began selling a software suite called Watson for Oncology to cancer-treatment centres around the world. The program is built around what IBM call cognitive computing and is designed to help clinicians to select the best treatment. The company claimed that by using its cloud-based data on cancer, Watson could recommend interventions for individual patients, although some say the effort was premature and oversold[3].

Over the past 12 months, Fitbit, the developer of several fitness trackers, has expanded into a health-care and health-research company. With more than 50 million registered users, it is involved in 400 research projects, including studies of diabetes and heart disease. In fact, Fitbit has just been listed as one of nine digital health companies to be considered by the US Food and Drug Administration (FDA) in its precertification pilot programme — a new, supposedly more agile, approach to regulation that will focus on the software developer rather than on individual products.

Since March 2015, Apple's ResearchKit has made it easier for developers to create health apps for the iPhone or Apple Watch. It has also provided a platform for enrolling thousands of participants remotely in clinical projects, for instance in diabetes, cancer and diseases of the central nervous system. A study at Johns Hopkins University in Baltimore, Maryland, for instance, has

used ResearchKit to capture data just before and throughout seizures in nearly 1,000 people with epilepsy[4].

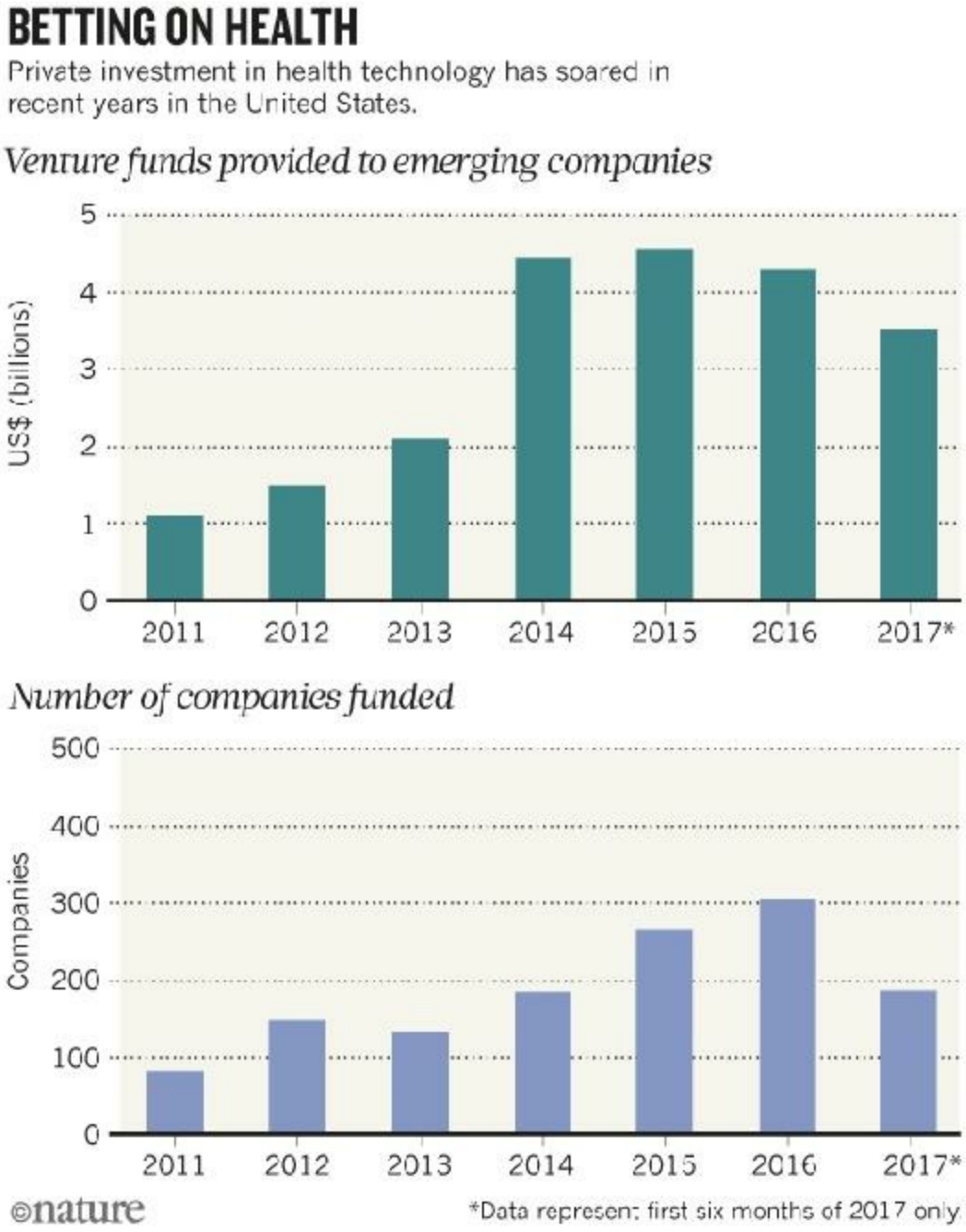
Kiyoshi Ota/Bloomberg/Getty

Fitbit, the developer of these sleep-monitoring wristbands, is currently involved in 400 research projects.

Also in 2015, Alphabet launched Verily — a company focused on creating software and hardware to transform health care. After growing to more than 500 employees in just over 2 years, Verily seeks to address diabetes, heart disease, cancer and diseases of the central nervous system using miniaturized sensors in smart devices — such as a contact lens that estimates blood sugar levels.

Just six months ago, Facebook revealed the existence of Building 8, a division focused on delivering consumer “hardware products that are social first”, including brain–computer interfaces designed to aid people with disabilities.

Meanwhile, health tech has become one of the hottest areas for venture investment in the United States: more than 1,000 new digital-health companies have started up since 2012. A report from Rock Health, a US venture-capital fund headquartered in San Francisco that invests in digital-health start-ups, estimates[5] that $15 billion has poured in to the sector over the past 5 years, up from $1.5 billion in 2012 and $1.1 billion in 2011 (see 'Betting on health').



Source: Rock Health

Like pharma and biotech, big and small tech companies are product-focused and team-based. This contrasts with academia, where scientists are rewarded for publishing papers and incentives are built around individual promotion

within a departmental structure.

But what struck me most on moving from the Beltway to the Bay Area was that, unlike pharma and biotech, tech companies enter biomedical and health research with a pedigree of software research and development, and a confident, even cocky, spirit of disruption and innovation. They have grown by learning how to move quickly from concept to execution. Software development may generate a minimally viable product within weeks. That product can be refined through 'dogfooding' (testing it on a few hundred employees, families or friends) in a month, then released to thousands of users for rapid iterative improvement.

During my first month working at Verily, I returned to Bethesda for the winter holidays; when I went back to work in early January, I found that a group of engineers had developed an entirely new product between Christmas and New Year's Day. Contrast that with the NIH-funded world of research, where it usually takes at least 18 months to go from proposing an idea to getting a project funded, or the years it can take to transform the discovery of a molecule into a marketable drug.

This intense focus on the rapid development of consumer products is very different from the pursuit of fundamental knowledge that has been a hallmark of academic research. And as a newcomer (what Google calls a noogler), I found the language of product development and the drive towards 'quarterly OKRs' (objectives and key results) a bit off-putting. But the truly disruptive impact of tech companies is not the rapid-fire push for consumer products or their deep pockets; it's their focus on AI and data resources.

Mining data

It is not surprising that companies that are dependent on information processing for their main revenue would be at the vanguard of developing the tools for collecting, storing and analysing data. A by-product of this is that tech companies are transforming data science — much as pharma and biotech transformed medicinal chemistry and molecular biology in the last decades of the twentieth century. In an era when biology is increasingly an information

science, the tools being created by tech companies can provide insights that will almost certainly be translated into advances for health.

The potential is awesome — for discovery as well as for product development.

Three examples illustrate what can be achieved through having extraordinary access to population data as well as massive data-storage and data-processing capacity. Importantly, none connects in an obvious way to a primary business of the company.

First, in 2016 a team at Google used a version of machine learning called convolutional neural nets to create an algorithm to detect diabetic retinopathy[6]. The researchers started by having 54 ophthalmologists rate 128,175 retinal images. Once the algorithm had been trained on this data set, the team used two new sets of retinal images to test against eight board-certified ophthalmologists. The results were striking: depending on how the researchers set its parameters, the algorithm performed better than seven of the eight clinical experts, in terms of sensitivity and specificity. This approach is not markedly different from previous efforts to identify cats and faces with machine learning, but the potential impact on diagnostics and clinical care is profound.

Second, a team in Facebook's Building 8 is seeking to develop new brain–computer interfaces that (with the use of non-invasive optical sensors) will enable people to type simply by thinking — what is now called 'silent speech'. Although several universities have teams working on brain–computer interactions, the number of engineers and the computational resources that Facebook can muster would be difficult for any academic investigator to fund using federal grants. Importantly, Facebook is supporting some of these academic scientists (as well as recruiting many) to expedite this project.

Third, a team at Microsoft has used anonymous Bing search histories from 9.2 million users to predict cases of pancreatic cancer several months before people are usually diagnosed with the disease[7]. The team identified characteristic patterns of historical symptom searches in more than 3,000 anonymous users who subsequently indicated a probable diagnosis of

pancreatic cancer — indicated by searches such as 'just diagnosed with pancreatic cancer'. This approach lacks the corroboration of a pathological diagnosis and the sensitivity is poor (only 5–15% of cases can be identified). But false-positive rates are extremely low (less than 0.0001).

In short, tech companies have scale and speed: an experiment can involve millions of people and be completed in months. But scale and speed aren't everything.

Sticking points

In moving from software or hardware development to biomedical research and health care, tech companies large and small face formidable challenges. They usually do not have the regulatory expertise needed to develop medical products, they rarely have access to clinical samples and they often lack a deep understanding of the clinical problem to be solved.

Gabriela Hasbun for *Nature*

At its California office, Mindstrong Health is developing digital phenotyping as a diagnostic tool.

Various moves are being made to try to address these issues. In May, Verily hired Robert Califf, former chief of the FDA, to help with its personalized-medicine effort called Project Baseline. In 2015, 23andMe, a personal-genomics company based in Mountain View, California, recruited Richard Scheller, former head of research at the biotech company Genentech in San Francisco, to lead its research programme. And in 2016, Apple brought Stephen Friend, an open-science advocate from the non-profit research organization Sage Bionetworks in Seattle, Washington, to assist with its health projects.

How a culture built around engineers and designers will incorporate people from different sectors remains to be seen, and whether companies that build consumer products will be able to work with health-care payers and providers is unclear. But the willingness of tech companies to hire national experts on health, regulation and health data to aid in discoveries that will have clinical utility is a hopeful sign.

Yet there are at least four further major areas of uncertainty.

Open science increasingly drives innovation in the public sector. It is unclear to what degree the drive for intellectual property and profits will limit the transparency of research in the tech sector[8]. The stereotype is that for-profit companies will focus only on commercial end points. But there are notable counter-examples from AI research, in addition to the biomedical examples above. In 2015, Google made its machine-learning software library, TensorFlow, open source, and AI researchers across the board quickly adopted this powerful tool. Likewise, the *Apple Machine Learning Journal* launched in July to provide more transparency about the company's current projects (see go.nature.com/2yckpi9).

It's too early to say whether big or small tech companies will favour open source for their biomedical scientific initiatives. The success of ResearchKit gives some indication of what could be accomplished if they do.

Another uncertainty is whether the business model in tech, which is often based on advertising revenue or the sales of devices, will limit the rigour, generalizability and validity of the science carried out. Especially in start-ups that are dependent on rapid returns for their investors, the financial runway may be too short for lengthy or large clinical trials.

And then there's the issue of trust. It has become the norm for tech companies to use personal shopping or geolocation data for commerce. It's unclear whether the public will be as accepting about the use of personal health data, especially by behemoths such as Google or Facebook.

The recent commitments of big and small tech companies to discovery and clinical research are exciting. But during an economic downturn, these projects could be the first to be axed to protect the company's bottom line.

Science needs commitment. Bell Labs — at its peak, the premier research and development company of the United States — is an example of extraordinary scientific success in a for-profit organization. But as author Jon Gertner pointed out[9] in *The New York Times* in 2012: “Mark Zuckerberg noted that one of his firm's mottoes was 'move fast and break things'; that of Bell Labs' might just as well have been 'move deliberately and build things'.”

Partners, In time

The practical questions are these. What will each of the sectors in the evolving ecosystem do best? What can be done across sectors? How can bridges be built between companies with unprecedented access to data and massive computational resources, and academic scientists who may have a deep understanding of a clinical problem or access to unique clinical populations?

It seems likely that the academic sector will continue to lead on those aspects of fundamental biology and clinical research that do not require big data or machine learning — the purification of an enzyme, perhaps, or the development of a mouse model for a rare disease. Pharma and biotech will continue to be the source of new medicines. The domain of the tech industry

will be research that is data-intensive, and product development that requires a legion of software engineers working with designers.

Transformative medical products that require clinical testing, regulatory standards and insights about the health-care marketplace, including the practical constraints faced by providers in the clinic, will almost certainly require partnerships between public research entities and private companies. These must include precompetitive partnerships across tech, pharma–biotech, academia and patient-advocacy groups. Developing these partnerships will not be easy, given the different stakeholders, cultures and incentives.

Yet there are successful public–private partnerships to learn from.

Since 2006, the Biomarkers Consortium, managed by the US charitable organization the Foundation for the NIH, has brought academics and private companies together to develop biomarkers across a range of diseases. The Alzheimer's Disease Neuroimaging Initiative, which since 2004 has worked to establish standards for imaging biomarkers in dementia, is among the studies it has supported. As is I-SPY2, which since 2010 has created treatment pathways based on biomarkers for breast cancer. Another Foundation for the NIH initiative is the Accelerating Medicines Partnership. This has paired the NIH and the FDA with 10 pharma and biotech companies as well as 12 non-profit patient-advocacy foundations to define new targets for drug development for rheumatoid arthritis, type 2 diabetes and Alzheimer's disease.

A new sector in the research ecosystem means that health problems, even those that do not present an obvious commercial opportunity, can be approached from a fresh angle. Data science could integrate the full stack of patient information, from genomics to socio-economic factors, to guide clinical care. Sensors and big data could transform our description of phenomics — each person's set of behavioural, physical and biochemical traits. For example, digital phenotyping through the use of smartphone sensors, keyboard performance and voice or speech features can provide, for the first time, an objective, continuous, passive measure of behaviour and cognition at the global scale. Mindstrong Health is using this approach to detect the earliest phases of dementia, mental illness and possibly a range of medical disorders[10].

As just one example of an urgent opportunity, attempts to prevent suicide worldwide have been remarkably ineffective — including public-health measures to reduce stigma, raise awareness and reduce access to guns. Social media, just-in-time interventions and new analytical tools for prediction could change our understanding of risk and yield new strategies for prevention[11]. Tech companies, paired with other players, could start to solve this and many other historically intractable problems.

There is an old African proverb: “To go fast, go alone; to go far, go together.” Science to improve health has proved frustratingly slow. Perhaps, with a new fast partner, all of us in research can go farther.

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Comments

Comments

There are currently no comments.

Pay for US postdocs varies wildly by institution

Analysis of universities' salary data suggests major disparities in pay for early-career researchers.

01 November 2017

Some postdoctoral researchers at public universities in the United States apparently work for fast-food wages whereas others make more than US$100,000 a year, an analysis of postdoc pay has revealed.

The salary data, which a science-advocacy group released on 1 November after a year-long investigation, are incomplete and — in some cases — appear to be incorrect. Some researchers are listed as earning nothing, and another study underway suggests a higher overall rate of pay for US postdocs. But the latest analysis underscores the challenges of getting basic information about an under-recognized and misunderstood segment of the

academic workforce.

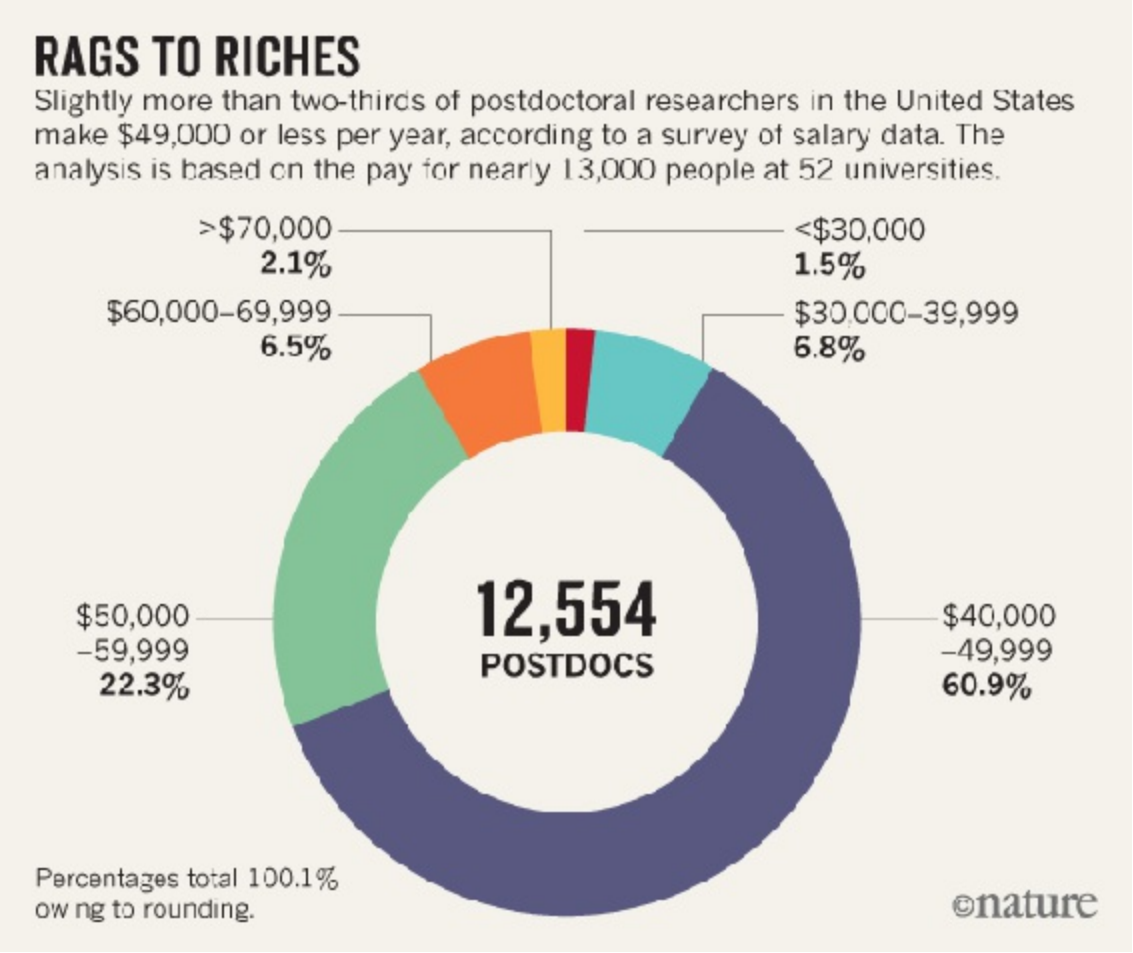
Gary McDowell, a former developmental biologist and executive director of Future of Research, an advocacy group in Boston, Massachusetts, used the US Freedom of Information Act to gather salary reports for nearly 13,000 postdocs at 51 public universities. Through personal connections, he also received salary information from one private institution, Boston University in Massachusetts.

Most universities made a good-faith effort to provide salary information, McDowell says, but few had the numbers at hand when he contacted them. McDowell says that he had to spend considerable time on the phone explaining to university employees what 'postdoc' means. “I asked a basic question — 'How much do your postdocs get paid?' — but there was a lot of confusion,” he says. “It points to how much interest there is in postdocs at these institutions.”

Multiply by zero?

Some universities still provided improbable numbers. They include the University of Utah in Salt Lake City, which reported that 50 postdocs each made $0 per year. McDowell says it is unlikely that these researchers were unpaid volunteers. Instead, he suspects that some institutions — including the University of Utah — reported only the money that postdocs received from the institution's payroll, and overlooked fellowships and other external sources of income. “University of Utah postdoctoral scholars are being paid for their work,” a university spokesman said.

While compiling data, McDowell opted to disregard the 411 reported salaries that were less than $23,660 a year. That is the threshold below which many postdocs would be eligible for overtime pay under a federal law called the Fair Labor Standards Act. “I gave them the benefit of the doubt,” McDowell says of those entries. “Those are likely reporting errors.”



Gary McDowell/Future of Research

The remaining 12,554 salary reports ranged from $23,660 to $114,600 a year (see 'Rags to riches'). McDowell suspects that some institutions mistakenly included pay data for staff scientists or other employees in their reports, which could explain some of the highest salaries. Even with that caveat, his survey suggests that postdoc salaries range widely. At any given institution, McDowell says, “It’s not uncommon for there to be fourfold differences between the highest and the lowest paid.”

Overall, 61% of reported salaries were between $40,000 and $49,999, and about 31% were reported at $50,000 or more. (The $50,000 figure is the minimum postdoctoral salary recommended in 2014 by the US National Academies of Sciences, Engineering, and Medicine.) The University of Illinois at Urbana-Champaign reported the lowest median salary at $27,515.

The University of Maryland at College Park reported the highest median figure — $56,000.

Emerging trends

McDowell notes that the data set is still incomplete. Some institutions reported salaries for only a small fraction of their workforce, and the University of California (UC) system denied his request outright. The university system's public-records office told *Nature* in a statement that it lacks the capacity to do "the programming required to create the custom data report that Mr McDowell requested". The University of California, Santa Barbara, had already provided numbers to McDowell when the broader UC system denied his request for data.

Other attempts to gather information on postdoctoral salaries have met with less resistance. The National Postdoctoral Association (NPA) in Rockville, Maryland, solicited salary information from its more than 200 member institutions for a forthcoming report. "We've worked with these institutions for over a decade, and when we ask for information they readily give it," says Kate Sleeth, chairwoman of the NPA's board of directors. "We didn't have to explain to anyone what a postdoc is."

Of the 127 NPA member institutions that participated in the survey, 85% reported paying all postdocs at least $47,484 — the minimum salary established by the US National Institutes of Health for the 2017 fiscal year. The NPA is set to publish the full results of its poll in January 2018.

In the meantime, McDowell is still combing through his data set. Throughout November, he plans to publish daily analyses on the Future of Research website, futureofresearch.org, that will examine salaries at individual institutions and university systems. In doing so, he hopes to promote conversation about the treatment of early-career researchers.

"In academia, we're not supposed to talk about money and we're not supposed to aspire to having money," McDowell says. "I think scientists should value scientists."

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Nature News

周四, 16 11月 2017

Nature News

[周四, 16 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Hazy skies cool down Pluto** [周三, 15 11月 08:00]
  Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.
- **African scientists get their own open-access publishing platform** [周三, 15 11月 08:00]
  Venture will launch next year and seeks to strengthen continent’s science by helping academics share work more quickly.
- **Puerto Rico struggles to assess hurricane’s health effects** [周三, 15 11月 08:00]
  While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.
- **Bioethics: Justice in genomics** [周三, 15 11月 08:00]
  Rosario Isasi examines a study on the societal impact of grand sequencing projects.
- **Economics: How science got a golden ticket** [周三, 15 11月 08:00]
  Ehsan Masood hails an account of the mixed implications of governments valuing research as an investment.
- **Computer science: Visionary of virtual reality** [周三, 15 11月 08:00]
  Aldo Faisal explores the immersive journey of technology pioneer Jaron Lanier.
- **China fires up next-generation neutron-science facility** [周二, 14 11月 08:00]
  Beam generator puts country in elite company for doing experiments in materials science and other fields.
- **High-jumping beetle inspires agile robots** [周一, 13 11月 08:00]
  Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.
- **Archaeologists say human-evolution study used stolen bone** [周一, 13 11月 08:00]
  Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.
- **Lab mice's ancestral ‘Eve’ gets her genome sequenced** [周一, 13 11月 08:00]
  Effort aims to help scientists understand how generations of inbreeding have altered the genetics

of research rodents.

- **World’s carbon emissions set to spike by 2% in 2017** [周一, 13 11月 08:00]
  Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.
- **South Africa tackles crime at sea with ship-spotting satellites** [周五, 10 11月 08:00]
  Automated vessel-tracking system aims to spy poachers and smugglers.
- **Resurrected malaria strategy saves thousands of lives in Africa** [周五, 10 11月 08:00]
  Pre-emptively treating kids for malaria is working, despite logistical challenges.
- **Physicists shrink plans for next major collider** [周四, 09 11月 08:00]
  Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.

Hazy skies cool down Pluto

Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.

15 November 2017

NASA/JHU-APL/SwRI

The temperature of Pluto's atmosphere is only about 70 degrees Celsius above absolute zero.

Pluto’s atmosphere is even more bone-chillingly cold than one might expect 5 billion kilometres from the Sun. New research suggests that’s because of the smog that envelops the dwarf planet.

“Haze is responsible for all the atmospheric cooling,” says Xi Zhang, a planetary scientist at the University of California in Santa Cruz. He and his colleagues describe the findings in the 16 November issue of *Nature*[1].

When NASA's New Horizons spacecraft flew past Pluto in July 2015, it discovered that the atmosphere was about -203 ºC, just 70 degrees above absolute zero[2]. That's around 30 degrees colder than predicted — and a big mystery to planetary scientists.

Figuring out how Pluto's atmosphere works is crucial for understanding atmospheres on other large icy worlds in the Solar System and beyond. "Until we know the reason for the cold temperatures, we can't extrapolate to other seasons on Pluto, much less other bodies," says Leslie Young, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, who was not involved in the study.

Smog blanket

Pluto's atmosphere is made mostly of nitrogen, with smaller amounts of compounds such as methane. High in the atmosphere — between 500 and 1,000 kilometres above the surface — sunlight triggers chemical reactions that transform some of these gases into solid hydrocarbon particles.

The particles then drift downward and, at around 350 kilometres above Pluto's surface, clump with others to form long chemical chains. By the time they reach 200 kilometres' altitude, the particles have transformed into thick layers of haze, which the New Horizons spacecraft saw dramatically blanketing Pluto.

Zhang and his colleagues compared the heating and cooling effects of the atmosphere's gas molecules to those of its haze particles. Earlier studies have suggested that the presence of gas molecules, such as hydrogen cyanide, could help explain why Pluto's atmosphere is so cold[3]. But Zhang's team found that including haze was the only way to get their model to match the temperatures that New Horizons measured as it flew by the dwarf planet.

"The fundamental difference is the size," Zhang says. Molecules are typically less than a nanometre across, whereas the haze particles are several hundred nanometres across. That means that the gas and the haze behave very differently in the way they absorb and re-radiate energy from the Sun. Haze

turns out to both heat up and cool down more efficiently than gas, Zhang says.

“It is a neat idea,” says Sarah Hörst, a planetary scientist at Johns Hopkins University in Baltimore, Maryland.

Scientists probably hadn't thought about haze as the cooling culprit before because the haze layers do not block light, says Tanguy Bertrand, a planetary scientist at the Laboratory for Dynamic Meteorology in Paris who has studied Pluto's atmosphere with his colleague François Forget[4]. “I find this study very convincing,” Bertrand says.

Competing ideas

But other researchers have proposed different ideas about why Pluto’s atmosphere is so cold. Roger Yelle, a planetary scientist at the University of Arizona in Tucson, reported one such approach at a conference in Latvia in September. His team’s model suggests that a combination of hydrogen cyanide, acetylene and ethane gas can cool things down. All three gases are known to exist in Pluto’s atmosphere.

Zhang’s team and Yelle’s team have yet to reconcile their contradictory conclusions. But after it launches in 2019, NASA’s James Webb Space Telescope could test Zhang's proposal. If the haze particles are indeed the main factor cooling Pluto’s atmosphere, they would make the dwarf planet appear relatively bright in mid-infrared wavelengths. Zhang hopes to observe Pluto with the Webb telescope to see if his team is right.

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Comments

There are currently no comments.

African scientists get their own open-access publishing platform

Venture will launch next year and seeks to strengthen continent's science by helping academics share work more quickly.

15 November 2017

Africa's academy of science has announced that it will launch an open-access publishing platform early next year — the first of its kind aimed exclusively at scientists on the continent.

The platform, called AAS Open Research and announced by the Kenya-based African Academy of Sciences on 15 November, is being created with the London-based open-access publisher F1000, adopting the model of its F1000Research publishing platform. AAS Open Research will publish articles, research protocols, data sets and code, usually within days of submission and before peer review. F1000 staff arrange post-publication peer review: the reviews and the names of their authors are published alongside the papers. The papers are indexed in abstract databases such as PubMed only after they pass review.

The AAS says that the platform will be especially useful for young African academics who can face difficulties publishing in overseas journals. Some studies suggest[1] that research from low-income countries is perceived differently from that done in high-income ones, for instance. The portal will cut the time and effort scientists have to put into finding homes for their work, and will make the review process more transparent, the academy says.

Although there are already open-access publishers that focus on Africa, such as AOSIS Publishing based in South Africa, AAS Open Research will be the first to adopt open peer review.

The new platform does carry a caveat, however: it will initially take submissions only from AAS fellows and affiliates (who together number around 400), as well as researchers funded through programmes managed by the Alliance for Accelerating Excellence in Africa. The Nairobi-based body manages grants for African research programmes that come from international funders, mostly targeting health research but also areas such as climate change.

Limiting eligibility to the platform is critical to ensure that submissions are of high quality, says AAS executive director Nelson Torto. Researchers who meet the initial criteria have already been vetted and selected through a rigorous grant-review process, he says. In future, to open up the platform to more researchers, the academy wants to partner with other African research funders whose selection processes are similarly rigorous, Torto adds.

Following a trend

The African venture follows a series of open publishing portals launched with F1000 in the past 18 months, including by the Wellcome Trust in London and the Bill & Melinda Gates Foundation in Seattle, Washington, both large charities that fund scientific research. Research centres including the UCL Great Ormond Street Institute of Child Health and the Montreal Neurological Institute have also teamed up with the firm; the European Commission is considering creating its own open publishing platform for outputs from its main Horizon 2020 research programme.

The AAS will not itself be covering the costs of publishing on the platform. Rather, the academy says that African researchers' grant funders will pay publishing fees directly to F1000: between £120–800 per article, depending on length.

Some scientists have raised concerns that publishing on open-research platforms might stop African academics from getting the recognition needed for career advancement that they receive for publishing in traditional journals. In South Africa, for instance, academics are rewarded for publishing in a list of titles maintained by the country's higher-education department.

“For open publishing to be successful, it will need to be accompanied by changes in the criteria for academic recognition and promotion within African institutions of higher learning,” says Salim Abdool Karim, a HIV researcher and AAS fellow in Durban, South Africa.

The risk of publishing on little-known platforms is a concern, agrees Gordon Awandare, a biochemist at the University of Ghana who will be eligible to publish on AAS Open Research. However, the AAS platform will help to chip away at the grip of the big journals, says Awandare, which will be good for African science. “Our approach has always been to spread our research across several platforms, so we will continue to do that.”

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Comments

Comments

There are currently no comments.

Puerto Rico struggles to assess hurricane’s health effects

While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.

15 November 2017

Mario Tama/Getty

Hurricane Maria, which hit Puerto Rico in mid-September, disrupted water supplies in some areas.

Nightfall sets a hard deadline for a team of public-health researchers in Puerto Rico. Since Hurricane Maria hit on 20 September, leaving large swathes of the island without a reliable power supply, the scientists have

rushed home each night to avoid being in the streets after dark. Many lack running water, and most have limited telephone access.

Yet the team —– co-led by José Cordero of the University of Georgia in Athens — has managed to contact several hundred women to begin assessing whether Hurricane Maria has worsened drinking-water contamination, stress and infectious disease that could harm developing fetuses. This wasn't what the researchers set out to study six years ago when they started a project to assess the impact of pollution on pre-term births. But Cordero's team is one of several research groups have scrambled to quantify Hurricane Maria's immediate health impacts, even as team members struggle to fulfil their own basic needs.

The devastation that Cordero saw on a recent visit to Puerto Rico, his birthplace, shocked him. "I thought I was prepared, but I wasn't," he says.

Even before the hurricane, the island's 18 'Superfund' sites — areas so polluted that the US Environmental Protection Agency deems them hazardous to human health or the environment — posed a potential risk to pregnant women, says Ingrid Padilla, an environmental engineer at the University of Puerto Rico at Mayagüez. Twelve of these sites sit on karst, a geological formation made of porous rock that allows toxic chemicals to flow down from the surface into groundwater.

Padilla's previous research suggests that flooding and other disturbances can quickly bring toxic substances in groundwater back to the surface, and carry them into the water supply. Now, she and her colleagues are collecting hair and blood samples from the research cohort to determine whether pregnant women are being exposed to hazardous chemicals, such as phthalates and chloroform. Since the hurricane hit, the researchers have begun to collect and test groundwater from karst regions and tap water from the homes of people living there.

Other research teams are worried that water that has pooled in hurricane debris could provide a breeding ground for disease-carrying mosquitoes. At the height of the Zika epidemic in 2016, experts debated whether a massive hurricane would destroy mosquito habitat or enhance it, says Carmen Zorrilla, an obstetrician and gynaecologist at the University of Puerto Rico in

San Juan. The evidence is still unclear, she says, and logistical problems may make it impossible for researchers to gather enough data to provide answers.

In some areas where hospitals faced extensive storm damage, the only medical care available is emergency treatment. Screening for the Zika virus is a low priority, and infected adults rarely experience severe symptoms and are unlikely to seek medical treatment.

There are also few labs on the island that can test samples for Zika and other mosquito-borne diseases. Like many Puerto Rican facilities, the US Centers for Disease Control and Prevention (CDC) dengue lab in San Juan lost power during the hurricane and was closed for a week. Diesel generators kept its freezers running to preserve blood and other biological samples, but the lab is still running on generator power and is behind on testing some samples. Shipping delays destroyed reagents that the lab had ordered, since the chemicals were not kept consistently cold during transport.

Lab director Stephen Waterman says that the CDC is collecting data on the incidence of mosquito-borne disease and other hurricane impacts. But its priority is to help US government workers and local communities recognize mosquito breeding grounds, and to provide technical help on efforts to control the spread of the insects. Agency staff would also like to verify reports that leptospirosis — a waterborne bacterial disease that is spread by rats — has sickened dozens of people. “We’re focused on preventing disease,” Waterman says.

Yet the ruined facilities and lack of power continue to tax public-health workers’ ability to know where hazards lie. Take the numerous diesel generators running on the island, which produce visible plumes of grey smoke. Benjamin Bolaños, a microbiologist at the University of Puerto Rico in San Juan, worries that these emissions could harm people with respiratory illnesses, but that the effect will be difficult to quantify. “We are blind because probably the [air quality] monitors were destroyed by the hurricane,” he says.

This makes the prospect of more months without reliable power even more frightening. "The kind of work we’re doing is not because it would be interesting to do,” Cordero says. “It has to be done now because a few years

from now, it’s too late.”

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Comments

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China fires up next-generation neutron-science facility

Beam generator puts country in elite company for doing experiments in materials science and other fields.

14 November 2017

Jin Liwang/Xinhua via ZUMAPRESS

Engineers work on an instrument at the China Spallation Neutron Source in Dongguan.

China is revving up its next-generation neutron generator and will soon start experiments there. That will lift the country into a select group of nations with facilities that produce intense neutron beams to study the structure of

materials.

The China Spallation Neutron Source (CSNS) in Dongguan, a 2.2-billion-yuan (US$331-million) centre, will allow the country's growing pool of top-notch physicists and material scientists, along with international collaborators, to compete in multiple physics and engineering fields. Its designers also hope that the facility will lead to commercial products and applications ranging from batteries and bridges to aeroplane engines and cancer therapy.

"It is not only a big step forward for Chinese scientists, but also a significant event for the international scientist community," says Wang Xun-Li, a physicist at the City University of Hong Kong who has been involved in planning the facility.

Beam bombardment

Spallation neutron sources produce neutrons by slamming protons onto a metal target — CSNS uses tungsten. They are more cost effective and safer than other methods, which use nuclear reactors to produce neutron beams. As neutrons have no charge, they can penetrate materials more easily than some other probing methods, and they are more sensitive to light elements such as hydrogen, making them useful for evaluating candidate materials for fuel cells. Similar facilities exist only in the United Kingdom, United States, Japan and Switzerland, and one is under construction in Sweden.

Fujio Maekawa, a specialist in neutron sources at the Japan Proton Accelerator Research Complex in Tokaimura, says that although the CSNS delivers neutrons at a lower density than other spallation sources — which means that experiments will take longer — a planned upgrade will bring it in line with other facilities. And given their scarcity, "neutron users around the world always welcome new sources", he says.

The CSNS will have capacity to host 20 beam lines, supplying as many instruments. Preliminary tests of its first three instruments began on 1 November. "Neutrons arrived at the samples as expected," says Wang

Fangwei, head of the neutron-science division at CSNS. Although debugging might take a couple of years, he expects the instruments to be calibrated and ready for initial experiments by the end of 2017.

Chinese physicists are eager to use the facility to analyse the underlying magnetic properties of materials, an area in which the country has significant experience. Wang Xun-Li says that several planned instruments will give scientists the chance to move to the forefront of fields such as the physics of skyrmions — vortex-like excitations in magnetic materials — and high-temperature superconductivity. “There are a whole bunch of early- to mid-career scientists who are hungry to use the facility for studying magnetism,” says Wang Xun-Li.

Global appeal

Wang Xun-Li thinks that the latest facility will encourage Chinese researchers to remain in the country instead of pursuing careers elsewhere. “In the past, it was common to see Chinese scientists go abroad for these kinds of studies,” he says.

The facility’s first instruments are also attracting international researchers. German material scientist Frank Klose says that the CSNS was a major factor when he and material scientist Christine Rehm, his wife, decided to join the new Guangdong Technion Israel Institute of Technology in Shantou, 400 kilometres east of Dongguan. Klose’s research focuses on designing data-storage devices and sensors that could be used in hydrogen-powered cars. He helped design one of the facility's instruments to investigate the magnetic properties of spintronic devices, which take advantage of the spin of electrons to store data.

But scientists contacted by *Nature* have raised concerns about CSNS’s location, saying that Dongguan lacks services and infrastructure, such as schools and universities, that will persuade top scientists and their families to move there. “I believe CSNS is suffering from a lack of first-grade scientists who actually are based in Dongguan,” says a researcher familiar with the facility, who asked for anonymity because of the sensitivity of the issue.

Potential users have also expressed some frustration that only 3 instruments will be ready this year, despite the facility’s capacity to host 20.

But more instruments are already being built. Shenzhen's government is funding two that are expected to be ready by the end of 2019, including one designed to model high-pressure environments, such as the Earth's core. Mao Ho-Kwang, a geophysicist at the Carnegie Institution for Science in Washington DC, is keen to use it to simulate what happens to materials in high-pressure conditions. “The CSNS instruments will be a great asset for Earth, environmental and energy science, as well as physics, chemistry and material science,” says Mao. “I am very excited, and the whole neutron community is getting very excited too”.

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Comments

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High-jumping beetle inspires agile robots

Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.

13 November 2017

Brian L. Stauffer

Click beetles have a hinged body that can propel them to great heights.

A beetle that can launch itself spectacularly into the air after falling on its back — flipping right side up without having to use its legs — could inspire a new generation of smart robots.

Imagine a rescue robot vaulting its way through a disaster zone riddled with obstacles, or a planetary robot extricating itself from an unexpected tumble on Mars. Each might use a trick or two learnt from the click beetles, a family of insects with the unique ability to catapult themselves out of trouble.

“A lot of robots out there jump using their legs,” says Aimy Wissa, a mechanical engineer at the University of Illinois in Urbana-Champaign. “What’s unique about this is if something breaks, you can still jump without legs and get out of the situation.”

Wissa and her Illinois colleagues, led by mechanical-engineering graduate student Ophelia Bolmin, described the mechanics of jumping click beetles on 7 November at a meeting of the Entomological Society of America in Denver, Colorado. They published early results in the proceedings of a bio-inspired robotics conference in July[1].

So far, the scientists have studied how click beetles manage to store and hold the energy needed to launch themselves into the air. They hope to soon start building prototype machines designed after the beetles.

Snap to it

There are about 10,000 species of click beetles around the world. The insect’s head and body are connected by a hinge that the beetle can slowly arch and then suddenly snap in the opposite direction, jack-knifing its body and sending it into the air with an audible ‘click’. Earlier work has shown that the beetles launch nearly vertically before somersaulting through the air[2].

Ophelia Bolmin/University of Illinois at Urbana-Champaign

Click beetles can launch themselves up with surprising force.

If the beetle lands on its back, it just does the same manoeuvre again. Compare that to an upended ladybird — also known as a ladybug — which has to wiggle around on its back until it manages to roll over far enough and get traction with its legs to flip itself over.

The Illinois team wanted to analyse how the click beetles pull off their acrobatic feat. “We thought we could look at, how do they really jump, how is that energy being released?” says Marianne Alleyne, an entomologist on the team.

Students measured the dimensions of dozens of beetles of four species (*Alaus oculatus*, *Ampedus nigricollis*, *Ampedus linteus* and *Melanotus* spp.), videotaped their jumps with high-speed cameras and analysed the energy required for the beetles to pull the hinge back and then release it. Muscles alone are not enough, because they contract relatively slowly, and so other body parts such as tendons must also be involved, the team says.

How high?

The researchers also measured the force drop as the hinge snapped shut, confirming that it corresponded to the click as the beetle begin to soar skyward. They are now analysing the energies involved as beetles of different sizes make the jump. Click beetles can range from just a few millimetres to a few centimetres long; early results suggest that the bigger the beetle, the higher it can jump, Wissa says.

Other engineers have developed a range of agile robots that can jump using their legs — including one inspired by the Senegal bushbaby (*Galago senegalensis*), which has the highest vertical jumping ability of any animal[3]. Compared with crawling, jumping is a fast and efficient way for small robots to get around obstacles, says Mark Cutkosky, a mechanical engineer at Stanford University in California.

The advantage of the beetle approach is that something could go wrong with the robot's legs, and it could still get out of its predicament, Wissa says. "It simplifies the design a lot."

Any robots inspired by the click beetle would probably have to be quite small — perhaps a few tens of grams, says Gal Ribak, a biomechanics specialist at Tel Aviv University who has studied the beetles' jumps[4]. "Otherwise, the jumping mechanism will require too much energy to lift the body into the air, and the repeated impacts at take-off and landing would result in mechanical damage," he says.

But those constraints might not apply to robots exploring planets other than Earth. On worlds with lower gravity, beetle-like robots could fly high.

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Comments

Comments

There are currently no comments.

Archaeologists say human-evolution study used stolen bone

Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.

13 November 2017 Updated:

1. 13 November 2017

Marc Steinmetz

The Untermassfeld site in Germany has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago.

Serious concerns have surfaced about three research papers claiming evidence for one of the earliest human occupations of Europe.

In an extraordinary letter posted to the bioRxiv.org preprint server on 31 October[1], archaeologists allege that the papers, published in 2013, 2016 and 2017, included material of questionable provenance, and that results reported in the 2016 paper were based on at least one stolen bone. Editors at the journals concerned have now published expressions of concern about the papers.

There is no suggestion that the authors of those papers were involved in theft, but the researchers behind the letter say they are concerned that appropriate questions regarding the provenance of the material appear not to have been asked. They also reject the authors' conclusion that a German site known for animal remains was also home to hominins, ancient relatives of humans, 1 million years ago. The authors have denied the allegations and say they stand by their conclusion.

The letter was initiated by archaeologist Wil Roebroeks at Leiden University in the Netherlands, and Ralf-Dietrich Kahlke, a palaeontologist and head of the Senckenberg Research Station of Quaternary Palaeontology in Weimar, Germany, who leads excavations at Untermassfeld, a fossil site about 150 kilometres northeast of Frankfurt. Their preprint describes repeated disappearances of bones from Untermassfeld, as well as fossils delivered in anonymous packages. The authors of the disputed papers insist, however, that they analysed independent collections of bones and stones, and reject the suggestion that any of it was stolen.

Untermassfeld, which has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago, holds the most complete record of northern European wildlife from this time period. But since yearly excavations began in the late 1970s, no hominin bones or signs of occupation have been found, says Kahlke. Hominins first settled in southern Europe around 800,000 to 1 million years ago, most archaeologists agree, and expanded farther north only sporadically until around 500,000 years ago.

Uncertain origins

One of the first claims that hominins lived near Untermassfeld more than 1 million years ago appeared in a 2013 paper in the journal *Quaternary International*, which contended that rocks from the site resembled stone tools[2]. In a 2016 *Journal of Human Evolution* paper[3], two of the original paper's authors, Günter Landeck at the North Hessian Society of Prehistory and Archeology of the Medieval in Bad Hersfeld, Germany, and Joan Garcia Garriga at the Universitat Oberta de Catalunya in Barcelona, concluded that marks on animal bones from Untermassfeld were made by humans. In 2017, Landeck and Garcia Garriga published further analysis of the bones in another *Quaternary International* paper[4].

There is no suggestion that the other co-authors of the 2013 paper had any connection with the material from Untermassfeld. And after this article was published, Garcia Garriga contacted *Nature* to say that he, also, did not have connections with the material; he said that Landeck had done the analysis, while he himself helped in discussing data and writing up its archaeological implications.

In their papers, Landeck and Garcia Garriga attributed the material, along with hundreds of rock fragments of limestone and chert, to “the Schleusingen collection”, which they stated was recovered by a biology teacher in the late 1970s and early 1980s.

Kahlke says he is personally unaware of a Schleusingen collection and questions whether the material was collected at this time. Rocks like those described in the papers can be found in the vicinity of the site, but he says that animal fossils are concentrated in a small area that has been under excavation since 1978. No other research teams had permission to excavate the site during that time, Kahlke says. But he says that material was routinely stolen from the site — which he reported to the police, most recently in 2012 — until the site and fossil bed were better secured. There is no suggestion that Landeck and Garcia Garriga were involved in these thefts.

Ralf-Dietrich Kahlke

Researchers excavating at Untermassfeld allege that part of a deer bone protruding from the sediment on 28 May 2009 (in box, left) had disappeared several days later.

One fossil that Kahlke considers suspicious is a right limb-bone fragment from an extinct species of fallow deer, described in Landeck and Garcia Garriga's 2016 *Journal of Human Evolution* paper. Kahlke says that the bone in the paper seems to match a piece of deer bone that thieves broke from a larger chunk of sediment at Untermassfeld, leaving part of the bone behind. The bone fragment is present in a photograph taken on 28 May 2009, and missing in a photograph taken several days later. A rhinoceros limb fragment that disappeared from the site in 2012 also closely resembles a fossil described in the 2016 paper, Kahlke says.

Case unsolved

Deepening the mystery, a deer bone fragment was among a jumble of bones and rocks in two packages sent anonymously to a museum near Untermassfeld in March 2014. Ralf Werneburg, a palaeontologist and director of the Natural History Museum Schloss Bertholdsburg in Schleusingen, Germany, recognized the material as originating from Untermassfeld and contacted Kahlke.

Ralf-Dietrich Kahlke

An anonymous package sent to a museum in Schleusingen contained a deer bone fragment (lower bone), which appears to match a fragment left behind (upper bone) after a theft from the Untermassfeld site in 2009. (The fragments are shown pieced together in the view on the far-right).

In Kahlke's opinion, the returned deer bone fragment is the one described in the 2016 paper, and matches up with the piece left behind after the 2009 theft**.** He says that the sixty-three other bone fragments in the packages also closely resemble some of the fossils described in the 2016 paper (the rhinoceros limb bone was not among them), and 11 rock fragments resemble

artefacts in the 2013 *Quaternary International* paper.

Roebroeks and Kahlke's team analysed the material in the returned packages, and concluded that it does not support a hominin occupation at Untermassfeld. They argue that the claimed cut-marks on the animal bones, including the deer bone, were probably caused by rodents or other natural wear, they say, and the rock fragments lack telltale marks typical of hominin tools. They say that it wasn't possible to analyse other material from Landeck and Garcia Garriga's paper because its location is unclear.

Nature exchanged multiple e-mails with Landeck and Garcia Garriga about this mystery and asking for comment on the contents of this article. The researchers responded that most of the material they examined, including the deer bone fragment, was from two private collections amassed in the 1970s and early 1980s, and that much of it came from the same geological layer as Untermassfeld, but not within the site itself. They said that they presumed that some of this material was returned to the Natural History Museum Schloss Bertholdsburg in 2014 by the individual who had loaned it to them. They would not name the individual, but insisted: "We have nothing to do with a stolen bone". They added that they are planning to publish a detailed response to Roebroeks and Kahlke's allegations.

The regional prosecutor's office in Meiningen that investigated the 2009 theft told *Nature* the case had been closed unsolved later that year. A 5-year statute of limitation prevents it from being reopened. The case involving the 2012 theft of the rhinoceros bone was reopened early this year after the *Journal of Human Evolution* paper was published. The prosecutor's office said that an individual, whom it declined to name because of data protection laws, had been found guilty and fined.

Ongoing inquiry

Expressions of concern published on each of the three papers note that the location of the Untermassfeld material "was not stated accurately in the publication", and that the authors have been unable to adequately clarify where it is now. Landeck and Garcia Garriga declined to comment to *Nature*

on the specific details of the notes but said that they plan to publish a response.

Sarah Elton, an anthropologist at the University of Durham, UK, and an editor at the *Journal of Human Evolution*, says that an investigation into the accusations is ongoing. She adds that, as a result of the case, the journal now asks prospective authors to supply complete information about the location of material included in a study, as well as how it was accessed.

Other experts have been shocked by the revelations. “This paper should be retracted, of course,” says Jean-Jacques Hublin, an anthropologist and a director at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, about the 2016 paper. But the concerns go beyond questions of provenance. Hublin says that, like Roebroeks and Kahlke, he does not accept the claim that Untermassfeld contains signs of hominin presence, and he worries that its appearance in prominent journals will cause others to accept the idea, despite the lack of evidence for it.

The debate around Untermassfeld, Roebroeks and his colleagues say, underscores the importance of providing accurate descriptions of the provenance of published material, which is needed to verify claims. The desire to set the record straight about the arrival of hominins to Europe was the primary motivation for the team’s letter, he says. Based on his analysis, Roebroeks argues: “These bones and stones are not indicative of hominin presence.”

With additional reporting by Alison Abbott

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Updates

Updated:

> This article was updated on 13 November to note that expressions of concern have been published on all three papers, and to include a statement made after publication by Garcia Garriga: that he was not involved in analysing the material from Untermassfeld.

Comments

Commenting is currently unavailable.

Lab mice's ancestral ‘Eve’ gets her genome sequenced

Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.

13 November 2017

Anne Chadwick Williams/Sacramento Bee/ZUMA Press/Alamy

The genomes of lab mice can shift in subtle and unpredictable ways over generations of breeding.

Adam and Eve, a pair of black mice, lived for less than two years and never left their home at the Jackson Laboratory (JAX) in Bar Harbor, Maine. But since they were bred in 2005, their progeny have spread around the globe: the

pair's living descendants, which likely number in the hundreds of thousands. They are members of the most popular strain of mice used in biomedical research, which was created nearly a century ago.

Now, researchers at JAX are reconstructing Eve's genome in the hopes of better understanding — and compensating for — the natural mutations that occur in lab mice over the course of generations. These genetic changes can cause unanticipated physiological effects that can confound experiments. Related substrains of lab mice can differ in their taste for alcohol or their sensitivity to insulin, for example, and researchers suspect that such differences between supposedly identical mice lines have hampered some areas of research.

The scientists who founded JAX created Adam and Eve's breed, which is called C57BL/6, in 1921. To keep the mice as genetically similar as possible, researchers have repeatedly bred brothers with sisters for nearly a century — and sold the resulting offspring to customers around the world. But this strategy created a genetic bottleneck: every generation, between 10 and 30 new mutations pop up and are passed down to offspring. This 'genetic drift' quickly accumulates over the years, says Laura Reinholdt, a geneticist at JAX. The genomes of the C57BL/6 mice that the lab sells today have thousands of genetic differences from the mouse reference genome, which was created in 2002 from three mice from the substrain C57BL/6J. The genome is used as a template for researchers developing genetically modified mice.

Other suppliers have inadvertently created divergent substrains of C57BL/6 mice when they've bought rodents from JAX and bred them over several generations. Although most mutations go unnoticed, some occur in genes that affect a mouse's appearance or physiology. In 2016, mouse supplier Envigo in Somerset, New Jersey, found that C57BL/6 mice at 6 of its 19 breeding facilities around the world had acquired a mutation in a gene related to the immune system. The company notified the researchers that bought these mice, and asked customers to specify which location they preferred to source mice from in the future, given that the company's stocks were no longer identical.

Hidden changes

And although it is easy to spot a mutation that changes fur from black to white, for instance, some changes are discovered only if researchers are investigating a particular trait. A substrain of C57BL/6 mice that the US National Institutes of Health bred for 50 generations are uninterested in alcohol, whereas those bred at JAX's facility display a preference for alcoholic beverages.

In 2005, a team at JAX decided to reset the genetic clock by selling only C57BL/6J mice descended from two chosen mice: Adam and Eve. The researchers froze hundreds of embryos of the duo's grandchildren, enough to last for 25-30 years. Every five generations, the company thaws some of these embryos and raises them to adulthood as new breeding pairs.

"In some ways, the changes that are acquired are insidious and unstoppable," says Michael Wiles, the lab's senior director of technology evaluation and development, who led the project. "We've not stopped general drift, but we've slowed it considerably." Once the stockpiled embryos run out, however, JAX will have to start over with new breeding pairs from a much later generation.

Yet Eve's genome is very different from the 2002 mouse reference genome. In a presentation last month at the American Society for Human Genetics' meeting in Orlando, Florida, JAX computational scientist Anuj Srivastava spoke about the company's effort to reconstruct Eve's genome in high detail, using three different sequencing methods. Wiles says that the genome will be finished by the end of November, and that JAX plans to publish it early in 2018.

Mouse trap

Other mouse breeders have started their own efforts to account for genetic drift. Taconic Biosciences, a mouse distributor in Hudson, New York, restarts its C57BL/6 line every ten generations from its stash of frozen embryos.

Because Taconic has bred its line separately from the JAX line for decades, the Eve genome won't necessarily reflect the genetic make-up of Taconic's mice any more than the current mouse reference genome does.

Ana Perez, Taconic's global director of genetic sciences and compliance, says that the company plans to publish the genome of its own Eve. "From my perspective, each particular breeder should have their own reference genome to follow," she says. Buying mice from different breeders and expecting them to be the same is a fallacy, she adds.

But most researchers don't think about the differences between the various substrains of C57BL/6 mice and how those disparities can affect reproducibility in research, says Cory Brayton, a pathobiologist at Johns Hopkins University in Baltimore, Maryland. "The vendors are pretty good about making the information available, but the awareness is still pretty low," she says. It is impossible to quantify how often experiments or entire research programmes are wasted when researchers realize that their supposedly identical mice have genetically diverged from the ancestor they bought from a vendor, but Brayton suspects it is common.

The Eve genome will be a useful addition for researchers who use animals from JAX, says Brayton, although it won't solve all the reproducibility problems inherent to inbred mouse lines. "If you use [inbred mice] wisely, they can be highly informative," she says. "If you use them stupidly, they may really confound your studies."

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Comments

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World’s carbon emissions set to spike by 2% in 2017

Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.

13 November 2017

Kevin Frayer/Getty

China, the world’s largest emitter of greenhouse gases, is trying to reduce its reliance on coal.

Humanity’s carbon emissions are likely to surge by 2% in 2017, driven mainly by increased coal consumption in China, scientists reported on 13 November[1–3]. The unexpected rise would end a three-year period in which

emissions have remained flat despite a growing global economy.

Researchers with the Global Carbon Project, an international research consortium, presented their findings at the United Nations climate talks in Bonn, Germany. Countries there are ironing out details of how to implement the 2015 Paris climate accord, which calls for limiting global warming to a rise of 1.5–2 °C. The projected jump in the world's greenhouse-gas output underlines the challenges ahead; if the latest analysis proves correct, global carbon dioxide emissions will reach a record-breaking 41 billion tonnes in 2017.

"We were not particularly surprised that emissions are up again, but we were surprised at the size of the growth," says Corinne Le Quéré, a climate scientist at the University of East Anglia in Norwich, UK, and co-author of the work, which was published in the journals *Nature Climate Change*, *Environmental Research Letters* and *Earth System Science Data Discussions*. To Le Quéré, the question now is whether 2017 is a temporary blip or a return to business as usual. "If 2018 is as big as 2017, then I will be very discouraged," she says.

Several factors caused the world's CO_2 emissions to level out from 2014 to 2016, including an economic slowdown in China, the world's largest emitter; a shift from coal to gas in the United States; and global growth in the use of renewable energies such as solar and wind. Many climate scientists and policymakers had hoped that the pause in emissions growth represented a shift in energy use that would eventually cause global greenhouse-gas emissions to peak — and then decline.

The latest analysis projects that CO_2 emissions in the United States and the European Union will continue to decline — by 0.4% and 0.2%, respectively, in 2017 — although at a slower pace than in recent years. And emissions growth in India is set to slow, rising by just 2% this year, compared with an average of 6% per year over the past decade.

But the picture is very different in China, which produces nearly 26% of the world's output of CO_2. This year, the country's emissions of the greenhouse gas are expected to surge by 3.5%, to 10.5 billion tonnes. The main causes

are increased activity at the country's factories and reduced hydroelectric-energy production, the Global Carbon Project analysis finds.

The effort highlights nagging uncertainties about greenhouse-gas emissions trends, particularly in China, India and other countries with economies that are rapidly growing and changing, says David Victor, a political scientist at the University of California, San Diego. He is not convinced that government actions — at the national or international level — have driven the recent levelling of emissions. And although emissions are projected to grow this year, Victor says that China is still on a trajectory that would see its emissions peak well before its 2030 target.

Taken together, the projections for 2017 reinforce the notion that the world has far to go before it solves the climate problem, says Glen Peters, a climate-policy researcher at the CICERO Center for International Climate Research in Oslo and a co-author of the Global Carbon Project's 2017 analysis.

"This is basically saying that we are not safe yet," Peters says. "We can't be complacent."

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South Africa tackles crime at sea with ship-spotting satellites

Automated vessel-tracking system aims to spy poachers and smugglers.

10 November 2017

Leeman/Getty

South Africa has started to combine data from satellites, vessel transponders and radar to monitor ships in its waters in real time.

In October last year, a fishing boat set out from Velddrif, a small town on South Africa’s west coast. It sailed northwest for about 25 nautical miles (46 kilometres), then turned sharply and headed back the way it had come. Staying clear of coastal settlements, it entered the West Coast National Park

marine protected area — a strictly no-fishing zone — where it slowed down and began to sail in a zigzag pattern.

“It was obvious what they were doing,” says Niel Malan, a marine biologist who works in South Africa’s Department of Environmental Affairs in Cape Town. “They were poaching.”

On any other day, the transgression would probably have passed undetected. But Malan and his colleagues were testing a new vessel-tracking system that — when fully operational — will send out alerts when ships are acting suspiciously anywhere in South African waters.

A test version of the Integrated Vessel Tracking Decision Support Tool was launched on 7 November by the South African Oceans and Coastal Information Management System (OCIMS), at its annual meeting in Cape Town. The tracking system, which has taken US$1 million and 5 years to develop, combines data from satellites, vessel transponders and radar to monitor ships in real time and spot any that might be engaged in criminal activities, such as illegal fishing or smuggling.

Similar remote-sensing systems have been developed over the last decade or so by countries including the United States, Australia and India. But South Africa is a particularly crucial area for maritime crime-fighting, because of its geographical location at the joining of three oceans — the Atlantic, Indian and Southern — and because of the sheer extent of its waters. The country’s Exclusive Economic Zone, which extends 200 miles off the coastline and includes an additional 400-mile-diameter circle around the Prince Edward Islands, exceeds its land area by 25%. “Because of the vastness of our EEZ, we see this as a critical technology,” says Waldo Kleynhans, the system’s lead developer based in Pretoria.

South Africa's coast is also a busy shipping lane and an area rich in natural resources. Cold, nutrient-rich waters sustain extensive commercial fishing on South Africa's west coast and to the south, while every year billions of sardines migrate down the east coast, attracting flocks of birds, as well as dolphins, sharks and whales.

South Africa has a well-documented problem with coastal poaching of high-

value species such as abalone and rock lobster, whereas the extent of illegal fishing in its open oceans is largely unknown. The area around the Prince Edward Islands — home to the prized Patagonian toothfish (*Dissostichus eleginoides*) — is particularly vulnerable, says Timothy Walker, a researcher focusing on maritime and water security at the Institute for Security Studies in Pretoria. South African authorities are also concerned about human trafficking and the smuggling of drugs or banned wildlife items, such as rhino horn and ivory.

Yet the navy has scant physical resources to monitor illegal activities, says Mark Blaine, a captain in the South African Navy and a part-time researcher in nautical science at Stellenbosch University — four frigates, three submarines and a handful of patrol vessels and aircraft — which he describes as equivalent to "a country the size of Algeria using around six police cars to patrol the entire country".

Satellite spotting

The satellite data used by the new system includes information from automated identification system (AIS) trackers, which all ships above a certain size are required to carry. South Africa currently buys this data from third-party suppliers, but plans to launch its own constellation of AIS nano-satellites in 2018 to collect the information. Meanwhile, satellites using synthetic-aperture radar, which can spot vessels in the dark or through thick cloud, will help to detect 'dark targets' that are not carrying trackers or that have turned them off.

Malan says that the tracking system can be set to flag up different suspicious behaviours. Users such as the fisheries department or the South African navy might create a digital fence around a marine reserve or other sensitive area, for example, and ask to receive alerts when ships enter it. Or they could request to be alerted if two ships meet in the open ocean for an extended time.

Ultimately, Malan says, the system's success will depend on the end-users, who will have to monitor incoming data, set up appropriate alerts and decide

how to respond. Enforcement will also be a challenge. Malan says that details of the suspicious boat he spotted in October 2016 were relayed to the fisheries department. “But we're not sure if they finished the investigation,” he says.

He hopes that once a few miscreants have been caught using the tracking system, however, its existence will act as a deterrent: “I think once we start prosecuting a few people, then the word will spread quickly — and we hope that will lead to better behaviour.”

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Resurrected malaria strategy saves thousands of lives in Africa

Pre-emptively treating kids for malaria is working, despite logistical challenges.

10 November 2017

Amy Maxmen

A healthworker in Mali prepares a dose of malaria chemoprevention.

In a sea of high-tech malaria fixes — everything from drug-delivery by drone to gene-edited mosquitoes — an old-fashioned approach is saving thousands of children in West Africa, according to studies presented this week at the American Society of Tropical Medicine and Hygiene (ASTMH) meeting in

Baltimore, Maryland.

The measure, called seasonal malaria chemoprevention, involves giving children a dose of antimalarial drugs once each month in the rainy season to prevent the disease in hard-hit regions. Researchers have previously demonstrated this strategy in large clinical trials but they had feared that their positive results wouldn't be replicated in the messy, real world, because chemoprevention requires thousands of local health workers to deliver drugs to children in villages far from hospitals, pharmacies and paved roads.

"People were doubtful this intervention would work, because it's so demanding," says Brian Greenwood, an infectious disease specialist at the London School of Hygiene and Tropical Medicine who helped to conduct trials that showed reductions in malaria prevalence up to 84%[1]. As a result of those studies, more than 6.4 million children in nine countries in sub-Saharan Africa (Burkina Faso, Cameroon, Chad, Gambia, Guinea, Mali, Niger, Nigeria, Senegal) received the drugs in 2016.

It seems to be working, according to data presented at the ASTMH meeting. "They are seeing the same level of efficacy against malaria that we saw in clinical trials and reducing hospital admissions," says Greenwood. "I am very happy." But researchers are also finding signs that this approach may not work for long.

Data driven

Malaria researchers deployed chemoprevention in the 1950s, but it fell out of favour when the widespread use of malaria drugs led to drug resistance. Yet by 2000, more than 830,000 people were dying of the disease each year — mainly children in Africa — and there were no blockbuster vaccines on the horizon. So malariologists revisited the approach. Between 2002 and 2012, clinical trials conducted in West Africa suggested that combinations of older malaria drugs had the power to prevent 8.8 million cases and 80,000 deaths every year if implemented solely during the rainy season, when the disease spikes.

Amy Maxmen

Children in Mali receive a dose of malaria drugs, to reduce their risk of becoming infected with the disease.

In 2012, the World Health Organization recommended the strategy with three old drugs — sulphadoxine, pyrimethamine and amodiaquine — so that the only sure-fire cure for malaria, artemisinin, would remain effective. Alassane Dicko, a malariologist at the University of Bamako in Mali, says that he did not take the intervention for granted when it launched in Mali in 2013, because he knew that funds were limited and drug resistance inevitable. “Research is essential,” he says. His lab began assessing chemoprevention’s efficacy, cost and effects on drug resistance.

In August, Dicko and his colleagues reported[2] that malaria prevalence was reduced by 65% in children under age 5 who were treated with chemoprevention in the Malian district of Kita, compared to a similar number of children in a neighbouring district that lacked the funds to roll out the intervention.

Race against resistance

On the basis of results such as these, malaria researchers at the meeting estimate that chemoprevention has averted roughly 6 million cases and 40,000 deaths in 2015 and 2016 in the countries where it is practised. “This intervention has been extremely well documented over three or four years,” says Erin Eckert, an epidemiologist at the US Agency for International Development’s President’s Malaria Initiative, based in Washington DC. As a result, the agency plans to help fund chemoprevention in eight countries next year.

Also at the ASTMH meeting, Dicko reported a 80-person trial showing that adding another old malaria drug, primaquine, to the regimen combo blocks the transfer of the malaria parasite, *Plasmodium falciparum*, from humans into mosquitoes. This would further reduce the amount of the parasite in circulation. Dicko aims to hit the disease hard and fast — with multiple drugs, as soon as possible — because he and his colleagues are already detecting genetic signs of drug resistance in parasites[3].

New chemoprevention drugs in the pipeline might not be ready before existing drugs fail because of resistance, Greenwood says. This year, he helped to launch a trial combining chemoprevention and a less effective malaria vaccine in Burkina Faso and Mali. The vaccine was previously shown to reduce the number of malaria cases by less than 36% in children[4], but Greenwood hopes the combined tools, together with bed nets, can suppress malaria enough to stop it from bouncing back once today’s drugs fail. By that time, he says, genetically engineered mosquitoes might be ready to fly.

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Comments

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Physicists shrink plans for next major collider

Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.

09 November 2017

CERN/SPL

The Large Hadron Collider (pictured) collides protons, whereas the proposed linear accelerator would smash together electrons and positrons.

Limited funding and a dearth of newly discovered particles are forcing physicists to cut back plans for their next major accelerator project: a multibillion-dollar facility known as the International Linear Collider (ILC)

in Japan.

On 7 November, the International Committee for Future Accelerators (ICFA), which oversees work on the ILC, endorsed halving the machine's planned energy from 500 to 250 gigaelectronvolts (GeV), and shortening its proposed 33.5-kilometre-long tunnel by as much as 13 kilometres. The scaled-down version would have to forego some of its planned research such as studies of the 'top' flavour of quark, which is produced only at higher energies.

Instead, the collider would focus on studying the particle that endows all others with mass — the Higgs boson, which was detected in 2012 by the Large Hadron Collider (LHC) at CERN, Europe's particle-physics lab near Geneva, Switzerland.

Leading particle physicists nevertheless remain upbeat. A 250-GeV machine still has "a convincing physics case", says Hugh Montgomery at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia. He says that it could be upgraded to higher energies in future.

High-energy physicists have been planning a future linear collider for 25 years, but the ILC is now unlikely to see the light of day until at least 2030. They viewed the linear collider as complementary to the LHC, allowing physicists to scrutinize in detail any particles discovered at CERN.

Linear design

The circular LHC smashes together protons, which allows it to reach very high energies (13 teraelectronvolts). But, as composite particles (made of quarks), protons create messy collisions with clouds of debris.

By contrast, the ILC would collide electrons and positrons head on after accelerating them in thousands of superconducting cavities joined end to end. Although yielding lower energies, its collisions — between fundamental particles — would be cleaner and more precise than those in a proton–proton machine.

The international physics community had hoped that Japan would foot much of the estimated US$10 billion needed to realize the original design, after researchers there put forward a proposal to host the facility in October 2012, just after the Higgs discovery. But the Japanese government — deterred by the project's huge price tag, according to Tatsuya Nakada, a physicist at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland — has not yet made any offer of funding.

That fact, coupled with an absence of any other new particle discoveries at the LHC beyond the Higgs, led the Japan Association of High Energy Physicists in July to propose capping the ILC's energy at 250 GeV.

Aiming for a higher energy, the association explained, made less sense after data collected by the LHC in 2015 and 2016 showed that any particles outside physicists' standard model are unlikely to weigh less than 1,000 GeV, and therefore would be out of reach even for a full-scale version of the ILC. However, 250 GeV is high enough to produce large numbers of Higgs bosons, which, the association said, could yield indirect signs of new physics through measurements of their interactions with other known particles.

Energy debate

This proposed 'Higgs factory' has also been endorsed by an international working group responsible for formulating the ILC's science case, in a paper uploaded to the preprint server arXiv last month[1]. The ICFA then gave the pared-down collider its thumbs up at a meeting held in Ottawa, Canada, this week.

Not all physicists are enthusiastic, however. John Ellis, a theorist at King's College London and CERN, maintains that only when operating at around 1,000 GeV will a linear collider provide "a more complete picture of the Higgs". He acknowledges that costs need to be reined in, but says that in limiting the ILC to 250 GeV, "you are making significant scientific compromises".

A report uploaded to arXiv last week[2] describes three possible layouts for the

250 GeV model (a technical design for the higher-energy ILC was published in 2013). Each requires halving the length of the superconducting electron–positron accelerators, but two of the options retain extra tunnel space to accommodate future upgrades.

Taking into account projected savings from ongoing research into accelerators, the report estimates that the collider's core construction cost could be reduced by as much as 40% — bringing it down to around $5 billion in 2012 prices. Manpower and detectors would then raise the total to about $7 billion, according to Lyn Evans, an accelerator physicist at CERN who is directing research on the ILC.

Michael Peskin, a theoretical partical physicist at the SLAC National Accelerator Laboratory in Menlo Park, California, and a member of the ILC working group, has no doubt about the value of a Higgs factory. He says that theoretical studies of the Higgs boson and the weak nuclear force — one of the four known fundamental forces — done over the past year have strengthened the case for experimental probes of the Higgs' interaction strength (the Higgs is required to give the carriers of the weak force finite mass). "The 250-GeV stage is actually more interesting scientifically than we thought," he says.

The ILC decision now rests with Japan. Evans describes the Japanese government's ongoing assessment of the linear-collider project as "very long and very frustrating". But other countries won't commit money until the host country makes its plans known, he says. "The rest of the world is waiting for the Japanese government to decide," he says.

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Comments

3 comments

1. *Pentcho Valev* • 2017-11-11 04:23 PM

   Peter Woit: "I think the worst thing that has happened to theoretical physics over the past 25 years is this descent into ideology, something that has accelerated with the multiverse mania of the last 10-15 years." http://www.math.columbia.edu/~woit/wordpress/?p=9375 Correct, except for the number 25 - it should be replaced by 112: Peter Hayes: "This paper investigates an alternative possibility: that the critics were right and that the success of Einstein's theory in overcoming them was due to its strengths as an ideology rather than as a science. The clock paradox illustrates how relativity theory does indeed contain inconsistencies that make it scientifically problematic. These same inconsistencies, however, make the theory ideologically powerful. [...] The gatekeepers of professional physics in the universities and research institutes are disinclined to support or employ anyone who raises problems over the elementary inconsistencies of relativity. A winnowing out process has made it very difficult for critics of Einstein to achieve or maintain professional status. Relativists are then able to use the argument of authority to discredit these critics. Were relativists to admit that Einstein may have made a series of elementary logical errors, they would be faced with the embarrassing question of why this had not been noticed earlier. Under these circumstances the marginalisation of antirelativists, unjustified on scientific grounds, is eminently justifiable on grounds of realpolitik. Supporters of relativity theory have protected both the theory and their own reputations by shutting their opponents out of professional discourse. [...] The triumph of relativity theory represents the triumph of ideology not only in the profession of physics bur also in the philosophy of science." The Ideology of Relativity: The Case of the Clock Paradox http://www.informaworld.com/smpp/content~content=a909857880 Joao Magueijo: "Lee [Smolin] and I discussed these paradoxes at great length for many months, starting in January 2001. We would meet in cafés in South Kensington or Holland Park to mull over the problem. THE ROOT OF ALL THE EVIL WAS CLEARLY SPECIAL RELATIVITY. All these paradoxes resulted from well known effects such as length contraction, time dilation, or E=mc^2,

all basic predictions of special relativity. And all denied the possibility of establishing a well-defined border, common to all observers, capable of containing new quantum gravitational effects." Faster Than the Speed of Light, p. 250 http://www.amazon.com/Faster-Than-Speed-Light-Speculation/dp/0738205257 Pentcho Valev

2. *Pentcho Valev* • 2017-11-11 07:32 AM

   Dead (schizophrenic) science - colliders are not necessary: "...Lorenzo Maccone, of the University of Pavia in Italy, Seth Lloyd at MIT in Cambridge, USA, and Vittorio Giovannetti at the Scuola Normale Superiore in Pisa, Italy. [...] They hope their strategy may make it possible to solve one of the biggest problems in physics: the apparent incompatibility of quantum mechanics, which governs the physics of the very small, and general relativity, which describes the motion of stars and planets. [...] In general relativity, space and time are woven together into a pliable thing called spacetime, but quantum mechanics runs on quaintly separate, classical notions of space and time. And when physicists try to apply the equations of general relativity to the realm of quantum mechanics, those equations spit out nonsense." http://fqxi.org/community/articles/display/224 Big Brother replaced 2+2=4 with 2+2=5: "In the end the Party would announce that two and two made five, and you would have to believe it. It was inevitable that they should make that claim sooner or later: the logic of their position demanded it. Not merely the validity of experience, but the very existence of external reality, was tacitly denied by their philosophy. The heresy of heresies was common sense. And what was terrifying was not that they would kill you for thinking otherwise, but that they might be right. For, after all, how do we know that two and two make four? Or that the force of gravity works? Or that the past is unchangeable? If both the past and the external world exist only in the mind, and if the mind itself is controllable what then?" https://ebooks.adelaide.edu.au/o/orwell/george/o79n/chapter1.7.htm Einstein replaced Newton's absolute time with spacetime: "Special relativity is based on the observation that the speed of light is always the same, independently of who measures it, or how fast the

source of the light is moving with respect to the observer. Einstein demonstrated that as an immediate consequence, space and time can no longer be independent, but should rather be considered a new joint entity called "spacetime." http://community.bowdoin.edu/news/2015/04/professor-baumgarte-describes-100-years-of-gravity/ Scientists in Big Brother's world are trying to reconcile 2+2=4 and 2+2=5. Scientists in Einstein's schizophrenic world are trying to reconcile Newton's absolute time and Einstein's spacetime: Natalie Wolchover: "The effort to unify quantum mechanics and general relativity means reconciling totally different notions of time. In quantum mechanics, time is universal and absolute; its steady ticks dictate the evolving entanglements between particles. But in general relativity (Albert Einstein's theory of gravity), time is relative and dynamical, a dimension that's inextricably interwoven with directions X, Y and Z into a four-dimensional "space-time" fabric." https://www.quantamagazine.org/20161201-quantum-gravitys-time-problem/ Perimeter Institute: "Quantum mechanics has one thing, time, which is absolute. But general relativity tells us that space and time are both dynamical so there is a big contradiction there. So the question is, can quantum gravity be formulated in a context where quantum mechanics still has absolute time?" https://www.perimeterinstitute.ca/research/conferences/convergence discussion-questions/what-are-lessons-quantum http://negrjp.fotoblog.uol.com.br/images/photo20150819051851.jpg Pentcho Valev

3. *Pentcho Valev* • 2017-11-09 08:59 PM

   Nowadays the conclusion "Physics is dead" is getting more and more explicit - it has even entered popular culture: Leonard: "I know I said physics is dead, but it is the opposite of dead. If anything, it is undead, like a zombie." https://www.youtube.com/watch?v=GDNP9KOEdh0 The problem is theoretical - experimentalists are just misguided: "The Large Hadron Collider is a particle accelerator currently under construction in the research centre CERN. From the point of view of relativity theory, it has several points of interest: First of all, the protons it accelerates will reach higher energies than ever, allowing

new tests of the relativistic quantum field theories that are at the core of modern particle physics. Secondly, at such high energies, there should be first traces of an as-yet unproven symmetry of nature called supersymmetry, which plays an important role in string theory, one of the candidates for a theory of quantum gravity (the quantum theory version of Einstein's general relativity). Finally, the high energies are interesting because they give information about the very early high temperature universe, and about the physics that should be included in the big bang models of relativistic cosmology." http://www.einstein-online.info/dictionary/large-hadron-collider There is a tenet which, if false, does convert modern physics into a zombie, and this is Einstein's constant-speed-of-light postulate. Here is the original formulation: Albert Einstein, ON THE ELECTRODYNAMICS OF MOVING BODIES, 1905: "...light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body." http://www.fourmilab.ch/etexts/einstein/specrel/www/ If interpreted correctly, the Doppler effect directly refutes the postulated independence from "the state of motion of the emitting body". Here is an incorrect interpretation - the postulate is saved by wrongly assuming that the light pulses bunch up in front of the moving source: Albert Einstein Institute: "We will start with a very simple set-up, which you can see in the following animation. On the right-hand side, drawn in green, there is a sender that emits pulses in regular succession. On the left-hand side there is a receiver, drawn in blue. The pulses themselves are drawn in red, and they all travel at the same speed from right to left. Everytime the sender emits a new pulse, a yellow indicator light flashes once. Likewise, a flashing light indicates when a pulse has reached the receiver: http://www.einstein-online.info/images/spotlights/doppler/doppler_static.gif Next, let us look at a slightly different situation, where the source is moving towards the detector. We assume that the motion of the sender does not influence the speed at which the pulses travel, and that the pulses are sent with the same frequency as before. Still, as we can see in the following animation, the motion influences the pulse

pattern: http://www.einstein-online.info/images/spotlights/doppler/doppler_source_blue.gif The distance between successive pulses is now smaller than when both sender and receiver were at rest. Consequently, the pulses arrive at the receiver in quicker succession. If we compare the rates at which the indicator lights at the receiver and at the sender are flashing, we find that the indicator light at the receiver is flashing faster." [END OF QUOTATION] http://www.einstein-online.info/spotlights/doppler Einsteinians make the following assumption above, which is essentially identical to Einstein's 1905 constant-speed-of-light postulate: Assumption 1: "The motion of the sender does not influence the speed at which the pulses travel." Assumption 1 goes hand in hand with another assumption: Assumption 2: "The distance between successive pulses is now smaller than when both sender and receiver were at rest." Assumption 2 is false - the pulses do not bunch up when the source (sender) is moving. If they did, by measuring the (variable) distance between the pulses, an observer associated with the source would know whether he is moving or at rest, which contradicts the principle of relativity. Since Assumption 2 is false, Assumption 1 is false as well. If the speed of the moving source is v, the speed of the light relative to the receiver is c'=c+v, in violation of Einstein's relativity. The following quotations suggest that, if the speed of light is variable, modern physics is dead: "The speaker Joao Magueijo, is a Reader in Theoretical Physics at Imperial College, London and author of Faster Than the Speed of Light: The Story of a Scientific Speculation. He opened by explaining how Einstein's theory of relativity is the foundation of every other theory in modern physics and that the assumption that the speed of light is constant is the foundation of that theory. Thus a constant speed of light is embedded in all of modern physics and to propose a varying speed of light (VSL) is worse than swearing! It is like proposing a language without vowels." http://www.thegreatdebate.org.uk/VSLRevPrnt.html "But the researchers said they spent a lot of time working on a theory that wouldn't destabilise our understanding of physics. "The whole of physics is predicated on the constancy of the speed of light," Joao

Magueijo told Motherboard. "So we had to find ways to change the speed of light without wrecking the whole thing too much." http://www.telegraph.co.uk/technology/2016/12/06/speed-light-discovered/ Pentcho Valev

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Nature News

周四, 23 11月 2017

Nature News

[周四, 23 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

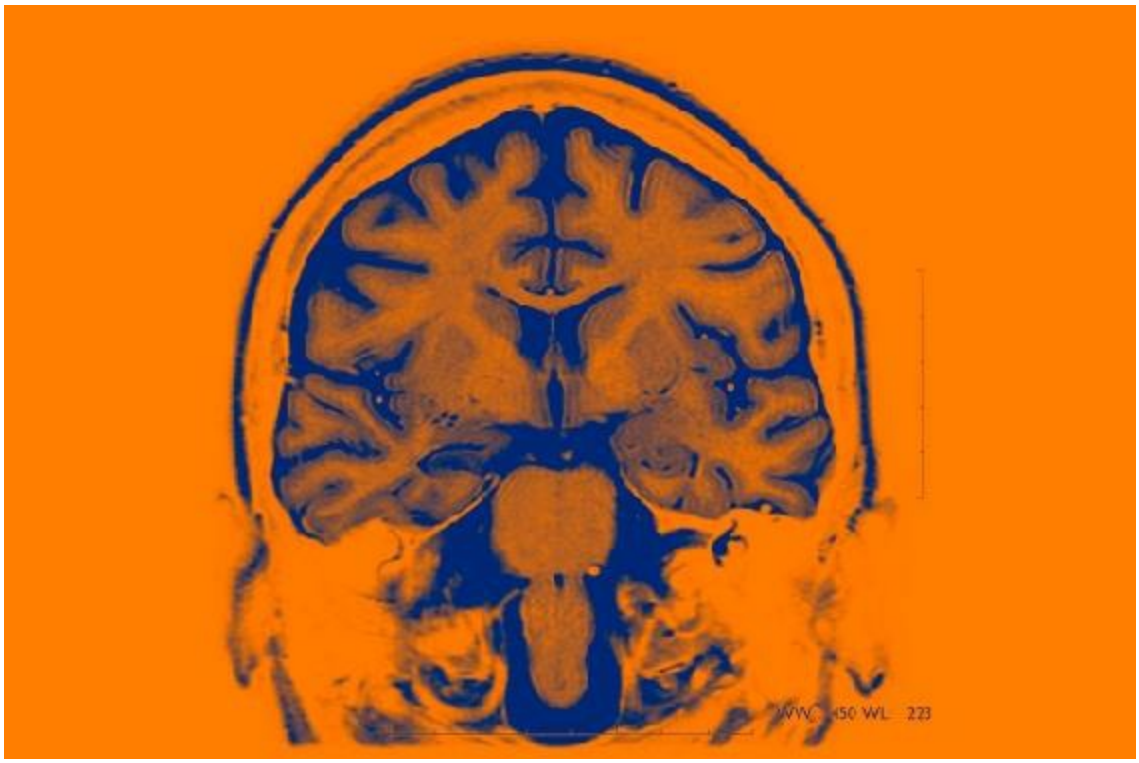
- **AI-controlled brain implants for mood disorders tested in people** [周三, 22 11月 08:00]
  Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.
- **Lightning makes new isotopes** [周三, 22 11月 08:00]
  Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.
- **Black academics soon to outnumber white researchers in South Africa** [周二, 21 11月 08:00]
  Legacy of apartheid means academia has remained largely white.
- **Hungary rewards highly cited scientists with bonus grants** [周二, 21 11月 08:00]
  Some top researchers prosper in Hungary as country tries to improve its international standing in science.
- **European Medicines Agency to move to Amsterdam** [周一, 20 11月 08:00]
  The European Union’s drug regulatory body will leave London because of the United Kingdom’s Brexit plans.
- **How alkali flies stay dry** [周一, 20 11月 08:00]
  Waxy and hairy covering enables flies to dive underwater without getting wet.
- **UK government announces research-spending hike ahead of budget** [周一, 20 11月 08:00]
  Pledge would raise country’s public research funding to £12.5 billion in 2021–22.
- **Exoplanet hunters rethink search for alien life** [周一, 20 11月 08:00]
  Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.
- **Online software spots genetic errors in cancer papers** [周一, 20 11月 08:00]
  Tool to scrutinize research papers identifies mistakes in gene sequences.
- **Sex matters in experiments on party drug — in mice** [周五, 17 11月 08:00]
  Ketamine lifts rodents' mood only if administered by male researchers.

- **Giant telescope’s mobile-phone ‘dead zones’ rile South African residents** [周五, 17 11月 08:00]
  Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.
- **Arecibo telescope wins reprieve from US government** [周四, 16 11月 08:00]
  National Science Foundation will look for partners to provide extra financial support for Puerto Rico facility.
- **What countries' constitutions reveal about how societies evolve** [周四, 16 11月 08:00]
  Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.
- **Europe sets priorities for hunting cosmic particles** [周四, 16 11月 08:00]
  Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.
- **Improved diagnostics fail to halt the rise of tuberculosis** [周四, 16 11月 08:00]
  TB remains a big killer despite the development of a better test for detecting the disease.
- **Hazy skies cool down Pluto** [周三, 15 11月 08:00]
  Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.
- **African scientists get their own open-access publishing platform** [周三, 15 11月 08:00]
  Venture will launch next year and seeks to strengthen continent’s science by helping academics share work more quickly.
- **Puerto Rico struggles to assess hurricane’s health effects** [周三, 15 11月 08:00]
  While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.
- **Bioethics: Justice in genomics** [周三, 15 11月 08:00]
  Rosario Isasi examines a study on the societal impact of grand sequencing projects.
- **Economics: How science got a golden ticket** [周三, 15 11月 08:00]
  Ehsan Masood hails an account of the mixed implications of governments valuing research as an investment.
- **Computer science: Visionary of virtual reality** [周三, 15 11月 08:00]
  Aldo Faisal explores the immersive journey of technology pioneer Jaron Lanier.

AI-controlled brain implants for mood disorders tested in people

Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.

22 November 2017



BSIP/UIG/Getty

Brain implants that deliver electrical pulses tuned to a person’s feelings and behaviour are being tested in people for the first time. Two teams funded by the US military’s research arm, the Defense Advanced Research Projects Agency (DARPA), have begun preliminary trials of ‘closed-loop’ brain implants that use algorithms to detect patterns associated with mood disorders. These devices can shock the brain back to a healthy state without

input from a physician.

The work, presented last week at the Society for Neuroscience (SfN) meeting in Washington DC, could eventually provide a way to treat severe mental illnesses that resist current therapies. It also raises thorny ethical concerns, not least because the technique could give researchers a degree of access to a person's inner feelings in real time.

The general approach — using a brain implant to deliver electric pulses that alter neural activity — is known as deep-brain stimulation. It is used to treat movement disorders such as Parkinson's disease, but has been less successful when tested against mood disorders. Early evidence suggested that constant stimulation of certain brain regions could ease chronic depression, but a major study involving 90 people with depression found no improvement after a year of treatment.[1]

The scientists behind the DARPA-funded projects say that their work might succeed where earlier attempts failed, because they have designed their brain implants specifically to treat mental illness — and to switch on only when needed. "We've learned a lot about the limitations of our current technology," says Edward Chang, a neuroscientist at the University of California, San Francisco (UCSF), who is leading one of the projects.

DARPA is supporting Chang's group and another at Massachusetts General Hospital (MGH) in Boston, with the eventual goal of treating soldiers and veterans who have depression and post-traumatic stress disorder. Each team hopes to create a system of implanted electrodes to track activity across the brain as they stimulate the organ.

The groups are developing their technologies in experiments with people with epilepsy who already have electrodes implanted in their brains to track their seizures. The researchers can use these electrodes to record what happens as they stimulate the brain intermittently — rather than constantly, as with older implants.

Mood map

At the SfN meeting, electrical engineer Omid Sani of the University of Southern California in Los Angeles — who is working with Chang's team — showed the first map of how mood is encoded in the brain over time. He and his colleagues worked with six people with epilepsy who had implanted electrodes, tracking their brain activity and moods in detail over the course of one to three weeks. By comparing the two types of information, the researchers could create an algorithm to 'decode' that person's changing moods from their brain activity. Some broad patterns emerged, particularly in brain areas that have previously been associated with mood.

Chang and his team are ready to test their new single closed-loop system in a person as soon as they find an appropriate volunteer, Sani says. Chang adds that the group has already tested some closed-loop stimulation in people, but he declined to provide details because the work is preliminary.

The MGH team is taking a different approach. Rather than detecting a particular mood or mental illness, they want to map the brain activity associated with behaviours that are present in multiple disorders — such as difficulties with concentration and empathy. At the SfN meeting, they reported on tests of algorithms they developed to stimulate the brain when a person is distracted from a set task, such as matching images of numbers or identifying emotions on faces.

The researchers found that delivering electrical pulses to areas of the brain involved in decision-making and emotion significantly improved the performance of test participants. The team also mapped the brain activity that occurred when a person began failing or slowing at a set task because they were forgetful or distracted, and found they were able to reverse it with stimulation. They are now beginning to test algorithms that use specific patterns of brain activity as a trigger to automatically stimulate the brain.

Personalized treatment

Wayne Goodman, a psychiatrist at Baylor College of Medicine in Houston, Texas, hopes that closed-loop stimulation will prove a better long-term treatment for mood disorders than previous attempts at deep-brain stimulation

— partly because the latest generation of algorithms is more personalized and based on physiological signals, rather than a doctor's judgement. “You have to do a lot of tuning to get it right,” says Goodman, who is about to launch a small trial of closed-loop stimulation to treat obsessive–compulsive disorder.

One challenge with stimulating areas of the brain associated with mood, he says, is the possibility of overcorrecting emotions to create extreme happiness that overwhelms all other feelings. Other ethical considerations arise from the fact that the algorithms used in closed-loop stimulation can tell the researchers about the person’s mood, beyond what may be visible from behaviour or facial expressions. While researchers won't be able to read people's minds, “we will have access to activity that encodes their feelings,” says Alik Widge, a neuroengineer and psychiatrist at Harvard University in Cambridge, Massachusetts, and engineering director of the MGH team. Like Chang and Goodman’s teams, Widge’s group is working with neuroethicists to address the complex ethical concerns surrounding its work.

Still, Chang says, the stimulation technologies that his team and others are developing are only a first step towards better treatment for mood disorders. He predicts that data from trials of brain implants could help researchers to develop non-invasive therapies for mental illnesses that stimulate the brain through the skull. “The exciting thing about these technologies,” he says, “is that for the first time we’re going to have a window on the brain where we know what’s happening in the brain when someone relapses.”

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Comments

Comments

There are currently no comments.

Lightning makes new isotopes

Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.

22 November 2017

Magalie L’Abbé/Getty

A lightning storm illuminates clouds over Kagoshima, Japan.

A streak of lightning in the skies over Japan has generated positrons — the antimatter equivalents of electrons — and radioactive carbon-14, confirming a theoretical prediction, according to a paper published in *Nature* on 22 November[1].

Since the 1990s, orbiting observatories designed to observe the heavens have

also detected flashes of γ-rays coming from Earth, which were thought to have their origins in atmospheric phenomena. To investigate this theory, Teruaki Enoto, an astrophysicist at Kyoto University in Japan, and his collaborators set up an array of γ-ray detectors close to the Kashiwazaki-Kariwa nuclear power plant. Winter thunderstorms in Japan are famous for their spectacular lightning, he says, and the low clouds make these relatively easy to observe.

On 6 February, the detectors sensed an unusual event. A double lightning bolt just off the coast shot out an initial, one-millisecond spike of γ-rays, with relatively high energies of up to 10 megaelectronvolts. This was followed by a γ-ray afterglow of less than half a second. Then there was a telltale signal — γ-rays concentrated at 511 kiloelectronvolts of energy, which lasted for about a minute. Physicists say this is the unmistakable signature of positrons annihilating in a puff of energy as they hit electrons in the surrounding matter.

Together, the three waves of γ-rays point to a photonuclear reaction first proposed[2] a decade ago by Leonid Babich, a physicist at the Russian Federal Nuclear Center in Sarov. Lightning can accelerate some electrons to almost the speed of light, and the electrons can then produce γ-rays. Babich proposed that when one of these γ-rays hits the nucleus of a nitrogen atom in the atmosphere, the collision can dislodge a neutron. After briefly bouncing around, most of the neutrons get absorbed by another nitrogen nucleus. This adds energy to the receiving nucleus and puts it in an excited state. As the receiving nucleus relaxes to its original state, it emits another γ-ray — contributing to the giveaway γ-ray glow.

Meanwhile, the nitrogen nucleus that has lost one neutron is extremely unstable. It decays radioactively over the next minute or so; in so doing, it emits a positron, which almost immediately annihilates with an electron, producing two 511-keV photons. This was the third signal, Enoto says. He suspects that his detectors were able to see it only because the briefly radioactive cloud was low, and moving towards the detectors. This combination of circumstances might help to explain why the photonuclear signature has been seen so rarely. Enoto says that his team has observed a few similar events, but that the one described in the paper is the only clear-

cut event so far.

Babich also predicted that not all of the neutrons dislodged from nitrogen by a γ-ray are absorbed. Some of them instead will trigger the transmutation of another nitrogen nucleus into carbon-14, a radioactive isotope that has two more neutrons than ordinary carbon. This isotope can be absorbed by organisms; it then decays at a predictable rate long after the organism's death, which makes it a useful clock for archaeologists.

The main source of the carbon-14 in the atmosphere has generally been considered to be cosmic rays. In principle, lightning could also contribute to the supply. But it is not clear yet how much of the isotope is produced in this way, says Enoto, in part because it's possible that not all bolts initiate photonuclear reactions.

"I agree with their interpretation of their data," says physicist Joseph Dwyer of the University of New Hampshire in Durham. But, he adds, Enoto's team's explanation does not solve all puzzles related to positrons in the atmosphere. In particular, the photonuclear reaction does not seem to match an event Dwyer observed in 2009 from a research aeroplane. His detector spotted a signature of positrons only for a fraction of a second — too short to originate from nuclear decay, he says. Also, his detector saw no initial flash in that case. "If it was there, it should have been very obvious."

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Comments

Comments

There are currently no comments.

Black academics soon to outnumber white researchers in South Africa

Legacy of apartheid means academia has remained largely white.

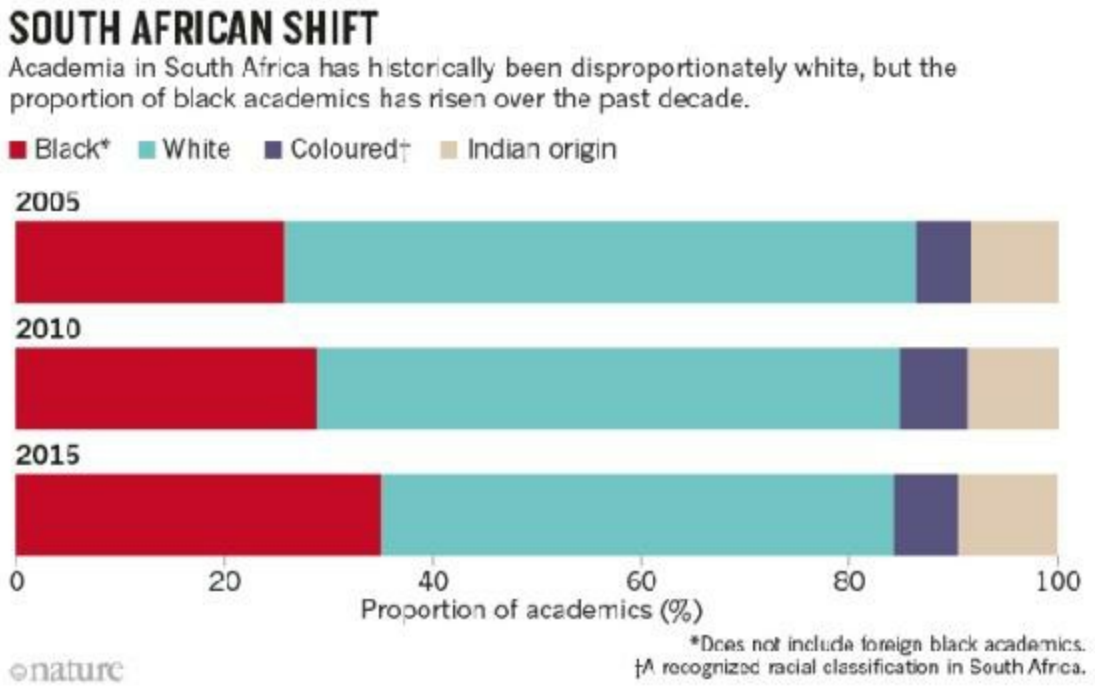
21 November 2017

There will soon be more black academics in South Africa than white ones, a study of demographic data suggests.

Although more than 80% of the country's population is black, its academic sector has remained disproportionately white — a legacy of the apartheid era.

But over the past decade, the proportion of black South African researchers has risen steadily: from 26% in 2005 to 35% in 2015, according to the study, which was published[1] in *Higher Education* last month. The proportion of white academics decreased by more than 10 percentage points over the same period, to 49% in 2015 (see 'South African shift').

"Our research shows that transformation is taking place and there are strong indications that it will accelerate in the future, particularly in the next decade," says David Hedding, a geomorphologist at the University of South Africa in Florida, Johannesburg, and co-author of the paper.



The authors suggest that in the next decade, more than 4,000 researchers — about 27% of the country's academics, and most of them white men — will retire, which should create opportunities for younger researchers. Black researchers could outnumber white ones some time between 2020 and 2025, they say.

Hedding says that it's not possible to attribute the change to a specific policy, but that the government should keep doing what it is currently doing. However, he thinks the country should focus more on nurturing PhD candidates and enticing them into academia. He and his co-author, geoinformatics specialist Greg Breetzke at the University of Pretoria, also note that black women, the country's largest demographic, remain significantly under-represented in universities, accounting for just 14% of academics in 2015.

Charles Sheppard, director of management information at Nelson Mandela University in Port Elizabeth, agrees that South Africa must focus on generating local PhDs. At the moment, it produces more doctorate-holders who hail from other African countries than from the home nation, he says. "We need to work harder on getting this right," he adds.

The latest study is the most well thought out, most evidenced-based and least anecdotal to address this complex problem yet, says Zeblon Vilakazi, deputy vice-chancellor at the University of the Witwatersrand in Johannesburg. “This is a step in the right direction,” says Vilakazi.

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Nature
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Comments

Comments

There are currently no comments.

Hungary rewards highly cited scientists with bonus grants

Some top researchers prosper in Hungary as country tries to improve its international standing in science.

21 November 2017

Richard Wareham Fotografie/Alamy

Hungarian commissioner for research and innovation József Pálinkás has designed grants that reward research excellence.

Earlier this year, cell biologist Attila Reményi was facing his toughest decision since returning to his native Hungary a decade ago. With his

generous start-up funding about to run out, should he downsize his lab?

Then, in June, the government's National Research, Development and Innovation Office (NRDNI) put out a call for five-year basic-research grants of up to 300 million Hungarian forints (US$1.18 million) each for highly cited scientists such as Reményi. "It came out of the blue," says Reményi at the Hungarian Academy of Sciences (HAS) Research Centre for Natural Sciences, Budapest, who learnt on 13 November that he was among 12 winners.

But for NRDNI president József Pálinkás, the Frontline Research Excellence grants are the result of years of work. They are part of a plan to create a long-term, systematic plan of grants and rewards to encourage researchers in all fields to strive for world-class publications and to tempt Hungarian scientists working abroad to return. In a country whose leaders are coming under increasing criticism for autocratic and xenophobic tendencies, scientists say that the situation for science has never been rosier.

Under Viktor Orbán's nationalist government, this small, post-communist country has been steadily falling on *The Economist* magazine's Democracy Index. Last year, several foreign members of the HAS resigned, citing the failure of the academy to protest against what they saw as anti-democratic moves by the government. HAS president, mathematician László Lovász, responded that the academy is not a political organization. Scientists in the country are noticeably reluctant to comment publicly on politics, and several young researchers told *Nature* they fear that criticizing the government might compromise their careers.

Yet within this troubled political environment, Pálinkás, a physicist, has spent the past few years quietly persuading the government that basic science matters as much as product-focused research. Shortly after becoming president of the HAS in 2008, he created the Momentum system of start-up funding — one-time, five-year grants of up to 50 million forints per year — to encourage Hungarian scientists to set up independent labs back home. Reményi was a Momentum recipient in 2013.

In 2015, Pálinkás left HAS to become the founding director of the NRDNI, where he designed a system of regular grants to help ensure that returnees

stay after the start-up money runs out. The frontline grants are a key part of this, giving the recipients salaries equivalent to the European Union average, which is two-and-a-half times higher than the salary that a scientist would normally earn in Hungary. Around 50 of these grants will eventually run each year. The programme is modelled on European Research Council grants, but with a twist: only those who have published a paper in the past five years that counted among the top 10% most-cited papers in their discipline are eligible to apply. This approach “creates a lot of tension in the community, but without such serious selection science won’t work well,” says Pálinkás. To further encourage scientists to aim for quality over quantity, last year he introduced another reward for high-impact publication: researchers who within two years have a paper among the top 5% most highly cited in their field automatically receive a one-off payment of 20 million forints.

Hungary has a long tradition of research and outperforms other former communist countries in the EU on many measures. It has won more European Research Council grants and was the only country this year to win two Teaming grants: prestigious EU awards to create centres of excellence in 15 mostly eastern European countries in partnership with a western European research organization. It has also made some large investments, most generously in the Hungarian Brain Research Programme, launched in 2014, which has received 18.5 million forints up to 2021 and enabled many principal investigators to start their own labs. A 3-billion-forints programme has just been agreed in quantum technology. Five new programmes in areas including artificial intelligence and water research will be added next year, thanks to a 3% increase in the NRDNI budget, agreed in principle this month.

Hungary’s research performance still lags behind that of science-strong western European countries, however, and at 1.2% of gross domestic product, its research investment is well below the EU average of 2%. To support its scientific ambitions, Hungary has heavily invested its EU structural funds — subsidies to poorer regions — in expanding research infrastructure. The country’s scientists fear that when the current round of these funds runs out in 2019, these major investments may go to waste.

Pálinkás says that to avoid this, he will request a doubling of the national research budget in 2019. And despite the political challenges, Hungarian

scientists seem optimistic: “The situation for science is better than it has been before,” says Reményi. Immunologist Adam Dénes returned from the United Kingdom in 2012 to start his own lab at the HAS Institute of Experimental Medicine in Budapest, a move he describes as a “political, philosophical and career challenge”. But for now, he says, “the pluses are more than the minuses.”

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Comments

Comments

There are currently no comments.

European Medicines Agency to move to Amsterdam

The European Union’s drug regulatory body will leave London because of the United Kingdom’s Brexit plans.

20 November 2017

Aurore Belot/AFP/Getty

A man crosses a canal in Amsterdam.

After more than a year of uncertainty, the new home of the European Medicines Agency (EMA) is finally clear. The European Union member states chose Amsterdam from among 19 candidates, after a secret ballot on 20 November.

The transition is expected to be relatively smooth because more than 80% of staff indicated in a survey earlier this year that they would be prepared to relocate to Amsterdam with the agency.

Slovakian capital Bratislava had also been a hot favourite among commentators, most particularly because Slovakia does not yet host any EU agency. However, only 14% of the staff said they would be prepared to go there. In an interview with *Nature* last month, EMA executive director Guido Rasi said that a catastrophic loss of staff on such a scale might have crippled the agency.

The EMA, with its 900 or so employees, is responsible for determining the safety and efficacy of therapies and licensing them for marketing in the EU. It also monitors adverse reactions to marketed treatments. And it has been fundamental to the development of harmonized EU-wide regulations on 'advanced therapies' for serious diseases such as cancer — including treatments involving biological molecules, stem cells or cells that have been genetically manipulated.

In an analysis of the various bids in September, the EMA said that any transfer could result in delays to the approval of new medicines and a slowing down of some public-health initiatives such as those to tackle antimicrobial resistance. But full recovery could be expected in two to three years, it said.

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Comments

Comments

There are currently no comments.

How alkali flies stay dry

Waxy and hairy covering enables flies to dive underwater without getting wet.

20 November 2017

Floris van Breugel/Caltech

More than 150 years ago, American writer Mark Twain described how flies enter Mono Lake in California then “pop up to the surface as dry as a patent office report”. Now scientists have identified how they do so.

The alkali fly *Ephydra hians* can crawl down the side of the lake to depths of 8 metres and remain submerged for 15 minutes before emerging unscathed. Not only can it achieve this unusual feat, it does so in a lake whose waters are so alkaline and so salty that they support only algae, bacteria and brine

shrimps.

Diving bubble

Now two biologists at the California Institute of Technology in Pasadena have worked out how the fly creates the bubble of air that surrounds it during the dive. Floris van Breugel and Michael Dickinson filmed flies entering a solution that mimics the sodium-carbonate-rich conditions of the lake. The flies are covered in hairs that are coated in a waxy substance that repels water. As they enter the water, an air bubble forms around their entire bodies, apart from their eyes. Not only is this bubble protective, it also provides the flies with breathable oxygen.

The scientists found that the flies had a denser coat of hairs than other species that were unable to stay dry underwater. They also found that the waxy substance that coats these hairs contained smaller hydrocarbons than other species. They think that these two traits combine to help prevent *E. hians* from getting wet, in particular as it emerges to the surface through the negatively electrically charged air-water interface created by the conditions in the lake. The researchers report their findings in the *Proceedings of the National Academy of Sciences*[1].

There are other shore flies of the same family (Ephydridae) that crawl underwater to lay eggs, but not in such hostile conditions, says van Breugel. He hopes to compare alkali flies from different lakes around the world.

During the annual autumn migration, there can be as many as 2 million birds at Mono Lake at any given time, says van Breugel, and the flies are an important source of food. “This story is a beautiful example of how tiny interactions can have global ecological effects, because Mono Lake is such an important habitat for migratory birds,” he says.

“Van Breugel and Dickinson's paper not only provides an insightful and detailed explanation of underlying mechanisms for this behaviour, it is also an elegant bit of insect natural history,” says Stephen Marshall, an entomologist at the University of Guelph in Canada.

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Comments

Comments

There are currently no comments.

UK government announces research-spending hike ahead of budget

Pledge would raise country’s public research funding to £12.5 billion in 2021–22.

20 November 2017

The UK government seems to be making good on its promises to increase research spending significantly over the next decade.

In an announcement on 20 November, the government said that it would boost public spending on research and development (R&D;) to £12.5 billion (US$16.5 billion) in 2021–22, an increase of £500 million on what is planned for the year before. The hike builds on a surprise announcement made last year, when politicians promised yearly increases in research funding until 2020.

According to the London-based Campaign for Science and Engineering (CASE), the increase puts the United Kingdom on track to hit a government target to raise combined public and private spending on R&D; to 2.4% of gross domestic product (GDP) by 2027.

That would be a huge uptick in spending for Britain: the most recent figures show that the country spent just 1.7% of its GDP on R&D; in 2015, compared with 2.9% in Germany and 2.8% in the United States.

Hitting the target will also require private investment in R&D; to rise, and some researchers had wondered whether the United Kingdom would rely on private spending to boost its budget past 2020. But writing in the *Times* newspaper to accompany the announcement — which came two days before

the release of Britain's annual budget — Prime Minister Theresa May confirmed that the government planned to increase its public spending on R&D; year on year.

"This gives confidence that the government's plan is to keep rising public R&D; investment on target over the next ten years to reach parity with our international competitors," said Sarah Main, director of CASE. "We seem to have turned a corner. Government is matching its long-term ambition with concrete investment."

The latest money forms part of the government's Industrial Strategy, a range of policies aimed at boosting the economy across the country. Full details of the strategy will be published on 27 November, but May added in her article that it would include ways to encourage UK leadership in artificial intelligence, big data, clean energy and self-driving cars.

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Comments

Comments

There are currently no comments.

Exoplanet hunters rethink search for alien life

Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.

20 November 2017 Corrected:

1. 20 November 2017

Laramie, Wyoming

M. Kornmesser/ESO

The exoplanet Ross 128b orbits a cool dwarf star at a distance that could allov the world to have liquid water.

Steve Desch can see the future of exoplanet research, and it's not pretty. Imagine, he says, that astronomers use NASA's upcoming James Webb Space Telescope to scour the atmosphere of an Earth-mass world for signs of life. Then imagine that they chase hints of atmospheric oxygen for years — before realizing that those were false positives produced by geological activity instead of living things.

Desch, an astrophysicist at Arizona State University in Tempe, and other planet hunters met from 13-17 November in Laramie, Wyoming, to plot better ways to scout for life beyond Earth. Many are starting to argue that the standard definition of habitability — having liquid water on a planet's surface — is not the factor that should guide exoplanet exploration. Instead, the scientists say, the field should focus on the chances of detecting alien life, should it exist.

"Planets can be habitable and not have life with any impact," Desch told researchers at the meeting.

It turns out that water worlds may be some of the worst places to look for living things. One study presented at the meeting shows how a planet covered in oceans could be starved of phosphorus, a nutrient without which earthly life cannot thrive. Other work concludes that a planet swamped in even deeper water would be geologically dead, lacking any of the planetary processes that nurture life on Earth.

"Habitability is not only about finding the signature of an alien life form taking a deep breath," says Elizabeth Tasker, an astronomer and exoplanet researcher at the Japan Aerospace Exploration Agency's Institute for Space and Aeronautical Sciences in Sagamihara. It's also about how a planet's geology and chemistry interconnect to create a welcoming or hostile environment, she says — complicating the search for extraterrestrial life.

Surf and turf

Astronomers have catalogued thousands of exoplanets, of which more than a dozen are potentially habitable. The most recent, announced on 15

November, is Ross 128b, which is 3.4 parsecs (11 light years) away from Earth. It resembles the target that scientists have spent decades hunting: an Earth-sized planet orbiting a nearby star, probably at the right distance to allow liquid water.

Most of these planets have some qualities that stop them from being true Earth twins. Ross 128b orbits a cool dwarf star rather than a Sun-like host, for instance. But Tasker says the usual metrics that scientists use to rank how habitable a world is, such as its location relative to its star or how closely it resembles Earth, are misguided[1].

To figure out how to parcel out valuable observing time, some scientists suggest targeting planets that, like Earth, are thought to have a mix of ocean and land. That's because worlds with nothing but water on their surfaces may not have key nutrients available in forms that can support life — if it is based on the same chemistry as life on Earth.

“We have this stereotype that if we have oceans, we have life,” says Tessa Fisher, a microbial ecologist at Arizona State. But her recent work contradicts this idea. Fisher and her colleagues studied what would happen on an “aqua planet” with a surface that is almost or completely covered by enough water to fill Earth’s oceans five times.

On Earth, rainwater hitting rocks washes phosphorus and other nutrients into the oceans. But without any exposed land, there is no way for phosphorus to enrich water on an aqua planet over time, Fisher reported at the Laramie meeting. There would be no ocean organisms, such as plankton, to build up oxygen in the planet’s atmosphere, she says — making this type of world a terrible place to find life.

Wet blanket

The wettest planets would run into a different sort of trouble, says Cayman Unterborn, a geologist at Arizona State who analysed the planet-wide effects of having as much as 50 Earth oceans’ worth of water. The sheer weight of all that liquid would exert so much pressure on the sea floor that the planet’s

interior would not melt at all, Unterborn found.

Planets need at least some internal melting to sustain geological activity, such as plate tectonics, and to provide the right geochemical environment for life. In this case, Unterborn says, “too much water is too much of a good thing.”

Water-rich worlds are easy to make. Many planets are likely to have formed far from their parent star, Tasker says, in chilly temperatures where they could have coalesced from fragments of rock and lots of ice. If such a planet later migrated closer to its star, the ice would melt and cover the surface in vast oceans. Some of the seven small planets orbiting the star TRAPPIST-1, which is 12.6 parsecs (41 light years) from Earth, are thought to have substantial water on their surfaces[2].

Instead of instinctively studying such water worlds, Tasker says, astronomers need to think more deeply about how planets have evolved through time. “We need to look carefully at picking the right planet,” she says.

The James Webb Space Telescope is set to launch in 2019. Once in space, the telescope will spend much of its time studying potentially Earth-like worlds. Researchers have already begun to analyse how oxygen, methane or other ‘biosignature’ gases in exoplanet atmospheres might appear to the telescope’s view[3].

Towards the end of the Laramie meeting, attendees voted on whether scientists will find evidence of life on an exoplanet by 2040. They were not optimistic: 47 said no and 29 said yes. But a greater share was willing to bet that life would be found on another world in the 2050s or 2060s.

That's presumably enough time to work through the debate over which worlds are the best to target.

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Corrections

Corrected:

> This story misstated the outcome of the vote at the Laramie meeting as 47% no to 29% yes. In fact, the result was 47 votes yes, 29 votes no.

Comments

Comments

There are currently no comments.

Online software spots genetic errors in cancer papers

Tool to scrutinize research papers identifies mistakes in gene sequences.

20 November 2017

Two scientists have rolled out a program that spots incorrect gene sequences reported in experiments — and have used it to identify flaws in more than 60 papers, almost all of them studies of cancer.

Jennifer Byrne, a cancer researcher at the Kids Research Institute of the Children's Hospital at Westmead in Sydney, Australia, and Cyril Labbé, a computer scientist at the University of Grenoble Alpes in Grenoble, France, made public an early version of the program, called Seek & Blastn, in October and now they want other researchers to test the program and help to improve it. They then plan to offer it to journal editors and publishers as an addition to the tools that most already use to check papers, such as software

to detect plagiarism.

Byrne has been working on identifying errors in human cancer papers since 2015, when she noticed problems with five papers on gene function in cancer cells. The authors of the papers described performing a common experiment in which they inactivated a gene using a short targeted nucleotide sequence, to observe its effects on tumour cells. Byrne was familiar with the gene because she was part of the team that reported it in 1998. And she realized that the papers reported using the wrong nucleotide sequences for the experiment they claimed to conduct. Two of these papers have since been retracted. Another two are expected to be retracted on 21 November.

Experimental errors

After noticing similar errors in another 25 papers, Byrne and Labbé developed the Seek & Blastn tool to discover more papers with incorrectly identified nucleotide fragments. The software extracts nucleotide sequences from uploaded papers and cross-checks them against a public database of nucleotides, called the Nucleotide Basic Local Alignment Search Tool (Blastn).

“Seek & Blastn tries to find mismatches between the claimed status of a sequence — what the paper says it does — and what the sequence actually is,” says Byrne. A mismatch is flagged, for instance, when a sequence described as targeting a human gene doesn’t find a match in the Blastn database. Sequences described as non-targeting that do have a match in the Blastn database are also detected.

So far, the program detects only misidentified human sequences, says Labbé, but the pair hope to develop it to check sequences from other species, such as mice. The program also struggles to pick up misidentified sequences if the description is unclear in the original paper. This can cause the program to miss some mistakes and to flag papers that have no errors, so all papers put through the software should also be checked manually, he says.

The pair say that they used Seek & Blastn to detect mismatched sequences in

another 60 papers. Many of these manuscripts have other problems, such as poor-quality images, graphs and large chunks of overlapping text, all of which make some of the papers “strikingly similar” to each other, says Byrne. With the help of colleagues, they are now manually checking the papers.

Although some errors are minor or accidental, Byrne says the majority of the mismatches they have detected in papers may invalidate the results and conclusions. When you see these incorrectly identified sequences, she says, “you do get concerned about how the results were produced and whether the results in the paper actually reflect the experiments that were done”.

In a 2016 study[1] in *Scientometrics*, Byrne and Labbé reported 48 problematic papers, including the 30 papers that had incorrectly identified nucleotide fragments. These were all written by authors from China. The duo did not publicly identify the papers, apart from the five papers from 2015, but privately contacted journal editors, Byrne says. Many of the editors have not responded, she says. But three more papers have been retracted. In total, the pair have identified incorrect sequences in more than 90 papers.

Automated tools such as Seek & Blastn are most valuable if they are used to promote good scientific practice and encourage scientists to avoid errors in the first place, rather than just catch people out, says statistician David Allison at Indiana University in Bloomington, who has spotted many papers with substantial errors. Such tools could also help to quantify error rates in particular journals and fields, he says.

Matt Hodgkinson, head of research integrity for open-access publisher Hindawi in London, which retracted two of the papers from its journal *BioMed Research International*, says he could see publishers using Seek & Blastn as part of the article-screening process. “It would depend on the cost and ease of use, whether it can be used and interpreted at scale,” says Hodgkinson. Staff or academic editors would also need to check the output, given the risk for false positives, he says.

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Comments

Commenting is currently unavailable.

Sex matters in experiments on party drug — in mice

Ketamine lifts rodents' mood only if administered by male researchers.

17 November 2017

unoL/Getty

When it comes to lab mice and antidepressants, it's complicated.

Mouse experiments with the popular club drug ketamine may be skewed by the sex of the researcher performing them, a study suggests.

The findings, presented on 14 November at the Society for Neuroscience (SfN) meeting in Washington DC, only deepen the mystery of how ketamine,

which has powerful mood-lifting properties, interacts with the brain. They also raise questions about the reproducibility of behavioural experiments in mice.

Ketamine is best known as a psychoactive recreational drug. But it has caught psychiatrists' interest because of its potential to treat depression within hours. It's unclear exactly how the drug works, however, and many researchers are using animal models to suss out the mechanism.

Polymnia Georgiou, a neuroscientist at the University of Maryland in Baltimore, is one of them. In 2015, a male colleague asked her to run some experiments for him while he was out of town, including a standard way of testing antidepressants called the forced-swim test. In this assay, researchers inject healthy mice with a drug, place them into a tank of water and measure how long they swim before they give up and wait for someone to rescue them.

Antidepressants can cause healthy mice to swim for longer than their untreated counterparts, which is what Georgiou's male colleague found during his experiments using ketamine.

Scents and the brain

But although Georgiou followed his protocol exactly, she found that treated mice did not swim for any longer than mice injected with a placebo. When she and three female and four male researchers investigated this disconnect by performing the experiments, they discovered that the ketamine acted as an antidepressant only when it was administered by men.

Suspecting that scent was involved, the researchers put the animals inside a fume hood so that the mice couldn't smell who was injecting them. This completely eliminated the effect of the ketamine, regardless of the experimenter's sex. When Georgiou and her colleagues placed a t-shirt worn by a man next to the mice in the fume hood, mice injected with ketamine swam for longer than those injected with a placebo. This suggested that male odour was necessary for the drug to work.

The head of Georgiou's lab, neuroscientist Todd Gould, learned that antidepressant researcher Ronald Duman at Yale University in New Haven, Connecticut, was seeing similar effects with female researchers in his lab that were working on ketamine experiments. So Gould asked Duman to repeat Georgiou's swim-test experiment in his own lab. When eight male and eight female researchers injected mice with ketamine, they saw the same results: mice injected by women did not respond to the drug.

Georgiou and her colleagues repeated the experiments with other antidepressants, but the researchers' sex didn't seem to matter. She and Gould suspect that the antidepressant effect is the result of a specific interaction between ketamine and the male odour in the mouse brain .

But other evidence suggests that the sex of the researcher can affect other types of behavioural experiment, not just those involving ketamine. A 2014 paper[1] in *Nature Methods* found that mice were more stressed and less likely to respond to pain when handled by a male researcher. And behavioural neuroscientist Silvana Chiavegatto of the University of São Paulo in Brazil, who was at Georgiou's SfN presentation, says that she has seen the same phenomenon in her lab, where she studies depression but doesn't use ketamine.

Rethinking the model

"I think it's really fascinating, with wide implications for our field," says Adrienne Betz, a behavioural neuroscientist at Quinnipiac University in Hamden, Connecticut. But she cautions that the results are preliminary, and it remains to be seen whether the effect is specific to ketamine and to mice.

Others disagree about the potential implications. Hundreds of papers with female experimenters demonstrate the effects of antidepressants — including ketamine — in mice, says Lisa Monteggia, a neuroscientist at the University of Texas Southwestern in Dallas. Other factors, such as whether the researcher is stressed when he or she injects the mice, might affect the animals' behaviour, she says.

Gould and Georgiou say that their results don’t necessarily invalidate previous studies; they simply show that ketamine experiments in their lab work only when men inject the mice. There is overwhelming evidence that ketamine is a powerful antidepressant in humans. Gould doubts that the sex of the person administering the drug affects how well it works in a depressed patient, but it's never been tested.

He adds that the findings suggest that researchers studying drugs' effects on mouse behaviour should report the sex of the experimenter in their publications to ensure that other labs can replicate the results. “There are a number of factors that influence replicability and are unrecognized — this is one of them,” Gould says. “For us, it is an inconvenient truth.”

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Comments

Comments

There are currently no comments.

Giant telescope’s mobile-phone ‘dead zones’ rile South African residents

Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.

17 November 2017

Mujahid Safodien/AFP/Getty

South Africa has already built prototype dishes that will form part of the Square Kilometre Array, which will be the world’s largest radio telescope.

A map showing how mobile-phone use might be restricted because of a giant

radio telescope in South Africa has angered people who will live near the instrument — deepening a rift between the local farming community and those backing the project.

The row has arisen over the South African portion of the Square Kilometre Array (SKA), which will eventually consist of thousands of radio dishes in Africa and up to a million antennas in Australia. The array, which begins construction in 2019 for completion in the 2030s, will have a total signal-collecting area of more than 1 square kilometre, making it the world's largest radio telescope. The telescope's first phase in South Africa involves 194 radio dishes, to be laid out like a galaxy with three arms spiralling out from a core cluster.

Local residents in the Northern Cape province, where the government has acquired nearly 1,400 square kilometres of land for the initial phase, have already expressed concerns about the telescope. Some are angry that the SKA won't boost the region's economy as much as they had expected; others fear the land acquisition will damage local agricultural activity — in particular, sheep farming.

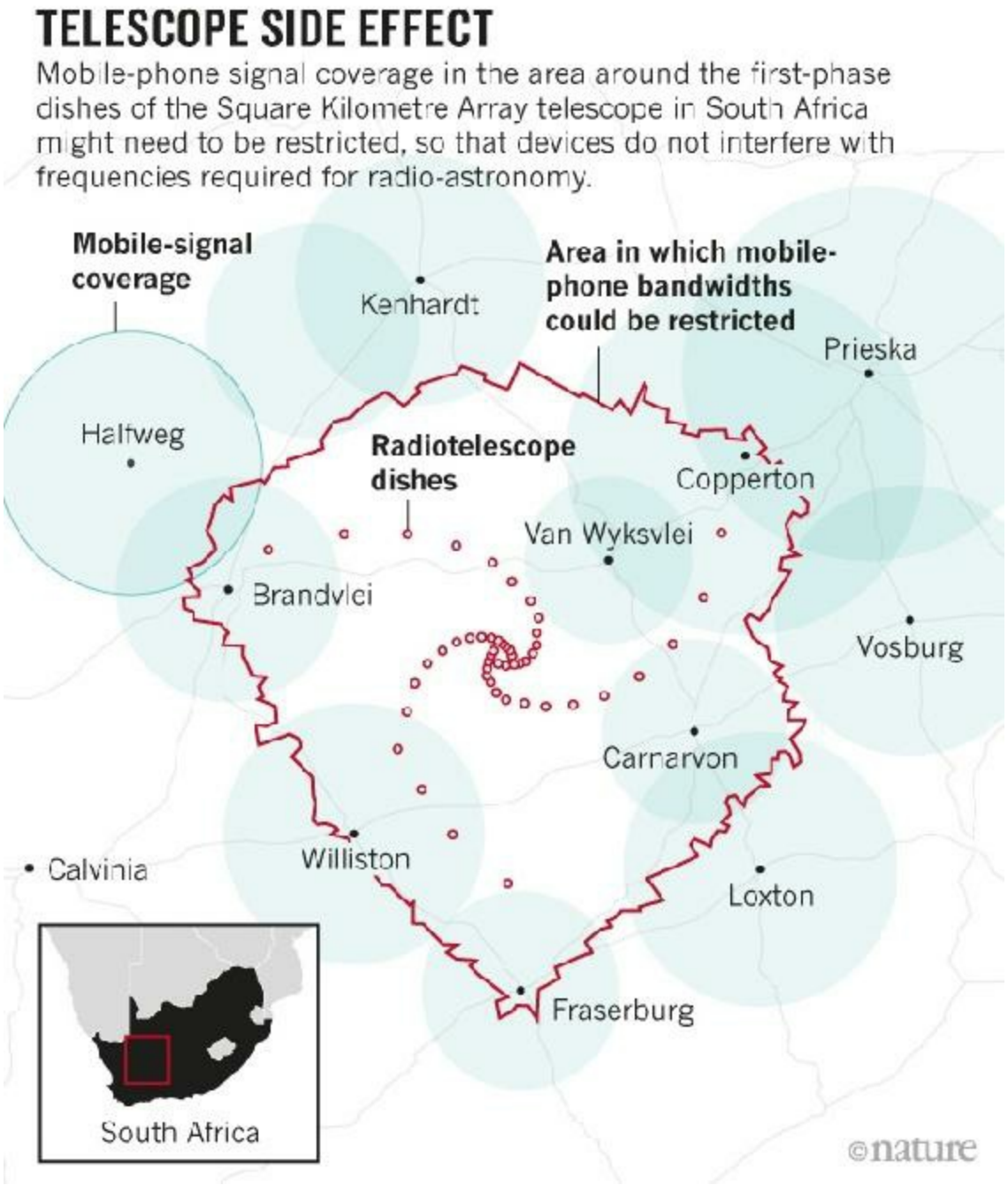
But the map of projected mobile-phone coverage around the project, uploaded to Facebook on 2 November, has brought to light another problem facing the local community. It shows the area around the SKA's radio dishes where the use of electronic devices will eventually be restricted, because their signals would interfere with the relatively weak radio signals that the dishes will try to pick up from the distant Universe.

Communications problem

Nearby residents had been aware that mobile-reception 'dead zones' could be a side effect of the SKA. But Eric Torr, a light-aircraft-business owner who uploaded the map, says it shows the area affected is "larger than we were led to believe". The map suggests that six towns fall into the dead zone, he says, and that this could have serious implications for their farming economies.

The map was produced by the South African Radio Astronomy Observatory

(SARAO), which is leading the SKA project in South Africa. Lorenzo Raynard, head of communications at the SARAO, says it shows areas where mobile-phone coverage could be reduced by 20% or more (see ‘Telescope side effect’). The chart was part of a presentation calling on businesses to submit alternative communications solutions for affected areas, he says.



Adapted from SARAO map

An informal collection of farming organizations has already been working with the observatory to find alternative communications technologies, such as satellite phones, that can be used around the antennas, according to Henning Myburgh, a farmer in the area. “Adequate electronic communications, especially for children, are a basic human right,” he says. Myburgh says that the cooperative’s search has now moved to finding cell-phone technologies that can co-exist with the SKA and replicate the phone facilities the farmers currently have. “This is a major shift and if possible will be a huge step forward,” he says.

Still, says Myburgh, there are farmers who are unhappy. “I don't think that anybody will ever be happy with the situation, taking into account the massively intrusive nature of the project in the region,” he says.

Nicol Jacobs, who farms in the spiral arms, says the SKA was originally going to affect only two farms. He says he found out about the full extent of the telescope when the government began buying more farms. “We’re going to be eaten piece by piece,” he says. Jacobs says he would like the government to return the bought farms to the agricultural community: “I will fight as long as I can,” he adds.

Despite residents’ annoyance, South African law says that the country’s science and technology minister can preserve the area of the SKA’s land for astronomy. The department of science and technology, which oversees astronomy in the country, is responsible for finalizing regulations about areas that will lose mobile-phone coverage, and to define radio-wave frequencies that will be protected for astronomy. Asked when they would be finalized, the department’s astronomy-management authority declined to give a firm date.

Environmental assessment

Although resident’s complaints may not affect the SKA’s layout, an environmental assessment — due to be finalized next year — could change matters.

Earlier this month, the SARAO tasked the South African Environmental Observation Network to implement an environmental assessment of the telescope site, and made 3 million rand (US$209,000) available for the work.

“The relative position of the dishes determines the quality of the telescope beam,” says Robert Braun, science director at SKA Organisation, which is designing the telescope.

The organization has drawn up an ideal map of dish positions, says Braun. But it might have to shift them if the environmental assessment finds that local habitats or biomes are affected, says Casper Crous, an ecologist who is part of the assessment collaboration.

The overarching plan is to turn South Africa’s SKA site into a nature reserve and a site for long-term environmental research once the telescope is operational, says Crous. So a no-go zone for dishes, for example, “would be kokerboom [quiver tree] populations or ephemeral wetlands — areas that if impacted are unlikely to ever recover,” he says.

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Comments

Comments

There are currently no comments.

Arecibo telescope wins reprieve from US government

National Science Foundation will look for partners to provide extra financial support for Puerto Rico facility.

16 November 2017 Updated:

1. 17 November 2017

Xavier Garcia/Bloomberg/Getty

The massive dish of the Arecibo radio telescope measures 305 metres across.

Nearly two months after Hurricane Maria devastated Puerto Rico, the people

who operate one of the world's pre-eminent radio telescopes — at the Arecibo Observatory, on the northwestern part of the island — are still without reliable water, electricity and phone service at their homes. But their jobs seem to be safe.

The US National Science Foundation (NSF), which funds about two-thirds of the observatory's annual US$12-million budget, has decided to continue operating it in collaboration with as-yet-to-be-decided partners. Over the next 5 years, the agency will reduce its annual contribution from $8.2 million to $2 million, with the rest coming from the unspecified partner institutions.

"This is very good news for the Arecibo Observatory and a huge win for the scientific community in general," says Francisco Córdova, the observatory's director. "There is definitely a sense of relief in the air."

The decision comes as part of the NSF's years-long effort to offload several of its astronomical research facilities to free up millions of dollars each year for future projects, such as the Large Synoptic Survey Telescope that is under construction in Chile.

"We have worked very hard to help bring Arecibo to a state where we still have cutting-edge research there, but with NSF not having to make the same investment that we've made historically," says James Ulvestad, acting assistant director for the agency's mathematical- and physical-sciences directorate.

The current management contract at the observatory will expire on 31 March 2018. Earlier this year, the NSF asked potential partners to come forward with ideas and funding offers to keep science operations going. Now, having made its commitment to continue funding the observatory official, the NSF can move forward with negotiating a collaboration agreement and revealing who its partners will be.

"I'm so happy they made the right decision," says Edgard Rivera-Valentín, a planetary scientist who works jointly at the observatory and the Lunar and Planetary Institute in Houston, Texas. "I'm so happy the observatory stays alive."

Slow recovery

The agency's decision is a welcome reprieve for the roughly 120 Arecibo staff who have suffered and rallied in Maria's wake. Hurricane-force winds blasted Puerto Rico on 20 September, downing power lines and damaging buildings across the island. Torrential rains washed out roads and knocked out water supplies.

At the observatory, which is nestled into the limestone mountains above the city of Arecibo, some of the staff sheltered in place during the worst of Maria. The observatory's concrete bunkers, built by the US government in 1963, weathered the storm with little problem. Still, Maria's winds tore down the 29-metre-long 'line feed' antenna that stretched across the observatory's 305-metre-wide dish, puncturing its aluminium skin in places.

Staff went to work helping to clear roads around the region, and government officials used the observatory's helipad as a distribution point for supplies. The facility's deep well supplied hundreds of local residents who had no other source of clean drinking water.

Within weeks, the Arecibo dish was cleaned up and back to doing science. On 29 September, it resumed taking observations, in a low-power mode that lets the sky drift across the field of view; on 7 November, it resumed pointing the dish at specific areas of the sky. The telescope has already observed a fast radio burst, one of a new class of astronomical phenomena that Arecibo is well suited to study with its enormous dish. Last week, the observing schedule expanded to include work at additional radio frequencies, Córdova says.

But telescope operations are still running off generators, and diesel is a precious commodity on the island, says Nicholas White, senior vice-president for science at the Universities Space Research Association in Columbia, Maryland, which helps to manage the observatory. "That's the biggest constraint — just getting back on the grid," he says.

Without a reliable power supply, the observatory cannot restart its planetary radar, which tracks and characterizes near-Earth asteroids. NASA supplies

$3.7 million — about one-third of Arecibo's budget — for this work.

The NSF estimates that it will take between $4 million and $8 million to fix the hurricane damage at the observatory, Ulvestad says. The agency "intends to repair Arecibo to its pre-hurricane condition", he says.

A long history

The NSF decision makes Arecibo the first of the agency's astronomical facilities to have completed a full environmental-impact review of its operations, with an eye towards divestment. The agency is working through a similar process to potentially divorce itself from the Green Bank Observatory in West Virginia, home to the world's premiere single-dish radio telescope, and several other observatories.

Arecibo occupies a unique place in the history of radio astronomy. On 16 November 1974, it beamed the most powerful intentional message ever sent in the hope of contacting extraterrestrial life. In the same year, it was used in the discovery of the first known binary pulsar, whose change in orbital period provided the first indirect evidence for gravitational waves — the ripples in space-time predicted by Albert Einstein.

"People have been telling us for five years: 'You guys are just out to close Arecibo,'" says Ulvestad. "This is a demonstration that that was not what we were ever out to do."

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Updates

Updated:

Added comments from Francisco Córdova.

Comments

Comments

There are currently no comments.

What countries' constitutions reveal about how societies evolve

Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.

16 November 2017

Bettmann/Getty

The right to form unions usually came before child labour protections in a country's constitution.

Timing can be everything when it comes to successfully expanding constitutional rights. Now, a study[1] looking at how constitutions around the world have evolved has revealed patterns that could help people predict the best moment to introduce such changes.

Amendments are generally introduced into a country's constitution in a certain sequence, the authors report in a paper on the preprint server arXiv, and now under review at a journal. In addition, their computer analyses corroborate previously proposed ideas that the addition of some provisions is heavily influenced by the zeitgeist — the dominant social mores of the time — whereas the adoption of others reflects a country's colonial history.

The study validates computational techniques that could be applied to pressing questions about how constitutions reflect and affect societies, says Mila Versteeg, a legal scholar at the University of Virginia in Charlottesville. "These methods might be able to move the ball if applied to the right questions," she says.

Organizations and advocates could use the results to push for policies in a more strategic way, say the paper's authors. "This can be seen as a road map to help get you to where you want to be," says lead researcher Alex Rutherford, a data scientist who was working at the United Nations children's agency UNICEF in New York City when the study was conducted.

The ties that bind

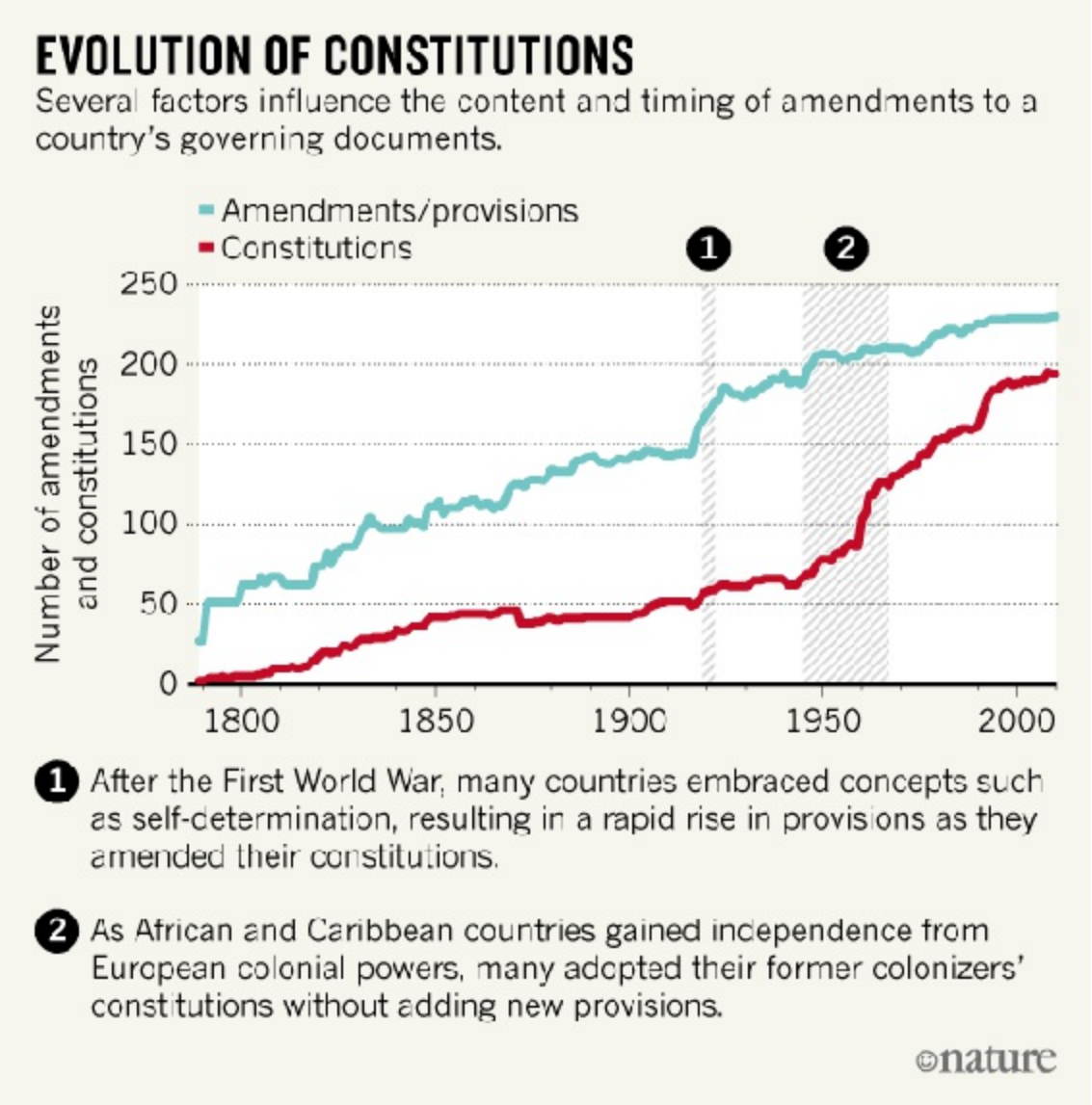
Rutherford and his colleagues used two kinds of computer analyses to look for patterns in provisions from the constitutions of 194 countries. In one, using hand-coded text, they found that the number of provisions increased over time (see 'Evolution of constitutions'). Moreover, the team found that provisions generally appeared in a particular order. Making education compulsory, for example, was usually preceded by the establishment of a right to a free education.

Some of the sequences were less straightforward: the right to form trade unions preceded laws against child labour, for example. This progression

probably reflects the identities of the people who have traditionally scripted constitutions, says Rutherford. Adult men, for instance, seem to have considered their own protections before thinking about others, including those who were unable to push for their own rights, he says. “I think we should protect the most vulnerable first, but this paper says this is not how laws have progressed historically.”

The team then performed a network analysis to identify words that the constitutions had in common and to detect how they grouped together. In some cases, with fundamental provisions such as freedom of religion, clusters included countries that had the same former colonizers.

Meanwhile, amendments such as those prohibiting torture or protecting the environment tended to emerge at specific points in time, regardless of a country’s colonial history. “If you draft a constitution now, you’d be more likely to include a clause on the environment than you would 20 years ago, since we didn’t know much about what was going on back then,” says Rutherford.



Source: REF. 1

Seeds of the future

Constitutional specialists say the team's timeline of provisions seems to be new. "It makes intuitive sense, but I don't think anyone had tried to show it empirically," says David Law, a political scientist at Washington University in St Louis, Missouri. The indexed data that Rutherford and his colleagues used came from the Comparative Constitutions Project, a US-based non-

profit organization partnered with Google. The project hand-codes constitutional texts by turning the words into zeroes and ones.

The credibility of the network approach is boosted by the fact that the analysis of constitutional language came to similar conclusions as previous, less-automated studies. Versteeg suggests that network analysis might next be applied to questions such as what sorts of rights are not well enforced, and whether constitutions can yield subtle clues signalling that a democracy is in decline.

To get at the latter query, Versteeg suggests analysing constitutional texts from democratic countries that have altered their constitutions and become increasingly authoritarian — such as Hungary and Turkey — to find language that gives a ruler more power. Next, researchers could search for these signatures in other countries, such as the United States. “Could we tell when added rights are actually red flags bearing the signs of authoritarianism?” Versteeg asks.

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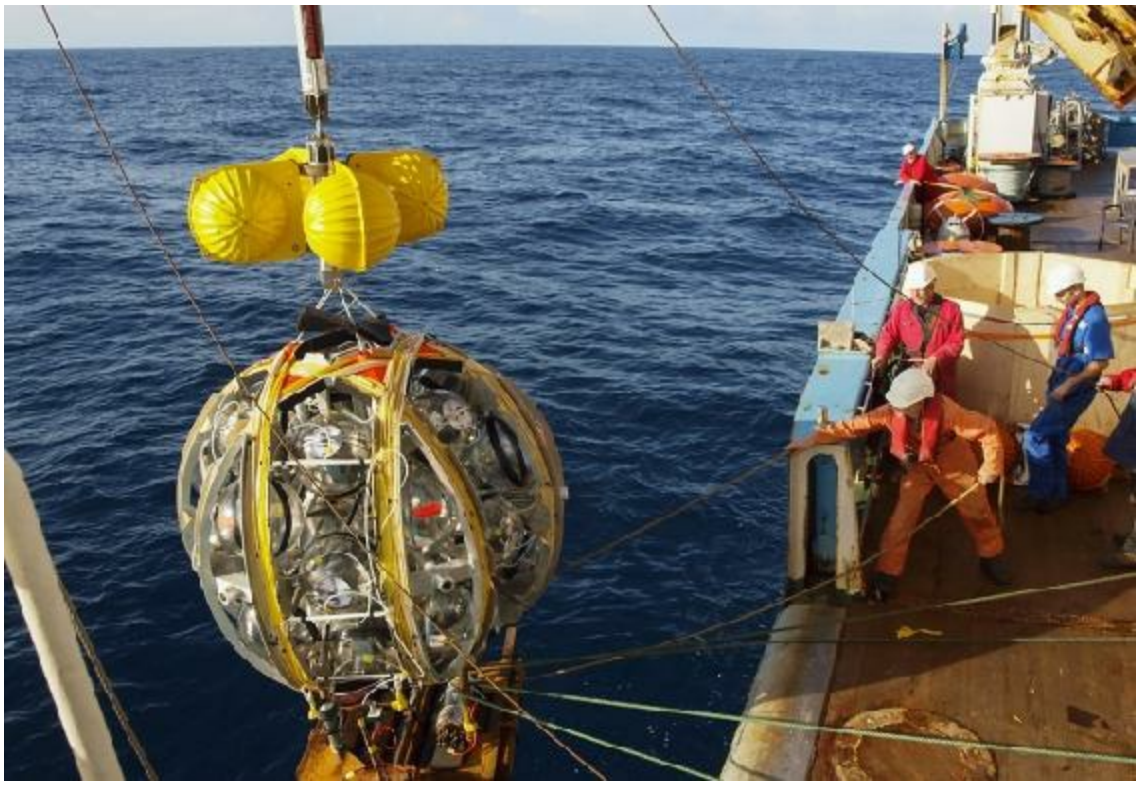
Comments

Commenting is currently unavailable.

Europe sets priorities for hunting cosmic particles

Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.

16 November 2017



KM3NeT

The KM3NeT neutrino telescope is deploying arrays of light sensors deep in the Mediterranean Sea.

Neutrinos, dark matter and γ-rays top European physicists' wish list for the next decade of efforts to catch high-energy particles from space. The

priorities are laid out in a roadmap for 2017–26, posted online last month by a group of funding agencies from fourteen European countries, ahead of being officially unveiled in January.

Twenty years ago, the field of astroparticle physics barely existed. But some of the major discoveries in particle physics — including neutrino research that earned Nobel prizes in 2002 and 2015 — are now coming from space-focused detectors, rather than through the more conventional venue of atom smashers. It's a field that ties together the largest and smallest scales of physics, says Antonio Masiero, a physicist at the University of Padua, Italy, from the expansion of the Universe to exotic types of nuclear decay: “The beauty of astroparticle physics is that it has no borders.”

The roadmap is the second such exercise by the Astroparticle Physics European Consortium (APPEC), which aims to coordinate funding plans for this fast-growing field. (CERN — Europe’s physics lab near Geneva, Switzerland — the European Southern Observatory and the European Space Agency do this for the continent’s particle-physics, astronomy and space-based facilities, respectively.) APPEC requested input from across the community, and held an open ‘town meeting’ in Paris in April 2016 before a panel of experts, chaired by Masiero, compiled the final document.

Infrastructure ideals

The resulting strategy covers huge observatories all the way down to tabletop experiments. At smaller scales, it urges funding agencies to be open to innovative proposals. But when it comes to the largest facilities, the strategy is to be “resource aware”, says Masiero: focusing on only a few projects and requiring only a modest increase over current funding levels. It’s not a “Santa Claus list”, agrees Frank Linde, a particle physicist at the Dutch National Institute for Subatomic Physics in Amsterdam and former APPEC chair.

Among the big projects endorsed by APPEC is the Cubic Kilometre Neutrino Telescope (KM3NeT), a double array of deep-sea light sensors being built by a primarily Dutch, French and Italian collaboration. One site, off the coast of Toulon, France, is designed to detect relatively low-energy neutrinos

produced by cosmic rays hitting the atmosphere, whereas the other, off the southern tip of Sicily, Italy, will aim to catch the signature of the highest-energy neutrinos coming from outer space, after they have travelled through Earth. Researchers hope to figure out where these particles come from.

So far, KM3NeT has received one third of the approximately €150 million (US$177 million) in funding it would need for building the full-size detector, says spokesperson Mauro Taiuti, a physicist at the University of Genoa, Italy. The APPEC stamp of approval could help it to win the rest.

Another major piece of infrastructure that garnered support was the Cherenkov Array Telescope, a €300-million γ-ray observatory to be split between Spain's La Palma Island and Paranal, in Chile's Atacama Desert. The two arrays of optical telescopes will seek flashes of blue light produced in the atmosphere when a high-energy photon collides with a molecule of air, creating a cascade of secondary particles across the sky.

In the nascent field of gravitational-wave astronomy, which APPEC also covers, the big priority is the Einstein Telescope (ET), a next-generation triple interferometer that will have light beams running along three 10-kilometre arms in an equilateral triangle, instead of the two perpendicular arms that current detectors use. Like the Japanese interferometer KAGRA — now under construction — the proposed ET would be built underground, to protect it from vibrations ranging from footsteps to falling leaves, says B. S. Sathyaprakash, a physicist at Pennsylvania State University in University Park, who helped to design it.

Dark-matter dash

APPEC also wants Europe to double-down on existing efforts to spot dark matter, calling for a dramatic scale-up of experiments that use tanks of liquid argon and xenon, to look for traces of collisions between these mysterious particles and atoms of ordinary matter. The largest such detectors now contain more than three tonnes of the noble gases, but according to the roadmap they need to be ten times larger.

These searches bet on the theory that dark matter is composed of weakly interacting massive particles, or WIMPs. Some physicists have called for more investment in ‘alternative’ searches for dark matter, for example, looking for particles known as axions. The road map is a “vanilla document, clearly redacted not to ruffle any feathers”, says Juan Collar, a physicist at the University of Chicago in Illinois. “If European programme managers follow this roadmap to the letter, they will turn the dark-matter field into a desert of ideas.”

But Mario Livio, an astrophysicist at the University of Nevada in Las Vegas who has also called for broadening the search for dark matter, counters that concentrating efforts on WIMPs will allow Europe “to build on existing experience and facilities”. Overall, the roadmap is “very reasonable”, he adds. “The programme, if executed as envisioned, will address some of the most exciting questions in astroparticle physics.”

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Comments

1 comment

1. *Pentcho Valev* • 2017-11-16 09:24 PM
   It seems dark matter is the unfortunate result of theoretical impotence: Cosmologists are unable to calculate the rotational curve for a system ESSENTIALLY different from our solar system, e.g. a spiral galaxy, take the solar-system rotational curve as a paradigm and fill the gap between theory and observation with dark matter. Similarly, cosmologists don't know how to model the local interaction between expansion and gravitational attraction (any such model would produce results incompatible with observations) and implicitly obey the following idiotic slogan: Wherever there is gravitational attraction, forget about expansion! Sabine Hossenfelder: "The solution of general relativity that

describes the expanding universe is a solution on average; it is good only on very large distances. But the solutions that describe galaxies are different - and just don't expand. It's not that galaxies expand unnoticeably, they just don't. The full solution, then, is both stitched together: Expanding space between non-expanding galaxies."
https://www.forbes.com/sites/startswithabang/2017/07/28/most-things-dont-actually-expand-in-an-expanding-universe/ Pentcho Valev

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Improved diagnostics fail to halt the rise of tuberculosis

TB remains a big killer despite the development of a better test for detecting the disease.

16 November 2017 Corrected:

1. 17 November 2017

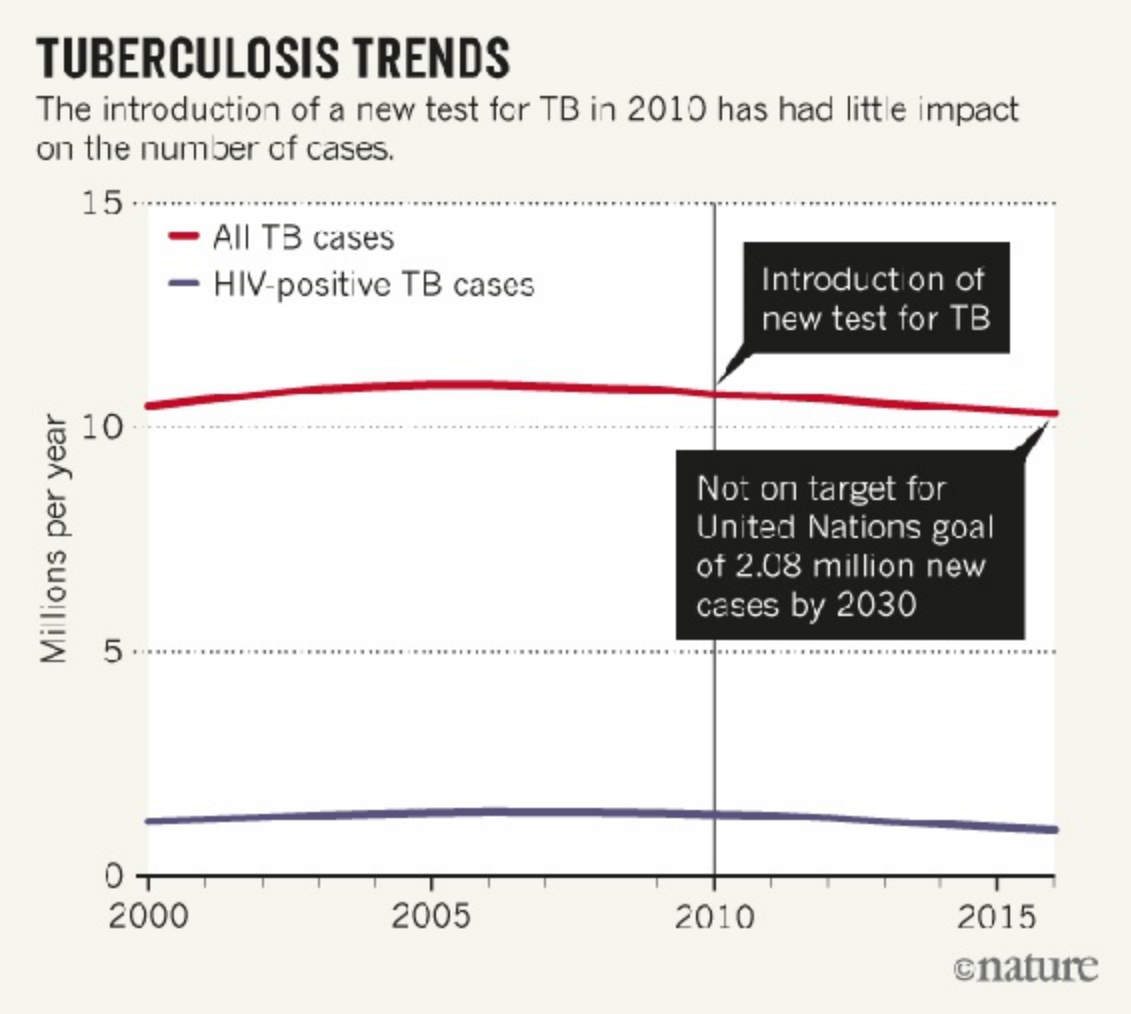
Beawiharta/Reuters

Newly diagnosed tuberculosis patients are treated at a clinic in Jakarta, Indonesia.

Seven years ago, the global community of researchers, health-care workers and activists battling tuberculosis was euphoric. A landmark 2010 trial showed that a new genetic test was highly effective at diagnosing TB, prompting hopes that countries could soon finally control the disease, which killed 1.45 million that year. The World Health Organization (WHO), promptly endorsed the test, called GeneXpert, and promoted its roll-out around the globe to replace a microscope-based test that missed half of all cases.

But the high hopes have since crashed as rates of tuberculosis rates have not fallen dramatically, and nations are now looking to address the problems that cause so many TB cases to be missed and the difficulties in treating those who are diagnosed. In an attempt to turn the tide, health ministers and officials from 100 countries are meeting in Moscow on 16–17 November. And a United Nations General Assembly devoted to TB is scheduled for September 2018. Experts say that the rollout of GeneXpert offers a cautionary lesson — although, in hindsight, an obvious one — in the battle against TB. The tale is a familiar one in global health care: a solution that seems extraordinarily promising in the lab or clinical trials falters when deployed in the struggling health-care systems of developing and middle-income countries.

“What GeneXpert has taught us in TB is that inserting one new tool into a system that isn’t working overall is not going to by itself be a game changer. We need more investment in health systems,” says Erica Lessem, deputy executive director at the Treatment Action Group, an activist organization in New York City.



Source: WHO

No game changer

Some 10.4 million people were infected with TB last year, according to a WHO report published on 30 October. More than half of the cases occurred in China, India, Indonesia, Pakistan and the Philippines. The infection, which causes coughing, weight loss and chest pain, often goes undiagnosed for months or years, spurring transmission. The US government and others spent more than US$100 million developing GeneXpert. Yet despite the WHO's ringing 2010 endorsement of the test, the roll-out of GeneXpert, which is manufactured by Cepheid, a company based in Sunnyvale, California (and

bought by Danaher, headquartered in Washington DC, earlier this year), was initially slow.

The machines cost $17,000 each and require constant electricity and air-conditioning — infrastructure that is not widely available in the TB clinics of countries with a high incidence of the disease, requiring the machines to be placed in central facilities. Until the US government together with the Bill & Melinda Gates Foundation and UNITAID, an international organization that aims to lower drug prices, began subsidizing tests in 2012, each cost $16.86 (the price fell to $9.98), compared with a few dollars for a microscope TB test.

Weak health systems

The WHO says that more than 23 million GeneXpert tests have now been purchased in the public sector in 130 countries that are eligible for the discount. But Madhukar Pai, an epidemiologist at McGill University in Montreal, Canada, says that this still represents a relatively small proportion of people suspected of having TB. Most countries use the tests on selected group of people, Pai says. India, for example, offers the test only to people co-infected with HIV.

Even countries that fully embraced GeneXpert are not seeing the returns they had hoped for. After a countrywide roll-out begun in 2011, the test is available for all suspected TB cases in South Africa. But a randomized clinical trial conducted in 2015 during the roll-out found that people diagnosed using GeneXpert were just as likely to die from TB as those diagnosed at labs still using the microscope test[1]. “Just intuitively one would think that finding TB cases earlier would avert TB deaths. The fact that we didn’t find that was surprising,” says Gavin Churchyard, a physician specializing in TB at the Aurum Institute in Johannesburg, South Africa, who led the study. Similar studies in other countries have come to much the same conclusion about GeneXpert.

Churchyard suspects that doctors have been giving people with TB-like symptoms drugs, even if their microscope test was negative or missing, and

that this helps to explain why his team found no benefit from implementing the GeneXpert test. Others have speculated that, by being involved in a clinical trial, patients in both arms of the trial received better care than they would otherwise have done, obfuscating any differences between the groups.

Either way, Churchyard says, his team's study illustrates how broken South Africa's TB treatment system is, a problem echoed across other countries with high incidences of TB. Even with accurate tests, cases are still being missed. Results from the GeneXpert tests take just as long to deliver as microscope tests, and many people never return to the clinic to get their results and drugs; those who begin antibiotics often do not complete the regimen. "What the study really unmasked was that it's not enough to have new technology and introduce it into a weak health system," Churchyard says.

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Date published:
(23 November 2017)
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doi:10.1038/nature.2017.23000

Corrections

Corrected:

An earlier version of this story gave the wrong citation for the 2015 trial.

Comments

Commenting is currently unavailable.

Hazy skies cool down Pluto

Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.

15 November 2017

NASA/JHU-APL/SwRI

The temperature of Pluto's atmosphere is only about 70 degrees Celsius above absolute zero.

Pluto’s atmosphere is even more bone-chillingly cold than one might expect 5 billion kilometres from the Sun. New research suggests that’s because of the smog that envelops the dwarf planet.

“Haze is responsible for all the atmospheric cooling,” says Xi Zhang, a planetary scientist at the University of California in Santa Cruz. He and his colleagues describe the findings in the 16 November issue of *Nature*[1].

When NASA's New Horizons spacecraft flew past Pluto in July 2015, it discovered that the atmosphere was about -203 ºC, just 70 degrees above absolute zero[2]. That's around 30 degrees colder than predicted — and a big mystery to planetary scientists.

Figuring out how Pluto's atmosphere works is crucial for understanding atmospheres on other large icy worlds in the Solar System and beyond. "Until we know the reason for the cold temperatures, we can't extrapolate to other seasons on Pluto, much less other bodies," says Leslie Young, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, who was not involved in the study.

Smog blanket

Pluto's atmosphere is made mostly of nitrogen, with smaller amounts of compounds such as methane. High in the atmosphere — between 500 and 1,000 kilometres above the surface — sunlight triggers chemical reactions that transform some of these gases into solid hydrocarbon particles.

The particles then drift downward and, at around 350 kilometres above Pluto's surface, clump with others to form long chemical chains. By the time they reach 200 kilometres' altitude, the particles have transformed into thick layers of haze, which the New Horizons spacecraft saw dramatically blanketing Pluto.

Zhang and his colleagues compared the heating and cooling effects of the atmosphere's gas molecules to those of its haze particles. Earlier studies have suggested that the presence of gas molecules, such as hydrogen cyanide, could help explain why Pluto's atmosphere is so cold[3]. But Zhang's team found that including haze was the only way to get their model to match the temperatures that New Horizons measured as it flew by the dwarf planet.

"The fundamental difference is the size," Zhang says. Molecules are typically less than a nanometre across, whereas the haze particles are several hundred nanometres across. That means that the gas and the haze behave very differently in the way they absorb and re-radiate energy from the Sun. Haze

turns out to both heat up and cool down more efficiently than gas, Zhang says.

“It is a neat idea,” says Sarah Hörst, a planetary scientist at Johns Hopkins University in Baltimore, Maryland.

Scientists probably hadn't thought about haze as the cooling culprit before because the haze layers do not block light, says Tanguy Bertrand, a planetary scientist at the Laboratory for Dynamic Meteorology in Paris who has studied Pluto's atmosphere with his colleague François Forget[4]. “I find this study very convincing,” Bertrand says.

Competing ideas

But other researchers have proposed different ideas about why Pluto’s atmosphere is so cold. Roger Yelle, a planetary scientist at the University of Arizona in Tucson, reported one such approach at a conference in Latvia in September. His team’s model suggests that a combination of hydrogen cyanide, acetylene and ethane gas can cool things down. All three gases are known to exist in Pluto’s atmosphere.

Zhang’s team and Yelle’s team have yet to reconcile their contradictory conclusions. But after it launches in 2019, NASA’s James Webb Space Telescope could test Zhang's proposal. If the haze particles are indeed the main factor cooling Pluto’s atmosphere, they would make the dwarf planet appear relatively bright in mid-infrared wavelengths. Zhang hopes to observe Pluto with the Webb telescope to see if his team is right.

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doi:10.1038/nature.2017.22996

Comments

Comments

There are currently no comments.

African scientists get their own open-access publishing platform

Venture will launch next year and seeks to strengthen continent's science by helping academics share work more quickly.

15 November 2017

Africa's academy of science has announced that it will launch an open-access publishing platform early next year — the first of its kind aimed exclusively at scientists on the continent.

The platform, called *AAS Open Research* and announced by the African Academy of Sciences (AAS) in Nairobi on 15 November, is being created with the London-based open-access publisher F1000, adopting the model of its *F1000Research* publishing platform. *AAS Open Research* will publish articles, research protocols, data sets and code, usually within days of submission and before peer review. F1000 staff will arrange post-publication peer review: the reviews and the names of their authors will be published alongside the papers. The papers will be indexed in abstract databases such as PubMed only after they pass review.

The AAS says that the platform will be especially useful for young African academics, who can face difficulties publishing in overseas journals. Some studies suggest[1] that research from low-income countries is perceived differently from that done in high-income ones, for instance. The portal will cut the time and effort scientists have to put into finding homes for their work, and will make the review process more transparent, the academy says.

Although there are already open-access publishers that focus on Africa, such as AOSIS Publishing, based in South Africa, *AAS Open Research* will be the first to adopt open peer review.

The new platform does carry a caveat, however: it will initially take submissions only from AAS fellows and affiliates (who together number around 400), as well as researchers funded through programmes managed by the Alliance for Accelerating Excellence in Africa. The Nairobi-based body manages grants for African research programmes that come from international funders, mostly targeting health research but also areas such as climate change.

Limiting eligibility to the platform is critical to ensure that submissions are of high quality, says AAS executive director Nelson Torto. Researchers who meet the initial criteria have already been vetted and selected through a rigorous grant-review process, he says. In future, to open up the platform to more researchers, the academy wants to partner with other African research funders whose selection processes are similarly rigorous, Torto adds.

Following a trend

The African venture follows a series of open publishing portals launched with F1000 in the past 18 months, including those set up by the Wellcome Trust in London and the Bill & Melinda Gates Foundation in Seattle, Washington — both large charities that fund scientific research. Research centres including the UCL Great Ormond Street Institute of Child Health and the Montreal Neurological Institute and Hospital in Canada have also teamed up with the firm; the European Commission is considering creating its own open publishing platform for outputs from its main Horizon 2020 research programme.

The AAS will not itself be covering the costs of publishing on the platform. Rather, the academy says, African researchers' grant funders will pay publishing fees directly to F1000: £120–800 (US$160–1,100) per article, depending on length.

Some scientists have raised concerns that publishing on open-research platforms might stop African academics from getting the recognition needed for career advancement that they receive for publishing in conventional journals. In South Africa, for instance, academics are rewarded for publishing

in a list of titles maintained by the country's higher-education department.

"For open publishing to be successful, it will need to be accompanied by changes in the criteria for academic recognition and promotion within African institutions of higher learning," says Salim Abdool Karim, an HIV researcher and AAS fellow in Durban, South Africa.

The risk of publishing on little-known platforms is a concern, agrees Gordon Awandare, a biochemist at the University of Ghana in Accra who will be eligible to publish on *AAS Open Research*. However, the AAS platform will help to chip away at the grip of the big journals, says Awandare, which will be good for African science. "Our approach has always been to spread our research across several platforms, so we will continue to do that."

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Comments

1 comment

1. *PROF CHUKWUEMEKA CH AGBAKWURU* • 2017-11-16 06:15 PM
   The African Scientists Open-Access Publishing Platform is a very welcomed innovation to give African Researcher (International & National) the much needed opportunity of making worthwhile intellectual contributions to African and World Development through publishing of their research studies.
   www.mastercomputeragency.net

Puerto Rico struggles to assess hurricane’s health effects

While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.

15 November 2017

Mario Tama/Getty

Hurricane Maria, which hit Puerto Rico in mid-September, disrupted water supplies in some areas.

Nightfall sets a hard deadline for a team of public-health researchers in Puerto Rico. Since Hurricane Maria hit on 20 September, leaving large swathes of the island without a reliable power supply, the scientists have

rushed home each night to avoid being in the streets after dark. Many lack running water, and most have limited telephone access.

Yet the team —– co-led by José Cordero of the University of Georgia in Athens — has managed to contact several hundred women to begin assessing whether Hurricane Maria has worsened drinking-water contamination, stress and infectious disease that could harm developing fetuses. This wasn't what the researchers set out to study six years ago when they started a project to assess the impact of pollution on pre-term births. But Cordero's team is one of several research groups have scrambled to quantify Hurricane Maria's immediate health impacts, even as team members struggle to fulfil their own basic needs.

The devastation that Cordero saw on a recent visit to Puerto Rico, his birthplace, shocked him. "I thought I was prepared, but I wasn't," he says.

Even before the hurricane, the island's 18 'Superfund' sites — areas so polluted that the US Environmental Protection Agency deems them hazardous to human health or the environment — posed a potential risk to pregnant women, says Ingrid Padilla, an environmental engineer at the University of Puerto Rico at Mayagüez. Twelve of these sites sit on karst, a geological formation made of porous rock that allows toxic chemicals to flow down from the surface into groundwater.

Padilla's previous research suggests that flooding and other disturbances can quickly bring toxic substances in groundwater back to the surface, and carry them into the water supply. Now, she and her colleagues are collecting hair and blood samples from the research cohort to determine whether pregnant women are being exposed to hazardous chemicals, such as phthalates and chloroform. Since the hurricane hit, the researchers have begun to collect and test groundwater from karst regions and tap water from the homes of people living there.

Other research teams are worried that water that has pooled in hurricane debris could provide a breeding ground for disease-carrying mosquitoes. At the height of the Zika epidemic in 2016, experts debated whether a massive hurricane would destroy mosquito habitat or enhance it, says Carmen Zorrilla, an obstetrician and gynaecologist at the University of Puerto Rico in

San Juan. The evidence is still unclear, she says, and logistical problems may make it impossible for researchers to gather enough data to provide answers.

In some areas where hospitals faced extensive storm damage, the only medical care available is emergency treatment. Screening for the Zika virus is a low priority, and infected adults rarely experience severe symptoms and are unlikely to seek medical treatment.

There are also few labs on the island that can test samples for Zika and other mosquito-borne diseases. Like many Puerto Rican facilities, the US Centers for Disease Control and Prevention (CDC) dengue lab in San Juan lost power during the hurricane and was closed for a week. Diesel generators kept its freezers running to preserve blood and other biological samples, but the lab is still running on generator power and is behind on testing some samples. Shipping delays destroyed reagents that the lab had ordered, since the chemicals were not kept consistently cold during transport.

Lab director Stephen Waterman says that the CDC is collecting data on the incidence of mosquito-borne disease and other hurricane impacts. But its priority is to help US government workers and local communities recognize mosquito breeding grounds, and to provide technical help on efforts to control the spread of the insects. Agency staff would also like to verify reports that leptospirosis — a waterborne bacterial disease that is spread by rats — has sickened dozens of people. “We’re focused on preventing disease,” Waterman says.

Yet the ruined facilities and lack of power continue to tax public-health workers’ ability to know where hazards lie. Take the numerous diesel generators running on the island, which produce visible plumes of grey smoke. Benjamin Bolaños, a microbiologist at the University of Puerto Rico in San Juan, worries that these emissions could harm people with respiratory illnesses, but that the effect will be difficult to quantify. “We are blind because probably the [air quality] monitors were destroyed by the hurricane,” he says.

This makes the prospect of more months without reliable power even more frightening. "The kind of work we’re doing is not because it would be interesting to do,” Cordero says. “It has to be done now because a few years

from now, it’s too late.”

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Comments

Comments

There are currently no comments.

Nature News

周四, 30 11月 2017

Nature News

[周四, 30 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Rise in malaria cases sparks fears of a resurgence** [周三, 29 11月 08:00]
  Progress in the fight against a curable disease that kills hundreds of thousands of children has stalled, according to the World Health Organization.
- **Health agency reveals scourge of fake drugs in developing world** [周三, 29 11月 08:00]
  WHO data suggest around 10% of medications in poorer countries are fraudulent or substandard.
- **‘Alien’ DNA makes proteins in living cells for the first time** [周三, 29 11月 08:00]
  Expanded genetic alphabet could allow for the production of new protein-based drugs.
- **China to roll back regulations for traditional medicine despite safety concerns** [周三, 29 11月 08:00]
  Scientists fear plans to abandon clinical trials of centuries-old remedies will put people at risk.
- **How an underwater sensor network is tracking Argentina's lost submarine** [周一, 27 11月 08:00]
  An expert from a nuclear-test-monitoring system explains how his team is trying to help in the search for the ARA San Juan .
- **European Union nations vote to keep using controversial weedkiller glyphosate** [周一, 27 11月 08:00]
  One agency has linked the widely used herbicide to cancer.
- **United Kingdom relies on science to revive flagging economy** [周一, 27 11月 08:00]
  Long-awaited industrial strategy pins hopes on commercial gains from research.
- **Nobel laureates demand release of Iranian scholar facing death sentence** [周五, 24 11月 08:00]
  Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.
- **Zimbabwe’s researchers hope political change will revitalize science** [周五, 24 11月 08:00]

Academics optimistic that the end of Robert Mugabe’s authoritarian rule could boost research and international collaboration.

- **Lightning makes new isotopes** [周三, 22 11月 08:00]
  Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.
- **AI-controlled brain implants for mood disorders tested in people** [周三, 22 11月 08:00]
  Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.

Rise in malaria cases sparks fears of a resurgence

Progress in the fight against a curable disease that kills hundreds of thousands of children has stalled, according to the World Health Organization.

29 November 2017

Sukree Sukplang/Reuters

A child is tested for malaria at a clinic in western Thailand.

The number of malaria cases rose in many countries in 2016, suggesting that progress has halted in the global fight against the disease, the World Health Organization (WHO) said in a report on 29 November[1].

Globally, malaria infections increased by about 5 million from 2015 to 2016, for a total of 216 million, with apparent jumps in parts of Asia, Africa and South America. The number of people who died from the disease remained relatively steady, at around 445,000, the WHO found. Although data on malaria is often inexact in countries with weak health-care systems, many researchers are concerned by the trends described in the WHO report, which the agency attributes to flat funding levels for anti-malaria programmes.

“For the first time, we can confidently say that we have stopped making progress,” says Pedro Alonso, the director of the Global Malaria Programme at the WHO in Geneva, Switzerland. Alonso worries that governments and donors have become complacent about malaria, given that deaths from the disease fell by an estimated 62% between 2000 and 2015. “We know what happens when we stop applying pressure,” Alonso says. “Malaria comes back with a vengeance.”

Access to treatment

When governments listed malaria reduction as one of the United Nations’ Millennium Development Goals in 2000, billions of dollars in funding flowed in from the Global Fund to Fight AIDS, Tuberculosis and Malaria and other donors, and death rates began to drop. One of the strongest pushes involved getting the gold-standard cure for the disease — pills called artemisinin-combination therapies (ACTs) — to remote regions. Children are at particularly high risk of death if malarial fevers are not treated within a couple of weeks.

Strategies for lowering the cost of ACTs to less than a few dollars per treatment course and to distribute the drugs to health workers have been relatively successful over the past decade. The Global Fund estimates that the malaria-control programmes it has helped to fund have provided 668 million malaria treatments.

And the spread of rapid diagnostic tests for malaria have likely helped to delay the development of drug resistance, by limiting the number of children who are treated for suspected, but not confirmed, cases of the disease. The

percentage of suspected cases tested in sub-Saharan Africa — the region hit hardest by malaria — increased from 36% in 2010 to 87% in 2016.

That does not mean that everyone who needs treatment is getting it. Between 2014 and 2016, 39% of African children under the age of five who developed fevers were not taken to a trained health-care provider, the WHO report says, citing household surveys. The percentage of children receiving care for fevers is often used as an indication of how many may have sought treatment for malaria, although it is an imperfect measure.

“If you ask me, the number-one priority must be to ensure that people stop dying of a disease that is entirely curable,” says Alonso.

Resistance fears

The spread of drug-resistant malaria is also a worry. Strains of *Plasmodium falciparum*, the parasite that causes the most deadly form of the disease, have become resistant to artemisinin in Thailand, Cambodia, Myanmar, Laos and Vietnam.

Southeast Asia accounts for just 3% of the world's malaria cases. But if drug-resistant malaria spreads from Asia to Africa, where 90% of *P. falciparum* cases occur, it would wreak havoc, says Nick White, a malariologist at the Mahidol Oxford Tropical Medicine Research Unit in Bangkok, Thailand. “There is a narrow window of opportunity to eliminate malaria in southeast Asia before we lose the drugs, and it’s shutting,” White says. “Time is running out.”

Next week at a meeting in Nay Pyi Taw, Myanmar, researchers and government officials from across southeast Asia will discuss how to accelerate malaria elimination. Achieving that goal by 2030 in a 22-nation area stretching from Afghanistan to Vanuatu would cost around US$29 billion, according to an analysis by the Global Health Group, a think-tank at the University of California, San Francisco. But it would also save roughly $90 billion over that period from reduced health-care costs and gains in productivity, the group found.

Nonetheless, the money available for malaria-elimination programmes has been dropping[2]. A review of 75 malaria resurgences between 1930 and 2011 found that most upticks in the disease followed funding disruptions that weakened malaria-control programmes[3]. Other causes included conflict and natural disaster.

However, François Nosten, a malariologist at the Mahidol Oxford Tropical Medicine Research Unit facility in Mae Sot, Thailand, would like to see more data. “We need to have a clear understanding of what needs to be done,” he says. “The solution is not just about money.”

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Comments

Comments

There are currently no comments.

Health agency reveals scourge of fake drugs in developing world

WHO data suggest around 10% of medications in poorer countries are fraudulent or substandard.

29 November 2017

Issouf Sanogo/AFP/Getty

Fake medicines are removed from a shop during a police raid of a market in Côte d'Ivoire.

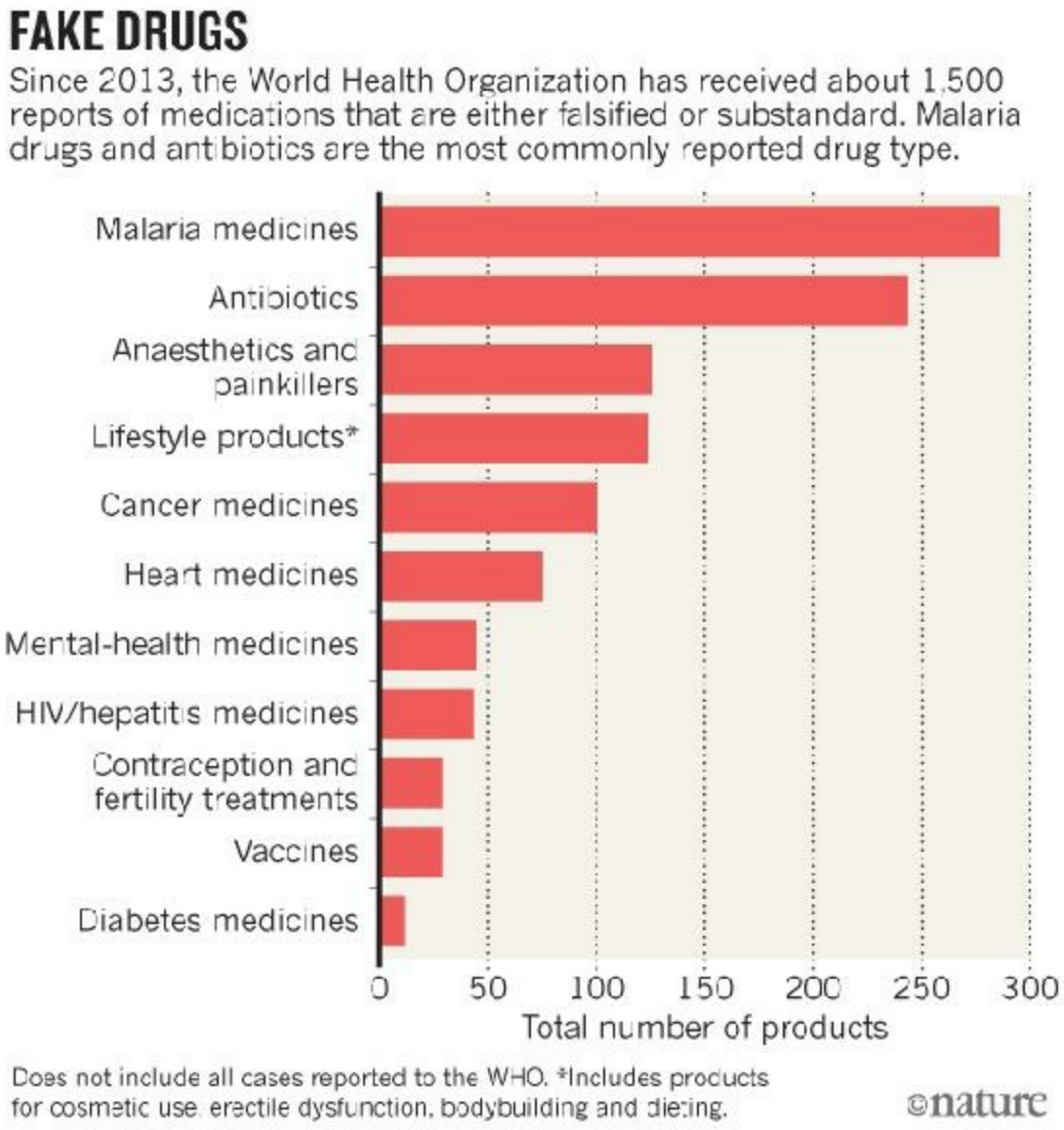
One in ten medicines in developing countries is fake or substandard, data from the World Health Organization (WHO) suggest.

Malaria drugs and antibiotics are among the most commonly reported, the agency found. But the problem extends to a variety of medications, including those for cancer, heart disease and HIV, as well as contraceptives and painkillers (see 'Fake drugs').

The latest figures come from a pair of reports[1, 2] released by the WHO on 28 November — the agency's first on fake medicines in about a decade. The findings focus on fradulent and poor-quality medications in low- and middle-income countries: of 1,500 hundred cases reported to the agency in the past four years, 42% were from Africa, 21% from the Americas and 21% from Europe.

Data on the issue had until now been scant, because there was no mechanism to track the problem. The WHO set up a global system to report inferior medicines in 2013, tracking drugs that are deliberately fraudulent, fail to meet quality standards, or which have not been evaluated or authorized for market. These medications are often referred as counterfeit drugs, but the agency stopped using the term in May to shift the focus from intellectual-property issues to public health.

The cases captured so far are probably just the tip of the iceberg, the WHO says, because many more go unreported. So far, the agency has trained 550 people in 141 countries to track these drugs. "The more one looks, the more one finds," it says.



Public-health problem

The studies estimate that roughly 10% of medicines in circulation in poorer countries — where technical capacity to enforce quality standards is often limited — are substandard or falsified. Cases aren’t limited to expensive or well-known medications, and are split about equally between generic and patented drugs. One analysis in the reports estimates that up to 169,000 children could be dying each year from pneumonia because of inferior antibiotics.

Poor-quality medicines not only fail to treat or prevent disease, they also risk worsening antimicrobial resistance, says Mariângela Simão, the WHO’s assistant director-general for Access to Medicines, Vaccines and Pharmaceuticals. People taking substandard antibiotics that don't fully treat an infection could develop resistant infections that spread.

The findings underestimate the scourge of fake drugs, says Marc Gentilini, a member of the French Academy of Medicine who studies the issue. But crucially, he adds, there is not yet a plan in sight to tackle the problem.

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Comments

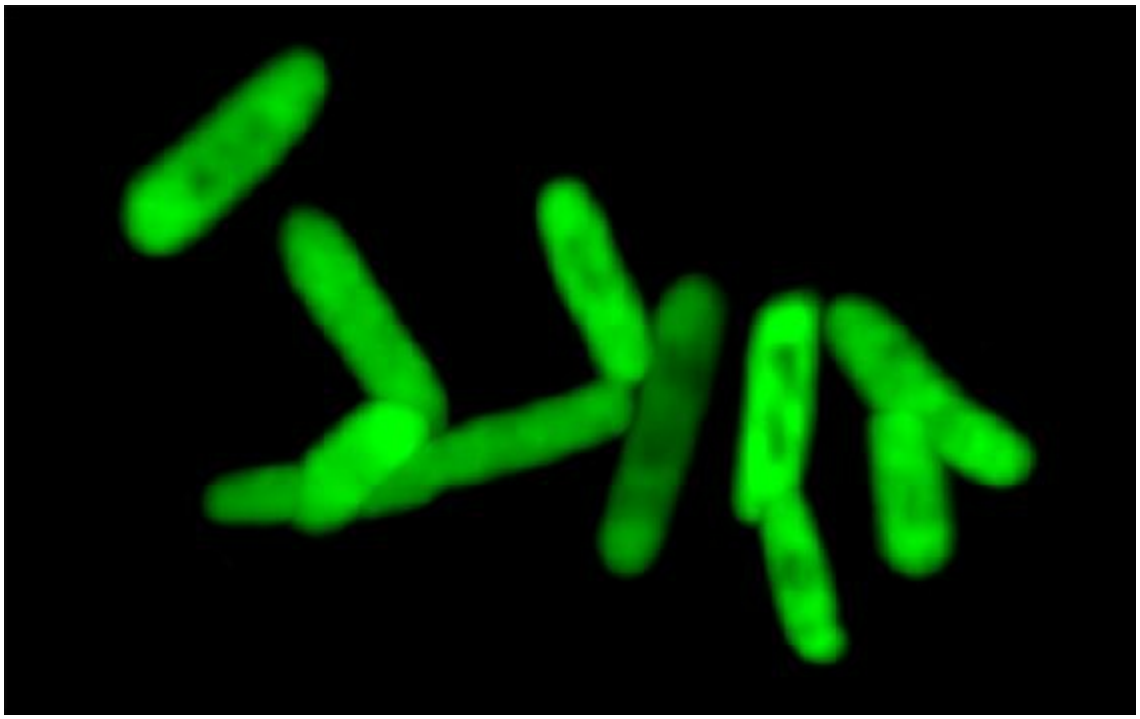
Comments

There are currently no comments.

‘Alien’ DNA makes proteins in living cells for the first time

Expanded genetic alphabet could allow for the production of new protein-based drugs.

29 November 2017



Images by William B. Kiosses

Bacterial cells used their expanded genetic code to make a modified version o a green fluorescent protein.

Life has spent the past few billion years working with a narrow vocabulary. Now researchers have broken those rules, adding extra letters to biology's limited lexicon.

Chemist Floyd Romesberg of the Scripps Research Institute in La Jolla, California, and his colleagues manipulated *Escherichia coli* bacterial cells to incorporate two types of foreign chemical bases, or letters, into their DNA. The cells then used that information to insert unnatural amino acids into a fluorescent protein[1].

Organisms naturally encode heritable information using just four bases: adenine (A), thymine (T), cytosine (C) and guanine (G). These form pairs that hold together DNA's double helix, and different three-letter sequences code for each of the 20 amino acids that make up all of the proteins in living cells. The new work is the first to show that unnatural bases can be used to make proteins within a living cell.

The achievement, Romesberg says, shows that synthetic biology — a field focused on imbuing organisms with new traits — can accomplish its goals by reinventing the most basic facets of life. "There is no biological system so fundamental and more intimately related to what we are than information storage and retrieval," he says. "What we've done is design a new part that functions right alongside the existing parts and can do everything they do."

Alphabet extensions

Several teams are attempting to expand the genetic code. The four natural DNA bases can be arranged in 64 different three-letter combinations, called codons, that specify amino acids. But redundancy in this code — for instance, CGC, CGA, CGG and CGT all stand for the amino acid arginine — means that nearly all proteins needed for life are made of just 20 amino acids.

Researchers including geneticist George Church of Harvard Medical School in Boston, Massachusetts, are working on repurposing redundant codons to specify new amino acids. Romesberg's group is exploring a different strategy: adding an entirely new base pair into DNA. That would vastly increase the number of possible codons, in theory giving cells the ability to exploit more than 100 extra amino acids.

Although Church still believes that his own approach is more practical for

most applications, he describes the new work as a “milestone in exploring the fundamental building blocks of life”.

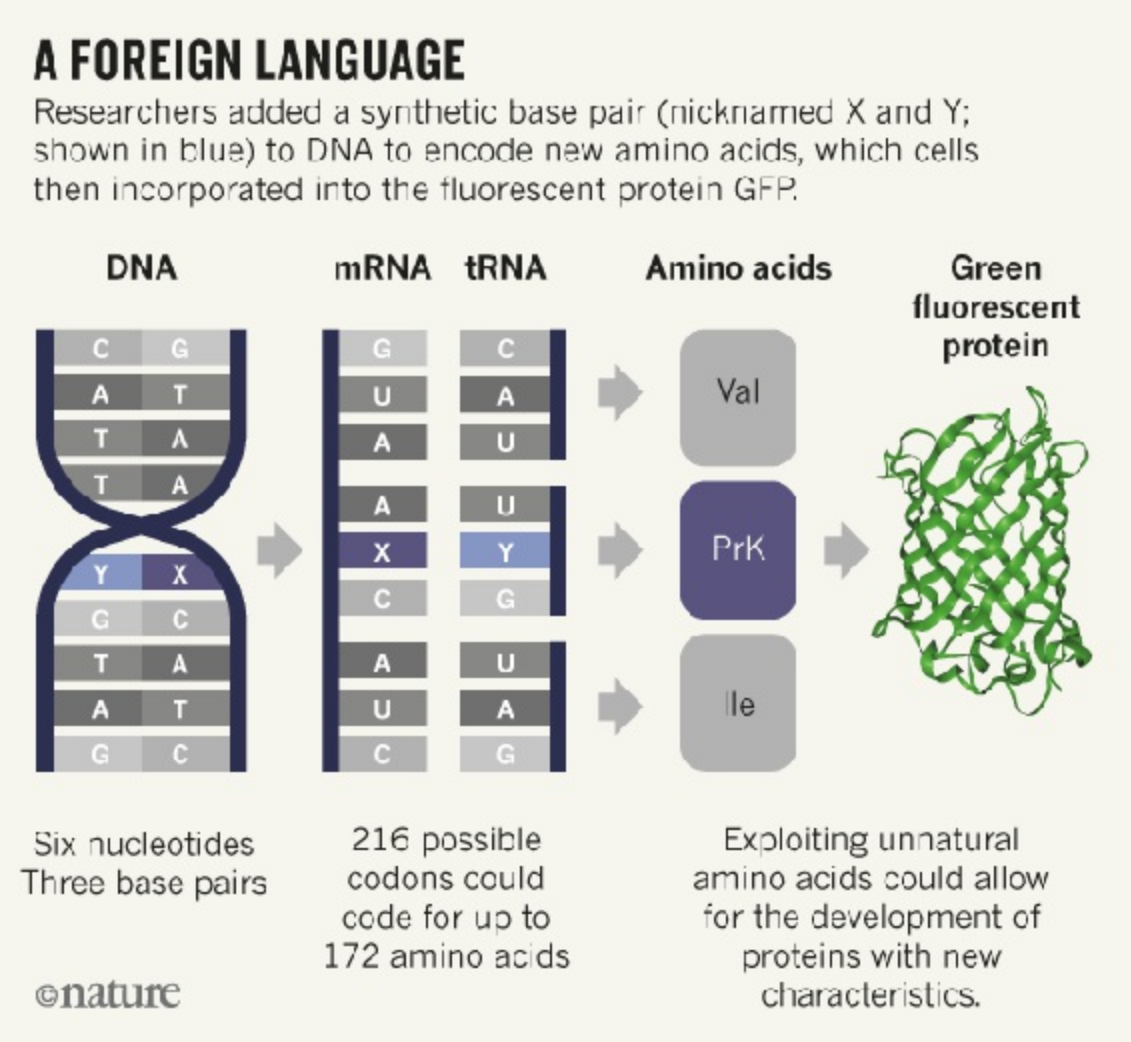
Researchers first imagined an expanded genetic alphabet in the early 1960s. The first big success came in 1989, when a team led by chemist Steven Benner, then at the Swiss Federal Institute of Technology in Zurich, forged DNA molecules containing modified forms of cytosine and guanine[2]. These “funny” DNA letters, as Benner has called them, could replicate and make RNA and proteins in test-tube reactions.

Funnier DNA

Over the past two decades, Romesberg’s team has made hundreds of even funnier DNA molecules. Unlike conventional base pairs in DNA and those made by Benner’s team — which are bound together by shared hydrogen atoms — these foreign bases stick together because of their insolubility in water, largely mimicking how grease droplets clump in water.

To function in living cells, though, the foreign base pairs need to sit alongside natural bases without disturbing the shape of DNA or disrupting essential tasks, such as the processes that faithfully copy DNA and transcribe it into messenger RNA — an intermediary molecule between DNA and proteins. In 2014, Romesberg’s lab reported a breakthrough: a strain of *E. coli* with a loop of DNA containing a single, unnatural base pair[3]. The ‘alien DNA’ was made of chemicals called dNaM and d5SICS (dubbed X and Y, respectively). But the cells divided sluggishly, and tended to lose their foreign DNA over time.

In a paper published earlier this year[4], Romesberg’s team created a healthier, semi-synthetic *E. coli* that didn’t so readily reject its foreign DNA (in this version, d5SICS was replaced with a similarly shaped chemical called dTPT3). Yet this strain, as did the one reported in 2014, lacked the ability to use its new codons.



Graphic: Adapted from Synthorx Inc. 2015. Structure: Pedelacq, J. D. et al. Nat. Biotechnol. 24, 79–88 (2006)/RCSB PDB

In the latest research[1], reported in *Nature* on 29 November, the team created healthy cells that can finally wield their foreign DNA. In separate experiments, the cells incorporated two unnatural amino acids (called PrK and pAzF) into a protein that emits a soft, green glow. Both the foreign bases and amino acids were fed to the cells, and any organism that somehow escaped the lab would not be able to produce them. To allow the cells to use these new components, the researchers created modified versions of molecules called tRNAs, which function to read codons and ferry the appropriate amino acids to the cells' protein factories — ribosomes.

The new amino acids did not change the shape or function of the green fluorescent protein. But “now that we can store and retrieve information”, says Romesberg, “let’s do something with it.” In unpublished work, his team has inserted a foreign base pair into a key site in the gene implicated in antibiotic resistance. Bacteria that shed their foreign DNA become sensitive to penicillin-related drugs.

Candy store

Romesberg has started a biotechnology company, called Synthorx, also in La Jolla, that is attempting to incorporate unnatural amino acids into protein-based drugs such as IL-2, a protein that regulates numbers of white blood cells. The approach could be used to design drugs that are taken up by cells more easily, for example, or that are less toxic or break down more quickly. Proteins could also be designed to have properties that conventional amino acids lack, such as the ability to strongly attract electrons. “It’s like being a kid in a candy store,” says Romesberg. But in this case, "the kid spent 20 years fantasizing about getting into that candy store. All of sudden I’m thinking what kind of candy can I get.”

Teams led by Benner and Ichiro Hirao, a biological chemist at the Institute of Bioengineering and Nanotechnology in Singapore, have already developed test-tube systems for using foreign DNA to encode unnatural amino acids. But Hirao sees advantages to moving into living cells. Proteins containing unnatural amino acids could be made at larger scale and more cheaply using bacterial cells, he says. Bringing the technology to eukaryotic cells would allow for the development of new antibody drugs, too.

However, Benner, who is now based at the Foundation for Applied Molecular Evolution near Gainesville, Florida, suggests that because Romesberg’s system relies on relatively weak hydrophobic forces to hold foreign base pairs together, its potential for industrial applications might be limited. Cells may tolerate the rare foreign base, Benner says, but “one simply cannot build an entire genetic system from them”.

Romesberg and his colleagues are now working on expanding their genetic

alphabet further. So far, the team has identified 12 more codons containing X and Y that are functional, says Romesberg, but “there’s a lot yet to do”.

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Comments

Comments

There are currently no comments.

China to roll back regulations for traditional medicine despite safety concerns

Scientists fear plans to abandon clinical trials of centuries-old remedies will put people at risk.

29 November 2017

David Gray/REUTERS

The Chinese government is promoting traditional Chinese medicines as an alternative to expensive Western drugs.

Support for traditional medicine in China goes right to the top. President Xi Jinping has called this type of medicine a “gem” of the country’s scientific heritage and promised to give alternative therapies and Western drugs equal government support. Now the country is taking dramatic steps to promote these cures even as researchers raise concerns about such treatments.

From early next year, traditional Chinese medicines may no longer be required to pass safety and efficacy trials in humans in China. Draft regulations announced in October by the China Food and Drug Administration (CFDA) mean traditional medicines can skip such costly and time-consuming trials as long as manufacturers prepare ingredients using essentially the same method as in classic Chinese formulations. The State Administration of Traditional Chinese Medicine and the CFDA will compose a list of the approved methods.

The Chinese government has been forcefully promoting traditional Chinese medicines (TCMs) as an alternative to expensive Western drugs. Doctors of Chinese medicine have welcomed the new policy, saying that it will make it easier for companies who produce such medicines to get drugs approved and make them available to patients. Lixing Lao, director of Hong Kong University’s School of Chinese Medicine, says that although traditional medicines will no longer need to go through clinical trials, the CFDA will still require remedies to undergo preclinical pharmacological testing and drug-toxicity studies in animals or cells to gain approval.

Safety concerns

But scientists say that safety concerns continue to plague the industry, and that minimizing clinical-trial requirements could put more patients at risk. On 23 September, the CFDA recalled batches of two injectable TCMs after about ten people fell ill with fevers and chills.

Less than a month later, on 18 October, researchers in Singapore and Taiwan published a study in *Science Translational Medicine* linking liver cancer to aristolochic acid, an ingredient widely used in traditional remedies[1]. Lead author Steven Rozen, a cancer-genomics researcher at Duke-NUS Medical

School in Singapore, is convinced that aristolochic acid contributed to the mutations, but says it's harder to determine to what extent it caused the tumours.

Aristolochic acid has also been linked to cancers of the urinary tract and can cause fatal kidney damage[2, 3]. Rozen says it is still in common use, despite warnings from the US Food and Drug Administration that it is associated with kidney disease. "It would be a good time to reassess regulations" of aristolochic acid, he says.

Lao sees people take remedies containing aristolochic acid every day, and says it should not cause problems if taken "moderately and to treat diseases" rather than as a regular supplement. He says more research is needed into how to ensure the safe use of the potentially toxic substance. Overall, Lao is not concerned about safety issues with traditional medicines because, "unlike Western drug development, these herbal formulas have been used for hundreds and thousands of years," he says.

But Li Qingchen, a paediatric surgeon at the Harbin Children's Hospital and a well-known critic of TCMs, says the recent recalls of remedies show that current safety measures aren't adequate. He says doctors need to inform the public about some of the dangers associated with traditional medicines, but that most are unwilling to speak out against them. "Few doctors would dare to publicly criticize TCMs," he says. Li thinks that the government's promotion of TCMs will make it harder for scientists to criticize the drugs "because the matter gets escalated to a political level and open discussions become restricted".

Criticism muted

With strong government support for the alternative medicines industry, Chinese censors have been quick to remove posts from the Internet that question its efficacy. On 23 October, an article on a medical news site that called for closer attention to the risks of aristolochic acid was removed from social media site WeChat. The story had been viewed more than 700,000 times in three days.

Debate over TCMs has been silenced before in China. Last year, a Beijing think tank — the Development Research Center of the State Council — proposed banning the practice of extracting Asiatic black bear bile, another common ingredient in TCMs. The think tank's report questioned the remedy's efficacy and suggested using synthetic alternatives. It was removed from the think tank's website after the Chinese Association of Traditional Chinese Medicine, which supports the development of TCM, called it biased and demanded an apology.

As well as reducing regulations for TCMs, the Chinese government has made it easier to become a doctor of traditional medicine and to open hospitals that use the approach. Since July 2017, students studying traditional medicine no longer need to pass the national medical exams based on Western medicine. Instead, traditional medicine students can attend apprenticeship training and pass a skills test. And practitioners who want to open a clinic no longer need approval from the CFDA. They need only register with the authority.

The government's ultimate goal is to have all Chinese health-care institutions provide a basic level of TCMs by 2020. A roadmap released in February 2016 by the State Council, China's highest administrative body, plans to increase the number of TCM-licensed doctors to 4 per 10,000 people, an increase from less than 3 practitioners per 10,000 people. The government also wants to push TCMs' share of pharmaceutical sales from 26% to 30% by the end of the decade.

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Comments

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How an underwater sensor network is tracking Argentina's lost submarine

An expert from a nuclear-test-monitoring system explains how his team is trying to help in the search for the ARA *San Juan*.

27 November 2017

AP/REX/Shutterstock

Argentina's ARA *San Juan*, a diesel-powered submarine, went missing this month off the east coast of South America.

On 15 November, Argentina’s Navy lost contact with the ARA *San Juan*, a small diesel-powered submarine that had been involved in exercises off the

east coast of Patagonia.

About a week later, on 23 November, the Vienna-based Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) announced that its International Monitoring System — a network of sensors designed to detect nuclear explosions wherever they happen around the globe — had picked up a sound consistent with that of an explosion near the vessel's last-known location. The submarine is carrying 44 crew members.

The CTBTO's system has numerous scientific applications and this is not the first time that it has been put to use in the aftermath of a possible disaster. In 2000, for example, researchers searched its data for signs of the lost Russian submarine *Kursk*, and in 2014 they used it to try to determine the fate of Malaysian Airlines flight MH370. *Nature* spoke to CTBTO hydroacoustic engineer Mario Zampolli about the latest search.

How does the international monitoring system work?

The system has 289 stations worldwide and, when complete, it will have 337. We use four different technologies: seismic, atmospheric infrasound and hydroacoustic, plus the radionuclide stations, which detect traces of radioactive isotopes from possible explosions. All the information goes to our international data centre in Vienna, and also to our analysts, to examine if there are any events that are of interest with regard to the detection of nuclear explosions. These systems record data 24/7. The signals are stored and are used for a variety of scientific applications and disaster mitigation.

How can you help in the search for the ARA *San Juan*?

Six of our underwater stations are equipped with hydrophones. Two stations picked up a signal: one in Ascension Island, slightly south of the equator in the Atlantic, and the other in the Crozet Islands in the Southern Indian Ocean,

half-way between Africa and Antarctica. These two stations saw the same signal. Also, because each station has three sensors, based on the delay between the times when the signal reached each of the sensors, you can compute a bearing, and calculate the direction in which the signal was coming from. If you compute the geodesics starting at those points, the two lines cross in a location quite near to the point where the submarine last made contact.

Is this type of analysis done in real time?

For nuclear-explosion detection the CTBTO has a real-time processing pipeline. The automatic processing pipelines are optimized for detecting nuclear explosions. Whichever type of detector you build, you have to strike a balance between the probability of detecting something and the probability of false alarms. If the system is so sensitive that it detects everything, you will also have 100% probability of detecting false alarms. We would be completely swamped with events. To search for other signals, it becomes a manual job. We have to write ad-hoc pieces of software, compare signals and discuss them.

And what did your data show?

We found the location where the sound originated. It was estimated to have occurred 3 hours and 21 minutes after the last contact between the submarine and the base. We carried out a detailed analysis of the sound and are confident that this is not a natural event. It was an impulsive signal — short and sharp. The fact that it was detected with a good signal-to-noise ratio at Ascension and also at Crozet — 6,000 to 8,000 kilometres away from the source — means it must have been fairly loud. Some aspects of the signal are consistent with what has been seen in explosions before. But it is really very difficult to say that this was an explosion.

Are you able to say what caused it? For

example, could some explosives aboard the vessel have detonated accidentally?

It is very difficult to speculate. You have an undersea structure, with a steel pressure vessel. It could be something that happened inside or outside. It could be many things. We don't know the dynamics. What’s important is that this was not a natural event. We are not about trying to find out what happened. What we try to do is contribute information to the search authorities, which could help to refine the area of search. Where the signal originated can very much change the intensity — for example, whether it was near the submarine or inside of it — all these detailed aspects can change the sound level. Let alone the fact that one does not know at what depth this happened.

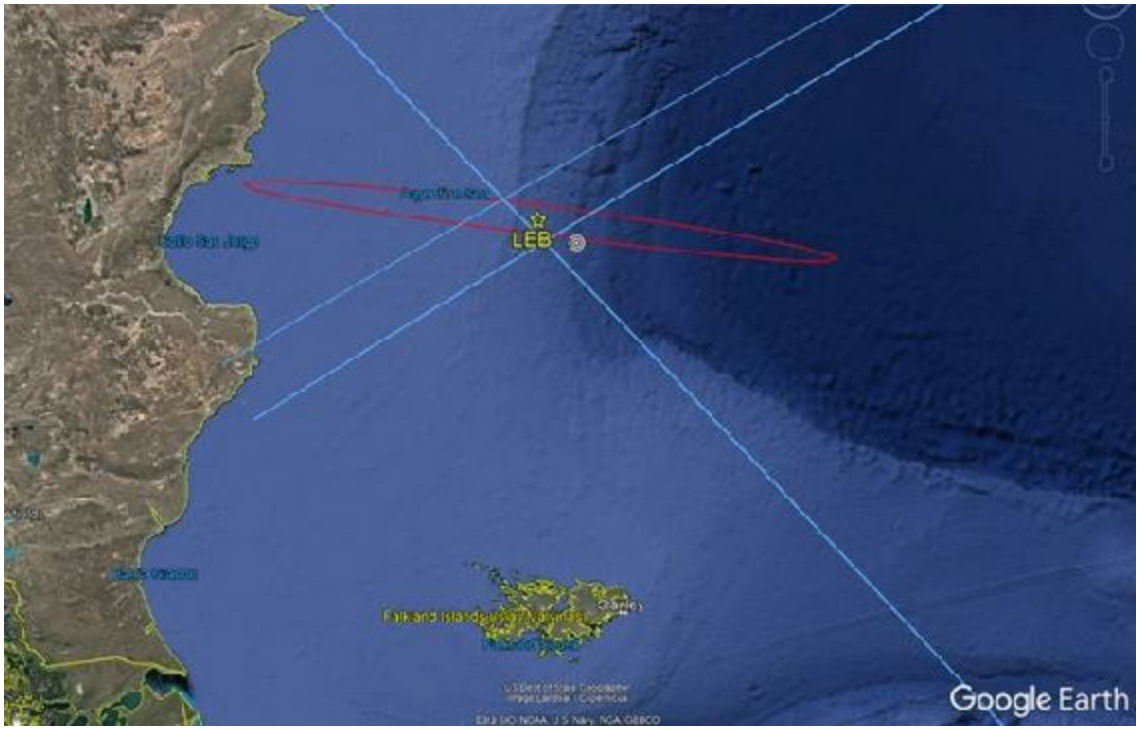
Why does water depth make a difference?

There is an optimum depth at which sound propagates. It is called the SOFAR channel, or sound fixing and ranging channel. It acts like a waveguide in which the sound propagation is more efficient. Because different layers of the ocean have different temperatures and salinities, the speed of sound also changes.

So sound waves in the SOFAR channel are reflected back at the boundaries between different layers, as in an optical fibre?

Yes. Around the time of the Second World War it was discovered that, at a particular depth, sound could be received at farther distances. Air force pilots had a charge with them that was set to detonate at that depth. If they were downed, they could eject; if they made it alive they’d throw out this charge. It would sink and explode, and then their position could be triangulated so they could be rescued. Our hydrophones are located on the axis of the SOFAR

channels.



CTBTO

The red ellipse, located off the coast of Argentina, indicates the possible location of the acoustic signal picked up by CTBTO stations.

Are your data used in other applications?

Data from the hydroacoustic network can help to characterize an earthquake. Tsunami-warning centres can use the data to understand details about the dynamics of an undersea earthquake.

We also detect underwater volcanic eruptions and we can help to locate their whereabouts. Like all the other signals from the monitoring network, the data are available for use by the scientific community. Areas of interest include research on marine mammals. We hear them from hundreds of kilometres away. Having a permanent system that records these data allows biologists to collect statistics about the number of whales that live in a given area and how

they migrate.

How much can your data help to narrow down the search for the *San Juan*?

The margin of error in our localization is still being assessed in detail, but most likely the source was in the vicinity of the submarine's last known location. With data from only two sensors we can point to an ellipse of maybe 100 to 200 kilometres wide (see above image). We have had some contact with the groups conducting the search. They seemed to be interested. But we have had no feedback from them.

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Comments

Commenting is currently unavailable.

European Union nations vote to keep using controversial weedkiller glyphosate

One agency has linked the widely used herbicide to cancer.

27 November 2017

Emmanuel Dunand/AFP/Getty

An activist in Brussels holds a sign that reads: “We are being deceived on glyphosate’s safety”. The weedkiller was deemed “probably” carcinogenic by the World Health Organization, but key EU safety bodies say it is not.

In a long-awaited decision, the European Union has voted to allow for

another five years the sale and use of the controversial herbicide glyphosate. The resolution comes amid arguments over whether the widely used weedkiller poses a cancer risk to people: one scientific body says it does, but others disagree.

The binding vote, taken on 27 November, came just before the product's current licence expires on 15 December, and ends two years of fierce divisions among the 28 EU nations.

International regulatory agencies, including the European Food Safety Authority (EFSA) and the European Chemicals Agency, have concluded that there is little evidence that the chemical causes cancer in people. But in March 2015, the International Agency for Research on Cancer (IARC), which is part of the World Health Organization, said that the substance was "probably carcinogenic" to humans, and that there was "convincing evidence" that glyphosate can cause cancer in laboratory animals.

On 25 October, the European Commission proposed a ten-year extension for the substance, which is used in broad-spectrum herbicides and was launched in 1974 by US agrochemical giant Monsanto as the active ingredient in Roundup. But France and other countries rejected the idea because of safety concerns. Eighteen countries eventually voted in favour of a five-year extension, nine voted against and one abstained.

Mass protest

The compromise seems to have left both sides disappointed. "European governments failed European citizens and future generations today," said Génon Jensen, executive director of the Health and Environment Alliance, a non-governmental organization in Brussels that had campaigned for a ban on glyphosate. French President Emmanuel Macron responded to the vote by tweeting that glyphosate will be banned in France as soon as alternatives can be found, and within three years at the latest. A European Citizens' Initiative petition to stop the use of glyphosate in Europe had gathered more than 1.3 million signatures by 27 November.

Meanwhile, the Glyphosate Task Force, which is based in Darmstadt, Germany, and represents 22 glyphosate manufacturers in the EU, complained that the vote “categorically ignored scientific advice (and was) mainly influenced by public opinion and driven by politics”.

Scientific conclusions on both sides have been criticized. Reuters reported in June that IARC members had not considered a large study showing no link between glyphosate and cancer in humans, because at the time, it had not yet been published. That study, which tracked the health of tens of thousands of farmers, agricultural workers and their families in Iowa and North Carolina starting in the 1990s, was published earlier this month[1].

What’s needed now is a “completely unbiased review of the evidence against glyphosate”, Christopher Connolly, a neurobiologist at the University of Dundee, UK, said in a statement. “We must make the next five years count.”

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Comments

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United Kingdom relies on science to revive flagging economy

Long-awaited industrial strategy pins hopes on commercial gains from research.

27 November 2017

Geoff Pugh/AFP/Getty

UK Chancellor Philip Hammond has promised tax-credit incentives to boost private spending on research.

The United Kingdom has laid out how it will pour money into research to boost its economy — including cash for artificial intelligence and other high-

tech industries — as the country prepares to leave the European Union in 2019.

Science does not usually sit at the forefront of British economic-policy documents. But the UK government's new industrial strategy, released on 27 November, is sprinkled liberally with references to research and development (R&D;) throughout, emphasizing the government's increasing focus on research as a remedy for economic woes. "It feels like science permeates this strategy," says Graeme Reid, a science-policy researcher at University College London.

The shift in emphasis is positive, but it will come with expectations, says Paul Nightingale, deputy director of the Science Policy Research Unit at the University of Sussex in Brighton, UK. Historically, commercializing research has not been seen as a strength of the UK universities system. But in return for more R&D; cash, universities will now be expected to improve how they interact with local businesses and people, and to increase their commercial focus, he says. "This isn't 'strings attached', this is ropes. My impression from talking to lots of academics is that they don't understand how big this is," he says.

The industrial strategy is an effort to boost the United Kingdom's levels of worker productivity — the output per hour worked in the economy — which has remained stagnant since the financial crisis and lags behind those of other industrialized nations. In part to counter that trend, the Conservative government has promised to massively boost the country's R&D; spending over the next decade: from 1.7% of gross domestic product (GDP) in 2015 to 2.4% by 2027. (By comparison, Germany already spends 2.9% of GDP on research; the United States, 2.8%).

UK scientists have already been promised boosts in public spending. Last year, politicians committed to yearly increases in research funding until 2020–21, and last week, they announced that they would continue that increase in 2021–22, raising public research funds by a further £500 million (US$667 million), to £12.5 billion. To raise private spending, the government promises to work with industry to produce a road map in the coming months; UK chancellor Philip Hammond made a start by announcing a rise in R&D;

tax credits (from 11% to 12%) in last week's budget.

Top targets

The industrial strategy has now picked out some specific areas on which to splash the cash. In particular, it identifies four 'grand challenges' in high-tech fields, which were agreed on after consultation with scientists: artificial intelligence (AI) and big data; clean growth; the future of mobility; and meeting the needs of an ageing society. These areas will benefit from an additional £725 million to be spent over the next 4 years from the Industrial Strategy Challenge Fund (ISCF) — a cash pot that has allocated £1 billion since its launch last year. Meanwhile, some £45 million will be spent to support more PhD students in AI and related disciplines, the strategy adds, increasing numbers by at least 200 places a year by 2020–21. And as parts of its efforts to address regional inequality, the government will launch a £115 million 'Strength in Places Fund' to support local pockets of excellence in science and innovation.

Other measures likely to directly affect academic scientists include a promised boost to a stream of funding that is allocated directly to universities, and spent at their discretion. This 'quality-related' funding (so named because it is allocated according to an audit of the quality of university research) is crucial for blue-skies and basic research, but has remained largely unchanged since 2010. An unspecified stream of money is also promised for a competitive fund designed to support multi- and interdisciplinary research that was proposed in a 2015 review by Nobel laureate Paul Nurse.

The strategy mentions a plethora of technology-based schemes, including unspecified 'sector deals' with industry to drive productivity in areas such as life sciences and automotive industries. It is likely that the government will not have enough capacity to manage them all internally, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School, UK.

Flanagan thinks that this will ultimately put greater responsibility into the hands of UK Research and Innovation (UKRI), an overarching organization

that from 2018 will consolidate and oversee the activities of nine existing UK funding agencies, including both basic funding and commercially-focused innovation. If the organization ends up steering the direction of more industrial R&D;, "it makes UKRI a uniquely powerful beast", he says.

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Nobel laureates demand release of Iranian scholar facing death sentence

Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.

24 November 2017

HAND OUT/Belga/PA Images

Iranian researcher Ahmadreza Djalali has appealed against the death sentence he received on 21 October.

Some 75 Nobel prizewinners have called on the Iranian government to release Ahmadreza Djalali, a researcher in disaster medicine who was

sentenced to death last month. The letter is the latest and most powerful protest against the ruling by the scientific community so far.

The group wrote to Gholamali Khoshroo, the Iranian ambassador to the United Nations, on 17 November, and the letter was made public on 21 November. The Nobel laureates express their concern for the conditions of Djalali's detention; they deem his trial "unfair" and "flawed", and they urge the Iranian authorities to let him return to Sweden, where he lived.

The list includes prominent names such as Harold Varmus, a former director of the US National Institutes of Health, now at the Weill Cornell Medicine institute in New York, and Andre Geim, a physicist based at the University of Manchester, UK. They wrote: "As members of a group of people and organizations who, according to the will of Alfred Nobel are deeply committed to the greatest benefit to mankind, we cannot stay silent, when the life and work of a similarly devoted researcher as Iranian disaster medicine scholar Ahmadreza Djalali is threatened by a death sentence."

Spying conviction

Djalali carried out research on emergency medicine — specifically, on the response of hospitals to terrorist attacks — while based at the University of Eastern Piedmont in Novara, Italy, and at the Karolinska Institute in Stockholm.

He was arrested in Tehran in April 2016 and accused of collaboration with a hostile government. On 21 October this year, Djalali was convicted of espionage and sentenced to death, according to Djalali's wife Vida Mehrannia and Italian diplomatic sources.

Tehran's prosecutor linked Djalali to the murder of several Iranian nuclear physicists. But a document thought to have been written by Djalali has claimed that he was sentenced after refusing to spy for Iran. Djalali's lawyer has appealed against the death sentence and is awaiting the court's decision.

Since the death sentence became public, many organisations have protested against Djalali's treatment. They include: Amnesty International, the human

rights group; senators in the Italian government; the directors of the European institutions at which Djalali worked; and academic groups including the Committee of Concerned Scientists and Scholars at Risk.

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Zimbabwe’s researchers hope political change will revitalize science

Academics optimistic that the end of Robert Mugabe’s authoritarian rule could boost research and international collaboration.

24 November 2017

AFP/Getty

Protesters gathered at the University of Zimbabwe in Harare this week, amid political ructions that precipitated the end of Robert Mugabe's 37-year rule.

Scientists in Zimbabwe say they are hopeful that the sudden change of

political power in their country could spell a new era for its beleaguered research system. Those working in the nation hope that the shift will unlock and attract research funds from overseas, while Zimbabwean researchers abroad say that the potential for new order in their country could encourage them to return home.

The authoritarian regime of Robert Mugabe, the 93-year-old who had been president of Zimbabwe for 37 years, ended abruptly on 21 November when he resigned following military and political pressure. Emmerson Mnangagwa, the former vice-president whose firing by Mugabe this month set off the revolt, was sworn in as the country's leader this morning. Elections are expected to be organized next year.

The ructions have been widely celebrated both inside and outside Zimbabwe. The southern African country’s economy has been in free fall for almost two decades since Mugabe fast-tracked a programme of land expropriation, which destroyed investment in its agricultural sector and undermined confidence in the economy. The turmoil led millions — including scientists — to flee the country, many into neighbouring South Africa.

Research roots

Traditionally, much of the country's research has come from ties between Zimbabwe's universities and the agriculture industry, where research and development was considered central to its productivity. Major study areas included maize, land-management and veterinary research. But science became difficult as government funding for research dried up. Last year, the Zimbabwe Academy of Sciences' situation became so desperate that it implored the country’s large diaspora to support the organization.

International sanctions against Zimbabwe have also penalized the country’s students and academics, who have not been able to access international grants, scholarships or buy equipment from foreign companies prohibited from trading with Zimbabwe, says Dexter Tagwireyi, a pharmacist at the University of Zimbabwe in Harare and head of the Zimbabwe Young Academy of Science. If the incoming government has better relationships

with Western countries, such as the United Kingdom and the United States, it could mean that researchers are able to access new sources of funds, he says.

At his inauguration, Mnangagwa said that Zimbabwe was ready to engage with other countries and urged the international community to reconsider their economic embargoes. The African Union, a continental group of nations including Zimbabwe, has been pushing science, technology and innovation as a way for African countries to achieve economic and social development.

The promise of a more democratic government could also attract researchers who have left to return and swell the country's academic ranks. "This change of leader interests me to go back and serve in Zimbabwe as an academic," says a Zimbabwean researcher at the University of Johannesburg in South Africa, who asked to remain anonymous because he was concerned about what his employer might think. The prospect of order in his home country would tempt him to return "at the speed of light", he says, in part because Zimbabwe is not as crime-ridden as South Africa. The sentiment was echoed by several other early-career Zimbabwean scientists in South Africa contacted by *Nature*.

Zimbabwe does not keep official figures on academics, but a 2012 report by the United Nations Educational, Scientific and Cultural Organization said that 1,300 researchers were working there at the time. And despite chronic underfunding, Zimbabwe has consistently produced around 400 peer-reviewed papers a year. (By comparison, South Africa produced 17,246 research publications in 2015.)

"I just hope the new regime will resuscitate the economy and generate significant research funding for higher-education institutions," says Rudo Gaidzanwa, a sociologist at the University of Zimbabwe. "That would boost the research output of academics in state universities."

Key collaborator

South Africa, with its comparatively strong research system, is a major destination for students from around Africa, and a key collaborator for

Zimbabwean scientists. A Web of Science search shows that since 2013, roughly one-third of 1,689 research articles authored by Zimbabwe-affiliated researchers had a collaborator who was based in South Africa.

A strengthened science system in Zimbabwe would benefit the entire region, open the door to greater collaboration and offer a destination for students trained in South Africa, says Valerie Mizrahi, director of the Institute of Infectious Disease and Molecular Medicine at the University of Cape Town in South Africa.

South Africa takes scholars from across the continent, and in many cases the idea of them going home is a pipe dream, because there is often not much to go back to, Mizrahi says. “Zimbabwe has a chance to change that.” Mizrahi, who was born in Zimbabwe but has lived in South Africa for decades, says that the situation is reminiscent of South Africa when apartheid was being dismantled in the 1990s and sanctions were lifted. “Funding flowed into the country,” she says.

Despite the celebrations in Zimbabwe, there are concerns that Mnangagwa’s presidency will not bring enough change. The new leader was a close associate of Mugabe and served in various positions in his government, which was characterized by nepotism and the silencing of opposition voices. “So we are not sure whether they will do things differently or all they wanted was just power to also suppress citizens and loot resources in the country," says Farayi Moyana, a PhD candidate at South Africa's University of the Witwatersrand who is based in Zimbabwe.

The uncertainty means that academics aren't making plans just yet: “There is no hurry to return home,” says a Zimbabwean scientist at Witwatersrand in Johannesburg, who also spoke on the condition of anonymity. Rather, he says, he will let the situation stabilize before making any decisions.

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Comments

There are currently no comments.

Lightning makes new isotopes

Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.

22 November 2017

Magalie L’Abbé/Getty

A lightning storm illuminates clouds over Kagoshima, Japan.

A streak of lightning in the skies over Japan has generated positrons — the antimatter equivalents of electrons — and radioactive carbon-14, confirming a theoretical prediction, according to a paper published in *Nature* on 22 November[1].

Since the 1990s, orbiting observatories designed to observe the heavens have

also detected flashes of γ-rays coming from Earth, which were thought to have their origins in atmospheric phenomena. To investigate this theory, Teruaki Enoto, an astrophysicist at Kyoto University in Japan, and his collaborators set up an array of γ-ray detectors close to the Kashiwazaki-Kariwa nuclear power plant. Winter thunderstorms in Japan are famous for their spectacular lightning, he says, and the low clouds make these relatively easy to observe.

On 6 February, the detectors sensed an unusual event. A double lightning bolt just off the coast shot out an initial, one-millisecond spike of γ-rays, with relatively high energies of up to 10 megaelectronvolts. This was followed by a γ-ray afterglow of less than half a second. Then there was a telltale signal — γ-rays concentrated at 511 kiloelectronvolts of energy, which lasted for about a minute. Physicists say this is the unmistakable signature of positrons annihilating in a puff of energy as they hit electrons in the surrounding matter.

Together, the three waves of γ-rays point to a photonuclear reaction first proposed[2] a decade ago by Leonid Babich, a physicist at the Russian Federal Nuclear Center in Sarov. Lightning can accelerate some electrons to almost the speed of light, and the electrons can then produce γ-rays. Babich proposed that when one of these γ-rays hits the nucleus of a nitrogen atom in the atmosphere, the collision can dislodge a neutron. After briefly bouncing around, most of the neutrons get absorbed by another nitrogen nucleus. This adds energy to the receiving nucleus and puts it in an excited state. As the receiving nucleus relaxes to its original state, it emits another γ-ray — contributing to the giveaway γ-ray glow.

Meanwhile, the nitrogen nucleus that has lost one neutron is extremely unstable. It decays radioactively over the next minute or so; in so doing, it emits a positron, which almost immediately annihilates with an electron, producing two 511-keV photons. This was the third signal, Enoto says. He suspects that his detectors were able to see it only because the briefly radioactive cloud was low, and moving towards the detectors. This combination of circumstances might help to explain why the photonuclear signature has been seen so rarely. Enoto says that his team has observed a few similar events, but that the one described in the paper is the only clear-

cut event so far.

Babich also predicted that not all of the neutrons dislodged from nitrogen by a γ-ray are absorbed. Some of them instead will trigger the transmutation of another nitrogen nucleus into carbon-14, a radioactive isotope that has two more neutrons than ordinary carbon. This isotope can be absorbed by organisms; it then decays at a predictable rate long after the organism's death, which makes it a useful clock for archaeologists.

The main source of the carbon-14 in the atmosphere has generally been considered to be cosmic rays. In principle, lightning could also contribute to the supply. But it is not clear yet how much of the isotope is produced in this way, says Enoto, in part because it's possible that not all bolts initiate photonuclear reactions.

"I agree with their interpretation of their data," says physicist Joseph Dwyer of the University of New Hampshire in Durham. But, he adds, Enoto's team's explanation does not solve all puzzles related to positrons in the atmosphere. In particular, the photonuclear reaction does not seem to match an event Dwyer observed in 2009 from a research aeroplane. His detector spotted a signature of positrons only for a fraction of a second — too short to originate from nuclear decay, he says. Also, his detector saw no initial flash in that case. "If it was there, it should have been very obvious."

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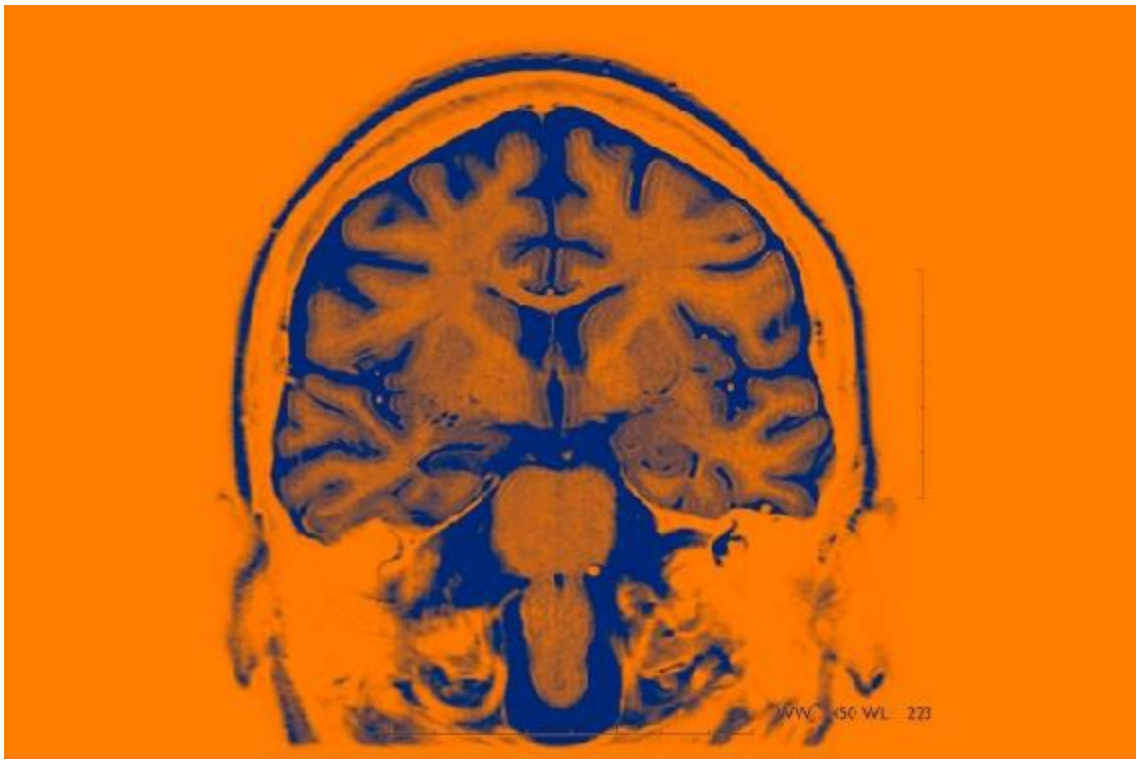
AI-controlled brain implants for mood disorders tested in people

Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.

22 November 2017



BSIP/UIG/Getty

Brain implants are used to treat epilepsy and movement disorders.

Brain implants that deliver electrical pulses tuned to a person’s feelings and behaviour are being tested in people for the first time. Two teams funded by the US military’s research arm, the Defense Advanced Research Projects Agency (DARPA), have begun preliminary trials of ‘closed-loop’ brain

implants that use algorithms to detect patterns associated with mood disorders. These devices can shock the brain back to a healthy state without input from a physician.

The work, presented last week at the Society for Neuroscience (SfN) meeting in Washington DC, could eventually provide a way to treat severe mental illnesses that resist current therapies. It also raises thorny ethical concerns, not least because the technique could give researchers a degree of access to a person's inner feelings in real time.

The general approach — using a brain implant to deliver electric pulses that alter neural activity — is known as deep-brain stimulation. It is used to treat movement disorders such as Parkinson's disease, but has been less successful when tested against mood disorders. Early evidence suggested that constant stimulation of certain brain regions could ease chronic depression, but a major study involving 90 people with depression found no improvement after a year of treatment.[1]

The scientists behind the DARPA-funded projects say that their work might succeed where earlier attempts failed, because they have designed their brain implants specifically to treat mental illness — and to switch on only when needed. "We've learned a lot about the limitations of our current technology," says Edward Chang, a neuroscientist at the University of California, San Francisco (UCSF), who is leading one of the projects.

DARPA is supporting Chang's group and another at Massachusetts General Hospital (MGH) in Boston, with the eventual goal of treating soldiers and veterans who have depression and post-traumatic stress disorder. Each team hopes to create a system of implanted electrodes to track activity across the brain as they stimulate the organ.

The groups are developing their technologies in experiments with people with epilepsy who already have electrodes implanted in their brains to track their seizures. The researchers can use these electrodes to record what happens as they stimulate the brain intermittently — rather than constantly, as with older implants.

Mood map

At the SfN meeting, electrical engineer Omid Sani of the University of Southern California in Los Angeles — who is working with Chang's team — showed the first map of how mood is encoded in the brain over time. He and his colleagues worked with six people with epilepsy who had implanted electrodes, tracking their brain activity and moods in detail over the course of one to three weeks. By comparing the two types of information, the researchers could create an algorithm to 'decode' that person's changing moods from their brain activity. Some broad patterns emerged, particularly in brain areas that have previously been associated with mood.

Chang and his team are ready to test their new single closed-loop system in a person as soon as they find an appropriate volunteer, Sani says. Chang adds that the group has already tested some closed-loop stimulation in people, but he declined to provide details because the work is preliminary.

The MGH team is taking a different approach. Rather than detecting a particular mood or mental illness, they want to map the brain activity associated with behaviours that are present in multiple disorders — such as difficulties with concentration and empathy. At the SfN meeting, they reported on tests of algorithms they developed to stimulate the brain when a person is distracted from a set task, such as matching images of numbers or identifying emotions on faces.

The researchers found that delivering electrical pulses to areas of the brain involved in decision-making and emotion significantly improved the performance of test participants. The team also mapped the brain activity that occurred when a person began failing or slowing at a set task because they were forgetful or distracted, and found they were able to reverse it with stimulation. They are now beginning to test algorithms that use specific patterns of brain activity as a trigger to automatically stimulate the brain.

Personalized treatment

Wayne Goodman, a psychiatrist at Baylor College of Medicine in Houston, Texas, hopes that closed-loop stimulation will prove a better long-term treatment for mood disorders than previous attempts at deep-brain stimulation — partly because the latest generation of algorithms is more personalized and based on physiological signals, rather than a doctor's judgement. “You have to do a lot of tuning to get it right,” says Goodman, who is about to launch a small trial of closed-loop stimulation to treat obsessive–compulsive disorder.

One challenge with stimulating areas of the brain associated with mood, he says, is the possibility of overcorrecting emotions to create extreme happiness that overwhelms all other feelings. Other ethical considerations arise from the fact that the algorithms used in closed-loop stimulation can tell the researchers about the person’s mood, beyond what may be visible from behaviour or facial expressions. While researchers won't be able to read people's minds, “we will have access to activity that encodes their feelings,” says Alik Widge, a neuroengineer and psychiatrist at Harvard University in Cambridge, Massachusetts, and engineering director of the MGH team. Like Chang and Goodman’s teams, Widge’s group is working with neuroethicists to address the complex ethical concerns surrounding its work.

Still, Chang says, the stimulation technologies that his team and others are developing are only a first step towards better treatment for mood disorders. He predicts that data from trials of brain implants could help researchers to develop non-invasive therapies for mental illnesses that stimulate the brain through the skull. “The exciting thing about these technologies,” he says, “is that for the first time we’re going to have a window on the brain where we know what’s happening in the brain when someone relapses.”

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Nature News

周五, 10 11月 2017

Nature News

[周五, 10 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Physicists shrink plans for next major collider** [周四, 09 11月 08:00]
  Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.
- **UK government appoints next chief scientific adviser** [周三, 08 11月 08:00]
  A former pharmaceutical boss will help navigate the UK's exit from the European Union.
- **Too many academics study the same people** [周三, 08 11月 08:00]
  Researchers should recognize communities that feel over-researched and under-rewarded.
- **Grant recipients can still give objective advice** [周三, 08 11月 08:00]
  The US environment agency should not ban researchers it funds from its advisory boards.
- **Rohingya refugees, Bulgarian protests and a prize for negative results** [周三, 08 11月 08:00]
  The week in science: 3–9 November 2017.
- **Dark-matter hunt fails to find the elusive particles** [周三, 08 11月 08:00]
  Physicists begin to embrace alternative explanations for the missing material.
- **The bitter battle over the world’s most popular insecticides** [周三, 08 11月 08:00]
  As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.
- **Four ethical priorities for neurotechnologies and AI** [周三, 08 11月 08:00]
  Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.
- **The catalogue that made metrics, and changed science** [周三, 08 11月 08:00]
  As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.
- **Polar exploration: The forgotten journey** [周三, 08 11月 08:00]
  Huw Lewis-Jones revisits a pioneering, ill-fated expedition to map the Arctic.
- **Books in brief** [周三, 08 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.

- **Indian scientists urged to speak out about pseudoscience** [周二, 07 11月 08:00]
  Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.
- **Pirate paper website Sci-Hub dealt another blow by US courts** [周二, 07 11月 08:00]
  American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.
- **Genetically modified apple reaches US stores, but will consumers bite?** [周二, 07 11月 08:00]
  Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.
- **US government approves 'killer' mosquitoes to fight disease** [周一, 06 11月 08:00]
  US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.
- **Language patterns reveal body's hidden response to stress** [周一, 06 11月 08:00]
  Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.
- **US government report says that climate change is real — and humans are to blame** [周五, 03 11月 08:00]
  Conclusions of climate-change science analysis are at odds with US President Donald Trump’s policies.
- **Energy researcher sues the US National Academy of Sciences for millions of dollars** [周五, 03 11月 08:00]
  Rare move stems from a conflict over two journal articles about renewable energy.
- **Gut microbes can shape responses to cancer immunotherapy** [周四, 02 11月 08:00]
  Studies find that species diversity and antibiotics influence cutting-edge treaments.
- **Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid** [周四, 02 11月 08:00]
  Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.
- **Controversial chairman of US House science committee to retire** [周四, 02 11月 08:00]
  Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.
- **Newly discovered orangutan species is also the most**

endangered [周四, 02 11月 08:00]

The first new species of great ape described in more than eight decades faces threats to its habitat.

Physicists shrink plans for next major collider

Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.

09 November 2017

CERN/SPL

The Large Hardron Collider (pictured) collides protons, whereas the proposed linear accelerator would smash together electrons and positrons.

Limited funding and a dearth of newly discovered particles are forcing physicists to cut back plans for their next major accelerator project: a multibillion-dollar facility known as the International Linear Collider (ILC)

in Japan.

On 7 November, the International Committee for Future Accelerators (ICFA), which oversees work on the ILC, endorsed halving the machine's planned energy from 500 to 250 gigaelectronvolts (GeV), and shortening its proposed 33.5-kilometre-long tunnel by as much as 13 kilometres. The scaled-down version would have to forego some of its planned research such as studies of the 'top' flavour of quark, which is produced only at higher energies.

Instead, the collider would focus on studying the particle that endows all others with mass — the Higgs boson, which was detected in 2012 by the Large Hadron Collider (LHC) at CERN, Europe's particle-physics lab near Geneva, Switzerland.

Leading particle physicists nevertheless remain upbeat. A 250-GeV machine still has "a convincing physics case", says Hugh Montgomery at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia. He says that it could be upgraded to higher energies in future.

High-energy physicists have been planning a future linear collider for 25 years, but the ILC is now unlikely to see the light of day until at least 2030. They viewed the linear collider as complementary to the LHC, allowing physicists to scrutinize in detail any particles discovered at CERN.

Linear design

The circular LHC smashes together protons, which allows it to reach very high energies (13 teraelectronvolts). But, as composite particles (made of quarks), protons create messy collisions with clouds of debris.

By contrast, the ILC would collide electrons and positrons head on after accelerating them in thousands of superconducting cavities joined end to end. Although yielding lower energies, its collisions — between fundamental particles — would be cleaner and more precise than those in a proton–proton machine.

The international physics community had hoped that Japan would foot much of the estimated US$10 billion needed to realize the original design, after researchers there put forward a proposal to host the facility in October 2012, just after the Higgs discovery. But the Japanese government — deterred by the project's huge price tag, according to Tatsuya Nakada, a physicist at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland — has not yet made any offer of funding.

That fact, coupled with an absence of any other new particle discoveries at the LHC beyond the Higgs, led the Japan Association of High Energy Physicists in July to propose capping the ILC's energy at 250 GeV.

Aiming for a higher energy, the association explained, made less sense after data collected by the LHC in 2015 and 2016 showed that any particles outside physicists' standard model are unlikely to weigh less than 1,000 GeV, and therefore would be out of reach even for a full-scale version of the ILC. However, 250 GeV is high enough to produce large numbers of Higgs bosons, which, the association said, could yield indirect signs of new physics through measurements of their interactions with other known particles.

Energy debate

This proposed 'Higgs factory' has also been endorsed by an international working group responsible for formulating the ILC's science case, in a paper uploaded to the preprint server arXiv last month[1]. The ICFA then gave the pared-down collider its thumbs up at a meeting held in Ottawa, Canada, this week.

Not all physicists are enthusiastic, however. John Ellis, a theorist at King's College London and CERN, maintains that only when operating at around 1,000 GeV will a linear collider provide "a more complete picture of the Higgs". He acknowledges that costs need to be reined in, but says that in limiting the ILC to 250 GeV, "you are making significant scientific compromises".

A report uploaded to arXiv last week[2] describes three possible layouts for the

250 GeV model (a technical design for the higher-energy ILC was published in 2013). Each requires halving the length of the superconducting electron–positron accelerators, but two of the options retain extra tunnel space to accommodate future upgrades.

Taking into account projected savings from ongoing research into accelerators, the report estimates that the collider's core construction cost could be reduced by as much as 40% — bringing it down to around $5 billion in 2012 prices. Manpower and detectors would then raise the total to about $7 billion, according to Lyn Evans, an accelerator physicist at CERN who is directing research on the ILC.

Michael Peskin, a theoretical partical physicist at the SLAC National Accelerator Laboratory in Menlo Park, California, and a member of the ILC working group, has no doubt about the value of a Higgs factory. He says that theoretical studies of the Higgs boson and the weak nuclear force — one of the four known fundamental forces — done over the past year have strengthened the case for experimental probes of the Higgs' interaction strength (the Higgs is required to give the carriers of the weak force finite mass). "The 250-GeV stage is actually more interesting scientifically than we thought," he says.

The ILC decision now rests with Japan. Evans describes the Japanese government's ongoing assessment of the linear-collider project as "very long and very frustrating". But other countries won't commit money until the host country makes its plans known, he says. "The rest of the world is waiting for the Japanese government to decide," he says.

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Comments

1 comment

1. *Pentcho Valev* • 2017-11-09 08:59 PM

    Nowadays the conclusion "Physics is dead" is getting more and more explicit - it has even entered popular culture: Leonard: "I know I said physics is dead, but it is the opposite of dead. If anything, it is undead, like a zombie." https://www.youtube.com/watch?v=GDNP9KOEdh0 The problem is theoretical - experimentalists are just misguided: "The Large Hadron Collider is a particle accelerator currently under construction in the research centre CERN. From the point of view of relativity theory, it has several points of interest: First of all, the protons it accelerates will reach higher energies than ever, allowing new tests of the relativistic quantum field theories that are at the core of modern particle physics. Secondly, at such high energies, there should be first traces of an as-yet unproven symmetry of nature called supersymmetry, which plays an important role in string theory, one of the candidates for a theory of quantum gravity (the quantum theory version of Einstein's general relativity). Finally, the high energies are interesting because they give information about the very early high temperature universe, and about the physics that should be included in the big bang models of relativistic cosmology." http://www.einstein-online.info/dictionary/large-hadron-collider There is a tenet which, if false, does convert modern physics into a zombie, and this is Einstein's constant-speed-of-light postulate. Here is the original formulation: Albert Einstein, ON THE ELECTRODYNAMICS OF MOVING BODIES, 1905: "...light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body." http://www.fourmilab.ch/etexts/einstein/specrel/www/ If interpreted correctly, the Doppler effect directly refutes the postulated independence from "the state of motion of the emitting body". Here is an incorrect interpretation - the postulate is saved by wrongly assuming that the light pulses bunch up in front of the moving source: Albert Einstein Institute: "We will start with a very simple set-up, which you can see in the following animation. On the right-hand side, drawn in green, there is a sender that emits pulses in regular succession. On the left-hand side there is a

receiver, drawn in blue. The pulses themselves are drawn in red, and they all travel at the same speed from right to left. Everytime the sender emits a new pulse, a yellow indicator light flashes once. Likewise, a flashing light indicates when a pulse has reached the receiver: http://www.einstein-online.info/images/spotlights/doppler/doppler_static.gif Next, let us look at a slightly different situation, where the source is moving towards the detector. We assume that the motion of the sender does not influence the speed at which the pulses travel, and that the pulses are sent with the same frequency as before. Still, as we can see in the following animation, the motion influences the pulse pattern: http://www.einstein-online.info/images/spotlights/doppler/doppler_source_blue.gif The distance between successive pulses is now smaller than when both sender and receiver were at rest. Consequently, the pulses arrive at the receiver in quicker succession. If we compare the rates at which the indicator lights at the receiver and at the sender are flashing, we find that the indicator light at the receiver is flashing faster." [END OF QUOTATION] http://www.einstein-online.info/spotlights/doppler Einsteinians make the following assumption above, which is essentially identical to Einstein's 1905 constant-speed-of-light postulate: Assumption 1: "The motion of the sender does not influence the speed at which the pulses travel." Assumption 1 goes hand in hand with another assumption: Assumption 2: "The distance between successive pulses is now smaller than when both sender and receiver were at rest." Assumption 2 is false - the pulses do not bunch up when the source (sender) is moving. If they did, by measuring the (variable) distance between the pulses, an observer associated with the source would know whether he is moving or at rest, which contradicts the principle of relativity. Since Assumption 2 is false, Assumption 1 is false as well. If the speed of the moving source is v, the speed of the light relative to the receiver is c'=c+v, in violation of Einstein's relativity. The following quotations suggest that, if the speed of light is variable, modern physics is dead: "The speaker Joao Magueijo, is a Reader in Theoretical Physics at Imperial College, London and author of Faster Than the Speed of Light: The Story of

a Scientific Speculation. He opened by explaining how Einstein's theory of relativity is the foundation of every other theory in modern physics and that the assumption that the speed of light is constant is the foundation of that theory. Thus a constant speed of light is embedded in all of modern physics and to propose a varying speed of light (VSL) is worse than swearing! It is like proposing a language without vowels."
http://www.thegreatdebate.org.uk/VSLRevPrnt.html "But the researchers said they spent a lot of time working on a theory that wouldn't destabilise our understanding of physics. "The whole of physics is predicated on the constancy of the speed of light," Joao Magueijo told Motherboard. "So we had to find ways to change the speed of light without wrecking the whole thing too much."
http://www.telegraph.co.uk/technology/2016/12/06/speed-light-discovered/ Pentcho Valev

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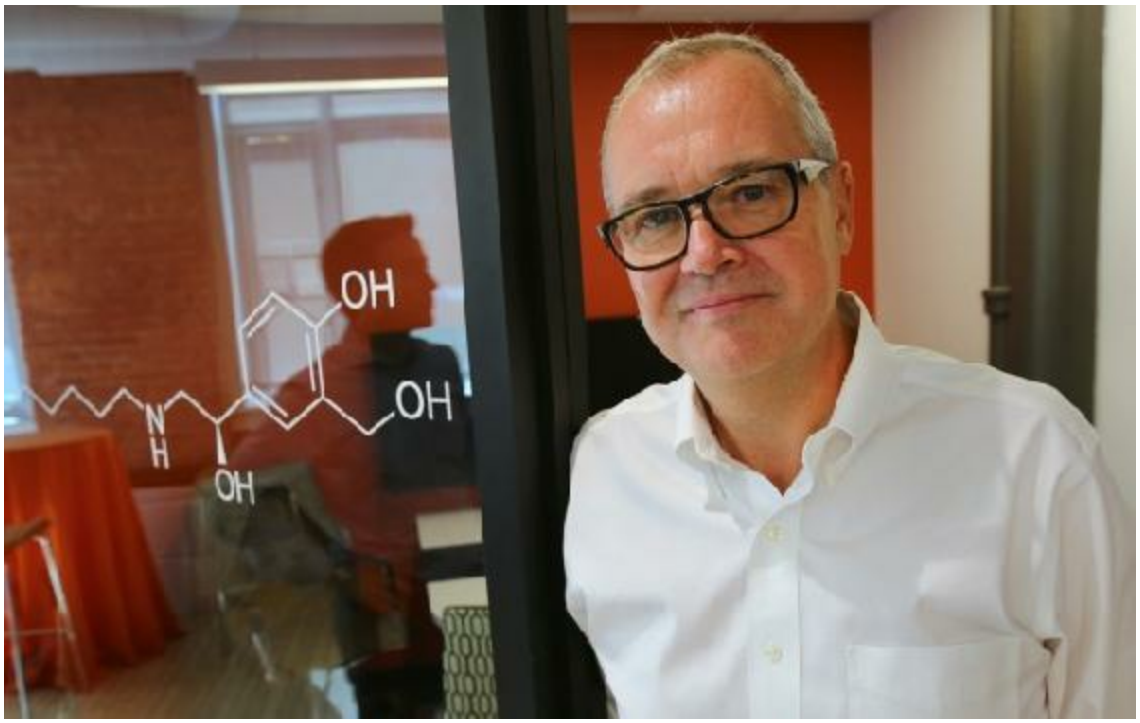
UK government appoints next chief scientific adviser

A former pharmaceutical boss will help navigate the UK's exit from the European Union.

08 November 2017



Pat Greenhouse/Boston Globe/Getty

Patrick Vallance is the third successive biomedial scientist to be appointed chief scientific adviser.

Patrick Vallance, president of research and development at the pharmaceutical giant GlaxoSmithKline, has been appointed as chief scientific adviser, the UK government announced on 8 November.

Vallance, a clinical pharmacologist who previously led the medical division at University College London, will replace Mark Walport in April 2018. Walport has left the government to become head of a powerful new funding body called UK Research and Innovation.

As chief scientific adviser Vallance will advise the prime minister and cabinet, the government's most senior decision-making body. He will also lead the Government Office for Science, which promotes the use of scientific evidence in policymaking across government.

A major part of his role will be to ensure that high-quality advice is available across government departments as they deal with the legal and regulatory consequences of the UK's decision to leave the European Union, says Graeme Reid, a science-policy researcher at University College London. The United Kingdom needs to manage the impact of Brexit on the regulation of the nuclear industry and the UK's role in fusion research, as well as environment policy and other things. “Patrick Vallance's experience in both business and universities will be of huge value,” says Reid.

Brexit is likely to boost the importance of the day-to-day role, but Vallance will also have to reinvent other, more informal aspects of the position, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School. The creation of UK Research and Innovation, intended to increase the power of UK research funding bodies, means Walport will continue to wield great influence over science in government. The chief scientific adviser has traditionally been the voice of science in government, he says.

The relationship between Vallance and Walport will be an interesting dynamic to watch, says James Wilsdon, a research policy specialist based at the University of Sheffield, UK. He says he hopes Vallance will act as a bridge between the science community and policymakers, and will be open to a wide range of people and perspectives. The network of chief scientific advisers is not yet operating at full strength, he says, “so re-energising the collegiality and connectivity of that network though Whitehall is a really important thing.”

The role is less well-paid than Vallance's present position. His base salary at

GlaxoSmithKline is £780,000 (US$1.02 million), but the science-adviser job was advertised in the salary range of £160,000–£180,000.

Vallance will be the third successive chief scientific adviser to come from the biomedical sciences. He follows Walport, who is a former director of the Wellcome Trust, and John Beddington, a population biologist now at the Oxford Martin School and the University of Oxford, UK.

In a separate announcement, GlaxoSmithKline announced that it had apopinted Hal Barron, current president of research and development at Alphabet-funded California Life Sciences, to replace Vallance.

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Comments

Commenting is currently unavailable.

Too many academics study the same people

Researchers should recognize communities that feel over-researched and under-rewarded.

08 November 2017

Susanna D'Aliesio/SOPA Images/LightRocket/Getty

Two women in Lebanon’s Shatila camp.

In southern Beirut, a temporary shelter has become a permanent home. The Shatila refugee camp was established to house displaced Palestinians in 1949 and now has thousands of families within its walls. Residents have learnt to contend with overcrowding, pollution — and a steady stream of well-funded

foreign researchers who come to study them.

Drawn by its unusual story and convenient position close to the airport, researchers flock to Shatila to track the effects of prolonged refugee status and cultural isolation on the community. Well-meaning researchers are so common in Shatila that locals have learnt how to spot them.

Before she became a social anthropologist at King's College London, Mayssoun Sukarieh did voluntary work in Shatila. Residents who saw her reach for her notebook would ask if she was a social researcher: "They come for a tiny bit, and then they leave," the locals explained.

Sukarieh realized that scholars' repeated visits were affecting the community. Academics were among the few contacts that people in Shatila had with the wider world. Again and again, the outsiders would fly out with what they wanted and offer little or nothing in return. The community started to view the visitors with amusement, then resentment.

Some people in Shatila, Sukarieh feared, were being 'over-researched' — an anecdotal concern that social scientists and biomedical researchers increasingly encounter at 'high-traffic' research sites around the world. Sometimes, it is a point raised by ethical-review committees. Occasionally, the community under study makes its own frustrations heard loud and clear.

How big is the problem? Ironically, the issue of over-research has not been researched much. In a study published last month, scientists in South Africa analysed concerns about over-research at two sites of HIV-prevention studies (J. Koen, D. Wassenaar and N. Mamotte *Soc. Sci. Med.* **194,** 1–9; 2017).

They found that the term 'over-research' is poorly defined and encompasses a range of concerns. For example, some use it to describe how other communities are being neglected in favour of one with a pre-established research structure or proximity to a university. This can lead to skewed data, and misconceptions about a particular phenomenon or place.

Alternatively, the term could be used to describe a local community that bears the burden of research participation without sufficient reward, creating a sense of frustration that leads to dwindling participation. In biomedical

studies, researchers sometimes worry that involvement in multiple clinical trials — and exposure to multiple medications — can increase the risk to participants and cloud results.

Repeated studies can certainly exaggerate the frustration that local people feel when their cooperation produces only data, publications and further research. In the South African study, many locals argued that the research should be more closely linked to developing their communities. Some projects, including certain grants from UNAIDS, a global United Nations effort to tackle HIV/AIDS, do require researchers to invest in infrastructure and education. More funders should look at this model. However, several HIV-prevention studies have done such a good job that their results are inconclusive: too few participants contracted the disease for the data to be statistically meaningful.

It is crucial that efforts to reward research participation are developed in consultation with the community being studied. Sukarieh describes well-intentioned educational courses aimed at Shatila-research participants that were impractically long — one consisted of 20 hourly sessions — and discussed issues irrelevant to the people's needs.

Over-research can bring benefits, though: a heavily studied community can become savvy in making its needs known to researchers and in influencing how a study is done. In Hackney, an ethnically diverse borough of London that underwent a period of rapid gentrification, a sociologist who came to study participants in a creative-writing group, for example, was told that, to do so, she had to join the group and write pieces like everyone else. The researcher reported how this strengthened her involvement and built stronger links to the community that helped the project to succeed (S. Neal *et al. Qual. Res.* **16,** 491–507; 2016).

Forging deep links with a community takes time, and time requires funding. Funders should recognize the need to build resources for such efforts into their grants; institutions should recognize and reward this time and effort, and acknowledge that it can eat into a researcher's publication record. It is not good enough to come in for a tiny bit, and then leave.

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Comments

There are currently no comments.

Grant recipients can still give objective advice

The US environment agency should not ban researchers it funds from its advisory boards.

08 November 2017

KEENPRESS/Getty

Melting ice caps are raising sea levels.

Scott Pruitt, administrator of the US Environmental Protection Agency (EPA), levelled a damning accusation against scientists on 31 October. In the interests of restoring scientific “integrity”, Pruitt signed a directive stating that the EPA would no longer allow researchers with active grants from the

agency to serve on the EPA's scientific advisory boards. By his tally, an unspecified number of scientists in voluntary positions on those boards had received US$77 million in EPA grants over the past three years — more than enough, Pruitt declared, to raise questions about their ability to provide independent scientific advice.

It was a cynical move — and entirely unnecessary. After all, it is ultimately up to Pruitt and his team to make the appointments to the boards, which advise the agency on everything from basic research programmes to contentious regulatory decisions. If Pruitt wanted to increase the geographical diversity, or include more people from local, state and tribal agencies, as claimed, he could have done so without raising a fuss. Instead, he opted for a public proclamation that singles out active academic scientists as a unique source of bias. He is wrong, on multiple counts.

Scientific enquiry requires money. That's a fact of life. But receiving a research grant is very different from being on the payroll of an institution, advocacy group or company. Those are all very real conflicts of interest that were ignored in Pruitt's directive.

Moreover, winning competitive research grants does not imply fealty to the granting institution. What drives EPA-funded researchers above all is the desire to deliver a public good: discovery and understanding.

Of course, scientific conflicts of interest do exist. So there are established procedures that require scientists to excuse themselves when their own work is under consideration by the boards. These same procedures apply to industry scientists — who are also rightfully represented on the advisory boards — when deliberations involve issues that could affect their companies' bottom lines.

What Pruitt either fails to understand, or has chosen to ignore, is that his advisory boards are designed to focus on science, not policy. Understanding the latest research requires perspectives from the leading scientists. And when it comes to environmental and human-health issues, it is only to be expected that many of those people will have research grants from the EPA.

In the end, Pruitt's directive seems crafted to incite US President Donald

Trump’s political base, and it’s yet another example of researchers being dragged into the political and cultural wars rending the country.

Happily, it is harder to argue with data. This might explain why the first volume of a comprehensive — and congressionally mandated — assessment of climate science released on 3 November (see page 152) sailed through reviews from officials at the EPA and other federal agencies.

That report, which integrates the latest climate research, found that greenhouse-gas emissions caused by human activity are altering the planet in fundamental ways. It lays out what we know about the threat of global warming — from deep in the ocean to the highest mountain peaks. And it stands in direct opposition to the climate scepticism voiced by Pruitt and Trump.

Some scientists had feared political interference, but senior officials at federal agencies gave the report the green light, without major changes. This is as it should be: scientists can assess what’s known and probe what is not. And it is up to policymakers to decide what to do with that information. This should be a lesson for Pruitt: the current administration has the right to create its own priorities, but it should not and cannot override what science reveals.

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Rohingya refugees, Bulgarian protests and a prize for negative results

The week in science: 3–9 November 2017.

08 November 2017

Events | Research | Policy | Climate | People | Publishing | Trend watch

EVENTS

Ice crack to close Antarctic base again For the second time in two years, the British Antarctic Survey (BAS) will close its Halley VI research station for the winter season because of an enormous crack in the floating ice shelf on which it rests. In March, operators finished moving the transportable station 23 kilometres inland from its initial 2012 location because of an ice chasm nearby. Now, another crack in the Brunt Ice Shelf, this one 50 kilometres long, is threatening the station from the other side. Halley VI will close between March and November 2018, the BAS said on 31 October, because it is too difficult to evacuate personnel quickly in winter if the crack develops further.

Michal Krzysztofowicz/BAS

Money for nothing A data organization has launched what it says is the world's first prize for publishing negative scientific results. The European College of Neuropsychopharmacology's Preclinical Data Forum says that the aim of the €10,000 (US$11,600) prize is to encourage researchers to publish data that don't confirm the hypothesis being tested. Such negative studies are much less likely to be published than positive results, meaning that other scientists may waste time trying to repeat the work. The call for entries — initially just for neuroscience research — opened on 8 November.

Bulgarian protest Hundreds of Bulgarian researchers took to the streets of Sofia on 1 November to demand higher wages and an increase in science funding marked out in the government's 2018 budget. Bulgaria has one of the lowest levels of research investment in the European Union. The demonstrators are threatening further protests when Bulgaria takes over the rotating EU presidency next January.

Rohingya refugees A survey of Rohingya refugees in Bangladesh suggests

that 7.5% of the children have life-threatening malnutrition. The United Nations children's charity UNICEF reported the figure on 3 November. More than 2,700 children are being treated for acute malnutrition in refugee camps, where conditions are expected to worsen because of poor sanitation and crowding. Since late August, more than 600,000 Rohingya people have fled from Myanmar to Bangladesh, following attacks by Myanmar's police.

RESEARCH

Weather forecasts Improving forecasts of severe weather is important, but meteorologists should also listen to social scientists to help save lives during storms, says a 1 November report from the US National Academies of Sciences, Engineering, and Medicine. It recommends that federal agencies do more to incorporate social- and behavioural-sciences research into their preparation for weather hazards. These changes might include researching people's processes for deciding how to respond to threats such as tornado or hurricane warnings, and evaluating how weather forecasters communicate with media and emergency-management officials to convey messages more effectively.

POLICY

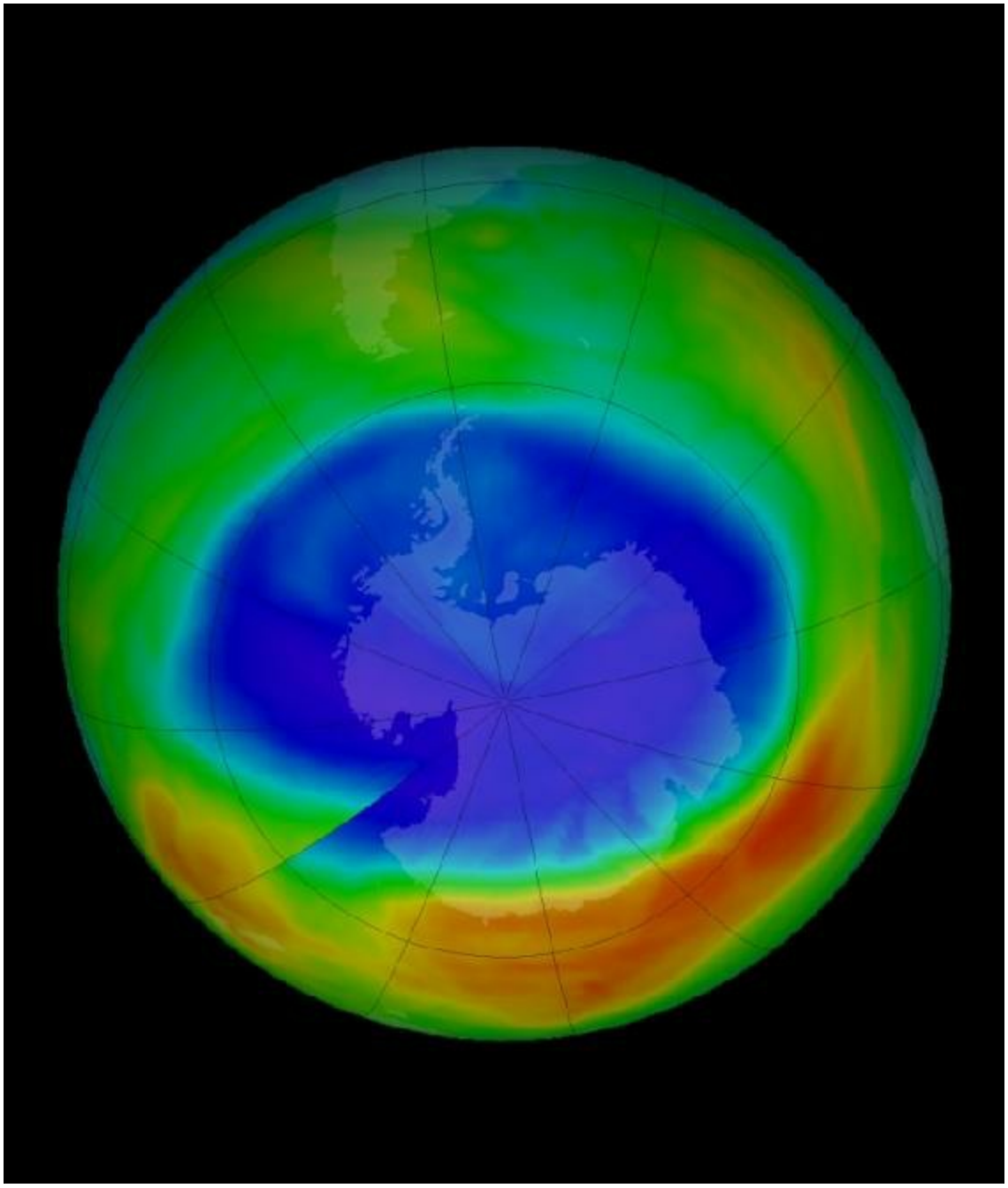
Antibiotic advice The World Health Organization (WHO) has recommended that animal-food industries curb the routine use of antibiotics for growth promotion and disease prevention. Healthy animals should receive the drugs only if others in the same flock or herdare diagnosed with communicable infections, the agency said in guidance published on 7 November. The recommendations were informed by a review of 179 studies; it found that the prevalence of multidrug-resistant bacteria in farmed animals dropped by up to 32% in places that had cut back on antibiotic use (K. L. Tang *et al. Lancet Planet. Health* http://doi.org/cfxh; 2017). The evidence connecting antibiotic restrictions in farm animals to drug resistance in humans was less robust, but hinted at a similar correlation.

Genetic-test rules The US Food and Drug Administration (FDA) is seeking

to loosen its regulation of genetic tests that are marketed directly to consumers, its commissioner, Scott Gottlieb, announced on 6 November. The FDA has proposed a policy that would allow genetic-testing companies to submit a product to the agency for a one-time review; if approved, the company would be allowed to market more tests without further review. The proposal is open for public comment until January. The agency also said that it has decided to exempt from review tests that are used to determine whether potential parents carry disease-causing genetic mutations that could cause an inherited disorder in their children.

CLIMATE

Small ozone hole This year's hole in the ozone layer was the smallest since 1988, NASA said on 2 November. The hole above Antarctica, which opens each September, was unusually small, owing to warm weather in the Southern Hemisphere. At its peak, the area of the hole was almost 2 billion hectares, or roughly two and a half times the size of the contiguous United States. Scientists attribute the shrinkage to natural variation, and not to rapid healing because of human intervention, NASA said. This year, warm air above Antarctica depleted cloud cover, which is where ozone-destroying chemical reactions occur. The hole has been shrinking since the introduction in 1987 of the Montreal Protocol to phase out ozone-depleting chemicals.



Katy Mersmann/NASA Ozone Watch/NASA

PUBLISHING

Censorship in China Springer Nature, one of the world's largest academic

publishers, has stopped readers in China from accessing some of its content. *The Financial Times* reported on 1 November that the publisher had blocked access to more than 1,000 articles from the websites of two of its journals, *The Journal of Chinese Political Science* and*International Politics*. The publishing house, which also owns *Nature*, said that the articles accounted for less than 1% of its content and had been blocked to comply with local Chinese laws. (*Nature*'s news team is editorially independent of its publisher.) The articles included politically sensitive terms such as Tibet, Taiwan and Cultural Revolution. Some in the academic community criticized the decision, which comes two-and-a-half months after UK firm Cambridge University Press blocked access to some articles in China and then swiftly reversed its decision.

Copyright battle The scholarly social network ResearchGate has over the past month disabled public access to 1.7 million papers on its site, according to five scientific publishers who have been tracking its activities. Early last month, the publishers formed a coalition to get ResearchGate to take down papers that breach copyright; two publishers have also filed a lawsuit against the site. The coalition says that the site has since disabled access to around 93% of its copyrighted material, although academics have re-uploaded some papers for public view. The publishers have now sent an undisclosed number of take-down notices to order the removal of remaining infringing content. ResearchGate, which is based in Berlin, declined to comment.

Piracy-site lawsuit The American Chemical Society (ACS) has won a lawsuit against the pirate site Sci-Hub over the website's illicit dissemination of copyrighted research articles. On 3 November, a US court granted the ACS US$4.8 million in damages for copyright infringement and trademark violation. The court also issued an injunction ordering Internet services that are "in active concert or participation" with Sci-Hub, including providers and search engines, to stop facilitating access to the site. Representatives of Sci-Hub, which was launched in 2011, did not appear in court to present their case.

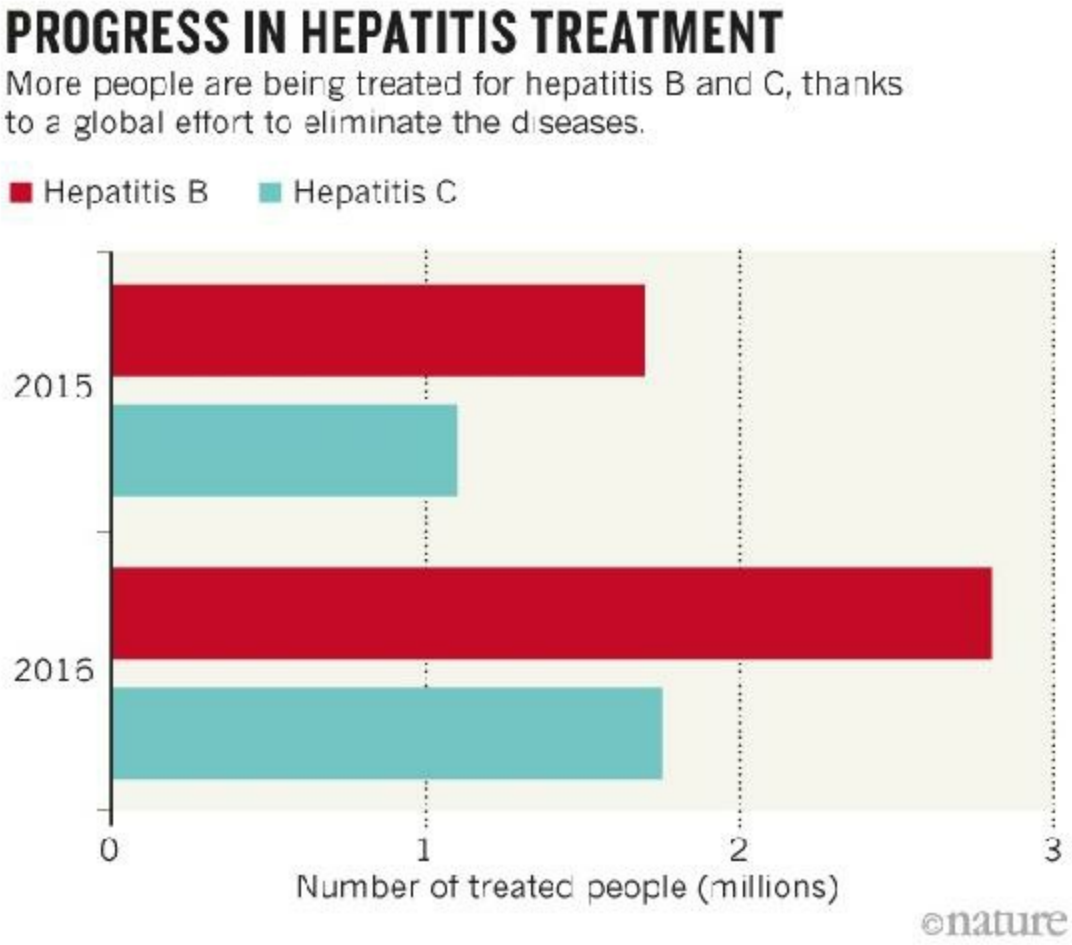
PEOPLE

Nominee withdraws Sam Clovis, the controversial nominee for the post of chief scientist at the US Department of Agriculture, withdrew from consideration on 2 November. The announcement came shortly after Clovis's name surfaced in the ongoing investigation into links between US President Donald Trump's election campaign and Russia. Clovis, a former conservative talk-show host and economics professor, was already a controversial pick for the chief-scientist position, which, by law, must be filled by a distinguished scientist.

Science chair to quit Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, said on 2 November that he will retire when his term expires late next year. The Texas Republican has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. The House of Representatives limits committee chairs to six years in the role, so Smith would have been forced to relinquish his post on the science panel in 2019.

TREND WATCH

The number of people who were able to access treatment for viral hepatitis C grew by some 1.7 million in 2016, a 60% increase over 2015, the World Health Organization (WHO) said on 31 October. A further 2.8 million people were given lifelong treatment for hepatitis B in 2016, a 65% jump over 2015. The WHO estimates that there were between 6 million and 10 million new cases of viral hepatitis B and C in 2015. The agency wants 80% of people diagnosed to be receiving treatment by 2030.



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Dark-matter hunt fails to find the elusive particles

Physicists begin to embrace alternative explanations for the missing material.

08 November 2017

XENON Collab.

Scientists working on the XENON1T experiment are searching for signs of dark matter.

Physicists are growing ever more frustrated in their hunt for dark matter — the massive but hard-to-detect substance that is thought to comprise 85% of the material Universe. Teams working with the world's most sensitive dark-matter detectors report that they have failed to find the

particles, and that the ongoing drought has challenged theorists' prevailing views.

The latest results from an experiment called XENON1T at the Gran Sasso National Laboratory in Italy, published on 30 October[1], continue a dry spell stretching back 30 years in the quest to nab dark-matter particles. An attempt by a Chinese team to detect the elusive stuff, the results of which were published on the same day[2], also came up empty-handed. Ongoing attempts by space-based telescopes, as well as at CERN, the European particle-physics laboratory near Geneva, Switzerland, have also not spotted any hints of dark-matter particles.

The findings have left researchers struggling for answers. "We do not understand how the Universe works at a deeper and more profound level than most of us care to admit," says Stacy McGaugh, an astrophysicist at Case Western Reserve University in Cleveland, Ohio.

Physicists have widely accepted the existence of dark matter since the 1980s as an explanation for why galaxies remain intact rather than flying apart, which would be expected given the amount of observable mass they contain and how fast they rotate. Researchers surmised that halos of invisible dark matter surround galaxies and stabilize them. Physicists grew more confident when dark-matter models successfully predicted the fluctuations detected in an observable echo of the Big Bang, known as the cosmic microwave background.

These observations became the most dramatic evidence for a proposal in the 1980s that dark matter might be formed of weakly interacting massive particles, known as WIMPs. The existence of such particles fits with how physicists think that the Universe evolved, and with the relative abundance of matter. Moreover, the properties of WIMPs would match those predicted by a branch of particle physics called supersymmetry.

The latest round of results seems to rule out the simplest and most elegant supersymmetry theories, casting doubt on the idea that the still-undetected particles are the missing dark matter. If simple supersymmetry theories are no longer viable, scientists say, any WIMP particle has to interact with matter much more feebly than physicists once thought. "It's not a wholesale retreat

from the WIMP paradigm, but it is definitely a change in emphasis," says Dan Hooper, a physicist at the Fermi National Accelerator Laboratory in Batavia, Illinois.

Attitudes are shifting, and physicists are increasingly embracing other possible explanations for dark matter, says David Spergel, a theoretical astrophysicist at Princeton University in New Jersey, who was an early proponent of WIMP models. "These experiments haven't completely closed the window. However, we also need to be thinking about other types of dark matter and new experiments," he says.

Dedicated detectors

It has taken decades to build experiments capable of detecting the minuscule rate at which WIMPs were thought to interact with matter. Only in the past ten years have experiments, carried out at about a dozen laboratories, reached the level of sensitivity needed to detect them. The most sensitive detector in the world is Gran Sasso's XENON1T, which looks for flashes of light created when dark matter interacts with atoms in its 3.5-tonne tank of extremely pure liquid xenon. But the team reported no dark matter from its first run. Neither was there any signal in data collected over two years during the second iteration of China's PandaX experiment, based in Jinping in Sichuan province. Hunts in space have also failed to find WIMPs, and hopes are fading that a once-promising γ-ray signal detected by NASA's Fermi telescope from the centre of the Milky Way was due to dark matter — more-conventional sources seem to explain the observation. There has been only one major report[3] of a dark-matter detection, made by the DAMA collaboration at Gran Sasso, but no group has succeeded in replicating that highly controversial result; renewed attempts to match it are under way.

Future generations of detectors based on the same principle as XENON1T are already in the works, and will be needed if physicists are to finally close the window on WIMPs. But the particles' continuing no-show is making theorists more open-minded and has allowed other theories to gain prominence, says Hooper. Perhaps dark matter consists of exotic axion particles, which are akin to strange, massive photons. Theorists are also

looking at whether dark matter might not interact with known particles at all, but exist in a “hidden sector”, he says.

The looming rejection of the WIMP hypothesis is encouraging for the few physicists who claim that dark matter itself is a red herring. “I hope people will become even more open-minded,” says McGaugh, who has studied modified versions of gravity that negate the need for dark matter. However, Hooper stresses that the fading support for WIMPs does not weaken the case for dark matter, which he thinks will eventually be found. “I’m not worried about the never possibility, but it could be very, very difficult,” he says.

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The bitter battle over the world's most popular insecticides

As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.

08 November 2017

Lucy Hulmes/CEH

Researchers have monitored the health of the red mason bee (*Osmia bicornis-rufa*), which nests in hollow cavities.

Maj Rundlöf remembers the moment she changed her mind about neonicotinoids. In December 2013, in her office at Lund University in Sweden, she and postdoc Georg Andersson were peering at data from their

latest study. It was designed to test what would happen to bees if they fed on crops treated with neonicotinoids — the world's most widely used insecticides. “I didn't expect to see any effect at all, to be honest,” says Rundlöf.

Hives of honeybees (*Apis mellifera*) weren't greatly affected by the chemicals in their pollen and nectar, the study suggested[1]. But the data on bumblebees (*Bombus terrestris*) told a different story. Bumblebee colonies that hadn't fed on the treated crops looked normal: they were packing on weight to survive the winter. But in the colonies exposed to neonicotinoids, the growth chart was a flat line.

When the Swedish study was published in April 2015, it made headlines around the world. It was the first to show that neonicotinoid chemicals — known as neonics — could harm bees in a real-world farming situation.

Bee populations are declining in many parts of the globe, a worrying sign for the crops and wild plants that rely on these pollinators for their survival. Parasites, disease and shrinking food resources are all prime suspects. But a link to neonics has become a major flashpoint.

Even before Rundlöf's results were revealed, the European Union had placed heavy restrictions on the three most widely used neonics in flowering crops — plants that might be attractive to bees — amid rising concerns that the chemicals might harm pollinators. The restricted neonics were imidacloprid and clothianidin, made by agrochemical giant Bayer, and thiamethoxam, made by Syngenta. But farmers, the agrochemical industry and some scientists pointed out that the moratorium was precautionary and based on limited evidence, gathered mostly from lab tests.

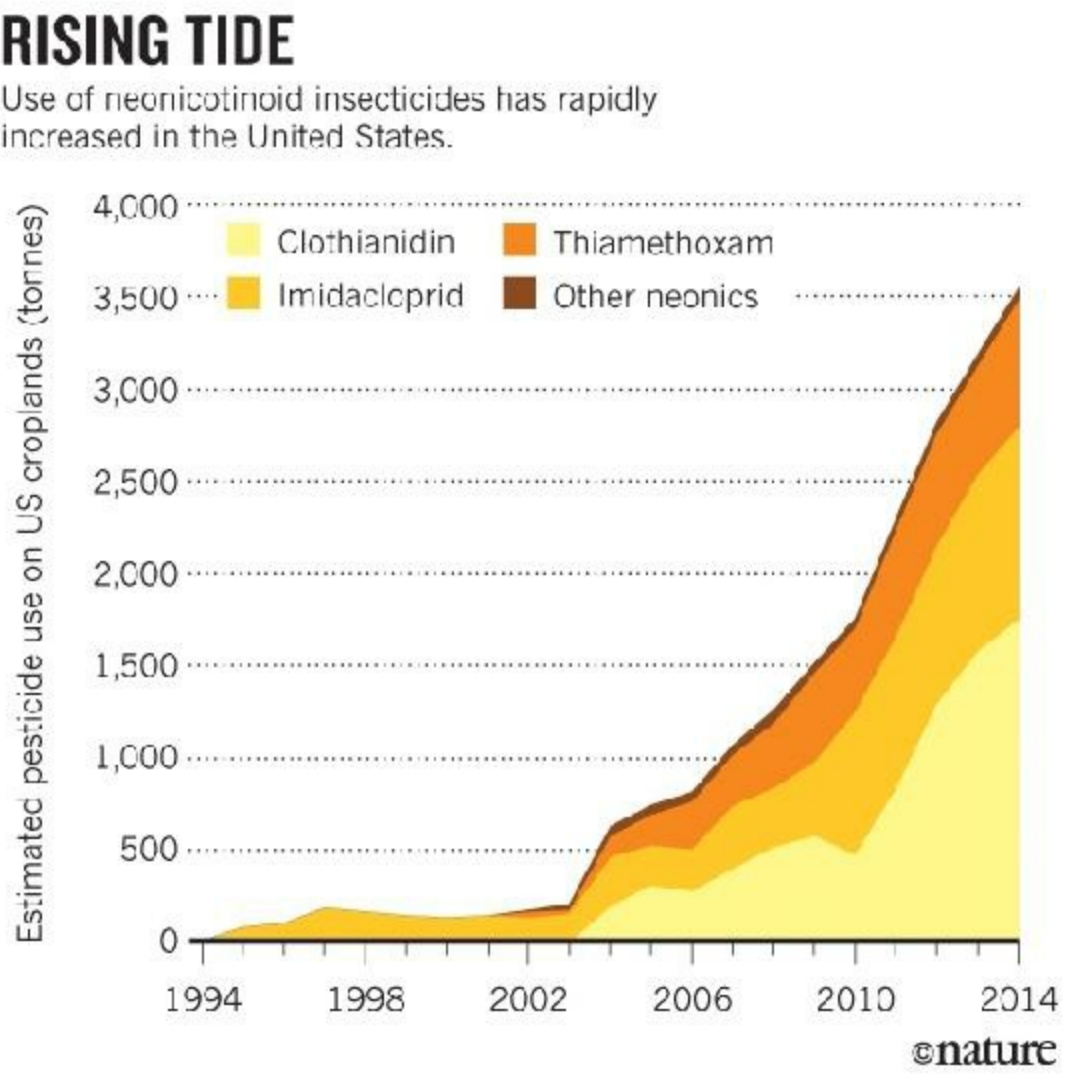
Since Rundlöf's paper, studies showing real-world evidence of harm from pesticides in the field have been mounting — and environmental organizations have demanded wide-ranging bans. Regulatory agencies will soon decide what to do about neonics, which have a global market worth more than US$1.5 billion per year. This month, the EU's European Food Safety Authority is due to complete a re-evaluation of evidence for restricting neonics; the EU will then need to decide what action to take. The US Environmental Protection Agency is expected to complete its own review of

the insecticides next year. France's parliament has passed a law that would ban neonics in 2018, although some exemptions will be allowed.

But industry groups and some scientists say the evidence still isn't conclusive. The picture is complicated: some studies show harm to some bees in some circumstances, whereas others find no harm. The results seem to be affected by many factors, including the species of bee and the kinds of crops involved. Scientists working on the question say the subject has become toxic: any new study is instantly and furiously picked at by entrenched advocates on both sides. Even the results of the largest study on the matter, funded by the agrochemical industry, failed to produce a consensus. Published this year[2], it launched another round of recriminations — including complaints from funders who criticized the paper that they had paid for. Ultimately, it's likely that political or regulatory decisions will settle the matter before opposing parties agree, says Sainath Suryanarayanan, an entomologist and sociologist at the University of Wisconsin–Madison who has studied the bee-health issue. “It is a common pattern for highly contentious and polarized debates,” he says.

The world's favourite insecticide

In the early 1980s, scientists at Nihon Tokushu Noyaku Seizo in Tokyo, an arm of Bayer, started to play around with nithiazine, an insecticide created in California a decade earlier. They discovered a new compound that was more than 100 times as effective at killing crop pests, such as aphids. Named imidacloprid, the chemical was launched onto the market in the 1990s, and it quickly became one of the most widely used insecticides in the world. By the mid-2000s, imidacloprid and similar compounds made up one-quarter of all insecticides (see 'Rising tide'). The compounds damage insects' nervous systems by causing the nerves to fire continually until they fail, eventually leading to death. Many neonics are applied directly to seeds, and are taken up by growing plants. If the plant flowers, the chemicals find their way into pollen and nectar.



Source: USGS/CalPIP

In France, where sunflower seeds coated with imidacloprid came on the market in 1994, beekeepers raised the alarm. They said that their honeybees were failing to make it home after foraging flights, and they pinned the blame on the sunflowers. The concerns triggered a 1999 French ban on imidacloprid-coated sunflower seeds, which continues to this day — although it was based on the precautionary principle, rather than formal proofs of harm, says Axel Decourtye, a researcher at the Institute for Bees in Avignon, France.

Scientists hurried to find those proofs — or evidence that the concern was overblown. Researchers quickly discovered that honeybees fed high doses of neonicotinoids died. And even sub-lethal doses triggered unusual behaviour: exposed honeybees changed their dining habits, foraging less often but for longer periods[3]. Other research showed[4] that neonics act on parts of a bee's brain associated with memory and learning. Honeybees trained to respond to particular scents by sticking out their tongues, for example, performed worse — or failed to learn the task at all — when dosed with a neonic.

At every stage, critics raised new queries about how realistic the experiments were, says Decourtye. “How do we know if the neonicotinoid doses are realistic? Does the effect on the individual have any effect on the colony?”

Out in the field

As work continued in the laboratory, researchers also began to turn to the fields. In 2012, Decourtye and his colleagues published a paper[5] showing that what they called “thiamethoxam intoxication” seemed to interfere with the ability of honeybees to return to their hives after looking for food in a realistic, outdoor setting. Yet that study still dosed bees' food with neonics, rather than allowing them to feed on treated crops.

Around the same time, a UK team found[6] that it was not just honeybees that could be at risk. They reported that colonies of bumblebees exposed to “field-realistic” levels of imidacloprid in the lab and then left to grow in field conditions grew slower than controls. They also produced 85% fewer new queens to carry on their line. That work was led by Dave Goulson, a bee researcher now at the University of Sussex in Brighton, UK. In 2006, Goulson had started a charity dedicated to conserving bumblebees, and people began telling him their concerns about neonics. “To start with, I was pretty dubious,” he says. But by 2014, the Task Force on Systemic Pesticides (TFSP) — a group of 30 scientists, including Goulson — announced that it had analysed 800 peer-reviewed studies on neonics and bees, and found “clear evidence of harm sufficient to trigger regulatory action”[8].

Rundlöf's study set out to be the most realistic yet. Her team sowed eight

Swedish fields with oilseed-rape seeds coated in clothianidin, and eight with untreated seeds. They found[1] not only that bumblebee colonies in treated fields grew less well than the controls, but also that the numbers of wild bees in the treated fields fell. Industry spokespeople noted that honeybee colonies weren't affected, and also quibbled with the study — arguing, for example, that the researchers had only placed a small number of wild bees into fields, so findings might not be statistically robust. Rundlöf, however, points out that the researchers also surveyed wild bees flying around, and had the bumblebee-colony data to draw on. “I know we have robust evidence,” she says.

Maj Rundlöf

Researchers examine the health of honeybees during a field study led by Maj Rundlöf in Sweden.

In mid-2017, the largest field study yet — funded with some $3 million from

industry — reported its long-awaited results[2]. Scientists from the Centre for Ecology and Hydrology (CEH) near Wallingford, UK, had put honeybees, mason bees (*Osmia bicornis*) and bumblebees in 33 oilseed-rape fields in the United Kingdom, Germany and Hungary. This time, the seeds, sown in winter, had been coated with either clothianidin or thiamethoxam, or with a neonicotinoid-free pesticide treatment.

The researchers, led by CEH entomologist Ben Woodcock, found that bumblebees and mason bees fared less well the more neonics they were exposed to. The honeybee picture was more complicated: in some cases, neonics seemed to affect bee health, but in others, they didn't. In the United Kingdom and Hungary, neonic compounds seemed to reduce worker-bee numbers in honeybee hives; in Hungary, researchers also saw fewer egg cells in these hives, an indication of reduced reproductive success. In Germany, however, the honeybee hives exposed to neonics had more egg cells — a puzzling result. Overall, the CEH study concluded that neonicotinoids reduced bees' ability to establish new colonies after winter. The journal editor's summary of the paper came under the headline: “Damage confirmed”.

The agrochemical firms that funded the study don't agree. At a press conference in June, when CEH scientists presented their results — without Woodcock, who was overseas — spokespeople from Syngenta and Bayer told reporters that both the study's analysis and its conclusions were questionable. They noted that Woodcock's team had analysed more than 200 pieces of information about honeybees; 9 showed a negative effect from neonicotinoids, whereas 7 were positive. “The one-line simplistic summary conclusion published does not reflect the data presented in this paper,” argued Peter Campbell, an environmental specialist at Syngenta in Reading, UK, in a separate statement released to the media.

Woodcock was incensed by the criticism. In an interview with environmental group Greenpeace, he said that industry had accused him of being a liar. Now, he says, he regrets that choice of words, but he still thinks industry took a blinkered view of the results. “I do feel that the sentiment of what I implied, while inappropriate, was not an unreasonable reaction,” he says. The negative effects were in key areas related to bee health, he says, adding that for

industrial firms to deny that neonics are having an effect on bees is “probably naive”.

Many of the academics *Nature* talked to agree. “I think the majority of researchers highlight that the weakening of bee populations caused by neonicotinoids is proved,” says Decourtye. But not everyone is so certain. “The question of whether the damage to bees is translated to an effect in fields on whole populations of bees is much harder to show,” says Linda Field, head of the department of Biointeractions and Crop Protection at Rothamsted Research in Harpenden, UK. Mature colonies may survive even if individual bees are impaired, because other worker bees compensate, notes Nigel Raine, a biologist at the University of Guelph in Canada. But solitary bees, such as wild bees and queen bumblebees emerging from hibernation, might be at greater risk.

Campbell thinks that many academics are “neutral” on the matter, but are not vocal about it. Studies showing harm to bees tend to garner media attention, and are published in widely read journals, whereas those showing no impact are relegated to less highly cited publications, he says. But Goulson and Woodcock say some of the studies that industry cites as showing no harm are statistically dubious, and more flawed than the headline-garnering trials that show harm.

Christian Maus, global lead scientist for bee care at Bayer in Monheim am Rhein, Germany, picks his words carefully. “I think it is clear and undebated that neonicotinoids do have some intrinsic toxicity to bees,” he says. “But under realistic conditions, as prevailing in the field and agricultural practice, we have not seen any evidence that they would be harming honeybee colonies, for instance, when they are correctly applied.”

Combinatorial effects

Researchers are looking beyond simple relationships between a single pesticide and bee harm. In a 2012 paper[8], Raine and his colleagues showed that exposing bumblebees to a neonicotinoid in combination with a pesticide called a pyrethroid hampered their ability to collect pollen. Colonies exposed

to both compounds experienced higher losses of worker bees than did controls, or colonies dosed with only one. The study was the first to show combinatorial effects, Raine says — which is important, because bees will be exposed to multiple compounds in the wild. And this year, in a paper[9] published alongside Woodcock's, a Canadian team studying honeybee colonies near maize (corn) plants found that the presence of the fungicide boscalid halved the dose of neonics needed to cause death.

That work also suggested that neonic chemicals can migrate away from the plants that they are supposed to protect: by identifying the sources of pollen grains in the hives, the researchers showed that bees were exposed to neonics mainly through pollen from untreated plants. Neonicotinoids are water-soluble — which is how they move from seeds into growing plant tissues. “But that also means they can be washed off the seed, into the soil, and maybe into other plants,” says Christian Krupke, an entomologist at Purdue University in West Lafayette, Indiana.

In one study[10], Krupke found that just 1.34% of clothianidin applied as seed treatment to maize ended up in the crop’s tissues. Neonics that get into the wider environment might cause other, more indirect problems. A 2014 study[11] in the Netherlands, for instance, reported a fall in populations of insect-eating birds in areas with high concentrations of neonicotinoids in the water. It suggested that the chemicals might have depleted the birds’ food resource.

Some researchers are now questioning whether there is any benefit to using neonicotinoids at all. In another study[12], Krupke’s group found no benefits on maize yield from the use of neonicotinoids in Indiana. In this crop, he says, the prophylactic use of neonicotinoids — which are often part of a bundle of pesticides sold pre-applied to seeds — is foolish.

“The way they’re used doesn’t make any sense,” he says. “It only makes sense from one motive. That is the profit motive for the manufacturer.”

Campbell insists that neonicotinoids do provide yield increases, but much of the evidence is proprietary and unpublished. Since the EU neonicotinoid restrictions, Maus says, research suggests there has been a 4% decline in

oilseed-rape yield. Whether or not the restrictions have had any effect, farmers have furiously protested against losing the ability to use neonics. Anecdotal reports suggest many are attempting to compensate by applying increasing amounts of pyrethroids, which are sprayed over crops, rather than applied to seeds; these chemicals may bring their own health risks if used in large quantities, because they are toxic to fish and aquatic insects.

The B word

Regulators in some countries will soon decide whether to take further action to restrict neonics — and here, researchers are split. Some campaign groups, such as Greenpeace and the Pesticide Action Network, have argued for a ban on the use of neonics on all outdoor crops, not just those that might be attractive to bees, such as the bright-yellow flowers of oilseed rape.

“A lot of farmers do fundamentally rely on neonicotinoids,” says Woodcock. And clamping down severely on one chemical might mean that greater amounts of other damaging substances are used. “If people can't use neonicotinoids and they go to other insecticides, is that any better? There are lots of knock-on effects,” says Field.

That concern points to wider doubts about the regulatory systems that allowed agrichemicals such as neonics onto the market in the first place, says Goulson. Many researchers are hesitant to advocate outright bans. Some, such as Rundlöf, say it isn't their job to make policy recommendations. But Goulson says his view has changed as the evidence has mounted. In 2014 — at the time of the TFSP's first synthesis report — he thought that there might be certain situations in which neonics were the best option. But since then, he says, there's been even stronger evidence of collapsing insect populations — and it is hard to regulate partial bans. “I think now I'd vote for a complete ban,” he says.

Whatever regulators do, Goulson says, he is growing increasingly downbeat about the chances of any consensus forming between industry and academia on the issue. “I'm starting to come to the conclusion there will never be a game-changer,” he says. “There is nothing I think any scientist could do at

this point to make people all sit down and have any answer.”

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Four ethical priorities for neurotechnologies and AI

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Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

BSIP/UIG/Getty

A man with a spinal-cord injury (right) prepares for a virtual cycle race in which competitors steer avatars using brain signals.

Consider the following scenario. A paralysed man participates in a clinical

trial of a brain–computer interface (BCI). A computer connected to a chip in his brain is trained to interpret the neural activity resulting from his mental rehearsals of an action. The computer generates commands that move a robotic arm. One day, the man feels frustrated with the experimental team. Later, his robotic hand crushes a cup after taking it from one of the research assistants, and hurts the assistant. Apologizing for what he says must have been a malfunction of the device, he wonders whether his frustration with the team played a part.

This scenario is hypothetical. But it illustrates some of the challenges that society might be heading towards.

Current BCI technology is mainly focused on therapeutic outcomes, such as helping people with spinal-cord injuries. It already enables users to perform relatively simple motor tasks — moving a computer cursor or controlling a motorized wheelchair, for example. Moreover, researchers can already interpret a person's neural activity from functional magnetic resonance imaging scans at a rudimentary level[1] — that the individual is thinking of a person, say, rather than a car.

It might take years or even decades until BCI and other neurotechnologies are part of our daily lives. But technological developments mean that we are on a path to a world in which it will be possible to decode people's mental processes and directly manipulate the brain mechanisms underlying their intentions, emotions and decisions; where individuals could communicate with others simply by thinking; and where powerful computational systems linked directly to people's brains aid their interactions with the world such that their mental and physical abilities are greatly enhanced.

Such advances could revolutionize the treatment of many conditions, from brain injury and paralysis to epilepsy and schizophrenia, and transform human experience for the better. But the technology could also exacerbate social inequalities and offer corporations, hackers, governments or anyone else new ways to exploit and manipulate people. And it could profoundly alter some core human characteristics: private mental life, individual agency and an understanding of individuals as entities bound by their bodies.

It is crucial to consider the possible ramifications now.

The Morningside Group comprises neuroscientists, neurotechnologists, clinicians, ethicists and machine-intelligence engineers. It includes representatives from Google and Kernel (a neurotechnology start-up in Los Angeles, California); from international brain projects; and from academic and research institutions in the United States, Canada, Europe, Israel, China, Japan and Australia. We gathered at a workshop sponsored by the US National Science Foundation at Columbia University, New York, in May 2017 to discuss the ethics of neurotechnologies and machine intelligence.

We believe that existing ethics guidelines are insufficient for this realm[2]. These include the Declaration of Helsinki, a statement of ethical principles first established in 1964 for medical research involving human subjects (go.nature.com/2z262ag); the Belmont Report, a 1979 statement crafted by the US National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research (go.nature.com/2hrezmb); and the Asilomar artificial intelligence (AI) statement of cautionary principles, published early this year and signed by business leaders and AI researchers, among others (go.nature.com/2ihnqac).

To begin to address this deficit, here we lay out recommendations relating to four areas of concern: privacy and consent; agency and identity; augmentation; and bias. Different nations and people of varying religions, ethnicities and socio-economic backgrounds will have differing needs and outlooks. As such, governments must create their own deliberative bodies to mediate open debate involving representatives from all sectors of society, and to determine how to translate these guidelines into policy, including specific laws and regulations.

Intelligent investments

Some of the world's wealthiest investors are betting on the interplay between neuroscience and AI. More than a dozen companies worldwide, including Kernel and Elon Musk's start-up firm Neuralink, which launched this year, are investing in the creation of devices that can both 'read' human brain activity and 'write' neural information into the brain. We estimate that current spending on neurotechnology by for-profit industry is already US$100

million per year, and growing fast.

BSIP/UIG/Getty

After having electrodes implanted in the brain to stimulate neural activity, some people have reported feeling an altered sense of identity.

Investment from other sectors is also considerable. Since 2013, more than $500 million in federal funds has gone towards the development of neurotechnology under the US BRAIN initiative alone.

Current capabilities are already impressive. A neuroscientist paralysed by amyotrophic lateral sclerosis (ALS; also known as Lou Gehrig's or motor neuron disease) has used a BCI to run his laboratory, write grant applications and send e-mails[3]. Meanwhile, researchers at Duke University in Durham, North Carolina, have shown that three monkeys with electrode implants can operate as a 'brain net' to move an avatar arm collaboratively[4]. These devices can work across thousands of kilometres if the signal is transmitted wirelessly by the Internet.

Soon such coarse devices, which can stimulate and read the activity of a few dozen neurons at most, will be surpassed. Earlier this year, the US Defense Advanced Research Projects Agency (DARPA) launched a project called Neural Engineering System Design. It aims to win approval from the US Food and Drug Administration within 4 years for a wireless human brain device that can monitor brain activity using 1 million electrodes simultaneously and selectively stimulate up to 100,000 neurons.

Meanwhile, Google, IBM, Microsoft, Facebook, Apple and numerous start-ups are building ever-more-sophisticated artificial neural networks that can already outperform humans on tasks with well-defined inputs and outputs.

Last year, for example, researchers at the University of Washington in Seattle demonstrated that Google's FaceNet system could recognize one face from a million others. Another Google system with similar neural-network architecture far outperforms well-travelled humans at guessing where in the world a street scene has been photographed, demonstrating the generality of the technique. In August, Microsoft announced that, in certain metrics, its neural network for recognizing conversational speech has matched the abilities of even trained professionals, who have the option of repeatedly rewinding and listening to words used in context. And using electroencephalogram (EEG) data, researchers at the University of Freiburg in Germany showed in July how neural networks can be used to decode planning-related brain activity and so control robots[5].

Future neural networks derived from a better understanding of how real ones work will almost certainly be much more powerful even than these examples. The artificial networks in current use have been inspired by models of brain circuits that are more than 50 years old, which are based on recording the activity of individual neurons in anaesthetized animals[6]. In today's neuroscience labs, researchers can monitor and manipulate the activity of thousands of neurons in awake, behaving animals, owing to advances in optical methods, computing, molecular engineering and microelectronics.

We are already intimately connected to our machines. Researchers at Google calculated this year that the average user touches their phone nearly one million times annually (unpublished data). The human brain controls auditory

and visual systems to decipher sounds and images, and commands limbs to hold and manipulate our gadgets. Yet the convergence of developments in neurotechnologies and AI would offer something qualitatively different — the direct linking of people's brains to machine intelligence, and the bypassing of the normal sensorimotor functions of brains and bodies.

Four concerns

For neurotechnologies to take off in general consumer markets, the devices would have to be non-invasive, of minimal risk, and require much less expense to deploy than current neurosurgical procedures. Nonetheless, even now, companies that are developing devices must be held accountable for their products, and be guided by certain standards, best practices and ethical norms.

We highlight four areas of concern that call for immediate action. Although we raise these issues in the context of neurotechnology, they also apply to AI.

Privacy and consent. An extraordinary level of personal information can already be obtained from people's data trails. Researchers at the Massachusetts Institute of Technology in Cambridge, for example, discovered in 2015 that fine-grained analysis of people's motor behaviour, revealed through their keyboard typing patterns on personal devices, could enable earlier diagnosis of Parkinson's disease[7]. A 2017 study suggests that measures of mobility patterns, such as those obtained from people carrying smartphones during their normal daily activities, can be used to diagnose early signs of cognitive impairment resulting from Alzheimer's disease[8].

Algorithms that are used to target advertising, calculate insurance premiums or match potential partners will be considerably more powerful if they draw on neural information — for instance, activity patterns from neurons associated with certain states of attention. And neural devices connected to the Internet open up the possibility of individuals or organizations (hackers, corporations or government agencies) tracking or even manipulating an individual's mental experience.

We believe that citizens should have the ability — and right — to keep their neural data private (see also 'Agency and identity'). We propose the following steps to ensure this.

For all neural data, the ability to opt out of sharing should be the default choice, and assiduously protected. People readily give up their privacy rights to commercial providers of services, such as Internet browsing, social media or entertainment, without fully understanding what they are surrendering. A default of opting out would mean that neural data are treated in the same way that organs or tissues are in most countries. Individuals would need to explicitly opt in to share neural data from any device. This would involve a safe and secure process, including a consent procedure that clearly specifies who will use the data, for what purposes and for how long.

Even with this approach, neural data from many willing sharers, combined with massive amounts of non-neural data — from Internet searches, fitness monitors and so on — could be used to draw 'good enough' conclusions about individuals who choose not to share. To limit this problem, we propose that the sale, commercial transfer and use of neural data be strictly regulated. Such regulations — which would also limit the possibility of people giving up their neural data or having neural activity written directly into their brains for financial reward — may be analogous to legislation that prohibits the sale of human organs, such as the 1984 US National Organ Transplant Act.

Another safeguard is to restrict the centralized processing of neural data. We advocate that computational techniques, such as differential privacy or 'federated learning', be deployed to protect user privacy (see 'Protecting privacy'). The use of other technologies specifically designed to protect people's data would help, too. Blockchain-based techniques, for instance, allow data to be tracked and audited, and 'smart contracts' can give transparent control over how data are used, without the need for a centralized authority. Lastly, open-data formats and open-source code would allow for greater transparency about what stays private and what is transmitted.

Protecting privacy: Federated learning

When technology companies use machine learning to improve their software, they typically gather user information on their servers to analyse how a particular service is being used and then train new algorithms on the aggregated data. Researchers at Google are experimenting with an alternative method of artificial-intelligence training called federated learning. Here, the teaching process happens locally on each user's device without the data being centralized: the lessons aggregated from the data (for instance, the knowledge that the word 'weekly' can be used as an adjective and an adverb) are sent back to Google's servers, but the actual e-mails, texts and so on remain on the user's own phone. Other groups are exploring similar ideas. Thus, information systems with improved designs could be used to enhance users' ownership and privacy over their personal data, while still enabling valuable computations to be performed on those data.

Agency and identity. Some people receiving deep-brain stimulation through electrodes implanted in their brains have reported feeling an altered sense of agency and identity. In a 2016 study, a man who had used a brain stimulator to treat his depression for seven years reported in a focus group[9] that he began to wonder whether the way he was interacting with others — for example, saying something that, in retrospect, he thought was inappropriate — was due to the device, his depression or whether it reflected something deeper about himself. He said: “It blurs to the point where I'm not sure ... frankly, who I am.”

Neurotechnologies could clearly disrupt people's sense of identity and agency, and shake core assumptions about the nature of the self and personal responsibility — legal or moral.

People could end up behaving in ways that they struggle to claim as their own, if machine learning and brain-interfacing devices enable faster translation between an intention and an action, perhaps by using an 'auto-complete' or 'auto-correct' function. If people can control devices through their thoughts across great distances, or if several brains are wired to work collaboratively, our understanding of who we are and where we are acting will be disrupted.

As neurotechnologies develop and corporations, governments and others start striving to endow people with new capabilities, individual identity (our

bodily and mental integrity) and agency (our ability to choose our actions) must be protected as basic human rights.

We recommend adding clauses protecting such rights ('neurorights') to international treaties, such as the 1948 Universal Declaration of Human Rights. However, this might not be enough — international declarations and laws are just agreements between states, and even the Universal Declaration is not legally binding. Thus, we advocate the creation of an international convention to define prohibited actions related to neurotechnology and machine intelligence, similar to the prohibitions listed in the 2010 International Convention for the Protection of All Persons from Enforced Disappearance. An associated United Nations working group could review the compliance of signatory states, and recommend sanctions when needed.

Such declarations must also protect people's rights to be educated about the possible cognitive and emotional effects of neurotechnologies. Currently, consent forms typically focus only on the physical risks of surgery, rather than the possible effects of a device on mood, personality or sense of self.

Augmentation. People frequently experience prejudice if their bodies or brains function differently from most[10]. The pressure to adopt enhancing neurotechnologies, such as those that allow people to radically expand their endurance or sensory or mental capacities, is likely to change societal norms, raise issues of equitable access and generate new forms of discrimination.

Moreover, it's easy to imagine an augmentation arms race. In recent years, we have heard staff at DARPA and the US Intelligence Advanced Research Projects Activity discuss plans to provide soldiers and analysts with enhanced mental abilities ('super-intelligent agents'). These would be used for combat settings and to better decipher data streams.

Any lines drawn will inevitably be blurry, given how hard it is to predict which technologies will have negative impacts on human life. But we urge that guidelines are established at both international and national levels to set limits on the augmenting neurotechnologies that can be implemented, and to define the contexts in which they can be used — as is happening for gene editing in humans.

Privacy and individuality are valued more highly in some cultures than in others. Therefore, regulatory decisions must be made within a culture-specific context, while respecting universal rights and global guidelines. Moreover, outright bans of certain technologies could simply push them underground, so efforts to establish specific laws and regulations must include organized forums that enable in-depth and open debate.

Such efforts should draw on the many precedents for building international consensus and incorporating public opinion into scientific decision-making at the national level[11]. For instance, after the First World War, a 1925 conference led to the development and ratification of the Geneva Protocol, a treaty banning the use of chemical and biological weapons. Similarly, after the Second World War, the UN Atomic Energy Commission was established to deal with the use of atomic energy for peaceful purposes and to control the spread of nuclear weapons.

In particular, we recommend that the use of neural technology for military purposes be stringently regulated. For obvious reasons, any moratorium should be global and sponsored by a UN-led commission. Although such commissions and similar efforts might not resolve all enhancement issues, they offer the best-available model for publicly acknowledging the need for restraint, and for wide input into the development and implementation of a technology.

Bias. When scientific or technological decisions are based on a narrow set of systemic, structural or social concepts and norms, the resulting technology can privilege certain groups and harm others. A 2015 study[12] found that postings for jobs displayed to female users by Google's advertising algorithm pay less well than those displayed to men. Similarly, a ProPublica investigation revealed last year that algorithms used by US law-enforcement agencies wrongly predict that black defendants are more likely to reoffend than white defendants with a similar criminal record (go.nature.com/29aznyw). Such biases could become embedded in neural devices. Indeed, researchers who have examined these kinds of cases have shown that defining fairness in a mathematically rigorous manner is very difficult (go.nature.com/2ztfjt9).

Practical steps to counter bias within technologies are already being discussed in industry and academia. Such ongoing public discussions and debate are necessary to shape definitions of problematic biases and, more generally, of normality.

We advocate that countermeasures to combat bias become the norm for machine learning. We also recommend that probable user groups (especially those who are already marginalized) have input into the design of algorithms and devices as another way to ensure that biases are addressed from the first stages of technology development.

Responsible neuroengineering

Underlying many of these recommendations is a call for industry and academic researchers to take on the responsibilities that come with devising devices and systems capable of bringing such change. In doing so, they could draw on frameworks that have already been developed for responsible innovation.

In addition to the guidelines mentioned above, the UK Engineering and Physical Sciences Research Council, for instance, provides a framework to encourage innovators to “anticipate, reflect, engage and act” in ways that “promote ... opportunities for science and innovation that are socially desirable and undertaken in the public interest”. Among the various efforts to address this in AI, the IEEE Standards Association created a global ethics initiative in April 2016, with the aim of embedding ethics into the design of processes for all AI and autonomous systems.

History indicates that profit hunting will often trump social responsibility in the corporate world. And even if, at an individual level, most technologists set out to benefit humanity, they can come up against complex ethical dilemmas for which they aren't prepared. We think that mindsets could be altered and the producers of devices better equipped by embedding an ethical code of conduct into industry and academia.

A first step towards this would be to expose engineers, other tech developers

and academic-research trainees to ethics as part of their standard training on joining a company or laboratory. Employees could be taught to think more deeply about how to pursue advances and deploy strategies that are likely to contribute constructively to society, rather than to fracture it.

This type of approach would essentially follow that used in medicine. Medical students are taught about patient confidentiality, non-harm and their duties of beneficence and justice, and are required to take the Hippocratic Oath to adhere to the highest standards of the profession.

The possible clinical and societal benefits of neurotechnologies are vast. To reap them, we must guide their development in a way that respects, protects and enables what is best in humanity.

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The catalogue that made metrics, and changed science

08 November 2017

As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.

Alamy

Cataloguers of the Royal Society developed the first record of published scientific research.

In 1830, Charles Babbage had an unusual idea. Exasperated by how little recognition science was getting in England, the computer pioneer and scientific provocateur suggested that quantifying authorship might be a way to identify scientific eminence.

Like many of Babbage's radical ideas, this one persuaded almost nobody, but it eventually proved prophetic. Before the end of the century, listing papers and comparing publication counts had become a popular pursuit among scientific authors and other observers. Within a few decades, academic scientists were coming to fear the creed of 'publish or perish' (see 'Catalogues and counts').

This transformation can inform current debates about the value of algorithms for quantifying scientific credibility and importance. History shows how search technologies and metrics are not neutral tools that simply speed up efforts to locate and evaluate scientific work. Metrics transform the very things that they measure. By changing the reward structure, they alter researchers' behaviour — both how results are communicated and which topics receive the most attention.

But there is a second, more subtle, transformation that we must be alert to. The processes by which scientific merit is judged have long been central to the public perception of scientific authority. As these processes change, we must also consider the ways in which broader cultural beliefs about scientific expertise are transformed.

Broken pieces of fact

Babbage's suggestion to count authors' papers was met with various criticisms. One author did the calculation for each fellow in the Royal Society in London, and showed that this was a terrible guide to scientific eminence. Another pointed out[1] that “a far more satisfactory criterion” would have been “the value of those papers”.

Back then, scientific reputations were built not on periodicals but on books and other proofs of genius that demonstrated mastery of a subject. Babbage himself had little respect for most scientific journals, and he limited his proposal to counting papers in the venerable *Philosophical Transactions of the Royal Society of London*. As late as 1867, the British physiologist Michael Foster, in a retrospective written on the life of Karl von Baer, heaped praise on the embryologist's multivolume masterwork, *On the Development*

of Animals, and dismissed his periodical publications. These, Foster claimed[2], were just “specimens of those broken pieces of fact, which every scientific worker throws out to the world, hoping that on them, some time or other, some truth may come to land”.

Alamy

But things were beginning to change. A young engineer working for the US

Coast and Geodetic Survey (now the National Geodetic Survey) had suggested that it would be useful if some catalogue could be devised to keep track of the publications of European scientific societies. Once the idea crossed the Atlantic and percolated up to the Royal Society, its scope grew to become a list of all periodical papers containing original scientific research published since 1800. Some questioned the need to preserve so much insignificant writing. The physicist William Thomson (later Lord Kelvin) warned that the project would lead the society to financial ruin.

The main argument for what would become the *Catalogue of Scientific Papers* was that periodical publishing was a mess. Although many authors published in the journals of scientific societies, vast quantities of valuable information appeared in popular-science magazines, encyclopaedias and general-interest weeklies. Authors distributed huge numbers of offprints that sometimes did not even make clear what journal they had come from.

When the society's indexers got down to work in 1867, they realized that the situation was worse than they'd imagined. For thousands of papers, they couldn't even figure out who the author was. Many who published in periodicals chose to remain anonymous, or signed only their initials. In other cases, it was hard to tell to what extent the writer of a paper was responsible for its contents, or whether another person ought to be credited. Moreover, vast numbers of papers were published in various forms in different periodicals, and it was no easy matter deciding what should count as the same publication. Today, such publishing habits would probably lead to accusations of misconduct; not very long ago this was business as usual.

The Royal Society's cataloguers did what they could, contacting editors and authors to match names to papers. They turned a significant portion of the society's library into a bibliographic workroom, and made their job simpler by excluding all general-interest periodicals from the search, as well as anything that smacked of reading for non-specialists. They compiled lists of which periodicals ought to be included in the count, and circulated them to other experts and academies for feedback. The decision about whether to index some doubtful titles sometimes made it all the way to the society's council for a vote.

As their work progressed, the directors of the project came to realize that

their charge to produce a master list of all 'scientific papers' published since 1800 might actually influence publishing practices in the future. They hoped that authors would be more careful about where they published — or at least sign their contributions[3]. They probably did not anticipate the full consequences of what they were about to unleash.

Counting what counts

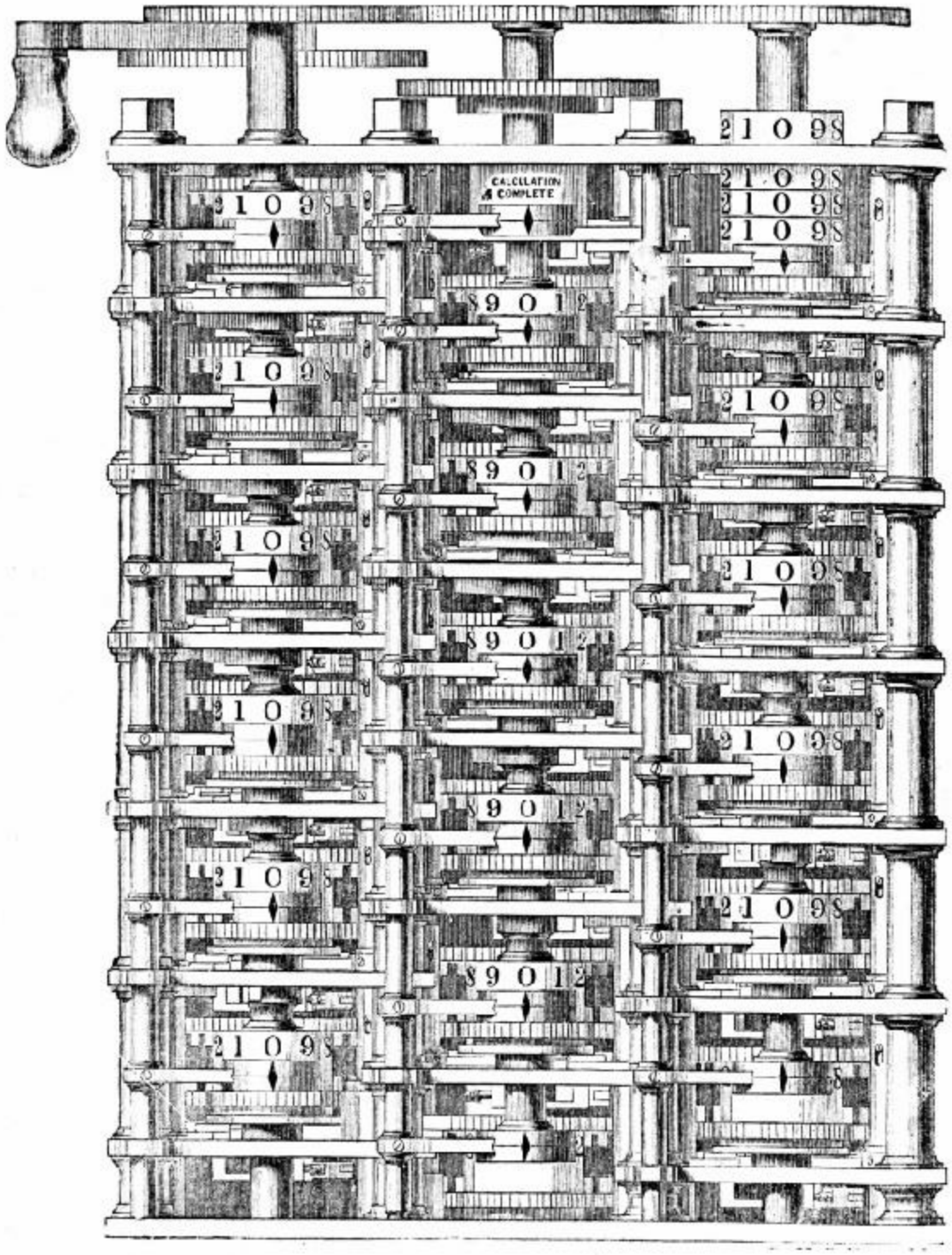
When the first volumes of the *Catalogue of Scientific Papers* appeared at the end of 1867, reaction across Europe and the United States was swift and wide-ranging. One observer wrote in awe that the catalogue made science look like a coral-island, a majestic edifice that grew imperceptibly larger with the addition of each new fact embodied in each paper. Some were less enthusiastic. One Royal Society fellow complained that the editors had distorted “the progress and history of discovery both in Physical and Natural Science” by excluding so many valuable contributions from “journals not professedly scientific”, accounts of scientific voyages, independently published treatises, encyclopaedia articles (which at the time often included original research), and much more[4].

Many observers hurried over the prospect of how helpful the catalogue would be for finding information and began comparing the productivity of individuals. By quantifying the contributions of each author, the catalogue seemed tailor-made for keeping score. A writer in *Nature* got down to business[5]: “Dr. Hooker appears for 58 papers; his late father for 72; and the late W. Hopkins, who did so much in mathematical geology, for 33 .... the indefatigable Isaac Lea, of Philadelphia, for 106, mostly about shells...”. And so forth. In a detailed review in a Viennese newspaper, the mineralogist Wilhelm von Haidinger began by urging prudence, warning that the mere comparison of numbers was no basis on which to make judgements of value[6]. But even he admitted that the numbers were somehow irresistible. Within two years, von Haidinger had taken his numerical analysis further. He published a study based on the catalogue that included a chart that compared the number of highly productive scientific authors in each region of Europe, lamenting the low position of Austria according to this ranking[7].

Such enthusiasm for counting had practical consequences. Within a decade of those first volumes appearing, the forms submitted by candidates for admission to the Royal Society transformed into long lists of papers. By the early 1870s, obituaries and biographical encyclopaedias were routinely noting the number of papers written by a researcher, and even following the chronology sketched out by those papers as guide-posts to a career. By 1900, even Foster, the physiologist once so sceptical of scientific periodicals, had changed his tune. Original science belonged in periodicals, he explained. Putting new findings in books — as Charles Darwin had famously done — was “out of place and even dangerous”[8]. To be an expert on scientific subjects meant being an author of scientific papers.

Publish or perish

There is a direct line from these developments to twentieth-century worries about scientific publishing going off the rails. A letter to *Nature* in 1932 lamented the growing practice of candidates submitting a “list of strictly technical publications” to the Royal Society, leading to the result that “our journals are filled with masses of unreadable trash” published by ambitious scholars hoping to strengthen their applications[9].



Alamy

Charles Babbage, inventor of the difference engine, was an advocate of counting papers.

This was around the same time that the phrase publish or perish began to circulate in academia. It did so first in the United States, where the spread of research universities was turning science into something resembling a profession. The slogan became shorthand for the corrupting influence of narrow, bureaucratic performance measures of research.

In the 1960s, Eugene Garfield launched a radically different search tool, known as the Science Citation Index. He hoped that it might end the harmful culture of publish or perish by showing that some papers were more cited — and hence more valuable — than others.

Immediately, commentators warned that new measures based on citations would only make things worse, leading to a “highly invidious pecking order” of journals that could distort science[10]. The journal impact factor made its public debut in 1972, soon after the US Congress called on the National Science Foundation to produce a better account of the benefits wrought by public funding of science. There is no doubt that the citation index changed practices of scientific publishing, just as the rise of counting papers had followed the introduction of the catalogue before.

Today, advocates of altmetrics argue that well-made algorithms can mimic and aggregate the everyday acts of judgement that researchers make when they read, cite, link or otherwise engage with published research. These algorithms, they claim, will turn out to be as good or better at replicating established processes — such as peer review — that are supposed to delimit what constitutes important and trustworthy research.

Whether or not these claims turn out to be true, they ignore the question of whether we deem the procedures that experts use to evaluate ideas to be intrinsically valuable (that is, independent of the content of those judgements).

Scientific judgement does not happen in a cultural vacuum. The rise of processes such as peer review to organize and evaluate research was never simply about getting scientific judgement right; it was about balancing scientists' expert cultures with public demands for accountability. The *Catalogue of Scientific Papers* was itself part of a cultural moment in which

indexes and card catalogues were celebrated for their potential to set knowledge free and even foster world peace. Interest in altmetrics has grown alongside widespread fascination with the potential of online platforms to make scientific communication both more open and more democratic.

At a time when the public status of the scientific expert is becoming increasingly uncertain, these questions are more important than ever. In a democracy, the procedures by which we decide what constitutes valuable scientific knowledge fundamentally depend on public conceptions of the aims of the scientific enterprise.

The question of whether new metrics might one day replicate the results of peer review (when it is working well) is a red herring. How we choose to judge what constitutes good science is just as important as the end results of those judgements. Even algorithms have politics.

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Further reading

Csiszar, A. *Br. J. Hist. Sci.* **50,** 23–60 (2017).

Comments

Comments

There are currently no comments.

Indian scientists urged to speak out about pseudoscience

Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.

07 November 2017

Pallava Bagla/Corbis/Getty

Scientists taking part in India's march for science in August were protesting against the spread of anti-science beliefs, superstitions and myths.

A leading Indian science-advocacy group is urging the country’s researchers to speak out against pseudoscience, which it fears has gained a foothold in the past few years, partly through support from some agencies of the Indian

government.

The call to arms, made by the non-profit Breakthrough Science Society, comes after some members of an alumni association of the prestigious Indian Institute of Science (IISc), Bangalore, planned a workshop on astrology at the IISc for 25–26 November.

Strong backlash from scientists resulted in the event being cancelled on 28 October. The society's general secretary, Soumitro Banerjee, says that it would be "detrimental to Indian science" for researchers to remain neutral on such issues. "India's scientific community must be proactive in propagating a scientific bent of mind," says Banerjee, a physicist at the Indian Institute of Science Education and Research Kolkata.

Timeline of events

Two days before the alumni association cancelled the workshop, dozens of scientists signed letters to the IISc director, Anurag Kumar, objecting to the workshop. The IISc director and the faculty were not involved in organizing the workshop.

Muthya Ravindra, a computer scientist and president of the alumni association, says that the event, organized by one of its members, was still under discussion when "due to some miscommunications", e-mails promoting the event were sent out.

But Ravindra says that despite criticism from scientists and other academics, people widely believe in astrology and seek its advice in newspapers, magazines and on television. He is unsure what role scientists should play in educating society on the dangers such practices may have. "It is very confusing to me whether we as scientists [should] criticize or take some part in finding a solution," he says.

India's ruling party, the conservative Bharatiya Janata Party (BJP) has shown support for giving astrology a place in universities. In 2001, then-science minister of the BJP-led coalition government Murli Manohar Joshi took steps to allow public universities to include astrology classes in curricula.

However, the Indian government and science ministry did not have a role in the IISc alumni association's planned astrology workshop.

Pseudoscience debate

Alarm in the Indian scientific community over anti-science policies and programmes has been brewing for some time. Several scientists who spoke with *Nature* are reluctant to comment publicly about it for fear of jeopardizing their jobs. Others took part in the March for Science organized by the 7,000-member Breakthrough Science Society in August in around 40 Indian cities, in part to protest the government's support for ideas not yet backed by science. One area of concern, says Banerjee, is the government's push for a national research programme on the health and other benefits of a combination of five cow products, known as panchgavya.

The Indian Institute of Technology (IIT), Delhi, hosted a two-day workshop last December to discuss ways to validate research on panchgavya, which was supported by India's Department of Science and Technology, Department of Biotechnology, and Council of Scientific and Industrial research (CSIR), and inaugurated by India's science minister Harsh Vardhan.

According to IIT Delhi's website, Vardhan, who is a physician, "emphasised that use of panchgavya in practice and in daily routines will help to address the pressing global issues like climate change, resistance development, malnourishment, global health etc".

Following the workshop, India's science ministry formed a national steering committee to initiate a national programme on the topic.

Supporters of this research say that cow products should be considered part of India's vast traditional knowledge base. But critics say that such unverified theories are pseudoscience, and that singling out the benefits of cow products is part of a larger political agenda by Hindus, for whom the cow is a sacred animal.

They also argue that research on topics such as panchgavya should be handled in a neutral manner rather than as a way of promoting traditional

knowledge. Rahul Siddharthan, a computation biologist at the Institute of Mathematical Sciences in Chennai, says that the government must accept that any research involving traditional hypotheses about health could potentially refute those hypotheses. “Refutability is the essence of science,” he says.

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Comments

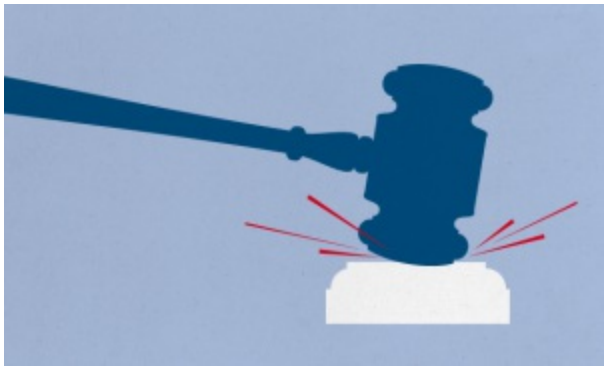
Commenting is currently unavailable.

Pirate paper website Sci-Hub dealt another blow by US courts

American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.

07 November 2017 Updated:

1. 08 November 2017



The American Chemical Society (ACS) has won a lawsuit against the pirate research-paper website Sci-Hub, over the site’s illicit use and dissemination of ACS articles.

On 3 November, a US court ordered Sci-Hub's operators to pay the ACS US$4.8 million in damages for copyright infringement and trademark violation. Sci-Hub’s owners did not appear in court to present their case.

The judge also ordered that any party “in active concert or participation” with Sci-Hub should “cease facilitating” access to the repository. This means that the ACS could request Internet services including web providers, search engines and domain-name registrars to stop linking or to block access to Sci-Hub and the various domains it is hosted under.

Which services might be approached by the ACS isn't yet clear: the meaning of the phrase "in active concert or participation with" is open to legal interpretation, says Michael Carroll, an information-justice and intellectual-property specialist at the American University Washington College of Law in Washington, DC.

There are no clear standards as to when an Internet service is in "active concert" with a pirate website, says Carroll. A user merely resolving a domain-name request to such a site, for example, does not yet qualify as active participation, he adds.

Such an order by a US court is exceptional, Carroll says. "In general, our federal courts do not have the power to issue orders against people or entities that were not part of the lawsuit." But he adds that US federal rules for civil procedures such as this do sometimes allow injunctions against persons who are in 'active participation' with an enjoined party. The current lawsuit is an example of that, he says.

The ruling is another legal blow for Sci-Hub, which provides free access to millions of paywalled research papers and is popular with researchers around the world. In June, a New York court granted the Dutch publisher Elsevier $15 million in damages from the site for large-scale copyright infringement.

But publishers are unlikely to see any money from Sci-Hub because its chief operator lives outside the United States. Alexandra Elbakyan, a former neuroscientist who created the portal in 2011, says the court order is an example of censorship.

The ACS, which filed its lawsuit in June in a Virginia court, said in a statement on 6 November that the ruling was "a victory for copyright law and the entire publishing enterprise". An analysis published in August estimated that as of March 2017, Sci-Hub's database contained 69% of the world's roughly 81.6 million scholarly articles — and 98.8% of the ACS's journal content.

The ACS says that it will now seek to enforce the court's order. Asked for comment, the society referred *Nature*'s news team to its statement. But Internet service providers are expected to resist what they may perceive as

undue censorship.

Attempts to stop people visiting Sci-Hub face another hurdle, too: the site has an alternative address that can be reached by users of the Tor network, a group of servers that encrypts Internet traffic and disguises its origins. No Internet provider can easily block access to such sites.

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Updates

Updated:

The story has been updated with comments from Alexandra Elbakyan.

Comments

Commenting is currently unavailable.

Genetically modified apple reaches US stores, but will consumers bite?

Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.

07 November 2017

Okanagan Specialty Fruits, Inc.

The apple on the right doesn’t bruise when dropped — it lacks a gene encoding an enzyme that causes plant cells to brown on exposure to oxygen.

This month, bags of sliced apples will hit grocery-store shelves in the midwestern United States for the first time. Shoppers who purchase the apples can leave the slices out for snacking, because of a feat of genetic engineering that prevents their flesh from browning when exposed to air.

The ‘Arctic apple’ is one of the first foods to be given a trait intended to please consumers rather than farmers, and it joins a small number of genetically modified organisms (GMOs) to be sold as a whole product, not an ingredient. Since Okanagan Specialty Fruits in Summerland, Canada, planted its first test apples in 2003, the array of foods modified in labs has expanded to include meatless burgers, made with soya protein produced by recombinant yeast, fish fillets grown from seafood stem cells, and mushrooms whose genomes have been edited with CRISPR technology. Most of these items have not yet reached the market.

Now, many small biotechnology companies developing such foods are watching the Arctic apple’s launch, eager for clues to how consumers will perceive the fruits of their labour.

“If the apple sells, it will pave the way for others,” says Yinong Yang, a plant pathologist at Pennsylvania State University in University Park, who used CRISPR to engineer a mushroom that resists browning. He hopes one day to license his mushroom to commercial growers.

Mary Maxon, who oversees biosciences programmes at Lawrence Berkeley National Laboratory in California, agrees. “The apple is not the first GMO that people would eat, but it’s the first one that consumers may value,” she says.

When Okanagan co-founder Neal Carter took over his family’s orchard in 1995, he thought hard about how to win over the US snack market. He found his answer in Australia, where researchers at the Commonwealth Scientific and Industrial Research Organisation had figured out how to delete a gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives.

Only later did he realize that if consumers were to be enticed to buy, Americans’ distrust of GMOs would need to be overcome. Okanagan’s subsequent surveys of people in America’s top apple-growing states — New York and Washington — revealed that about 20% were wary of GMOs. But the company also found that many people changed their minds when told that the apples were engineered to silence browning genes, and then tested for

safety.

Mike Seldon, the co-founder of Finless Foods, a firm in New York City that is developing fish fillets from fish stem cells, agrees that providing more information helps to win over consumers. “We’re not going to repeat the mistakes of the GMO industries in the past, and just put foods on the market without public conversation,” he says. “If we do, you can expect a backlash — and that’s warranted.”

Seldon sees a parallel between the Arctic apple and his fillets: both were created with attributes to please consumers. Finless Foods, which has made prototypes of bluefin-tuna fillets, hopes that people will be won over by the idea of eating fish without worrying about overfishing, animal slaughter or environmental pollution.

But others say that Okanagan hasn’t gone far enough in telling consumers how its apple was made. The company does not mention GMOs on the apples’ bags; instead, the bags have a QR code — which links to online information when it is scanned by a smartphone. “Not everyone has a smartphone, and even if you have one, are you going to check every item with it?” says Bill Freese, a science-policy analyst at the Center for Food Safety, an advocacy group in Washington DC. He wants the apples to be clearly labelled as GMOs.

Consumer reaction isn’t the only concern for developers of genetically engineered or other lab-made foods who want to sell their wares in the United States. One major stumbling block is the US regulatory process, which involves a complicated tangle of federal agencies — and, for many companies, an unclear path forward. US regulators assessed the Arctic apple for five years before approving it for sale, but spent just two years reviewing a non-browning GM potato developed by agricultural firm J. R. Simplot of Boise, Idaho.

Then there is the case of the CRISPR mushroom. The US Department of Agriculture (USDA) said in 2016 that it would not evaluate the mushroom, which was created by using CRISPR to delete a gene. That seemed to clear the fungus’s path to the market. But Yang says that, after *Nature*’s news team reported on the USDA’s decision, the US Food and Drug Administration

contacted him to ask whether it could review the mushroom. “I agreed to that since it would give consumers a peace of mind,” he says.

As far as investors are concerned, regulatory uncertainty may be less of a barrier to the success of engineered foods than customer uncertainty. James Hardiman, a partner at the venture-capital fund Data Collective in San Francisco, California, says that companies developing such foods can always build a few extra years into their long-term plans, to account for twists in the regulatory process. “The public narrative is much more difficult to control,” he says. “We know the public can be irrational.”

Still, Carter is optimistic about how his Arctic apple will be received. “We rarely get e-mails saying we are Satan any more,” he says of his company. “Now we have people asking where they can buy the apples.”

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Comments

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US government approves 'killer' mosquitoes to fight disease

US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.

06 November 2017

Dennis Kunkel Microscopy/SPL

The lab-grown mosquitoes developed by MosquitoMate seek to eliminate the disease-carrying Asian tiger mosquito (*Aedes albopictus*, shown here).

The US Environmental Protection Agency (EPA) has approved the use of a common bacterium to kill wild mosquitoes that transmit viruses such as dengue, yellow fever and Zika, *Nature*'s news team has learned.

On 3 November, the agency told biotechnology start-up MosquitoMate that it could release the bacterium *Wolbachia pipientis* into the environment as a tool against the Asian tiger mosquito (*Aedes albopictus*). Lab-reared mosquitoes will deliver the bacterium to wild mosquito populations.

The decision — which the EPA has not formally announced — allows the company, which is based in Lexington, Kentucky, to release the bacteria-infected mosquitoes in 20 US states and Washington DC.

“It’s a non-chemical way of dealing with mosquitoes, so from that perspective, you’d think it would have a lot of appeal,” says David O’Brochta, an entomologist at the University of Maryland in Rockville.“I’m glad to see it pushed forward, as I think it could be potentially really important.”

MosquitoMate will rear the *Wolbachia*-infected *A. albopictus* mosquitoes in its laboratories, and then sort males from females. Then the laboratory males, which don’t bite, will be released at treatment sites. When these males mate with wild females, which do not carry the same strain of *Wolbachia*, the resulting fertilized eggs don’t hatch because the paternal chromosomes do not form properly.

The company says that over time, as more of the *Wolbachia*-infected males are released and breed with the wild partners, the pest population of *A. albopictus* mosquitoes dwindles. Other insects, including other species of mosquito, are not harmed by the practice, says Stephen Dobson, an entomologist at the University of Kentucky in Lexington and founder of MosquitoMate.

Production challenges

The EPA restricted the release of MosquitoMate’s product, called ZAP males, to 20 states and Washington DC. The agency has previously said that those places “are similar in temperature and precipitation to areas where efficacy of the ZAP males was tested” — Kentucky, New York and California. The EPA decision excludes much of the southeastern United

States, which is home to dense populations of mosquitoes and a long mosquito season, because MosquitoMate did not conduct field trials there.

MosquitoMate plans to begin selling its mosquitoes locally, in Lexington, and will expand from there to nearby cities such as Louisville, Kentucky, and Cincinnati, Ohio. The company will work with homeowners, golf courses, hotels and other customers to deploy its insects, according to Dobson. “Now the work starts,” he says.

The company will have to start small. Suppressing the mosquito population of an entire city is likely to require the weekly production of millions of these mosquitoes. To reach that level, Dobson’s company must find a way to efficiently separate male mosquitoes from females. The company’s technicians now separate them both by hand and mechanically, Dobson says.

Another group that is also developing mosquitoes infected with *Wolbachia* to control wild populations has succeeded in producing large quantities of their insects. Researchers from Sun Yat-sen University in Guangzhou, China, and Michigan State University in East Lansing say they are releasing 5 million *Wolbachia*-infected *A. albopictus* each week in Guangzhou.

The scientists use mechanical sorters to separate males from females, on the basis of size differences at the pupal stage, at more than 99% efficiency, says Zhiyong Xi, a medical entomologist and microbiologist at Michigan State University, who leads the project. They expose the remaining mosquitoes to X-ray radiation at a dose that sterilizes any remaining females, but is too low to affect the males.

Looking ahead

Using lab-grown mosquitoes to kill mosquito pests has been tested extensively in Brazil in recent years. The country has allowed large-scale releases of such mosquitoes in response to an epidemic of the Zika virus that began in 2015. Zika is a mosquito-borne virus that has been linked to severe birth defects, such as abnormally small heads — a condition known as microcephaly. *Aedes aegypti* mosquitoes are thought to be the primary vector

for the virus.

One type of mosquito being tested in Brazil is a genetically modified variety of *A. aegypti* developed by Oxitec in Milton, UK. When the modified male mosquitoes mate with wild females, they pass a lethal gene on to any progeny.

Oxitec has run into challenges when attempting to test its GM mosquitoes in the United States, however. A community in the Florida Keys voted last year against allowing Oxitec to conduct field trials there, although the rest of the county in which the community is located voted in favour of the plans.

By contrast, MosquitoMate has developed and tested a variety of *Wolbachia*-carrying *A. aegypti* mosquitoes in the Florida Keys and Fresno, California, without drawing much public attention. The EPA received only 14 comments during the public-comment period for the Florida trials, and most of them were positive. The company plans to submit an application to the EPA for nationwide release of that species, says Dobson.

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Language patterns reveal body's hidden response to stress

Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

06 November 2017

Carlo Allegri/Getty

Listen in: the words people say may reveal the body's biological response to threat.

Subtleties in the language people use may reveal physiological stress.

Psychologists found that tracking certain words used by volunteers in randomly collected audio clips reflected stress-related changes in their gene expression. The speech patterns predicted those physiological changes more

accurately than speakers' own ratings of their stress levels.

The research, which is published on 6 November in *Proceedings of the National Academy of Sciences*[1] suggests that changes in language may track the biological effects of stress better than how we consciously feel. It's a new approach to studying stress, says David Creswell, a psychologist at Carnegie Mellon University in Pittsburgh, Pennsylvania, and one that "holds tremendous promise" for understanding how psychological adversity affects physical health.

Adverse life circumstances — such as poverty, trauma or social isolation — can have devastating effects on health, increasing the risk of a variety of chronic disorders ranging from heart disease to dementia. Researchers trying to pin down the biological mechanisms involved have found that people who experience these circumstances also undergo broad changes in gene expression in the cells of their immune system. Genes involved in inflammation become more active, for example, and antiviral genes are turned down.

These biological changes seem to represent the body's evolutionary response to threat, says Steve Cole, a genomicist at the University of California, Los Angeles, and a co-author on the paper. But he was always troubled by a "nagging observation": they don't tally well with how stressed people say they are.

Cole wondered whether stress biology is triggered instead by an automatic assessment of threat in the brain, which doesn't necessarily reach conscious awareness. To find out, he and his colleagues teamed up with Matthias Mehl, a psychologist at the University of Arizona, Tucson, who studies how stress affects language.

Stress on speech

The researchers asked 143 adult volunteers in the United States to wear audio recorders, which switched on every few minutes for two days, capturing a total of 22,627 clips. Mehl transcribed any words spoken by the volunteers,

and analysed the language they used.

He was particularly interested in what psychologists call 'function' words, such as pronouns and adjectives. “By themselves they don’t have any meaning, but they clarify what’s going on,” says Mehl. Whereas we consciously choose 'meaning' words such as nouns and verbs, researchers believe that function words “are produced more automatically and they betray a bit more about what’s going on with the speaker”. Mehl and others have found, for example, that people’s use of function words changes when they face a personal crisis or following terrorist attacks.

The researchers compared the language used by each volunteer with the expression in their white blood cells of 50 genes known to be influenced by adversity. They found that the volunteers’ use of function words predicted gene expression significantly better than self-reports of stress, depression and anxiety.

People with more stressed-out gene-expression signatures tended to talk less overall. But they used more adverbs such as 'really' or 'incredibly'. These words may act as “emotional intensifiers”, says Mehl, signifying a higher state of arousal. They were also less likely to use third-person plural pronouns, such as 'they' or 'their'. That makes sense too, he says, because when people are under threat, they may focus less on others and the outside world.

He cautions that more research is needed to test these specific effects, and to assess whether stress influences language, or vice versa. But he suggests that the approach could ultimately help to identify people at risk of developing stress-related disease. Doctors may need to “listen beyond the content” of what patients tell them, he says, “to the way it is expressed”.

Cole suggests that assessing language use could help to test whether interventions aimed at reducing stress really work. Perhaps “you could even ditch self-report stress measures”, he says, and instead listen passively to how trial participants speak.

“Language reflects how people connect with their world, but who would ever have thought that gene expression would be related to language?” says James

Pennebaker, a psychologist at the University of Texas, Austin, who has pioneered research on language and social processes (and has previously worked with Mehl). “It’s such an exciting new way of thinking,” he adds. “I was blown away.”

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Comments

Comments

There are currently no comments.

US government report says that climate change is real — and humans are to blame

Conclusions of climate-change science analysis are at odds with US President Donald Trump’s policies.

03 November 2017

Drew Angerer/Getty

Heat waves are growing more common in many parts of the United States.

From warmer temperatures to more extreme weather, melting glaciers and rising sea levels, humanity is fundamentally changing the planet by pumping

greenhouse gases into the atmosphere, US government scientists said on 3 November in their latest assessment of climate science.

The average global temperature has increased by 1 °C since the pre-industrial era, the 477-page report says — adding that the past 115 years comprise the warmest period "in the history of modern civilization". The analysis warns that temperatures could increase by another 4 °C by the end of the century, with dramatic consequences for humans and natural ecosystems.

The findings are at odds with the policies of US President Donald Trump, who has questioned well-established tenets of climate science and vowed to protect and promote the US fossil-fuel industry. Trump's stances led many scientists to worry that his administration would try to block or tamper with the climate-change assessment, but several scientists who helped to write the document reported no problems.

"We weren't interfered with, and we ended up producing something that I think is of tremendous value," says David Fahey, an atmospheric scientist with the National Oceanic and Atmospheric Administration in Boulder, Colorado, and a coordinating lead author of the analysis.

The climate-science report is the first volume of the fourth National Climate Assessment, a legally mandated analysis of the causes and impacts of global warming that is due in 2018. The second volume focuses on how climate change is affecting life in the United States, from crop yields to property damage from extreme weather. That document was released in draft form, along with a report on the carbon cycle. The US National Academy of Sciences is set to review the latter two documents.

"The science speaks for itself," says Don Wuebbles, a climate scientist at the University of Illinois at Urbana-Champaign and a coordinating lead author of the climate-science report. "It's hard to counteract the basic observations and the truth of the science with any kind of political playing around."

The trio of documents paints a dramatic picture of how global warming is affecting people and communities across the United States. Tidal flooding is accelerating in more than 25 cities along the coasts of the Atlantic Ocean and the Gulf of Mexico. Large forest fires have become more frequent in the

western part of the country, and warmer spring temperatures combined with shrinking mountain snowpack are reducing the amount of water available to the region's cities and farms. As a result, the draft climate-impacts report warns, "chronic, long-duration hydrological drought is increasingly possible before the end of the century".

The climate-science report was released just days before the latest United Nations climate talks kick off in Bonn, Germany. The summit will be the first major meeting of its kind since Trump vowed to pull the United States out of the 2015 Paris climate pact.

Few observers expect the US government's latest set of climate-change analyses to affect how the Trump administration approaches energy and environmental issues. In August, the National Oceanic and Atmospheric Administration disbanded an advisory committee that was intended to help the nation prepare for a warmer climate by translating the findings of the coming climate assessment into guidance for cities, states and industry.

Nor is it clear whether senior Trump administration officials will accept the reports' core scientific conclusions. As recently as March, US Environmental Protection Agency administrator Scott Pruitt said he did not believe that carbon dioxide is a major driver of global warming.

Nonetheless, many scientists and environmentalists lauded the new reports for bolstering the case for more-aggressive action against climate change.

"The full assessment, when it gets published, is going to show that there are palpable impacts that are going to hit every part of the country," says Andrew Light, a senior fellow at the World Resources Institute, an environmental think-tank based in Washington DC. "It's the responsibility of leaders to take note of that and act accordingly."

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Comments

Commenting is currently unavailable.

Energy researcher sues the US National Academy of Sciences for millions of dollars

Rare move stems from a conflict over two journal articles about renewable energy.

03 November 2017 Corrected:

1. 07 November 2017

Eric Thayer/Bloomberg/Getty

Renewable energy, including from wind, is at the heart of a multi-million dollar lawsuit.

A scientific dispute about the future of alternative energy has landed in a US court. Mark Jacobson, an environmental and civil engineer at Stanford University in California, has filed a libel lawsuit against the US National Academy of Sciences (NAS) and a researcher who published a study in the academy's journal that criticized Jacobson's work.

Jacobson, who filed suit in superior court in Washington DC in late September, is seeking damages of US$10 million. He also wants the *Proceedings of the National Academy of Sciences* (*PNAS*) to retract the article it published by mathematician Christopher Clack this year. The NAS and Clack have until late November to respond, according to court documents. Some experts are worried that the lawsuit could dampen scientific progress on renewable energies. But others defend the move, saying researchers should be able to take advantage of all civil avenues in defense of their work.

Jacobson was the lead author of a high-profile *PNAS* paper[1] published in December 2015 making the case that the continental United States could meet nearly 100% of its energy needs using wind, water and solar sources as early as 2050. A rebuttal[2] written by Clack — then at the University of Colorado Boulder — and 20 co-authors, and published in *PNAS* in June 2017, questioned Jacobson's methodology and challenged his conclusions. The authors argued, among other things, that Jacobson's paper overestimated the maximum outputs from hydroelectric facilities and the nation's capacity to store energy produced by renewable sources.

In the lawsuit, Jacobson says that he had alerted *PNAS* to 30 falsehoods and five "materially misleading statements" in Clack's paper before its publication. The complaint states that almost all of those inaccuracies remained in the published version. Jacobson also argues that "the decision by NAS to publish the Clack Paper in PNAS has had grave ramifications" for his reputation and career.

In a letter[3] accompanying Clack's paper in *PNAS*, Jacobson and three co-authors wrote that Clack's criticisms are "demonstrably false". They maintained that their projections regarding hydroelectric power were based

on an assumed increase in the number of turbines and were not a “modeling mistake”.

Conflict resolution

Some observers are disappointed to see the conflict play out in court. The diversity of engineering models that form the basis of long-term energy projections should be celebrated, not litigated, says chemical engineer Daniel Schwartz, director of the Clean Energy Institute at the University of Washington in Seattle. “Bringing this dispute into the court of law, regardless of outcome, is a step towards devaluing the debate of underlying engineering assumptions,” he says.

“This dispute is likely to be most harmful to the scientific community, which has already been subject to lawsuits from groups sceptical of climate change,” says David Adelman, who studies environmental law at the University of Texas in Austin.

Suing a journal over a scientific disagreement is a rare move, says Adil Shamoo, a biochemist at the University of Maryland School of Medicine in Baltimore and editor-in-chief of the journal *Accountability in Research*, which is published by Taylor & Francis. But Shamoo thinks that scientists should be able to sue if they feel that a paper is “reckless” or “malicious”. “I’m a great believer in using all of the avenues of a civil society,” he says.

Shamoo does think that Clack’s paper was “unduly harsh and personal”. He says that “it was not written as if it was part of a scientific dialogue”.

Clack declined to respond to Shamoo’s characterization of his paper, but says that he is disappointed that Jacobson filed the lawsuit. Clack — now chief executive of Vibrant Clean Energy LLC in Boulder — says that his rebuttal paper “underwent very vigorous peer review”, and that the *PNAS* editors had considered Jacobson’s criticisms but found them to be “without merit”.

Jacobson says that he “cannot comment” on the lawsuit. And a spokesperson for the NAS says that “we do not comment on pending litigation”.

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Corrections

Corrected:

A previous version of this story stated that *PNAS* published Clack's article in 2015.

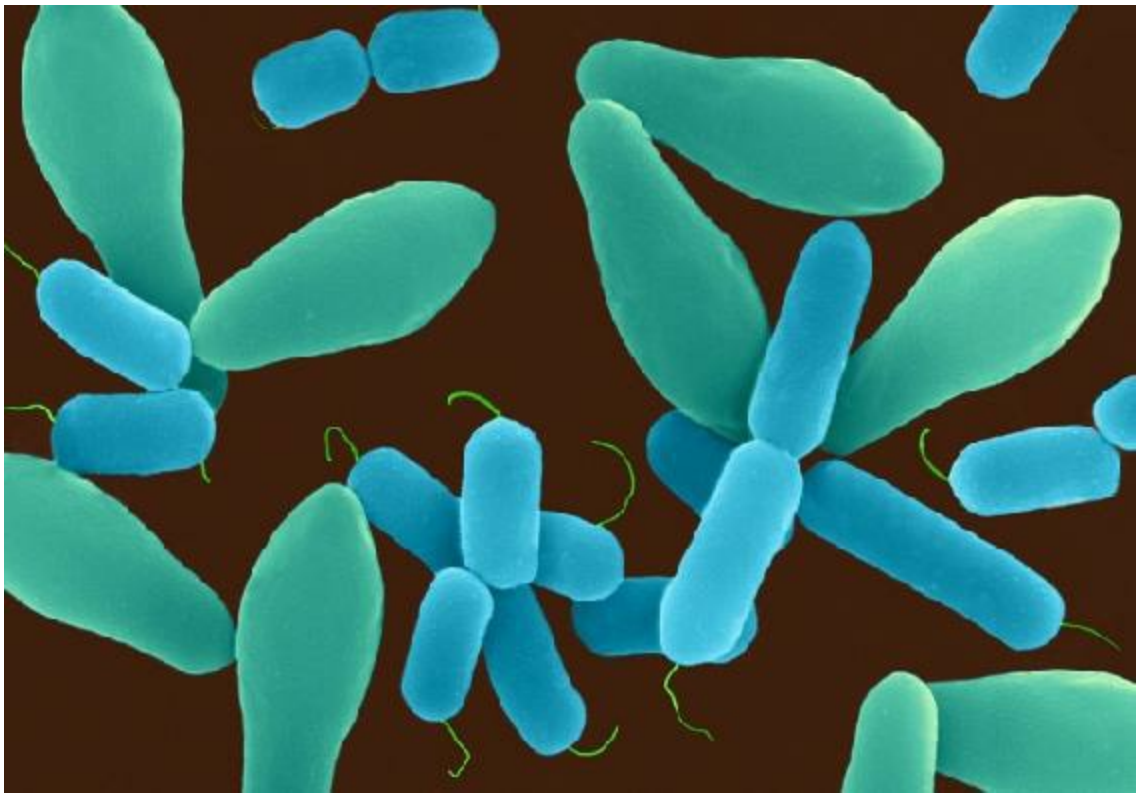
Comments

Commenting is currently unavailable.

Gut microbes can shape responses to cancer immunotherapy

Studies find that species diversity and antibiotics influence cutting-edge treaments.

02 November 2017



Dennis Kunkel Microscopy/SPL

Gut bacteria such as these *Clostridium* could improve a patient's reponse to cancer immunotherapies.

Cancer immunotherapies unleash the body’s immune system to fight cancer, but microbes living in a patient’s gut can affect the outcome of those

treatments, two research teams have found.

Their studies, published on 2 November in *Science*[1, 2], are the latest in a wave of results linking two of the hottest fields in biomedical research: cancer immunotherapy and the role of the body's resident microbes, referred to collectively as the microbiome, in disease.

They also highlight the impact of antibiotics on cancer immunotherapies, particularly drugs that block either of two related proteins called PD-1 and PD-L1. One of the studies found that people treated with antibiotics for unrelated infections had a reduced response to these immunotherapies.

“It raises important questions,” says cancer researcher Jennifer Wargo of the University of Texas MD Anderson Cancer Center in Houston, and an author of one of the studies. “Should we be limiting or tightly monitoring antibiotic use in these patients? And can we actually change the microbiome to enhance responses to therapy?”

The composition and diversity of the microbiome has been linked to everything from mental-health disorders to some side effects of cancer chemotherapy. In 2015, researchers working on mice reported that a specific genus of bacterium in the gut enhanced anti-tumour responses to drugs that target PD-L1[3].

Wargo saw a presentation about the work at a cancer meeting several years ago. “I was floored,” she says. Wargo saw an opportunity to expand the work to humans through her access to clinical samples at MD Anderson.

Exerting influence

Wargo teamed up with epidemiologist Vancheswaran Gopalakrishnan and other researchers to collect faecal samples from more than 100 people with advanced melanoma before they began treatment with anti-PD-1 immunotherapy drugs. The scientists found that those who had the most diverse gut microbes were most likely to respond to the immunotherapy[1]. And tumour growth was reduced in mice that received faecal transplants from

people who responded to immunotherapy.

The type of microbe was also linked to differences in responses to treatment, the researchers discovered. For example, people whose guts contained a lot of bacteria from a group called Clostridiales were more likely to respond to treatment, whereas those who had more Bacteroidales bacteria were less likely to respond.

A second study[2] showed that people who received antibiotics to treat infections shortly before or after starting immunotherapy did not respond as well to PD-1-blocking therapies. The researchers — led by cancer immunologist Laurence Zitvogel and cancer biologist Guido Kroemer, both of the Gustave Roussy Cancer Campus in Villejuif, France — also found that the presence of the bacterium *Akkermansia muciniphila* in both humans and mice was linked to better responses to immunotherapy.

Although it's too early for clinicians to change how they use antibiotics in people with cancer, the work is a step beyond previous studies that relied mainly on mouse models of cancer, says immunologist Romina Goldszmid of the National Cancer Institute in Bethesda, Maryland.

Now, she says, researchers need to learn more about how those microbes exert their influence on the immune system. "What's really missing in the field, rather than knowing who is there and who isn't there, is knowing what the bugs are doing," she says. "We need more information about that."

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Comments

Comments

There are currently no comments.

Cosmic-ray particles reveal secret chamber in Egypt's Great Pyramid

Researchers have used muon detectors to discover a mysterious, 30-metre-long space — which could help to reveal how the 4,500-year-old monument was built.

02 November 2017 Corrected:

1. 06 November 2017

Tomasz Tomaszewski/VISUM creativ/eyevine

A previously unknown chamber has been found in the largest of the pyramids in Giza, Egypt.

Physicists have used the by-products of cosmic rays to reveal a large, previously unidentified chamber inside the 4,500-year-old Great Pyramid in Giza, Egypt. The find is the first discovery since the nineteenth century of a major new space inside the pyramid.

Egyptologists have been quick to dismiss any idea of finding lost treasure in the 30-metre-long void. “There’s zero chance of hidden burial chambers,” says Aidan Dodson, an Egyptologist at the University of Bristol, UK, who studies ancient Egyptian tombs. But experts hope that the finding will lead to significant insights into how this spectacular pyramid was built.

The Great Pyramid was constructed by the pharaoh Khufu (also known as Cheops), who reigned from 2509–2483 BC. Constructed from limestone and granite blocks, and rising to 139 metres, it is the oldest and largest of the Giza pyramids and one of the most impressive structures to survive from the ancient world.

Chamber layout

Whereas other pyramids from this period sit above underground burial chambers, Khufu’s Pyramid contains several large rooms inside the body of the structure itself. These include the King’s chamber, which still holds a stone sarcophagus, the smaller Queen’s chamber and a sloping passageway known as the Grand Gallery.

These large chambers were discovered in the ninth century AD and explored extensively by Western archaeologists in the nineteenth century. But enthusiasts have wondered ever since whether there might be more hidden chambers inside the pyramid, or even whether the king’s real burial chamber is yet to be found.

“There are so many theories — nice ones but also crazy ones,” says Mehdi Tayoubi, president of the Heritage Innovation Preservation institute in Paris. So, he co-founded an international collaboration called Scan Pyramids to find out; the project was supervised by the Egyptian Ministry of Antiquities. The

group is “agnostic” about particular theories, he says, but is using non-invasive technologies to search for hidden chambers.

ScanPyramids

Researchers placed muons detectors inside and outside the pyramid to find ou whether theories of a hidden space in the Great Pyramid were true.

To see through the Great Pyramid, the researchers used a technique developed in high-energy particle physics: they tracked particles called muons, which are produced when cosmic rays strike atoms in the upper atmosphere. Around 10,000 muons rain down on each square metre of Earth’s surface every minute. Sensitive muon detectors have been developed for use in particle accelerators, but they have also been used in the past decade or so to determine the inner structures of volcanoes and to study the damaged nuclear reactor at Fukushima, Japan.

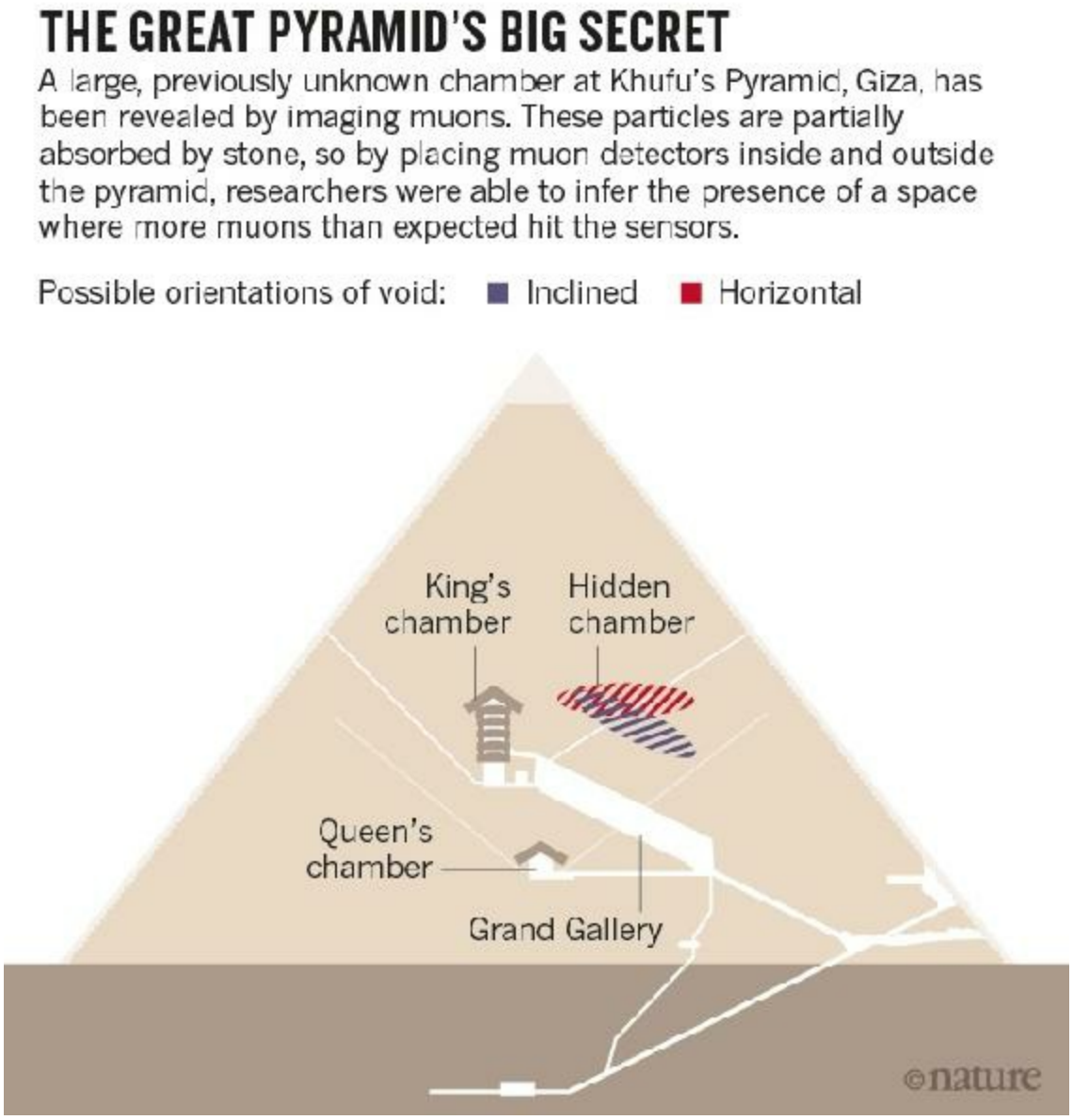
Muon maps

In December 2015, physicist Kunihiro Morishima of Nagoya University, Japan, and his colleagues placed a series of detectors inside the Queen's chamber, where they would detect muons passing through the pyramid from above. The particles are partially absorbed by stone, so any large holes in the pyramid would result in more muons than expected hitting the detectors.

After several months, "we had an unexpected line", says Tayoubi. To check the result, two other teams of physicists, from the Japanese High Energy Accelerator Research Organization in Tsukuba and the French Alternative Energies and Atomic Energy Commision in Paris, then used different types of muon detector placed in other locations both inside and outside the pyramid.

All three teams observed a large, unexpected void in the same location above the Grand Gallery (see 'The Great Pyramid's big secret'). Their results were reported in *Nature*[1] on 2 November. The space is at least 30 metres long, with a similar cross section to the Grand Gallery. "It was a big surprise," says Tayoubi. "We're really excited."

The chamber could be either horizontal or inclined, the researchers say, and might be made up of two or more smaller spaces. The purpose of the space is unknown, but Tayoubi suggests that it could be "a second Grand Gallery".



With high, corbelled — or stepped — ceilings and mysterious stone benches, the Grand Gallery is “one of the most fantastic rooms constructed in the ancient world”, says Bob Brier, an Egyptologist at Long Island University in Brookville, New York, who co-wrote the 2008 book *The Secret of the Great Pyramid* (Smithsonian). “If there’s another one, that’s real news.”

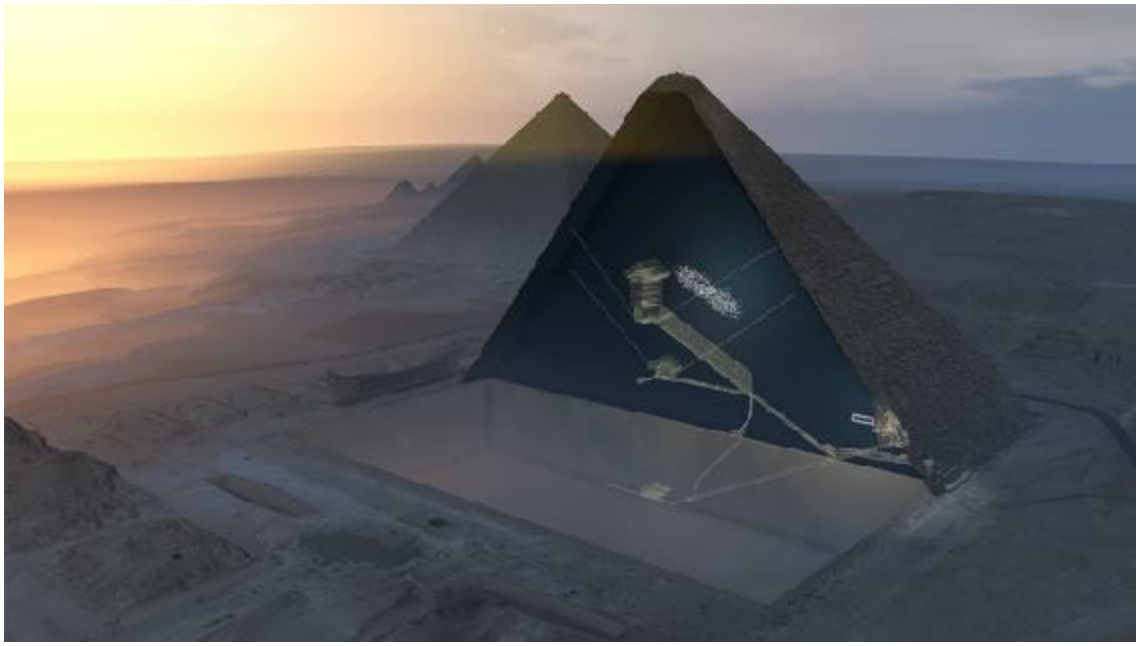
Theories abound

The newly discovered space is unlikely to contain any artefacts relating to the

king’s burial, says Dodson, because there’s already a burial chamber with a sarcophagus in it. Instead he speculates that the space might be a “relieving chamber”, intended to reduce the weight of masonry pressing down on the Grand Gallery. Similar relieving chambers are seen above the King’s chamber and in the pyramid of Khufu’s father, Sneferu, at Meidum, another pyramid site in Egypt.

But Colin Reader, an independent geologist and engineer based in Liverpool, UK, who has studied Egyptian pyramids, suggests that the new chamber is too far from the Grand Gallery to serve this purpose. He wonders whether, just as the Grand Gallery leads to the King’s chamber, the void might lead to another, higher chamber. “You would want to investigate and rule that out,” he says.

Brier has a third theory. In 2007, he and French architect Jean-Pierre Houdin suggested that the Grand Gallery formed part of a huge counterweight system. Weights sliding down the floor of the Grand Gallery could have raised the hefty, granite blocks that comprise the King’s chamber, he says. He speculates that the new space could be part of a second counterweight system higher up.



ScanPyramids

A 3D visualization of the Great Pyramid and its hidden chamber (white dots).

The results also seem to reject the theory, put forward by Houdin and Brier, that the builders of the Great Pyramid used an internal ramp to raise blocks up to the highest levels. “These data suggest that the ramp is not there,” says Brier. “I think we’ve lost.”

Tayoubi says that he next wants to scan Khafre’s (also known as Chephren’s) Pyramid, Egypt’s second largest pyramid. A team led by Nobel-prizewinning physicist Luis Alvarez carried out muon imaging in this pyramid in the late 1960s, using spark chambers as detectors and recording the cosmic-ray data on magnetic tape.

They reported no new chambers in the areas scanned[2]. But technology has improved dramatically since then, points out Tayoubi.

“I think Alvarez was a real visionary guy,” says Tayoubi. “He had the right idea, maybe too early. Our dream would be to give a tribute to Alvarez and redo the Khafre experiment, to see if he was right.”

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Corrections

Corrected:

An earlier version of this story erroneously stated that the Great Pyramid is the oldest of the Egyptian pyramids.

Comments

Commenting is currently unavailable.

Controversial chairman of US House science committee to retire

Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.

02 November 2017

Bill Clark/CQ Roll Call/Getty

Representative Lamar Smith was first elected to the US Congress in 1987.

Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, will retire when his term expires late next year.

Smith, a Texas Republican, has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation (NSF) and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. Since taking the helm of the science committee in 2013, he has transformed it from a relatively deliberative panel into an investigative weapon.

Under the rules of the House of Representatives, which limit committee chairs to six years in the role, Smith would have been forced to relinquish his post on the science panel in 2019. That is one of the reasons he decided against running for re-election, according to news reports; the other is the upcoming birth of his second grandchild. As the news of his retirement made the rounds, many scientists and environmentalists celebrated.

“It is a relief,” says Katharine Hayhoe, director of the Climate Science Center at Texas Tech University in Lubbock. Although many politicians have rejected the conclusions of climate science out of political expediency, she says, Smith has been more aggressive than most.

The congressman has repeatedly tried to reshape the NSF, sponsoring multiple pieces of legislation that would require the agency to justify its grants and explain how they serve the “national interest”. He has also pushed unsuccessfully to scale back programmes in geoscience and social sciences, among other fields.

Smith has notably scrutinized the work of climate scientists. In 2015, he attempted to compel the US National Oceanic and Atmospheric Administration (NOAA) to hand over internal documents related to a climate-change study. The research, published in *Science* in 2015[1], sought to dispel the idea that the rate of global warming had slowed down around the turn of the century. Smith went so far as to accuse a NOAA official — Thomas Karl, who has since retired — of manipulating data to advance an “extreme climate change agenda”.

In 2016, Smith came to the defence of oil giant Exxon Mobil when it was being investigated by the attorneys-general of New York and Massachusetts, who wanted to know whether the firm had misled investors about the

financial implications of global warming. Smith issued subpoenas to the attorneys-general as part of a broader probe, which also targeted environmental groups that have accused Exxon Mobil of suppressing internal research and spreading false information about climate change.

“I think [Smith’s] position on peer review, on the NSF and climate science put him at odds with the science community,” says physicist Neal Lane, a former NSF director who served as science adviser to former president Bill Clinton. “But it was consistent with that of the leadership in the House, which can hardly be described as pro-science.”

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Comments

Comments

There are currently no comments.

Newly discovered orangutan species is also the most endangered

The first new species of great ape described in more than eight decades faces threats to its habitat.

02 November 2017

Maxime Aliaga/SOCP-Batang Toru Programme

Orangutans in Sumatra's Batang Toru forest are now officially a new species: *Pongo tapanuliensis.*

Almost a century after scientists first heard rumours of its existence, an isolated population of orangutans on the Indonesian island of Sumatra has

been confirmed as a new species — just as its habitat faces imminent threats.

The population, estimated at fewer than 800 individuals, inhabits the Batang Toru forest in western Sumatra. A researcher exploring the area in the 1930s wrote of reports of an isolated orangutan population. But it wasn't until biological anthropologist Erik Meijaard, the founder of conservation group Borneo Futures in Jakarta, discovered the paper in the mid-1990s that scientists went looking for the Batang Toru group. Local villagers showed researchers the remains of a female orangutan, and nests in the area confirmed the presence of a population. A male orangutan killed by locals in 2013 provided key evidence: intact tissue and bone.

From the start, scientists noticed that these apes looked different from other orangutans. They had smaller heads, with flatter faces, and their hair was frizzier than that of their cousins living farther north on Sumatra or on the nearby island of Borneo.

Gene gap

Now, genetic tests, field observations and a comparison of the male skeleton against 33 orangutan specimens in museums have revealed that the Batang Toru group is, in fact, a distinct species. Named *Pongo tapanuliensis*, the newly identified great ape is described in *Current Biology*[1] on 2 November by a team that included most of the world's orangutan experts. "It's taken 20 years to come to the realization of what this is," Meijaard says.

Although the genetic analysis of *P. tapanuliensis* relies on a single skeleton, Meijaard says that's not unusual in taxonomy. Many studies, including others he's contributed to, rely on a single piece of evidence, and typically consider only morphology. The latest study shows that the group is distinct not only in morphology, but also in genetics and behaviour, he says.

Matthew G. Nowak

P. tapanuliensis orangutans have smaller heads and flatter faces than their cousins elsewhere on Sumatra and on Borneo.

Russ Mittermeier, executive vice-chair of Washington, DC-based Conservation International and chair of the primate-specialist group at the International Union for Conservation of Nature (IUCN), describes the evidence as “unquestionably” sufficient to support the new species designation. “Although we have had 87 new species of primates described since 2000, this is the first new great ape species since 1929.”

Biruté Mary Galdikas, an orangutan specialist in Los Angeles who founded Orangutan Foundation International, says that the study confirms what she and other orangutan researchers have suspected for decades. “I am not surprised that there is a new species or subspecies of orangutan described from Sumatra,” she says.

Ancestral ties

Key to the determination was tracing the population’s ancestry. Surprisingly, Meijaard says, genetic testing of the Batang Toru skeleton revealed that the population is more closely related to Bornean orangutans, despite living on the same island as the other Sumatran group. That’s probably because of how

orangutans migrated to the region, he says.

All orangutans trace their origins to ancestors that lived on the Asian mainland about 8 million years ago. Those great apes migrated to what is now Sumatra, when sea levels were lower and the lands were connected. Genetic data suggest the Batang Toru species is the closest descendant of those first arrivals.

The other Sumatran orangutans, which live in the island's far north, split off from the Batang Toru group about 3.4 million years ago, modelling based on genetic data suggests. The Bornean orangutans also split from the Batang Toru group, but much later — about 674,000 years ago — which explains why those two populations are more similar, Meijaard says.

Even as Batang Toru's orangutans are named a new species, the animals' long-term survival is uncertain. Previous population analyses suggest there are fewer than 800 individuals, making it the most endangered of the great apes. Although much of its habitat is protected by the Indonesian government, a proposed hydroelectric dam on the Batang Toru river would flood part of the area and divide the population into two, isolating the groups on either side of the river. That's likely to further shrink the gene pool in the already inbred population, Meijaard says. The dam would also bring more people to the area, potentially increasing hunting pressure.

Conservation groups are working with government officials to find an alternative site for the project, says Meijaard. "There is no doubt that conservation efforts are needed immediately," Mittermeier says.

The IUCN primate-specialist group has recently recommended that the species be included on the IUCN Red List of Threatened Species. A decision is expected in December. "It would be bitterly ironic if it goes extinct as a biologically viable population just as it is described as a new species," says Galdikas.

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Comments

Comments

There are currently no comments.

Nature News

周五, 17 11月 2017

Nature News

[周五, 17 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Arecibo telescope wins reprieve from US government** [周四, 16 11月 08:00]
  National Science Foundation will look for partners to provide additional financial support for Puerto Rico facility.
- **Improved diagnostics fail to halt the rise of tuberculosis** [周四, 16 11月 08:00]
  TB remains a big killer despite the development of a better test for detecting the disease.
- **What countries' constitutions reveal about how societies evolve** [周四, 16 11月 08:00]
  Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.
- **Europe sets priorities for hunting cosmic particles** [周四, 16 11月 08:00]
  Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.
- **Hazy skies cool down Pluto** [周三, 15 11月 08:00]
  Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.
- **African scientists get their own open-access publishing platform** [周三, 15 11月 08:00]
  Venture will launch next year and seeks to strengthen continent’s science by helping academics share work more quickly.
- **Puerto Rico struggles to assess hurricane’s health effects** [周三, 15 11月 08:00]
  While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.
- **Bioethics: Justice in genomics** [周三, 15 11月 08:00]
  Rosario Isasi examines a study on the societal impact of grand sequencing projects.
- **Economics: How science got a golden ticket** [周三, 15 11月 08:00]
  Ehsan Masood hails an account of the mixed implications of governments valuing research as an investment.

- **Computer science: Visionary of virtual reality** [周三, 15 11月 08:00]
  Aldo Faisal explores the immersive journey of technology pioneer Jaron Lanier.
- **China fires up next-generation neutron-science facility** [周二, 14 11月 08:00]
  Beam generator puts country in elite company for doing experiments in materials science and other fields.
- **High-jumping beetle inspires agile robots** [周一, 13 11月 08:00]
  Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.
- **Race for quantum supremacy hits theoretical quagmire** [周一, 13 11月 08:00]
  It’s far from obvious how to tell whether a quantum computer can outperform a classical one, says Philip Ball.
- **Archaeologists say human-evolution study used stolen bone** [周一, 13 11月 08:00]
  Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.
- **Lab mice's ancestral ‘Eve’ gets her genome sequenced** [周一, 13 11月 08:00]
  Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.
- **South Africa tackles crime at sea with ship-spotting satellites** [周五, 10 11月 08:00]
  Automated vessel-tracking system aims to spy poachers and smugglers.
- **Resurrected malaria strategy saves thousands of lives in Africa** [周五, 10 11月 08:00]
  Pre-emptively treating kids for malaria is working, despite logistical challenges.

Arecibo telescope wins reprieve from US government

National Science Foundation will look for partners to provide additional financial support for Puerto Rico facility.

16 November 2017

Xavier Garcia/Bloomberg/Getty

The massive dish of the Arecibo radio telescope measures 305 metres across.

Nearly two months after Hurricane Maria devastated Puerto Rico, the people who operate one of the world's pre-eminent radio telescopes — at the Arecibo Observatory, on the northwestern part of the island — are still without reliable water, electricity, and phone service at their homes. But their

jobs appear to be safe.

The US National Science Foundation (NSF), which funds about two-thirds of the observatory's annual US$12-million budget, has decided to continue operating it in collaboration with as-yet-to-be-decided partners. Over the next five years the agency will reduce its annual contribution from $8.2 million to $2 million, with the rest coming from the unspecified partner institutions.

"I'm so happy they made the right decision," says Edgard Rivera-Valentín, a planetary scientist who works jointly at the observatory and the Lunar and Planetary Institute in Houston, Texas. "I'm so happy the observatory stays alive."

The decision comes as part of the NSF's years-long effort to offload several of its astronomical research facilities in order to free up millions of dollars each year for future projects, such as the Large Synoptic Survey Telescope that is under construction in Chile.

"We have worked very hard to help bring Arecibo to a state where we still have cutting-edge research there, but with NSF not having to make the same investment that we've made historically," says James Ulvestad, acting assistant director for the agency's mathematical and physical sciences directorate.

The current management contract at the observatory expires on 31 March 2018. Earlier this year, the NSF asked potential partners to come forward with ideas and funding offers to keep science operations going. Now, with its commitment to continue funding the observatory made official, the NSF can move forward with negotiating a collaboration agreement and revealing who its partners will be.

Slow recovery

The agency's decision is a welcome reprieve for the approximately 120 Arecibo staff who have suffered and rallied in Maria's wake. Hurricane-force winds blasted Puerto Rico on 21 September, downing power lines and damaging buildings across the island. Torrential rains washed out roads and

knocked out water supplies.

At the observatory, which nestles into the limestone mountains above the city of Arecibo, about a dozen staff sheltered in place during the worst of Maria. The observatory's concrete bunkers, built by the US government in 1963, weathered the storm with little problem. Still, Maria's winds tore down the 29-metre-long 'line feed' antenna that stretched across the observatory's 305-metre-wide dish, puncturing its aluminium skin in places.

Staff went to work helping to clear roads around the region, and government officials used the observatory's helipad as a distribution point for supplies. The facility's deep well supplied hundreds of local residents who had no other source of clean drinking water.

Within weeks, the Arecibo dish was cleaned up and back to doing science. On 29 September, it resumed taking observations, in a low-power mode that lets the sky drift across the field of view; on 7 November, it resumed pointing the dish at specific areas of the sky. The telescope has already observed a fast radio burst, one of a new class of astronomical phenomena that Arecibo is well suited to study with its enormous dish.

But telescope operations are still running off of generators, and diesel is a precious commodity on the island, says Nicholas White, senior vice president for science at the Universities Space Research Association in Columbia, Maryland, which helps to manage the observatory. "That's the biggest constraint, just getting back on the grid," he says.

Without a reliable power supply, the observatory cannot re-start its planetary radar, which tracks and characterizes near-Earth asteroids. NASA supplies $3.7 million, about one-third of Arecibo's budget, for this work.

The NSF estimates that it will take between $4 million and $8 million to fix the hurricane damage at the observatory, Ulvestad says. The agency "intends to repair Arecibo to its pre-hurricane condition", he says.

A long history

With today’s decision, Arecibo becomes the first of NSF’s astronomical facilities to have completed a full environmental review of its operations, with an eye to divestment. The agency is working through a similar process to potentially divorce itself from the Green Bank Observatory in West Virginia, home to the world’s premiere single-dish radio telescope, and several other observatories.

Arecibo occupies a unique place in the history of radio astronomy. On this day in 1974, it beamed the most powerful intentional message ever sent in hopes of contacting extraterrestrial life. The same year it was used to discover the first known binary pulsar, whose change in orbital period was the first indirect evidence for gravitational waves, the ripples in spacetime predicted by Albert Einstein.

“People have been telling us for five years, 'You guys are just out to close Arecibo,'” says Ulvestad. “This is a demonstration that that was not what we were ever out to do.”

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Nature
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Comments

Comments

There are currently no comments.

Improved diagnostics fail to halt the rise of tuberculosis

TB remains a big killer despite the development of a better test for detecting the disease.

16 November 2017

Beawiharta/Reuters

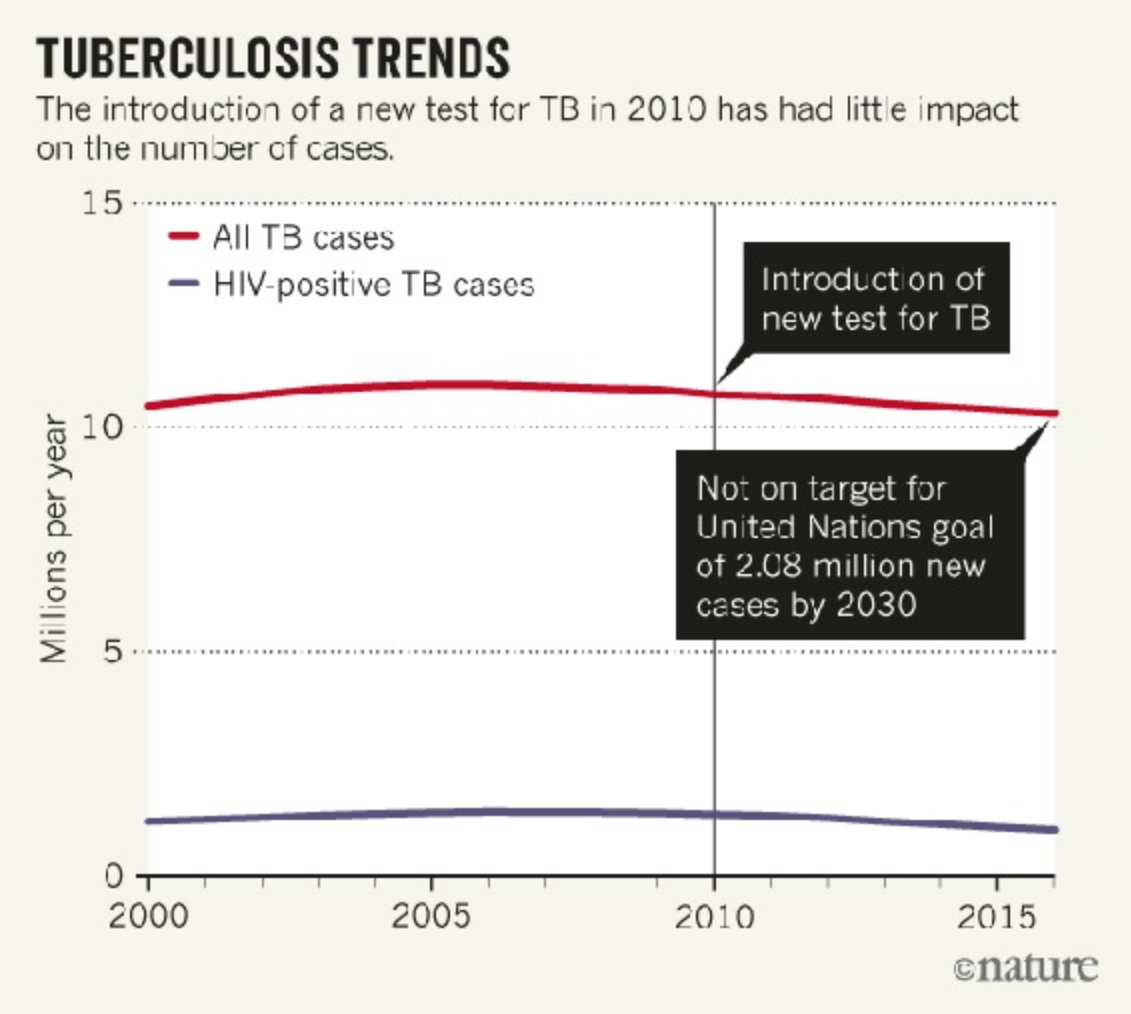
Newly diagnosed tuberculosis patients are treated at a clinic in Jakarta, Indonesia.

Seven years ago, the global community of researchers, health-care workers and activists battling tuberculosis was euphoric. A landmark 2010 trial

showed that a new genetic test was highly effective at diagnosing TB, prompting hopes that countries could soon finally control the disease, which killed 1.45 million that year. The World Health Organization (WHO), promptly endorsed the test, called GeneXpert, and promoted its roll-out around the globe to replace a microscope-based test that missed half of all cases.

But the high hopes have since crashed as rates of tuberculosis rates have not fallen dramatically, and nations are now looking to address the problems that cause so many TB cases to be missed and the difficulties in treating those who are diagnosed. In an attempt to turn the tide, health ministers and officials from 100 countries are meeting in Moscow on 16–17 November. And a United Nations General Assembly devoted to TB is scheduled for September 2018. Experts say that the rollout of GeneXpert offers a cautionary lesson — although, in hindsight, an obvious one — in the battle against TB. The tale is a familiar one in global health care: a solution that seems extraordinarily promising in the lab or clinical trials falters when deployed in the struggling health-care systems of developing and middle-income countries.

“What GeneXpert has taught us in TB is that inserting one new tool into a system that isn’t working overall is not going to by itself be a game changer. We need more investment in health systems,” says Erica Lessem, deputy executive director at the Treatment Action Group, an activist organization in New York City.



Source: WHO

No game changer

Some 10.4 million people were infected with TB last year, according to a WHO report published on 30 October. More than half of the cases occurred in China, India, Indonesia, Pakistan and the Philippines. The infection, which causes coughing, weight loss and chest pain, often goes undiagnosed for months or years, spurring transmission. The US government and others spent more than US$100 million developing GeneXpert. Yet despite the WHO's ringing 2010 endorsement of the test, the roll-out of GeneXpert, which is manufactured by Cepheid, a company based in Sunnyvale, California (and

bought by Danaher, headquartered in Washington DC, earlier this year), was initially slow.

The machines cost $17,000 each and require constant electricity and air-conditioning — infrastructure that is not widely available in the TB clinics of countries with a high incidence of the disease, requiring the machines to be placed in central facilities. Until the US government together with the Bill & Melinda Gates Foundation and UNITAID, an international organization that aims to lower drug prices, began subsidizing tests in 2012, each cost $16.86 (the price fell to $9.98), compared with a few dollars for a microscope TB test.

Weak health systems

The WHO says that more than 23 million GeneXpert tests have now been purchased in the public sector in the 130 countries eligible for the discount. But Madhukar Pai, an epidemiologist at McGill University in Montreal, Canada, says that this still represents a relatively small proportion of people suspected of having TB. Most countries use the tests on selected group of people, Pai says. India, for example, offers the test only to people co-infected with HIV.

Even countries that fully embraced GeneXpert are not seeing the returns they had hoped for. After a countrywide roll-out begun in 2011, the test is available for all suspected TB cases in South Africa. But a randomized clinical trial conducted in 2015 during the roll-out found that people diagnosed using GeneXpert were just as likely to die from TB as those diagnosed at labs still using the microscope test[1]. “Just intuitively one would think that finding TB cases earlier would avert TB deaths. The fact that we didn’t find that was surprising,” says Gavin Churchyard, a physician specializing in TB at the Aurum Institute in Johannesburg, South Africa, who led the study. Similar studies in other countries have come to much the same conclusion about GeneXpert.

Churchyard suspects that doctors have been giving people with TB-like symptoms drugs, even if their microscope test was negative or missing, and

that this helps to explain why his team found no benefit from implementing the GeneXpert test. Others have speculated that, by being involved in a clinical trial, patients in both arms of the trial received better care than they would otherwise have done, obfuscating any differences between the groups.

Either way, Churchyard says, his team's study illustrates how broken South Africa's TB treatment system is, a problem echoed across other countries with high incidences of TB. Even with accurate tests, cases are still being missed. Results from the GeneXpert tests take just as long to deliver as microscope tests, and many people never return to the clinic to get their results and drugs; those who begin antibiotics often do not complete the regimen. "What the study really unmasked was that it's not enough to have new technology and introduce it into a weak health system," Churchyard says.

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Comments

Comments

There are currently no comments.

What countries' constitutions reveal about how societies evolve

Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.

16 November 2017

Bettmann/Getty

The right to form unions usually came before child labour protections in a country's constitution.

Timing can be everything when it comes to successfully expanding constitutional rights. Now, a study[1] looking at how constitutions around the world have evolved has revealed patterns that could help people predict the best moment to introduce such changes.

Amendments are generally introduced into a country's constitution in a certain sequence, the authors report in a paper on the preprint server arXiv, and now under review at a journal. In addition, their computer analyses corroborate previously proposed ideas that the addition of some provisions is heavily influenced by the zeitgeist — the dominant social mores of the time — whereas the adoption of others reflects a country's colonial history.

The study validates computational techniques that could be applied to pressing questions about how constitutions reflect and affect societies, says Mila Versteeg, a legal scholar at the University of Virginia in Charlottesville. "These methods might be able to move the ball if applied to the right questions," she says.

Organizations and advocates could use the results to push for policies in a more strategic way, say the paper's authors. "This can be seen as a road map to help get you to where you want to be," says lead researcher Alex Rutherford, a data scientist who was working at the United Nations children's agency UNICEF in New York City when the study was conducted.

The ties that bind

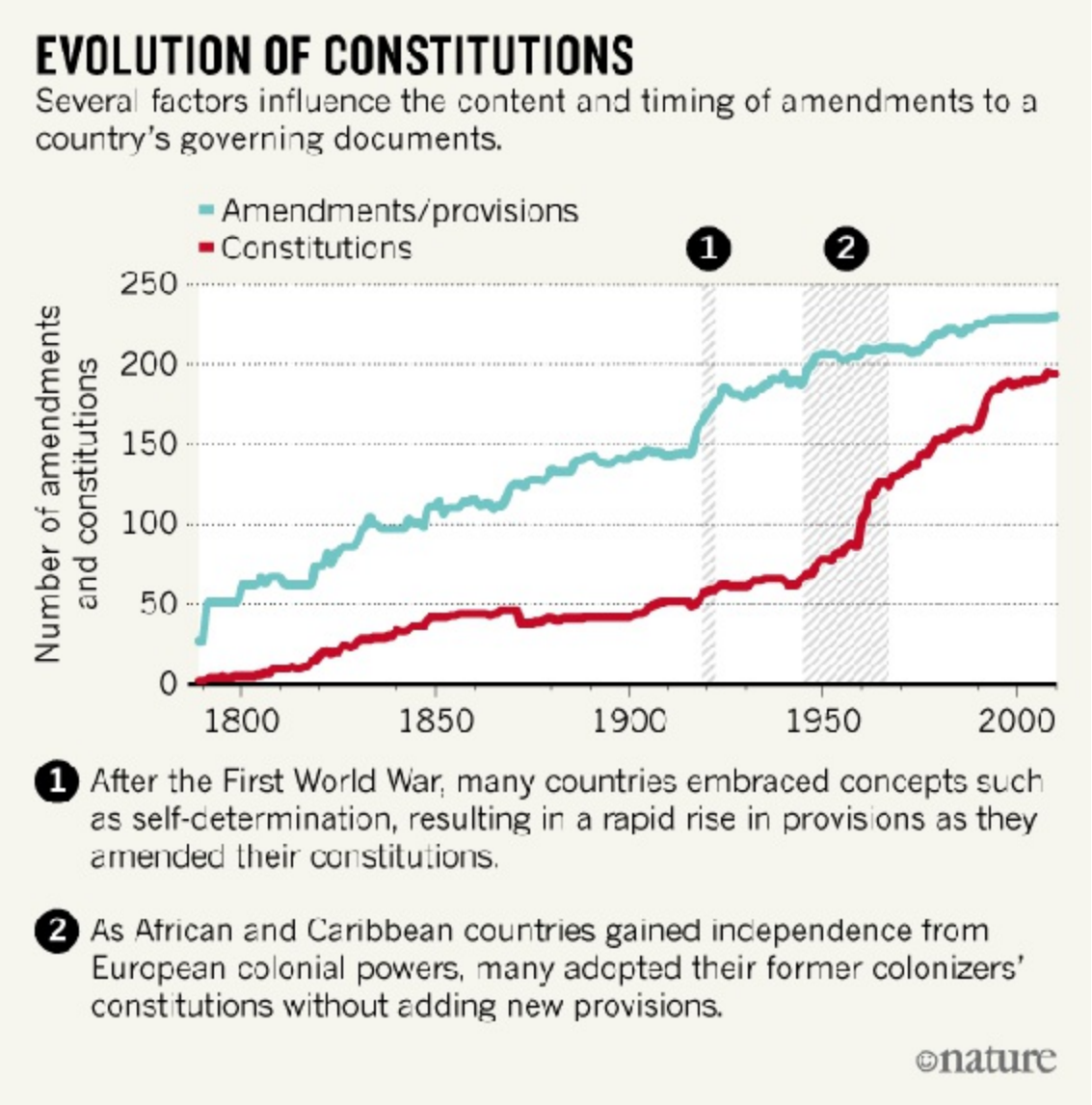
Rutherford and his colleagues used two kinds of computer analyses to look for patterns in provisions from the constitutions of 194 countries. In one, using hand-coded text, they found that the number of provisions increased over time (see 'Evolution of constitutions'). Moreover, the team found that provisions generally appeared in a particular order. Making education compulsory, for example, was usually preceded by the establishment of a right to a free education.

Some of the sequences were less straightforward: the right to form trade unions preceded laws against child labour, for example. This progression

probably reflects the identities of the people who have traditionally scripted constitutions, says Rutherford. Adult men, for instance, seem to have considered their own protections before thinking about others, including those who were unable to push for their own rights, he says. “I think we should protect the most vulnerable first, but this paper says this is not how laws have progressed historically.”

The team then performed a network analysis to identify words that the constitutions had in common and to detect how they grouped together. In some cases, with fundamental provisions such as freedom of religion, clusters included countries that had the same former colonizers.

Meanwhile, amendments such as those prohibiting torture or protecting the environment tended to emerge at specific points in time, regardless of a country’s colonial history. “If you draft a constitution now, you’d be more likely to include a clause on the environment than you would 20 years ago, since we didn’t know much about what was going on back then,” says Rutherford.



Source: REF. 1

Seeds of the future

Constitutional specialists say the team's timeline of provisions seems to be new. "It makes intuitive sense, but I don't think anyone had tried to show it empirically," says David Law, a political scientist at Washington University in St Louis, Missouri. The indexed data that Rutherford and his colleagues used came from the Comparative Constitutions Project, a US-based non-

profit organization partnered with Google. The project hand-codes constitutional texts by turning the words into zeroes and ones.

The credibility of the network approach is boosted by the fact that the analysis of constitutional language came to similar conclusions as previous, less-automated studies. Versteeg suggests that network analysis might next be applied to questions such as what sorts of rights are not well enforced, and whether constitutions can yield subtle clues signalling that a democracy is in decline.

To get at the latter query, Versteeg suggests analysing constitutional texts from democratic countries that have altered their constitutions and become increasingly authoritarian — such as Hungary and Turkey — to find language that gives a ruler more power. Next, researchers could search for these signatures in other countries, such as the United States. “Could we tell when added rights are actually red flags bearing the signs of authoritarianism?” Versteeg asks.

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Nature
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doi:10.1038/nature.2017.23001

Comments

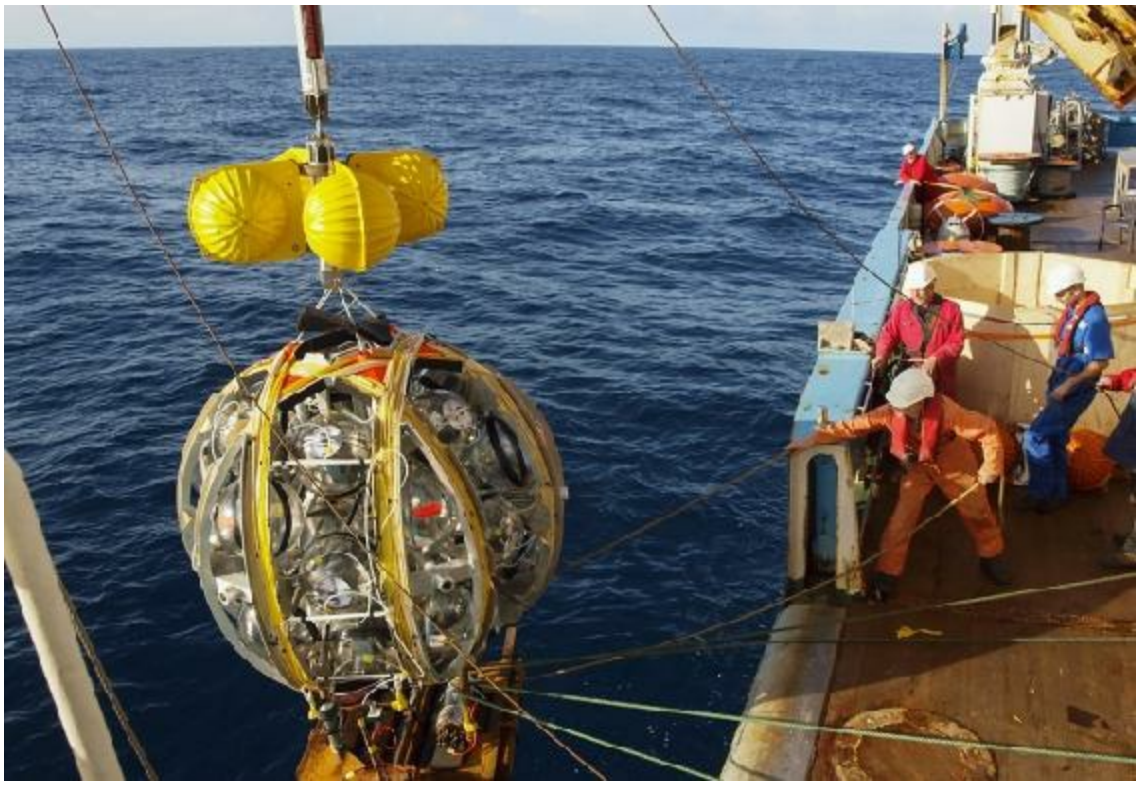
1 comment

1. *thu hien* • 2017-11-17 04:58 AM
   thank you for sharing http://howtoget.wiki/

Europe sets priorities for hunting cosmic particles

Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.

16 November 2017



KM3NeT

The KM3NeT neutrino telescope is deploying arrays of light sensors deep in the Mediterranean Sea.

Neutrinos, dark matter and γ-rays top European physicists' wish list for the next decade of efforts to catch high-energy particles from space. The

priorities are laid out in a roadmap for 2017–26, posted online last month by a group of funding agencies from fourteen European countries, ahead of being officially unveiled in January.

Twenty years ago, the field of astroparticle physics barely existed. But some of the major discoveries in particle physics — including neutrino research that earned Nobel prizes in 2002 and 2015 — are now coming from space-focused detectors, rather than through the more conventional venue of atom smashers. It's a field that ties together the largest and smallest scales of physics, says Antonio Masiero, a physicist at the University of Padua, Italy, from the expansion of the Universe to exotic types of nuclear decay: “The beauty of astroparticle physics is that it has no borders.”

The roadmap is the second such exercise by the Astroparticle Physics European Consortium (APPEC), which aims to coordinate funding plans for this fast-growing field. (CERN — Europe’s physics lab near Geneva, Switzerland — the European Southern Observatory and the European Space Agency do this for the continent’s particle-physics, astronomy and space-based facilities, respectively.) APPEC requested input from across the community, and held an open ‘town meeting’ in Paris in April 2016 before a panel of experts, chaired by Masiero, compiled the final document.

Infrastructure ideals

The resulting strategy covers huge observatories all the way down to tabletop experiments. At smaller scales, it urges funding agencies to be open to innovative proposals. But when it comes to the largest facilities, the strategy is to be “resource aware”, says Masiero: focusing on only a few projects and requiring only a modest increase over current funding levels. It’s not a “Santa Claus list”, agrees Frank Linde, a particle physicist at the Dutch National Institute for Subatomic Physics in Amsterdam and former APPEC chair.

Among the big projects endorsed by APPEC is the Cubic Kilometre Neutrino Telescope (KM3NeT), a double array of deep-sea light sensors being built by a primarily Dutch, French and Italian collaboration. One site, off the coast of Toulon, France, is designed to detect relatively low-energy neutrinos

produced by cosmic rays hitting the atmosphere, whereas the other, off the southern tip of Sicily, Italy, will aim to catch the signature of the highest-energy neutrinos coming from outer space, after they have travelled through Earth. Researchers hope to figure out where these particles come from.

So far, KM3NeT has received one third of the approximately €150 million (US$177 million) in funding it would need for building the full-size detector, says spokesperson Mauro Taiuti, a physicist at the University of Genoa, Italy. The APPEC stamp of approval could help it to win the rest.

Another major piece of infrastructure that garnered support was the Cherenkov Array Telescope, a €300-million γ-ray observatory to be split between Spain's La Palma Island and Paranal, in Chile's Atacama Desert. The two arrays of optical telescopes will seek flashes of blue light produced in the atmosphere when a high-energy photon collides with a molecule of air, creating a cascade of secondary particles across the sky.

In the nascent field of gravitational-wave astronomy, which APPEC also covers, the big priority is the Einstein Telescope (ET), a next-generation triple interferometer that will have light beams running along three 10-kilometre arms in an equilateral triangle, instead of the two perpendicular arms that current detectors use. Like the Japanese interferometer KAGRA — now under construction — the proposed ET would be built underground, to protect it from vibrations ranging from footsteps to falling leaves, says B. S. Sathyaprakash, a physicist at Pennsylvania State University in University Park, who helped to design it.

Dark-matter dash

APPEC also wants Europe to double-down on existing efforts to spot dark matter, calling for a dramatic scale-up of experiments that use tanks of liquid argon and xenon, to look for traces of collisions between these mysterious particles and atoms of ordinary matter. The largest such detectors now contain more than three tonnes of the noble gases, but according to the roadmap they need to be ten times larger.

These searches bet on the theory that dark matter is composed of weakly interacting massive particles, or WIMPs. Some physicists have called for more investment in 'alternative' searches for dark matter, for example, looking for particles known as axions. The road map is a "vanilla document, clearly redacted not to ruffle any feathers", says Juan Collar, a physicist at the University of Chicago in Illinois. "If European programme managers follow this roadmap to the letter, they will turn the dark-matter field into a desert of ideas."

But Mario Livio, an astrophysicist at the University of Nevada in Las Vegas who has also called for broadening the search for dark matter, counters that concentrating efforts on WIMPs will allow Europe "to build on existing experience and facilities". Overall, the roadmap is "very reasonable", he adds. "The programme, if executed as envisioned, will address some of the most exciting questions in astroparticle physics."

Journal name:
Nature
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doi:10.1038/nature.2017.23019

Comments

2 comments

1. *thu hien* • 2017-11-17 06:35 AM
   Wherever there is a gravitational attraction, forget about expansion! block noti group
2. *Pentcho Valev* • 2017-11-16 09:24 PM
   It seems dark matter is the unfortunate result of theoretical impotence: Cosmologists are unable to calculate the rotational curve for a system ESSENTIALLY different from our solar system, e.g. a spiral galaxy, take the solar-system rotational curve as a paradigm and fill the gap between theory and observation with dark matter. Similarly, cosmologists don't know how to model the local interaction between expansion and gravitational attraction (any such model would produce results incompatible with

observations) and implicitly obey the following idiotic slogan: Wherever there is gravitational attraction, forget about expansion! Sabine Hossenfelder: "The solution of general relativity that describes the expanding universe is a solution on average; it is good only on very large distances. But the solutions that describe galaxies are different - and just don't expand. It's not that galaxies expand unnoticeably, they just don't. The full solution, then, is both stitched together: Expanding space between non-expanding galaxies."
https://www.forbes.com/sites/startswithabang/2017/07/28/most-things-dont-actually-expand-in-an-expanding-universe/ Pentcho Valev

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Hazy skies cool down Pluto

Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.

15 November 2017

NASA/JHU-APL/SwRI

The temperature of Pluto's atmosphere is only about 70 degrees Celsius above absolute zero.

Pluto’s atmosphere is even more bone-chillingly cold than one might expect 5 billion kilometres from the Sun. New research suggests that’s because of the smog that envelops the dwarf planet.

“Haze is responsible for all the atmospheric cooling,” says Xi Zhang, a planetary scientist at the University of California in Santa Cruz. He and his colleagues describe the findings in the 16 November issue of *Nature*[1].

When NASA's New Horizons spacecraft flew past Pluto in July 2015, it discovered that the atmosphere was about -203 ºC, just 70 degrees above absolute zero[2]. That's around 30 degrees colder than predicted — and a big mystery to planetary scientists.

Figuring out how Pluto's atmosphere works is crucial for understanding atmospheres on other large icy worlds in the Solar System and beyond. "Until we know the reason for the cold temperatures, we can't extrapolate to other seasons on Pluto, much less other bodies," says Leslie Young, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, who was not involved in the study.

Smog blanket

Pluto's atmosphere is made mostly of nitrogen, with smaller amounts of compounds such as methane. High in the atmosphere — between 500 and 1,000 kilometres above the surface — sunlight triggers chemical reactions that transform some of these gases into solid hydrocarbon particles.

The particles then drift downward and, at around 350 kilometres above Pluto's surface, clump with others to form long chemical chains. By the time they reach 200 kilometres' altitude, the particles have transformed into thick layers of haze, which the New Horizons spacecraft saw dramatically blanketing Pluto.

Zhang and his colleagues compared the heating and cooling effects of the atmosphere's gas molecules to those of its haze particles. Earlier studies have suggested that the presence of gas molecules, such as hydrogen cyanide, could help explain why Pluto's atmosphere is so cold[3]. But Zhang's team found that including haze was the only way to get their model to match the temperatures that New Horizons measured as it flew by the dwarf planet.

"The fundamental difference is the size," Zhang says. Molecules are typically less than a nanometre across, whereas the haze particles are several hundred nanometres across. That means that the gas and the haze behave very differently in the way they absorb and re-radiate energy from the Sun. Haze

turns out to both heat up and cool down more efficiently than gas, Zhang says.

“It is a neat idea,” says Sarah Hörst, a planetary scientist at Johns Hopkins University in Baltimore, Maryland.

Scientists probably hadn't thought about haze as the cooling culprit before because the haze layers do not block light, says Tanguy Bertrand, a planetary scientist at the Laboratory for Dynamic Meteorology in Paris who has studied Pluto's atmosphere with his colleague François Forget[4]. “I find this study very convincing,” Bertrand says.

Competing ideas

But other researchers have proposed different ideas about why Pluto’s atmosphere is so cold. Roger Yelle, a planetary scientist at the University of Arizona in Tucson, reported one such approach at a conference in Latvia in September. His team’s model suggests that a combination of hydrogen cyanide, acetylene and ethane gas can cool things down. All three gases are known to exist in Pluto’s atmosphere.

Zhang’s team and Yelle’s team have yet to reconcile their contradictory conclusions. But after it launches in 2019, NASA’s James Webb Space Telescope could test Zhang's proposal. If the haze particles are indeed the main factor cooling Pluto’s atmosphere, they would make the dwarf planet appear relatively bright in mid-infrared wavelengths. Zhang hopes to observe Pluto with the Webb telescope to see if his team is right.

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Nature
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doi:10.1038/nature.2017.22996

Comments

1 comment

1. *thuy lien* • 2017-11-17 06:36 AM
   The article is great, there is a lot of useful information. Thank the author very much. http://howtoget.wiki/

African scientists get their own open-access publishing platform

Venture will launch next year and seeks to strengthen continent's science by helping academics share work more quickly.

15 November 2017

Africa's academy of science has announced that it will launch an open-access publishing platform early next year — the first of its kind aimed exclusively at scientists on the continent.

The platform, called *AAS Open Research* and announced by the African Academy of Sciences (AAS) in Nairobi on 15 November, is being created with the London-based open-access publisher F1000, adopting the model of its *F1000Research* publishing platform. *AAS Open Research* will publish articles, research protocols, data sets and code, usually within days of submission and before peer review. F1000 staff will arrange post-publication peer review: the reviews and the names of their authors will be published alongside the papers. The papers will be indexed in abstract databases such as PubMed only after they pass review.

The AAS says that the platform will be especially useful for young African academics, who can face difficulties publishing in overseas journals. Some studies suggest[1] that research from low-income countries is perceived differently from that done in high-income ones, for instance. The portal will cut the time and effort scientists have to put into finding homes for their work, and will make the review process more transparent, the academy says.

Although there are already open-access publishers that focus on Africa, such as AOSIS Publishing, based in South Africa, *AAS Open Research* will be the first to adopt open peer review.

The new platform does carry a caveat, however: it will initially take submissions only from AAS fellows and affiliates (who together number around 400), as well as researchers funded through programmes managed by the Alliance for Accelerating Excellence in Africa. The Nairobi-based body manages grants for African research programmes that come from international funders, mostly targeting health research but also areas such as climate change.

Limiting eligibility to the platform is critical to ensure that submissions are of high quality, says AAS executive director Nelson Torto. Researchers who meet the initial criteria have already been vetted and selected through a rigorous grant-review process, he says. In future, to open up the platform to more researchers, the academy wants to partner with other African research funders whose selection processes are similarly rigorous, Torto adds.

Following a trend

The African venture follows a series of open publishing portals launched with F1000 in the past 18 months, including those set up by the Wellcome Trust in London and the Bill & Melinda Gates Foundation in Seattle, Washington — both large charities that fund scientific research. Research centres including the UCL Great Ormond Street Institute of Child Health and the Montreal Neurological Institute and Hospital in Canada have also teamed up with the firm; the European Commission is considering creating its own open publishing platform for outputs from its main Horizon 2020 research programme.

The AAS will not itself be covering the costs of publishing on the platform. Rather, the academy says, African researchers' grant funders will pay publishing fees directly to F1000: £120–800 (US$160–1,100) per article, depending on length.

Some scientists have raised concerns that publishing on open-research platforms might stop African academics from getting the recognition needed for career advancement that they receive for publishing in conventional journals. In South Africa, for instance, academics are rewarded for publishing

in a list of titles maintained by the country's higher-education department.

"For open publishing to be successful, it will need to be accompanied by changes in the criteria for academic recognition and promotion within African institutions of higher learning," says Salim Abdool Karim, an HIV researcher and AAS fellow in Durban, South Africa.

The risk of publishing on little-known platforms is a concern, agrees Gordon Awandare, a biochemist at the University of Ghana in Accra who will be eligible to publish on *AAS Open Research*. However, the AAS platform will help to chip away at the grip of the big journals, says Awandare, which will be good for African science. "Our approach has always been to spread our research across several platforms, so we will continue to do that."

Journal name:
Nature
DOI:
doi:10.1038/nature.2017.23018

Comments

1 comment

1. *PROF CHUKWUEMEKA CH AGBAKWURU* • 2017-11-16 06:15 PM
   The African Scientists Open-Access Publishing Platform is a very welcomed innovation to give African Researcher (International & National) the much needed opportunity of making worthwhile intellectual contributions to African and World Development through publishing of their research studies.
   www.mastercomputeragency.net

Puerto Rico struggles to assess hurricane’s health effects

While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.

15 November 2017

Mario Tama/Getty

Hurricane Maria, which hit Puerto Rico in mid-September, disrupted water supplies in some areas.

Nightfall sets a hard deadline for a team of public-health researchers in Puerto Rico. Since Hurricane Maria hit on 20 September, leaving large swathes of the island without a reliable power supply, the scientists have

rushed home each night to avoid being in the streets after dark. Many lack running water, and most have limited telephone access.

Yet the team —– co-led by José Cordero of the University of Georgia in Athens — has managed to contact several hundred women to begin assessing whether Hurricane Maria has worsened drinking-water contamination, stress and infectious disease that could harm developing fetuses. This wasn't what the researchers set out to study six years ago when they started a project to assess the impact of pollution on pre-term births. But Cordero's team is one of several research groups have scrambled to quantify Hurricane Maria's immediate health impacts, even as team members struggle to fulfil their own basic needs.

The devastation that Cordero saw on a recent visit to Puerto Rico, his birthplace, shocked him. "I thought I was prepared, but I wasn't," he says.

Even before the hurricane, the island's 18 'Superfund' sites — areas so polluted that the US Environmental Protection Agency deems them hazardous to human health or the environment — posed a potential risk to pregnant women, says Ingrid Padilla, an environmental engineer at the University of Puerto Rico at Mayagüez. Twelve of these sites sit on karst, a geological formation made of porous rock that allows toxic chemicals to flow down from the surface into groundwater.

Padilla's previous research suggests that flooding and other disturbances can quickly bring toxic substances in groundwater back to the surface, and carry them into the water supply. Now, she and her colleagues are collecting hair and blood samples from the research cohort to determine whether pregnant women are being exposed to hazardous chemicals, such as phthalates and chloroform. Since the hurricane hit, the researchers have begun to collect and test groundwater from karst regions and tap water from the homes of people living there.

Other research teams are worried that water that has pooled in hurricane debris could provide a breeding ground for disease-carrying mosquitoes. At the height of the Zika epidemic in 2016, experts debated whether a massive hurricane would destroy mosquito habitat or enhance it, says Carmen Zorrilla, an obstetrician and gynaecologist at the University of Puerto Rico in

San Juan. The evidence is still unclear, she says, and logistical problems may make it impossible for researchers to gather enough data to provide answers.

In some areas where hospitals faced extensive storm damage, the only medical care available is emergency treatment. Screening for the Zika virus is a low priority, and infected adults rarely experience severe symptoms and are unlikely to seek medical treatment.

There are also few labs on the island that can test samples for Zika and other mosquito-borne diseases. Like many Puerto Rican facilities, the US Centers for Disease Control and Prevention (CDC) dengue lab in San Juan lost power during the hurricane and was closed for a week. Diesel generators kept its freezers running to preserve blood and other biological samples, but the lab is still running on generator power and is behind on testing some samples. Shipping delays destroyed reagents that the lab had ordered, since the chemicals were not kept consistently cold during transport.

Lab director Stephen Waterman says that the CDC is collecting data on the incidence of mosquito-borne disease and other hurricane impacts. But its priority is to help US government workers and local communities recognize mosquito breeding grounds, and to provide technical help on efforts to control the spread of the insects. Agency staff would also like to verify reports that leptospirosis — a waterborne bacterial disease that is spread by rats — has sickened dozens of people. “We’re focused on preventing disease,” Waterman says.

Yet the ruined facilities and lack of power continue to tax public-health workers’ ability to know where hazards lie. Take the numerous diesel generators running on the island, which produce visible plumes of grey smoke. Benjamin Bolaños, a microbiologist at the University of Puerto Rico in San Juan, worries that these emissions could harm people with respiratory illnesses, but that the effect will be difficult to quantify. “We are blind because probably the [air quality] monitors were destroyed by the hurricane,” he says.

This makes the prospect of more months without reliable power even more frightening. "The kind of work we’re doing is not because it would be interesting to do,” Cordero says. “It has to be done now because a few years

from now, it’s too late.”

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Comments

Comments

There are currently no comments.

China fires up next-generation neutron-science facility

Beam generator puts country in elite company for doing experiments in materials science and other fields.

14 November 2017

Jin Liwang/Xinhua via ZUMAPRESS

Engineers work on an instrument at the China Spallation Neutron Source in Dongguan.

China is revving up its next-generation neutron generator and will soon start experiments there. That will lift the country into a select group of nations with facilities that produce intense neutron beams to study the structure of

materials.

The China Spallation Neutron Source (CSNS) in Dongguan, a 2.2-billion-yuan (US$331-million) centre, will allow the country's growing pool of top-notch physicists and material scientists, along with international collaborators, to compete in multiple physics and engineering fields. Its designers also hope that the facility will lead to commercial products and applications ranging from batteries and bridges to aeroplane engines and cancer therapy.

"It is not only a big step forward for Chinese scientists, but also a significant event for the international scientist community," says Wang Xun-Li, a physicist at the City University of Hong Kong who has been involved in planning the facility.

Beam bombardment

Spallation neutron sources produce neutrons by slamming protons onto a metal target — CSNS uses tungsten. They are more cost effective and safer than other methods, which use nuclear reactors to produce neutron beams. As neutrons have no charge, they can penetrate materials more easily than some other probing methods, and they are more sensitive to light elements such as hydrogen, making them useful for evaluating candidate materials for fuel cells. Similar facilities exist only in the United Kingdom, United States, Japan and Switzerland, and one is under construction in Sweden.

Fujio Maekawa, a specialist in neutron sources at the Japan Proton Accelerator Research Complex in Tokaimura, says that although the CSNS delivers neutrons at a lower density than other spallation sources — which means that experiments will take longer — a planned upgrade will bring it in line with other facilities. And given their scarcity, "neutron users around the world always welcome new sources", he says.

The CSNS will have capacity to host 20 beam lines, supplying as many instruments. Preliminary tests of its first three instruments began on 1 November. "Neutrons arrived at the samples as expected," says Wang

Fangwei, head of the neutron-science division at CSNS. Although debugging might take a couple of years, he expects the instruments to be calibrated and ready for initial experiments by the end of 2017.

Chinese physicists are eager to use the facility to analyse the underlying magnetic properties of materials, an area in which the country has significant experience. Wang Xun-Li says that several planned instruments will give scientists the chance to move to the forefront of fields such as the physics of skyrmions — vortex-like excitations in magnetic materials — and high-temperature superconductivity. “There are a whole bunch of early- to mid-career scientists who are hungry to use the facility for studying magnetism,” says Wang Xun-Li.

Global appeal

Wang Xun-Li thinks that the latest facility will encourage Chinese researchers to remain in the country instead of pursuing careers elsewhere. “In the past, it was common to see Chinese scientists go abroad for these kinds of studies,” he says.

The facility’s first instruments are also attracting international researchers. German material scientist Frank Klose says that the CSNS was a major factor when he and material scientist Christine Rehm, his wife, decided to join the new Guangdong Technion Israel Institute of Technology in Shantou, 400 kilometres east of Dongguan. Klose’s research focuses on designing data-storage devices and sensors that could be used in hydrogen-powered cars. He helped design one of the facility's instruments to investigate the magnetic properties of spintronic devices, which take advantage of the spin of electrons to store data.

But scientists contacted by *Nature* have raised concerns about CSNS’s location, saying that Dongguan lacks services and infrastructure, such as schools and universities, that will persuade top scientists and their families to move there. “I believe CSNS is suffering from a lack of first-grade scientists who actually are based in Dongguan,” says a researcher familiar with the facility, who asked for anonymity because of the sensitivity of the issue.

Potential users have also expressed some frustration that only 3 instruments will be ready this year, despite the facility’s capacity to host 20.

But more instruments are already being built. Shenzhen's government is funding two that are expected to be ready by the end of 2019, including one designed to model high-pressure environments, such as the Earth's core. Mao Ho-Kwang, a geophysicist at the Carnegie Institution for Science in Washington DC, is keen to use it to simulate what happens to materials in high-pressure conditions. “The CSNS instruments will be a great asset for Earth, environmental and energy science, as well as physics, chemistry and material science,” says Mao. “I am very excited, and the whole neutron community is getting very excited too”.

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Commenting is currently unavailable.

High-jumping beetle inspires agile robots

Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.

13 November 2017

Brian L. Stauffer

Click beetles have a hinged body that can propel them to great heights.

A beetle that can launch itself spectacularly into the air after falling on its back — flipping right side up without having to use its legs — could inspire a new generation of smart robots.

Imagine a rescue robot vaulting its way through a disaster zone riddled with obstacles, or a planetary robot extricating itself from an unexpected tumble on Mars. Each might use a trick or two learnt from the click beetles, a family of insects with the unique ability to catapult themselves out of trouble.

“A lot of robots out there jump using their legs,” says Aimy Wissa, a mechanical engineer at the University of Illinois in Urbana-Champaign. “What’s unique about this is if something breaks, you can still jump without legs and get out of the situation.”

Wissa and her Illinois colleagues, led by mechanical-engineering graduate student Ophelia Bolmin, described the mechanics of jumping click beetles on 7 November at a meeting of the Entomological Society of America in Denver, Colorado. They published early results in the proceedings of a bio-inspired robotics conference in July[1].

So far, the scientists have studied how click beetles manage to store and hold the energy needed to launch themselves into the air. They hope to soon start building prototype machines designed after the beetles.

Snap to it

There are about 10,000 species of click beetles around the world. The insect’s head and body are connected by a hinge that the beetle can slowly arch and then suddenly snap in the opposite direction, jack-knifing its body and sending it into the air with an audible ‘click’. Earlier work has shown that the beetles launch nearly vertically before somersaulting through the air[2].

Ophelia Bolmin/University of Illinois at Urbana-Champaign

Click beetles can launch themselves up with surprising force.

If the beetle lands on its back, it just does the same manoeuvre again. Compare that to an upended ladybird — also known as a ladybug — which has to wiggle around on its back until it manages to roll over far enough and get traction with its legs to flip itself over.

The Illinois team wanted to analyse how the click beetles pull off their acrobatic feat. “We thought we could look at, how do they really jump, how is that energy being released?” says Marianne Alleyne, an entomologist on the team.

Students measured the dimensions of dozens of beetles of four species (*Alaus oculatus*, *Ampedus nigricollis*, *Ampedus linteus* and *Melanotus* spp.), videotaped their jumps with high-speed cameras and analysed the energy required for the beetles to pull the hinge back and then release it. Muscles alone are not enough, because they contract relatively slowly, and so other body parts such as tendons must also be involved, the team says.

How high?

The researchers also measured the force drop as the hinge snapped shut, confirming that it corresponded to the click as the beetle begin to soar skyward. They are now analysing the energies involved as beetles of different sizes make the jump. Click beetles can range from just a few millimetres to a few centimetres long; early results suggest that the bigger the beetle, the higher it can jump, Wissa says.

Other engineers have developed a range of agile robots that can jump using their legs — including one inspired by the Senegal bushbaby (*Galago senegalensis*), which has the highest vertical jumping ability of any animal[3]. Compared with crawling, jumping is a fast and efficient way for small robots to get around obstacles, says Mark Cutkosky, a mechanical engineer at Stanford University in California.

The advantage of the beetle approach is that something could go wrong with the robot's legs, and it could still get out of its predicament, Wissa says. "It simplifies the design a lot."

Any robots inspired by the click beetle would probably have to be quite small — perhaps a few tens of grams, says Gal Ribak, a biomechanics specialist at Tel Aviv University who has studied the beetles' jumps[4]. "Otherwise, the jumping mechanism will require too much energy to lift the body into the air, and the repeated impacts at take-off and landing would result in mechanical damage," he says.

But those constraints might not apply to robots exploring planets other than Earth. On worlds with lower gravity, beetle-like robots could fly high.

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Comments

Comments

There are currently no comments.

Richard
Haughton

Race for quantum supremacy hits theoretical quagmire

It’s far from obvious how to tell whether a quantum computer can outperform a classical one, says Philip Ball.

13 November 2017 Corrected:

1. 14 November 2017

Quantum supremacy might sound ominously like the denouement of the *Terminator* movie franchise, or a misguided political movement. In fact, it denotes the stage at which the capabilities of a quantum computer exceed those of any available classical computer. The term, coined in 2012 by quantum theorist John Preskill at the California Institute of Technology, Pasadena[1], has gained cachet because this point seems imminent. According to various quantum-computing proponents, it could happen before the end of the year.

But does the concept of quantum supremacy make sense? A moment’s thought reveals many problems. By what measure should a quantum computer be judged to outperform a classical one? For solving which

problem? And how would anyone know the quantum computer has succeeded, if they can’t check with a classical one?

Computer scientists and engineers are rather more phlegmatic about the notion of quantum supremacy than excited commentators who foresee an impending quantum takeover of information technology. They see it not as an abrupt boundary but as a symbolic gesture: a conceptual tool on which to peg a discussion of the differences between the two methods of computation. And, perhaps, a neat advertising slogan.

IBM Research

An IBM cryostat wired for a 50-qubit system.

Magic number

Quantum computers manipulate bits of information according to the quantum rules that govern the behaviour of matter on the smallest scales. In this quantum world, information can be coded as quantum bits (qubits), physically composed of objects that represent binary 1s and 0s as quantum states. By keeping the qubits in a coherent quantum superposition of states –

so that in effect their settings are correlated, rather than being independent as in the bits (transistors) of classical computer circuitry – it becomes possible to carry out some computations much more efficiently, and thus faster, with far fewer (qu)bits, than on classical computers.

Both IBM and Google have already developed prototype quantum-computing devices. IBM has made a 5-qubit device available for public use as a cloud-based resource and on 10 November it announced that it had made a 20-qubit device available for commercial users. Its computer scientists also reported on the same day that they had successfully tested a 50-qubit circuit. Google, too, is developing devices with 49–50 qubits on which its researchers hope to demonstrate quantum supremacy by the end of this year[2].

How could anyone know, though, that a quantum computer is genuinely doing something that is impossible for a classical one to do – rather than that they just haven't yet found a classical algorithm that is clever enough to do the job? This is what makes quantum supremacy a theoretically interesting challenge: are there classes of problem for which it can be rigorously shown that quantum computing can do what classical cannot?

Among the favourite candidates are so-called sampling problems, in which in-effect random bits are transformed into bits that come from a predefined distribution. The Google team in Santa Barbara, California, led by John Martinis, has described an experimental procedure for implementing such a sampling scheme on a quantum computer, and has argued that at the 50-qubit level it could show quantum supremacy[2].

Because of this paper, 50 qubits has become something of an iconic number. That's why a recent preprint[3] from Edwin Pednault and co-workers at IBM's Thomas J. Watson Research Center in Yorktown Heights, New York, showing how, with enough ingenuity, some 49-qubit problems can be simulated classically, has been interpreted in some news reports as a challenge to Google's aim to demonstrate quantum supremacy with only 50 qubits.

It's all about depth

But it's not really that. Quantum-computing experts are now finding themselves obliged to repeat a constant refrain: it's not just about the number of qubits. One of the main measures of the power of a quantum circuit is its so-called depth: in effect, how many logical operations ('gates') can be implemented in a system of qubits before their coherence decays, at which point errors proliferate and further computation becomes impossible. How the qubits are connected also matters. So the true measure of the power of a quantum circuit is a combination of factors, which IBM researchers have called the "quantum volume".

This means that the extent to which a quantum-computational task is challenging to perform classically depends also on the algorithmic depth, not just on how many qubits you have to throw at it. Martinis says that the IBM paper is concerned only with small-depth problems, so it's not so surprising that a classical solution still exists at the 49-qubit level. "We at Google are well aware that small-depth circuits are easier to classically compute", he says. "It is an issue we covered in our original paper."

Scott Aaronson, a computer scientist at the Massachusetts Institute of Technology, agrees that the IBM work doesn't obviously put quantum supremacy further out of reach. "It is an excellent paper, which sets a new record for the classical simulation of generic quantum circuits," he writes – but "it does not undercut the rationale for quantum supremacy experiments."

Indeed, he says, the truth is almost the opposite: the paper shows that it's "possible to simulate 49-qubit circuits using a classical computer, [which] is a precondition for Google's planned quantum supremacy experiment, because it's the only way we know to check such an experiment's results." In essence, the IBM paper shows how to verify the quantum result right up to the edge of what is feasible – so computer scientists and engineers can be confident that things are OK when they go beyond it. The goal, Aaronson says, can be likened to "get[ting] as far as you can up the mountain, conditioned on people still being able to see you from the base."

These views seem to sit comfortably with the IBM team's own perspective on their work. "I think the appropriate conclusion to draw from the simulation methods we have developed is that quantum supremacy should properly be viewed as a matter of degree, and not as an absolute threshold,"

says Pednault. “I, along with others, prefer to use the term ‘quantum advantage’ to emphasize this perspective.”

Theorist Jay Gambetta at IBM agrees that for such reasons, quantum supremacy might not mean very much. “I don’t believe that quantum supremacy represents a magical milestone that we will reach and declare victory,” he says. “I see these ‘supremacy’ experiments more as a set of benchmarking experiments to help develop quantum devices.”

In any event, demonstrating quantum supremacy, says Pednault, “should not be misconstrued as the definitive moment when quantum computing will do something useful for economic and societal impact. There is still a lot of science and hard work to do.”

Which, of course, is just applied science as normal. The idea of quantum supremacy sets a nice theoretical puzzle, but says little about what quantum computers might ultimately do for society.

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Corrections

Corrected:

An earlier version of this story erroneously stated that IBM had created a 20-qubit device for public use. It is available only for commercial users, however IBM does have a 5-qubit device for public use.

Comments

Commenting is currently unavailable.

Archaeologists say human-evolution study used stolen bone

Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.

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1. 13 November 2017

Marc Steinmetz

The Untermassfeld site in Germany has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago.

Serious concerns have surfaced about three research papers claiming evidence for one of the earliest human occupations of Europe.

In an extraordinary letter posted to the bioRxiv.org preprint server on 31 October[1], archaeologists allege that the papers, published in 2013, 2016 and 2017, included material of questionable provenance, and that results reported in the 2016 paper were based on at least one stolen bone. Editors at the journals concerned have now published expressions of concern about the papers.

There is no suggestion that the authors of those papers were involved in theft, but the researchers behind the letter say they are concerned that appropriate questions regarding the provenance of the material appear not to have been asked. They also reject the authors' conclusion that a German site known for animal remains was also home to hominins, ancient relatives of humans, 1 million years ago. The authors have denied the allegations and say they stand by their conclusion.

The letter was initiated by archaeologist Wil Roebroeks at Leiden University in the Netherlands, and Ralf-Dietrich Kahlke, a palaeontologist and head of the Senckenberg Research Station of Quaternary Palaeontology in Weimar, Germany, who leads excavations at Untermassfeld, a fossil site about 150 kilometres northeast of Frankfurt. Their preprint describes repeated disappearances of bones from Untermassfeld, as well as fossils delivered in anonymous packages. The authors of the disputed papers insist, however, that they analysed independent collections of bones and stones, and reject the suggestion that any of it was stolen.

Untermassfeld, which has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago, holds the most complete record of northern European wildlife from this time period. But since yearly excavations began in the late 1970s, no hominin bones or signs of occupation have been found, says Kahlke. Hominins first settled in southern Europe around 800,000 to 1 million years ago, most archaeologists agree, and expanded farther north only sporadically until around 500,000 years ago.

Uncertain origins

One of the first claims that hominins lived near Untermassfeld more than 1 million years ago appeared in a 2013 paper in the journal *Quaternary International*, which contended that rocks from the site resembled stone tools[2]. In a 2016 *Journal of Human Evolution* paper[3], two of the original paper's authors, Günter Landeck at the North Hessian Society of Prehistory and Archeology of the Medieval in Bad Hersfeld, Germany, and Joan Garcia Garriga at the Universitat Oberta de Catalunya in Barcelona, concluded that marks on animal bones from Untermassfeld were made by humans. In 2017, Landeck and Garcia Garriga published further analysis of the bones in another *Quaternary International* paper[4].

There is no suggestion that the other co-authors of the 2013 paper had any connection with the material from Untermassfeld. And after this article was published, Garcia Garriga contacted *Nature* to say that he, also, did not have connections with the material; he said that Landeck had done the analysis, while he himself helped in discussing data and writing up its archaeological implications.

In their papers, Landeck and Garcia Garriga attributed the material, along with hundreds of rock fragments of limestone and chert, to “the Schleusingen collection”, which they stated was recovered by a biology teacher in the late 1970s and early 1980s.

Kahlke says he is personally unaware of a Schleusingen collection and questions whether the material was collected at this time. Rocks like those described in the papers can be found in the vicinity of the site, but he says that animal fossils are concentrated in a small area that has been under excavation since 1978. No other research teams had permission to excavate the site during that time, Kahlke says. But he says that material was routinely stolen from the site — which he reported to the police, most recently in 2012 — until the site and fossil bed were better secured. There is no suggestion that Landeck and Garcia Garriga were involved in these thefts.

Ralf-Dietrich Kahlke

Researchers excavating at Untermassfeld allege that part of a deer bone protruding from the sediment on 28 May 2009 (in box, left) had disappeared several days later.

One fossil that Kahlke considers suspicious is a right limb-bone fragment from an extinct species of fallow deer, described in Landeck and Garcia Garriga's 2016 *Journal of Human Evolution* paper. Kahlke says that the bone in the paper seems to match a piece of deer bone that thieves broke from a larger chunk of sediment at Untermassfeld, leaving part of the bone behind. The bone fragment is present in a photograph taken on 28 May 2009, and missing in a photograph taken several days later. A rhinoceros limb fragment that disappeared from the site in 2012 also closely resembles a fossil described in the 2016 paper, Kahlke says.

Case unsolved

Deepening the mystery, a deer bone fragment was among a jumble of bones and rocks in two packages sent anonymously to a museum near Untermassfeld in March 2014. Ralf Werneburg, a palaeontologist and director of the Natural History Museum Schloss Bertholdsburg in Schleusingen, Germany, recognized the material as originating from Untermassfeld and contacted Kahlke.

Ralf-Dietrich Kahlke

An anonymous package sent to a museum in Schleusingen contained a deer bone fragment (lower bone), which appears to match a fragment left behind (upper bone) after a theft from the Untermassfeld site in 2009. (The fragments are shown pieced together in the view on the far-right).

In Kahlke's opinion, the returned deer bone fragment is the one described in the 2016 paper, and matches up with the piece left behind after the 2009 theft**.** He says that the sixty-three other bone fragments in the packages also closely resemble some of the fossils described in the 2016 paper (the rhinoceros limb bone was not among them), and 11 rock fragments resemble

artefacts in the 2013 *Quaternary International* paper.

Roebroeks and Kahlke's team analysed the material in the returned packages, and concluded that it does not support a hominin occupation at Untermassfeld. They argue that the claimed cut-marks on the animal bones, including the deer bone, were probably caused by rodents or other natural wear, they say, and the rock fragments lack telltale marks typical of hominin tools. They say that it wasn't possible to analyse other material from Landeck and Garcia Garriga's paper because its location is unclear.

Nature exchanged multiple e-mails with Landeck and Garcia Garriga about this mystery and asking for comment on the contents of this article. The researchers responded that most of the material they examined, including the deer bone fragment, was from two private collections amassed in the 1970s and early 1980s, and that much of it came from the same geological layer as Untermassfeld, but not within the site itself. They said that they presumed that some of this material was returned to the Natural History Museum Schloss Bertholdsburg in 2014 by the individual who had loaned it to them. They would not name the individual, but insisted: "We have nothing to do with a stolen bone". They added that they are planning to publish a detailed response to Roebroeks and Kahlke's allegations.

The regional prosecutor's office in Meiningen that investigated the 2009 theft told *Nature* the case had been closed unsolved later that year. A 5-year statute of limitation prevents it from being reopened. The case involving the 2012 theft of the rhinoceros bone was reopened early this year after the *Journal of Human Evolution* paper was published. The prosecutor's office said that an individual, whom it declined to name because of data protection laws, had been found guilty and fined.

Ongoing inquiry

Expressions of concern published on each of the three papers note that the location of the Untermassfeld material "was not stated accurately in the publication", and that the authors have been unable to adequately clarify where it is now. Landeck and Garcia Garriga declined to comment to *Nature*

on the specific details of the notes but said that they plan to publish a response.

Sarah Elton, an anthropologist at the University of Durham, UK, and an editor at the *Journal of Human Evolution*, says that an investigation into the accusations is ongoing. She adds that, as a result of the case, the journal now asks prospective authors to supply complete information about the location of material included in a study, as well as how it was accessed.

Other experts have been shocked by the revelations. “This paper should be retracted, of course,” says Jean-Jacques Hublin, an anthropologist and a director at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, about the 2016 paper. But the concerns go beyond questions of provenance. Hublin says that, like Roebroeks and Kahlke, he does not accept the claim that Untermassfeld contains signs of hominin presence, and he worries that its appearance in prominent journals will cause others to accept the idea, despite the lack of evidence for it.

The debate around Untermassfeld, Roebroeks and his colleagues say, underscores the importance of providing accurate descriptions of the provenance of published material, which is needed to verify claims. The desire to set the record straight about the arrival of hominins to Europe was the primary motivation for the team’s letter, he says. Based on his analysis, Roebroeks argues: “These bones and stones are not indicative of hominin presence.”

With additional reporting by Alison Abbott

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Updates

Updated:

> This article was updated on 13 November to note that expressions of concern have been published on all three papers, and to include a statement made after publication by Garcia Garriga: that he was not involved in analysing the material from Untermassfeld.

Comments

Commenting is currently unavailable.

Lab mice's ancestral ‘Eve’ gets her genome sequenced

Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.

13 November 2017

Anne Chadwick Williams/Sacramento Bee/ZUMA Press/Alamy

The genomes of lab mice can shift in subtle and unpredictable ways over generations of breeding.

Adam and Eve, a pair of black mice, lived for less than two years and never left their home at the Jackson Laboratory (JAX) in Bar Harbor, Maine. But since they were bred in 2005, their progeny have spread around the globe: the

pair's living descendants, which likely number in the hundreds of thousands. They are members of the most popular strain of mice used in biomedical research, which was created nearly a century ago.

Now, researchers at JAX are reconstructing Eve's genome in the hopes of better understanding — and compensating for — the natural mutations that occur in lab mice over the course of generations. These genetic changes can cause unanticipated physiological effects that can confound experiments. Related substrains of lab mice can differ in their taste for alcohol or their sensitivity to insulin, for example, and researchers suspect that such differences between supposedly identical mice lines have hampered some areas of research.

The scientists who founded JAX created Adam and Eve's breed, which is called C57BL/6, in 1921. To keep the mice as genetically similar as possible, researchers have repeatedly bred brothers with sisters for nearly a century — and sold the resulting offspring to customers around the world. But this strategy created a genetic bottleneck: every generation, between 10 and 30 new mutations pop up and are passed down to offspring. This 'genetic drift' quickly accumulates over the years, says Laura Reinholdt, a geneticist at JAX. The genomes of the C57BL/6 mice that the lab sells today have thousands of genetic differences from the mouse reference genome, which was created in 2002 from three mice from the substrain C57BL/6J. The genome is used as a template for researchers developing genetically modified mice.

Other suppliers have inadvertently created divergent substrains of C57BL/6 mice when they've bought rodents from JAX and bred them over several generations. Although most mutations go unnoticed, some occur in genes that affect a mouse's appearance or physiology. In 2016, mouse supplier Envigo in Somerset, New Jersey, found that C57BL/6 mice at 6 of its 19 breeding facilities around the world had acquired a mutation in a gene related to the immune system. The company notified the researchers that bought these mice, and asked customers to specify which location they preferred to source mice from in the future, given that the company's stocks were no longer identical.

Hidden changes

And although it is easy to spot a mutation that changes fur from black to white, for instance, some changes are discovered only if researchers are investigating a particular trait. A substrain of C57BL/6 mice that the US National Institutes of Health bred for 50 generations are uninterested in alcohol, whereas those bred at JAX's facility display a preference for alcoholic beverages.

In 2005, a team at JAX decided to reset the genetic clock by selling only C57BL/6J mice descended from two chosen mice: Adam and Eve. The researchers froze hundreds of embryos of the duo's grandchildren, enough to last for 25-30 years. Every five generations, the company thaws some of these embryos and raises them to adulthood as new breeding pairs.

"In some ways, the changes that are acquired are insidious and unstoppable," says Michael Wiles, the lab's senior director of technology evaluation and development, who led the project. "We've not stopped general drift, but we've slowed it considerably." Once the stockpiled embryos run out, however, JAX will have to start over with new breeding pairs from a much later generation.

Yet Eve's genome is very different from the 2002 mouse reference genome. In a presentation last month at the American Society for Human Genetics' meeting in Orlando, Florida, JAX computational scientist Anuj Srivastava spoke about the company's effort to reconstruct Eve's genome in high detail, using three different sequencing methods. Wiles says that the genome will be finished by the end of November, and that JAX plans to publish it early in 2018.

Mouse trap

Other mouse breeders have started their own efforts to account for genetic drift. Taconic Biosciences, a mouse distributor in Hudson, New York, restarts its C57BL/6 line every ten generations from its stash of frozen embryos.

Because Taconic has bred its line separately from the JAX line for decades, the Eve genome won't necessarily reflect the genetic make-up of Taconic's mice any more than the current mouse reference genome does.

Ana Perez, Taconic's global director of genetic sciences and compliance, says that the company plans to publish the genome of its own Eve. "From my perspective, each particular breeder should have their own reference genome to follow," she says. Buying mice from different breeders and expecting them to be the same is a fallacy, she adds.

But most researchers don't think about the differences between the various substrains of C57BL/6 mice and how those disparities can affect reproducibility in research, says Cory Brayton, a pathobiologist at Johns Hopkins University in Baltimore, Maryland. "The vendors are pretty good about making the information available, but the awareness is still pretty low," she says. It is impossible to quantify how often experiments or entire research programmes are wasted when researchers realize that their supposedly identical mice have genetically diverged from the ancestor they bought from a vendor, but Brayton suspects it is common.

The Eve genome will be a useful addition for researchers who use animals from JAX, says Brayton, although it won't solve all the reproducibility problems inherent to inbred mouse lines. "If you use [inbred mice] wisely, they can be highly informative," she says. "If you use them stupidly, they may really confound your studies."

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Comments

Comments

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South Africa tackles crime at sea with ship-spotting satellites

Automated vessel-tracking system aims to spy poachers and smugglers.

10 November 2017

Leeman/Getty

South Africa has started to combine data from satellites, vessel transponders and radar to monitor ships in its waters in real time.

In October last year, a fishing boat set out from Velddrif, a small town on South Africa’s west coast. It sailed northwest for about 25 nautical miles (46 kilometres), then turned sharply and headed back the way it had come. Staying clear of coastal settlements, it entered the West Coast National Park

marine protected area — a strictly no-fishing zone — where it slowed down and began to sail in a zigzag pattern.

“It was obvious what they were doing,” says Niel Malan, a marine biologist who works in South Africa’s Department of Environmental Affairs in Cape Town. “They were poaching.”

On any other day, the transgression would probably have passed undetected. But Malan and his colleagues were testing a new vessel-tracking system that — when fully operational — will send out alerts when ships are acting suspiciously anywhere in South African waters.

A test version of the Integrated Vessel Tracking Decision Support Tool was launched on 7 November by the South African Oceans and Coastal Information Management System (OCIMS), at its annual meeting in Cape Town. The tracking system, which has taken US$1 million and 5 years to develop, combines data from satellites, vessel transponders and radar to monitor ships in real time and spot any that might be engaged in criminal activities, such as illegal fishing or smuggling.

Similar remote-sensing systems have been developed over the last decade or so by countries including the United States, Australia and India. But South Africa is a particularly crucial area for maritime crime-fighting, because of its geographical location at the joining of three oceans — the Atlantic, Indian and Southern — and because of the sheer extent of its waters. The country’s Exclusive Economic Zone, which extends 200 miles off the coastline and includes an additional 400-mile-diameter circle around the Prince Edward Islands, exceeds its land area by 25%. “Because of the vastness of our EEZ, we see this as a critical technology,” says Waldo Kleynhans, the system’s lead developer based in Pretoria.

South Africa's coast is also a busy shipping lane and an area rich in natural resources. Cold, nutrient-rich waters sustain extensive commercial fishing on South Africa's west coast and to the south, while every year billions of sardines migrate down the east coast, attracting flocks of birds, as well as dolphins, sharks and whales.

South Africa has a well-documented problem with coastal poaching of high-

value species such as abalone and rock lobster, whereas the extent of illegal fishing in its open oceans is largely unknown. The area around the Prince Edward Islands — home to the prized Patagonian toothfish (*Dissostichus eleginoides*) — is particularly vulnerable, says Timothy Walker, a researcher focusing on maritime and water security at the Institute for Security Studies in Pretoria. South African authorities are also concerned about human trafficking and the smuggling of drugs or banned wildlife items, such as rhino horn and ivory.

Yet the navy has scant physical resources to monitor illegal activities, says Mark Blaine, a captain in the South African Navy and a part-time researcher in nautical science at Stellenbosch University — four frigates, three submarines and a handful of patrol vessels and aircraft — which he describes as equivalent to "a country the size of Algeria using around six police cars to patrol the entire country".

Satellite spotting

The satellite data used by the new system includes information from automated identification system (AIS) trackers, which all ships above a certain size are required to carry. South Africa currently buys this data from third-party suppliers, but plans to launch its own constellation of AIS nano-satellites in 2018 to collect the information. Meanwhile, satellites using synthetic-aperture radar, which can spot vessels in the dark or through thick cloud, will help to detect 'dark targets' that are not carrying trackers or that have turned them off.

Malan says that the tracking system can be set to flag up different suspicious behaviours. Users such as the fisheries department or the South African navy might create a digital fence around a marine reserve or other sensitive area, for example, and ask to receive alerts when ships enter it. Or they could request to be alerted if two ships meet in the open ocean for an extended time.

Ultimately, Malan says, the system's success will depend on the end-users, who will have to monitor incoming data, set up appropriate alerts and decide

how to respond. Enforcement will also be a challenge. Malan says that details of the suspicious boat he spotted in October 2016 were relayed to the fisheries department. “But we're not sure if they finished the investigation,” he says.

He hopes that once a few miscreants have been caught using the tracking system, however, its existence will act as a deterrent: “I think once we start prosecuting a few people, then the word will spread quickly — and we hope that will lead to better behaviour.”

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Comments

Commenting is currently unavailable.

Resurrected malaria strategy saves thousands of lives in Africa

Pre-emptively treating kids for malaria is working, despite logistical challenges.

10 November 2017

Amy Maxmen

A healthworker in Mali prepares a dose of malaria chemoprevention.

In a sea of high-tech malaria fixes — everything from drug-delivery by drone to gene-edited mosquitoes — an old-fashioned approach is saving thousands of children in West Africa, according to studies presented this week at the American Society of Tropical Medicine and Hygiene (ASTMH) meeting in

Baltimore, Maryland.

The measure, called seasonal malaria chemoprevention, involves giving children a dose of antimalarial drugs once each month in the rainy season to prevent the disease in hard-hit regions. Researchers have previously demonstrated this strategy in large clinical trials but they had feared that their positive results wouldn't be replicated in the messy, real world, because chemoprevention requires thousands of local health workers to deliver drugs to children in villages far from hospitals, pharmacies and paved roads.

"People were doubtful this intervention would work, because it's so demanding," says Brian Greenwood, an infectious disease specialist at the London School of Hygiene and Tropical Medicine who helped to conduct trials that showed reductions in malaria prevalence up to 84%[1]. As a result of those studies, more than 6.4 million children in nine countries in sub-Saharan Africa (Burkina Faso, Cameroon, Chad, Gambia, Guinea, Mali, Niger, Nigeria, Senegal) received the drugs in 2016.

It seems to be working, according to data presented at the ASTMH meeting. "They are seeing the same level of efficacy against malaria that we saw in clinical trials and reducing hospital admissions," says Greenwood. "I am very happy." But researchers are also finding signs that this approach may not work for long.

Data driven

Malaria researchers deployed chemoprevention in the 1950s, but it fell out of favour when the widespread use of malaria drugs led to drug resistance. Yet by 2000, more than 830,000 people were dying of the disease each year — mainly children in Africa — and there were no blockbuster vaccines on the horizon. So malariologists revisited the approach. Between 2002 and 2012, clinical trials conducted in West Africa suggested that combinations of older malaria drugs had the power to prevent 8.8 million cases and 80,000 deaths every year if implemented solely during the rainy season, when the disease spikes.

Amy Maxmen

Children in Mali receive a dose of malaria drugs, to reduce their risk of becoming infected with the disease.

In 2012, the World Health Organization recommended the strategy with three old drugs — sulphadoxine, pyrimethamine and amodiaquine — so that the only sure-fire cure for malaria, artemisinin, would remain effective. Alassane Dicko, a malariologist at the University of Bamako in Mali, says that he did not take the intervention for granted when it launched in Mali in 2013, because he knew that funds were limited and drug resistance inevitable. “Research is essential,” he says. His lab began assessing chemoprevention’s efficacy, cost and effects on drug resistance.

In August, Dicko and his colleagues reported[2] that malaria prevalence was reduced by 65% in children under age 5 who were treated with chemoprevention in the Malian district of Kita, compared to a similar number of children in a neighbouring district that lacked the funds to roll out the intervention.

Race against resistance

On the basis of results such as these, malaria researchers at the meeting estimate that chemoprevention has averted roughly 6 million cases and 40,000 deaths in 2015 and 2016 in the countries where it is practised. “This intervention has been extremely well documented over three or four years,” says Erin Eckert, an epidemiologist at the US Agency for International Development’s President’s Malaria Initiative, based in Washington DC. As a result, the agency plans to help fund chemoprevention in eight countries next year.

Also at the ASTMH meeting, Dicko reported a 80-person trial showing that adding another old malaria drug, primaquine, to the regimen combo blocks the transfer of the malaria parasite, *Plasmodium falciparum*, from humans into mosquitoes. This would further reduce the amount of the parasite in circulation. Dicko aims to hit the disease hard and fast — with multiple drugs, as soon as possible — because he and his colleagues are already detecting genetic signs of drug resistance in parasites[3].

New chemoprevention drugs in the pipeline might not be ready before existing drugs fail because of resistance, Greenwood says. This year, he helped to launch a trial combining chemoprevention and a less effective malaria vaccine in Burkina Faso and Mali. The vaccine was previously shown to reduce the number of malaria cases by less than 36% in children[4], but Greenwood hopes the combined tools, together with bed nets, can suppress malaria enough to stop it from bouncing back once today’s drugs fail. By that time, he says, genetically engineered mosquitoes might be ready to fly.

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Comments

Comments

There are currently no comments.

Nature News

周五, 24 11月 2017

Nature News

[周五, 24 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Nobel laureates demand release of Iranian scholar facing death sentence** [周五, 24 11月 08:00]
  Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.
- **AI-controlled brain implants for mood disorders tested in people** [周三, 22 11月 08:00]
  Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.
- **Lightning makes new isotopes** [周三, 22 11月 08:00]
  Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.
- **Black academics soon to outnumber white researchers in South Africa** [周二, 21 11月 08:00]
  Legacy of apartheid means academia has remained largely white.
- **Hungary rewards highly cited scientists with bonus grants** [周二, 21 11月 08:00]
  Some top researchers prosper in Hungary as country tries to improve its international standing in science.
- **European Medicines Agency to move to Amsterdam** [周一, 20 11月 08:00]
  The European Union’s drug regulatory body will leave London because of the United Kingdom’s Brexit plans.
- **How alkali flies stay dry** [周一, 20 11月 08:00]
  Waxy and hairy covering enables flies to dive underwater without getting wet.
- **UK government announces research-spending hike ahead of budget** [周一, 20 11月 08:00]
  Pledge would raise country’s public research funding to £12.5 billion in 2021–22.
- **Exoplanet hunters rethink search for alien life** [周一, 20 11月 08:00]
  Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.
- **Online software spots genetic errors in cancer papers** [周一, 20 11月 08:00]

Tool to scrutinize research papers identifies mistakes in gene sequences.

- **Sex matters in experiments on party drug — in mice** [周五, 17 11月 08:00]
  Ketamine lifts rodents' mood only if administered by male researchers.
- **Giant telescope’s mobile-phone ‘dead zones’ rile South African residents** [周五, 17 11月 08:00]
  Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.

Nobel laureates demand release of Iranian scholar facing death sentence

Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.

24 November 2017

HAND OUT/Belga/PA Images

Iranian researcher Ahmadreza Djalali has appealed against the death sentence he received on 21 October.

Some 75 Nobel prizewinners have called on the Iranian government to release Ahmadreza Djalali, a researcher in disaster medicine who was

sentenced to death last month. The letter is the latest and most powerful protest against the ruling by the scientific community so far.

The group wrote to Gholamali Khoshroo, the Iranian ambassador to the United Nations, on 17 November, and the letter was made public on 21 November. The Nobel laureates express their concern for the conditions of Djalali's detention; they deem his trial "unfair" and "flawed", and they urge the Iranian authorities to let him return to Sweden, where he lived.

The list includes prominent names such as Harold Varmus, a former director of the US National Institutes of Health, now at the Weill Cornell Medicine institute in New York, and Andre Geim, a physicist based at the University of Manchester, UK. They wrote: "As members of a group of people and organizations who, according to the will of Alfred Nobel are deeply committed to the greatest benefit to mankind, we cannot stay silent, when the life and work of a similarly devoted researcher as Iranian disaster medicine scholar Ahmadreza Djalali is threatened by a death sentence."

Spying conviction

Djalali carried out research on emergency medicine — specifically, on the response of hospitals to terrorist attacks — while based at the University of Eastern Piedmont in Novara, Italy, and at the Karolinska Institute in Stockholm.

He was arrested in Tehran in April 2016 and accused of collaboration with a hostile government. On 21 October this year, Djalali was convicted of espionage and sentenced to death, according to Djalali's wife Vida Mehrannia and Italian diplomatic sources.

Tehran's prosecutor linked Djalali to the murder of several Iranian nuclear physicists. But a document thought to have been written by Djalali has claimed that he was sentenced after refusing to spy for Iran. Djalali's lawyer has appealed against the death sentence and is awaiting the court's decision.

Since the death sentence became public, many organisations have protested against Djalali's treatment. They include: Amnesty International, the human

rights group; senators in the Italian government; the directors of the European institutions at which Djalali worked; and academic groups including the Committee of Concerned Scientists and Scholars at Risk.

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Comments

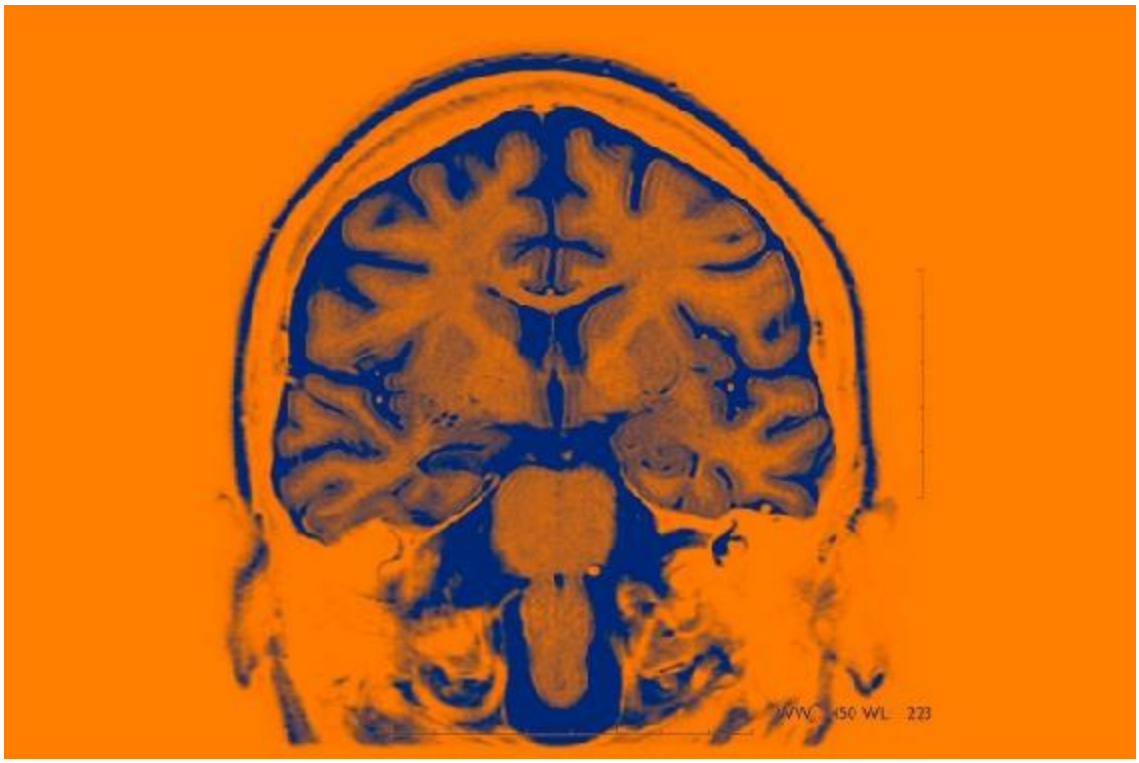
Comments

There are currently no comments.

AI-controlled brain implants for mood disorders tested in people

Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.

22 November 2017



BSIP/UIG/Getty

Brain implants that deliver electrical pulses tuned to a person’s feelings and behaviour are being tested in people for the first time. Two teams funded by the US military’s research arm, the Defense Advanced Research Projects Agency (DARPA), have begun preliminary trials of ‘closed-loop’ brain implants that use algorithms to detect patterns associated with mood disorders. These devices can shock the brain back to a healthy state without

input from a physician.

The work, presented last week at the Society for Neuroscience (SfN) meeting in Washington DC, could eventually provide a way to treat severe mental illnesses that resist current therapies. It also raises thorny ethical concerns, not least because the technique could give researchers a degree of access to a person's inner feelings in real time.

The general approach — using a brain implant to deliver electric pulses that alter neural activity — is known as deep-brain stimulation. It is used to treat movement disorders such as Parkinson's disease, but has been less successful when tested against mood disorders. Early evidence suggested that constant stimulation of certain brain regions could ease chronic depression, but a major study involving 90 people with depression found no improvement after a year of treatment.[1]

The scientists behind the DARPA-funded projects say that their work might succeed where earlier attempts failed, because they have designed their brain implants specifically to treat mental illness — and to switch on only when needed. "We've learned a lot about the limitations of our current technology," says Edward Chang, a neuroscientist at the University of California, San Francisco (UCSF), who is leading one of the projects.

DARPA is supporting Chang's group and another at Massachusetts General Hospital (MGH) in Boston, with the eventual goal of treating soldiers and veterans who have depression and post-traumatic stress disorder. Each team hopes to create a system of implanted electrodes to track activity across the brain as they stimulate the organ.

The groups are developing their technologies in experiments with people with epilepsy who already have electrodes implanted in their brains to track their seizures. The researchers can use these electrodes to record what happens as they stimulate the brain intermittently — rather than constantly, as with older implants.

Mood map

At the SfN meeting, electrical engineer Omid Sani of the University of Southern California in Los Angeles — who is working with Chang's team — showed the first map of how mood is encoded in the brain over time. He and his colleagues worked with six people with epilepsy who had implanted electrodes, tracking their brain activity and moods in detail over the course of one to three weeks. By comparing the two types of information, the researchers could create an algorithm to 'decode' that person's changing moods from their brain activity. Some broad patterns emerged, particularly in brain areas that have previously been associated with mood.

Chang and his team are ready to test their new single closed-loop system in a person as soon as they find an appropriate volunteer, Sani says. Chang adds that the group has already tested some closed-loop stimulation in people, but he declined to provide details because the work is preliminary.

The MGH team is taking a different approach. Rather than detecting a particular mood or mental illness, they want to map the brain activity associated with behaviours that are present in multiple disorders — such as difficulties with concentration and empathy. At the SfN meeting, they reported on tests of algorithms they developed to stimulate the brain when a person is distracted from a set task, such as matching images of numbers or identifying emotions on faces.

The researchers found that delivering electrical pulses to areas of the brain involved in decision-making and emotion significantly improved the performance of test participants. The team also mapped the brain activity that occurred when a person began failing or slowing at a set task because they were forgetful or distracted, and found they were able to reverse it with stimulation. They are now beginning to test algorithms that use specific patterns of brain activity as a trigger to automatically stimulate the brain.

Personalized treatment

Wayne Goodman, a psychiatrist at Baylor College of Medicine in Houston, Texas, hopes that closed-loop stimulation will prove a better long-term treatment for mood disorders than previous attempts at deep-brain stimulation

— partly because the latest generation of algorithms is more personalized and based on physiological signals, rather than a doctor's judgement. “You have to do a lot of tuning to get it right,” says Goodman, who is about to launch a small trial of closed-loop stimulation to treat obsessive–compulsive disorder.

One challenge with stimulating areas of the brain associated with mood, he says, is the possibility of overcorrecting emotions to create extreme happiness that overwhelms all other feelings. Other ethical considerations arise from the fact that the algorithms used in closed-loop stimulation can tell the researchers about the person’s mood, beyond what may be visible from behaviour or facial expressions. While researchers won't be able to read people's minds, “we will have access to activity that encodes their feelings,” says Alik Widge, a neuroengineer and psychiatrist at Harvard University in Cambridge, Massachusetts, and engineering director of the MGH team. Like Chang and Goodman’s teams, Widge’s group is working with neuroethicists to address the complex ethical concerns surrounding its work.

Still, Chang says, the stimulation technologies that his team and others are developing are only a first step towards better treatment for mood disorders. He predicts that data from trials of brain implants could help researchers to develop non-invasive therapies for mental illnesses that stimulate the brain through the skull. “The exciting thing about these technologies,” he says, “is that for the first time we’re going to have a window on the brain where we know what’s happening in the brain when someone relapses.”

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Comments

Comments

There are currently no comments.

Lightning makes new isotopes

Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.

22 November 2017

Magalie L’Abbé/Getty

A lightning storm illuminates clouds over Kagoshima, Japan.

A streak of lightning in the skies over Japan has generated positrons — the antimatter equivalents of electrons — and radioactive carbon-14, confirming a theoretical prediction, according to a paper published in *Nature* on 22 November[1].

Since the 1990s, orbiting observatories designed to observe the heavens have

also detected flashes of γ-rays coming from Earth, which were thought to have their origins in atmospheric phenomena. To investigate this theory, Teruaki Enoto, an astrophysicist at Kyoto University in Japan, and his collaborators set up an array of γ-ray detectors close to the Kashiwazaki-Kariwa nuclear power plant. Winter thunderstorms in Japan are famous for their spectacular lightning, he says, and the low clouds make these relatively easy to observe.

On 6 February, the detectors sensed an unusual event. A double lightning bolt just off the coast shot out an initial, one-millisecond spike of γ-rays, with relatively high energies of up to 10 megaelectronvolts. This was followed by a γ-ray afterglow of less than half a second. Then there was a telltale signal — γ-rays concentrated at 511 kiloelectronvolts of energy, which lasted for about a minute. Physicists say this is the unmistakable signature of positrons annihilating in a puff of energy as they hit electrons in the surrounding matter.

Together, the three waves of γ-rays point to a photonuclear reaction first proposed[2] a decade ago by Leonid Babich, a physicist at the Russian Federal Nuclear Center in Sarov. Lightning can accelerate some electrons to almost the speed of light, and the electrons can then produce γ-rays. Babich proposed that when one of these γ-rays hits the nucleus of a nitrogen atom in the atmosphere, the collision can dislodge a neutron. After briefly bouncing around, most of the neutrons get absorbed by another nitrogen nucleus. This adds energy to the receiving nucleus and puts it in an excited state. As the receiving nucleus relaxes to its original state, it emits another γ-ray — contributing to the giveaway γ-ray glow.

Meanwhile, the nitrogen nucleus that has lost one neutron is extremely unstable. It decays radioactively over the next minute or so; in so doing, it emits a positron, which almost immediately annihilates with an electron, producing two 511-keV photons. This was the third signal, Enoto says. He suspects that his detectors were able to see it only because the briefly radioactive cloud was low, and moving towards the detectors. This combination of circumstances might help to explain why the photonuclear signature has been seen so rarely. Enoto says that his team has observed a few similar events, but that the one described in the paper is the only clear-

cut event so far.

Babich also predicted that not all of the neutrons dislodged from nitrogen by a γ-ray are absorbed. Some of them instead will trigger the transmutation of another nitrogen nucleus into carbon-14, a radioactive isotope that has two more neutrons than ordinary carbon. This isotope can be absorbed by organisms; it then decays at a predictable rate long after the organism's death, which makes it a useful clock for archaeologists.

The main source of the carbon-14 in the atmosphere has generally been considered to be cosmic rays. In principle, lightning could also contribute to the supply. But it is not clear yet how much of the isotope is produced in this way, says Enoto, in part because it's possible that not all bolts initiate photonuclear reactions.

"I agree with their interpretation of their data," says physicist Joseph Dwyer of the University of New Hampshire in Durham. But, he adds, Enoto's team's explanation does not solve all puzzles related to positrons in the atmosphere. In particular, the photonuclear reaction does not seem to match an event Dwyer observed in 2009 from a research aeroplane. His detector spotted a signature of positrons only for a fraction of a second — too short to originate from nuclear decay, he says. Also, his detector saw no initial flash in that case. "If it was there, it should have been very obvious."

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Comments

Commenting is currently unavailable.

Black academics soon to outnumber white researchers in South Africa

Legacy of apartheid means academia has remained largely white.

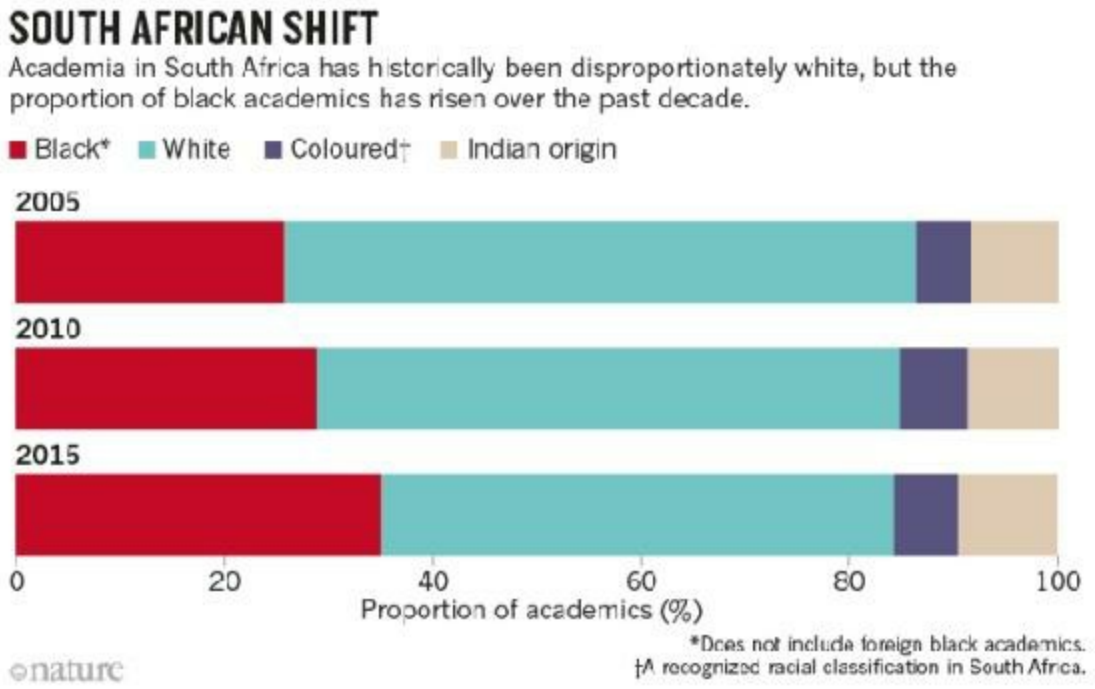
21 November 2017

There will soon be more black academics in South Africa than white ones, a study of demographic data suggests.

Although more than 80% of the country's population is black, its academic sector has remained disproportionately white — a legacy of the apartheid era.

But over the past decade, the proportion of black South African researchers has risen steadily: from 26% in 2005 to 35% in 2015, according to the study, which was published[1] in *Higher Education* last month. The proportion of white academics decreased by more than 10 percentage points over the same period, to 49% in 2015 (see 'South African shift').

"Our research shows that transformation is taking place and there are strong indications that it will accelerate in the future, particularly in the next decade," says David Hedding, a geomorphologist at the University of South Africa in Florida, Johannesburg, and co-author of the paper.



The authors suggest that in the next decade, more than 4,000 researchers — about 27% of the country's academics, and most of them white men — will retire, which should create opportunities for younger researchers. Black researchers could outnumber white ones some time between 2020 and 2025, they say.

Hedding says that it's not possible to attribute the change to a specific policy, but that the government should keep doing what it is currently doing. However, he thinks the country should focus more on nurturing PhD candidates and enticing them into academia. He and his co-author, geoinformatics specialist Greg Breetzke at the University of Pretoria, also note that black women, the country's largest demographic, remain significantly under-represented in universities, accounting for just 14% of academics in 2015.

Charles Sheppard, director of management information at Nelson Mandela University in Port Elizabeth, agrees that South Africa must focus on generating local PhDs. At the moment, it produces more doctorate-holders who hail from other African countries than from the home nation, he says. "We need to work harder on getting this right," he adds.

The latest study is the most well thought out, most evidenced-based and least anecdotal to address this complex problem yet, says Zeblon Vilakazi, deputy vice-chancellor at the University of the Witwatersrand in Johannesburg. “This is a step in the right direction,” says Vilakazi.

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Comments

Comments

There are currently no comments.

Hungary rewards highly cited scientists with bonus grants

Some top researchers prosper in Hungary as country tries to improve its international standing in science.

21 November 2017

Richard Wareham Fotografie/Alamy

Hungarian commissioner for research and innovation József Pálinkás has designed grants that reward research excellence.

Earlier this year, cell biologist Attila Reményi was facing his toughest decision since returning to his native Hungary a decade ago. With his

generous start-up funding about to run out, should he downsize his lab?

Then, in June, the government's National Research, Development and Innovation Office (NRDNI) put out a call for five-year basic-research grants of up to 300 million Hungarian forints (US$1.18 million) each for highly cited scientists such as Reményi. "It came out of the blue," says Reményi at the Hungarian Academy of Sciences (HAS) Research Centre for Natural Sciences, Budapest, who learnt on 13 November that he was among 12 winners.

But for NRDNI president József Pálinkás, the Frontline Research Excellence grants are the result of years of work. They are part of a plan to create a long-term, systematic plan of grants and rewards to encourage researchers in all fields to strive for world-class publications and to tempt Hungarian scientists working abroad to return. In a country whose leaders are coming under increasing criticism for autocratic and xenophobic tendencies, scientists say that the situation for science has never been rosier.

Under Viktor Orbán's nationalist government, this small, post-communist country has been steadily falling on *The Economist* magazine's Democracy Index. Last year, several foreign members of the HAS resigned, citing the failure of the academy to protest against what they saw as anti-democratic moves by the government. HAS president, mathematician László Lovász, responded that the academy is not a political organization. Scientists in the country are noticeably reluctant to comment publicly on politics, and several young researchers told *Nature* they fear that criticizing the government might compromise their careers.

Yet within this troubled political environment, Pálinkás, a physicist, has spent the past few years quietly persuading the government that basic science matters as much as product-focused research. Shortly after becoming president of the HAS in 2008, he created the Momentum system of start-up funding — one-time, five-year grants of up to 50 million forints per year — to encourage Hungarian scientists to set up independent labs back home. Reményi was a Momentum recipient in 2013.

In 2015, Pálinkás left HAS to become the founding director of the NRDNI, where he designed a system of regular grants to help ensure that returnees

stay after the start-up money runs out. The frontline grants are a key part of this, giving the recipients salaries equivalent to the European Union average, which is two-and-a-half times higher than the salary that a scientist would normally earn in Hungary. Around 50 of these grants will eventually run each year. The programme is modelled on European Research Council grants, but with a twist: only those who have published a paper in the past five years that counted among the top 10% most-cited papers in their discipline are eligible to apply. This approach “creates a lot of tension in the community, but without such serious selection science won’t work well,” says Pálinkás. To further encourage scientists to aim for quality over quantity, last year he introduced another reward for high-impact publication: researchers who within two years have a paper among the top 5% most highly cited in their field automatically receive a one-off payment of 20 million forints.

Hungary has a long tradition of research and outperforms other former communist countries in the EU on many measures. It has won more European Research Council grants and was the only country this year to win two Teaming grants: prestigious EU awards to create centres of excellence in 15 mostly eastern European countries in partnership with a western European research organization. It has also made some large investments, most generously in the Hungarian Brain Research Programme, launched in 2014, which has received 18.5 million forints up to 2021 and enabled many principal investigators to start their own labs. A 3-billion-forints programme has just been agreed in quantum technology. Five new programmes in areas including artificial intelligence and water research will be added next year, thanks to a 3% increase in the NRDNI budget, agreed in principle this month.

Hungary’s research performance still lags behind that of science-strong western European countries, however, and at 1.2% of gross domestic product, its research investment is well below the EU average of 2%. To support its scientific ambitions, Hungary has heavily invested its EU structural funds — subsidies to poorer regions — in expanding research infrastructure. The country’s scientists fear that when the current round of these funds runs out in 2019, these major investments may go to waste.

Pálinkás says that to avoid this, he will request a doubling of the national research budget in 2019. And despite the political challenges, Hungarian

scientists seem optimistic: “The situation for science is better than it has been before,” says Reményi. Immunologist Adam Dénes returned from the United Kingdom in 2012 to start his own lab at the HAS Institute of Experimental Medicine in Budapest, a move he describes as a “political, philosophical and career challenge”. But for now, he says, “the pluses are more than the minuses.”

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Comments

Comments

There are currently no comments.

European Medicines Agency to move to Amsterdam

The European Union’s drug regulatory body will leave London because of the United Kingdom’s Brexit plans.

20 November 2017

Aurore Belot/AFP/Getty

A man crosses a canal in Amsterdam.

After more than a year of uncertainty, the new home of the European Medicines Agency (EMA) is finally clear. The European Union member states chose Amsterdam from among 19 candidates, after a secret ballot on 20 November.

The transition is expected to be relatively smooth because more than 80% of staff indicated in a survey earlier this year that they would be prepared to relocate to Amsterdam with the agency.

Slovakian capital Bratislava had also been a hot favourite among commentators, most particularly because Slovakia does not yet host any EU agency. However, only 14% of the staff said they would be prepared to go there. In an interview with *Nature* last month, EMA executive director Guido Rasi said that a catastrophic loss of staff on such a scale might have crippled the agency.

The EMA, with its 900 or so employees, is responsible for determining the safety and efficacy of therapies and licensing them for marketing in the EU. It also monitors adverse reactions to marketed treatments. And it has been fundamental to the development of harmonized EU-wide regulations on 'advanced therapies' for serious diseases such as cancer — including treatments involving biological molecules, stem cells or cells that have been genetically manipulated.

In an analysis of the various bids in September, the EMA said that any transfer could result in delays to the approval of new medicines and a slowing down of some public-health initiatives such as those to tackle antimicrobial resistance. But full recovery could be expected in two to three years, it said.

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Comments

Comments

There are currently no comments.

How alkali flies stay dry

Waxy and hairy covering enables flies to dive underwater without getting wet.

20 November 2017

Floris van Breugel/Caltech

More than 150 years ago, American writer Mark Twain described how flies enter Mono Lake in California then “pop up to the surface as dry as a patent office report”. Now scientists have identified how they do so.

The alkali fly *Ephydra hians* can crawl down the side of the lake to depths of 8 metres and remain submerged for 15 minutes before emerging unscathed. Not only can it achieve this unusual feat, it does so in a lake whose waters are so alkaline and so salty that they support only algae, bacteria and brine

shrimps.

Diving bubble

Now two biologists at the California Institute of Technology in Pasadena have worked out how the fly creates the bubble of air that surrounds it during the dive. Floris van Breugel and Michael Dickinson filmed flies entering a solution that mimics the sodium-carbonate-rich conditions of the lake. The flies are covered in hairs that are coated in a waxy substance that repels water. As they enter the water, an air bubble forms around their entire bodies, apart from their eyes. Not only is this bubble protective, it also provides the flies with breathable oxygen.

The scientists found that the flies had a denser coat of hairs than other species that were unable to stay dry underwater. They also found that the waxy substance that coats these hairs contained smaller hydrocarbons than those of other species. They think that these two traits combine to help prevent *E. hians* from getting wet, in particular as it emerges to the surface through the negatively electrically charged air-water interface created by the conditions in the lake. The researchers report their findings in the *Proceedings of the National Academy of Sciences*[1].

There are other shore flies of the same family (Ephydridae) that crawl underwater to lay eggs, but not in such hostile conditions, says van Breugel. He hopes to compare alkali flies from different lakes around the world.

During the annual autumn migration, there can be as many as 2 million birds at Mono Lake at any given time, says van Breugel, and the flies are an important source of food. “This story is a beautiful example of how tiny interactions can have global ecological effects, because Mono Lake is such an important habitat for migratory birds,” he says.

“Van Breugel and Dickinson's paper not only provides an insightful and detailed explanation of underlying mechanisms for this behaviour, it is also an elegant bit of insect natural history,” says Stephen Marshall, an entomologist at the University of Guelph in Canada.

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Comments

Comments

There are currently no comments.

UK government announces research-spending hike ahead of budget

Pledge would raise country’s public research funding to £12.5 billion in 2021–22.

20 November 2017

The UK government seems to be making good on its promises to increase research spending significantly over the next decade.

In an announcement on 20 November, the government said that it would boost public spending on research and development (R&D;) to £12.5 billion (US$16.5 billion) in 2021–22, an increase of £500 million on what is planned for the year before. The hike builds on a surprise announcement made last year, when politicians promised yearly increases in research funding until 2020.

According to the London-based Campaign for Science and Engineering (CASE), the increase puts the United Kingdom on track to hit a government target to raise combined public and private spending on R&D; to 2.4% of gross domestic product (GDP) by 2027.

That would be a huge uptick in spending for Britain: the most recent figures show that the country spent just 1.7% of its GDP on R&D; in 2015, compared with 2.9% in Germany and 2.8% in the United States.

Hitting the target will also require private investment in R&D; to rise, and some researchers had wondered whether the United Kingdom would rely on private spending to boost its budget past 2020. But writing in the *Times* newspaper to accompany the announcement — which came two days before

the release of Britain's annual budget — Prime Minister Theresa May confirmed that the government planned to increase its public spending on R&D; year on year.

"This gives confidence that the government's plan is to keep rising public R&D; investment on target over the next ten years to reach parity with our international competitors," said Sarah Main, director of CASE. "We seem to have turned a corner. Government is matching its long-term ambition with concrete investment."

The latest money forms part of the government's Industrial Strategy, a range of policies aimed at boosting the economy across the country. Full details of the strategy will be published on 27 November, but May added in her article that it would include ways to encourage UK leadership in artificial intelligence, big data, clean energy and self-driving cars.

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Comments

Comments

There are currently no comments.

Exoplanet hunters rethink search for alien life

Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.

20 November 2017 Corrected:

1. 20 November 2017

Laramie, Wyoming

M. Kornmesser/ESO

The exoplanet Ross 128b orbits a cool dwarf star at a distance that could allov the world to have liquid water.

Steve Desch can see the future of exoplanet research, and it's not pretty. Imagine, he says, that astronomers use NASA's upcoming James Webb Space Telescope to scour the atmosphere of an Earth-mass world for signs of life. Then imagine that they chase hints of atmospheric oxygen for years — before realizing that those were false positives produced by geological activity instead of living things.

Desch, an astrophysicist at Arizona State University in Tempe, and other planet hunters met from 13-17 November in Laramie, Wyoming, to plot better ways to scout for life beyond Earth. Many are starting to argue that the standard definition of habitability — having liquid water on a planet's surface — is not the factor that should guide exoplanet exploration. Instead, the scientists say, the field should focus on the chances of detecting alien life, should it exist.

"Planets can be habitable and not have life with any impact," Desch told researchers at the meeting.

It turns out that water worlds may be some of the worst places to look for living things. One study presented at the meeting shows how a planet covered in oceans could be starved of phosphorus, a nutrient without which earthly life cannot thrive. Other work concludes that a planet swamped in even deeper water would be geologically dead, lacking any of the planetary processes that nurture life on Earth.

"Habitability is not only about finding the signature of an alien life form taking a deep breath," says Elizabeth Tasker, an astronomer and exoplanet researcher at the Japan Aerospace Exploration Agency's Institute for Space and Aeronautical Sciences in Sagamihara. It's also about how a planet's geology and chemistry interconnect to create a welcoming or hostile environment, she says — complicating the search for extraterrestrial life.

Surf and turf

Astronomers have catalogued thousands of exoplanets, of which more than a dozen are potentially habitable. The most recent, announced on 15

November, is Ross 128b, which is 3.4 parsecs (11 light years) away from Earth. It resembles the target that scientists have spent decades hunting: an Earth-sized planet orbiting a nearby star, probably at the right distance to allow liquid water.

Most of these planets have some qualities that stop them from being true Earth twins. Ross 128b orbits a cool dwarf star rather than a Sun-like host, for instance. But Tasker says the usual metrics that scientists use to rank how habitable a world is, such as its location relative to its star or how closely it resembles Earth, are misguided[1].

To figure out how to parcel out valuable observing time, some scientists suggest targeting planets that, like Earth, are thought to have a mix of ocean and land. That's because worlds with nothing but water on their surfaces may not have key nutrients available in forms that can support life — if it is based on the same chemistry as life on Earth.

“We have this stereotype that if we have oceans, we have life,” says Tessa Fisher, a microbial ecologist at Arizona State. But her recent work contradicts this idea. Fisher and her colleagues studied what would happen on an “aqua planet” with a surface that is almost or completely covered by enough water to fill Earth’s oceans five times.

On Earth, rainwater hitting rocks washes phosphorus and other nutrients into the oceans. But without any exposed land, there is no way for phosphorus to enrich water on an aqua planet over time, Fisher reported at the Laramie meeting. There would be no ocean organisms, such as plankton, to build up oxygen in the planet’s atmosphere, she says — making this type of world a terrible place to find life.

Wet blanket

The wettest planets would run into a different sort of trouble, says Cayman Unterborn, a geologist at Arizona State who analysed the planet-wide effects of having as much as 50 Earth oceans’ worth of water. The sheer weight of all that liquid would exert so much pressure on the sea floor that the planet’s

interior would not melt at all, Unterborn found.

Planets need at least some internal melting to sustain geological activity, such as plate tectonics, and to provide the right geochemical environment for life. In this case, Unterborn says, “too much water is too much of a good thing.”

Water-rich worlds are easy to make. Many planets are likely to have formed far from their parent star, Tasker says, in chilly temperatures where they could have coalesced from fragments of rock and lots of ice. If such a planet later migrated closer to its star, the ice would melt and cover the surface in vast oceans. Some of the seven small planets orbiting the star TRAPPIST-1, which is 12.6 parsecs (41 light years) from Earth, are thought to have substantial water on their surfaces[2].

Instead of instinctively studying such water worlds, Tasker says, astronomers need to think more deeply about how planets have evolved through time. “We need to look carefully at picking the right planet,” she says.

The James Webb Space Telescope is set to launch in 2019. Once in space, the telescope will spend much of its time studying potentially Earth-like worlds. Researchers have already begun to analyse how oxygen, methane or other ‘biosignature’ gases in exoplanet atmospheres might appear to the telescope’s view[3].

Towards the end of the Laramie meeting, attendees voted on whether scientists will find evidence of life on an exoplanet by 2040. They were not optimistic: 47 said no and 29 said yes. But a greater share was willing to bet that life would be found on another world in the 2050s or 2060s.

That's presumably enough time to work through the debate over which worlds are the best to target.

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Corrections

Corrected:

This story misstated the outcome of the vote at the Laramie meeting as 47% no to 29% yes. In fact, the result was 47 votes yes, 29 votes no.

Comments

Commenting is currently unavailable.

Online software spots genetic errors in cancer papers

Tool to scrutinize research papers identifies mistakes in gene sequences.

20 November 2017

Two scientists have rolled out a program that spots incorrect gene sequences reported in experiments — and have used it to identify flaws in more than 60 papers, almost all of them studies of cancer.

Jennifer Byrne, a cancer researcher at the Kids Research Institute of the Children's Hospital at Westmead in Sydney, Australia, and Cyril Labbé, a computer scientist at the University of Grenoble Alpes in Grenoble, France, made public an early version of the program, called Seek & Blastn, in October and now they want other researchers to test the program and help to improve it. They then plan to offer it to journal editors and publishers as an addition to the tools that most already use to check papers, such as software

to detect plagiarism.

Byrne has been working on identifying errors in human cancer papers since 2015, when she noticed problems with five papers on gene function in cancer cells. The authors of the papers described performing a common experiment in which they inactivated a gene using a short targeted nucleotide sequence, to observe its effects on tumour cells. Byrne was familiar with the gene because she was part of the team that reported it in 1998. And she realized that the papers reported using the wrong nucleotide sequences for the experiment they claimed to conduct. Two of these papers have since been retracted. Another two are expected to be retracted on 21 November.

Experimental errors

After noticing similar errors in another 25 papers, Byrne and Labbé developed the Seek & Blastn tool to discover more papers with incorrectly identified nucleotide fragments. The software extracts nucleotide sequences from uploaded papers and cross-checks them against a public database of nucleotides, called the Nucleotide Basic Local Alignment Search Tool (Blastn).

“Seek & Blastn tries to find mismatches between the claimed status of a sequence — what the paper says it does — and what the sequence actually is,” says Byrne. A mismatch is flagged, for instance, when a sequence described as targeting a human gene doesn’t find a match in the Blastn database. Sequences described as non-targeting that do have a match in the Blastn database are also detected.

So far, the program detects only misidentified human sequences, says Labbé, but the pair hope to develop it to check sequences from other species, such as mice. The program also struggles to pick up misidentified sequences if the description is unclear in the original paper. This can cause the program to miss some mistakes and to flag papers that have no errors, so all papers put through the software should also be checked manually, he says.

The pair say that they used Seek & Blastn to detect mismatched sequences in

another 60 papers. Many of these manuscripts have other problems, such as poor-quality images, graphs and large chunks of overlapping text, all of which make some of the papers “strikingly similar” to each other, says Byrne. With the help of colleagues, they are now manually checking the papers.

Although some errors are minor or accidental, Byrne says the majority of the mismatches they have detected in papers may invalidate the results and conclusions. When you see these incorrectly identified sequences, she says, “you do get concerned about how the results were produced and whether the results in the paper actually reflect the experiments that were done”.

In a 2016 study[1] in *Scientometrics*, Byrne and Labbé reported 48 problematic papers, including the 30 papers that had incorrectly identified nucleotide fragments. These were all written by authors from China. The duo did not publicly identify the papers, apart from the five papers from 2015, but privately contacted journal editors, Byrne says. Many of the editors have not responded, she says. But three more papers have been retracted. In total, the pair have identified incorrect sequences in more than 90 papers.

Automated tools such as Seek & Blastn are most valuable if they are used to promote good scientific practice and encourage scientists to avoid errors in the first place, rather than just catch people out, says statistician David Allison at Indiana University in Bloomington, who has spotted many papers with substantial errors. Such tools could also help to quantify error rates in particular journals and fields, he says.

Matt Hodgkinson, head of research integrity for open-access publisher Hindawi in London, which retracted two of the papers from its journal *BioMed Research International*, says he could see publishers using Seek & Blastn as part of the article-screening process. “It would depend on the cost and ease of use, whether it can be used and interpreted at scale,” says Hodgkinson. Staff or academic editors would also need to check the output, given the risk for false positives, he says.

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Comments

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Sex matters in experiments on party drug — in mice

Ketamine lifts rodents' mood only if administered by male researchers.

17 November 2017

unoL/Getty

When it comes to lab mice and antidepressants, it's complicated.

Mouse experiments with the popular club drug ketamine may be skewed by the sex of the researcher performing them, a study suggests.

The findings, presented on 14 November at the Society for Neuroscience (SfN) meeting in Washington DC, only deepen the mystery of how ketamine,

which has powerful mood-lifting properties, interacts with the brain. They also raise questions about the reproducibility of behavioural experiments in mice.

Ketamine is best known as a psychoactive recreational drug. But it has caught psychiatrists' interest because of its potential to treat depression within hours. It's unclear exactly how the drug works, however, and many researchers are using animal models to suss out the mechanism.

Polymnia Georgiou, a neuroscientist at the University of Maryland in Baltimore, is one of them. In 2015, a male colleague asked her to run some experiments for him while he was out of town, including a standard way of testing antidepressants called the forced-swim test. In this assay, researchers inject healthy mice with a drug, place them into a tank of water and measure how long they swim before they give up and wait for someone to rescue them.

Antidepressants can cause healthy mice to swim for longer than their untreated counterparts, which is what Georgiou's male colleague found during his experiments using ketamine.

Scents and the brain

But although Georgiou followed his protocol exactly, she found that treated mice did not swim for any longer than mice injected with a placebo. When she and three female and four male researchers investigated this disconnect by performing the experiments, they discovered that the ketamine acted as an antidepressant only when it was administered by men.

Suspecting that scent was involved, the researchers put the animals inside a fume hood so that the mice couldn't smell who was injecting them. This completely eliminated the effect of the ketamine, regardless of the experimenter's sex. When Georgiou and her colleagues placed a t-shirt worn by a man next to the mice in the fume hood, mice injected with ketamine swam for longer than those injected with a placebo. This suggested that male odour was necessary for the drug to work.

The head of Georgiou's lab, neuroscientist Todd Gould, learned that antidepressant researcher Ronald Duman at Yale University in New Haven, Connecticut, was seeing similar effects with female researchers in his lab that were working on ketamine experiments. So Gould asked Duman to repeat Georgiou's swim-test experiment in his own lab. When eight male and eight female researchers injected mice with ketamine, they saw the same results: mice injected by women did not respond to the drug.

Georgiou and her colleagues repeated the experiments with other antidepressants, but the researchers' sex didn't seem to matter. She and Gould suspect that the antidepressant effect is the result of a specific interaction between ketamine and the male odour in the mouse brain .

But other evidence suggests that the sex of the researcher can affect other types of behavioural experiment, not just those involving ketamine. A 2014 paper[1] in *Nature Methods* found that mice were more stressed and less likely to respond to pain when handled by a male researcher. And behavioural neuroscientist Silvana Chiavegatto of the University of São Paulo in Brazil, who was at Georgiou's SfN presentation, says that she has seen the same phenomenon in her lab, where she studies depression but doesn't use ketamine.

Rethinking the model

"I think it's really fascinating, with wide implications for our field," says Adrienne Betz, a behavioural neuroscientist at Quinnipiac University in Hamden, Connecticut. But she cautions that the results are preliminary, and it remains to be seen whether the effect is specific to ketamine and to mice.

Others disagree about the potential implications. Hundreds of papers with female experimenters demonstrate the effects of antidepressants — including ketamine — in mice, says Lisa Monteggia, a neuroscientist at the University of Texas Southwestern in Dallas. Other factors, such as whether the researcher is stressed when he or she injects the mice, might affect the animals' behaviour, she says.

Gould and Georgiou say that their results don’t necessarily invalidate previous studies; they simply show that ketamine experiments in their lab work only when men inject the mice. There is overwhelming evidence that ketamine is a powerful antidepressant in humans. Gould doubts that the sex of the person administering the drug affects how well it works in a depressed patient, but it's never been tested.

He adds that the findings suggest that researchers studying drugs' effects on mouse behaviour should report the sex of the experimenter in their publications to ensure that other labs can replicate the results. “There are a number of factors that influence replicability and are unrecognized — this is one of them,” Gould says. “For us, it is an inconvenient truth.”

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Comments

Comments

There are currently no comments.

Giant telescope’s mobile-phone ‘dead zones’ rile South African residents

Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.

17 November 2017

Mujahid Safodien/AFP/Getty

South Africa has already built prototype dishes that will form part of the Square Kilometre Array, which will be the world’s largest radio telescope.

A map showing how mobile-phone use might be restricted because of a giant

radio telescope in South Africa has angered people who will live near the instrument — deepening a rift between the local farming community and those backing the project.

The row has arisen over the South African portion of the Square Kilometre Array (SKA), which will eventually consist of thousands of radio dishes in Africa and up to a million antennas in Australia. The array, which begins construction in 2019 for completion in the 2030s, will have a total signal-collecting area of more than 1 square kilometre, making it the world's largest radio telescope. The telescope's first phase in South Africa involves 194 radio dishes, to be laid out like a galaxy with three arms spiralling out from a core cluster.

Local residents in the Northern Cape province, where the government has acquired nearly 1,400 square kilometres of land for the initial phase, have already expressed concerns about the telescope. Some are angry that the SKA won't boost the region's economy as much as they had expected; others fear the land acquisition will damage local agricultural activity — in particular, sheep farming.

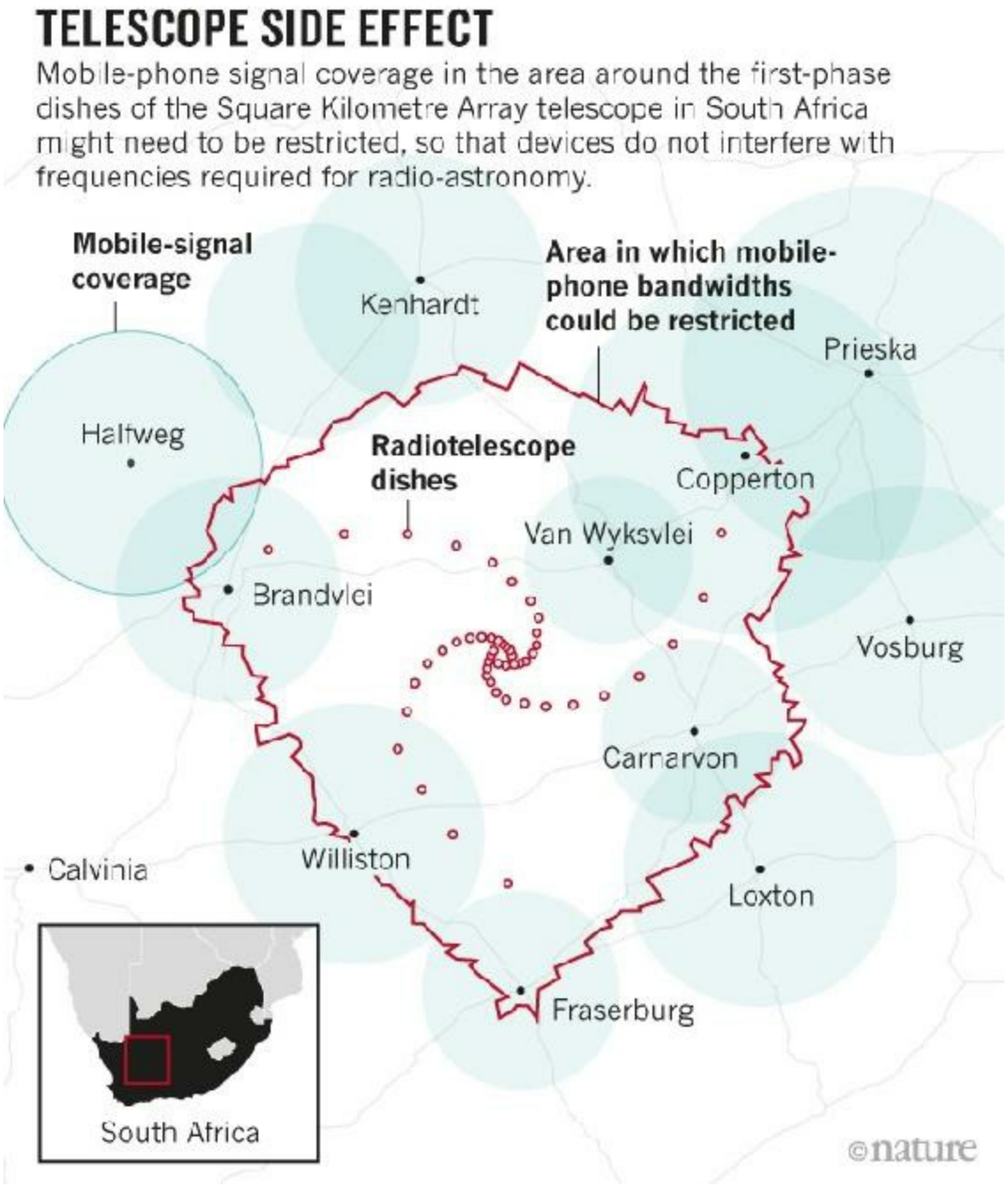
But the map of projected mobile-phone coverage around the project, uploaded to Facebook on 2 November, has brought to light another problem facing the local community. It shows the area around the SKA's radio dishes where the use of electronic devices will eventually be restricted, because their signals would interfere with the relatively weak radio signals that the dishes will try to pick up from the distant Universe.

Communications problem

Nearby residents had been aware that mobile-reception 'dead zones' could be a side effect of the SKA. But Eric Torr, a light-aircraft-business owner who uploaded the map, says it shows the area affected is "larger than we were led to believe". The map suggests that six towns fall into the dead zone, he says, and that this could have serious implications for their farming economies.

The map was produced by the South African Radio Astronomy Observatory

(SARAO), which is leading the SKA project in South Africa. Lorenzo Raynard, head of communications at the SARAO, says it shows areas where mobile-phone coverage could be reduced by 20% or more (see ‘Telescope side effect’). The chart was part of a presentation calling on businesses to submit alternative communications solutions for affected areas, he says.



Adapted from SARAO map

An informal collection of farming organizations has already been working with the observatory to find alternative communications technologies, such as satellite phones, that can be used around the antennas, according to Henning Myburgh, a farmer in the area. “Adequate electronic communications, especially for children, are a basic human right,” he says. Myburgh says that the cooperative’s search has now moved to finding cell-phone technologies that can co-exist with the SKA and replicate the phone facilities the farmers currently have. “This is a major shift and if possible will be a huge step forward,” he says.

Still, says Myburgh, there are farmers who are unhappy. “I don't think that anybody will ever be happy with the situation, taking into account the massively intrusive nature of the project in the region,” he says.

Nicol Jacobs, who farms in the spiral arms, says the SKA was originally going to affect only two farms. He says he found out about the full extent of the telescope when the government began buying more farms. “We’re going to be eaten piece by piece,” he says. Jacobs says he would like the government to return the bought farms to the agricultural community: “I will fight as long as I can,” he adds.

Despite residents’ annoyance, South African law says that the country’s science and technology minister can preserve the area of the SKA’s land for astronomy. The department of science and technology, which oversees astronomy in the country, is responsible for finalizing regulations about areas that will lose mobile-phone coverage, and to define radio-wave frequencies that will be protected for astronomy. Asked when they would be finalized, the department’s astronomy-management authority declined to give a firm date.

Environmental assessment

Although resident’s complaints may not affect the SKA’s layout, an environmental assessment — due to be finalized next year — could change matters.

Earlier this month, the SARAO tasked the South African Environmental Observation Network to implement an environmental assessment of the telescope site, and made 3 million rand (US$209,000) available for the work.

“The relative position of the dishes determines the quality of the telescope beam,” says Robert Braun, science director at SKA Organisation, which is designing the telescope.

The organization has drawn up an ideal map of dish positions, says Braun. But it might have to shift them if the environmental assessment finds that local habitats or biomes are affected, says Casper Crous, an ecologist who is part of the assessment collaboration.

The overarching plan is to turn South Africa’s SKA site into a nature reserve and a site for long-term environmental research once the telescope is operational, says Crous. So a no-go zone for dishes, for example, “would be kokerboom [quiver tree] populations or ephemeral wetlands — areas that if impacted are unlikely to ever recover,” he says.

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Nature News

周一, 06 11月 2017

Nature News

[周一, 06 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Energy researcher sues the US National Academy of Sciences for millions of dollars** [周五, 03 11月 08:00]
  Rare move stems from a conflict over two journal articles about renewable energy.
- **US government report says that climate change is real — and humans are to blame** [周五, 03 11月 08:00]
  Conclusions of climate-change science analysis are at odds with US President Donald Trump's policies.
- **Newly discovered orangutan species is also the most endangered** [周四, 02 11月 08:00]
  The first new species of great ape described in more than eight decades faces threats to its habitat.
- **Gut microbes can shape responses to cancer immunotherapy** [周四, 02 11月 08:00]
  Studies find that species diversity and antibiotics influence cutting-edge treaments.
- **Controversial chairman of US House science committee to retire** [周四, 02 11月 08:00]
  Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.
- **Infusions of young blood tested in patients with dementia** [周三, 01 11月 08:00]
  The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.
- **Pay for US postdocs varies wildly by institution** [周三, 01 11月 08:00]
  Analysis of universities' salary data suggests major disparities in pay for early-career researchers.
- **Citation is not the only impact** [周三, 01 11月 08:00]
  A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.
- **University systems allow sexual harassers to thrive** [周三, 01 11月 08:00]
  It's time for academic institutions to take responsibility for protecting students and staff, says

Laurel Issen.

- **Interstellar visitor, Arctic shipwrecks and a retraction recommendation** [周三, 01 11月 08:00]
  The week in science: 27 October–2 November 2017.
- **Plans to promote German research excellence come under fire** [周三, 01 11月 08:00]
  Critics say selection process for high-stakes funding programme is flawed.
- **The new thermodynamics: how quantum physics is bending the rules** [周三, 01 11月 08:00]
  Experiments are starting to probe the limits of the classical laws of thermodynamics.
- **Join the disruptors of health science** [周三, 01 11月 08:00]
  Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.
- **Astrophysics: Chasing ghosts in Antarctica** [周三, 01 11月 08:00]
  Alexandra Witze welcomes a history of IceCube, an ambitious neutrino observatory.
- **Books in brief** [周三, 01 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.
- **Zoology: The joys of spinelessness** [周三, 01 11月 08:00]
  Lisa-ann Gershwin delights in two books on marine invertebrates.
- **Human embryos: Collect reliable data on embryo selection** [周三, 01 11月 08:00]
- **Night shifts: Circadian biology for public health** [周三, 01 11月 08:00]
- **Crime fiction: Sherlock Holmes — a family likeness?** [周三, 01 11月 08:00]
- **Forestry: Sustainability crisis brews in EU forestry** [周三, 01 11月 08:00]
- **Spanish government takes control of Catalonian universities** [周二, 31 10月 08:00]
  Madrid will oversee the finances of the region's research centres and seven public universities.
- **Seeds, sponges and spinal surgery** [周二, 31 10月 08:00]
  October’s sharpest science shots, selected by Nature ’s photo team.
- **Small group scoops international effort to sequence huge wheat genome** [周二, 31 10月 08:00]
  Just six scientists conquer one of the most complicated genomes ever read.
- **Astronomers race to learn from first interstellar asteroid ever seen** [周二, 31 10月 08:00]

Wonky orbit confirms that this visitor isn’t from around here.

- **How baby bats develop their dialects** [周二, 31 10月 08:00]
  The young animals crowdsource the pitch of their calls from colony members.
- **US environment agency bars scientists it funds from serving on its advisory boards** [周二, 31 10月 08:00]
  The US Environmental Protection Agency says the policy will address potential conflicts of interest, but scientists raise alarms.
- **Frédéric Chopin’s telltale heart** [周二, 31 10月 08:00]
  Scientists have written another chapter in the curious case of the composer’s heart. But it is unlikely to be the end of the story.
- **Lower emissions on the high seas** [周二, 31 10月 08:00]
  Global regulations to limit carbon dioxide from the shipping industry are overdue.
- **Lessons from first campus carbon-pricing scheme** [周二, 31 10月 08:00]
  Putting a value on emissions can lower energy use, write Kenneth Gillingham, Stefano Carattini and Daniel Esty.
- **Huge microwave observatory to search for cosmic inflation** [周一, 30 10月 08:00]
  Multi-telescope project has ambitious goals and a big price tag.
- **Geneticists are starting to unravel evolution's role in mental illness** [周一, 30 10月 08:00]
  Hints emerge that past environments could have influenced psychiatric disorders.

Energy researcher sues the US National Academy of Sciences for millions of dollars

Rare move stems from a conflict over two journal articles about renewable energy.

03 November 2017

Eric Thayer/Bloomberg/Getty

Renewable energy, including from wind, is at the heart of a multi-million dollar lawsuit.

A scientific dispute about the future of alternative energy has landed in a US

court. Mark Jacobson, an environmental and civil engineer at Stanford University in California, has filed a libel lawsuit against the US National Academy of Sciences (NAS) and a researcher who published a study in the academy's journal that criticized Jacobson's work.

Jacobson, who filed suit in superior court in Washington DC in late September, is seeking damages of US$10 million. He also wants the *Proceedings of the National Academy of Sciences* (*PNAS*) to retract the article it published by mathematician Christopher Clack in 2015. The NAS and Clack have until late November to respond, according to court documents. Some experts are worried that the lawsuit could dampen scientific progress on renewable energies. But others defend the move, saying researchers should be able to take advantage of all civil avenues in defense of their work.

Jacobson was the lead author of a high-profile *PNAS* paper[1] published in December 2015 making the case that the continental United States could meet nearly 100% of its energy needs using wind, water and solar sources as early as 2050. A rebuttal[2] written by Clack — then at the University of Colorado Boulder — and 20 co-authors, and published in *PNAS* in June 2017, questioned Jacobson's methodology and challenged his conclusions. The authors argued, among other things, that Jacobson’s paper overestimated the maximum outputs from hydroelectric facilities and the nation’s capacity to store energy produced by renewable sources.

In the lawsuit, Jacobson says that he had alerted *PNAS* to 30 falsehoods and five “materially misleading statements” in Clack’s paper before its publication. The complaint states that almost all of those inaccuracies remained in the published version. Jacobson also argues that “the decision by NAS to publish the Clack Paper in PNAS has had grave ramifications” for his reputation and career.

In a letter[3] accompanying Clack’s paper in *PNAS*, Jacobson and three co-authors wrote that Clack’s criticisms are “demonstrably false”. They maintained that their projections regarding hydroelectric power were based on an assumed increase in the number of turbines and were not a “modeling mistake”.

Conflict resolution

Some observers are disappointed to see the conflict play out in court. The diversity of engineering models that form the basis of long-term energy projections should be celebrated, not litigated, says chemical engineer Daniel Schwartz, director of the Clean Energy Institute at the University of Washington in Seattle. “Bringing this dispute into the court of law, regardless of outcome, is a step towards devaluing the debate of underlying engineering assumptions,” he says.

“This dispute is likely to be most harmful to the scientific community, which has already been subject to lawsuits from groups sceptical of climate change,” says David Adelman, who studies environmental law at the University of Texas in Austin.

Suing a journal over a scientific disagreement is a rare move, says Adil Shamoo, a biochemist at the University of Maryland School of Medicine in Baltimore and editor-in-chief of the journal *Accountability in Research*, which is published by Taylor & Francis. But Shamoo thinks that scientists should be able to sue if they feel that a paper is “reckless” or “malicious”. “I’m a great believer in using all of the avenues of a civil society,” he says.

Shamoo does think that Clack’s paper was “unduly harsh and personal”. He says that “it was not written as if it was part of a scientific dialogue”.

Clack declined to respond to Shamoo’s characterization of his paper, but says that he is disappointed that Jacobson filed the lawsuit. Clack — now chief executive of Vibrant Clean Energy LLC in Boulder — says that his rebuttal paper “underwent very vigorous peer review”, and that the *PNAS* editors had considered Jacobson’s criticisms but found them to be “without merit”.

Jacobson says that he “cannot comment” on the lawsuit. And a spokesperson for the NAS says that “we do not comment on pending litigation”.

Journal name:
Nature
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Comments

Commenting is currently unavailable.

US government report says that climate change is real — and humans are to blame

Conclusions of climate-change science analysis are at odds with US President Donald Trump's policies.

03 November 2017

Drew Angerer/Getty

Heat waves are growing more common in many parts of the United States.

From warmer temperatures to more extreme weather, melting glaciers and rising sea levels, humanity is fundamentally changing the planet by pumping

greenhouse gases into the atmosphere, US government scientists said on 3 November in their latest assessment of climate science.

The average global temperature has increased by 1 °C since the start of the Industrial Revolution, the 600-page report says — adding that the last 115 years comprise “the warmest period in the history of modern civilization”. The analysis warns that temperatures could increase another 4 °C by the end of the century, with dramatic consequences for humans and natural ecosystems.

The findings are at odds with the policies of US President Donald Trump, who has questioned well-established tenets of climate science and vowed to protect and promote the US fossil-fuel industry. Trump's stances led many scientists to worry that his administration would try to block or tamper with the climate-change assessment, but several scientists who helped to write the document reported no problems.

“We weren’t interfered with, and we ended up producing something that I think is of tremendous value,” says David Fahey, an atmospheric scientist with the National Oceanic and Atmospheric Administration in Boulder, Colorado, and a coordinating lead author of the analysis.

The climate-science report is the first volume of the fourth National Climate Assessment, a legally mandated analysis of the causes and impacts of global warming that is due in 2018. The other two parts of the forthcoming assessment were released today in draft form, for public comment. One analysis focuses on how climate change is affecting life in the United States, from crop yields to property damage from extreme weather. The other summarizes the latest findings on the global carbon cycle. Both of those documents will undergo a formal review by the US National Academy of Sciences.

“The science speaks for itself,” says Don Wuebbles, a climate scientist at the University of Illinois at Urbana-Champaign and co-chair of the climate-science report. “It’s hard to counteract the basic observations and the truth of the science with any kind of political playing around.”

The trio of documents paints a dramatic picture of how global warming is

affecting people and communities across the United States. Tidal flooding is accelerating in more than 25 coastal cities along the Atlantic Ocean and Gulf of Mexico. Large forest fires have become more frequent in the western part of the country, while warmer spring temperatures and shrinking mountain snowpack are combining to reduce the amount of water available to the region's cities and farms. As a result, the draft climate-impacts report warns, “chronic, long-duration hydrological drought is increasingly possible before the end of the century”.

The report comes just days before the latest United Nations climate talks kick off in Bonn, Germany. It will also be the first major summit since Trump vowed to pull the United States out of the 2015 Paris climate pact.

Few observers expect US government's latest set of climate-change analyses to affect how the Trump administation approaches energy and environmental issues. In August, the US National Oceanic and Atmospheric Administration disbanded an advisory committee that was intended to help the nation prepare for a warmer climate, by translating the findings of the coming climate assessment into guidance for cities, states and industry.

Nor is it clear whether senior Trump administration officials will accept the reports' core scientific conclusions. As recently as March, US Environmental Protection Agency administrator Scott Pruitt said he did not believe that carbon dioxide is a major driver of global warming.

Nonetheless, many scientists and environmentalists lauded the new reports for bolstering the case for more-aggressive action against climate change.

“The full assessment, when it gets published, is going to show that there are palpable impacts that are going to hit every part of the country,” says Andrew Light, a senior fellow at the World Resources Institute, an environmental think-tank in Washington DC. “It’s the responsibility of leaders to take note of that and act accordingly.”

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Nature
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doi:10.1038/nature.2017.22958

Comments

There are currently no comments.

Newly discovered orangutan species is also the most endangered

The first new species of great ape described in more than eight decades faces threats to its habitat.

02 November 2017

Maxime Aliaga/SOCP-Batang Toru Programme

Orangutans in Sumatra's Batang Toru forest are now officially a new species: *Pongo tapanuliensis.*

Almost a century after scientists first heard rumours of its existence, an isolated population of orangutans on the Indonesian island of Sumatra has

been confirmed as a new species — just as its habitat faces imminent threats.

The population, estimated at fewer than 800 individuals, inhabits the Batang Toru forest in western Sumatra. A researcher exploring the area in the 1930s wrote of reports of an isolated orangutan population. But it wasn't until biological anthropologist Erik Meijaard, the founder of conservation group Borneo Futures in Jakarta, discovered the paper in the mid-1990s that scientists went looking for the Batang Toru group. Local villagers showed researchers the remains of a female orangutan, and nests in the area confirmed the presence of a population. A male orangutan killed by locals in 2013 provided key evidence: intact tissue and bone.

From the start, scientists noticed that these apes looked different from other orangutans. They had smaller heads, with flatter faces, and their hair was frizzier than that of their cousins living farther north on Sumatra or on the nearby island of Borneo.

Gene gap

Now, genetic tests, field observations and a comparison of the male skeleton against 33 orangutan specimens in museums have revealed that the Batang Toru group is, in fact, a distinct species. Named *Pongo tapanuliensis*, the newly identified great ape is described in *Current Biology*[1] on 2 November by a team that included most of the world's orangutan experts. "It's taken 20 years to come to the realization of what this is," Meijaard says.

Although the genetic analysis of *P. tapanuliensis* relies on a single skeleton, Meijaard says that's not unusual in taxonomy. Many studies, including others he's contributed to, rely on a single piece of evidence, and typically consider only morphology. The latest study shows that the group is distinct not only in morphology, but also in genetics and behaviour, he says.

Matthew G. Nowak

P. tapanuliensis orangutans have smaller heads and flatter faces than their cousins elsewhere on Sumatra and on Borneo.

Russ Mittermeier, executive vice-chair of Washington, DC-based Conservation International and chair of the primate-specialist group at the International Union for Conservation of Nature (IUCN), describes the evidence as “unquestionably” sufficient to support the new species designation. “Although we have had 87 new species of primates described since 2000, this is the first new great ape species since 1929.”

Biruté Mary Galdikas, an orangutan specialist in Los Angeles who founded Orangutan Foundation International, says that the study confirms what she and other orangutan researchers have suspected for decades. “I am not surprised that there is a new species or subspecies of orangutan described from Sumatra,” she says.

Ancestral ties

Key to the determination was tracing the population’s ancestry. Surprisingly, Meijaard says, genetic testing of the Batang Toru skeleton revealed that the population is more closely related to Bornean orangutans, despite living on the same island as the other Sumatran group. That’s probably because of how

orangutans migrated to the region, he says.

All orangutans trace their origins to ancestors that lived on the Asian mainland about 8 million years ago. Those great apes migrated to what is now Sumatra, when sea levels were lower and the lands were connected. Genetic data suggest the Batang Toru species is the closest descendant of those first arrivals.

The other Sumatran orangutans, which live in the island's far north, split off from the Batang Toru group about 3.4 million years ago, modelling based on genetic data suggests. The Bornean orangutans also split from the Batang Toru group, but much later — about 674,000 years ago — which explains why those two populations are more similar, Meijaard says.

Even as Batang Toru's orangutans are named a new species, the animals' long-term survival is uncertain. Previous population analyses suggest there are fewer than 800 individuals, making it the most endangered of the great apes. Although much of its habitat is protected by the Indonesian government, a proposed hydroelectric dam on the Batang Toru river would flood part of the area and divide the population into two, isolating the groups on either side of the river. That's likely to further shrink the gene pool in the already inbred population, Meijaard says. The dam would also bring more people to the area, potentially increasing hunting pressure.

Conservation groups are working with government officials to find an alternative site for the project, says Meijaard. "There is no doubt that conservation efforts are needed immediately," Mittermeier says.

The IUCN primate-specialist group has recently recommended that the species be included on the IUCN Red List of Threatened Species. A decision is expected in December. "It would be bitterly ironic if it goes extinct as a biologically viable population just as it is described as a new species," says Galdikas.

Journal name:
Nature
DOI:
doi:10.1038/nature.2017.22934

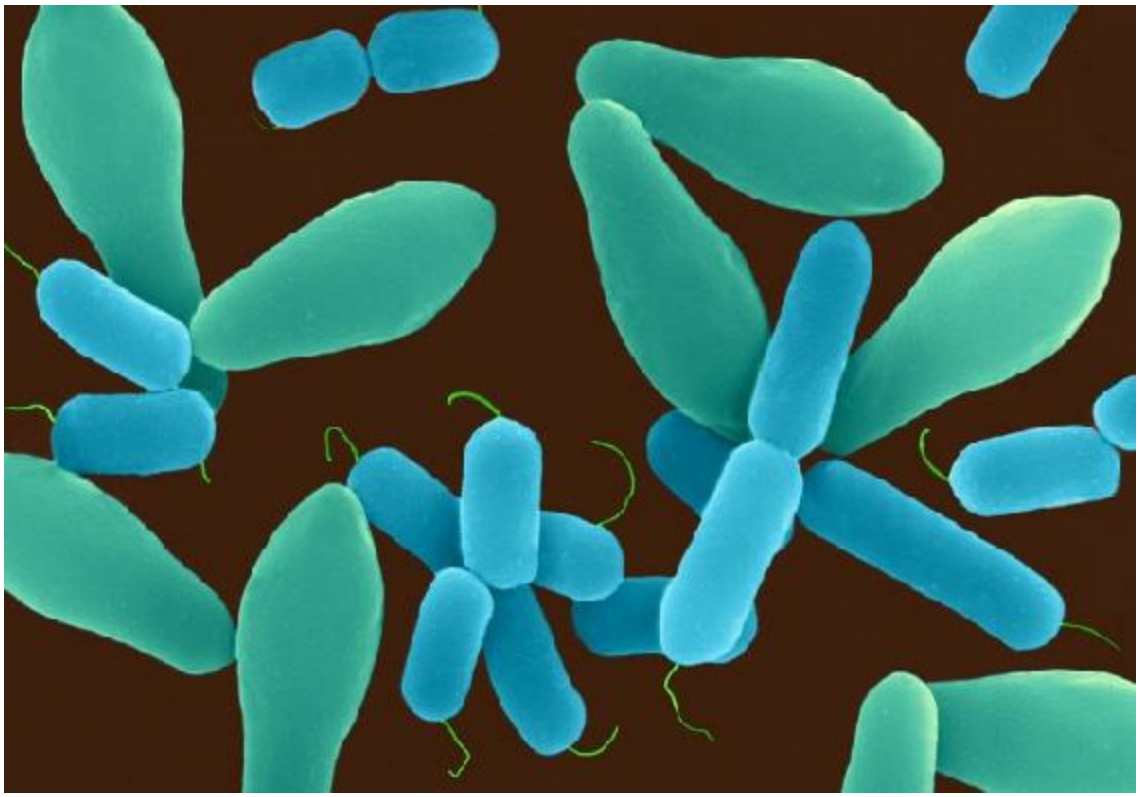
Comments

There are currently no comments.

Gut microbes can shape responses to cancer immunotherapy

Studies find that species diversity and antibiotics influence cutting-edge treaments.

02 November 2017



Dennis Kunkel Microscopy/SPL

Gut bacteria such as these *Clostridium* could improve a patient's reponse to cancer immunotherapies.

Cancer immunotherapies unleash the body’s immune system to fight cancer, but microbes living in a patient’s gut can affect the outcome of those

treatments, two research teams have found.

Their studies, published on 2 November in *Science*[1, 2], are the latest in a wave of results linking two of the hottest fields in biomedical research: cancer immunotherapy and the role of the body's resident microbes, referred to collectively as the microbiome, in disease.

They also highlight the impact of antibiotics on cancer immunotherapies, particularly drugs that block either of two related proteins called PD-1 and PD-L1. One of the studies found that people treated with antibiotics for unrelated infections had a reduced response to these immunotherapies.

“It raises important questions,” says cancer researcher Jennifer Wargo of the University of Texas MD Anderson Cancer Center in Houston, and an author of one of the studies. “Should we be limiting or tightly monitoring antibiotic use in these patients? And can we actually change the microbiome to enhance responses to therapy?”

The composition and diversity of the microbiome has been linked to everything from mental-health disorders to some side effects of cancer chemotherapy. In 2015, researchers working on mice reported that a specific genus of bacterium in the gut enhanced anti-tumour responses to drugs that target PD-L1[3].

Wargo saw a presentation about the work at a cancer meeting several years ago. “I was floored,” she says. Wargo saw an opportunity to expand the work to humans through her access to clinical samples at MD Anderson.

Exerting influence

Wargo teamed up with epidemiologist Vancheswaran Gopalakrishnan and other researchers to collect faecal samples from more than 100 people with advanced melanoma before they began treatment with anti-PD-1 immunotherapy drugs. The scientists found that those who had the most diverse gut microbes were most likely to respond to the immunotherapy[1]. And tumour growth was reduced in mice that received faecal transplants from

people who responded to immunotherapy.

The type of microbe was also linked to differences in responses to treatment, the researchers discovered. For example, people whose guts contained a lot of bacteria from a group called Clostridiales were more likely to respond to treatment, whereas those who had more Bacteroidales bacteria were less likely to respond.

A second study[2] showed that people who received antibiotics to treat infections shortly before or after starting immunotherapy did not respond as well to PD-1-blocking therapies. The researchers — led by cancer immunologist Laurence Zitvogel and cancer biologist Guido Kroemer, both of the Gustave Roussy Cancer Campus in Villejuif, France — also found that the presence of the bacterium *Akkermansia muciniphila* in both humans and mice was linked to better responses to immunotherapy.

Although it's too early for clinicians to change how they use antibiotics in people with cancer, the work is a step beyond previous studies that relied mainly on mouse models of cancer, says immunologist Romina Goldszmid of the National Cancer Institute in Bethesda, Maryland.

Now, she says, researchers need to learn more about how those microbes exert their influence on the immune system. "What's really missing in the field, rather than knowing who is there and who isn't there, is knowing what the bugs are doing," she says. "We need more information about that."

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Nature
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doi:10.1038/nature.2017.22938

Comments

Comments

There are currently no comments.

Controversial chairman of US House science committee to retire

Representative Lamar Smith, a Republican from Texas, will not run for re-election in 2018.

02 November 2017

Bill Clark/CQ Roll Call/Getty

Representative Lamar Smith was first elected to the US Congress in 1987.

Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, will retire when his term expires late next year.

Smith, a Texas Republican, has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation (NSF) and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. Since taking the helm of the science committee in 2013, he has transformed it from a relatively deliberative panel into an investigative weapon.

Under the rules of the House of Representatives, which limit committee chairs to six years in the role, Smith would have been forced to relinquish his post on the science panel in 2019. That is one of the reasons he decided against running for re-election, according to news reports; the other is the upcoming birth of his second grandchild. As the news of his retirement made the rounds, many scientists and environmentalists celebrated.

“It is a relief,” says Katharine Hayhoe, director of the Climate Science Center at Texas Tech University in Lubbock. Although many politicians have rejected the conclusions of climate science out of political expediency, she says, Smith has been more aggressive than most.

The congressman has repeatedly tried to reshape the NSF, sponsoring multiple pieces of legislation that would require the agency to justify its grants and explain how they serve the “national interest”. He has also pushed unsuccessfully to scale back programmes in geoscience and social sciences, among other fields.

Smith has notably scrutinized the work of climate scientists. In 2015, he attempted to compel the US National Oceanic and Atmospheric Administration (NOAA) to hand over internal documents related to a climate-change study. The research, published in *Science* in 2015[1], sought to dispel the idea that the rate of global warming had slowed down around the turn of the century. Smith went so far as to accuse a NOAA official — Thomas Karl, who has since retired — of manipulating data to advance an “extreme climate change agenda”.

In 2016, Smith came to the defence of oil giant Exxon Mobil when it was being investigated by the attorneys-general of New York and Massachusetts, who wanted to know whether the firm had misled investors about the

financial implications of global warming. Smith issued subpoenas to the attorneys-general as part of a broader probe, which also targeted environmental groups that have accused Exxon Mobil of suppressing internal research and spreading false information about climate change.

“I think [Smith’s] position on peer review, on the NSF and climate science put him at odds with the science community,” says physicist Neal Lane, a former NSF director who served as science adviser to former president Bill Clinton. “But it was consistent with that of the leadership in the House, which can hardly be described as pro-science.”

Journal name:
Nature
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doi:10.1038/nature.2017.22954

Comments

Comments

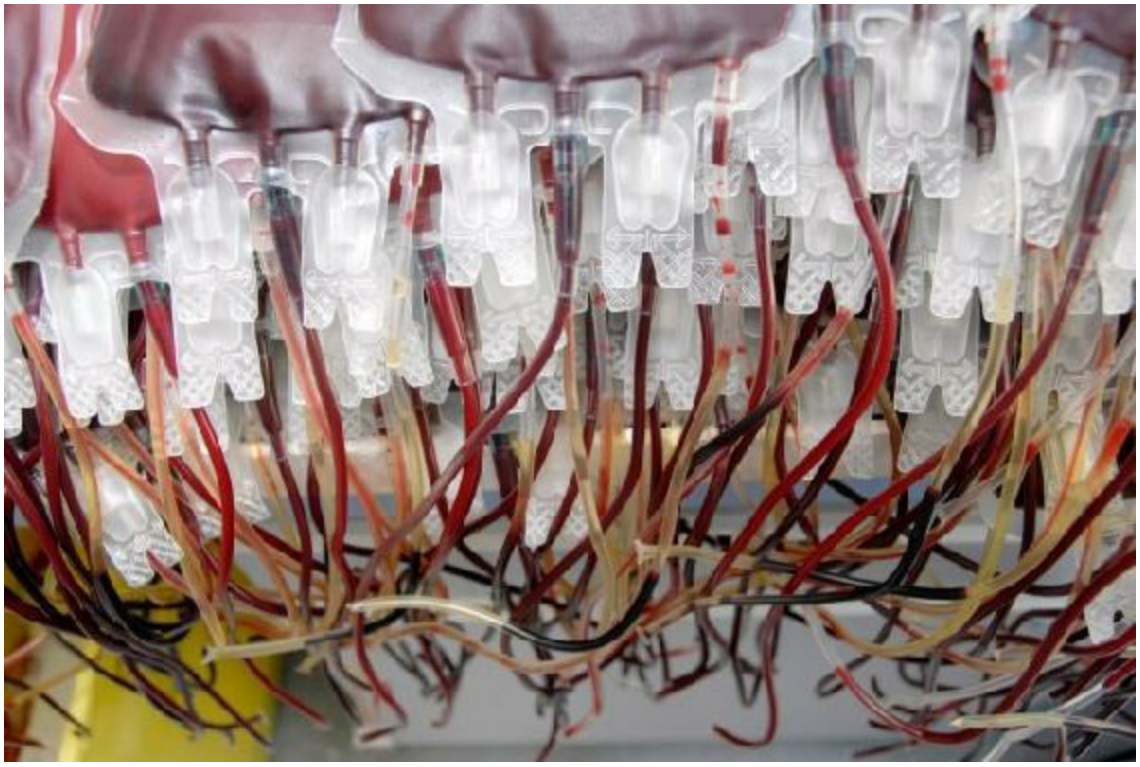
There are currently no comments.

Infusions of young blood tested in patients with dementia

The first controlled human trial of whether blood from young donors rejuvenates old tissue has reported.

01 November 2017 Corrected:

1. 03 November 2017



AJ Photo/SPL

Donor blood from young people has been transfused into people with dementia.

The first controlled, but controversial and small, clinical trial of giving young blood to people with dementia has reported that the procedure appears safe. It has also hinted that it may even produce modest improvements in the daily lives of people who have Alzheimer's disease.

Researchers who conducted the trial and others caution that the results are based on just 18 people and therefore are only a first step in exploring this type of treatment. "This is a really very small trial and the results should not be over-interpreted," says Tony Wyss-Coray, a neuroscientist at Stanford University in California. The trial was conducted by his start-up company Alkahest, which is based in San Carlos, California, and was led by Stanford neurologist Sharon Sha.

The results suggest the procedure is safe and hint that it could even boost the ability of people with dementia to undertake everyday skills, such as shopping or preparing a meal. The team announced the results on 1 November and plans to present them on 4 November at the 10th Clinical Trials on Alzheimer's Disease conference in Boston, Massachusetts.

The team tested people aged between 54 and 86 with mild to moderate Alzheimer's disease. The team gave the 18 subjects weekly infusions for four weeks. They received either a saline placebo or plasma — blood from which the red cells have been removed — from blood donors aged 18–30. During the study, the team monitored the patients to assess their cognitive skills, mood and general abilities to manage their lives independently.

The study detected no serious adverse reactions. It saw no significant effect on cognition, but two different batteries of tests assessing daily living skills both showed significant improvement.

The human trial grew out of earlier 'parabiosis' experiments, in which the blood systems of two rodents are surgically joined together to see what happens when molecules circulating in one animal enter another animal.

Alkahest now plans to conduct a second, larger trial using plasma from which many proteins and other molecules have been removed. Wyss-Coray, whose group did most of the mouse studies that inspired the clinical trial[1] told *Nature* that his experiments suggest that such a treatment could be more

effective than using whole plasma.

Transfusion confusion

Blood-transfusion trials are controversial because the active molecules in plasma that seem to lead to the purported effects are unknown.

Irina Conboy, a neurologist at the University of California, Berkeley, and her colleagues have performed extensive parabiosis experiments stitching together young and old mice that have been genetically matched. She has found that young blood clearly rejuvenates mouse tissues such as the heart and the brain[2]. But she says that the effects are probably coordinated by a complex orchestration of factors in the blood that needs to be understood more fully before moving to the clinic.

“The scientific basis for the trial is simply not there,” she says. “The effects of young blood on cognition have not been replicated by an independent group, and there has never been a test with a mouse model of Alzheimer’s.” She says that frequently exposing older people to foreign plasma may be unsafe, because hyperactivation of their immune systems could lead to autoimmune or inflammatory disease.

But, Wyss-Coray says, “Alzheimer’s patients don’t want to wait until the exact mode of action is discovered.”

He says that it is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain, which has so far failed to result in any treatments.

Blood transfusions used for this purpose do not require approval by the US Food and Drug Administration, and some American companies are already charging hefty fees for transfusions of blood from young people.

Journal name:
Nature
DOI:

doi:10.1038/nature.2017.22930

Corrections

Corrected:

An earlier version of this story wrongly identified Tony Wyss-Coray as leading the clinical trial. In fact, the trial was led by neurologist Sharon Sha of Stanford University and doctors working for Alkahest. Alkahest, not Wyss-Coray, will conduct the second, larger trial. Wyss-Coray was also wrongly identified as a neurologist.

Comments

1 comment

1. *Chris Exley* • 2017-11-02 03:10 PM

   Wyss-Coray is clearly wrong to suggest that this 'is the first new approach for Alzheimer’s disease that is not based on the prevailing theory that the disease is caused by rogue amyloid-β or tau molecules in the brain'. We showed that silicon-rich mineral waters provided some cognitive improvements in individuals with AD over only 12 weeks (https://content.iospress.com/articles/journal-of-alzheimers-disease-reports/adr170010) and similar research published today has suggested benefits in individuals with multiple sclerosis (http://www.ebiomedicine.com/article/S2352-3964(17)30428-0/fulltext). Unfortunately we do not have the resources of Wyss-Coray to take these prospective therapies further.

Pay for US postdocs varies wildly by institution

Analysis of universities' salary data suggests major disparities in pay for early-career researchers.

01 November 2017

Some postdoctoral researchers at public universities in the United States apparently work for fast-food wages whereas others make more than US$100,000 a year, an analysis of postdoc pay has revealed.

The salary data, which a science-advocacy group released on 1 November after a year-long investigation, are incomplete and — in some cases — appear to be incorrect. Some researchers are listed as earning nothing, and another study underway suggests a higher overall rate of pay for US postdocs. But the latest analysis underscores the challenges of getting basic information about an under-recognized and misunderstood segment of the

academic workforce.

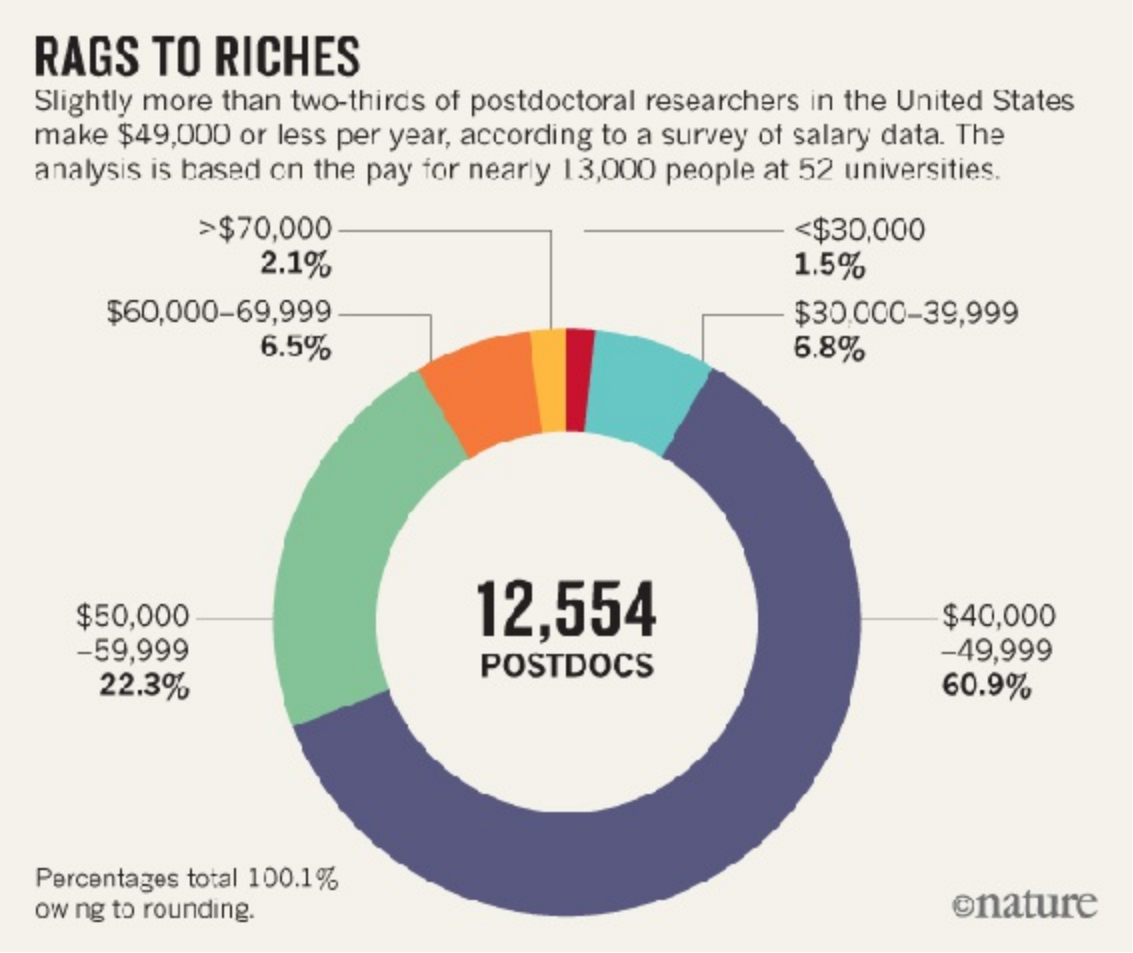
Gary McDowell, a former developmental biologist and executive director of Future of Research, an advocacy group in Boston, Massachusetts, used the US Freedom of Information Act to gather salary reports for nearly 13,000 postdocs at 51 public universities. Through personal connections, he also received salary information from one private institution, Boston University in Massachusetts.

Most universities made a good-faith effort to provide salary information, McDowell says, but few had the numbers at hand when he contacted them. McDowell says that he had to spend considerable time on the phone explaining to university employees what 'postdoc' means. “I asked a basic question — 'How much do your postdocs get paid?' — but there was a lot of confusion,” he says. “It points to how much interest there is in postdocs at these institutions.”

Multiply by zero?

Some universities still provided improbable numbers. They include the University of Utah in Salt Lake City, which reported that 50 postdocs each made $0 per year. McDowell says it is unlikely that these researchers were unpaid volunteers. Instead, he suspects that some institutions — including the University of Utah — reported only the money that postdocs received from the institution's payroll, and overlooked fellowships and other external sources of income. “University of Utah postdoctoral scholars are being paid for their work,” a university spokesman said.

While compiling data, McDowell opted to disregard the 411 reported salaries that were less than $23,660 a year. That is the threshold below which many postdocs would be eligible for overtime pay under a federal law called the Fair Labor Standards Act. “I gave them the benefit of the doubt,” McDowell says of those entries. “Those are likely reporting errors.”



Gary McDowell/Future of Research

The remaining 12,554 salary reports ranged from $23,660 to $114,600 a year (see 'Rags to riches'). McDowell suspects that some institutions mistakenly included pay data for staff scientists or other employees in their reports, which could explain some of the highest salaries. Even with that caveat, his survey suggests that postdoc salaries range widely. At any given institution, McDowell says, “It’s not uncommon for there to be fourfold differences between the highest and the lowest paid.”

Overall, 61% of reported salaries were between $40,000 and $49,999, and about 31% were reported at $50,000 or more. (The $50,000 figure is the minimum postdoctoral salary recommended in 2014 by the US National Academies of Sciences, Engineering, and Medicine.) The University of Illinois at Urbana-Champaign reported the lowest median salary at $27,515.

The University of Maryland at College Park reported the highest median figure — $56,000.

Emerging trends

McDowell notes that the data set is still incomplete. Some institutions reported salaries for only a small fraction of their workforce, and the University of California (UC) system denied his request outright. The university system's public-records office told *Nature* in a statement that it lacks the capacity to do "the programming required to create the custom data report that Mr McDowell requested". The University of California, Santa Barbara, had already provided numbers to McDowell when the broader UC system denied his request for data.

Other attempts to gather information on postdoctoral salaries have met with less resistance. The National Postdoctoral Association (NPA) in Rockville, Maryland, solicited salary information from its more than 200 member institutions for a forthcoming report. "We've worked with these institutions for over a decade, and when we ask for information they readily give it," says Kate Sleeth, chairwoman of the NPA's board of directors. "We didn't have to explain to anyone what a postdoc is."

Of the 127 NPA member institutions that participated in the survey, 85% reported paying all postdocs at least $47,484 — the minimum salary established by the US National Institutes of Health for the 2017 fiscal year. The NPA is set to publish the full results of its poll in January 2018.

In the meantime, McDowell is still combing through his data set. Throughout November, he plans to publish daily analyses on the Future of Research website, futureofresearch.org, that will examine salaries at individual institutions and university systems. In doing so, he hopes to promote conversation about the treatment of early-career researchers.

"In academia, we're not supposed to talk about money and we're not supposed to aspire to having money," McDowell says. "I think scientists should value scientists."

Journal name:
Nature
DOI:
doi:10.1038/nature.2017.22932

Comments

Commenting is currently unavailable.

Citation is not the only impact

A look at what we have published highlights the variety of editorial judgements in selecting and assessing papers.

01 November 2017

Getty

A research paper on drying coffee stains had unusual and unexpected applications.

What makes good science? And how do *Nature*'s editors select papers to publish? The answers to both questions are many and varied. But they have one thing in common: neither is necessarily reflected in citations.

Nature publishes about 800 papers each year. Over, say, two years following

publication, the pattern of citations typically ranges from a few papers with citations in the hundreds, to a large number with tens of citations, and a tail with single figures.

We are pleased when our papers make an impact. But there is much more to scientific impact than citations. For example, last week, in an 'In Retrospect' article in News & Views, Ronald Larson described a remarkable story (R. Larson *Nature* **550,** 466–467; 2017). In 1997, *Nature* published a paper by Robert Deegan and his colleagues that provided an explanation of the 'coffee-ring effect' in spilt liquids, based on considerations of evaporation and surface interactions (R. D. Deegan *et al. Nature* **389,** 827–829; 1997). For several years, the paper sat proudly in our pages, typically gathering about 20 citations per year. In 2006, as new implications and applications became clear, the rate picked up to well over 100 a year. So far, it has attracted about 4,000 citations. The paper is worth highlighting as an example of the varied types of judgement that *Nature* editors use to select papers.

Our most highly cited papers are indeed often key landmarks in their fields. But there are papers that turn out to have low citations that we are equally happy to have published. The work by Deegan *et al.* was selected not because of any editorial ability to anticipate advances years in the future, but because, at the time, we considered it to be a noteworthy and pleasing piece of insight. Nothing more, nothing less. The developments celebrated by Larson are an editor's unexpected bonus.

Most papers that we publish, with the invaluable help of our reviewers, are selected with a view to their scientific significance, whether as a powerful insight or an unusually empowering resource. And often that will correlate closely with citations (although citation patterns differ across disciplines). But it's important also, for editors in all the disciplines from which we publish, sometimes to appreciate the interest in a paper using quite different criteria. It may be compelling for its sheer creativity or logical elegance, for making the reader stop and think very differently about a question, or for a stimulating and even mysterious observation. Many of these may be slow burners citation-wise — or simply be textbook examples that never get taken up in abundance. Here are other examples, drawn from the physical sciences,

that, despite low citations, we like to celebrate.

One such paper illustrated how images could be taken using X-rays radiated when sticky tape was peeled (C. G. Camara *et al. Nature* **455,** 1089–1092; 2008). The citations are not huge by physics standards (165 since 2008) but we still love it, and we did not fully anticipate how it would go viral on social media. Another (11 citations) reported an actual sample of Cretaceous seawater from 145 million years ago. (W. E. Sanford *et al. Nature* **503,** 252–256; 2013). And finally, a theoretical paper providing an exact textbook solution for the capacity of noisy quantum communication channels has been cited just six times since 2013 (G. Smith and J. A. Smolin *Nature* **504,** 263–267; 2013), but we value it for what it is and anticipate that its take-up could increase as research moves from idealized 'noise-free' systems to more realistic noisy ones.

There are examples in other disciplines too. Why highlight such papers? Because we are glad to have published them. And because it's perhaps salutary to appreciate just how unrelated scientific interest (at least, as we at *Nature* see it) and citation numbers can be.

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Urban Vibe
Studios
London

University systems allow sexual harassers to thrive

It's time for academic institutions to take responsibility for protecting students and staff, says Laurel Issen[1].

01 November 2017

Harvey Weinstein, Roger Ailes, Geoff Marcy. From entertainment to academia, accusations of these people's abuses of power have helped to create a sea change in the numbers of people willing to discuss sexual harassment in the workplace. Much of the conversation has concerned condemnation of harassers and praise for those who come forward to talk about what they have seen and experienced. This puts an interpersonal frame on a systemic problem. Attention must also be paid to systems that allow harassers to thrive.

In 2006, I joined the Brain and Cognitive Sciences Department at the University of Rochester, New York, as a PhD student. This August, I joined other female graduate students and postdocs who contributed testimony to a complaint to the US Equal Employment Opportunity Commission over

sexual harassment, poor handling of investigations of our claims and discrimination. We described how we actively avoided Florian Jaeger, a professor in our department, because of his frequent sexual innuendos, pressure to have intimate relationships and other unprofessional behaviour. We were faced with the unfair and unreasonable choice of losing professional opportunities or exposing ourselves to profoundly disturbing encounters. (According to *The New York Times*, Jaeger has since taken a leave of absence but said this was not an admission of guilt.)

I knew this behaviour was not acceptable. I was also convinced that if I came forward alone, I risked retribution and the university would not take my claims seriously. I felt my best option was to warn other students privately and make it known that I would come forward if we reached a critical mass.

After I chose to move away to finish my dissertation, I learnt that in 2013 two colleagues had complained to the department chair about Jaeger's behaviour and given my name as someone who should be interviewed. I was not contacted. In 2016, other senior faculty members learnt of these claims and filed a second complaint to the university to investigate. This time the university first contacted me during an appeal, after issuing a report that cleared Jaeger. The first person to secure testimony from me was from McAllister Olivarius, a London-based legal firm hired by the plaintiffs. My former colleagues had found a powerful ally in getting their complaints taken seriously.

It should not have taken such heroic efforts.

In this regard, Hollywood and academia have troubling similarities. Both rely too much on mentor–protégé relationships, with few checks on individual power. In academia, there is scant protection for lab members. Graduate students and postdocs are viewed more as part of their supervisor's lab than part of the university community. By contrast, institutions have many incentives to protect their powerful, permanent and often lucrative faculty members.

Administrators can reasonably assume that, if they ignore claims for long enough, they will never be held to account. People like me graduate or leave without a degree, the statute of limitations passes, and the harassers get

promoted. Sometimes universities don't interview suggested witnesses or collect other evidence; in my view, this allows them to claim that they investigated complaints but found insufficient reasons for further action. (The University of Rochester has said it took the allegations seriously and that its investigation was thorough.)

Since completing my PhD, I've taken a position at a large company. There are still power differentials in such settings, and sexual harassment can occur unpunished anywhere. However, I've seen several practices that I think academia could learn from.

In my first week of employment, the company explained my rights to a safe workplace and gave me options for reporting concerns. As a graduate student, I had mistakenly believed that the only instances of sexual harassment that could be brought forward were the most egregious: assault or quid-pro-quo propositions. I was unaware of legal precedents involving pervasive harassment creating a hostile and unequal environment. I was also unaware of the standard of preponderance of evidence, and thought that every instance had to be recorded and irrefutable. Graduate students and employees should not have to be legal scholars to win protections.

Another problem is how much the fate of a graduate student or postdoc depends on a supervisor who controls funding for their position, when they can submit a dissertation or paper and what other opportunities they can apply for. Power is less likely to be abused when it is more distributed.

My current company holds drop-in conference calls throughout the year, some of which are reserved for women only. We can discuss concerns off the record or even anonymously; topics range from standardizing the promotion process and improving diversity in recruitment, to discussing comments that have made us feel undermined or uncomfortable. People bringing concerns have options about whether and how they are reported outside the call. At the same time, leaders can become aware of even minor problems and address them (through discussion with staff and line managers, or through memos) before they become patterns that lead to a toxic work environment.

We used to consider those in leadership positions blameless simply by virtue of not being harassers themselves. We now expect better.

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Interstellar visitor, Arctic shipwrecks and a retraction recommendation

The week in science: 27 October–2 November 2017.

01 November 2017

History | Universities | People | Medicines | Research | Space | Events | Facilities | Climate | Trend watch | Awards

HISTORY

Arctic explorer's wrecks given to Canada The UK government is giving Canada two historic shipwrecks: those of HMS *Erebus* and HMS *Terror*. The vessels were part of British explorer Sir John Franklin's ill-fated 1845 expedition to find the Northwest Passage, a long-sought shipping route that connects the Atlantic and Pacific oceans through the Canadian Arctic. Franklin died, along with his entire crew, after the ships became ice-bound and the team abandoned them. Marine archaeologists discovered *Erebus* and *Terror* in 2014 and 2016, respectively, off King William Island. In 1997, an agreement had granted custody of the yet-to-be located wrecks to Canada, although they remained property of the United Kingdom. On 23 October, the UK government said that it would transfer ownership of the ships to Parks Canada, a government agency.

Parks Canada

Part of the wreck of the HMS *Terror*.

UNIVERSITIES

Institute dissolved The Swiss Federal Institute of Technology in Zurich (ETH Zurich), one of Europe's leading universities, has launched an investigation into allegations that PhD students were regularly bullied in its Institute for Astronomy. ETH Zurich released a statement on 25 October saying that it had closed the institute in August in response to the accusations, which were made earlier this year. Newspaper reports say students had complained that astrophysicist Marcella Carollo — a professor, and wife of the institute's director Simon Lilly — had been inappropriately and personally critical, and overly demanding of their time. The university did not publicly name the couple, but said that it had transferred their professorships to the university's physics department. It moved other Institute for Astronomy staff to a newly created Institute for Particle Physics and

Astronomy, and assigned the students new supervisors.

Science cluster French President Emmanuel Macron has announced a plan to save the troubled Paris-Saclay project, an attempt to create a single science 'super-campus' southwest of the city. During a visit to the site on 25 October, Macron said that the project would now proceed in two clusters, one made up of elite institutions called *grandes écoles*, and one made up largely of universities. The project, which initially aimed to bring together nearly 20 research and teaching institutions under one umbrella university, had been mired by the *grandes écoles*' refusal to give up their names and autonomy. A previous effort this year to find a compromise solution had failed. "The time of procrastination is behind us," Macron said.

PEOPLE

Surgeon's papers Six research papers co-written by disgraced thoracic surgeon Paolo Macchiarini should be retracted because they contain evidence of scientific misconduct, the Swedish Central Ethical Review Board said in a statement dated 27 October. The papers had been central to Macchiarini's claims about a radical stem-cell-based tracheal transplant, which he developed partly during his employment by the Karolinska Institute in Stockholm. The institute had asked the ethics board to examine the papers. Earlier last month, Swedish public prosecutors dropped their investigations into charges of manslaughter and grievous bodily harm by the surgeon. The charges involved four people on whom Macchiarini had performed operations at the Karolinska University Hospital between 2011 and 2013. Three have since died, but the prosecutors said there was a lack of conclusive evidence that the surgery caused the deaths. They noted negligent procedures in some of the operations.

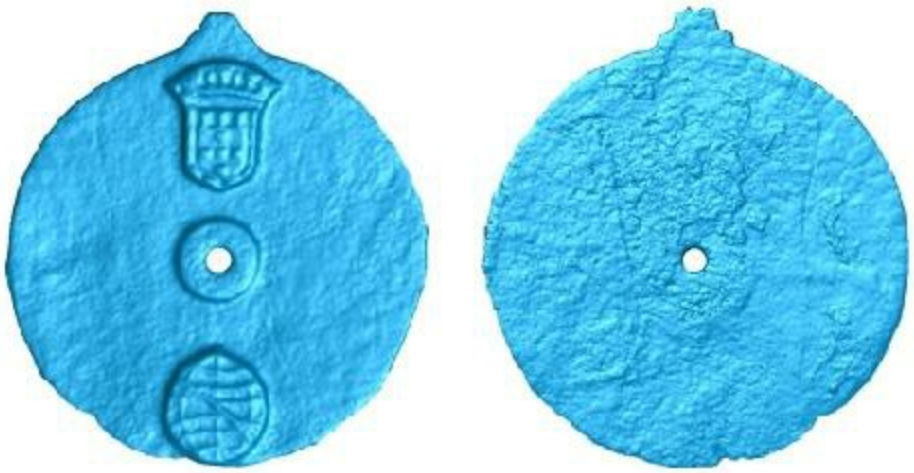
MEDICINES

Hepatitis C drugs On 25 October, a US non-profit organization filed challenges against six core patents for sofosbuvir, a key component of three hepatitis C drugs. The medicines — Sovaldi, Harvoni and Epclusa — belong

to Gilead Sciences in Foster City, California. The Initiative for Medicines, Access and Knowledge (I-MAK) in New York City argues that Gilead's patents are unmerited because the drug is not different enough to warrant a US patent, saying that the company developed the compound by tweaking existing HIV and cancer drugs. The patents prevent cheaper, generic drugs from entering the US market. Using a similar argument, I-MAK had a sofosbuvir patent removed in China in 2015.

RESEARCH

Old astrolabe A 500-year-old bronze disc recovered from a shipwreck in 2014 might be the oldest-known example of a technology that changed world history. The artefact was retrieved from the wreck of the *Esmeralda*, part of the fleet of the Portuguese explorer Vasco da Gama. On 24 October, researchers at the University of Warwick in Coventry, UK, said that laser scanning has now revealed markings at 5-degree intervals around its circumference, suggesting that the 17.5-centimetre-diameter object is a mariner's astrolabe. Developed by Portuguese navigators in the late fifteenth century, these devices determine latitude by measuring the Sun's altitude, and helped sailors to explore the oceans and map the world. The *Esmeralda* sank in the Indian Ocean in 1503, making this mariner's astrolabe several decades older than any of the hundred or so others that survive.



WMG/University of Warwick

Composite image of scans of a 500-year-old bronze astrolabe.

SPACE

Foreign object Astronomers have spotted a space rock that might have come from outside the Solar System. The small asteroid or comet, named A/2017 U1, swooped towards and then past the Sun from an angle almost perpendicular to the plane in which most of the planets orbit. Its trajectory — a hyperbolic orbit — suggests that it came from interstellar space, NASA said on 26 October, a week after the object's discovery. If further observations confirm its orbit, it would be the first such interstellar object known.

Earth mission ends The paired satellites of the US–German Gravity Recovery and Climate Experiment (GRACE), which have been making fundamental observations of Earth since their 2002 launch, have ceased science operations. Mission controllers realized on 12 October that the

batteries in one of the satellites had failed because of its age, a long-expected outcome. NASA and the German space agency DLR announced the mission's end on 27 October, and said the other satellite will be decommissioned next year. GRACE has provided crucial measurements of melting ice sheets and groundwater storage, among other things.

EVENTS

Weedkiller dispute The European Union postponed a decisive vote on 25 October on proposals to renew its licence for the controversial weedkiller glyphosate. The current EU authorization expires on 15 December. But member states were unable to settle on a compromise for how long the licence should be extended by. The World Health Organization says that glyphosate is "probably" carcinogenic to humans, but key EU safety agencies say it is not. Member states will be asked to vote on a five-year extension on 9 November. More than 1.3 million Europeans have signed a petition calling for the substance to be banned.

Harassment probe The US House Committee on Science, Space, and Technology is investigating allegations of sexual harassment against geologist David Marchant of Boston University, Massachusetts. Marchant has received about US$5.4 million in funding since the 1990s from federal agencies, including the National Science Foundation (NSF) and NASA. In letters sent to the NSF, NASA and Boston University on 26 October, the committee asked for all documents and communications involving federal grants awarded to Marchant, as well as complaints of alleged assault and harassment and any actions taken by each institution. Two of Marchant's former graduate students filed complaints with Boston University, in October 2016 and May 2017, for behaviour that allegedly occurred while they were on research trips with him in Antarctica in the 1990s.

FACILITIES

Genome database A Chinese province is building a large sequencing centre that will create a database of genetic information from Chinese people. The

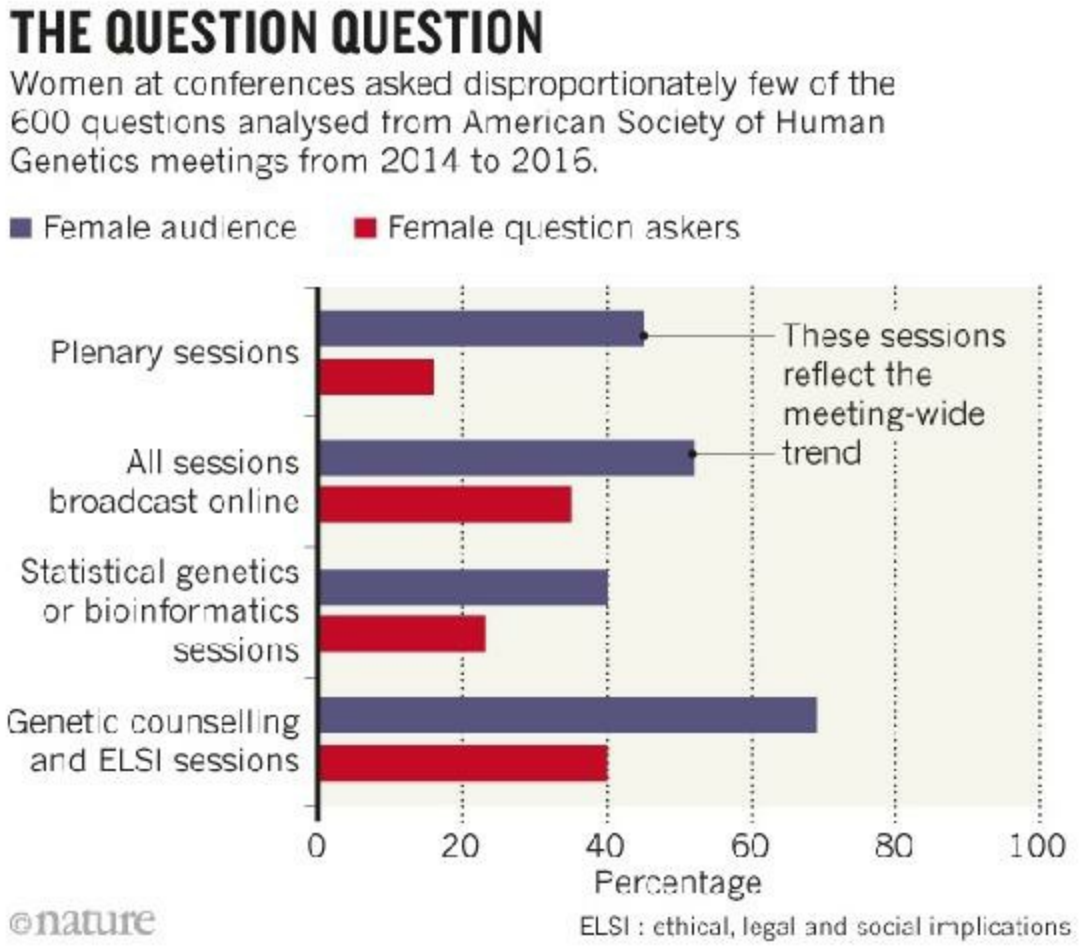
National Health & Medicine Big Data Center is being built in Nanjing, the capital of Jiangsu province, as part of a 6-billion-yuan (US$905-million) genome project announced by the local government on 29 October. The centre will house multiple firms that will together sequence up to 500,000 samples a year. Data will be used to look for mutations related to disease, as well as environmental factors that might trigger illness. Researchers will also use the data to tailor treatments to individual patients.

CLIMATE

Record CO_2 levels Atmospheric concentrations of carbon dioxide surged at a record pace and to a record high in 2016 because of human emissions and an El Niño warming event, the World Meteorological Organization said on 30 October. Average global CO_2 concentrations rose from 400 to 403.3 parts per million, roughly 45% above pre-industrial levels. The last time Earth had comparable CO_2 levels was during the mid-Pliocene epoch around 4 million years ago, when temperatures were 2–3 °C warmer than those today and sea levels were 10–20 metres higher. Concentrations of the greenhouse gases methane and nitrous oxide also increased, to 157% and 22% above pre-industrial levels, respectively.

TREND WATCH

Women ask fewer questions than men at conferences, even if there are more women in the room, according to an analysis of talks at American Society of Human Genetics (ASHG) meetings in 2014–16. Natalie Telis of Stanford University in California and her colleagues looked at 600 questions asked at 222 conference talks. To reach parity in question-asking, the audience would have to be at least 85% women, they say. Women are most likely to question female speakers, but still speak up less often than men.



Source: Natalie Telis

AWARDS

Space pioneers The first woman and the first Chinese national in space were among four recipients of the inaugural medal for space science from the United Nations Educational, Scientific and Cultural Organization (UNESCO). Awards for Chinese astronaut Yang Liwei, who completed the country's first crewed space mission in October 2003, and Russian cosmonaut Valentina Tereshkova were announced at a ceremony in Paris on 27 October. Also honoured were Koichi Wakata, the first Japanese commander of the International Space Station, and Arnaldo Tamayo Mendez, the first Cuban in space. The medal, established in June, recognizes

prominent researchers or public figures who have contributed to space science.

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Plans to promote German research excellence come under fire

Critics say selection process for high-stakes funding programme is flawed.

01 November 2017

Bern Lauter/vario images GmbH/Alamy

Peter Strohschneider, president of the DFG.

Germany’s latest programme to boost research at its universities and make them more competitive internationally risks missing its goals, according to

observers.

The Excellence Initiative was launched in 2005 with €4.6 billion (US$5.4 billion) in funding and the aim of creating a handful of elite universities. Researchers across Germany are now preparing for the programme's next round, dubbed the Excellence Strategy, which starts in 2019.

Earlier this year, almost 200 groups of scientists submitted proposals to form Clusters of Excellence — large collaborations of research groups at one or more universities that form the core element of the strategy. And last month, an international committee invited 88 of the groups to submit full project proposals by late February. Up to 50 such clusters will from 2019 receive top-up funding of about €8 million per year for seven years.

But observers question whether the 88 selected projects represent Germany's best science, particularly because the focus for selection has shifted away from basic science and towards applied research. Unsuccessful applicants say that the rules for submitting proposals for the initiative were not clearly defined and communicated. Several high-profile groups came away empty-handed, including biology teams in Frankfurt, Heidelberg and Munich involving dozens of scientists funded by the prestigious European Research Council.

"The Excellence Initiative has brought German science some welcome structural change," says Dieter Imboden, a Swiss environmental physicist who chaired a 2016 review of the initiative. "But its achievements must not obscure the view of its flaws."

The competition to form clusters should be run independently of that for elite-university status, he says. Otherwise, second-tier universities could outperform those with a much stronger overall research portfolio and gain the sought-after title, which is currently held by 11 universities.

Critics also say that the geographic spread of positively reviewed applications for future excellence clusters — across 41 universities in 13 of Germany's 16 states — hints at a political desire to distribute the funds more evenly across the country.

But Peter Strohschneider, president of Germany's main research-funding agency, the DFG, which runs the programme, says the selection panels chose the projects strictly on the basis of scientific quality, without any regional or political considerations. Scientists will figure strongly on the Excellence Commission, which will make the final selection in September 2018 and will also include federal and state science ministers, he says.

Until 2005, responsibility for funding universities in Germany lay exclusively with the states. The Excellence Initiative was created to allow central government to inject federal money into research, a move now guaranteed by a change to the German constitution. But many say the changes have not gone far enough.

"The initiative has quite lost sight of its goal," says a former president of a large German university, speaking on condition of anonymity. "Universities here remain trapped in a federal political system that is unable to create a powerhouse like Yale or Harvard."

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The new thermodynamics: how quantum physics is bending the rules

Experiments are starting to probe the limits of the classical laws of thermodynamics.

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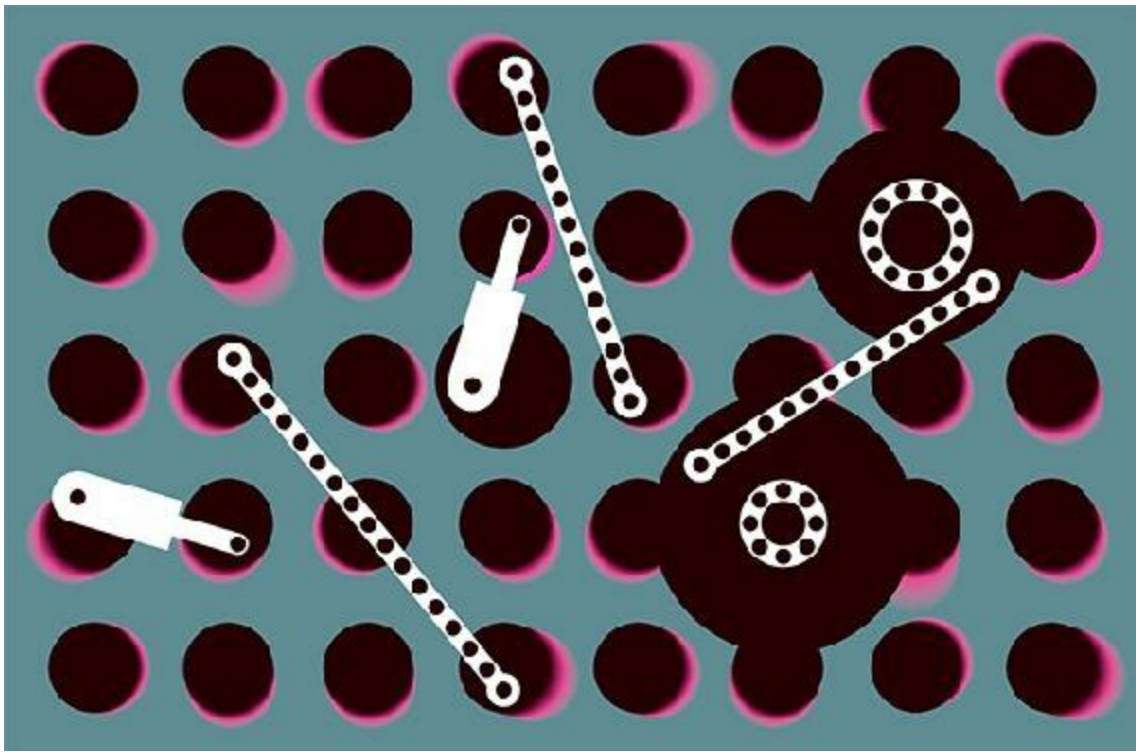


Illustration by Edgar Bąk

It would take a foolhardy physicist to dare attempt to break the laws of thermodynamics. But it turns out that there may be ways to bend them. At a lab at the University of Oxford, UK, quantum physicists are trying to do so with a small lump of synthetic diamond. At first, the diamond is barely

visible, nestled inside a chaotic mess of optical fibres and mirrors. But when they switch on a green laser, defects in the diamond are illuminated, and the crystal begins to glow red.

In that light, the team has found preliminary evidence of an effect that was theorized only a few years ago[1]: a quantum boost that would push the diamond's power output above the level prescribed by classical thermodynamics. If the results hold up, they will be a tangible boon for the study of quantum thermodynamics, a relatively new field that aims to uncover the rules that govern heat and energy flow at the atomic scale.

There is reason to suspect that the laws of thermodynamics, which are based on how large numbers of particles behave, are different in the quantum realm. Over the past five years or so, a quantum-thermodynamics community has grown around that idea. What was once the domain of a handful of theoreticians now includes a few hundred theoretical and experimental physicists around the globe. “The field is moving so fast I can barely keep up,” says Ronnie Kosloff, an early pioneer of the field at the Hebrew University of Jerusalem in Israel.

A number of quantum thermodynamicists hope to find behaviour outside the remit of conventional thermodynamics that could be adapted for practical purposes, including improving lab-based refrigeration techniques, creating batteries with enhanced capabilities and refining technology for quantum computing.

But the field is still in its infancy. Experiments such as the one taking place at Oxford are just starting to put theoretical predictions to the test. And physicists working at the periphery are watching such tests closely for evidence of the useful applications that theorists have predicted. “Quantum thermodynamics is clearly hot — pardon the pun,” says Ronald Walsworth, a physicist at Harvard University in Cambridge, Massachusetts, who specializes in developing precision atomic-scale tools. “But for those of us looking in from the outside, the question is: can it really shed new light on the development of technologies?”

Breaking the law

The development of the classical laws of thermodynamics stretches back to the nineteenth century. They emerged from the effort to understand steam engines and other macroscopic systems. Thermodynamic quantities such as temperature and heat are statistical in nature and defined in reference to the average motion of large ensembles of particles. But back in the 1980s, Kosloff began pondering whether this picture would continue to make sense for much smaller systems.

It wasn't a popular line of research at the time, says Kosloff, because the questions being asked were largely abstract, with little hope of connection to experiments. “The field developed very slowly,” he says. “I was alone for years.”

That changed dramatically around a decade ago, as questions about the limits of technological miniaturization became more pressing and experimental techniques advanced. A flurry of attempts were made to calculate how thermodynamics and quantum theory might combine. But the resulting proposals created more confusion than clarity, Kosloff says. Some claimed that quantum devices could violate classical thermodynamic constraints with impunity and so act as perpetual-motion machines, capable of performing work without needing any energy input. Others, suggesting that the laws of thermodynamics should hold unmodified at very small scales, were equally perplexing. “In some sense, you can use the same equations to work out the performance of a single atom engine and your car engine,” says Kosloff. “But that seems shocking, too — surely as you get smaller and smaller you should hit some quantum limit.” In classical thermodynamics, a single particle doesn't have a temperature. So as both the system generating work and its environment approach that limit, it becomes increasingly absurd to imagine that they would obey standard thermodynamic rules, says Tobias Schaetz, a quantum physicist at the University of Freiburg in Germany.

The preponderance of conflicting theoretical claims and predictions initially undermined the burgeoning field's credibility. “I have been very critical of the field because there is far too much theory and not enough experiment,” says quantum physicist Peter Hänggi, at the University of Augsburg in Germany. But the community is beginning to coalesce more formally around core questions in an effort to cut through the chaos. One goal has been to use

experiments to uncover the point at which the classical laws of thermodynamics no longer perfectly predict the thermal behaviour of quantum systems.

Experiments are starting to pin down that quantum–classical boundary. Last year, for example, Schaetz and his colleagues showed that, under certain conditions, strings of five or fewer magnesium ions in a crystal do not reach and remain in thermal equilibrium with their surroundings like larger systems do[2]. In their test, each ion started in a high-energy state and its spin oscillated between two states corresponding to the direction of its magnetism — 'up' and 'down'. Standard thermodynamics predicts that such spin oscillations should die down as the ions cool by interacting with the other atoms in the crystal around them, just as hot coffee cools when its molecules collide with molecules in the colder surrounding air.

Such collisions transfer energy from the coffee molecules to the air molecules. A similar cooling mechanism is at play in the crystal, where quantized vibrations in the lattice called phonons carry heat away from the oscillating spins. Schaetz and his colleagues found that their small ion systems did stop oscillating, suggesting that they had cooled. But after a few milliseconds, the ions began oscillating vigorously again. This resurgence has a quantum origin, says Schaetz. Rather than dissipating away entirely, the phonons rebounded at the edges of the crystal and returned, in phase, to their source ions, reinstating the original spin oscillations.

Schaetz says that his experiment sends a warning to engineers attempting to reduce the size of existing electronics. “You may have a wire that is only 10 or 15 atoms wide, and you may think that it has successfully carried the heat away from your chip, but then boop — suddenly this quantum revival happens,” Schaetz says. “It is very disturbing.”

Rebounding phonons could present a challenge in some applications, but other quantum phenomena could turn out to be useful. Efforts to identify such phenomena had been stalled by the difficulty in defining basic quantities, such as heat and temperature, in quantum systems. But the solution to a famous thought experiment, laid out 150 years ago by Scottish physicist James Clerk Maxwell, provided a clue about where to turn, posing an intriguing link between information and energy. Maxwell imagined an entity

that could sort slow- and fast-moving molecules, creating a temperature difference between two chambers simply by opening and closing a door between them.

Such a 'demon', as it was later called, thus generates a hot and a cold chamber that can be harnessed to produce useful energy. The problem is that by sorting particles in this way, the demon reduces the system's entropy — a measure of the disorder of the particles' arrangements — without having done any work on the particles themselves. This seemingly violates the second law of thermodynamics.

But physicists eventually realized that the demon would pay a thermodynamic price to process the information about the molecules' speeds. It would need to store, erase and rewrite that information in its brain. That process consumes energy and creates an overall increase in entropy[3]. Information was once thought to be immaterial, “but Maxwell's demon shows that it can have objective physical consequences”, says quantum physicist Arnau Riera, at the Institute of Photonic Sciences in Barcelona, Spain.

Finding the limit

Inspired by the idea that information is a physical quantity — and that it is intimately linked to thermodynamics — researchers have attempted to recast the laws of thermodynamics so that they work in the quantum regime.

Perpetual-motion machines may be impossible. But an early hope was that limits prescribed by quantum thermodynamics might be less stringent than those that hold in the classical realm. “This was the train of thought we had learned from quantum computing — that quantum effects help you beat classical bounds,” says Raam Uzdin, a quantum physicist at the Technion–Israel Institute of Technology in Haifa.

Disappointingly, Uzdin says, this is not the case. Recent analyses suggest that quantum versions of the second law, which governs efficiency, and the third law, which prohibits systems from reaching absolute zero, retain similar and, in some cases, more-stringent constraints than their classical incarnations.

Some differences arise because the macroscopic thermodynamic quantity 'free energy'— the energy a system has available to do work — doesn't have just one counterpart at the microscale, but many, says Jonathan Oppenheim, a quantum physicist at University College London. Classically, the free energy is calculated by assuming that all states of the system, determined by the arrangement of particles at a given energy, are equally likely. But that assumption isn't true on tiny scales, says Oppenheim; certain states might be much more probable than others. To account for this, additional free energies need to be defined in order to accurately describe the system and how it will evolve. Oppenheim and his colleagues propose that individual second laws exist for each type of free energy, and that quantum devices must obey all of them[4]. “Since the second law tells you what you aren't allowed to do, in some ways, it seems that having more laws on the microscale leaves you worse off,” says Oppenheim.

Much of the work done to calculate equivalents of the second and third laws remains, for now, theoretical. But proponents argue that it can help to illuminate how thermodynamic bounds are physically enforced at small scales. For instance, a theoretical analysis carried out by a pair of quantum physicists based in Argentina showed that as a quantum refrigerator nears absolute zero, photons will spontaneously appear in the vicinity of the device[5]. “This dumps energy into the surroundings, causing a heating effect that counters the cooling and stops you ever reaching absolute zero,” explains team member Nahuel Freitas of Ciudad University in Buenos Aires.

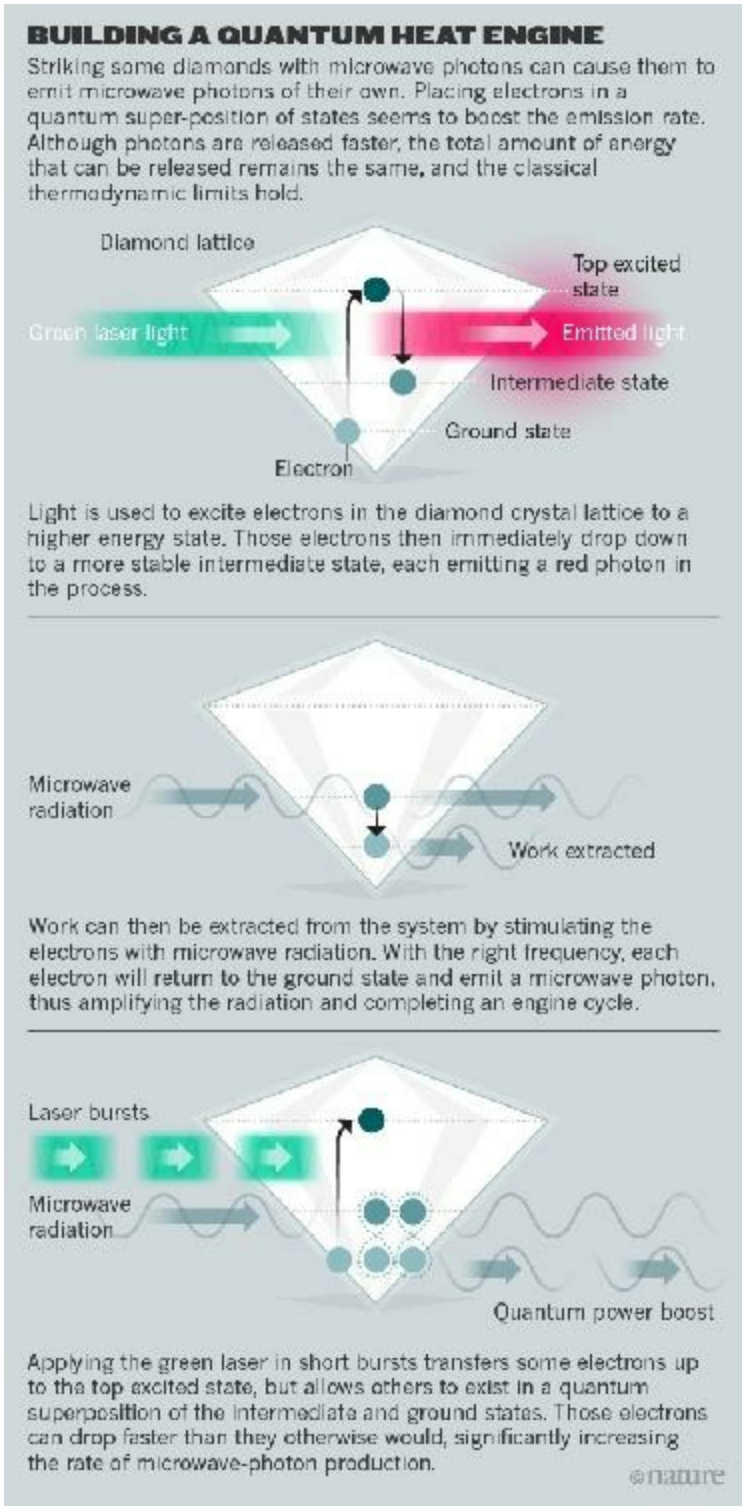
Theory has also revealed some potential wiggle room. In a theoretical analysis examining information flow between hot and cold chambers, or 'baths', of particles, a team based in Barcelona that included Riera and quantum physicist Manabendra Nath Bera discovered a strange scenario in which the hot bath seemed to spontaneously get hotter, while the cold bath became colder[6]. “At first, this looks crazy, like we can violate thermodynamics,” says Bera. But the researchers soon realized that they had overlooked the quantum twist: the particles in the baths can become entangled. In theory, making and breaking these correlations provides a way to store and release energy. Once this quantum resource was budgeted for, the laws of thermodynamics fell into place.

A number of independent groups have proposed using such entanglement to store energy in a 'quantum battery', and a group at the Italian Institute of Technology in Genoa is attempting to confirm the Barcelona team's predictions with batteries built from superconducting quantum bits, or 'qubits'[7]. In principle, such quantum batteries could charge considerably faster than their classical equivalents. “You won't be able to extract and store more energy than the classical bound allows — that's set by the second law,” says Riera. “But you may be able to speed things up.”

Some researchers are looking for easier ways to manipulate qubits for quantum-computing applications. Quantum physicist Nayeli Azucena Rodríguez Briones at the University of Waterloo in Canada and her colleagues have devised[8] an operation that might enhance the cooling needed for quantum-computing operations by manipulating pairs of qubit energy levels. They are currently planning to test this idea in the lab using superconducting qubits.

A small spark

The concept that quantum effects could be exploited to improve thermodynamic performance also inspired the diamond experiment under way at Oxford, which was first proposed by Kosloff, Uzdin and Amikam Levy, also at the Hebrew University[1]. Defects created by nitrogen atoms scattered through the diamond can serve as an engine — a machine that performs an operation after being brought into contact with first a hot reservoir (in this case a laser) and then a cold one. But Kosloff and his colleagues expect that such an engine can be operated in an enhanced mode, by exploiting a quantum effect that enables some of the electrons to exist in two energy states simultaneously. Maintaining these superpositions by pulsing the laser light rather than using a continuous beam should enable the crystal to emit microwave photons more rapidly than it otherwise would (see 'Building a quantum heat engine').



Last week, the Oxford-based team posted a preliminary analysis[9] showing evidence of the predicted quantum boost. The paper has yet to be peer reviewed, but if the work holds up, then “it is a groundbreaking result,” says

Janet Anders, a quantum physicist at Exeter University, UK. But, she adds, it's still not clear exactly what enables this feat. “It seems to be a magic fuel, not so much adding energy, but enabling the engine to extract energy faster,” Anders says. “Theoretical physicists will need to examine just how it does this.”

Focusing on experiments is a major step in the right direction for revitalizing the field, says Hänggi. But, for him, the experiments are not yet bold enough to give truly ground-breaking insights. There is also the challenge that quantum systems can be irrevocably disturbed by measurement and interaction with the environment. These effects are rarely sufficiently accounted for in theoretical proposals for new experiments, he says. “That is difficult to calculate, and much more difficult to implement in an experiment,” he says.

Ian Walmsley, who heads the Oxford lab where the diamond experiment was conducted, is also circumspect about the future of the field. Although he and other experimenters have been drawn to quantum thermodynamics research in recent years, he says that their interest has been largely “opportunistic”. They have spotted the chance to carry out relatively quick and easy experiments by piggybacking on set-ups already in place for other uses; the diamond-defect set-up, for instance, is already being widely studied for quantum computing and sensor applications. Today, quantum thermodynamics is fizzing with energy, Walmsley says. “But whether it will continue to sparkle, or just explode into nothing, well, we will have to wait and see.”

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Comments

8 comments

1. *Pentcho Valev* • 2017-11-03 08:02 AM

   Clifford Truesdell, The Tragicomical History of Thermodynamics, 1822-1854, p. 6: "Finally, I confess to a heartfelt hope - very slender but tough - that even some thermodynamicists of the old tribe will study this book, master the contents, and so share in my discovery: Thermodynamics need never have been the Dismal Swamp of Obscurity that from the first it was and that today in common instruction it is; in consequence, it need not so remain." [...] p. 333: "Clausius' verbal statement of the "Second Law" makes no sense, for "some other change connected therewith" introduces two new and unexplained concepts: "other change" and "connection" of changes. Neither of these finds any place in Clausius' formal structure. All that remains is a Mosaic prohibition. A century of philosophers and journalists have acclaimed this commandment; a century of mathematicians have shuddered and averted their eyes from the unclean."
   https://www.amazon.com/Tragicomical-Thermodynamics-1822-1854-Mathematics-Physical/dp/1461394465 Jos Uffink, Bluff your way in the Second Law of Thermodynamics: "Before one can claim that acquaintance with the Second Law is as indispensable to a cultural education as Macbeth or Hamlet, it should obviously be clear what this law states. This question is surprisingly difficult. The Second Law made its appearance in physics around 1850, but a half century later it was already surrounded by so much confusion that the British Association for the Advancement of Science decided to appoint a special committee with the task of providing clarity about the meaning of this law. However, its final report (Bryan 1891) did not settle the issue. Half a century later, the physicist/philosopher Bridgman still complained that there are almost as many formulations of the second law as there have been discussions of it. And even today, the Second Law remains so obscure that it continues to attract new efforts at clarification."

http://philsci-archive.pitt.edu/313/1/engtot.pdf As Clifford Truesdell suggests, the confusion started with Clausius's 1850 idiotic argument - later formulations of the second law of thermodynamics have all been defective. However previous formulations - those of Carnot - were both clear and correct. The simplest one is this: "A cold body is necessary" That is, heat cannot be cyclically converted into work unless a hot body, source of heat, and a cold body, receiver of heat, are available. The problem is that in 1824 Carnot deduced "A cold body is necessary" from a postulate that eventually turned out to be false: Carnot's (false) postulate: Heat is an indestructible substance (caloric) that cannot be converted into work by the heat engine. Unpublished notes written in the period 1824-1832 reveal that, after realizing that his postulate was false (and discovering the first law of thermodynamics), Carnot found "A cold body is necessary" implausible: Sadi Carnot, REFLECTIONS ON THE MOTIVE POWER OF HEAT, p. 225: "Heat is simply motive power, or rather motion which has changed form. It is a movement among the particles of bodies. Wherever there is destruction of motive power there is, at the same time, production of heat in quantity exactly proportional to the quantity of motive power destroyed. Reciprocally, wherever there is destruction of heat, there is production of motive power." p. 222: "Could a motion (that of radiating heat) produce matter (caloric)? No, undoubtedly; it can only produce a motion. Heat is then the result of a motion. Then it is plain that it could be produced by the consumption of motive power, and that it could produce this power. All the other phenomena - composition and decomposition of bodies, passage to the gaseous state, specific heat, equilibrium of heat, its more or less easy transmission, its constancy in experiments with the calorimeter - could be explained by this hypothesis. But it would be DIFFICULT TO EXPLAIN WHY, IN THE DEVELOPMENT OF MOTIVE POWER BY HEAT, A COLD BODY IS NECESSARY; why, in consuming the heat of a warm body, motion cannot be produced." http://www.nd.edu/~powers/ame.20231/carnot1897.pdf Generally, a cold body is not necessary, that is, the second law of thermodynamics is false. The cold body is only

TECHNOLOGICALLY necessary – non-isothermal heat engines are fast-working and powerful. Heat engines working under isothermal conditions (in the absence of a cold body) are commonplace but are too slow and impuissant to be of any technological importance. Except, perhaps, for the case where water is placed in an electric field - the non-conservative force (pressure) that emerges seems to be able to convert ambient heat into work quite vigorously: Wolfgang K. H. Panofsky, Melba Phillips, Classical Electricity and Magnetism, pp.115-116: "Thus the decrease in force that is experienced between two charges when they are immersed in a dielectric liquid can be understood only by considering the effect of the PRESSURE OF THE LIQUID ON THE CHARGES themselves." http://www.amazon.com/Classical-Electricity-Magnetism-Second-Physics/dp/0486439240?tag=viglink21401-20 "However, in experiments in which a capacitor is submerged in a dielectric liquid the force per unit area exerted by one plate on another is observed to decrease... [...] This apparent paradox can be explained by taking into account the DIFFERENCE IN LIQUID PRESSURE in the field filled space between the plates and the field free region outside the capacitor." http://farside.ph.utexas.edu/teaching/jk1/lectures/node46.html Tai Chow, Introduction to Electromagnetic Theory: A Modern Perspective, p. 267: "The strictly electric forces between charges on the conductors are not influenced by the presence of the dielectric medium. The medium is polarized, however, and the interaction of the electric field with the polarized medium results in an INCREASED FLUID PRESSURE ON THE CONDUCTORS that reduces the net forces acting on them." http://www.amazon.com/Introduction-To-Electromagnetic-Theory-Perspective/dp/0763738271 "Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ Pentcho Valev

2. *Vyacheslav Somsikov* • 2017-11-03 04:34 AM

   For the verification of the deterministic mechanism of irreversibility, which obtained within the framework of the classical mechanics laws [Somsikov V.M. Non-Linearity of Dynamics of the

Non-Equilibrium Systems. World Journal of Mechanics, 2017, Vol.7 No.2, 11-23], we was performed the numerical calculations of the change of D-entropy for the system with different number of the potentially interacting material points (MP) when it moves through a potential barrier. D – entropy is a relation of the value of change of the systems internal energy to its full value. [Somsikov V. M. and Andreev A. B. On criteria of transition to a thermodynamic description of system dynamics. Russian Physics Journal, Vol. 58, No. 11, March, 2016; http://www.ijSciences.com Volume 4 – May 2015 (05)]. The calculations were carried 400 times for a given number of particles for different initial states of the system, but for the same predetermined amount of energy. This made it possible to determine the change of the D-entropy for different states of the system for a given value of its energy and a given number of MP. It was found that the fluctuations of internal energy decreasing with increasing number of particles in the system for different initial conditions. When number of particles less 64, the D –entropy can be as positive as negative.When number of particles more 64 then none of the 400 numerical experiments gave a negative value change of the internal energy. This means that when number of particles more 64 the dynamics of the system becomes irreversible. Therefore, the number 64 can be called as a first critical number of the system, beyond which the system becomes irreversible. When number of particles more than 1000, the dispersion of the internal energy reaches to the minimum. With further increase in the number of MP the increment of the internal energy is not changed. This number can be called as a second critical number. Thus if the system consist from number of particles more than 1000, the thermodynamic description is a correct. Obviously, in the general case, these critical numbers will depend on the parameters of the task, for example, the width and height of the barrier.

3. *Pentcho Valev* • 2017-11-02 07:25 PM

   "Entropy was discovered when it was noticed to be a quantity that behaves as a function of state, as a consequence of the second law of thermodynamics." https://en.wikipedia.org/wiki/Entropy It was Clausius who "noticed" that the entropy is a state function, but was

he correct? Here is the story: If you define the entropy S as a quantity that obeys the equation dS=dQrev/T, you will find that, so defined, the entropy is a state function FOR AN IDEAL GAS. Clausius was very impressed by this statefunctionness and decided to prove that the entropy (so defined) is a state function for ANY system. So "Entropy is a state function" became a fundamental theorem in thermodynamics. Clausius deduced it from the assumption that any cycle can be disintegrated into small Carnot cycles, and nowadays this deduction remains the only justification of "Entropy is a state function": "Carnot Cycles: S is a State Function. Any reversible cycle can be thought of as a collection of Carnot cycles - this approximation becomes exact as cycles become infinitesimal. Entropy change around an individual cycle is zero. Sum of entropy changes over all cycles is zero." http://mutuslab.cs.uwindsor.ca/schurko/introphyschem/lectures/240 "Entropy Changes in Arbitrary Cycles. What if we have a process which occurs in a cycle other than the Carnot cycle, e.g., the cycle depicted in Fig. 3. If entropy is a state function, cyclic integral of dS = 0, no matter what the nature of the cycle. In order to see that this is true, break up the cycle into sub-cycles, each of which is a Carnot cycle, as shown in Fig. 3. If we apply Eq. (7) to each piece, and add the results, we get zero for the sum." http://ronispc.chem.mcgill.ca/ronis/chem213/hnd8.pdf The assumption on which "Entropy is a state function" is based - that any cycle can be subdivided into small Carnot cycles - is obviously false. An isothermal cycle CANNOT be subdivided into small Carnot cycles. A cycle involving the action of conservative forces CANNOT be subdivided into small Carnot cycles. Conclusion: The belief that the entropy is a state function is totally unjustified. Any time scientists use the term "entropy", they don't know what they are talking about. "My greatest concern was what to call it. I thought of calling it 'information', but the word was overly used, so I decided to call it 'uncertainty'. When I discussed it with John von Neumann, he had a better idea. Von Neumann told me, 'You should call it entropy, for two reasons: In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important,

nobody knows what entropy really is, so in a debate you will always have the advantage."
https://en.wikipedia.org/wiki/History_of_entropy Pentcho Valev

4. *Pentcho Valev* • 2017-11-02 10:05 PM
   The version of the second law of thermodynamics known as "Entropy always increases" (a version which, according to A. Eddington, holds "the supreme position among the laws of Nature") is in fact a theorem deduced by Clausius in 1865: Jos Uffink, Bluff your Way in the Second Law of Thermodynamics, p. 37: "Hence we obtain: THE ENTROPY PRINCIPLE (Clausius' version) For every nicht umkehrbar [irreversible] process in an adiabatically isolated system which begins and ends in an equilibrium state, the entropy of the final state is greater than or equal to that of the initial state. For every umkehrbar [reversible] process in an adiabatical system, the entropy of the final state is equal to that of the initial state." http://philsci-archive.pitt.edu/archive/00000313/ Clausius' deduction was based on three postulates: Postulate 1 (implicit): The entropy is a state function. Postulate 2: Clausius' inequality (formula 10 on p. 33 in Uffink's paper) is correct. Postulate 3: Any irreversible process can be closed by a reversible process to become a cycle. All the three postulates remain totally unjustified even nowadays. Postulate 1 can easily be disproved by considering cycles (heat engines) converting heat into work in ISOTHERMAL conditions. Postulate 3 is also false: Uffink, p.39: "A more important objection, it seems to me, is that Clausius bases his conclusion that the entropy increases in a nicht umkehrbar [irreversible] process on the assumption that such a process can be closed by an umkehrbar [reversible] process to become a cycle. This is essential for the definition of the entropy difference between the initial and final states. But the assumption is far from obvious for a system more complex than an ideal gas, or for states far from equilibrium, or for processes other than the simple exchange of heat and work. Thus, the generalisation to all transformations occurring in Nature is somewhat rash." Note that, even if Clausius's theorem were true (it is not), it only holds for "an adiabatically isolated system which begins and ends in an equilibrium state". This means that (even if Clausius's theorem were true) applications of "Entropy

always increases" to processes which do not begin and end in equilibrium, that is, to processes in Nature, not in a cylinder with a piston, would still be incorrect: Jos Uffink, in the same article: "I therefore argue for the view that the second law has nothing to do with the arrow of time. [...] This summary leads to the question whether it is fruitful to see irreversibility or time-asymmetry as the essence of the second law. Is it not more straightforward, in view of the unargued statements of Kelvin, the bold claims of Clausius and the strained attempts of Planck, to give up this idea? I believe that Ehrenfest-Afanassjewa was right in her verdict that the discussion about the arrow of time as expressed in the second law of the thermodynamics is actually a RED HERRING." Pentcho Valev

5. *Raji Heyrovska* • 2017-11-02 02:45 PM

   I just saw the interesting article by Merali [1]. In this context, I wish to draw attention to the First International Conference [2] on Quantum Limits to the Second Law. In her contribution [3] to this conference, she points out that thermodynamic functions and laws were developed over the years to "bridge" the gap between the equations of state and thermal properties of matter. In [3] the author has incorporated the thermodynamic properties into the equation of state thereby forming one simple composite equation. The heat capacity difference is introduced in place of the gas constant in her earlier concise equation of state for gases, based on free volume and molecular association/dissociation. This provides a new and simple relation between the P, V, T properties, internal energy (E), enthalpy (H), Gibbs (G) and Helmholtz (A) free energies, heat energy (Q), entropy (S), partition function (f) and the thermodynamic laws. Since a proper definition of "heat" is essential for the discussion of the second law, Q for a gas at the given P, V, T, S is defined as TS = PVflnW, where W is the thermodynamic probability related to f. The latter is expressed as the ratio of free volume to volume corresponding to the de Broglie wave length. Also, for the first time experimental heat capacities at various P, V and T are correlated with the extent of molecular association. The available data for nitrogen have been used to demonstrate the validity of the new equation of state. References: 1. Merali, Z., Nature 551, 20–22 (02 November 2017) doi:10.1038/551020a 2.

“QUANTUM LIMITS TO THE SECOND LAW: First International Conference on Quantum Limits to the Second Law”: 29-31 July 2002, San Diego, California (USA), ISBN: 0-7354-0098-9, Editors: Daniel P. Sheehan, Volume number: 643, Published: Nov 20, 2002, http://aip.scitation.org/toc/apc/643/1?expanded=643 3. Heyrovska, R., AIP Conference Proceedings 643, 157-162 (2002); http://aip.scitation.org/doi/10.1063/1.1523797

6. *Pentcho Valev* • 2017-11-02 09:37 AM

The second law of thermodynamics has an absurd implication that proves its falsehood: If we have a reversible chemical reaction and a catalyst increases the rate of the forward reaction by a factor of, say, 745492, it obligatorily increases the rate of the reverse reaction by exactly the same factor, 745492, despite the fact that the two reactions - forward and reverse - may be entirely different (e.g. the diffusion factor is crucial for one but not important for the other) and accordingly require entirely different catalytic mechanisms. The absurd implication is usually referred to as "Catalysts do not shift chemical equilibrium": "A catalyst reduces the time taken to reach equilibrium, but does not change the position of the equilibrium. This is because the catalyst increases the rates of the forward and reverse reactions BY THE SAME AMOUNT." http://www.bbc.co.uk/bitesize/higher/chemistry/reactions/equilibriu "In the presence of a catalyst, both the forward and reverse reaction rates will speed up EQUALLY... [...] If the addition of catalysts could possibly alter the equilibrium state of the reaction, this would violate the second rule of thermodynamics..." https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/chemical-equilibrium-14/factors-that-affect-chemical-equilibrium-106/the-effect-of-a-catalyst-447-3459/ The absurd implication is not obeyed by chemical reactions of course. Here is a publication in Nature describing a catalyst accelerating the forward and SUPPRESSING the reverse reaction: http://images.nature.com/m685/nature-assets/ncomms/2013/130917/ncomms3500/images_hires/ncomms35 f1.jpg Yu Hang Li et al. Unidirectional suppression of hydrogen oxidation on oxidized platinum clusters. https://www.nature.com/articles/ncomms3500 Another example of

disobedience: Perpetual (limited only by the deterioration of the system) motion of dimer A_2 and monomer A between two catalytic surfaces, S1 and S2 (a time crystal par excellence): http://upload.wikimedia.org/wikipedia/commons/c/ce/NatureSLTD-Fig1c.jpg See the explanations here: https://en.wikipedia.org/wiki/Duncan%27s_Paradox That catalysts can violate the second law of thermodynamics by shifting chemical equilibrium is presented by Wikipedia as a fact: "Epicatalysis is a newly identified class of gas-surface heterogeneous catalysis in which specific gas-surface reactions shift gas phase species concentrations away from those normally associated with gas-phase equilibrium. [...] A traditional catalyst adheres to three general principles, namely: 1) it speeds up a chemical reaction; 2) it participates in, but is not consumed by, the reaction; and 3) it does not change the chemical equilibrium of the reaction. Epicatalysts overcome the third principle..." https://en.wikipedia.org/wiki/Epicatalysis Pentcho Valev

7. *Pentcho Valev* • 2017-11-01 07:17 PM

   The second law of thermodynamics has long been under attack but only for small, microscopic, quantum etc. systems: Nature 2002: "Second law broken. Researchers have shown for the first time that, on the level of thousands of atoms and molecules, fleeting energy increases violate the second law of thermodynamics." http://www.nature.com/news/2002/020722/full/news020722-2.html The truth is that MACROSCOPIC systems violating the second law of thermodynamics are COMMONPLACE. The problem is that misleading education diverts the attention from relevant examples: "A necessary component of a heat engine, then, is that two temperatures are involved. At one stage the system is heated, at another it is cooled." http://physics.bu.edu/~duffy/py105/Heatengines.html So educators present the two temperatures as NECESSARY and deal with non-isothermal heat engines only: http://readingpenrose.files.wordpress.com/2015/07/rubber-band-engine.gif "All materials react to heat in some way. But this new shape-changing polymer reacts to temperatures as small as the touch of human skin to contract - in the process lifting as much as

1,000 times its own weight." http://gizmodo.com/this-new-shape-changing-polymer-can-lift-1-000-times-it-1759165438 "Stretchy Science: A Rubber Band Heat Engine. Learn how a rubber band can turn heat into mechanical work with this simple activity. [...] Your blow dryer essentially turned your rubber band into a heat engine - a machine that turns thermal energy into mechanical work." https://www.scientificamerican.com/article/bring-science-home-rubber-band-heat/ The second law of thermodynamics would be long forgotten if isothermal analogs which almost obviously violate the second law of thermodynamics had been analyzed (one should only evaluate the work involved in a quasi-static cycle): http://www.gsjournal.net/old/valev/val3.gif "When the pH is lowered (that is, on raising the chemical potential, μ, of the protons present) at the isothermal condition of 37°C, these matrices can exert forces, f, sufficient to lift weights that are a thousand times their dry weight." http://www.google.com/patents/US5520672 A. KATCHALSKY, POLYELECTROLYTES AND THEIR BIOLOGICAL INTERACTIONS, p. 15, Figure 4: "Polyacid gel in sodium hydroxide solution: expanded. Polyacid gel in acid solution: contracted; weight is lifted." https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1367611/pdf/bioph0017.pdf The following four-step isothermal cycle, if carried out quasi-statically (reversibly), clearly violates the second law of thermodynamics: 1. The polymer is initially stretched. The operator adds hydrogen ions (H+) to the system. The force of contraction increases. 2. The polymers contracts and lifts a weight. 3. The operator removes the same amount of H+ from the system. The force of contraction decreases. 4. The operator stretches the polymer and restores the initial state of the system. The net work extracted from the cycle is positive unless the following is the case: The operator, as he decreases and then increases the pH of the system (steps 1 and 3), does (loses; wastes) more work than the work he gains from weight-lifting. However electrochemists know that, if both adding hydrogen ions to the system and then removing them are performed quasi-statically, the net work involved is virtually zero (the operator gains work if the hydrogen ions are transported from a high to a low concentration and then loses the

same amount of work in the backward transport). That is, the net work involved in steps 1 and 3 is zero, and the net work extracted from steps 2 and 4 is positive, in violation of the second law of thermodynamics. Pentcho Valev

8. *Pentcho Valev* • 2017-11-01 06:36 PM

    Philip Ball explains why Frank Wilczek's time crystals are bogus: "But to make that happen, the researchers must deliver kicks to the spins, provided by a laser or pulses of microwaves, to keep them out of equilibrium. The time crystals are sustained only by constant kicking, even though - crucially - their oscillation doesn't match the rhythm of the kicking. The experiments are ingenious and the results show that this modified version of Wilczek's vision is feasible. But are we right to award the new findings this eye-catching new label, or are they really just a new example of a phenomenon that has been going on since the first primeval heart started beating? If these fancy arrangements of quantum spins deserve to be called time crystals, can we then say that we each already have a time crystal pulsing inside of us, keeping us alive?" http://www.prospectmagazine.co.uk/blogs/philip-ball/time-crystals-could-they-exist-science-physics That is, Frank Wilczek's time crystals are regularly "kicked" by the experimentalist. However, there are genuine time crystals "kicked" by ambient heat and breathtakingly violating the second law of thermodynamics. Here is perpetual (limited only by the deterioration of the system) motion of water in an electric field, obviously able to produce work - e.g. by rotating a waterwheel: "The Formation of the Floating Water Bridge including electric breakdowns" https://www.youtube.com/watch?v=17UD1goTFhQ "The water movement is bidirectional, i.e., it simultaneously flows in both directions." https://www.wetsus.nl/home/wetsus-news/more-than-just-a-party-trick-the-floating-water-bridge-holds-insight-into-nature-and-human-innovation/1 The work will be done at the expense of what energy? The first hypothesis that comes to mind is: At the expense of electric energy. The system is, essentially, an electric motor. However, close inspection would suggest that the hypothesis is untenable. Scientists use triply distilled water to reduce the conductivity and the electric current passing through the

system to minimum. If, for some reason, the current is increased, the motion stops - the system cannot be an electric motor. If the system is not an electric motor, then it is ... a perpetual-motion machine of the second kind! Here arguments describing perpetual-motion machines as impossible, idiotic, etc. are irrelevant - the following conditional is valid: IF THE SYSTEM IS NOT AN ELECTRIC MOTOR, then it is a perpetual-motion machine of the second kind. In other words, if the work is not done at the expense of electric energy, then it is done at the expense of ambient heat, in violation of the second law of thermodynamics. No third source of energy is conceivable. In the electric field between the plates of a capacitor, the same perpetual motion of water can be seen (we have a time crystal again): " Liquid Dielectric Capacitor" http://www.youtube.com/watch?v=T6KAH1JpdPg In the capacitor system the rising water can repeatedly do work, e.g. by lifting floating weights. The crucial question is: The work (lifting floating weights) will be done at the expense of what energy? Obviously "electric energy" is not the correct answer - the capacitor is not an electric motor. Then the only possible answer remains "ambient heat". The system is a heat engine violating the second law of thermodynamics! Pentcho Valev

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Join the disruptors of health science

01 November 2017

Thomas R. Insel's biggest lesson from his shift from NIMH director to Silicon Valley entrepreneur: academic and technology company researchers should partner up.

Gabriela Hasbun for *Nature*

Thomas Insel left Verily, a health-science spin-off formed by Google's parent company, to co-found a start-up called Mindstrong Health this year.

In early 2015, I testified with several other National Institutes of Health (NIH) directors at an annual hearing held by the US Senate. It was my 13th and final year as director of the US National Institute of Mental Health

(NIMH) in Bethesda, Maryland. What struck me most was how the harsh fiscal reality tempered the passionate bipartisan support for the NIH. As one senator noted, with a federal deficit of nearly US$500 billion, there was little hope of any significant increase in funding.

Six months after that hearing, I left the NIH for Silicon Valley, first working at Verily in South San Francisco, California, a health-science spin-off formed by Google's parent company Alphabet. Since May, I've been president and co-founder of a start-up called Mindstrong Health in Palo Alto, California. I've witnessed the tremendous possibilities that immense resources, massive computing power and the application of data science can bring to biomedical research. I've watched some of today's best junior faculty members and postdocs launch their careers in Silicon Valley instead of in academic departments. And I've wondered how technology giants and start-ups will change biomedical and health-care research.

These companies have transformed the worlds of information, entertainment and commerce. But by moving into health care, they face some formidable challenges. In my view, solving them will require deep partnerships between technology companies, clinical experts, patient advocates and academic scientists.

A financial frontier

In the United States, public funding for science has not kept up with inflation over the past decade. The proposed 2018 budget from the White House recommends funding cuts for the NIH and the National Science Foundation of more than 10% each. Appropriations may ultimately be more generous, but no one is expecting Congress to repair a decade's loss of purchasing power.

Meanwhile, private-sector investment has become a bigger piece of the research-funding pie — increasing from 46% in 1994 to 58% in 2012 for biomedical research[1]. Tech companies, in particular, have been ploughing more funds into research, and moving into areas such as health and life sciences that have typically been the domain of the NIH, pharmaceutical and

biotechnology companies. By any measure, tech companies have enormous sums to spend. The collective cash reserves of Apple, Microsoft, Alphabet and Facebook — roughly $500 billion — exceed by tenfold the annual federal investment in biomedical research.

So what does this changing ecosystem mean for US biomedical science? Has the locus of innovation shifted from academia to Google and Facebook?

In some areas, such as artificial intelligence (AI), tech companies already dominate. According to a 2017 report, the tech giants invested between US$20 billion and $30 billion in AI in 2016, with 90% of this going towards research and development. Some, such as Google and the Chinese web-services company Baidu, are rebranding themselves as AI or deep-learning companies, with a focus on both expanding the science of machine learning and applying the approach to big-data problems[2].

In health research, the landscape is still evolving. Three years ago, IBM began selling a software suite called Watson for Oncology to cancer-treatment centres around the world. The program is built around what IBM call cognitive computing and is designed to help clinicians to select the best treatment. The company claimed that by using its cloud-based data on cancer, Watson could recommend interventions for individual patients, although some say the effort was premature and oversold[3].

Over the past 12 months, Fitbit, the developer of several fitness trackers, has expanded into a health-care and health-research company. With more than 50 million registered users, it is involved in 400 research projects, including studies of diabetes and heart disease. In fact, Fitbit has just been listed as one of nine digital health companies to be considered by the US Food and Drug Administration (FDA) in its precertification pilot programme — a new, supposedly more agile, approach to regulation that will focus on the software developer rather than on individual products.

Since March 2015, Apple's ResearchKit has made it easier for developers to create health apps for the iPhone or Apple Watch. It has also provided a platform for enrolling thousands of participants remotely in clinical projects, for instance in diabetes, cancer and diseases of the central nervous system. A study at Johns Hopkins University in Baltimore, Maryland, for instance, has

used ResearchKit to capture data just before and throughout seizures in nearly 1,000 people with epilepsy[4].

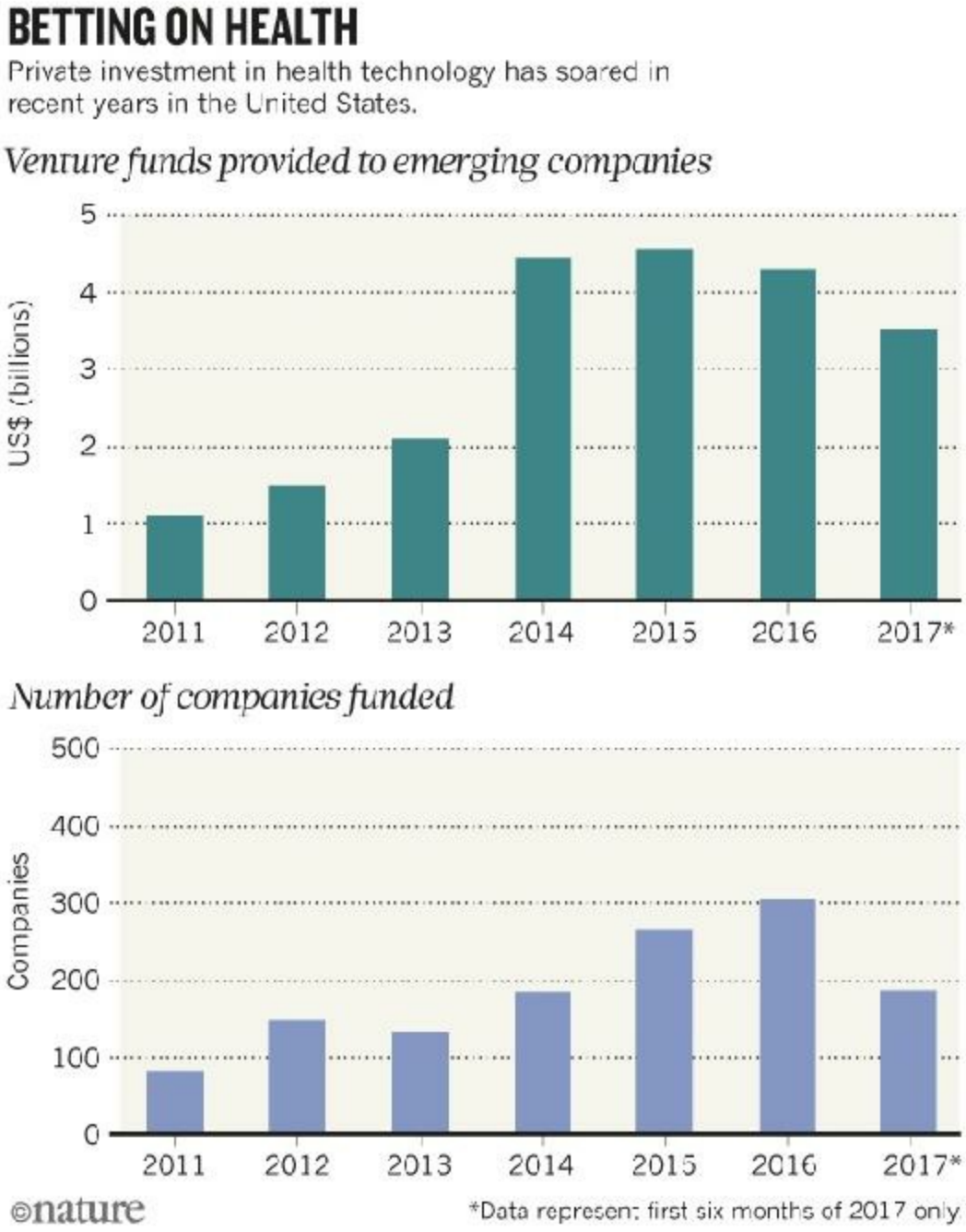
Kiyoshi Ota/Bloomberg/Getty

Fitbit, the developer of these sleep-monitoring wristbands, is currently involved in 400 research projects.

Also in 2015, Alphabet launched Verily — a company focused on creating software and hardware to transform health care. After growing to more than 500 employees in just over 2 years, Verily seeks to address diabetes, heart disease, cancer and diseases of the central nervous system using miniaturized sensors in smart devices — such as a contact lens that estimates blood sugar levels.

Just six months ago, Facebook revealed the existence of Building 8, a division focused on delivering consumer “hardware products that are social first”, including brain–computer interfaces designed to aid people with disabilities.

Meanwhile, health tech has become one of the hottest areas for venture investment in the United States: more than 1,000 new digital-health companies have started up since 2012. A report from Rock Health, a US venture-capital fund headquartered in San Francisco that invests in digital-health start-ups, estimates[5] that $15 billion has poured in to the sector over the past 5 years, up from $1.5 billion in 2012 and $1.1 billion in 2011 (see 'Betting on health').



Source: Rock Health

Like pharma and biotech, big and small tech companies are product-focused and team-based. This contrasts with academia, where scientists are rewarded for publishing papers and incentives are built around individual promotion

within a departmental structure.

But what struck me most on moving from the Beltway to the Bay Area was that, unlike pharma and biotech, tech companies enter biomedical and health research with a pedigree of software research and development, and a confident, even cocky, spirit of disruption and innovation. They have grown by learning how to move quickly from concept to execution. Software development may generate a minimally viable product within weeks. That product can be refined through 'dogfooding' (testing it on a few hundred employees, families or friends) in a month, then released to thousands of users for rapid iterative improvement.

During my first month working at Verily, I returned to Bethesda for the winter holidays; when I went back to work in early January, I found that a group of engineers had developed an entirely new product between Christmas and New Year's Day. Contrast that with the NIH-funded world of research, where it usually takes at least 18 months to go from proposing an idea to getting a project funded, or the years it can take to transform the discovery of a molecule into a marketable drug.

This intense focus on the rapid development of consumer products is very different from the pursuit of fundamental knowledge that has been a hallmark of academic research. And as a newcomer (what Google calls a noogler), I found the language of product development and the drive towards 'quarterly OKRs' (objectives and key results) a bit off-putting. But the truly disruptive impact of tech companies is not the rapid-fire push for consumer products or their deep pockets; it's their focus on AI and data resources.

Mining data

It is not surprising that companies that are dependent on information processing for their main revenue would be at the vanguard of developing the tools for collecting, storing and analysing data. A by-product of this is that tech companies are transforming data science — much as pharma and biotech transformed medicinal chemistry and molecular biology in the last decades of the twentieth century. In an era when biology is increasingly an information

science, the tools being created by tech companies can provide insights that will almost certainly be translated into advances for health.

The potential is awesome — for discovery as well as for product development.

Three examples illustrate what can be achieved through having extraordinary access to population data as well as massive data-storage and data-processing capacity. Importantly, none connects in an obvious way to a primary business of the company.

First, in 2016 a team at Google used a version of machine learning called convolutional neural nets to create an algorithm to detect diabetic retinopathy[6]. The researchers started by having 54 ophthalmologists rate 128,175 retinal images. Once the algorithm had been trained on this data set, the team used two new sets of retinal images to test against eight board-certified ophthalmologists. The results were striking: depending on how the researchers set its parameters, the algorithm performed better than seven of the eight clinical experts, in terms of sensitivity and specificity. This approach is not markedly different from previous efforts to identify cats and faces with machine learning, but the potential impact on diagnostics and clinical care is profound.

Second, a team in Facebook's Building 8 is seeking to develop new brain–computer interfaces that (with the use of non-invasive optical sensors) will enable people to type simply by thinking — what is now called 'silent speech'. Although several universities have teams working on brain–computer interactions, the number of engineers and the computational resources that Facebook can muster would be difficult for any academic investigator to fund using federal grants. Importantly, Facebook is supporting some of these academic scientists (as well as recruiting many) to expedite this project.

Third, a team at Microsoft has used anonymous Bing search histories from 9.2 million users to predict cases of pancreatic cancer several months before people are usually diagnosed with the disease[7]. The team identified characteristic patterns of historical symptom searches in more than 3,000 anonymous users who subsequently indicated a probable diagnosis of

pancreatic cancer — indicated by searches such as 'just diagnosed with pancreatic cancer'. This approach lacks the corroboration of a pathological diagnosis and the sensitivity is poor (only 5–15% of cases can be identified). But false-positive rates are extremely low (less than 0.0001).

In short, tech companies have scale and speed: an experiment can involve millions of people and be completed in months. But scale and speed aren't everything.

Sticking points

In moving from software or hardware development to biomedical research and health care, tech companies large and small face formidable challenges. They usually do not have the regulatory expertise needed to develop medical products, they rarely have access to clinical samples and they often lack a deep understanding of the clinical problem to be solved.

Gabriela Hasbun for *Nature*

At its California office, Mindstrong Health is developing digital phenotyping as a diagnostic tool.

Various moves are being made to try to address these issues. In May, Verily hired Robert Califf, former chief of the FDA, to help with its personalized-medicine effort called Project Baseline. In 2015, 23andMe, a personal-genomics company based in Mountain View, California, recruited Richard Scheller, former head of research at the biotech company Genentech in San Francisco, to lead its research programme. And in 2016, Apple brought Stephen Friend, an open-science advocate from the non-profit research organization Sage Bionetworks in Seattle, Washington, to assist with its health projects.

How a culture built around engineers and designers will incorporate people from different sectors remains to be seen, and whether companies that build consumer products will be able to work with health-care payers and providers is unclear. But the willingness of tech companies to hire national experts on health, regulation and health data to aid in discoveries that will have clinical utility is a hopeful sign.

Yet there are at least four further major areas of uncertainty.

Open science increasingly drives innovation in the public sector. It is unclear to what degree the drive for intellectual property and profits will limit the transparency of research in the tech sector[8]. The stereotype is that for-profit companies will focus only on commercial end points. But there are notable counter-examples from AI research, in addition to the biomedical examples above. In 2015, Google made its machine-learning software library, TensorFlow, open source, and AI researchers across the board quickly adopted this powerful tool. Likewise, the *Apple Machine Learning Journal* launched in July to provide more transparency about the company's current projects (see go.nature.com/2yckpi9).

It's too early to say whether big or small tech companies will favour open source for their biomedical scientific initiatives. The success of ResearchKit gives some indication of what could be accomplished if they do.

Another uncertainty is whether the business model in tech, which is often based on advertising revenue or the sales of devices, will limit the rigour, generalizability and validity of the science carried out. Especially in start-ups that are dependent on rapid returns for their investors, the financial runway may be too short for lengthy or large clinical trials.

And then there's the issue of trust. It has become the norm for tech companies to use personal shopping or geolocation data for commerce. It's unclear whether the public will be as accepting about the use of personal health data, especially by behemoths such as Google or Facebook.

The recent commitments of big and small tech companies to discovery and clinical research are exciting. But during an economic downturn, these projects could be the first to be axed to protect the company's bottom line.

Science needs commitment. Bell Labs — at its peak, the premier research and development company of the United States — is an example of extraordinary scientific success in a for-profit organization. But as author Jon Gertner pointed out[9] in *The New York Times* in 2012: “Mark Zuckerberg noted that one of his firm's mottoes was 'move fast and break things'; that of Bell Labs' might just as well have been 'move deliberately and build things'.”

Partners, In time

The practical questions are these. What will each of the sectors in the evolving ecosystem do best? What can be done across sectors? How can bridges be built between companies with unprecedented access to data and massive computational resources, and academic scientists who may have a deep understanding of a clinical problem or access to unique clinical populations?

It seems likely that the academic sector will continue to lead on those aspects of fundamental biology and clinical research that do not require big data or machine learning — the purification of an enzyme, perhaps, or the development of a mouse model for a rare disease. Pharma and biotech will continue to be the source of new medicines. The domain of the tech industry

will be research that is data-intensive, and product development that requires a legion of software engineers working with designers.

Transformative medical products that require clinical testing, regulatory standards and insights about the health-care marketplace, including the practical constraints faced by providers in the clinic, will almost certainly require partnerships between public research entities and private companies. These must include precompetitive partnerships across tech, pharma–biotech, academia and patient-advocacy groups. Developing these partnerships will not be easy, given the different stakeholders, cultures and incentives.

Yet there are successful public–private partnerships to learn from.

Since 2006, the Biomarkers Consortium, managed by the US charitable organization the Foundation for the NIH, has brought academics and private companies together to develop biomarkers across a range of diseases. The Alzheimer's Disease Neuroimaging Initiative, which since 2004 has worked to establish standards for imaging biomarkers in dementia, is among the studies it has supported. As is I-SPY2, which since 2010 has created treatment pathways based on biomarkers for breast cancer. Another Foundation for the NIH initiative is the Accelerating Medicines Partnership. This has paired the NIH and the FDA with 10 pharma and biotech companies as well as 12 non-profit patient-advocacy foundations to define new targets for drug development for rheumatoid arthritis, type 2 diabetes and Alzheimer's disease.

A new sector in the research ecosystem means that health problems, even those that do not present an obvious commercial opportunity, can be approached from a fresh angle. Data science could integrate the full stack of patient information, from genomics to socio-economic factors, to guide clinical care. Sensors and big data could transform our description of phenomics — each person's set of behavioural, physical and biochemical traits. For example, digital phenotyping through the use of smartphone sensors, keyboard performance and voice or speech features can provide, for the first time, an objective, continuous, passive measure of behaviour and cognition at the global scale. Mindstrong Health is using this approach to detect the earliest phases of dementia, mental illness and possibly a range of medical disorders[10].

As just one example of an urgent opportunity, attempts to prevent suicide worldwide have been remarkably ineffective — including public-health measures to reduce stigma, raise awareness and reduce access to guns. Social media, just-in-time interventions and new analytical tools for prediction could change our understanding of risk and yield new strategies for prevention[11]. Tech companies, paired with other players, could start to solve this and many other historically intractable problems.

There is an old African proverb: “To go fast, go alone; to go far, go together.” Science to improve health has proved frustratingly slow. Perhaps, with a new fast partner, all of us in research can go farther.

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Comments

Comments

There are currently no comments.

Spanish government takes control of Catalonian universities

Madrid will oversee the finances of the region's research centres and seven public universities.

31 October 2017

Alain Pitton/NurPhoto/Getty

Supporters of independence for Catalonia.

The Spanish government has taken over responsibility for higher education and research in Catalonia, following the region’s unilateral declaration of independence on 27 October. It will retain control of spending on research centres and universities, which the League of European Research Universities

says threatens institutional autonomy.

The Catalonia region of north-east Spain has been in political turmoil ever since a highly controversial vote on independence was taken on 1 October. For the past 32 years the Catalan government has set and financed the budgets of universities, which were allocated €700 million (US$814 million) of the nearly €1-billion Catalan budget for science and universities in 2017. The region is strong in science: between 2007 and 2015, its universities won a 210 grants from the European Research Council, totalling €334 million. In the most recent round, 10 of the 22 ERC starting grants awarded to researchers in Spain were won by researchers based at Catalan institutions.

The Ministry of Education, Culture and Sport in Madrid will run Catalan universities and the Ministry of Economy, Industry and Competitiveness will oversee the region's research policy with immediate effect.

The changes mean that the Spanish government will be able to make decisions affecting research centres and universities in Catalonia, after it dismissed all the members of the Catalan government.

Carmen Vela, Spain's secretary of state for research, development and innovation, says that the government hopes the difficulties will be resolved shortly. "Today's situation is a bit different, but it has a very clear goal: restoring normality and tranquility. We are going to work to ensure that there are no negative impacts on research and innovation in Catalonia." She says that the Spanish government will manage but not devise science policy in Catalonia ahead of regional elections due in December.

University connections

Santi Vila, minister of business and knowledge in the Catalan government, stepped down a day before the independence declaration. Arcadi Navarro, secretary of state for universities and research in the Catalan government and a geneticist at Pompeu Fabra University in Barcelona, who used to report to Vila, might yet remain in his job. Vela says that she would like him to continue. "Arcadi is an excellent researcher and someone with whom we

have always had an excellent relationship," Vela says. "We want to keep working with him."

Jaume Casals, rector of Pompeu Fabra University, says that he does not expect the Spanish government to interfere directly in universities' affairs. "The relationship between Madrid and Barcelona when it comes to science and universities has always been fluid, and I hope that will not change," says Casals, who also leads the Alliance 4 Universities, a group of research-intensive universities consisting of two based in Madrid and another two in Catalonia.

Enric Banda, senior adviser at the Barcelona Supercomputing Centre and former president of the grass-roots association EuroScience, agrees. "This is the first time these type of measures, stipulated in the Spanish constitution, are applied. The uncertainty is high because nobody knows exactly how they will be implemented. But I don't expect any additional disruption in the daily activities of the Catalan universities," he says.

Financial ties

The League of European Research Universities, headquartered in Leuven, Belgium, has criticized the financial arrangements on the grounds that they undermine institutional autonomy. In a statement issued on 23 October, the group's secretary-general, Kurt Deketelaere, wrote: "Just like academic freedom, institutional autonomy is key for the academic world and society at large. It cannot be limited on the basis of political considerations, or to serve political goals."

Ahead of the Catalan elections in December, both Casals and Banda are calling on the Spanish government to lift the financial controls and to minimise the impact of the political upheaval on the region's international image. "Catalonia has done very well at attracting international researchers and students and we would like that to continue," says Casals.

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Nature

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Comments

Commenting is currently unavailable.

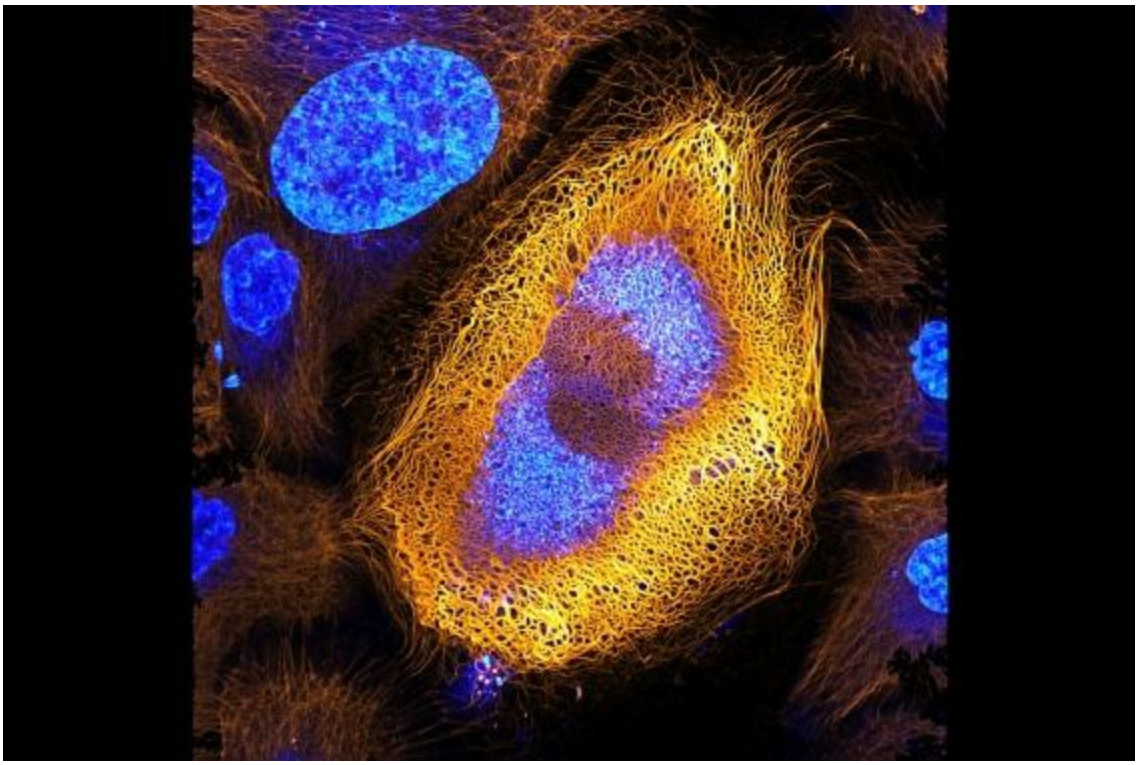
Seeds, sponges and spinal surgery

October’s sharpest science shots, selected by *Nature*’s photo team.

31 October 2017

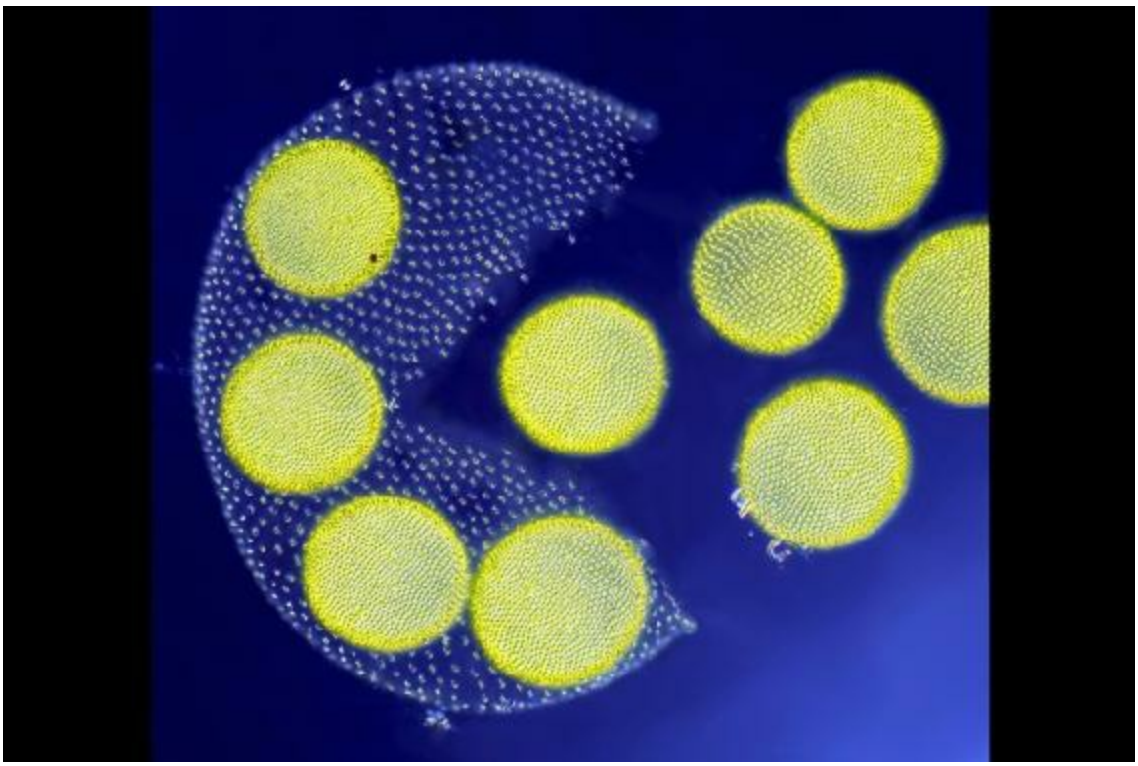
Small beauties

Image Slideshow

1. 

   This image of an immortalized human skin cell won first place in the Nikon Small World Photomicrography Competition. It was taken by Bram van den Broek, a biophysicist at the Netherlands Cancer Institute in Amsterdam.

B. van den Broek, A. Volkov, K. Jalink, N. Schwartz, R. Windoffer/Nikon Small World 2017

2. 

This might look like computer-game character Pac-Man, but it is actually a type of alga called Volvox releasing daughter colonies to continue its line.

Jean-Marc Babalian/Nikon Small World 2017

3. 

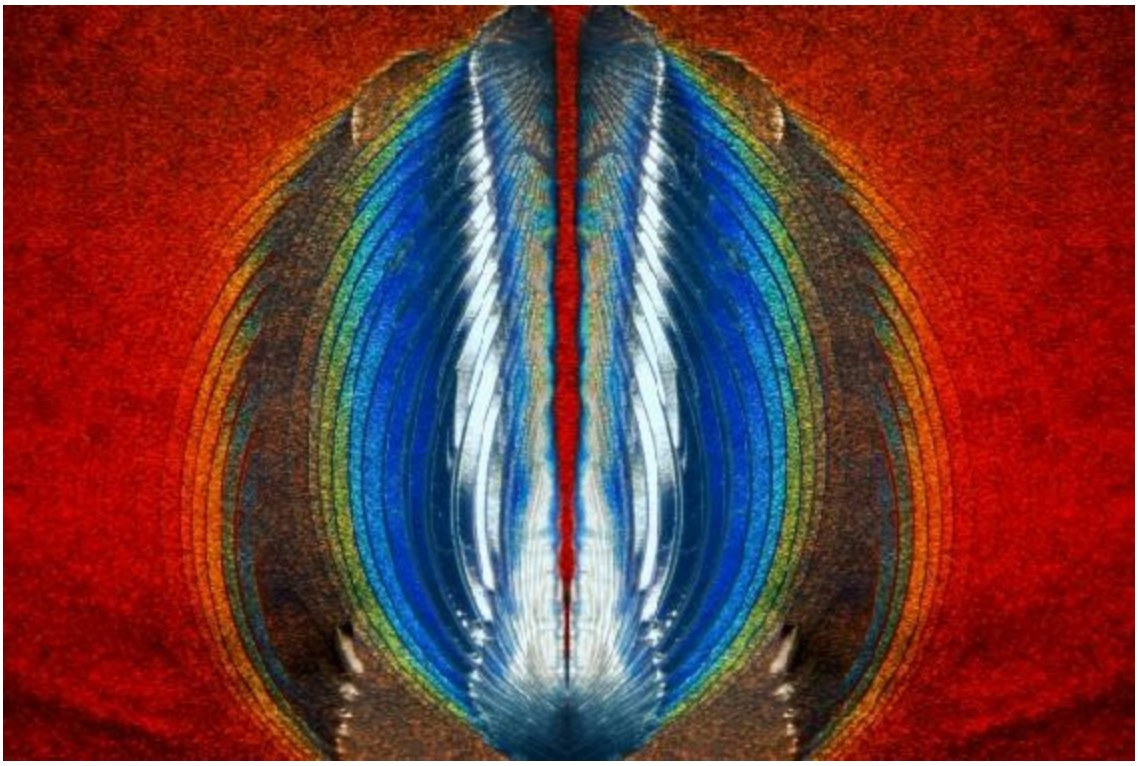
This portrait of a tropical weevil (*Rhigus nigrosparsus*) was given an ‘image of distinction’ award.

M. Clemens/Nikon Small World 2017

4. 

An eerie green crystal of the mineral pyromorphite featured in another shot that received an image of distinction.

E. C. Márquez/Nikon Small World 2017

5. 

This butterfly-like shape is in fact the fractured plastic of a credit-card hologram, seen at ten times its real size.

S. Simon/Nikon Small World 2017

6. 

   This startlingly alien shape is a cross-section through something very common: a needle from a Scots pine tree (*Pinus sylvestris*).

   A. Klepnev/Nikon Small World 2017

From tragic to touching

Image Slideshow

1. 

   The grand-title winner of this year's Wildlife Photographer of the Year competition features a black rhino (*Diceros bicornis*) in Hluhluwe Imfolozi Game Reserve in South Africa, after it was butchered by poachers who were after its horns. Brent Stirton has seen more than 30 such tragic scenes.

   Brent Stirton/Wildlife Photographer of the Year

2. 

This Maori octopus (*Macroctopus maorum*) was spoilt for choice when it came across a huge congregation of giant spider crabs off Tasmania, Australia. The photograph won the invertebrate-behaviour category of the Wildlife Photographer of the Year competition, which is developed and produced by the Natural History Museum, London.

Justin Gilligan/Wildlife Photographer of the Year

3. 

Divers from the Dumont d’Urville scientific base in East Antarctica worked for 3 days in the frigid waters off the continent to capture this image of an ice berg, which was stitched together from 147 separate shots. It won the Earth’s environments category.

Laurent Ballesta/Wildlife Photographer of the Year

4. 

These polar bears (*Ursus maritimus*) near Norway's Arctic island of Svalbard were photographed feeding on waste from a ship's kitchen. The image won the black-and-white category in this year's awards.

Eilo Elvinger/Wildlife Photographer of the Year

5. 

Controversial oil drilling is an increasing threat to the residents of Yasuní National Park in Ecuador. Among the animals imperilled is this toad, the star of this finalist in the animal-portraits category.

Jaime Culebras/Wildlife Photographer of the Year

6. 

The Sonoran Desert in the United States and Mexico hosts many saguaro cacti (*Carnegiea gigantea*), including this example that has suffered frost damage, causing its limbs to fall to the ground. The image is a finalist in the plants and fungi category.

Jack Dykinga/Wildlife Photographer of the Year

Syrian seeds

Diego Ibarra Sanchez/The New York Times/eyevine

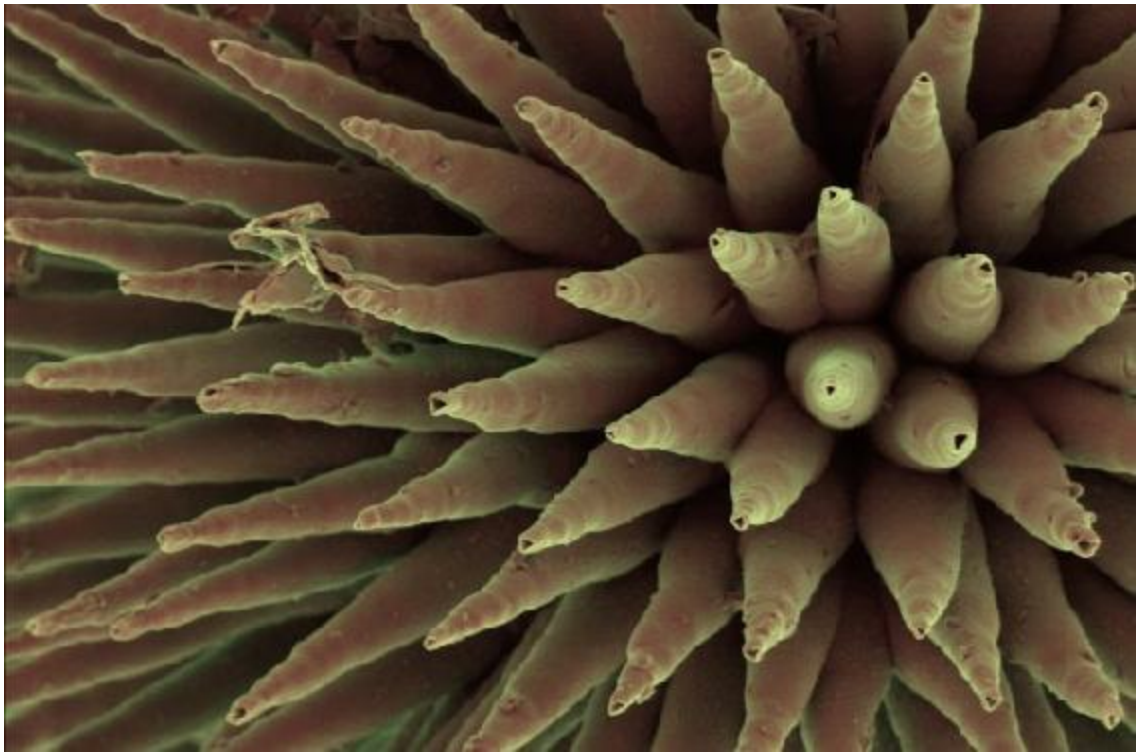
Among the people forced out of their country by the war in Syria are researchers from the nation's seed bank, who are now rebuilding their lives in locations around the world. Ali Shehadeh (pictured) is one of them. A researcher who was based at a International Center for Agricultural Research in the Dry Areas seed bank in Aleppo, he now works in Terbol, Lebanon.

Capturing sunlight

Xu Haijing/Xinhua/ZUMA Wire

The 2017 World Solar Challenge this month saw strange vehicles racing 3,00(kilometres across Australia, powered only by sunlight. Here, the Dutch-built vehicle RED Shift passes a rock formation known as the Devil's Marbles, near Tennant Creek in the Northern Territory.

Sponge spikes



Zlotnikov Group, B CUBE, TU Dresden

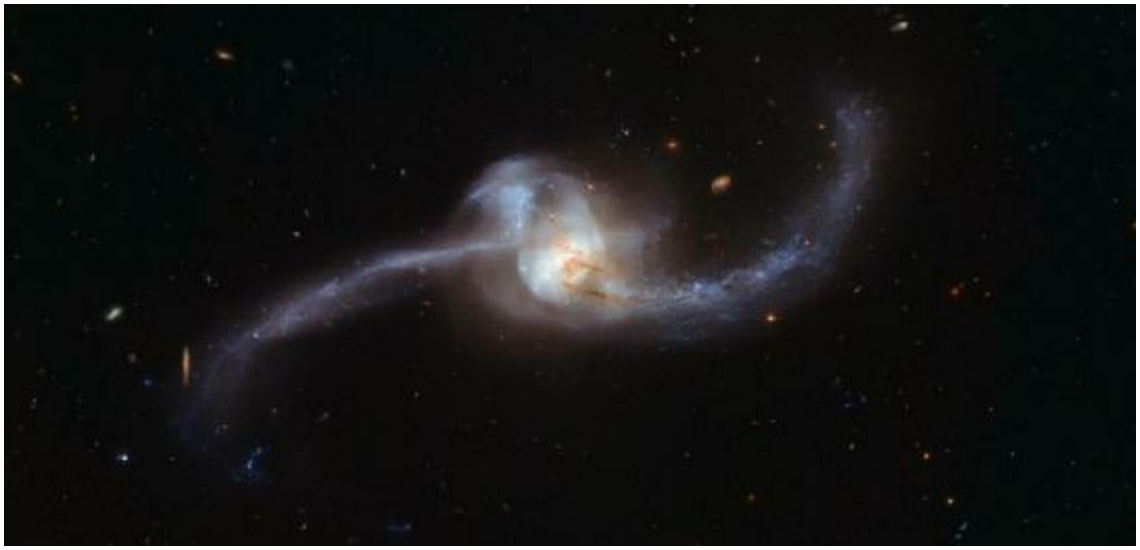
Marine sponges called demospongiae make their skeletons out of silica-glass structures called spicules. Using this image and others, researchers have been unpicking what they call the “half-a-billion-year-old fabrication concept” that produces these structures.

Spinal surgery

Beatrice de Gea/The New York Times/Redux/eyevine

Physicians at Texas Children’s Hospital in Houston now operate on fetuses with spina bifida while they are still in the womb using a new, experimental technique. This technique involves lifting the mother’s uterus out of her body to operate on the spine of the baby inside it.

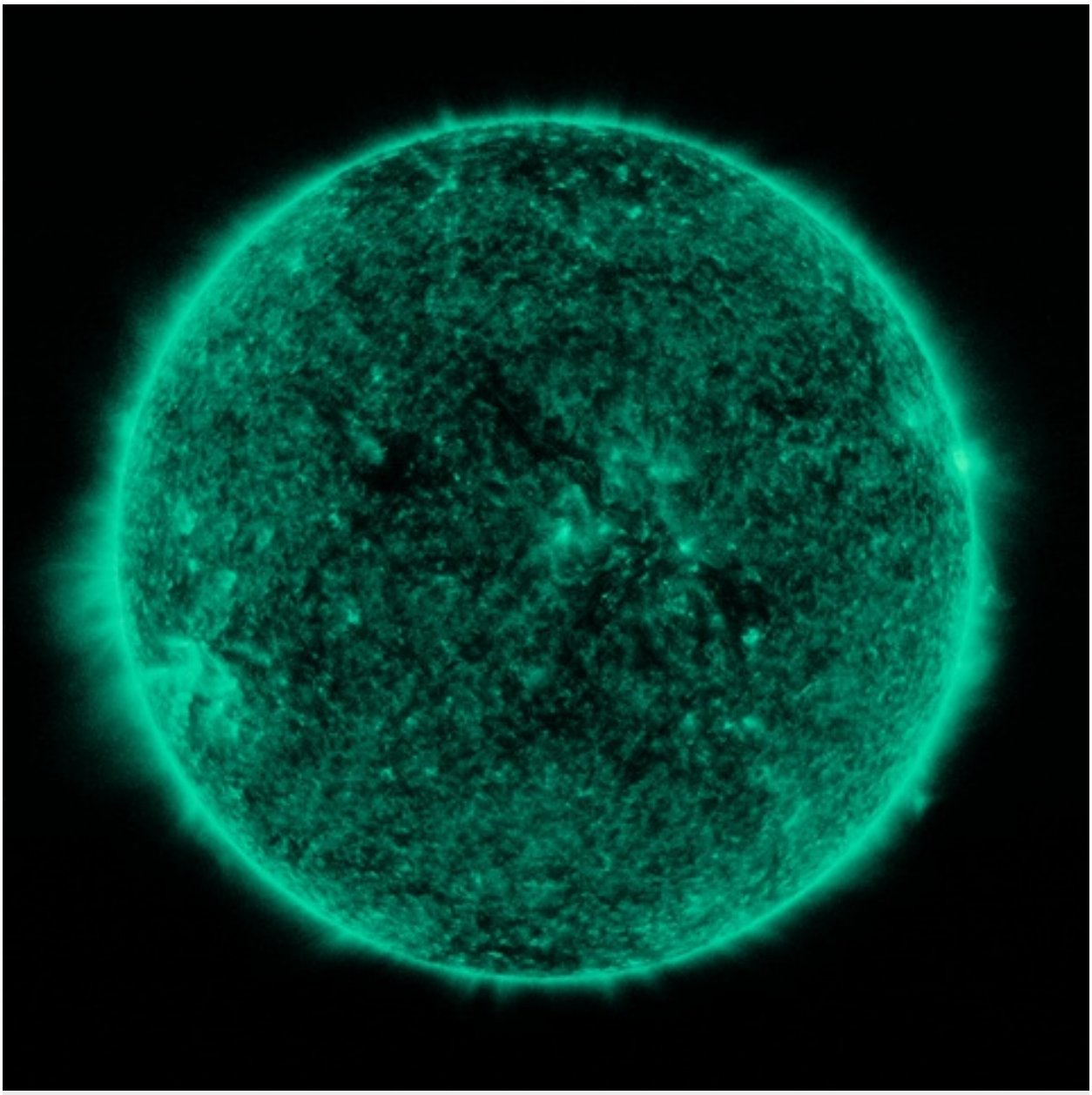
A cosmic collision’s aftermath



ESA/Hubble & NASA

Two galaxies smashed together into one to form this cluster of stars, with tails some 15,000 parsecs (50,000 light years) long. NASA released the image this month, and cheerfully pointed out that this is what our Milky Way will look like in 4 billion years' time, after it collides with neighbouring galaxy Andromeda.

Sun block



NASA’s Goddard Space Flight Center/SDO/Joy Ng

NASA’s Solar Dynamics Observatory was launched into space in 2010 to supply researchers back on Earth with an uninterrupted view of the Sun. Uninterrupted, that is, except when the Moon gets in the way, as shown in this ultraviolet spectrum from 19 October.

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Comments

Comments

There are currently no comments.

Small group scoops international effort to sequence huge wheat genome

Just six scientists conquer one of the most complicated genomes ever read.

31 October 2017

Nico van Kappel/Minden Pictures/Getty

The genome of wheat (*Triticum aestivum*) is huge, and full of repetitive sequences.

The wheat genome is finally complete. A giant international consortium of academics and companies has been trying to finish the challenging DNA

sequence for more than a decade, but in the end, it was a small US-led team that scooped the prize. Researchers hope that the genome of bread wheat (*Triticum aestivum*) — described in the journal *GigaScience* this month[1] — will aid efforts to study and improve a staple crop on which around 2 billion people rely.

The wheat genome is crop geneticists' Mount Everest. It is huge — more than five times the size of a single copy of the human genome — and harbours six copies of each chromosome, adding up to between 16 billion and 17 billion letters of DNA. And more than 80% of it is made of repetitive sequences. These stretches are especially vexing for scientists trying to assemble the short DNA segments generated by sequencing machines into much longer chromosome sequences.

It’s like putting together a jigsaw puzzle filled with pieces of blue sky, says Steven Salzberg, a genomicist at Johns Hopkins University in Baltimore, Maryland, who led the latest sequencing effort. “The wheat genome is full of blue sky. All these pieces look like a lot of other pieces, but they’re not exactly alike.”

As a result, previous wheat-genome sequences contained gaps that made it hard for scientists to locate and examine any particular gene, says Klaus Mayer, a plant genomicist at the Helmholtz Center in Munich, Germany, and one of 1,800 members of the International Wheat Genome Sequencing Consortium (IWGSC) that have been tackling the genome since 2005.

A sequence released by the consortium in 2014 covered about two-thirds of the genome, but it was highly fragmented and lacked details about the sequences between genes[2]. Improved versions were released in 2016 and 2017, but the use of these data is restricted until the IWGSC publishes its analysis (Mayer says the team is preparing to submit its report to a journal). The sequence was also produced using proprietary software from a company called NRGene, preventing other scientists from reproducing the effort.

Puzzle pieces

Salzberg, who specializes in assembling genome sequences, and his five colleagues decided to tackle the problem themselves. To overcome the challenge of ordering repetitive DNA — the puzzle pieces of blue sky — the researchers used a sequencing technology that generates very long DNA stretches (often in excess of 10,000 DNA letters). They also created much shorter, but highly accurate sequences, using another technology.

Stitching these ‘reads’ together — which amounted to 1.5 trillion DNA letters and consumed 880,000 hours of processor time on a cluster of parallel computers — resulted in nearly continuous chromosome sequences that encompassed 15.3 billion letters of the wheat genome.

Mayer calls the new sequence “a major leap forward”. Postdocs can spend whole fellowships locating a single wheat gene of interest, he says. “Those genes which took 10 man- or woman-years to clone, this will melt down to a couple of months, hopefully.” The results of such research should help breeders to develop strains of wheat that are better able to tolerate climate change, disease and other stresses.

Some scientists are already using the new wheat genome — including, Salzberg says, members of the IWGSC working on one particular chromosome. But if it is to be of widespread use, all of the genes and sequences will need to be identified and labelled, a laborious process known as annotation. Salzberg says that a collaborator of his is planning to do this, “unless someone does it sooner”.

Neil Hall, a genomicist and director of the Earlham Institute, a genomics research centre in Norwich, UK, sees Salzberg’s approach as a sign of the times. If the wheat genome — considered one of the most complicated to be tackled by scientists — can be sequenced by a small team using the latest technology, almost any genome could.

“I think we’ve moved beyond the era where genome projects have to be these monolithic international cooperations,” Hall says. “Genomics is more like the gig economy now.”

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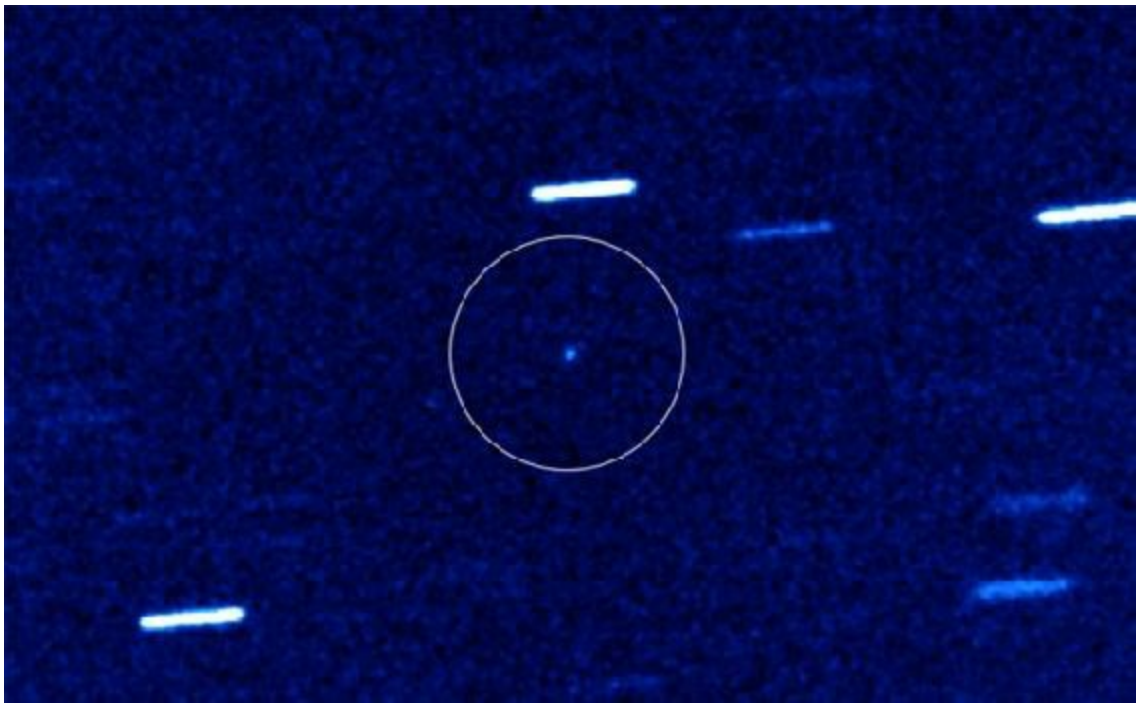
Comments

Commenting is currently unavailable.

Astronomers race to learn from first interstellar asteroid ever seen

Wonky orbit confirms that this visitor isn’t from around here.

31 October 2017



Alan Fitzsimmons, Queen’s University Belfast/Isaac Newton Group, La Palma.

The interstellar asteroid A/2017 U1 (circled) is rushing away from Earth and is currently traversing the Pisces constellation.

Scientists are trying to learn everything that they can from the first interstellar asteroid they have ever observed crossing into our Solar System. Spotted less than two weeks ago, the object is now whizzing across the constellation Pisces and, in a couple of months, will be too faint and far away for even the

largest telescopes to see.

“It’s fascinating,” says astronomer David Jewitt of the University of California, Los Angeles. “We are seeing a body from elsewhere in the Galaxy passing through our Solar System. It’s the first time we’ve seen such a thing.”

Unfortunately, the asteroid, dubbed A/2017 U1, is dashing away, never to return. “It’s going really fast,” says Jewitt. “So we have a limited time to get any measurements at all.” Astronomers would love to know what it’s made of, but it’s so dim that spectra — light that observers use to determine the compositions of celestial objects — have so far revealed little information[1]. Nor can anyone say what solar system it came from, or how old it is.

A curious path

Researchers with the Pan-STARRS1 telescope atop Haleakala in Maui, Hawaii, spied the first images of the intruder, made during the new Moon, in mid-October. “It didn’t move like comets or asteroids normally do,” says astronomer Rob Weryk at the University of Hawaii at Manoa, who first noticed the object on the morning of 19 October.

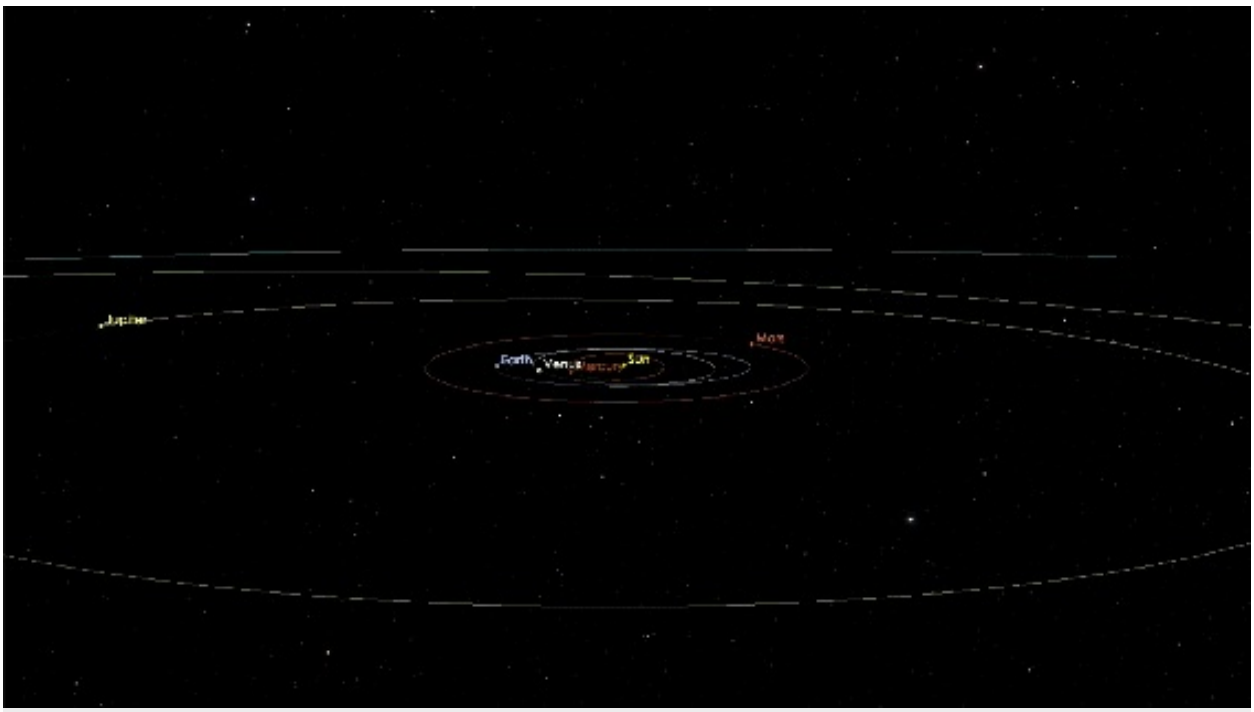
Comets and asteroids usually move on elliptical orbits around the Sun. These orbits have an eccentricity — a measure used to describe orbital shape — of less than 1. But an object zipping through the Solar System from beyond should instead follow a hyperbolic orbit, whose eccentricity exceeds 1.

The latest observations of the asteroid’s changing position indicate that its orbital eccentricity is a whopping 1.20. “It is virtually certain that the object moves in a hyperbolic trajectory,” says Carlos de la Fuente Marcos, an astronomer at the Complutense University of Madrid.

The asteroid skirted the Sun on 9 September, when it was inside Mercury’s orbit, and then passed by Earth at a distance of 24 million kilometres on 14 October.

On the lookout

Astronomers know little else about the exotic visitor. It’s faint, which means that it’s small: fewer than 400 metres across. And despite its excursion near the Sun, it did not develop a tail — as a comet would — and so astronomers are currently classifying it as an asteroid.



NASA/JPL-Caltech

The path of A/2017 U1, an interstellar object that swung through our Solar System.

Researchers have anticipated interstellar visitors for years. “We have waited a long time,” says planetary scientist Alan Stern at the Southwest Research Institute in Boulder, Colorado, who studied the matter in the 1990s.

That expectation is based on the knowledge that the gravitational pulls of the giant planets Jupiter, Saturn, Uranus and Neptune catapulted trillions of comets and asteroids from the young Solar System into interstellar

space. Planets in other solar systems presumably did the same, littering interstellar space with rogue objects. “By measuring how many there are sweeping through our Solar System, we can get a gauge of how many are in the entire Galaxy, and how many solar systems have contributed to that population,” says Stern.

“If one hadn’t been discovered fairly soon, that would start to worry me a bit,” says astronomer David Hughes, emeritus professor at the University of Sheffield, UK.

The asteroid came from the direction of the constellation Lyra, which is roughly where our Solar System is heading. Given this trajectory, researchers are expecting to see more objects coming from this direction than from elsewhere, just as runners heading into the rain encounter more drops on their chests than their backs.

A/2017 U1 is the first of many such objects, predicts Jewitt.

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Comments

Comments

There are currently no comments.

How baby bats develop their dialects

The young animals crowdsource the pitch of their calls from colony members.

31 October 2017

Joel Sartore/National Geographic Creative

Adult Egyptian fruit bats have a hand in what young bats learn.

It takes a village to teach a bat how to communicate. Baby Egyptian fruit bats learn calls from their mothers, but research now shows that they can learn new dialects, or the pitch of their vocalizations, from the colony members around them.

Learning to communicate by repeating the noises that others make is something only a few mammal groups — including humans, whales and dolphins — are known to do. Researchers call this vocal learning, and it's something that they're starting to study in bats. Findings published on 31 October in *PLOS Biology*[1] show that bats can also pick things up from the group around them, a process that the authors dub crowd vocal learning.

Bats are becoming the best organism to use in studies of how mammals learn to vocalize, because they’re more easily manipulated in the lab than whales or dolphins. The latest research underscores their importance, says neuroscientist Michael Yartsev of the University of California, Berkeley, who was not involved with the work.

Songbirds demonstrate vocal learning beautifully, but their brains are organized differently from human brains. Pinning down a mammalian model to explore how this function develops is important for neurologists studying vocal learning, says Yartsev.

The call of the colony

Egyptian fruit bats (*Rousettus aegyptiacus*) are highly social and live in colonies with dozens to thousands of other bats. To see how the pups learn dialects, researchers caught 15 pregnant Egyptian fruit bats and took them into the lab. To control for potential genetic effects, they ensured that the mothers weren't closely related. The team then split the mothers into three groups of five and put each group into one of three chambers, where the mothers gave birth to their young. The scientists used recordings of wild Egyptian fruit bat colonies that were low in frequency, high or a mix of both frequencies, and then piped one pitch into each chamber.

The team released the mothers back into the wild after 14 weeks, around the time the young would naturally be weaned. After another 17 weeks in the enclosures, the young bats were mimicking the pitch of the recordings they had grown up with: bats in the high-frequency chamber made more high-frequency calls than the bats that grew up hearing the other two frequency soundscapes.

The findings make sense, says Yossi Yovel, a neuroecologist at Tel Aviv University in Israel and a study co-author. Baby bats grow up in the dark, surrounded by noisy neighbours, so it would be odd if they didn't pick things up from the animals around them. "It's perhaps not surprising, but it was never demonstrated before now."

Yovel and his team plan to release the young bats into the wild and observe whether their dialect changes to match that of the wild bats, or whether the colony members pick up the experimental bats' dialect.

Studying how this process works in mammalian brains could provide insight into how humans learn language, too, says Sonja Vernes, a neurogeneticist at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands. "If we can understand how bats do it, I think we can learn something about how humans do it."

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Comments

Comments

There are currently no comments.

US environment agency bars scientists it funds from serving on its advisory boards

The US Environmental Protection Agency says the policy will address potential conflicts of interest, but scientists raise alarms.

31 October 2017 Updated:

1. 31 October 2017

Andrew Harrer/Bloomberg/Getty

EPA administrator Scott Pruitt is poised to reshape the mix of experts that advise his agency.

The US Environmental Protection Agency (EPA) moved today to ban researchers who receive agency grants from serving on EPA advisory boards.

In crafting the policy, EPA administrator Scott Pruitt sided with his agency's most vociferous critics, who claim that EPA science panels are stacked with scientists who are biased in favour of the agency's regulatory agenda. The policy does not extend to scientists who work for local, state and tribal agencies that receive EPA grants, instead focusing on academic researchers. At a press conference, Pruitt said that scientists on three major EPA advisory panels have received US$77 million in grants over the past three years.

"When you receive that much money, there's a question that arises about independence," Pruitt said. Moving forward, he said, scientists "will have to choose — either the grant, or service, but not both."

Scientists and environmentalists blasted the policy as hypocritical and dangerous, saying it will exclude many top researchers while rendering the volunteer posts less attractive for those who remain eligible. The EPA's multitude of science advisory boards provide input on everything from proposed regulations to the agency's long-term research agenda.

"It's a disturbing and short-sighted action," says Peter Thorne, who chaired the agency's main science advisory board until the end of September. Thorne, a toxicologist at the University of Iowa in Iowa City, says that the board already has policies in place to deal with conflicts of interest — such as those related to research by a board member or financial interests among industry scientists. "I'm really baffled as to why this is necessary," he says.

The EPA's new policy borrows from legislation backed by Republican lawmakers that has been circulating in the US Congress for several years. In March, the US House of Representatives passed the latest version, which would restrict scientists with EPA grants from serving on the Science Advisory Board and loosen rules that seek to address any conflicts of interest related to industry scientists who serve on the panel. The fate of that bill is uncertain, however, since the Senate — which would have to give its approval before the legislation could become law — has not taken action on

the matter.

“The reason it couldn’t get through Congress is that it doesn’t make any sense,” says Andrew Rosenberg, who heads the Center for Science and Democracy at the Union of Concerned Scientists (UCS), an advocacy group in Cambridge, Massachusetts. “It turns the idea of conflict of interest on its head.”

Competing interests

Rosenberg’s group analysed the current membership of the EPA’s main science advisory board and found that 5 of the 47 members could be barred by the new policy. But the EPA restrictions on advisory-board members could soon affect a much larger swathe of panel appointments. The terms of 15 people on the agency’s main science advisory board expired at the end of September. EPA watchers are also expecting to soon see appointments to the Board of Scientific Counselors, which advises the EPA’s main research arm, and a third panel that advises the agency on air regulations.

All three of those boards have new leaders, Pruitt announced today. Michael Honeycutt, a toxicologist at the Texas Commission on Environmental Quality, will lead the agency’s main science advisory board. Honeycutt has long opposed EPA proposals to enact stricter air-quality standards. Tony Cox, an independent consultant, will lead the Clean Air Safety Advisory Committee, while Paul Gilman, chief sustainability officer at the energy firm Covanta in Morristown, New Jersey, will lead the Board of Scientific Counselors.

One senior EPA official, who declined to be named for fear of retaliation, says that agency leadership initially considered barring any scientist who had ever received an EPA grant from serving on any agency advisory panel. Ultimately, the agency decided to focus on researchers with active grants — in part because EPA officials discovered that it was hard to find qualified scientists who had never received EPA grants.

The agency’s overhaul of its advisory boards has been in the works for

months. The EPA sparked an uproar in May and June by dismissing dozens of scientists who had served a single three-year term on the Board of Scientific Counselors. In the past, the agency has appointed many scientists for a second term to provide more continuity for programme managers who are seeking input on the vast array of research efforts at the agency.

For Thorne, the question is how the administration is going to engage with its new science advisers. In September, the main science advisory board issued a letter describing its activities and inviting Pruitt to attend one of its meetings. Whether Pruitt will take the committee up on its invitation remains to be seen, but Thorne says one thing is clear: if the agency chooses to marginalize or ignore the board, it will do so “at its own peril”.

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Updates

Updated:

The story has been updated with information from the EPA press conference.

Comments

1 comment

1. *Rainald Koch* • 2017-11-01 12:58 PM
   "Tony Cox, an independent consultant, will lead the Clean Air Safety Advisory Committee" -- reminds me to Richard Anthony (Tony) Cox www-tonycox.ch.cam.ac.uk -- would be a better fit.

http://www.nature.com/doifinder/10.1038/nature.2017.22929

| 章节菜单 | 主菜单 |

Frédéric Chopin’s telltale heart

Scientists have written another chapter in the curious case of the composer’s heart. But it is unlikely to be the end of the story.

31 October 2017

De Agostini/A. Dagli Orti/Getty

The composer Frédéric Chopin died in 1849, but the debate about what killed him continues.

Edgar Allen Poe was a master of the macabre. His 1843 *The Tell-Tale Heart*

is a classic gothic tale for Halloween with its roots in guilt and fear: a murderer is haunted by the imagined beating of the excised heart of his victim.

The piano works of Frédéric Chopin — one of the greatest composers of the same period — tend more towards the uplifting. But events after his death have puzzled experts for more than a century and are worthy of any horror story. Scientists in Poland now claim to have solved the mystery. As the researchers conclude in a long-awaited report, he almost certainly died of complications caused by tuberculosis (M. Witt *et al. Am. J. Med.*; in the press; available at http://doi.org/cfpt). The evidence? The scientists have examined Chopin's own telltale heart.

The macabre afterlife of Chopin began with his recorded last words: "Swear to make them cut me open, so that I won't be buried alive." Taphephobia, as this fear is called, was a nineteenth-century obsession (shared by Alfred Nobel, among others), and saw some coffins made with alarm systems to be rung from within. Chopin's sister had an autopsy performed on him, during which his heart was removed. So although most of her brother lies in the famous Père Lachaise Cemetery in Paris, the city in which he died, she sealed his heart in a jar of (probably) brandy and took it back to Warsaw, the city closest to where he was born.

This wasn't too unusual. Remote burial of the heart was a fairly common practice, partly because it was too difficult to repatriate the bodies of kings and nobles who fell in foreign fields. (The heart of the English writer Thomas Hardy is said to be buried in his beloved Dorset, UK, although a more gruesome version of the story has the precious organ being eaten by a cat, and that of the offending animal interred instead.) But Chopin's status as a Polish national hero has helped to make sure that his heart never really rested in peace. His sister smuggled it into Poland past Russian border guards and it was later sealed inside a church pillar. Decades afterwards, during the Second World War, it was retrieved and protected by a Nazi SS commander who claimed to love Chopin's music. After the war, the heart was returned to rest in the church — but only until 2014.

Then, scientists were invited to join an official inspection of the jar and its contents. Their examination — and brief comments to journalists months

later — focused on how he died. The original autopsy notes are lost, and an entire academic subfield across many disciplines has emerged to discuss whether Chopin had tuberculosis or something much rarer, perhaps an early known case of cystic fibrosis. Those academics now have a Halloween treat: a draft of a paper to appear in *The American Journal of Medicine* offers more details on the state of the heart.

The original autopsy caused significant damage to both atria, but the paper claims "with high probability" that the remains show that Chopin had chronic tuberculosis, and that the immediate cause of death was a life-threatening complication called pericarditis — inflammation of the membrane enclosing the heart.

Chopin is not the only ghost from the past to offer their secrets to scientists. The artist Salvador Dalí was exhumed in July, moustache reportedly intact, to provide samples to decide a paternity case (he was not the father); and 2015 tests on bones of the Communist poet and winner of the Nobel Prize in Literature, Pablo Neruda, have fuelled theories that he was poisoned in Chile after Augusto Pinochet seized power in 1973.

There could yet be a twist in Chopin's tale. Some scholars are unsure that the heart is the composer's, and DNA tests to check for cystic fibrosis have so far been refused. The scientists were not allowed to open the jar in 2014, and Michał Witt at the Polish Academy of Sciences' Institute of Human Genetics in Poznan, who worked on the project, says that they didn't want to. The next opportunity will be in 50 years, when the heart is again scheduled for inspection. Witt does not expect to be around to see it. Still, he does have something more planned: the team was allowed to take photographs of the embalmed heart, and although none is yet public, he does plan to include them in the final manuscript. The full tale, after all, has not yet been told.

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Comments

Comments

There are currently no comments.

Lower emissions on the high seas

Global regulations to limit carbon dioxide from the shipping industry are overdue.

31 October 2017

Getty

Voluntary efforts to tackle carbon pollution from the shipping industry have failed.

In Herman Melville’s novel *Moby-Dick*, seafaring is the occupation of adventure-lovers. But since the maritime classic was published in 1851, the act of ‘sailing about a little’ has become a huge commercial undertaking. Today, a massive fleet of cargo ships transports 90% of global consumer goods. Shipping is efficient — but comes with an environmental cost that has

not been adequately accounted for.

Worldwide, there are about half a million ships in operation, together producing almost one billion tonnes of carbon dioxide each year. That's between 2% and 3% of the global total, and more CO_2 than Germany emits annually. But unlike greenhouse-gas emissions from Germany and other nations, shipping emissions are not subject to the reduction pledges made by individual nations under the Paris climate agreement. (The Paris deal does, however, include shipping emissions in its global carbon-budget calculations.)

After years of inaction, the great white whale of greenhouse-gas pollution is now in the cross hairs of the International Maritime Organization (IMO), the specialized United Nations agency that sets safety and environmental standards for the global shipping industry. The IMO is under pressure from campaigners and representatives of other, regulated sectors to agree a global cap on shipping emissions.

Following sharp increases in the early 2000s, the sector's emissions have remained more or less stable since the global financial crisis of 2008. But that is unlikely to continue. The current overcapacity in the maritime cargo market means that ship traffic (and emissions) can increase quickly to meet demand. Moreover, the shipping industry at large — including the cruise sector — has potential to grow, and rapidly.

The IMO has a specialist greenhouse-gas working group that is grappling with the idea of a cap. But its latest meeting, held last week in London, closed without declaring much progress. Overall, the IMO is committed to tightening environmental standards for new ships. Yet its technology-oriented strategy — including an Energy Efficiency Design Index that requires the engines of vessels to burn less fuel — is unlikely to be enough. Cleaning up the industry will require adequate market instruments and economic incentives to encourage owners and operators of both ships and ports to adopt climate-friendly practices, such as enforcing lower speeds.

Owing to the peculiarities of this volatile business, the routes, speed and fuel consumption of tens of thousands of container ships are hard to monitor and verify. An emissions-trading system, for example, would be difficult to

implement and even harder to manage. The IMO agreed last year to set up a global CO_2 data-collection system that will yield welcome knowledge, as will improvements in tracking the positions and movements of ships from space. But a tax by national governments on fossil fuels used by ships — incurred at refinery level — might be a more effective economic mechanism.

Voluntary efforts alone will not do. The industry has set up a series of half-hearted and overlapping eco-ratings schemes since the 2000s. But an analysis published online on 16 October shows that these have had no notable effect on the environmental performance of ships (R. T. Poulsen *et al. Mar. Policy* **87,** 94–103; 2018). Whereas eco-ratings can steer companies to make more-efficient refrigerators and washing machines in line with the preferences of consumers and regulators, maritime transport is different. The pressure of end-users is too distant to influence ship owners and operators. And price remains the dominant factor for builders and buyers of cargo ships.

As a global business, shipping must be tackled by global regulations, and not through a patchwork of voluntary efforts and regional laws. It is true that some regional efforts, such as the European Union's scheme to monitor, report and verify CO_2 emissions from large ships using its ports, might be a step towards global regulations.

The IMO has already shown that it can tackle other environmental issues. Measures it introduced in the wake of the *Exxon Valdez* oil spill in 1989 ensure that oil tankers are now much safer. An international convention for ballast-water management, which aims to control the spread of harmful invasive species, came into force in September after years of preparation (although it does not address biofouling on ships' hulls, which is potentially more harmful to local ecology). The IMO has also agreed measures to encourage environmentally responsible ship recycling and minimize uncontrolled shipbreaking, much of which occurs on South Asian beaches. However, this 2009 Hong Kong convention is still not implemented and is awaiting ratification by most member parties.

When it comes to the impact on climate, there is no excuse for delay. Emissions from shipping largely escape the public scrutiny and criticism attracted by those from aviation. Parties to the IMO should step up and hasten

the implementation of the necessary standards.

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Commenting is currently unavailable.

Lessons from first campus carbon-pricing scheme

31 October 2017

Putting a value on emissions can lower energy use, write Kenneth Gillingham, Stefano Carattini and Daniel Esty.

Enzo Figueres/Getty

Kroon Hall, home to Yale University's environment school in New Haven, Connecticut, reduced emissions substantially in the face of the carbon charge.

In July, Yale became the first university to launch a carbon-price programme across its campus. More than 250 buildings, together accounting for nearly

70% of the institution's emissions, will be charged US$40 per tonne of carbon dioxide that they emit as a result of energy use. Buildings that reduce their emissions more than the average will receive a share of the funds collected.

More than 500 firms around the world — three times more than a year ago — consider a carbon price of some kind when judging where to invest their money. Hundreds more are expected to start doing so in the coming months. Faced with higher prices, these organizations are shifting to forms of energy that generate less emissions and are more efficient.

Although some large companies have tried internal carbon pricing over the past two decades — BP was the first, in 1998 — little has been published about the value of such programmes. Here, we share initial insights and ideas for future research from a pilot scheme tried in 2015–16 at Yale — a prelude to the university's decision to roll out carbon pricing more broadly this year.

Price signals

Carbon pricing offers a direct incentive to reduce energy consumption and thus mitigate global climate change. In 2015, 13% of global greenhouse-gas emissions were subject to some form of carbon price, and this percentage is rising[1], despite the challenges currently facing government-backed schemes (see 'Faltering policies').

Faltering policies

Governments are struggling to put an appropriate price on carbon dioxide. In 2016, voters in the state of Washington rejected an initiative that would have set a tax on carbon emissions, despite broad support in polls for policy action on climate change. US President Donald Trump has backed away from the previous administration's Clean Power Plan. South Africa has delayed implementing a carbon tax. The United Kingdom has frozen its price floor for trading carbon at £18 (US$24) per tonne of CO_2 until 2021, rather than gradually raising it, as intended. According to the International Monetary Fund, most developed countries should price carbon at at least US$100 per

tonne of CO_2 equivalent to reach their emissions-reduction targets for the 2015 Paris climate -change agreement. The longer they wait, the higher these prices will need to be.

A company or institution can implement a carbon price through an internal emissions-trading programme, a carbon charge or a 'proxy price' (or 'shadow price') on greenhouse-gas emissions.

In the first case, the firm caps its emissions at a given level for a fixed period and divides its allowances between its organizational units — in a similar way to the European Union Emissions Trading Scheme. Units then trade their allowances with each other. Buying allowances from units with lower pollution-reduction costs minimizes the overall cost to the company. BP used this approach to reduce its company emissions, quickly achieving its goal of a 10% cut from 1990 levels by 2010[2].

An internal charge increases the price of carbon-intensive goods and services exchanged within the organization. The higher the price, the greater the incentive for the firm to decarbonize.

Companies can redistribute the revenue raised, or invest it in emissions-abatement schemes, as the luxury-goods conglomerate LVMH does. Ice-cream manufacturer Ben & Jerry's invests its revenue in programmes to reduce emissions across its supply chain, on the basis of a “cow-to-cone” life-cycle analysis.

For the past five years, Microsoft has charged its business groups a carbon fee that appears quarterly in their profit-and-loss statements. The fee covers energy consumption (adjusted for employee count) from data centres, offices and software-development labs, as well as from business air travel[3]. The revenue raised goes towards buying renewable energy or improving the treatment of electronic waste or the energy efficiency of lighting, heating, ventilation and air-conditioning systems[4]. In 2015, this fee was about $4 per tonne of CO_2 (ref. 5); this is much less than the US government estimate of the 'social cost of carbon', which is $44 per tonne. Low fees are common, with most internal carbon charges below $30 per tonne of carbon dioxide.

Proxy prices — which involve no financial transactions but are taken into account when weighing up business decisions — are often higher. No revenue is raised, but the carbon price shapes long-term investment choices. When deciding what sorts of buildings to construct or equipment to buy, the proxy price favours low-carbon solutions.

Ben & Jerry's

A solar-energy installation under construction next to the Ben & Jerry's ice-cream factory in Vermont.

For example, ExxonMobil, the Texas-based oil-and-gas multinational, is using a proxy price of $10 per tonne of CO_2; that will rise to $80 per tonne by 2040 (ref. 5). Proxy pricing drove Bristol Water, a British public utility company, to install more energy-efficient water pumps[6]. Saint-Gobain, a building-materials manufacturer based in Paris, uses a carbon price to drive investments in research and development for breakthrough technologies[6]. Some companies, such as the Dutch multinational Royal DSM in Heerlen, present two business cases for investments: one with and one without carbon

pricing[6].

Getting ahead

Organizations are implementing internal carbon pricing for many reasons. By aligning investment decisions now, firms are preparing for more-stringent domestic climate policies and for future mandatory carbon pricing. They are also avoiding becoming locked into unprofitable investments and 'stranded assets', which are a concern for investors and others, and are preparing for changed future circumstances. For example, more than 80% of current coal reserves might need to remain untouched if countries are to limit warming to 2° C (ref. 7). Committing to carbon pricing sends a signal to rating agencies and regulators that an enterprise is forward-looking and attentive to emerging climate risks[8].

Internal carbon pricing is part of broader corporate or organizational social-responsibility efforts[4]. By using a carbon price rather than targets for renewable-energy procurement, or internal energy-efficiency standards, organizations achieve those goals in the most cost-effective way. Innovations may result from directing managerial attention to cheaper projects that improve operations or that reduce energy expenditure[2]. Managers do not need to know the exact costs of abatement to achieve progress.

Organizations can also pilot internal carbon-pricing schemes to shape future governmental decisions. Policy leadership was one of the motivations behind BP's internal carbon pricing[9].

Lessons from Yale

Yale University's carbon-charge pilot was launched as part of the university's broader sustainability initiative and ran from December 2015 to May 2016. The charges covered direct and indirect emissions from consuming energy sources such as electricity, gas, steam and chilled water. The price was set at $40 per tonne of CO_2, which was close to the US government's estimated social cost.

Each of the 20 buildings selected for the pilot received a monthly report that detailed energy consumption and carbon use. They were all randomly allocated to one of four approaches: no carbon price; carbon pricing with 20% of the revenue earmarked for energy-efficiency actions; pricing with the revenue redistributed to buildings that reduced their emissions by at least 1% relative to their historic level of emissions; and pricing with revenue that was returned to buildings whose percentage reduction in emissions exceeded the average. This last approach is revenue-neutral: a net charge applied if emissions reductions were below average, and a net rebate if cuts were above average. Campus buildings outside the scheme served as a control group. Emissions were estimated in proportion to the amount of energy used, with different factors for different sources.

By the end of the trial, buildings that had faced carbon charges had used less energy than those that had not (see 'Energy savings'). Reasons for this included increased awareness of energy use, competition between buildings and the higher price of energy.

Building managers were mainly responsible for responding to the charge. Some favoured cheap options, such as turning down the heat by 1° C. Behavioural or operational changes, such as turning off lights and unused electrical equipment, also cost little. Others, including the departments of economics, environmental studies, public health and the boathouse, took more expensive measures such as installing occupancy sensors, thermal window shades or bulbs that use light-emitting diodes.

At the end of the pilot, the university selected the revenue-neutral pricing structure to implement campus-wide, because of its financial stability. The structure is not subject to potentially large outflows of funds if buildings exceed a target, saving energy because of an unusually mild winter, for example, or if energy needs rise unexpectedly owing to a cold snap or other reasons.

Of course, there are caveats. The scheme's novelty might have boosted engagement. Academics might be more interested than others in adopting challenging and original innovations. The sample size is small and the findings might not generalize to other situations.

Nonetheless, we feel that Yale's experience highlights important ingredients and challenges for internal carbon pricing.

First, information and incentives must be conveyed clearly for carbon charges to change behaviour.

After the pilot, more than half of the staff involved reported an improved understanding of energy use. The flow of information began with the energy reports to managers and spread through meetings with the staff and faculty, and through posters that explained energy savings. Students carried out energy audits. Actions were often collectively identified and followed up by monthly e-mail updates.

Second, the details of the scheme matter. How energy information is presented and carbon-charge revenue is redistributed influence the effectiveness of the scheme. For example, exit surveys of managers indicated that they responded more to the 'net' carbon charge, calculated after they had received a rebate, than to the higher 'gross' charge. Thus, many perceived the price signal as smaller. To increase managers' response to the price signal, one of them suggested a “bump in pay” for good performance on the carbon charge.

Third, carbon pricing is more effective when participants consider the rules to be fair. Perceived fairness increases engagement and encourages competition. The baseline from which emissions reductions are compared is a crucial design factor because it influences winners and losers. Yale's carbon-pricing system recognizes that buildings vary in size, age and energy efficiency, and that research in some disciplines is more energy-intensive than in others. Hence, only emissions above the historic baseline count towards the carbon charge. Emissions in the divinity school might be 100 times lower than those in the medical school, which hosts magnetic-resonance equipment.

For the pilot, the average emissions in the previous three fiscal years, 2013–15, were used as the baseline. In the campus-wide scheme, fiscal years 2011–15 are being used, with adjustments for a few buildings with large renovations, additions, construction or directed growth. For example, emissions at Ezra Stiles College were exceptionally low in 2011–12. during a period of major renovation. Brand new buildings will require projections.

Future research

Four areas of research could improve the design of internal carbon-pricing schemes. First, scientists, engineers and economists need to identify and test design options using rigorous pilot projects, similar to Yale's. These should span organizations of many different sizes and complexities. Such tests would provide insights for policymakers.

Second, no evidence exists on how internal carbon charges interact with non-carbon-pricing policies, such as tax credits or other incentives for renewable energy or energy efficiency. Economists should explore these interactions through data analysis and natural experiments, such as from regulatory changes, including effects on consumers.

Third, building scientists and other metrics experts must develop methods to assure high-quality benchmarking and data analytics for emissions inventories and baseline calculations. Ideally, these metrics should cover a wide range of energy uses before an internal carbon price is set up.

Fourth, accounting and managerial expertise is required to define the tax and financial implications of internal carbon pricing, in particular for multinational and transnational organizations.

We are only beginning to understand internal carbon pricing, but it seems to hold great promise as a way to sharpen incentives and reduce greenhouse-gas emissions.

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Supplementary information

PDF files

1. Supplementary information (258K)

Comments

Comments

There are currently no comments.

Huge microwave observatory to search for cosmic inflation

Multi-telescope project has ambitious goals and a big price tag.

30 October 2017

NSF/Steffen Richter/Harvard Univ./SPL

Telescopes in Antarctica track the cosmic microwave background radiation left over from the Big Bang.

US researchers have drafted plans to study the faint afterglow of the Big Bang using a new facility. They hope it will be sensitive enough to confirm whether or not the infant Universe underwent a brief period of explosive expansion known as inflation.

The Cosmic Microwave Background Stage-4 experiment (CMB-S4) would comprise three 6-metre and 14 half-metre telescopes distributed across two sites in Antarctica and Chile, according to a preliminary design due to be made public this week. Potentially up and running within a decade, the facility would be nearly 100 times as sensitive as existing ground-based CMB experiments.

It won't be cheap, however. Construction will cost a little over US$400 million, according to the expert task force commissioned by the US Department of Energy (DOE) and National Science Foundation (NSF) to produce the design. That is at least twice as much as envisioned in a less-detailed review 3 years ago, and 30 times the cost of existing experiments.

The price tag is "not necessarily" a showstopper, says Richard Barvainis, who directs the NSF's extragalactic astronomy and cosmology programme. But CMB-S4 will have to compete for limited funding with other large proposed facilities.

Primordial ripples

The CMB provides an image of the Universe as it was just 380,000 years after the Big Bang. Discovered in 1964, the radiation has since been observed by experiments on the ground, on balloons and in space, yielding increasingly precise insights into the Universe's geometry, contents and age — currently calculated at a little under 14 billion years.

But physicists think that the CMB has more to offer. In particular, distinctive patterns in its polarization known as B modes could reveal the existence of primordial gravitational waves. Gravitational waves — ripples in space-time — were first observed directly in 2015, but their detection in the very early Universe would be a major breakthrough, providing the strongest evidence yet for inflation, according to Charles Lawrence, an astrophysicist at NASA's Jet Propulsion Laboratory in Pasadena, California, who chairs the CMB-S4 task force.

Current ground-based CMB experiments typically detect microwaves using a

few thousand pixels and are based either near the South Pole or in Chile's Atacama Desert, where very dry conditions make the atmosphere nearly transparent to microwave radiation. None of the experiments has so far spotted the telltale B mode. One group did make a well-publicized claim in 2014, but it transpired that the sighting was actually caused by emissions from Galactic dust. Researchers are now building several more experiments that will be ten times as sensitive.

But Lawrence says that detecting the gravitational waves predicted by many of today's models of inflation would require sensitivity boosted by a further order of magnitude. Hence CMB-S4, which would comprise nearly 400,000 pixels. If it, too, came up empty-handed, the task force writes, it might be necessary "to give up on inflation".

Fight for funding

CMB-S4 is too large for any single group to build, so researchers across the US started collaborating on the design in 2013. Their initial plans were approved a year later by a panel advising the DOE on particle physics. But they must wait until 2020 to see how they fare in the next round of the once-per-decade survey of astronomy and astrophysics that the NSF uses to assess funding priorities.

Barvainis says that the agency will support CMB-S4 only if it gets "a very high priority" in the decadal survey, which is also likely to include a proposed upgrade to the National Radio Astronomy Observatory's Very Large Array in New Mexico, along with the development of one or more large optical telescopes. Even if the project does prevail, he adds, further agency reviews could delay the envisaged start of operations — due in 2026 — by at least two years.

The task force suggests that instead, CMB-S4 could be started by adding DOE detectors to existing telescopes in Chile while installing a few of the smaller telescopes at the South Pole. Under that strategy, the NSF would initially fund only operations. However, officials at the DOE also foresee snags. James Siegrist, the agency's associate director for high-energy

physics, says budgetary disagreements between the White House and Congress are creating “a lot of uncertainty” in Washington DC. A delay until 2027 or 2028 “could easily happen”, he predicts.

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Comments

2 comments

1. *Pentcho Valev* • 2017-10-30 10:41 PM
   Vacuum is not empty, and this makes the Cosmic Microwave Background concept rather silly. It is unreasonable to believe that the vacuum is full of energy and at the same time to claim that the noise known as CMB is not a product of this energy but just traverses it, unchanged. You have vacuum energy, detectors in contact with the vacuum which register strange noise coming from all directions, and you conclude that the noise is not produced by the vacuum energy but comes from the miraculous beginning of space and time. In addition, you implicitly assume that the vacuum energy does not change the noise. Silly, isn't it? Vacuum slows down light - this explains the Hubble redshift (in a STATIC universe): "...explains Liberati. "If spacetime is a kind of fluid, then we must also take into account its viscosity and other dissipative effects, which had never been considered in detail". Liberati and Maccione catalogued these effects and showed that viscosity tends to rapidly dissipate photons and other particles along their path, "And yet we can see photons travelling from astrophysical objects located millions of light years away!" he continues. "If spacetime is a fluid, then according to our calculations it must necessarily be a superfluid. This means that its viscosity value is extremely low, close to zero"." https://phys.org/news/2014-04-liquid-spacetime-slippery-superfluid.html Nature: "As waves travel through a

medium, they lose energy over time. This dampening effect would also happen to photons traveling through spacetime, the researchers found." http://www.nature.com/news/superfluid-spacetime-points-to-unification-of-physics-1.15437 "Some physicists, however, suggest that there might be one other cosmic factor that could influence the speed of light: quantum vacuum fluctuation. This theory holds that so-called empty spaces in the Universe aren't actually empty - they're teeming with particles that are just constantly changing from existent to non-existent states. Quantum fluctuations, therefore, could slow down the speed of light." https://www.sciencealert.com/how-much-do-we-really-know-about-the-speed-of-light?perpetual=yes&limitstart;=1 The transition from expanding to STATIC universe is unavoidable because the implications of the expanding universe theory are absurd: Sabine Hossenfelder: "If The Universe Is Expanding, Then Why Aren't We? The solution of general relativity that describes the expanding universe is a solution on average; it is good only on very large distances. But the solutions that describe galaxies are different - and just don't expand. It's not that galaxies expand unnoticeably, they just don't. The full solution, then, is both stitched together: Expanding space between non-expanding galaxies."
https://www.forbes.com/sites/startswithabang/2017/07/28/most-things-dont-actually-expand-in-an-expanding-universe/ "The Multiverse Is Inevitable, And We're Living In It. Alan Guth: "It's hard to build models of inflation that don't lead to a multiverse. It's not impossible, so I think there's still certainly research that needs to be done. But most models of inflation do lead to a multiverse, and evidence for inflation will be pushing us in the direction of taking [it] seriously." The Multiverse itself may not give rise to any observable, testable predictions, but arises as a direct consequences of other physical theories that have already been validated." http://scienceblogs.com/startswithabang/2017/10/12/the-multiverse-is-inevitable-and-were-living-in-it-synopsis/ Pentcho Valev

2. *Pentcho Valev* • 2017-10-31 07:35 AM
In my view, the following dialog marks the beginning of a

sweeping revolution in cosmology: http://backreaction.blogspot.bg/2017/10/space-may-not-be-as-immaterial-as-we.html Sabine Hossenfelder: "Is Space-Time Fluid? We have known at least since Einstein that space and time are inseparable, two hemispheres of the same cosmic brain, joined to a single entity: space-time. Einstein also taught us that space-time isn't flat, like paper, but bent and wiggly, like a rubber sheet. Space-time curves around mass and energy and this gives rise to the effect we call gravity. That's what Einstein said. But turns out... [...] That space itself isn't fundamental but made of other things is one way to approach the problem. Not everyone likes the idea. What irks physicists most about giving substance to space-time is that this breaks Einstein's bond between space and time which has worked dramatically well - so far. Only further experiment will reveal whether Einstein's theory holds up." Arun: "How does a fluid analog of general relativity avoid having a preferred reference frame?" Sabine Hossenfelder: "Arun, it doesn't. It's why I write it breaks the union between space and time." [END OF QUOTATION] Sabine Hossenfelder is on the right track. The "preferred reference frame" does not affect the validity of the principle of relativity in its traditional usage - it is only responsible for the vacuum friction that slows down photons coming from distant stars, in a STATIC universe. So the Hubble redshift is produced, but at the end of their journey photons redshift less vigorously than at the beginning. This has wrongly been interpreted as accelerating expansion: "In the mid 1990s two teams of scientists, one led by Brian Schmidt and Adam Riess, and the other by Saul Perlmutter, independently measured distances to Type 1a supernovae in the distant universe, finding that they appeared to be further way than they should be if the universe's rate of expansion was constant. The observations led to the hypothesis that some kind of dark energy anti-gravitational force has caused the expansion of the universe to accelerate over the past six billion years." https://cosmosmagazine.com/physics/dark-energy-may-not-exist Below I'm showing that the redshifting varies EXPONENTIALLY with time. The "finding that they appeared to be further way than they should be" is an illusion due to using an approximation to the

exponential function. Assume that, as the photon travels through space (in a STATIC universe), a factor equivalent to vacuum friction (see relevant references below) slows it down so that the photon loses speed in much the same way that a golf ball loses speed due to the resistance of the air. On this hypothesis the resistive force (Fr) is proportional to the speed of the photon (V): Fr = - KV That is, the speed of light decreases with time in accordance with the equation: dV/dt = - K'V Clearly, at the end of a very long journey of photons (coming from a very distant object), the contribution to the redshift is much smaller than the contribution at the beginning of the journey. Light coming from nearer objects is less subject to this effect, that is, the increase of the redshift with distance is closer to LINEAR for short distances. For distant light sources we have: f' = f(exp(-kt)) where f is the initial and f' the measured (redshifted) frequency. For short distances the following approximations can be made: f' = f(exp(-kt)) ~ f(1-kt) ~ f - kd/λ where d is the distance between the light source and the observer and λ is the wavelength. The approximate equation, f' = f - kd/λ, is only valid for short distances and corresponds to the Hubble law. The original equation, f' = f(exp(-kt)), shows that at the end of a very long journey (in a STATIC universe) photons redshift much less vigorously than at the beginning of the journey. This means that photons coming from very distant objects have undergone some initial "vigorous" redshifting which is unaccounted for by the Hubble law. This explains why the very distant objects "appeared to be further way than they should be if the universe's rate of expansion was constant". Is there "vacuum friction" that slows down photons? Yes there is: "This leads to the prediction of vacuum friction: The quantum vacuum can act in a manner reminiscent of a viscous fluid." http://philpapers.org/rec/DAVQVN New Scientist: "Vacuum has friction after all." https://www.newscientist.com/article/mg20927994.100-vacuum-has-friction-after-all "So how can a vacuum carry force? One of the first things we learn in classical physics is that in a perfect vacuum - a place entirely devoid of matter - friction can't exist, because empty space can't exert a force on objects traveling through it. But,

in recent years, quantum physicists have shown that vacuums are actually filled by tiny electromagnetic fluctuations that can interfere with the activity of photons - particles of light - and produce a measurable force on objects."
http://www.businessinsider.com/casimir-effect-vacuum-space-nanoparticles-2017-4 Pentcho Valev

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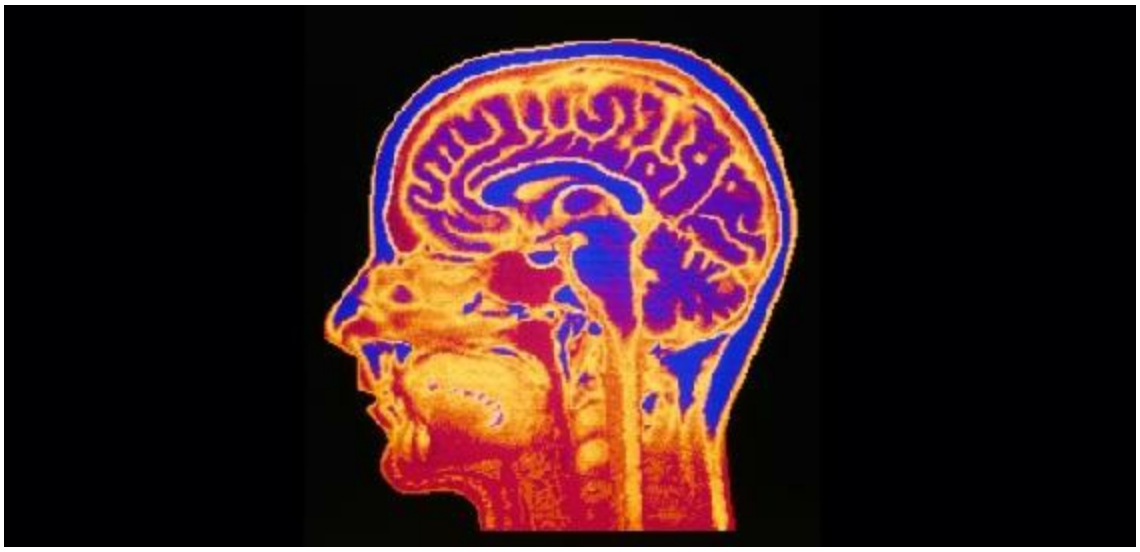
Geneticists are starting to unravel evolution's role in mental illness

Hints emerge that past environments could have influenced psychiatric disorders.

30 October 2017



Mehau Kulyk/SPL

Human genome databases are enabling researchers to take a deeper dive into the evolution of psychiatric disorders.

Psychiatric disorders can be debilitating and often involve a genetic component, yet, evolution hasn’t weeded them out. Now, recent work is beginning to reveal the role of natural selection — offering a peek at how the genetic underpinnings of mental illness has changed over time.

Many psychiatric disorders are polygenic: they can involve hundreds or thousands of genes and DNA mutations. It can be difficult to track how so

many genetic regions evolved, and such studies require large genome data sets. But the advent of massive human genome databases is enabling researchers to look for possible connections between mental illnesses and the environmental and societal conditions that might have driven their emergence and development. Others are looking to Neanderthal genetic sequences to help inform the picture of these disorders, as well as cognitive abilities, in humans. Several of these teams presented their findings at the American Society of Human Genetics (ASHG) meeting in Orlando, Florida, in late October.

One project found that evolution selected for DNA variants thought to protect against schizophrenia. The study, led by population geneticist Barbara Stranger of the University of Chicago in Illinois, looked at hundreds of thousands of human genomes using a statistical method that identified signals of selection over the past 2,000 years[1]. There were no signs of selection in genetic regions associated with any other mental illness.

Many of schizophrenia's symptoms, such as auditory hallucinations and jumbling sentences, involve brain regions tied to speech, says Bernard Crespi, an evolutionary biologist at Simon Fraser University in Burnaby, Canada. Over the course of hominid evolution, he says, the ability to speak could have outweighed the small, but unavoidable risk that the genes involved in language could malfunction and result in schizophrenia in a small percentage of the population.

A quest for context

Another team, lead by human geneticist Renato Polimanti at Yale University in New Haven, Connecticut, is trying to tease out links between environmental factors, mental illnesses and behavioural traits. Polimanti and his colleagues looked at 2,455 DNA samples from individuals at 23 sites across Europe and quantified each person’s overall genetic risk for mental disorders, such as autism, and personality traits, such as extraversion. They then calculated whether that risk was associated with certain environmental factors, such as rainfall, winter temperatures or the prevalence of infectious disease — exploring the idea that these factors might have been involved in

selecting for the human traits.

People who live in European regions with relatively lower winter temperatures, they found, were slightly more genetically prone to schizophrenia. Polimanti suggests that if genes that helped people tolerate cold were located close to variants that promote schizophrenia in the genome, then the latter could have been inadvertently carried along during evolution as a “fellow traveller”.

“This was a nice first attempt to put some environmental context” on the polygenic variants associated with mental illness, says Tony Capra, an evolutionary geneticist at Vanderbilt University in Nashville, Tennessee. Polimanti now plans to repeat the study in other parts of the world.

For and against

Untangling the roles of genetics and the environment will be difficult, however, because unknown environmental conditions in the past could have selected for traits that were advantageous then, but considered negative today. And other evolutionary factors could contribute to mental illness indirectly. An overactive immune system is thought to be involved in many psychiatric disorders, such as depression[2], but a stronger immune system would have made human ancestors more resistant to diseases, says Stranger.

Some researchers are exploring the evolution of mental illness through a different lens: by looking at possible differences in gene activity in tissues of Neanderthals and humans. A group lead by Capra and Vanderbilt human geneticist Laura Colbran used databases of modern human genomes to find DNA markers that suggest a gene is differently regulated in various tissues in the body. They then looked for these markers in two Neanderthal genomes. The team found that genes associated with neurological development were regulated differently in the Neanderthal brain compared with that of humans.

So while the DNA sequence of a gene such as *FOXP2* — which is associated with language — is identical[3] in humans and Neanderthals, human brains might have produced more of the associated protein, accounting for increased

language ability. The results could eventually lead to a better understanding of how Neanderthal brains functioned, if they were similar to human brains and whether they might have suffered from similar psychiatric disorders.

Studying how mental illness evolved is still at an early stage, but the ability to use massive human genome databases is an exciting step forward, says Capra. He and his colleagues plan to take advantage of this with a survey of genetic areas that differ between Neanderthals and humans, searching for differences in how the genes are expressed.

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Comments

Comments

There are currently no comments.

Nature News

周一, 13 11月 2017

Nature News

[周一, 13 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **South Africa tackles crime at sea with ship-spotting satellites** [周五, 10 11月 08:00]
  Automated vessel-tracking system aims to spy poachers and smugglers.
- **Resurrected malaria strategy saves thousands of lives in Africa** [周五, 10 11月 08:00]
  Pre-emptively treating kids for malaria is working, despite logistical challenges.
- **Physicists shrink plans for next major collider** [周四, 09 11月 08:00]
  Large Hadron Collider's failure to detect new particles beyond the Higgs has eroded the case for Japan's proposed linear accelerator.
- **UK government appoints next chief scientific adviser** [周三, 08 11月 08:00]
  A former pharmaceutical boss will help navigate the UK's exit from the European Union.
- **Skin regeneration with insights** [周三, 08 11月 08:00]
  A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.
- **Too many academics study the same people** [周三, 08 11月 08:00]
  Researchers should recognize communities that feel over-researched and under-rewarded.
- **Grant recipients can still give objective advice** [周三, 08 11月 08:00]
  The US environment agency should not ban researchers it funds from its advisory boards.
- **Rohingya refugees, Bulgarian protests and a prize for negative results** [周三, 08 11月 08:00]
  The week in science: 3–9 November 2017.
- **Dark-matter hunt fails to find the elusive particles** [周三, 08 11月 08:00]
  Physicists begin to embrace alternative explanations for the missing material.
- **The bitter battle over the world's most popular insecticides** [周三, 08 11月 08:00]
  As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.
- **Four ethical priorities for neurotechnologies and AI** [周三, 08 11月 08:00]

Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

- **The catalogue that made metrics, and changed science** [周三, 08 11月 08:00]
  As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.
- **Polar exploration: The forgotten journey** [周三, 08 11月 08:00]
  Huw Lewis-Jones revisits a pioneering, ill-fated expedition to map the Arctic.
- **Books in brief** [周三, 08 11月 08:00]
  Barbara Kiser reviews five of the week's best science picks.
- **Indian scientists urged to speak out about pseudoscience** [周二, 07 11月 08:00]
  Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.
- **Pirate paper website Sci-Hub dealt another blow by US courts** [周二, 07 11月 08:00]
  American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.
- **Genetically modified apple reaches US stores, but will consumers bite?** [周二, 07 11月 08:00]
  Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.
- **US government approves 'killer' mosquitoes to fight disease** [周一, 06 11月 08:00]
  US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.
- **Language patterns reveal body's hidden response to stress** [周一, 06 11月 08:00]
  Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

South Africa tackles crime at sea with ship-spotting satellites

Automated vessel-tracking system aims to spy poachers and smugglers.

10 November 2017

Leeman/Getty

South Africa has started to combine data from satellites, vessel transponders and radar to monitor ships in its waters in real time.

In October last year, a fishing boat set out from Velddrif, a small town on South Africa's west coast. It sailed northwest for about 25 nautical miles (46 kilometres), then turned sharply and headed back the way it had come. Staying clear of coastal settlements, it entered the West Coast National Park

marine protected area — a strictly no-fishing zone — where it slowed down and began to sail in a zigzag pattern.

“It was obvious what they were doing,” says Niel Malan, a marine biologist who works in South Africa’s Department of Environmental Affairs in Cape Town. “They were poaching.”

On any other day, the transgression would probably have passed undetected. But Malan and his colleagues were testing a new vessel-tracking system that — when fully operational — will send out alerts when ships are acting suspiciously anywhere in South African waters.

A test version of the Integrated Vessel Tracking Decision Support Tool was launched on 7 November by the South African Oceans and Coastal Information Management System (OCIMS), at its annual meeting in Cape Town. The tracking system, which has taken US$1 million and 5 years to develop, combines data from satellites, vessel transponders and radar to monitor ships in real time and spot any that might be engaged in criminal activities, such as illegal fishing or smuggling.

Similar remote-sensing systems have been developed over the last decade or so by countries including the United States, Australia and India. But South Africa is a particularly crucial area for maritime crime-fighting, because of its geographical location at the joining of three oceans — the Atlantic, Indian and Southern — and because of the sheer extent of its waters. The country’s Exclusive Economic Zone, which extends 200 miles off the coastline and includes an additional 400-mile-diameter circle around the Prince Edward Islands, exceeds its land area by 25%. “Because of the vastness of our EEZ, we see this as a critical technology,” says Waldo Kleynhans, the system’s lead developer based in Pretoria.

South Africa's coast is also a busy shipping lane and an area rich in natural resources. Cold, nutrient-rich waters sustain extensive commercial fishing on South Africa's west coast and to the south, while every year billions of sardines migrate down the east coast, attracting flocks of birds, as well as dolphins, sharks and whales.

South Africa has a well-documented problem with coastal poaching of high-

value species such as abalone and rock lobster, whereas the extent of illegal fishing in its open oceans is largely unknown. The area around the Prince Edward Islands — home to the prized Patagonian toothfish (*Dissostichus eleginoides*) — is particularly vulnerable, says Timothy Walker, a researcher focusing on maritime and water security at the Institute for Security Studies in Pretoria. South African authorities are also concerned about human trafficking and the smuggling of drugs or banned wildlife items, such as rhino horn and ivory.

Yet the navy has scant physical resources to monitor illegal activities, says Mark Blaine, a captain in the South African Navy and a part-time researcher in nautical science at Stellenbosch University — four frigates, three submarines and a handful of patrol vessels and aircraft — which he describes as equivalent to "a country the size of Algeria using around six police cars to patrol the entire country".

Satellite spotting

The satellite data used by the new system includes information from automated identification system (AIS) trackers, which all ships above a certain size are required to carry. South Africa currently buys this data from third-party suppliers, but plans to launch its own constellation of AIS nano-satellites in 2018 to collect the information. Meanwhile, satellites using synthetic-aperture radar, which can spot vessels in the dark or through thick cloud, will help to detect 'dark targets' that are not carrying trackers or that have turned them off.

Malan says that the tracking system can be set to flag up different suspicious behaviours. Users such as the fisheries department or the South African navy might create a digital fence around a marine reserve or other sensitive area, for example, and ask to receive alerts when ships enter it. Or they could request to be alerted if two ships meet in the open ocean for an extended time.

Ultimately, Malan says, the system's success will depend on the end-users, who will have to monitor incoming data, set up appropriate alerts and decide

how to respond. Enforcement will also be a challenge. Malan says that details of the suspicious boat he spotted in October 2016 were relayed to the fisheries department. “But we're not sure if they finished the investigation,” he says.

He hopes that once a few miscreants have been caught using the tracking system, however, its existence will act as a deterrent: “I think once we start prosecuting a few people, then the word will spread quickly — and we hope that will lead to better behaviour.”

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Comments

Commenting is currently unavailable.

Resurrected malaria strategy saves thousands of lives in Africa

Pre-emptively treating kids for malaria is working, despite logistical challenges.

10 November 2017

Amy Maxmen

A healthworker in Mali prepares a dose of malaria chemoprevention.

In a sea of high-tech malaria fixes — everything from drug-delivery by drone to gene-edited mosquitoes — an old-fashioned approach is saving thousands of children in West Africa, according to studies presented this week at the American Society of Tropical Medicine and Hygiene (ASTMH) meeting in

Baltimore, Maryland.

The measure, called seasonal malaria chemoprevention, involves giving children a dose of antimalarial drugs once each month in the rainy season to prevent the disease in hard-hit regions. Researchers have previously demonstrated this strategy in large clinical trials but they had feared that their positive results wouldn't be replicated in the messy, real world, because chemoprevention requires thousands of local health workers to deliver drugs to children in villages far from hospitals, pharmacies and paved roads.

"People were doubtful this intervention would work, because it's so demanding," says Brian Greenwood, an infectious disease specialist at the London School of Hygiene and Tropical Medicine who helped to conduct trials that showed reductions in malaria prevalence up to 84%[1]. As a result of those studies, more than 6.4 million children in nine countries in sub-Saharan Africa (Burkina Faso, Cameroon, Chad, Gambia, Guinea, Mali, Niger, Nigeria, Senegal) received the drugs in 2016.

It seems to be working, according to data presented at the ASTMH meeting. "They are seeing the same level of efficacy against malaria that we saw in clinical trials and reducing hospital admissions," says Greenwood. "I am very happy." But researchers are also finding signs that this approach may not work for long.

Data driven

Malaria researchers deployed chemoprevention in the 1950s, but it fell out of favour when the widespread use of malaria drugs led to drug resistance. Yet by 2000, more than 830,000 people were dying of the disease each year — mainly children in Africa — and there were no blockbuster vaccines on the horizon. So malariologists revisited the approach. Between 2002 and 2012, clinical trials conducted in West Africa suggested that combinations of older malaria drugs had the power to prevent 8.8 million cases and 80,000 deaths every year if implemented solely during the rainy season, when the disease spikes.

Amy Maxmen

Children in Mali receive a dose of malaria drugs, to reduce their risk of becoming infected with the disease.

In 2012, the World Health Organization recommended the strategy with three old drugs — sulphadoxine, pyrimethamine and amodiaquine — so that the only sure-fire cure for malaria, artemisinin, would remain effective. Alassane Dicko, a malariologist at the University of Bamako in Mali, says that he did not take the intervention for granted when it launched in Mali in 2013, because he knew that funds were limited and drug resistance inevitable. “Research is essential,” he says. His lab began assessing chemoprevention’s efficacy, cost and effects on drug resistance.

In August, Dicko and his colleagues reported[2] that malaria prevalence was reduced by 65% in children under age 5 who were treated with chemoprevention in the Malian district of Kita, compared to a similar number of children in a neighbouring district that lacked the funds to roll out the intervention.

Race against resistance

On the basis of results such as these, malaria researchers at the meeting estimate that chemoprevention has averted roughly 6 million cases and 40,000 deaths in 2015 and 2016 in the countries where it is practised. “This intervention has been extremely well documented over three or four years,” says Erin Eckert, an epidemiologist at the US Agency for International Development’s President’s Malaria Initiative, based in Washington DC. As a result, the agency plans to help fund chemoprevention in eight countries next year.

Also at the ASTMH meeting, Dicko reported a 80-person trial showing that adding another old malaria drug, primaquine, to the regimen combo blocks the transfer of the malaria parasite, *Plasmodium falciparum*, from humans into mosquitoes. This would further reduce the amount of the parasite in circulation. Dicko aims to hit the disease hard and fast — with multiple drugs, as soon as possible — because he and his colleagues are already detecting genetic signs of drug resistance in parasites[3].

New chemoprevention drugs in the pipeline might not be ready before existing drugs fail because of resistance, Greenwood says. This year, he helped to launch a trial combining chemoprevention and a less effective malaria vaccine in Burkina Faso and Mali. The vaccine was previously shown to reduce the number of malaria cases by less than 36% in children[4], but Greenwood hopes the combined tools, together with bed nets, can suppress malaria enough to stop it from bouncing back once today’s drugs fail. By that time, he says, genetically engineered mosquitoes might be ready to fly.

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Comments

Comments

There are currently no comments.

Physicists shrink plans for next major collider

Large Hadron Collider’s failure to detect new particles beyond the Higgs has eroded the case for Japan’s proposed linear accelerator.

09 November 2017

CERN/SPL

The Large Hadron Collider (pictured) collides protons, whereas the proposed linear accelerator would smash together electrons and positrons.

Limited funding and a dearth of newly discovered particles are forcing physicists to cut back plans for their next major accelerator project: a multibillion-dollar facility known as the International Linear Collider (ILC)

in Japan.

On 7 November, the International Committee for Future Accelerators (ICFA), which oversees work on the ILC, endorsed halving the machine's planned energy from 500 to 250 gigaelectronvolts (GeV), and shortening its proposed 33.5-kilometre-long tunnel by as much as 13 kilometres. The scaled-down version would have to forego some of its planned research such as studies of the 'top' flavour of quark, which is produced only at higher energies.

Instead, the collider would focus on studying the particle that endows all others with mass — the Higgs boson, which was detected in 2012 by the Large Hadron Collider (LHC) at CERN, Europe's particle-physics lab near Geneva, Switzerland.

Leading particle physicists nevertheless remain upbeat. A 250-GeV machine still has "a convincing physics case", says Hugh Montgomery at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia. He says that it could be upgraded to higher energies in future.

High-energy physicists have been planning a future linear collider for 25 years, but the ILC is now unlikely to see the light of day until at least 2030. They viewed the linear collider as complementary to the LHC, allowing physicists to scrutinize in detail any particles discovered at CERN.

Linear design

The circular LHC smashes together protons, which allows it to reach very high energies (13 teraelectronvolts). But, as composite particles (made of quarks), protons create messy collisions with clouds of debris.

By contrast, the ILC would collide electrons and positrons head on after accelerating them in thousands of superconducting cavities joined end to end. Although yielding lower energies, its collisions — between fundamental particles — would be cleaner and more precise than those in a proton–proton machine.

The international physics community had hoped that Japan would foot much of the estimated US$10 billion needed to realize the original design, after researchers there put forward a proposal to host the facility in October 2012, just after the Higgs discovery. But the Japanese government — deterred by the project's huge price tag, according to Tatsuya Nakada, a physicist at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland — has not yet made any offer of funding.

That fact, coupled with an absence of any other new particle discoveries at the LHC beyond the Higgs, led the Japan Association of High Energy Physicists in July to propose capping the ILC's energy at 250 GeV.

Aiming for a higher energy, the association explained, made less sense after data collected by the LHC in 2015 and 2016 showed that any particles outside physicists' standard model are unlikely to weigh less than 1,000 GeV, and therefore would be out of reach even for a full-scale version of the ILC. However, 250 GeV is high enough to produce large numbers of Higgs bosons, which, the association said, could yield indirect signs of new physics through measurements of their interactions with other known particles.

Energy debate

This proposed 'Higgs factory' has also been endorsed by an international working group responsible for formulating the ILC's science case, in a paper uploaded to the preprint server arXiv last month[1]. The ICFA then gave the pared-down collider its thumbs up at a meeting held in Ottawa, Canada, this week.

Not all physicists are enthusiastic, however. John Ellis, a theorist at King's College London and CERN, maintains that only when operating at around 1,000 GeV will a linear collider provide "a more complete picture of the Higgs". He acknowledges that costs need to be reined in, but says that in limiting the ILC to 250 GeV, "you are making significant scientific compromises".

A report uploaded to arXiv last week[2] describes three possible layouts for the

250 GeV model (a technical design for the higher-energy ILC was published in 2013). Each requires halving the length of the superconducting electron–positron accelerators, but two of the options retain extra tunnel space to accommodate future upgrades.

Taking into account projected savings from ongoing research into accelerators, the report estimates that the collider's core construction cost could be reduced by as much as 40% — bringing it down to around $5 billion in 2012 prices. Manpower and detectors would then raise the total to about $7 billion, according to Lyn Evans, an accelerator physicist at CERN who is directing research on the ILC.

Michael Peskin, a theoretical partical physicist at the SLAC National Accelerator Laboratory in Menlo Park, California, and a member of the ILC working group, has no doubt about the value of a Higgs factory. He says that theoretical studies of the Higgs boson and the weak nuclear force — one of the four known fundamental forces — done over the past year have strengthened the case for experimental probes of the Higgs' interaction strength (the Higgs is required to give the carriers of the weak force finite mass). "The 250-GeV stage is actually more interesting scientifically than we thought," he says.

The ILC decision now rests with Japan. Evans describes the Japanese government's ongoing assessment of the linear-collider project as "very long and very frustrating". But other countries won't commit money until the host country makes its plans known, he says. "The rest of the world is waiting for the Japanese government to decide," he says.

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Comments

3 comments

1. *Pentcho Valev* • 2017-11-11 04:23 PM

   Peter Woit: "I think the worst thing that has happened to theoretical physics over the past 25 years is this descent into ideology, something that has accelerated with the multiverse mania of the last 10-15 years." http://www.math.columbia.edu/~woit/wordpress/?p=9375 Correct, except for the number 25 - it should be replaced by 112: Peter Hayes: "This paper investigates an alternative possibility: that the critics were right and that the success of Einstein's theory in overcoming them was due to its strengths as an ideology rather than as a science. The clock paradox illustrates how relativity theory does indeed contain inconsistencies that make it scientifically problematic. These same inconsistencies, however, make the theory ideologically powerful. [...] The gatekeepers of professional physics in the universities and research institutes are disinclined to support or employ anyone who raises problems over the elementary inconsistencies of relativity. A winnowing out process has made it very difficult for critics of Einstein to achieve or maintain professional status. Relativists are then able to use the argument of authority to discredit these critics. Were relativists to admit that Einstein may have made a series of elementary logical errors, they would be faced with the embarrassing question of why this had not been noticed earlier. Under these circumstances the marginalisation of antirelativists, unjustified on scientific grounds, is eminently justifiable on grounds of realpolitik. Supporters of relativity theory have protected both the theory and their own reputations by shutting their opponents out of professional discourse. [...] The triumph of relativity theory represents the triumph of ideology not only in the profession of physics bur also in the philosophy of science." The Ideology of Relativity: The Case of the Clock Paradox http://www.informaworld.com/smpp/content~content=a909857880 Joao Magueijo: "Lee [Smolin] and I discussed these paradoxes at great length for many months, starting in January 2001. We would meet in cafés in South Kensington or Holland Park to mull over the problem. THE ROOT OF ALL THE EVIL WAS CLEARLY SPECIAL RELATIVITY. All these paradoxes resulted from well known effects such as length contraction, time dilation, or E=mc^2,

all basic predictions of special relativity. And all denied the possibility of establishing a well-defined border, common to all observers, capable of containing new quantum gravitational effects." Faster Than the Speed of Light, p. 250 http://www.amazon.com/Faster-Than-Speed-Light-Speculation/dp/0738205257 Pentcho Valev

2. *Pentcho Valev* • 2017-11-11 07:32 AM

   Dead (schizophrenic) science - colliders are not necessary: "...Lorenzo Maccone, of the University of Pavia in Italy, Seth Lloyd at MIT in Cambridge, USA, and Vittorio Giovannetti at the Scuola Normale Superiore in Pisa, Italy. [...] They hope their strategy may make it possible to solve one of the biggest problems in physics: the apparent incompatibility of quantum mechanics, which governs the physics of the very small, and general relativity, which describes the motion of stars and planets. [...] In general relativity, space and time are woven together into a pliable thing called spacetime, but quantum mechanics runs on quaintly separate, classical notions of space and time. And when physicists try to apply the equations of general relativity to the realm of quantum mechanics, those equations spit out nonsense." http://fqxi.org/community/articles/display/224 Big Brother replaced 2+2=4 with 2+2=5: "In the end the Party would announce that two and two made five, and you would have to believe it. It was inevitable that they should make that claim sooner or later: the logic of their position demanded it. Not merely the validity of experience, but the very existence of external reality, was tacitly denied by their philosophy. The heresy of heresies was common sense. And what was terrifying was not that they would kill you for thinking otherwise, but that they might be right. For, after all, how do we know that two and two make four? Or that the force of gravity works? Or that the past is unchangeable? If both the past and the external world exist only in the mind, and if the mind itself is controllable what then?" https://ebooks.adelaide.edu.au/o/orwell/george/o79n/chapter1.7.htm Einstein replaced Newton's absolute time with spacetime: "Special relativity is based on the observation that the speed of light is always the same, independently of who measures it, or how fast the

source of the light is moving with respect to the observer. Einstein demonstrated that as an immediate consequence, space and time can no longer be independent, but should rather be considered a new joint entity called "spacetime." http://community.bowdoin.edu/news/2015/04/professor-baumgarte-describes-100-years-of-gravity/ Scientists in Big Brother's world are trying to reconcile 2+2=4 and 2+2=5. Scientists in Einstein's schizophrenic world are trying to reconcile Newton's absolute time and Einstein's spacetime: Natalie Wolchover: "The effort to unify quantum mechanics and general relativity means reconciling totally different notions of time. In quantum mechanics, time is universal and absolute; its steady ticks dictate the evolving entanglements between particles. But in general relativity (Albert Einstein's theory of gravity), time is relative and dynamical, a dimension that's inextricably interwoven with directions X, Y and Z into a four-dimensional "space-time" fabric." https://www.quantamagazine.org/20161201-quantum-gravitys-time-problem/ Perimeter Institute: "Quantum mechanics has one thing, time, which is absolute. But general relativity tells us that space and time are both dynamical so there is a big contradiction there. So the question is, can quantum gravity be formulated in a context where quantum mechanics still has absolute time?" https://www.perimeterinstitute.ca/research/conferences/convergence discussion-questions/what-are-lessons-quantum http://negrjp.fotoblog.uol.com.br/images/photo20150819051851.jpg Pentcho Valev

3. *Pentcho Valev* • 2017-11-09 08:59 PM

   Nowadays the conclusion "Physics is dead" is getting more and more explicit - it has even entered popular culture: Leonard: "I know I said physics is dead, but it is the opposite of dead. If anything, it is undead, like a zombie." https://www.youtube.com/watch?v=GDNP9KOEdh0 The problem is theoretical - experimentalists are just misguided: "The Large Hadron Collider is a particle accelerator currently under construction in the research centre CERN. From the point of view of relativity theory, it has several points of interest: First of all, the protons it accelerates will reach higher energies than ever, allowing

new tests of the relativistic quantum field theories that are at the core of modern particle physics. Secondly, at such high energies, there should be first traces of an as-yet unproven symmetry of nature called supersymmetry, which plays an important role in string theory, one of the candidates for a theory of quantum gravity (the quantum theory version of Einstein's general relativity). Finally, the high energies are interesting because they give information about the very early high temperature universe, and about the physics that should be included in the big bang models of relativistic cosmology." http://www.einstein-online.info/dictionary/large-hadron-collider There is a tenet which, if false, does convert modern physics into a zombie, and this is Einstein's constant-speed-of-light postulate. Here is the original formulation: Albert Einstein, ON THE ELECTRODYNAMICS OF MOVING BODIES, 1905: "...light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body." http://www.fourmilab.ch/etexts/einstein/specrel/www/ If interpreted correctly, the Doppler effect directly refutes the postulated independence from "the state of motion of the emitting body". Here is an incorrect interpretation - the postulate is saved by wrongly assuming that the light pulses bunch up in front of the moving source: Albert Einstein Institute: "We will start with a very simple set-up, which you can see in the following animation. On the right-hand side, drawn in green, there is a sender that emits pulses in regular succession. On the left-hand side there is a receiver, drawn in blue. The pulses themselves are drawn in red, and they all travel at the same speed from right to left. Everytime the sender emits a new pulse, a yellow indicator light flashes once. Likewise, a flashing light indicates when a pulse has reached the receiver: http://www.einstein-online.info/images/spotlights/doppler/doppler_static.gif Next, let us look at a slightly different situation, where the source is moving towards the detector. We assume that the motion of the sender does not influence the speed at which the pulses travel, and that the pulses are sent with the same frequency as before. Still, as we can see in the following animation, the motion influences the pulse

pattern: http://www.einstein-online.info/images/spotlights/doppler/doppler_source_blue.gif The distance between successive pulses is now smaller than when both sender and receiver were at rest. Consequently, the pulses arrive at the receiver in quicker succession. If we compare the rates at which the indicator lights at the receiver and at the sender are flashing, we find that the indicator light at the receiver is flashing faster." [END OF QUOTATION] http://www.einstein-online.info/spotlights/doppler Einsteinians make the following assumption above, which is essentially identical to Einstein's 1905 constant-speed-of-light postulate: Assumption 1: "The motion of the sender does not influence the speed at which the pulses travel." Assumption 1 goes hand in hand with another assumption: Assumption 2: "The distance between successive pulses is now smaller than when both sender and receiver were at rest." Assumption 2 is false - the pulses do not bunch up when the source (sender) is moving. If they did, by measuring the (variable) distance between the pulses, an observer associated with the source would know whether he is moving or at rest, which contradicts the principle of relativity. Since Assumption 2 is false, Assumption 1 is false as well. If the speed of the moving source is v, the speed of the light relative to the receiver is c'=c+v, in violation of Einstein's relativity. The following quotations suggest that, if the speed of light is variable, modern physics is dead: "The speaker Joao Magueijo, is a Reader in Theoretical Physics at Imperial College, London and author of Faster Than the Speed of Light: The Story of a Scientific Speculation. He opened by explaining how Einstein's theory of relativity is the foundation of every other theory in modern physics and that the assumption that the speed of light is constant is the foundation of that theory. Thus a constant speed of light is embedded in all of modern physics and to propose a varying speed of light (VSL) is worse than swearing! It is like proposing a language without vowels." http://www.thegreatdebate.org.uk/VSLRevPrnt.html "But the researchers said they spent a lot of time working on a theory that wouldn't destabilise our understanding of physics. "The whole of physics is predicated on the constancy of the speed of light," Joao

Magueijo told Motherboard. "So we had to find ways to change the speed of light without wrecking the whole thing too much." http://www.telegraph.co.uk/technology/2016/12/06/speed-light-discovered/ Pentcho Valev

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UK government appoints next chief scientific adviser

A former pharmaceutical boss will help navigate the UK's exit from the European Union.

08 November 2017

Pat Greenhouse/Boston Globe/Getty

Patrick Vallance is the third successive biomedial scientist to be appointed chief scientific adviser.

Patrick Vallance, president of research and development at the pharmaceutical giant GlaxoSmithKline, has been appointed as chief scientific adviser, the UK government announced on 8 November.

Vallance, a clinical pharmacologist who previously led the medical division at University College London, will replace Mark Walport in April 2018. Walport has left the government to become head of a powerful new funding body called UK Research and Innovation.

As chief scientific adviser, Vallance will advise the prime minister and her cabinet, the government's most senior decision-making body. He will also lead the Government Office for Science, which promotes the use of scientific evidence in policymaking across government.

A major part of his role will be to ensure that high-quality advice is available across government departments as they deal with the legal and regulatory consequences of the UK's decision to leave the European Union, says Graeme Reid, a science-policy researcher at University College London. The United Kingdom needs to manage the impact of Brexit on the regulation of

the nuclear industry and the UK's role in fusion research, as well as on environment policy and other science-related issues. "Patrick Vallance's experience in both business and universities will be of huge value," says Reid.

Brexit is likely to boost the day-to-day importance of chief scientific advisor's role, but Vallance will also have to reinvent other, more informal aspects of the position, says Kieron Flanagan, a science-policy researcher at the Alliance Manchester Business School. The creation of UK Research and Innovation, intended to increase the power of UK research-funding bodies, means Walport will continue to wield great influence over science in government. The chief scientific adviser has traditionally been the voice of science in government, Flanagan says.

The relationship between Vallance and Walport will be an interesting dynamic to watch, says James Wilsdon, a research-policy specialist based at the University of Sheffield, UK. He says he hopes that Vallance will act as a bridge between the science community and policymakers, and will be open to a wide range of people and perspectives. The network of chief scientific advisers is not yet operating at full strength, he says, "so re-energising the collegiality and connectivity of that network though Whitehall is a really important thing".

The role is less well-paid than Vallance's present position. His base salary at GlaxoSmithKline is £780,000 (US$1.02 million), but the science-adviser job was advertised in the salary range of £160,000–£180,000.

Vallance will be the third successive chief scientific adviser to come from the biomedical sciences. He follows Walport, who is a former director of the Wellcome Trust, and John Beddington, a population biologist now at the Oxford Martin School and the University of Oxford, UK.

In a separate announcement, GlaxoSmithKline announced that it had appointed Hal Barron, current president of research and development at Alphabet-funded California Life Sciences, to replace Vallance.

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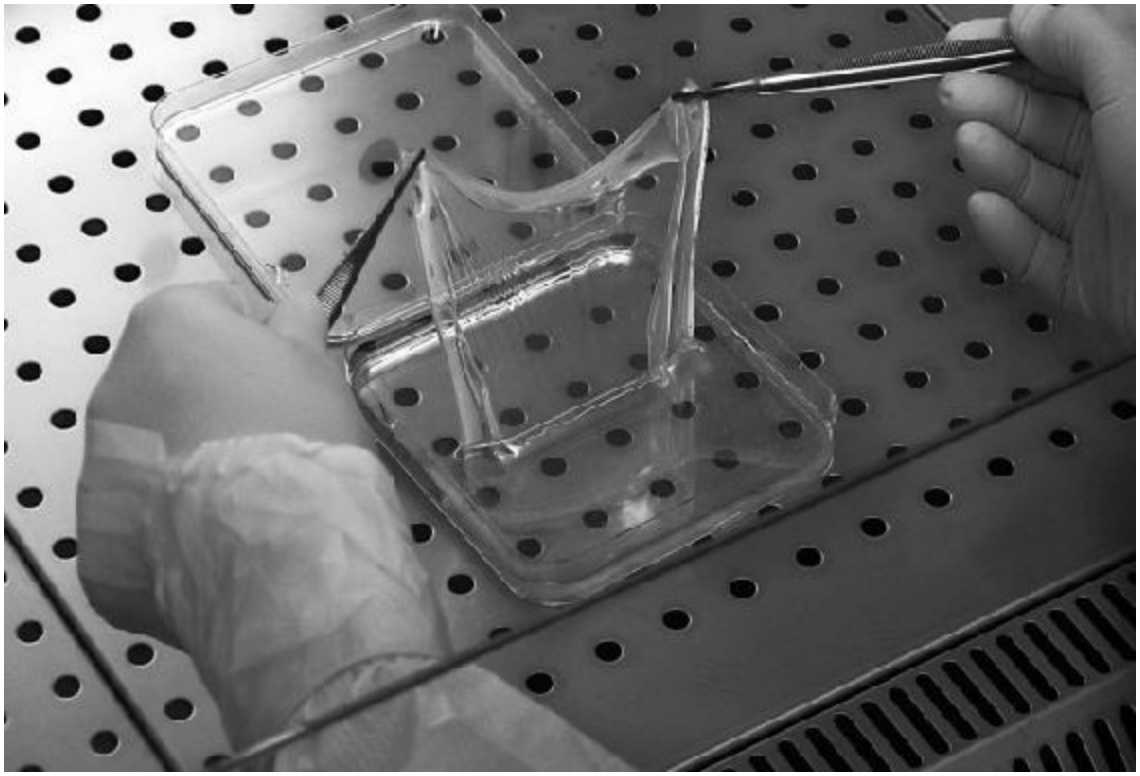
Comments

Commenting is currently unavailable.

Skin regeneration with insights

A feat in stem-cell therapy highlights what can be achieved when basic and clinical research combine to advance biological understanding and treatment.

08 November 2017



A sheet of skin cells grown in culture.

Somewhere in Germany’s Ruhr valley, a nine-year-old boy is doing what children do: playing football, joking around with friends and going to school. Two years ago, he was confined to a hospital bed, dying of a rare and cruel genetic skin disease. In a landmark paper online in *Nature* this week, scientists and clinicians present the details of his astonishing recovery (T. Hirsch *et al.* *Nature* http://dx.doi.org/10.1038/nature24487; 2017).

The boy had junctional epidermolysis bullosa, or JEB. He, like other people with the disease, carried a mutation in a gene that controls the integrity of the skin. Doctors could only try to ease his suffering as some 80% of his skin simply fell away.

A team of Italian researchers came to his aid by combining stem-cell techniques with gene therapy. As a young scientist at Harvard Medical School in Boston, Massachusetts, in the 1980s, Michele De Luca — the lead author of the new study — watched pioneers in skin regeneration learn to grow small sheets of skin from cells taken from burns patients, and to use them in grafts. He extended the work in Italy, applying new genetic and stem-cell technologies. He developed ways to generate stem cells from human skin, replace disease-causing genes in them and grow sheets of healthy skin on scaffolds in the lab.

He chose JEB for his first clinical trial, which he registered with the Italian Medicines Agency in 2002. Four years later, he reported his first success, in which he created healthy skin patches from biopsies to replace small areas of sloughed-off skin on the legs of a patient with a form of JEB (F. Mavilio *et al. Nature Med.* **12,** 1397–1402; 2006). New European Commission regulations introduced in 2007 required him to pause the project while he created facilities adhering to ‘good manufacturing practices’ (GMPs) and a spin-off company to meet the demands for strengthened oversight of cell-based therapies.

Having a company refocused his team’s attention on a different type of stem-cell therapy, one likely to yield a product for the market faster. Holoclar, a treatment that replaces the eye’s cornea in a form of blindness, became the world’s first commercial stem-cell therapy in 2015.

A few months later, at the University of Modena, De Luca got a call out of the blue from doctors in Germany who were trying to treat the little boy. Because the therapy had been in a clinical trial, albeit one on hold at the time, and because De Luca could provide GMP services, German regulatory authorities quickly approved the one-off compassionate use of the JEB therapy. Surgeons in Germany sent a skin biopsy to Modena, and two major skin transplants followed. Six months after the initial biopsy, the boy returned to school. During the many months since, he has not had so much as a blister,

and loves to show off his ‘new skin’.

This major clinical development was based on decades of basic research. The clinical data gathered during 21 months of follow-up after the boy’s treatment have also led to major insights into human skin biology, as discussed in an accompanying News & Views (M. Aragona and C. Blanpain *Nature* http://dx.doi.org/10.1038/nature24753; 2017). For example, normal regeneration of the epidermis is directed by only a few stem-cell clones that can self-renew.

By their nature, highly personalized treatments using gene therapies and products derived from an individual’s stem cells are likely to be applicable to only a subset of patients. Although the report presents the treatment of one patient, it is a classic case of researchers standing on the shoulders of others. This project, for example, relied on long-term follow-up of a patient treated in 2006, as well as parallel studies that underpinned the development of tools for *ex vivo* gene therapy and for growing transplantable sheets of epidermis *in vitro*.

The work is both a technical achievement and an example of how translational medicine should be conducted. It involves research informing the clinic and the clinic informing research, with seamless collaboration between doctors, scientists, regulators and technicians at many levels — a particularly important aspect in areas such as stem-cell biology. It requires the highest standards of scientific and ethical diligence. Similar treatments are starting to be rolled out in other labs for other diseases. *Nature* is glad to celebrate and support such an enterprise.

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Too many academics study the same people

Researchers should recognize communities that feel over-researched and under-rewarded.

08 November 2017

Susanna D'Aliesio/SOPA Images/LightRocket/Getty

Two women in Lebanon’s Shatila camp.

In southern Beirut, a temporary shelter has become a permanent home. The Shatila refugee camp was established to house displaced Palestinians in 1949 and now has thousands of families within its walls. Residents have learnt to contend with overcrowding, pollution — and a steady stream of well-funded

foreign researchers who come to study them.

Drawn by its unusual story and convenient position close to the airport, researchers flock to Shatila to track the effects of prolonged refugee status and cultural isolation on the community. Well-meaning researchers are so common in Shatila that locals have learnt how to spot them.

Before she became a social anthropologist at King's College London, Mayssoun Sukarieh did voluntary work in Shatila. Residents who saw her reach for her notebook would ask if she was a social researcher: "They come for a tiny bit, and then they leave," the locals explained.

Sukarieh realized that scholars' repeated visits were affecting the community. Academics were among the few contacts that people in Shatila had with the wider world. Again and again, the outsiders would fly out with what they wanted and offer little or nothing in return. The community started to view the visitors with amusement, then resentment.

Some people in Shatila, Sukarieh feared, were being 'over-researched' — an anecdotal concern that social scientists and biomedical researchers increasingly encounter at 'high-traffic' research sites around the world. Sometimes, it is a point raised by ethical-review committees. Occasionally, the community under study makes its own frustrations heard loud and clear.

How big is the problem? Ironically, the issue of over-research has not been researched much. In a study published last month, scientists in South Africa analysed concerns about over-research at two sites of HIV-prevention studies (J. Koen, D. Wassenaar and N. Mamotte *Soc. Sci. Med.* **194,** 1–9; 2017).

They found that the term 'over-research' is poorly defined and encompasses a range of concerns. For example, some use it to describe how other communities are being neglected in favour of one with a pre-established research structure or proximity to a university. This can lead to skewed data, and misconceptions about a particular phenomenon or place.

Alternatively, the term could be used to describe a local community that bears the burden of research participation without sufficient reward, creating a sense of frustration that leads to dwindling participation. In biomedical

studies, researchers sometimes worry that involvement in multiple clinical trials — and exposure to multiple medications — can increase the risk to participants and cloud results.

Repeated studies can certainly exaggerate the frustration that local people feel when their cooperation produces only data, publications and further research. In the South African study, many locals argued that the research should be more closely linked to developing their communities. Some projects, including certain grants from UNAIDS, a global United Nations effort to tackle HIV/AIDS, do require researchers to invest in infrastructure and education. More funders should look at this model. However, several HIV-prevention studies have done such a good job that their results are inconclusive: too few participants contracted the disease for the data to be statistically meaningful.

It is crucial that efforts to reward research participation are developed in consultation with the community being studied. Sukarieh describes well-intentioned educational courses aimed at Shatila-research participants that were impractically long — one consisted of 20 hourly sessions — and discussed issues irrelevant to the people's needs.

Over-research can bring benefits, though: a heavily studied community can become savvy in making its needs known to researchers and in influencing how a study is done. In Hackney, an ethnically diverse borough of London that underwent a period of rapid gentrification, a sociologist who came to study participants in a creative-writing group, for example, was told that, to do so, she had to join the group and write pieces like everyone else. The researcher reported how this strengthened her involvement and built stronger links to the community that helped the project to succeed (S. Neal *et al. Qual. Res.* **16,** 491–507; 2016).

Forging deep links with a community takes time, and time requires funding. Funders should recognize the need to build resources for such efforts into their grants; institutions should recognize and reward this time and effort, and acknowledge that it can eat into a researcher's publication record. It is not good enough to come in for a tiny bit, and then leave.

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Comments

Comments

There are currently no comments.

Grant recipients can still give objective advice

The US environment agency should not ban researchers it funds from its advisory boards.

08 November 2017

KEENPRESS/Getty

Melting ice caps are raising sea levels.

Scott Pruitt, administrator of the US Environmental Protection Agency (EPA), levelled a damning accusation against scientists on 31 October. In the interests of restoring scientific “integrity”, Pruitt signed a directive stating that the EPA would no longer allow researchers with active grants from the

agency to serve on the EPA's scientific advisory boards. By his tally, an unspecified number of scientists in voluntary positions on those boards had received US$77 million in EPA grants over the past three years — more than enough, Pruitt declared, to raise questions about their ability to provide independent scientific advice.

It was a cynical move — and entirely unnecessary. After all, it is ultimately up to Pruitt and his team to make the appointments to the boards, which advise the agency on everything from basic research programmes to contentious regulatory decisions. If Pruitt wanted to increase the geographical diversity, or include more people from local, state and tribal agencies, as claimed, he could have done so without raising a fuss. Instead, he opted for a public proclamation that singles out active academic scientists as a unique source of bias. He is wrong, on multiple counts.

Scientific enquiry requires money. That's a fact of life. But receiving a research grant is very different from being on the payroll of an institution, advocacy group or company. Those are all very real conflicts of interest that were ignored in Pruitt's directive.

Moreover, winning competitive research grants does not imply fealty to the granting institution. What drives EPA-funded researchers above all is the desire to deliver a public good: discovery and understanding.

Of course, scientific conflicts of interest do exist. So there are established procedures that require scientists to excuse themselves when their own work is under consideration by the boards. These same procedures apply to industry scientists — who are also rightfully represented on the advisory boards — when deliberations involve issues that could affect their companies' bottom lines.

What Pruitt either fails to understand, or has chosen to ignore, is that his advisory boards are designed to focus on science, not policy. Understanding the latest research requires perspectives from the leading scientists. And when it comes to environmental and human-health issues, it is only to be expected that many of those people will have research grants from the EPA.

In the end, Pruitt's directive seems crafted to incite US President Donald

Trump’s political base, and it’s yet another example of researchers being dragged into the political and cultural wars rending the country.

Happily, it is harder to argue with data. This might explain why the first volume of a comprehensive — and congressionally mandated — assessment of climate science released on 3 November (see page 152) sailed through reviews from officials at the EPA and other federal agencies.

That report, which integrates the latest climate research, found that greenhouse-gas emissions caused by human activity are altering the planet in fundamental ways. It lays out what we know about the threat of global warming — from deep in the ocean to the highest mountain peaks. And it stands in direct opposition to the climate scepticism voiced by Pruitt and Trump.

Some scientists had feared political interference, but senior officials at federal agencies gave the report the green light, without major changes. This is as it should be: scientists can assess what’s known and probe what is not. And it is up to policymakers to decide what to do with that information. This should be a lesson for Pruitt: the current administration has the right to create its own priorities, but it should not and cannot override what science reveals.

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Rohingya refugees, Bulgarian protests and a prize for negative results

The week in science: 3–9 November 2017.

08 November 2017

Events | Research | Policy | Climate | People | Publishing | Trend watch

EVENTS

Ice crack to close Antarctic base again For the second time in two years, the British Antarctic Survey (BAS) will close its Halley VI research station for the winter season because of an enormous crack in the floating ice shelf on which it rests. In March, operators finished moving the transportable station 23 kilometres inland from its initial 2012 location because of an ice chasm nearby. Now, another crack in the Brunt Ice Shelf, this one 50 kilometres long, is threatening the station from the other side. Halley VI will close between March and November 2018, the BAS said on 31 October, because it is too difficult to evacuate personnel quickly in winter if the crack develops further.

Michal Krzysztofowicz/BAS

Money for nothing A data organization has launched what it says is the world's first prize for publishing negative scientific results. The European College of Neuropsychopharmacology's Preclinical Data Forum says that the aim of the €10,000 (US$11,600) prize is to encourage researchers to publish data that don't confirm the hypothesis being tested. Such negative studies are much less likely to be published than positive results, meaning that other scientists may waste time trying to repeat the work. The call for entries — initially just for neuroscience research — opened on 8 November.

Bulgarian protest Hundreds of Bulgarian researchers took to the streets of Sofia on 1 November to demand higher wages and an increase in science funding marked out in the government's 2018 budget. Bulgaria has one of the lowest levels of research investment in the European Union. The demonstrators are threatening further protests when Bulgaria takes over the rotating EU presidency next January.

Rohingya refugees A survey of Rohingya refugees in Bangladesh suggests

that 7.5% of the children have life-threatening malnutrition. The United Nations children's charity UNICEF reported the figure on 3 November. More than 2,700 children are being treated for acute malnutrition in refugee camps, where conditions are expected to worsen because of poor sanitation and crowding. Since late August, more than 600,000 Rohingya people have fled from Myanmar to Bangladesh, following attacks by Myanmar's police.

RESEARCH

Weather forecasts Improving forecasts of severe weather is important, but meteorologists should also listen to social scientists to help save lives during storms, says a 1 November report from the US National Academies of Sciences, Engineering, and Medicine. It recommends that federal agencies do more to incorporate social- and behavioural-sciences research into their preparation for weather hazards. These changes might include researching people's processes for deciding how to respond to threats such as tornado or hurricane warnings, and evaluating how weather forecasters communicate with media and emergency-management officials to convey messages more effectively.

POLICY

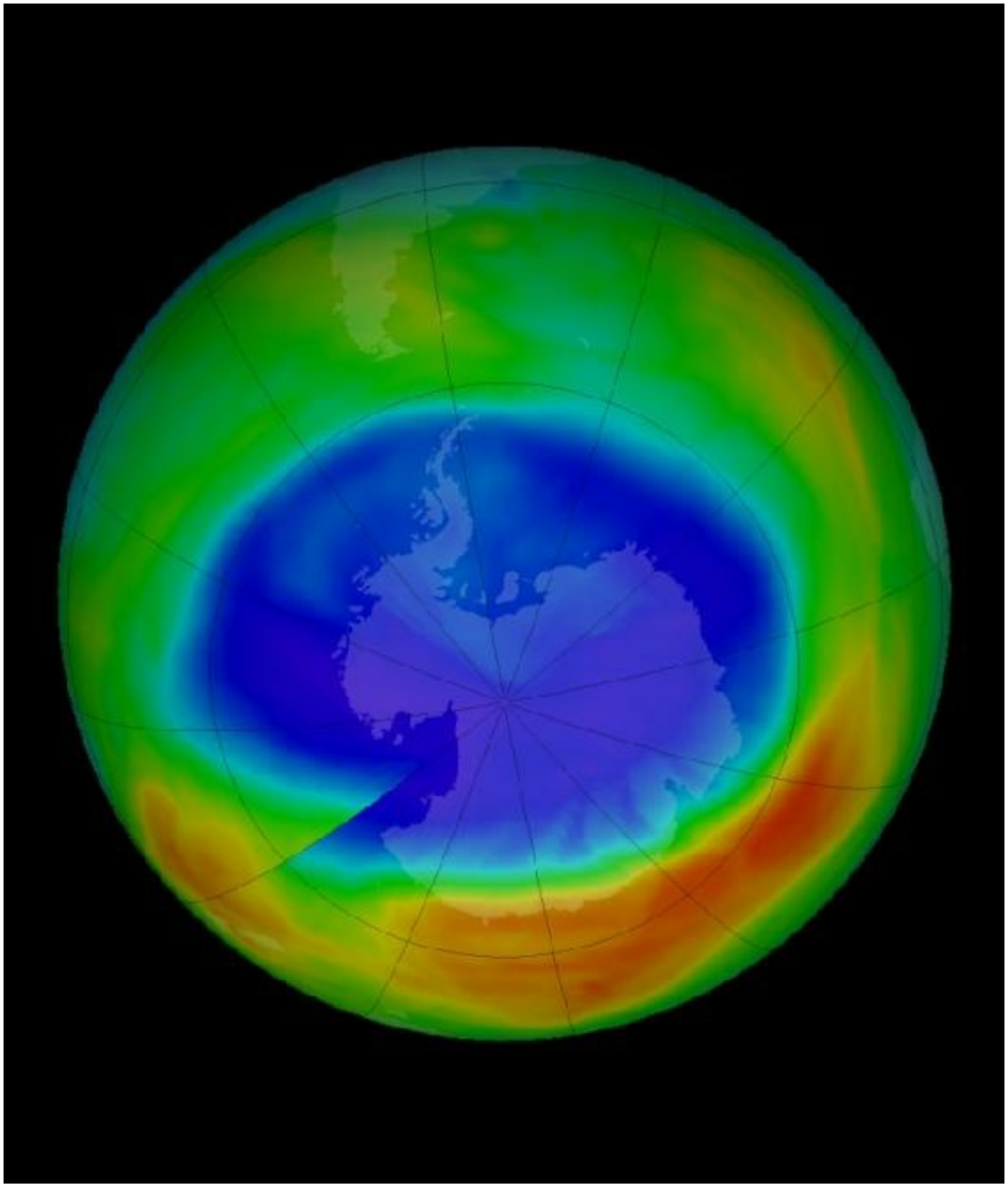
Antibiotic advice The World Health Organization (WHO) has recommended that animal-food industries curb the routine use of antibiotics for growth promotion and disease prevention. Healthy animals should receive the drugs only if others in the same flock or herdare diagnosed with communicable infections, the agency said in guidance published on 7 November. The recommendations were informed by a review of 179 studies; it found that the prevalence of multidrug-resistant bacteria in farmed animals dropped by up to 32% in places that had cut back on antibiotic use (K. L. Tang *et al. Lancet Planet. Health* http://doi.org/cfxh; 2017). The evidence connecting antibiotic restrictions in farm animals to drug resistance in humans was less robust, but hinted at a similar correlation.

Genetic-test rules The US Food and Drug Administration (FDA) is seeking

to loosen its regulation of genetic tests that are marketed directly to consumers, its commissioner, Scott Gottlieb, announced on 6 November. The FDA has proposed a policy that would allow genetic-testing companies to submit a product to the agency for a one-time review; if approved, the company would be allowed to market more tests without further review. The proposal is open for public comment until January. The agency also said that it has decided to exempt from review tests that are used to determine whether potential parents carry disease-causing genetic mutations that could cause an inherited disorder in their children.

CLIMATE

Small ozone hole This year's hole in the ozone layer was the smallest since 1988, NASA said on 2 November. The hole above Antarctica, which opens each September, was unusually small, owing to warm weather in the Southern Hemisphere. At its peak, the area of the hole was almost 2 billion hectares, or roughly two and a half times the size of the contiguous United States. Scientists attribute the shrinkage to natural variation, and not to rapid healing because of human intervention, NASA said. This year, warm air above Antarctica depleted cloud cover, which is where ozone-destroying chemical reactions occur. The hole has been shrinking since the introduction in 1987 of the Montreal Protocol to phase out ozone-depleting chemicals.



Katy Mersmann/NASA Ozone Watch/NASA

PUBLISHING

Censorship in China Springer Nature, one of the world's largest academic

publishers, has stopped readers in China from accessing some of its content. *The Financial Times* reported on 1 November that the publisher had blocked access to more than 1,000 articles from the websites of two of its journals, *The Journal of Chinese Political Science* and*International Politics*. The publishing house, which also owns *Nature*, said that the articles accounted for less than 1% of its content and had been blocked to comply with local Chinese laws. (*Nature*'s news team is editorially independent of its publisher.) The articles included politically sensitive terms such as Tibet, Taiwan and Cultural Revolution. Some in the academic community criticized the decision, which comes two-and-a-half months after UK firm Cambridge University Press blocked access to some articles in China and then swiftly reversed its decision.

Copyright battle The scholarly social network ResearchGate has over the past month disabled public access to 1.7 million papers on its site, according to five scientific publishers who have been tracking its activities. Early last month, the publishers formed a coalition to get ResearchGate to take down papers that breach copyright; two publishers have also filed a lawsuit against the site. The coalition says that the site has since disabled access to around 93% of its copyrighted material, although academics have re-uploaded some papers for public view. The publishers have now sent an undisclosed number of take-down notices to order the removal of remaining infringing content. ResearchGate, which is based in Berlin, declined to comment.

Piracy-site lawsuit The American Chemical Society (ACS) has won a lawsuit against the pirate site Sci-Hub over the website's illicit dissemination of copyrighted research articles. On 3 November, a US court granted the ACS US$4.8 million in damages for copyright infringement and trademark violation. The court also issued an injunction ordering Internet services that are "in active concert or participation" with Sci-Hub, including providers and search engines, to stop facilitating access to the site. Representatives of Sci-Hub, which was launched in 2011, did not appear in court to present their case.

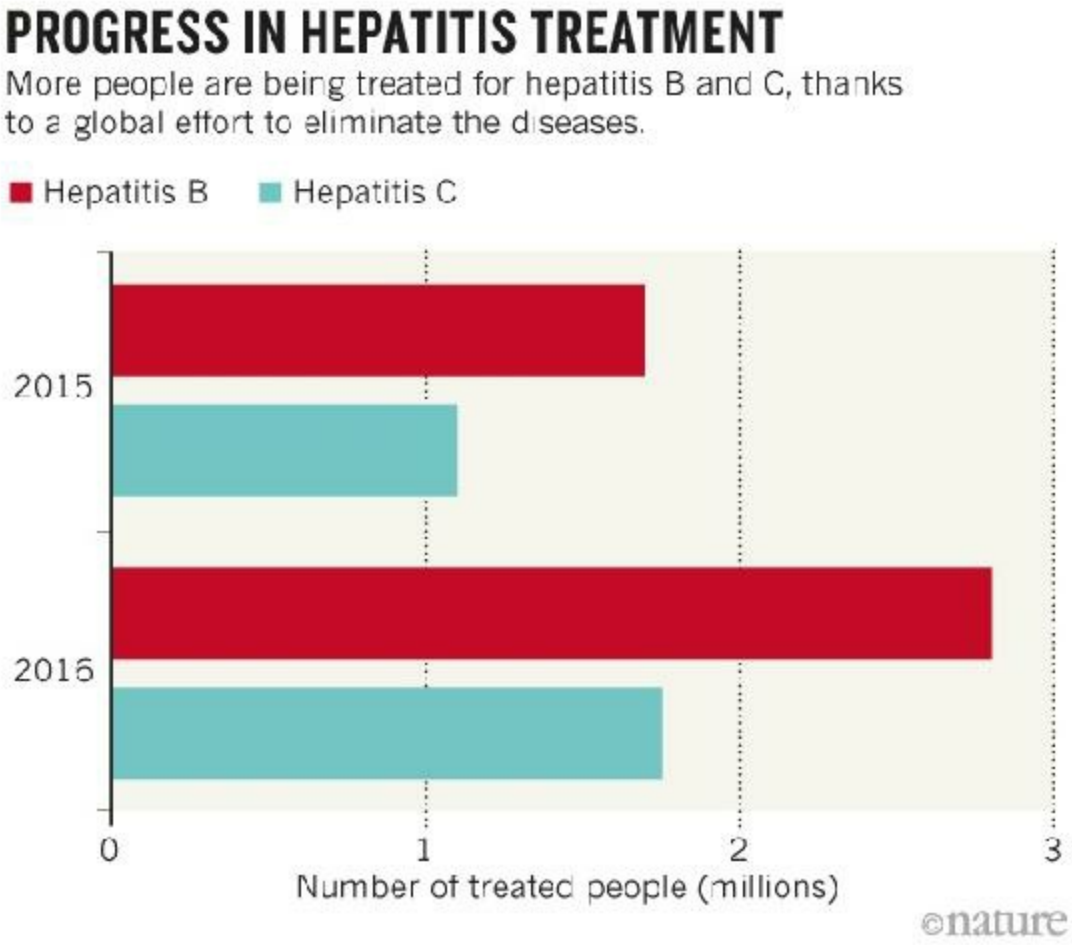
PEOPLE

Nominee withdraws Sam Clovis, the controversial nominee for the post of chief scientist at the US Department of Agriculture, withdrew from consideration on 2 November. The announcement came shortly after Clovis's name surfaced in the ongoing investigation into links between US President Donald Trump's election campaign and Russia. Clovis, a former conservative talk-show host and economics professor, was already a controversial pick for the chief-scientist position, which, by law, must be filled by a distinguished scientist.

Science chair to quit Representative Lamar Smith, the controversial chair of the US House of Representatives' science committee, said on 2 November that he will retire when his term expires late next year. The Texas Republican has repeatedly questioned the science behind climate change, has sought to pare back the research portfolio of the US National Science Foundation and has launched dozens of probes into alleged wrongdoing by individual scientists and US government science agencies. The House of Representatives limits committee chairs to six years in the role, so Smith would have been forced to relinquish his post on the science panel in 2019.

TREND WATCH

The number of people who were able to access treatment for viral hepatitis C grew by some 1.7 million in 2016, a 60% increase over 2015, the World Health Organization (WHO) said on 31 October. A further 2.8 million people were given lifelong treatment for hepatitis B in 2016, a 65% jump over 2015. The WHO estimates that there were between 6 million and 10 million new cases of viral hepatitis B and C in 2015. The agency wants 80% of people diagnosed to be receiving treatment by 2030.



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Dark-matter hunt fails to find the elusive particles

Physicists begin to embrace alternative explanations for the missing material.

08 November 2017

XENON Collab.

Scientists working on the XENON1T experiment are searching for signs of dark matter.

Physicists are growing ever more frustrated in their hunt for dark matter — the massive but hard-to-detect substance that is thought to comprise 85% of the material Universe. Teams working with the world's most sensitive dark-matter detectors report that they have failed to find the

particles, and that the ongoing drought has challenged theorists' prevailing views.

The latest results from an experiment called XENON1T at the Gran Sasso National Laboratory in Italy, published on 30 October[1], continue a dry spell stretching back 30 years in the quest to nab dark-matter particles. An attempt by a Chinese team to detect the elusive stuff, the results of which were published on the same day[2], also came up empty-handed. Ongoing attempts by space-based telescopes, as well as at CERN, the European particle-physics laboratory near Geneva, Switzerland, have also not spotted any hints of dark-matter particles.

The findings have left researchers struggling for answers. "We do not understand how the Universe works at a deeper and more profound level than most of us care to admit," says Stacy McGaugh, an astrophysicist at Case Western Reserve University in Cleveland, Ohio.

Physicists have widely accepted the existence of dark matter since the 1980s as an explanation for why galaxies remain intact rather than flying apart, which would be expected given the amount of observable mass they contain and how fast they rotate. Researchers surmised that halos of invisible dark matter surround galaxies and stabilize them. Physicists grew more confident when dark-matter models successfully predicted the fluctuations detected in an observable echo of the Big Bang, known as the cosmic microwave background.

These observations became the most dramatic evidence for a proposal in the 1980s that dark matter might be formed of weakly interacting massive particles, known as WIMPs. The existence of such particles fits with how physicists think that the Universe evolved, and with the relative abundance of matter. Moreover, the properties of WIMPs would match those predicted by a branch of particle physics called supersymmetry.

The latest round of results seems to rule out the simplest and most elegant supersymmetry theories, casting doubt on the idea that the still-undetected particles are the missing dark matter. If simple supersymmetry theories are no longer viable, scientists say, any WIMP particle has to interact with matter much more feebly than physicists once thought. "It's not a wholesale retreat

from the WIMP paradigm, but it is definitely a change in emphasis," says Dan Hooper, a physicist at the Fermi National Accelerator Laboratory in Batavia, Illinois.

Attitudes are shifting, and physicists are increasingly embracing other possible explanations for dark matter, says David Spergel, a theoretical astrophysicist at Princeton University in New Jersey, who was an early proponent of WIMP models. "These experiments haven't completely closed the window. However, we also need to be thinking about other types of dark matter and new experiments," he says.

Dedicated detectors

It has taken decades to build experiments capable of detecting the minuscule rate at which WIMPs were thought to interact with matter. Only in the past ten years have experiments, carried out at about a dozen laboratories, reached the level of sensitivity needed to detect them. The most sensitive detector in the world is Gran Sasso's XENON1T, which looks for flashes of light created when dark matter interacts with atoms in its 3.5-tonne tank of extremely pure liquid xenon. But the team reported no dark matter from its first run. Neither was there any signal in data collected over two years during the second iteration of China's PandaX experiment, based in Jinping in Sichuan province. Hunts in space have also failed to find WIMPs, and hopes are fading that a once-promising γ-ray signal detected by NASA's Fermi telescope from the centre of the Milky Way was due to dark matter — more-conventional sources seem to explain the observation. There has been only one major report[3] of a dark-matter detection, made by the DAMA collaboration at Gran Sasso, but no group has succeeded in replicating that highly controversial result; renewed attempts to match it are under way.

Future generations of detectors based on the same principle as XENON1T are already in the works, and will be needed if physicists are to finally close the window on WIMPs. But the particles' continuing no-show is making theorists more open-minded and has allowed other theories to gain prominence, says Hooper. Perhaps dark matter consists of exotic axion particles, which are akin to strange, massive photons. Theorists are also

looking at whether dark matter might not interact with known particles at all, but exist in a “hidden sector”, he says.

The looming rejection of the WIMP hypothesis is encouraging for the few physicists who claim that dark matter itself is a red herring. “I hope people will become even more open-minded,” says McGaugh, who has studied modified versions of gravity that negate the need for dark matter. However, Hooper stresses that the fading support for WIMPs does not weaken the case for dark matter, which he thinks will eventually be found. “I’m not worried about the never possibility, but it could be very, very difficult,” he says.

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The bitter battle over the world's most popular insecticides

As regulators consider a ban on neonicotinoids, debate rages over the harm they cause to bees.

08 November 2017

Lucy Hulmes/CEH

Researchers have monitored the health of the red mason bee (*Osmia bicornis-rufa*), which nests in hollow cavities.

Maj Rundlöf remembers the moment she changed her mind about neonicotinoids. In December 2013, in her office at Lund University in Sweden, she and postdoc Georg Andersson were peering at data from their

latest study. It was designed to test what would happen to bees if they fed on crops treated with neonicotinoids — the world's most widely used insecticides. “I didn't expect to see any effect at all, to be honest,” says Rundlöf.

Hives of honeybees (*Apis mellifera*) weren't greatly affected by the chemicals in their pollen and nectar, the study suggested[1]. But the data on bumblebees (*Bombus terrestris*) told a different story. Bumblebee colonies that hadn't fed on the treated crops looked normal: they were packing on weight to survive the winter. But in the colonies exposed to neonicotinoids, the growth chart was a flat line.

When the Swedish study was published in April 2015, it made headlines around the world. It was the first to show that neonicotinoid chemicals — known as neonics — could harm bees in a real-world farming situation.

Bee populations are declining in many parts of the globe, a worrying sign for the crops and wild plants that rely on these pollinators for their survival. Parasites, disease and shrinking food resources are all prime suspects. But a link to neonics has become a major flashpoint.

Even before Rundlöf's results were revealed, the European Union had placed heavy restrictions on the three most widely used neonics in flowering crops — plants that might be attractive to bees — amid rising concerns that the chemicals might harm pollinators. The restricted neonics were imidacloprid and clothianidin, made by agrochemical giant Bayer, and thiamethoxam, made by Syngenta. But farmers, the agrochemical industry and some scientists pointed out that the moratorium was precautionary and based on limited evidence, gathered mostly from lab tests.

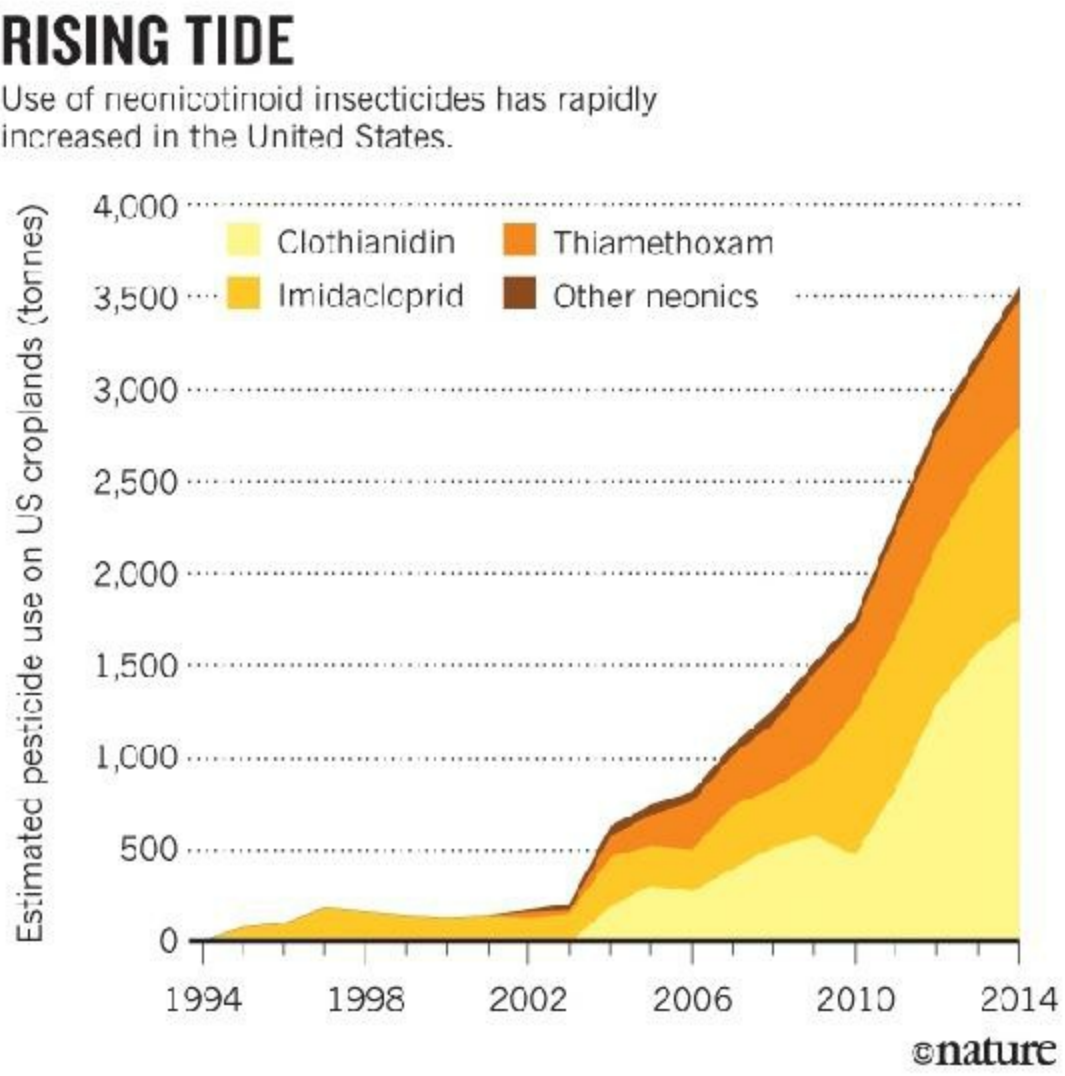
Since Rundlöf's paper, studies showing real-world evidence of harm from pesticides in the field have been mounting — and environmental organizations have demanded wide-ranging bans. Regulatory agencies will soon decide what to do about neonics, which have a global market worth more than US$1.5 billion per year. This month, the EU's European Food Safety Authority is due to complete a re-evaluation of evidence for restricting neonics; the EU will then need to decide what action to take. The US Environmental Protection Agency is expected to complete its own review of

the insecticides next year. France's parliament has passed a law that would ban neonics in 2018, although some exemptions will be allowed.

But industry groups and some scientists say the evidence still isn't conclusive. The picture is complicated: some studies show harm to some bees in some circumstances, whereas others find no harm. The results seem to be affected by many factors, including the species of bee and the kinds of crops involved. Scientists working on the question say the subject has become toxic: any new study is instantly and furiously picked at by entrenched advocates on both sides. Even the results of the largest study on the matter, funded by the agrochemical industry, failed to produce a consensus. Published this year[2], it launched another round of recriminations — including complaints from funders who criticized the paper that they had paid for. Ultimately, it's likely that political or regulatory decisions will settle the matter before opposing parties agree, says Sainath Suryanarayanan, an entomologist and sociologist at the University of Wisconsin–Madison who has studied the bee-health issue. “It is a common pattern for highly contentious and polarized debates,” he says.

The world's favourite insecticide

In the early 1980s, scientists at Nihon Tokushu Noyaku Seizo in Tokyo, an arm of Bayer, started to play around with nithiazine, an insecticide created in California a decade earlier. They discovered a new compound that was more than 100 times as effective at killing crop pests, such as aphids. Named imidacloprid, the chemical was launched onto the market in the 1990s, and it quickly became one of the most widely used insecticides in the world. By the mid-2000s, imidacloprid and similar compounds made up one-quarter of all insecticides (see 'Rising tide'). The compounds damage insects' nervous systems by causing the nerves to fire continually until they fail, eventually leading to death. Many neonics are applied directly to seeds, and are taken up by growing plants. If the plant flowers, the chemicals find their way into pollen and nectar.



Source: USGS/CalPIP

In France, where sunflower seeds coated with imidacloprid came on the market in 1994, beekeepers raised the alarm. They said that their honeybees were failing to make it home after foraging flights, and they pinned the blame on the sunflowers. The concerns triggered a 1999 French ban on imidacloprid-coated sunflower seeds, which continues to this day — although it was based on the precautionary principle, rather than formal proofs of harm, says Axel Decourtye, a researcher at the Institute for Bees in Avignon, France.

Scientists hurried to find those proofs — or evidence that the concern was overblown. Researchers quickly discovered that honeybees fed high doses of neonicotinoids died. And even sub-lethal doses triggered unusual behaviour: exposed honeybees changed their dining habits, foraging less often but for longer periods[3]. Other research showed[4] that neonics act on parts of a bee's brain associated with memory and learning. Honeybees trained to respond to particular scents by sticking out their tongues, for example, performed worse — or failed to learn the task at all — when dosed with a neonic.

At every stage, critics raised new queries about how realistic the experiments were, says Decourtye. “How do we know if the neonicotinoid doses are realistic? Does the effect on the individual have any effect on the colony?”

Out in the field

As work continued in the laboratory, researchers also began to turn to the fields. In 2012, Decourtye and his colleagues published a paper[5] showing that what they called “thiamethoxam intoxication” seemed to interfere with the ability of honeybees to return to their hives after looking for food in a realistic, outdoor setting. Yet that study still dosed bees' food with neonics, rather than allowing them to feed on treated crops.

Around the same time, a UK team found[6] that it was not just honeybees that could be at risk. They reported that colonies of bumblebees exposed to “field-realistic” levels of imidacloprid in the lab and then left to grow in field conditions grew slower than controls. They also produced 85% fewer new queens to carry on their line. That work was led by Dave Goulson, a bee researcher now at the University of Sussex in Brighton, UK. In 2006, Goulson had started a charity dedicated to conserving bumblebees, and people began telling him their concerns about neonics. “To start with, I was pretty dubious,” he says. But by 2014, the Task Force on Systemic Pesticides (TFSP) — a group of 30 scientists, including Goulson — announced that it had analysed 800 peer-reviewed studies on neonics and bees, and found “clear evidence of harm sufficient to trigger regulatory action”[8].

Rundlöf's study set out to be the most realistic yet. Her team sowed eight

Swedish fields with oilseed-rape seeds coated in clothianidin, and eight with untreated seeds. They found[1] not only that bumblebee colonies in treated fields grew less well than the controls, but also that the numbers of wild bees in the treated fields fell. Industry spokespeople noted that honeybee colonies weren't affected, and also quibbled with the study — arguing, for example, that the researchers had only placed a small number of wild bees into fields, so findings might not be statistically robust. Rundlöf, however, points out that the researchers also surveyed wild bees flying around, and had the bumblebee-colony data to draw on. “I know we have robust evidence,” she says.

Maj Rundlöf

Researchers examine the health of honeybees during a field study led by Maj Rundlöf in Sweden.

In mid-2017, the largest field study yet — funded with some $3 million from

industry — reported its long-awaited results[2]. Scientists from the Centre for Ecology and Hydrology (CEH) near Wallingford, UK, had put honeybees, mason bees (*Osmia bicornis*) and bumblebees in 33 oilseed-rape fields in the United Kingdom, Germany and Hungary. This time, the seeds, sown in winter, had been coated with either clothianidin or thiamethoxam, or with a neonicotinoid-free pesticide treatment.

The researchers, led by CEH entomologist Ben Woodcock, found that bumblebees and mason bees fared less well the more neonics they were exposed to. The honeybee picture was more complicated: in some cases, neonics seemed to affect bee health, but in others, they didn't. In the United Kingdom and Hungary, neonic compounds seemed to reduce worker-bee numbers in honeybee hives; in Hungary, researchers also saw fewer egg cells in these hives, an indication of reduced reproductive success. In Germany, however, the honeybee hives exposed to neonics had more egg cells — a puzzling result. Overall, the CEH study concluded that neonicotinoids reduced bees' ability to establish new colonies after winter. The journal editor's summary of the paper came under the headline: “Damage confirmed”.

The agrochemical firms that funded the study don't agree. At a press conference in June, when CEH scientists presented their results — without Woodcock, who was overseas — spokespeople from Syngenta and Bayer told reporters that both the study's analysis and its conclusions were questionable. They noted that Woodcock's team had analysed more than 200 pieces of information about honeybees; 9 showed a negative effect from neonicotinoids, whereas 7 were positive. “The one-line simplistic summary conclusion published does not reflect the data presented in this paper,” argued Peter Campbell, an environmental specialist at Syngenta in Reading, UK, in a separate statement released to the media.

Woodcock was incensed by the criticism. In an interview with environmental group Greenpeace, he said that industry had accused him of being a liar. Now, he says, he regrets that choice of words, but he still thinks industry took a blinkered view of the results. “I do feel that the sentiment of what I implied, while inappropriate, was not an unreasonable reaction,” he says. The negative effects were in key areas related to bee health, he says, adding that for

industrial firms to deny that neonics are having an effect on bees is “probably naive”.

Many of the academics *Nature* talked to agree. “I think the majority of researchers highlight that the weakening of bee populations caused by neonicotinoids is proved,” says Decourtye. But not everyone is so certain. “The question of whether the damage to bees is translated to an effect in fields on whole populations of bees is much harder to show,” says Linda Field, head of the department of Biointeractions and Crop Protection at Rothamsted Research in Harpenden, UK. Mature colonies may survive even if individual bees are impaired, because other worker bees compensate, notes Nigel Raine, a biologist at the University of Guelph in Canada. But solitary bees, such as wild bees and queen bumblebees emerging from hibernation, might be at greater risk.

Campbell thinks that many academics are “neutral” on the matter, but are not vocal about it. Studies showing harm to bees tend to garner media attention, and are published in widely read journals, whereas those showing no impact are relegated to less highly cited publications, he says. But Goulson and Woodcock say some of the studies that industry cites as showing no harm are statistically dubious, and more flawed than the headline-garnering trials that show harm.

Christian Maus, global lead scientist for bee care at Bayer in Monheim am Rhein, Germany, picks his words carefully. “I think it is clear and undebated that neonicotinoids do have some intrinsic toxicity to bees,” he says. “But under realistic conditions, as prevailing in the field and agricultural practice, we have not seen any evidence that they would be harming honeybee colonies, for instance, when they are correctly applied.”

Combinatorial effects

Researchers are looking beyond simple relationships between a single pesticide and bee harm. In a 2012 paper[8], Raine and his colleagues showed that exposing bumblebees to a neonicotinoid in combination with a pesticide called a pyrethroid hampered their ability to collect pollen. Colonies exposed

to both compounds experienced higher losses of worker bees than did controls, or colonies dosed with only one. The study was the first to show combinatorial effects, Raine says — which is important, because bees will be exposed to multiple compounds in the wild. And this year, in a paper[9] published alongside Woodcock's, a Canadian team studying honeybee colonies near maize (corn) plants found that the presence of the fungicide boscalid halved the dose of neonics needed to cause death.

That work also suggested that neonic chemicals can migrate away from the plants that they are supposed to protect: by identifying the sources of pollen grains in the hives, the researchers showed that bees were exposed to neonics mainly through pollen from untreated plants. Neonicotinoids are water-soluble — which is how they move from seeds into growing plant tissues. “But that also means they can be washed off the seed, into the soil, and maybe into other plants,” says Christian Krupke, an entomologist at Purdue University in West Lafayette, Indiana.

In one study[10], Krupke found that just 1.34% of clothianidin applied as seed treatment to maize ended up in the crop’s tissues. Neonics that get into the wider environment might cause other, more indirect problems. A 2014 study[11] in the Netherlands, for instance, reported a fall in populations of insect-eating birds in areas with high concentrations of neonicotinoids in the water. It suggested that the chemicals might have depleted the birds’ food resource.

Some researchers are now questioning whether there is any benefit to using neonicotinoids at all. In another study[12], Krupke’s group found no benefits on maize yield from the use of neonicotinoids in Indiana. In this crop, he says, the prophylactic use of neonicotinoids — which are often part of a bundle of pesticides sold pre-applied to seeds — is foolish.

“The way they’re used doesn’t make any sense,” he says. “It only makes sense from one motive. That is the profit motive for the manufacturer.”

Campbell insists that neonicotinoids do provide yield increases, but much of the evidence is proprietary and unpublished. Since the EU neonicotinoid restrictions, Maus says, research suggests there has been a 4% decline in

oilseed-rape yield. Whether or not the restrictions have had any effect, farmers have furiously protested against losing the ability to use neonics. Anecdotal reports suggest many are attempting to compensate by applying increasing amounts of pyrethroids, which are sprayed over crops, rather than applied to seeds; these chemicals may bring their own health risks if used in large quantities, because they are toxic to fish and aquatic insects.

The B word

Regulators in some countries will soon decide whether to take further action to restrict neonics — and here, researchers are split. Some campaign groups, such as Greenpeace and the Pesticide Action Network, have argued for a ban on the use of neonics on all outdoor crops, not just those that might be attractive to bees, such as the bright-yellow flowers of oilseed rape.

“A lot of farmers do fundamentally rely on neonicotinoids,” says Woodcock. And clamping down severely on one chemical might mean that greater amounts of other damaging substances are used. “If people can't use neonicotinoids and they go to other insecticides, is that any better? There are lots of knock-on effects,” says Field.

That concern points to wider doubts about the regulatory systems that allowed agrichemicals such as neonics onto the market in the first place, says Goulson. Many researchers are hesitant to advocate outright bans. Some, such as Rundlöf, say it isn't their job to make policy recommendations. But Goulson says his view has changed as the evidence has mounted. In 2014 — at the time of the TFSP's first synthesis report — he thought that there might be certain situations in which neonics were the best option. But since then, he says, there's been even stronger evidence of collapsing insect populations — and it is hard to regulate partial bans. “I think now I'd vote for a complete ban,” he says.

Whatever regulators do, Goulson says, he is growing increasingly downbeat about the chances of any consensus forming between industry and academia on the issue. “I'm starting to come to the conclusion there will never be a game-changer,” he says. “There is nothing I think any scientist could do at

this point to make people all sit down and have any answer.”

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Four ethical priorities for neurotechnologies and AI

08 November 2017

Artificial intelligence and brain–computer interfaces must respect and preserve people's privacy, identity, agency and equality, say Rafael Yuste, Sara Goering and colleagues.

BSIP/UIG/Getty

A man with a spinal-cord injury (right) prepares for a virtual cycle race in which competitors steer avatars using brain signals.

Consider the following scenario. A paralysed man participates in a clinical

trial of a brain–computer interface (BCI). A computer connected to a chip in his brain is trained to interpret the neural activity resulting from his mental rehearsals of an action. The computer generates commands that move a robotic arm. One day, the man feels frustrated with the experimental team. Later, his robotic hand crushes a cup after taking it from one of the research assistants, and hurts the assistant. Apologizing for what he says must have been a malfunction of the device, he wonders whether his frustration with the team played a part.

This scenario is hypothetical. But it illustrates some of the challenges that society might be heading towards.

Current BCI technology is mainly focused on therapeutic outcomes, such as helping people with spinal-cord injuries. It already enables users to perform relatively simple motor tasks — moving a computer cursor or controlling a motorized wheelchair, for example. Moreover, researchers can already interpret a person's neural activity from functional magnetic resonance imaging scans at a rudimentary level[1] — that the individual is thinking of a person, say, rather than a car.

It might take years or even decades until BCI and other neurotechnologies are part of our daily lives. But technological developments mean that we are on a path to a world in which it will be possible to decode people's mental processes and directly manipulate the brain mechanisms underlying their intentions, emotions and decisions; where individuals could communicate with others simply by thinking; and where powerful computational systems linked directly to people's brains aid their interactions with the world such that their mental and physical abilities are greatly enhanced.

Such advances could revolutionize the treatment of many conditions, from brain injury and paralysis to epilepsy and schizophrenia, and transform human experience for the better. But the technology could also exacerbate social inequalities and offer corporations, hackers, governments or anyone else new ways to exploit and manipulate people. And it could profoundly alter some core human characteristics: private mental life, individual agency and an understanding of individuals as entities bound by their bodies.

It is crucial to consider the possible ramifications now.

The Morningside Group comprises neuroscientists, neurotechnologists, clinicians, ethicists and machine-intelligence engineers. It includes representatives from Google and Kernel (a neurotechnology start-up in Los Angeles, California); from international brain projects; and from academic and research institutions in the United States, Canada, Europe, Israel, China, Japan and Australia. We gathered at a workshop sponsored by the US National Science Foundation at Columbia University, New York, in May 2017 to discuss the ethics of neurotechnologies and machine intelligence.

We believe that existing ethics guidelines are insufficient for this realm[2]. These include the Declaration of Helsinki, a statement of ethical principles first established in 1964 for medical research involving human subjects (go.nature.com/2z262ag); the Belmont Report, a 1979 statement crafted by the US National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research (go.nature.com/2hrezmb); and the Asilomar artificial intelligence (AI) statement of cautionary principles, published early this year and signed by business leaders and AI researchers, among others (go.nature.com/2ihnqac).

To begin to address this deficit, here we lay out recommendations relating to four areas of concern: privacy and consent; agency and identity; augmentation; and bias. Different nations and people of varying religions, ethnicities and socio-economic backgrounds will have differing needs and outlooks. As such, governments must create their own deliberative bodies to mediate open debate involving representatives from all sectors of society, and to determine how to translate these guidelines into policy, including specific laws and regulations.

Intelligent investments

Some of the world's wealthiest investors are betting on the interplay between neuroscience and AI. More than a dozen companies worldwide, including Kernel and Elon Musk's start-up firm Neuralink, which launched this year, are investing in the creation of devices that can both 'read' human brain activity and 'write' neural information into the brain. We estimate that current spending on neurotechnology by for-profit industry is already US$100

million per year, and growing fast.

BSIP/UIG/Getty

After having electrodes implanted in the brain to stimulate neural activity, some people have reported feeling an altered sense of identity.

Investment from other sectors is also considerable. Since 2013, more than $500 million in federal funds has gone towards the development of neurotechnology under the US BRAIN initiative alone.

Current capabilities are already impressive. A neuroscientist paralysed by amyotrophic lateral sclerosis (ALS; also known as Lou Gehrig's or motor neuron disease) has used a BCI to run his laboratory, write grant applications and send e-mails[3]. Meanwhile, researchers at Duke University in Durham, North Carolina, have shown that three monkeys with electrode implants can operate as a 'brain net' to move an avatar arm collaboratively[4]. These devices can work across thousands of kilometres if the signal is transmitted wirelessly by the Internet.

Soon such coarse devices, which can stimulate and read the activity of a few dozen neurons at most, will be surpassed. Earlier this year, the US Defense Advanced Research Projects Agency (DARPA) launched a project called Neural Engineering System Design. It aims to win approval from the US Food and Drug Administration within 4 years for a wireless human brain device that can monitor brain activity using 1 million electrodes simultaneously and selectively stimulate up to 100,000 neurons.

Meanwhile, Google, IBM, Microsoft, Facebook, Apple and numerous start-ups are building ever-more-sophisticated artificial neural networks that can already outperform humans on tasks with well-defined inputs and outputs.

Last year, for example, researchers at the University of Washington in Seattle demonstrated that Google's FaceNet system could recognize one face from a million others. Another Google system with similar neural-network architecture far outperforms well-travelled humans at guessing where in the world a street scene has been photographed, demonstrating the generality of the technique. In August, Microsoft announced that, in certain metrics, its neural network for recognizing conversational speech has matched the abilities of even trained professionals, who have the option of repeatedly rewinding and listening to words used in context. And using electroencephalogram (EEG) data, researchers at the University of Freiburg in Germany showed in July how neural networks can be used to decode planning-related brain activity and so control robots[5].

Future neural networks derived from a better understanding of how real ones work will almost certainly be much more powerful even than these examples. The artificial networks in current use have been inspired by models of brain circuits that are more than 50 years old, which are based on recording the activity of individual neurons in anaesthetized animals[6]. In today's neuroscience labs, researchers can monitor and manipulate the activity of thousands of neurons in awake, behaving animals, owing to advances in optical methods, computing, molecular engineering and microelectronics.

We are already intimately connected to our machines. Researchers at Google calculated this year that the average user touches their phone nearly one million times annually (unpublished data). The human brain controls auditory

and visual systems to decipher sounds and images, and commands limbs to hold and manipulate our gadgets. Yet the convergence of developments in neurotechnologies and AI would offer something qualitatively different — the direct linking of people's brains to machine intelligence, and the bypassing of the normal sensorimotor functions of brains and bodies.

Four concerns

For neurotechnologies to take off in general consumer markets, the devices would have to be non-invasive, of minimal risk, and require much less expense to deploy than current neurosurgical procedures. Nonetheless, even now, companies that are developing devices must be held accountable for their products, and be guided by certain standards, best practices and ethical norms.

We highlight four areas of concern that call for immediate action. Although we raise these issues in the context of neurotechnology, they also apply to AI.

Privacy and consent. An extraordinary level of personal information can already be obtained from people's data trails. Researchers at the Massachusetts Institute of Technology in Cambridge, for example, discovered in 2015 that fine-grained analysis of people's motor behaviour, revealed through their keyboard typing patterns on personal devices, could enable earlier diagnosis of Parkinson's disease[7]. A 2017 study suggests that measures of mobility patterns, such as those obtained from people carrying smartphones during their normal daily activities, can be used to diagnose early signs of cognitive impairment resulting from Alzheimer's disease[8].

Algorithms that are used to target advertising, calculate insurance premiums or match potential partners will be considerably more powerful if they draw on neural information — for instance, activity patterns from neurons associated with certain states of attention. And neural devices connected to the Internet open up the possibility of individuals or organizations (hackers, corporations or government agencies) tracking or even manipulating an individual's mental experience.

We believe that citizens should have the ability — and right — to keep their neural data private (see also 'Agency and identity'). We propose the following steps to ensure this.

For all neural data, the ability to opt out of sharing should be the default choice, and assiduously protected. People readily give up their privacy rights to commercial providers of services, such as Internet browsing, social media or entertainment, without fully understanding what they are surrendering. A default of opting out would mean that neural data are treated in the same way that organs or tissues are in most countries. Individuals would need to explicitly opt in to share neural data from any device. This would involve a safe and secure process, including a consent procedure that clearly specifies who will use the data, for what purposes and for how long.

Even with this approach, neural data from many willing sharers, combined with massive amounts of non-neural data — from Internet searches, fitness monitors and so on — could be used to draw 'good enough' conclusions about individuals who choose not to share. To limit this problem, we propose that the sale, commercial transfer and use of neural data be strictly regulated. Such regulations — which would also limit the possibility of people giving up their neural data or having neural activity written directly into their brains for financial reward — may be analogous to legislation that prohibits the sale of human organs, such as the 1984 US National Organ Transplant Act.

Another safeguard is to restrict the centralized processing of neural data. We advocate that computational techniques, such as differential privacy or 'federated learning', be deployed to protect user privacy (see 'Protecting privacy'). The use of other technologies specifically designed to protect people's data would help, too. Blockchain-based techniques, for instance, allow data to be tracked and audited, and 'smart contracts' can give transparent control over how data are used, without the need for a centralized authority. Lastly, open-data formats and open-source code would allow for greater transparency about what stays private and what is transmitted.

Protecting privacy: Federated learning

When technology companies use machine learning to improve their software, they typically gather user information on their servers to analyse how a particular service is being used and then train new algorithms on the aggregated data. Researchers at Google are experimenting with an alternative method of artificial-intelligence training called federated learning. Here, the teaching process happens locally on each user's device without the data being centralized: the lessons aggregated from the data (for instance, the knowledge that the word 'weekly' can be used as an adjective and an adverb) are sent back to Google's servers, but the actual e-mails, texts and so on remain on the user's own phone. Other groups are exploring similar ideas. Thus, information systems with improved designs could be used to enhance users' ownership and privacy over their personal data, while still enabling valuable computations to be performed on those data.

Agency and identity. Some people receiving deep-brain stimulation through electrodes implanted in their brains have reported feeling an altered sense of agency and identity. In a 2016 study, a man who had used a brain stimulator to treat his depression for seven years reported in a focus group[9] that he began to wonder whether the way he was interacting with others — for example, saying something that, in retrospect, he thought was inappropriate — was due to the device, his depression or whether it reflected something deeper about himself. He said: “It blurs to the point where I'm not sure ... frankly, who I am.”

Neurotechnologies could clearly disrupt people's sense of identity and agency, and shake core assumptions about the nature of the self and personal responsibility — legal or moral.

People could end up behaving in ways that they struggle to claim as their own, if machine learning and brain-interfacing devices enable faster translation between an intention and an action, perhaps by using an 'auto-complete' or 'auto-correct' function. If people can control devices through their thoughts across great distances, or if several brains are wired to work collaboratively, our understanding of who we are and where we are acting will be disrupted.

As neurotechnologies develop and corporations, governments and others start striving to endow people with new capabilities, individual identity (our

bodily and mental integrity) and agency (our ability to choose our actions) must be protected as basic human rights.

We recommend adding clauses protecting such rights ('neurorights') to international treaties, such as the 1948 Universal Declaration of Human Rights. However, this might not be enough — international declarations and laws are just agreements between states, and even the Universal Declaration is not legally binding. Thus, we advocate the creation of an international convention to define prohibited actions related to neurotechnology and machine intelligence, similar to the prohibitions listed in the 2010 International Convention for the Protection of All Persons from Enforced Disappearance. An associated United Nations working group could review the compliance of signatory states, and recommend sanctions when needed.

Such declarations must also protect people's rights to be educated about the possible cognitive and emotional effects of neurotechnologies. Currently, consent forms typically focus only on the physical risks of surgery, rather than the possible effects of a device on mood, personality or sense of self.

Augmentation. People frequently experience prejudice if their bodies or brains function differently from most[10]. The pressure to adopt enhancing neurotechnologies, such as those that allow people to radically expand their endurance or sensory or mental capacities, is likely to change societal norms, raise issues of equitable access and generate new forms of discrimination.

Moreover, it's easy to imagine an augmentation arms race. In recent years, we have heard staff at DARPA and the US Intelligence Advanced Research Projects Activity discuss plans to provide soldiers and analysts with enhanced mental abilities ('super-intelligent agents'). These would be used for combat settings and to better decipher data streams.

Any lines drawn will inevitably be blurry, given how hard it is to predict which technologies will have negative impacts on human life. But we urge that guidelines are established at both international and national levels to set limits on the augmenting neurotechnologies that can be implemented, and to define the contexts in which they can be used — as is happening for gene editing in humans.

Privacy and individuality are valued more highly in some cultures than in others. Therefore, regulatory decisions must be made within a culture-specific context, while respecting universal rights and global guidelines. Moreover, outright bans of certain technologies could simply push them underground, so efforts to establish specific laws and regulations must include organized forums that enable in-depth and open debate.

Such efforts should draw on the many precedents for building international consensus and incorporating public opinion into scientific decision-making at the national level[11]. For instance, after the First World War, a 1925 conference led to the development and ratification of the Geneva Protocol, a treaty banning the use of chemical and biological weapons. Similarly, after the Second World War, the UN Atomic Energy Commission was established to deal with the use of atomic energy for peaceful purposes and to control the spread of nuclear weapons.

In particular, we recommend that the use of neural technology for military purposes be stringently regulated. For obvious reasons, any moratorium should be global and sponsored by a UN-led commission. Although such commissions and similar efforts might not resolve all enhancement issues, they offer the best-available model for publicly acknowledging the need for restraint, and for wide input into the development and implementation of a technology.

Bias. When scientific or technological decisions are based on a narrow set of systemic, structural or social concepts and norms, the resulting technology can privilege certain groups and harm others. A 2015 study[12] found that postings for jobs displayed to female users by Google's advertising algorithm pay less well than those displayed to men. Similarly, a ProPublica investigation revealed last year that algorithms used by US law-enforcement agencies wrongly predict that black defendants are more likely to reoffend than white defendants with a similar criminal record (go.nature.com/29aznyw). Such biases could become embedded in neural devices. Indeed, researchers who have examined these kinds of cases have shown that defining fairness in a mathematically rigorous manner is very difficult (go.nature.com/2ztfjt9).

Practical steps to counter bias within technologies are already being discussed in industry and academia. Such ongoing public discussions and debate are necessary to shape definitions of problematic biases and, more generally, of normality.

We advocate that countermeasures to combat bias become the norm for machine learning. We also recommend that probable user groups (especially those who are already marginalized) have input into the design of algorithms and devices as another way to ensure that biases are addressed from the first stages of technology development.

Responsible neuroengineering

Underlying many of these recommendations is a call for industry and academic researchers to take on the responsibilities that come with devising devices and systems capable of bringing such change. In doing so, they could draw on frameworks that have already been developed for responsible innovation.

In addition to the guidelines mentioned above, the UK Engineering and Physical Sciences Research Council, for instance, provides a framework to encourage innovators to “anticipate, reflect, engage and act” in ways that “promote ... opportunities for science and innovation that are socially desirable and undertaken in the public interest”. Among the various efforts to address this in AI, the IEEE Standards Association created a global ethics initiative in April 2016, with the aim of embedding ethics into the design of processes for all AI and autonomous systems.

History indicates that profit hunting will often trump social responsibility in the corporate world. And even if, at an individual level, most technologists set out to benefit humanity, they can come up against complex ethical dilemmas for which they aren't prepared. We think that mindsets could be altered and the producers of devices better equipped by embedding an ethical code of conduct into industry and academia.

A first step towards this would be to expose engineers, other tech developers

and academic-research trainees to ethics as part of their standard training on joining a company or laboratory. Employees could be taught to think more deeply about how to pursue advances and deploy strategies that are likely to contribute constructively to society, rather than to fracture it.

This type of approach would essentially follow that used in medicine. Medical students are taught about patient confidentiality, non-harm and their duties of beneficence and justice, and are required to take the Hippocratic Oath to adhere to the highest standards of the profession.

The possible clinical and societal benefits of neurotechnologies are vast. To reap them, we must guide their development in a way that respects, protects and enables what is best in humanity.

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Comments

Comments

There are currently no comments.

The catalogue that made metrics, and changed science

08 November 2017

As new ways emerge to assess research, Alex Csiszar recalls how the first one transformed the practice and place of science in society.

Alamy

Cataloguers of the Royal Society developed the first record of published scientific research.

In 1830, Charles Babbage had an unusual idea. Exasperated by how little recognition science was getting in England, the computer pioneer and scientific provocateur suggested that quantifying authorship might be a way to identify scientific eminence.

Like many of Babbage's radical ideas, this one persuaded almost nobody, but it eventually proved prophetic. Before the end of the century, listing papers and comparing publication counts had become a popular pursuit among scientific authors and other observers. Within a few decades, academic scientists were coming to fear the creed of 'publish or perish' (see 'Catalogues and counts').

This transformation can inform current debates about the value of algorithms for quantifying scientific credibility and importance. History shows how search technologies and metrics are not neutral tools that simply speed up efforts to locate and evaluate scientific work. Metrics transform the very things that they measure. By changing the reward structure, they alter researchers' behaviour — both how results are communicated and which topics receive the most attention.

But there is a second, more subtle, transformation that we must be alert to. The processes by which scientific merit is judged have long been central to the public perception of scientific authority. As these processes change, we must also consider the ways in which broader cultural beliefs about scientific expertise are transformed.

Broken pieces of fact

Babbage's suggestion to count authors' papers was met with various criticisms. One author did the calculation for each fellow in the Royal Society in London, and showed that this was a terrible guide to scientific eminence. Another pointed out[1] that “a far more satisfactory criterion” would have been “the value of those papers”.

Back then, scientific reputations were built not on periodicals but on books and other proofs of genius that demonstrated mastery of a subject. Babbage himself had little respect for most scientific journals, and he limited his proposal to counting papers in the venerable *Philosophical Transactions of the Royal Society of London*. As late as 1867, the British physiologist Michael Foster, in a retrospective written on the life of Karl von Baer, heaped praise on the embryologist's multivolume masterwork, *On the Development*

of Animals, and dismissed his periodical publications. These, Foster claimed[2], were just “specimens of those broken pieces of fact, which every scientific worker throws out to the world, hoping that on them, some time or other, some truth may come to land”.

Alamy

But things were beginning to change. A young engineer working for the US

Coast and Geodetic Survey (now the National Geodetic Survey) had suggested that it would be useful if some catalogue could be devised to keep track of the publications of European scientific societies. Once the idea crossed the Atlantic and percolated up to the Royal Society, its scope grew to become a list of all periodical papers containing original scientific research published since 1800. Some questioned the need to preserve so much insignificant writing. The physicist William Thomson (later Lord Kelvin) warned that the project would lead the society to financial ruin.

The main argument for what would become the *Catalogue of Scientific Papers* was that periodical publishing was a mess. Although many authors published in the journals of scientific societies, vast quantities of valuable information appeared in popular-science magazines, encyclopaedias and general-interest weeklies. Authors distributed huge numbers of offprints that sometimes did not even make clear what journal they had come from.

When the society's indexers got down to work in 1867, they realized that the situation was worse than they'd imagined. For thousands of papers, they couldn't even figure out who the author was. Many who published in periodicals chose to remain anonymous, or signed only their initials. In other cases, it was hard to tell to what extent the writer of a paper was responsible for its contents, or whether another person ought to be credited. Moreover, vast numbers of papers were published in various forms in different periodicals, and it was no easy matter deciding what should count as the same publication. Today, such publishing habits would probably lead to accusations of misconduct; not very long ago this was business as usual.

The Royal Society's cataloguers did what they could, contacting editors and authors to match names to papers. They turned a significant portion of the society's library into a bibliographic workroom, and made their job simpler by excluding all general-interest periodicals from the search, as well as anything that smacked of reading for non-specialists. They compiled lists of which periodicals ought to be included in the count, and circulated them to other experts and academies for feedback. The decision about whether to index some doubtful titles sometimes made it all the way to the society's council for a vote.

As their work progressed, the directors of the project came to realize that

their charge to produce a master list of all 'scientific papers' published since 1800 might actually influence publishing practices in the future. They hoped that authors would be more careful about where they published — or at least sign their contributions[3]. They probably did not anticipate the full consequences of what they were about to unleash.

Counting what counts

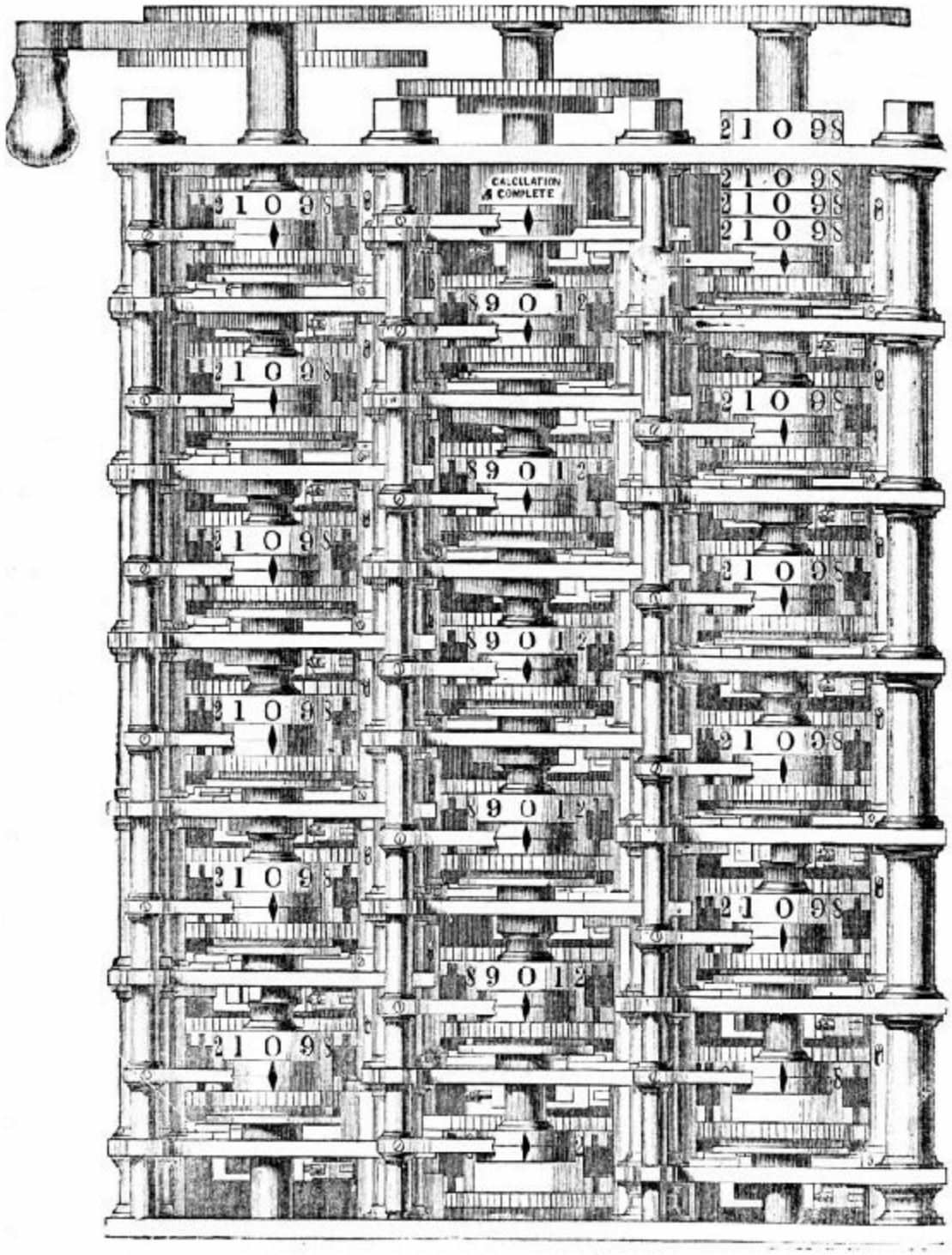
When the first volumes of the *Catalogue of Scientific Papers* appeared at the end of 1867, reaction across Europe and the United States was swift and wide-ranging. One observer wrote in awe that the catalogue made science look like a coral-island, a majestic edifice that grew imperceptibly larger with the addition of each new fact embodied in each paper. Some were less enthusiastic. One Royal Society fellow complained that the editors had distorted “the progress and history of discovery both in Physical and Natural Science” by excluding so many valuable contributions from “journals not professedly scientific”, accounts of scientific voyages, independently published treatises, encyclopaedia articles (which at the time often included original research), and much more[4].

Many observers hurried over the prospect of how helpful the catalogue would be for finding information and began comparing the productivity of individuals. By quantifying the contributions of each author, the catalogue seemed tailor-made for keeping score. A writer in *Nature* got down to business[5]: “Dr. Hooker appears for 58 papers; his late father for 72; and the late W. Hopkins, who did so much in mathematical geology, for 33 .... the indefatigable Isaac Lea, of Philadelphia, for 106, mostly about shells...”. And so forth. In a detailed review in a Viennese newspaper, the mineralogist Wilhelm von Haidinger began by urging prudence, warning that the mere comparison of numbers was no basis on which to make judgements of value[6]. But even he admitted that the numbers were somehow irresistible. Within two years, von Haidinger had taken his numerical analysis further. He published a study based on the catalogue that included a chart that compared the number of highly productive scientific authors in each region of Europe, lamenting the low position of Austria according to this ranking[7].

Such enthusiasm for counting had practical consequences. Within a decade of those first volumes appearing, the forms submitted by candidates for admission to the Royal Society transformed into long lists of papers. By the early 1870s, obituaries and biographical encyclopaedias were routinely noting the number of papers written by a researcher, and even following the chronology sketched out by those papers as guide-posts to a career. By 1900, even Foster, the physiologist once so sceptical of scientific periodicals, had changed his tune. Original science belonged in periodicals, he explained. Putting new findings in books — as Charles Darwin had famously done — was “out of place and even dangerous”[8]. To be an expert on scientific subjects meant being an author of scientific papers.

Publish or perish

There is a direct line from these developments to twentieth-century worries about scientific publishing going off the rails. A letter to *Nature* in 1932 lamented the growing practice of candidates submitting a “list of strictly technical publications” to the Royal Society, leading to the result that “our journals are filled with masses of unreadable trash” published by ambitious scholars hoping to strengthen their applications[9].



Alamy

Charles Babbage, inventor of the difference engine, was an advocate of counting papers.

This was around the same time that the phrase publish or perish began to circulate in academia. It did so first in the United States, where the spread of research universities was turning science into something resembling a profession. The slogan became shorthand for the corrupting influence of narrow, bureaucratic performance measures of research.

In the 1960s, Eugene Garfield launched a radically different search tool, known as the Science Citation Index. He hoped that it might end the harmful culture of publish or perish by showing that some papers were more cited — and hence more valuable — than others.

Immediately, commentators warned that new measures based on citations would only make things worse, leading to a “highly invidious pecking order” of journals that could distort science[10]. The journal impact factor made its public debut in 1972, soon after the US Congress called on the National Science Foundation to produce a better account of the benefits wrought by public funding of science. There is no doubt that the citation index changed practices of scientific publishing, just as the rise of counting papers had followed the introduction of the catalogue before.

Today, advocates of altmetrics argue that well-made algorithms can mimic and aggregate the everyday acts of judgement that researchers make when they read, cite, link or otherwise engage with published research. These algorithms, they claim, will turn out to be as good or better at replicating established processes — such as peer review — that are supposed to delimit what constitutes important and trustworthy research.

Whether or not these claims turn out to be true, they ignore the question of whether we deem the procedures that experts use to evaluate ideas to be intrinsically valuable (that is, independent of the content of those judgements).

Scientific judgement does not happen in a cultural vacuum. The rise of processes such as peer review to organize and evaluate research was never simply about getting scientific judgement right; it was about balancing scientists' expert cultures with public demands for accountability. The *Catalogue of Scientific Papers* was itself part of a cultural moment in which

indexes and card catalogues were celebrated for their potential to set knowledge free and even foster world peace. Interest in altmetrics has grown alongside widespread fascination with the potential of online platforms to make scientific communication both more open and more democratic.

At a time when the public status of the scientific expert is becoming increasingly uncertain, these questions are more important than ever. In a democracy, the procedures by which we decide what constitutes valuable scientific knowledge fundamentally depend on public conceptions of the aims of the scientific enterprise.

The question of whether new metrics might one day replicate the results of peer review (when it is working well) is a red herring. How we choose to judge what constitutes good science is just as important as the end results of those judgements. Even algorithms have politics.

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Further reading

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Comments

Commenting is currently unavailable.

Indian scientists urged to speak out about pseudoscience

Cancelled astrology workshop prompts calls for researchers to be vigilant about stamping out unscientific beliefs.

07 November 2017

Pallava Bagla/Corbis/Getty

Scientists taking part in India's march for science in August were protesting against the spread of anti-science beliefs, superstitions and myths.

A leading Indian science-advocacy group is urging the country’s researchers to speak out against pseudoscience, which it fears has gained a foothold in the past few years, partly through support from some agencies of the Indian

government.

The call to arms, made by the non-profit Breakthrough Science Society, comes after some members of an alumni association of the prestigious Indian Institute of Science (IISc), Bangalore, planned a workshop on astrology at the IISc for 25–26 November.

Strong backlash from scientists resulted in the event being cancelled on 28 October. The society's general secretary, Soumitro Banerjee, says that it would be "detrimental to Indian science" for researchers to remain neutral on such issues. "India's scientific community must be proactive in propagating a scientific bent of mind," says Banerjee, a physicist at the Indian Institute of Science Education and Research Kolkata.

Timeline of events

Two days before the alumni association cancelled the workshop, dozens of scientists signed letters to the IISc director, Anurag Kumar, objecting to the workshop. The IISc director and the faculty were not involved in organizing the workshop.

Muthya Ravindra, a computer scientist and president of the alumni association, says that the event, organized by one of its members, was still under discussion when "due to some miscommunications", e-mails promoting the event were sent out.

But Ravindra says that despite criticism from scientists and other academics, people widely believe in astrology and seek its advice in newspapers, magazines and on television. He is unsure what role scientists should play in educating society on the dangers such practices may have. "It is very confusing to me whether we as scientists [should] criticize or take some part in finding a solution," he says.

India's ruling party, the conservative Bharatiya Janata Party (BJP) has shown support for giving astrology a place in universities. In 2001, then-science minister of the BJP-led coalition government Murli Manohar Joshi took steps to allow public universities to include astrology classes in curricula.

However, the Indian government and science ministry did not have a role in the IISc alumni association's planned astrology workshop.

Pseudoscience debate

Alarm in the Indian scientific community over anti-science policies and programmes has been brewing for some time. Several scientists who spoke with *Nature* are reluctant to comment publicly about it for fear of jeopardizing their jobs. Others took part in the March for Science organized by the 7,000-member Breakthrough Science Society in August in around 40 Indian cities, in part to protest the government's support for ideas not yet backed by science. One area of concern, says Banerjee, is the government's push for a national research programme on the health and other benefits of a combination of five cow products, known as panchgavya.

The Indian Institute of Technology (IIT), Delhi, hosted a two-day workshop last December to discuss ways to validate research on panchgavya, which was supported by India's Department of Science and Technology, Department of Biotechnology, and Council of Scientific and Industrial research (CSIR), and inaugurated by India's science minister Harsh Vardhan.

According to IIT Delhi's website, Vardhan, who is a physician, "emphasised that use of panchgavya in practice and in daily routines will help to address the pressing global issues like climate change, resistance development, malnourishment, global health etc".

Following the workshop, India's science ministry formed a national steering committee to initiate a national programme on the topic.

Supporters of this research say that cow products should be considered part of India's vast traditional knowledge base. But critics say that such unverified theories are pseudoscience, and that singling out the benefits of cow products is part of a larger political agenda by Hindus, for whom the cow is a sacred animal.

They also argue that research on topics such as panchgavya should be handled in a neutral manner rather than as a way of promoting traditional

knowledge. Rahul Siddharthan, a computation biologist at the Institute of Mathematical Sciences in Chennai, says that the government must accept that any research involving traditional hypotheses about health could potentially refute those hypotheses. “Refutability is the essence of science,” he says.

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Comments

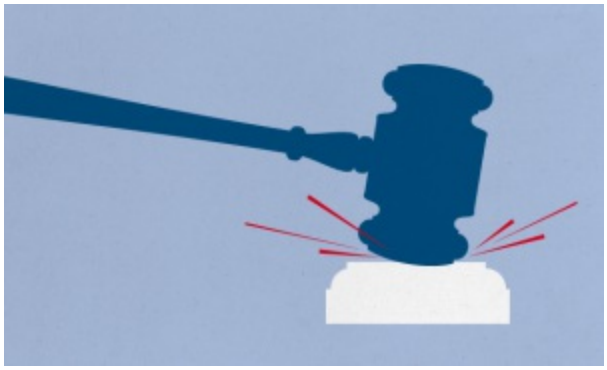
Commenting is currently unavailable.

Pirate paper website Sci-Hub dealt another blow by US courts

American Chemical Society wins lawsuit against the site, and could seek to block access to the portal in the United States.

07 November 2017 Updated:

1. 08 November 2017



The American Chemical Society (ACS) has won a lawsuit against the pirate research-paper website Sci-Hub, over the site’s illicit use and dissemination of ACS articles.

On 3 November, a US court ordered Sci-Hub's operators to pay the ACS US$4.8 million in damages for copyright infringement and trademark violation. Sci-Hub’s owners did not appear in court to present their case.

The judge also ordered that any party “in active concert or participation” with Sci-Hub should “cease facilitating” access to the repository. This means that the ACS could request Internet services including web providers, search engines and domain-name registrars to stop linking or to block access to Sci-Hub and the various domains it is hosted under.

Which services might be approached by the ACS isn't yet clear: the meaning of the phrase "in active concert or participation with" is open to legal interpretation, says Michael Carroll, an information-justice and intellectual-property specialist at the American University Washington College of Law in Washington, DC.

There are no clear standards as to when an Internet service is in "active concert" with a pirate website, says Carroll. A user merely resolving a domain-name request to such a site, for example, does not yet qualify as active participation, he adds.

Such an order by a US court is exceptional, Carroll says. "In general, our federal courts do not have the power to issue orders against people or entities that were not part of the lawsuit." But he adds that US federal rules for civil procedures such as this do sometimes allow injunctions against persons who are in 'active participation' with an enjoined party. The current lawsuit is an example of that, he says.

The ruling is another legal blow for Sci-Hub, which provides free access to millions of paywalled research papers and is popular with researchers around the world. In June, a New York court granted the Dutch publisher Elsevier $15 million in damages from the site for large-scale copyright infringement.

But publishers are unlikely to see any money from Sci-Hub because its chief operator lives outside the United States. Alexandra Elbakyan, a former neuroscientist who created the portal in 2011, says the court order is an example of censorship.

The ACS, which filed its lawsuit in June in a Virginia court, said in a statement on 6 November that the ruling was "a victory for copyright law and the entire publishing enterprise". An analysis published in August estimated that as of March 2017, Sci-Hub's database contained 69% of the world's roughly 81.6 million scholarly articles — and 98.8% of the ACS's journal content.

The ACS says that it will now seek to enforce the court's order. Asked for comment, the society referred *Nature*'s news team to its statement. But Internet service providers are expected to resist what they may perceive as

undue censorship.

Attempts to stop people visiting Sci-Hub face another hurdle, too: the site has an alternative address that can be reached by users of the Tor network, a group of servers that encrypts Internet traffic and disguises its origins. No Internet provider can easily block access to such sites.

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Updates

Updated:

The story has been updated with comments from Alexandra Elbakyan.

Comments

Commenting is currently unavailable.

Genetically modified apple reaches US stores, but will consumers bite?

Success for the ‘Arctic apple’ could herald a new wave of lab-grown foods.

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1. 10 November 2017

Okanagan Specialty Fruits, Inc.

The apple on the right doesn’t bruise when dropped — it lacks a gene encoding an enzyme that causes plant cells to brown on exposure to oxygen.

This month, bags of sliced apples will hit grocery-store shelves in the midwestern United States for the first time. Shoppers who purchase the

apples can leave the slices out for snacking, because of a feat of genetic engineering that prevents their flesh from browning when exposed to air.

The ‘Arctic apple’ is one of the first foods to be given a trait intended to please consumers rather than farmers, and it joins a small number of genetically modified organisms (GMOs) to be sold as a whole product, not an ingredient. Since Okanagan Specialty Fruits in Summerland, Canada, planted its first test apples in 2003, the array of foods modified in labs has expanded to include meatless burgers, made with soya protein produced by recombinant yeast, fish fillets grown from seafood stem cells, and mushrooms whose genomes have been edited with CRISPR technology. Most of these items have not yet reached the market.

Now, many small biotechnology companies developing such foods are watching the Arctic apple’s launch, eager for clues to how consumers will perceive the fruits of their labour.

“If the apple sells, it will pave the way for others,” says Yinong Yang, a plant pathologist at Pennsylvania State University in University Park, who used CRISPR to engineer a mushroom that resists browning. He hopes one day to license his mushroom to commercial growers.

Mary Maxon, who oversees biosciences programmes at Lawrence Berkeley National Laboratory in California, agrees. “The apple is not the first GMO that people would eat, but it’s the first one that consumers may value,” she says.

When Okanagan co-founder Neal Carter bought an orchard in 1995, he thought hard about how to win over the US snack market. He found his answer in Australia, where researchers at the Commonwealth Scientific and Industrial Research Organisation had figured out how to delete a gene encoding an enzyme that causes plant cells to brown when exposed to oxygen. Carter realized that suppressing production of the enzyme in apples might allow him to sell them in snackable slices without preservatives.

Only later did he realize that if consumers were to be enticed to buy, Americans’ distrust of GMOs would need to be overcome. Okanagan’s subsequent surveys of people in America’s top apple-growing states — New

York and Washington — revealed that about 20% were wary of GMOs. But the company also found that many people changed their minds when told that the apples were engineered to silence browning genes, and then tested for safety.

Mike Seldon, the co-founder of Finless Foods, a firm in New York City that is developing fish fillets from fish stem cells, agrees that providing more information helps to win over consumers. “We’re not going to repeat the mistakes of the GMO industries in the past, and just put foods on the market without public conversation,” he says. “If we do, you can expect a backlash — and that’s warranted.”

Seldon sees a parallel between the Arctic apple and his fillets: both were created with attributes to please consumers. Finless Foods, which has made prototypes of bluefin-tuna fillets, hopes that people will be won over by the idea of eating fish without worrying about overfishing, animal slaughter or environmental pollution.

But others say that Okanagan hasn’t gone far enough in telling consumers how its apple was made. The company does not mention GMOs on the apples’ bags; instead, the bags have a QR code — which links to online information when it is scanned by a smartphone. “Not everyone has a smartphone, and even if you have one, are you going to check every item with it?” says Bill Freese, a science-policy analyst at the Center for Food Safety, an advocacy group in Washington DC. He wants the apples to be clearly labelled as GMOs.

Consumer reaction isn’t the only concern for developers of genetically engineered or other lab-made foods who want to sell their wares in the United States. One major stumbling block is the US regulatory process, which involves a complicated tangle of federal agencies — and, for many companies, an unclear path forward. US regulators assessed the Arctic apple for five years before approving it for sale, but spent just two years reviewing a non-browning GM potato developed by agricultural firm J. R. Simplot of Boise, Idaho.

Then there is the case of the CRISPR mushroom. The US Department of Agriculture (USDA) said in 2016 that it would not evaluate the mushroom,

which was created by using CRISPR to delete a gene. That seemed to clear the fungus's path to the market. But Yang says that, after *Nature*'s news team reported on the USDA's decision, the US Food and Drug Administration contacted him to ask whether it could review the mushroom. "I agreed to that since it would give consumers a peace of mind," he says.

As far as investors are concerned, regulatory uncertainty may be less of a barrier to the success of engineered foods than customer uncertainty. James Hardiman, a partner at the venture-capital fund Data Collective in San Francisco, California, says that companies developing such foods can always build a few extra years into their long-term plans, to account for twists in the regulatory process. "The public narrative is much more difficult to control," he says. "We know the public can be irrational."

Still, Carter is optimistic about how his Arctic apple will be received. "We rarely get e-mails saying we are Satan any more," he says of his company. "Now we have people asking where they can buy the apples."

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Corrections

Corrected:

An earlier version of this story stated that Carter took over his family's orchard.

Comments

Commenting is currently unavailable.

US government approves 'killer' mosquitoes to fight disease

US Environmental Protection Agency will allow release of insects in 20 states and Washington DC.

06 November 2017

Dennis Kunkel Microscopy/SPL

The lab-grown mosquitoes developed by MosquitoMate seek to eliminate the disease-carrying Asian tiger mosquito (*Aedes albopictus*, shown here).

The US Environmental Protection Agency (EPA) has approved the use of a common bacterium to kill wild mosquitoes that transmit viruses such as dengue, yellow fever and Zika, *Nature*'s news team has learned.

On 3 November, the agency told biotechnology start-up MosquitoMate that it could release the bacterium *Wolbachia pipientis* into the environment as a tool against the Asian tiger mosquito (*Aedes albopictus*). Lab-reared mosquitoes will deliver the bacterium to wild mosquito populations.

The decision — which the EPA has not formally announced — allows the company, which is based in Lexington, Kentucky, to release the bacteria-infected mosquitoes in 20 US states and Washington DC.

“It’s a non-chemical way of dealing with mosquitoes, so from that perspective, you’d think it would have a lot of appeal,” says David O’Brochta, an entomologist at the University of Maryland in Rockville.“I’m glad to see it pushed forward, as I think it could be potentially really important.”

MosquitoMate will rear the *Wolbachia*-infected *A. albopictus* mosquitoes in its laboratories, and then sort males from females. Then the laboratory males, which don’t bite, will be released at treatment sites. When these males mate with wild females, which do not carry the same strain of *Wolbachia*, the resulting fertilized eggs don’t hatch because the paternal chromosomes do not form properly.

The company says that over time, as more of the *Wolbachia*-infected males are released and breed with the wild partners, the pest population of *A. albopictus* mosquitoes dwindles. Other insects, including other species of mosquito, are not harmed by the practice, says Stephen Dobson, an entomologist at the University of Kentucky in Lexington and founder of MosquitoMate.

Production challenges

The EPA restricted the release of MosquitoMate’s product, called ZAP males, to 20 states and Washington DC. The agency has previously said that those places “are similar in temperature and precipitation to areas where efficacy of the ZAP males was tested” — Kentucky, New York and California. The EPA decision excludes much of the southeastern United

States, which is home to dense populations of mosquitoes and a long mosquito season, because MosquitoMate did not conduct field trials there.

MosquitoMate plans to begin selling its mosquitoes locally, in Lexington, and will expand from there to nearby cities such as Louisville, Kentucky, and Cincinnati, Ohio. The company will work with homeowners, golf courses, hotels and other customers to deploy its insects, according to Dobson. “Now the work starts,” he says.

The company will have to start small. Suppressing the mosquito population of an entire city is likely to require the weekly production of millions of these mosquitoes. To reach that level, Dobson’s company must find a way to efficiently separate male mosquitoes from females. The company’s technicians now separate them both by hand and mechanically, Dobson says.

Another group that is also developing mosquitoes infected with *Wolbachia* to control wild populations has succeeded in producing large quantities of their insects. Researchers from Sun Yat-sen University in Guangzhou, China, and Michigan State University in East Lansing say they are releasing 5 million *Wolbachia*-infected *A. albopictus* each week in Guangzhou.

The scientists use mechanical sorters to separate males from females, on the basis of size differences at the pupal stage, at more than 99% efficiency, says Zhiyong Xi, a medical entomologist and microbiologist at Michigan State University, who leads the project. They expose the remaining mosquitoes to X-ray radiation at a dose that sterilizes any remaining females, but is too low to affect the males.

Looking ahead

Using lab-grown mosquitoes to kill mosquito pests has been tested extensively in Brazil in recent years. The country has allowed large-scale releases of such mosquitoes in response to an epidemic of the Zika virus that began in 2015. Zika is a mosquito-borne virus that has been linked to severe birth defects, such as abnormally small heads — a condition known as microcephaly. *Aedes aegypti* mosquitoes are thought to be the primary vector

for the virus.

One type of mosquito being tested in Brazil is a genetically modified variety of *A. aegypti* developed by Oxitec in Milton, UK. When the modified male mosquitoes mate with wild females, they pass a lethal gene on to any progeny.

Oxitec has run into challenges when attempting to test its GM mosquitoes in the United States, however. A community in the Florida Keys voted last year against allowing Oxitec to conduct field trials there, although the rest of the county in which the community is located voted in favour of the plans.

By contrast, MosquitoMate has developed and tested a variety of *Wolbachia*-carrying *A. aegypti* mosquitoes in the Florida Keys and Fresno, California, without drawing much public attention. The EPA received only 14 comments during the public-comment period for the Florida trials, and most of them were positive. The company plans to submit an application to the EPA for nationwide release of that species, says Dobson.

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Comments

Commenting is currently unavailable.

Language patterns reveal body's hidden response to stress

Volunteers' use of certain words predicted stress-related changes in gene expression better than their self-reported feelings.

06 November 2017

Carlo Allegri/Getty

Listen in: the words people say may reveal the body's biological response to threat.

Subtleties in the language people use may reveal physiological stress.

Psychologists found that tracking certain words used by volunteers in randomly collected audio clips reflected stress-related changes in their gene expression. The speech patterns predicted those physiological changes more

accurately than speakers' own ratings of their stress levels.

The research, which is published on 6 November in *Proceedings of the National Academy of Sciences*[1] suggests that changes in language may track the biological effects of stress better than how we consciously feel. It's a new approach to studying stress, says David Creswell, a psychologist at Carnegie Mellon University in Pittsburgh, Pennsylvania, and one that "holds tremendous promise" for understanding how psychological adversity affects physical health.

Adverse life circumstances — such as poverty, trauma or social isolation — can have devastating effects on health, increasing the risk of a variety of chronic disorders ranging from heart disease to dementia. Researchers trying to pin down the biological mechanisms involved have found that people who experience these circumstances also undergo broad changes in gene expression in the cells of their immune system. Genes involved in inflammation become more active, for example, and antiviral genes are turned down.

These biological changes seem to represent the body's evolutionary response to threat, says Steve Cole, a genomicist at the University of California, Los Angeles, and a co-author on the paper. But he was always troubled by a "nagging observation": they don't tally well with how stressed people say they are.

Cole wondered whether stress biology is triggered instead by an automatic assessment of threat in the brain, which doesn't necessarily reach conscious awareness. To find out, he and his colleagues teamed up with Matthias Mehl, a psychologist at the University of Arizona, Tucson, who studies how stress affects language.

Stress on speech

The researchers asked 143 adult volunteers in the United States to wear audio recorders, which switched on every few minutes for two days, capturing a total of 22,627 clips. Mehl transcribed any words spoken by the volunteers,

and analysed the language they used.

He was particularly interested in what psychologists call 'function' words, such as pronouns and adjectives. “By themselves they don’t have any meaning, but they clarify what’s going on,” says Mehl. Whereas we consciously choose 'meaning' words such as nouns and verbs, researchers believe that function words “are produced more automatically and they betray a bit more about what’s going on with the speaker”. Mehl and others have found, for example, that people’s use of function words changes when they face a personal crisis or following terrorist attacks.

The researchers compared the language used by each volunteer with the expression in their white blood cells of 50 genes known to be influenced by adversity. They found that the volunteers’ use of function words predicted gene expression significantly better than self-reports of stress, depression and anxiety.

People with more stressed-out gene-expression signatures tended to talk less overall. But they used more adverbs such as 'really' or 'incredibly'. These words may act as “emotional intensifiers”, says Mehl, signifying a higher state of arousal. They were also less likely to use third-person plural pronouns, such as 'they' or 'their'. That makes sense too, he says, because when people are under threat, they may focus less on others and the outside world.

He cautions that more research is needed to test these specific effects, and to assess whether stress influences language, or vice versa. But he suggests that the approach could ultimately help to identify people at risk of developing stress-related disease. Doctors may need to “listen beyond the content” of what patients tell them, he says, “to the way it is expressed”.

Cole suggests that assessing language use could help to test whether interventions aimed at reducing stress really work. Perhaps “you could even ditch self-report stress measures”, he says, and instead listen passively to how trial participants speak.

“Language reflects how people connect with their world, but who would ever have thought that gene expression would be related to language?” says James

Pennebaker, a psychologist at the University of Texas, Austin, who has pioneered research on language and social processes (and has previously worked with Mehl). “It’s such an exciting new way of thinking,” he adds. “I was blown away.”

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Comments

Comments

There are currently no comments.

Nature News

周一, 20 11月 2017

Nature News

[周一, 20 11月 2017]

- **Nature News**

Nature News

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- **Giant telescope’s mobile-phone ‘dead zones’ rile South African residents** [周五, 17 11月 08:00]
  Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.
- **Sex matters in experiments on party drug — in mice** [周五, 17 11月 08:00]
  Ketamine lifts rodents' mood only if administered by male researchers.
- **Arecibo telescope wins reprieve from US government** [周四, 16 11月 08:00]
  National Science Foundation will look for partners to provide extra financial support for Puerto Rico facility.
- **Improved diagnostics fail to halt the rise of tuberculosis** [周四, 16 11月 08:00]
  TB remains a big killer despite the development of a better test for detecting the disease.
- **What countries' constitutions reveal about how societies evolve** [周四, 16 11月 08:00]
  Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.
- **Europe sets priorities for hunting cosmic particles** [周四, 16 11月 08:00]
  Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.
- **Hazy skies cool down Pluto** [周三, 15 11月 08:00]
  Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.
- **African scientists get their own open-access publishing platform** [周三, 15 11月 08:00]
  Venture will launch next year and seeks to strengthen continent’s science by helping academics share work more quickly.
- **Puerto Rico struggles to assess hurricane’s health effects** [周三, 15 11月 08:00]
  While dealing with their own losses, public-health researchers are regrouping to study the

aftermath of Hurricane Maria.

- **Bioethics: Justice in genomics** [周三, 15 11月 08:00]
  Rosario Isasi examines a study on the societal impact of grand sequencing projects.
- **Economics: How science got a golden ticket** [周三, 15 11月 08:00]
  Ehsan Masood hails an account of the mixed implications of governments valuing research as an investment.
- **Computer science: Visionary of virtual reality** [周三, 15 11月 08:00]
  Aldo Faisal explores the immersive journey of technology pioneer Jaron Lanier.
- **China fires up next-generation neutron-science facility** [周二, 14 11月 08:00]
  Beam generator puts country in elite company for doing experiments in materials science and other fields.
- **High-jumping beetle inspires agile robots** [周一, 13 11月 08:00]
  Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.
- **Race for quantum supremacy hits theoretical quagmire** [周一, 13 11月 08:00]
  It’s far from obvious how to tell whether a quantum computer can outperform a classical one, says Philip Ball.
- **Archaeologists say human-evolution study used stolen bone** [周一, 13 11月 08:00]
  Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.
- **Lab mice's ancestral ‘Eve’ gets her genome sequenced** [周一, 13 11月 08:00]
  Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.
- **World’s carbon emissions set to spike by 2% in 2017** [周一, 13 11月 08:00]
  Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.

Giant telescope’s mobile-phone ‘dead zones’ rile South African residents

Sensitive radio dishes of the Square Kilometre Array will affect phone reception — and could harm local economies, say farmers.

17 November 2017

Mujahid Safodien/AFP/Getty

South Africa has already built prototype dishes that will form part of the Square Kilometre Array, which will be the world’s largest radio telescope.

A map showing how mobile-phone use might be restricted because of a giant

radio telescope in South Africa has angered people who will live near the instrument — deepening a rift between the local farming community and those backing the project.

The row has arisen over the South African portion of the Square Kilometre Array (SKA), which will eventually consist of thousands of radio dishes in Africa and up to a million antennas in Australia. The array, which begins construction in 2019 for completion in the 2030s, will have a total signal-collecting area of more than 1 square kilometre, making it the world's largest radio telescope. The telescope's first phase in South Africa involves 194 radio dishes, to be laid out like a galaxy with three arms spiralling out from a core cluster.

Local residents in the Northern Cape province, where the government has acquired nearly 1,400 square kilometres of land for the initial phase, have already expressed concerns about the telescope. Some are angry that the SKA won't boost the region's economy as much as they had expected; others fear the land acquisition will damage local agricultural activity — in particular, sheep farming.

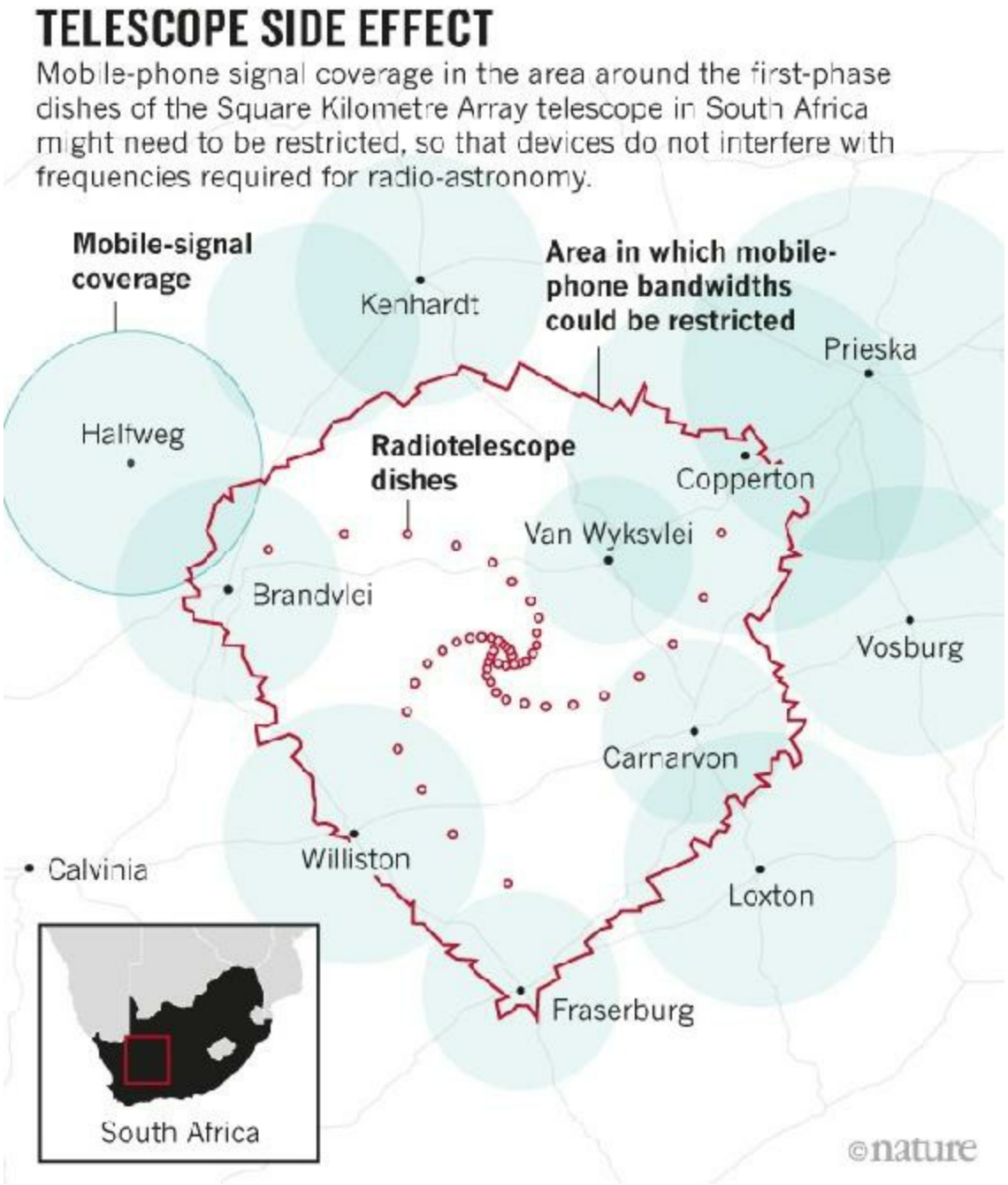
But the map of projected mobile-phone coverage around the project, uploaded to Facebook on 2 November, has brought to light another problem facing the local community. It shows the area around the SKA's radio dishes where the use of electronic devices will eventually be restricted, because their signals would interfere with the relatively weak radio signals that the dishes will try to pick up from the distant Universe.

Communications problem

Nearby residents had been aware that mobile-reception 'dead zones' could be a side effect of the SKA. But Eric Torr, a light-aircraft-business owner who uploaded the map, says it shows the area affected is "larger than we were led to believe". The map suggests that six towns fall into the dead zone, he says, and that this could have serious implications for their farming economies.

The map was produced by the South African Radio Astronomy Observatory

(SARAO), which is leading the SKA project in South Africa. Lorenzo Raynard, head of communications at the SARAO, says it shows areas where mobile-phone coverage could be reduced by 20% or more (see ‘Telescope side effect’). The chart was part of a presentation calling on businesses to submit alternative communications solutions for affected areas, he says.



Adapted from SARAO map

An informal collection of farming organizations has already been working with the observatory to find alternative communications technologies, such as satellite phones, that can be used around the antennas, according to Henning Myburgh, a farmer in the area. “Adequate electronic communications, especially for children, are a basic human right,” he says. Myburgh says that the cooperative’s search has now moved to finding cell-phone technologies that can co-exist with the SKA and replicate the phone facilities the farmers currently have. “This is a major shift and if possible will be a huge step forward,” he says.

Still, says Myburgh, there are farmers who are unhappy. “I don't think that anybody will ever be happy with the situation, taking into account the massively intrusive nature of the project in the region,” he says.

Nicol Jacobs, who farms in the spiral arms, says the SKA was originally going to affect only two farms. He says he found out about the full extent of the telescope when the government began buying more farms. “We’re going to be eaten piece by piece,” he says. Jacobs says he would like the government to return the bought farms to the agricultural community: “I will fight as long as I can,” he adds.

Despite residents’ annoyance, South African law says that the country’s science and technology minister can preserve the area of the SKA’s land for astronomy. The department of science and technology, which oversees astronomy in the country, is responsible for finalizing regulations about areas that will lose mobile-phone coverage, and to define radio-wave frequencies that will be protected for astronomy. Asked when they would be finalized, the department’s astronomy-management authority declined to give a firm date.

Environmental assessment

Although resident’s complaints may not affect the SKA’s layout, an environmental assessment — due to be finalized next year — could change matters.

Earlier this month, the SARAO tasked the South African Environmental Observation Network to implement an environmental assessment of the telescope site, and made 3 million rand (US$209,000) available for the work.

“The relative position of the dishes determines the quality of the telescope beam,” says Robert Braun, science director at SKA Organisation, which is designing the telescope.

The organization has drawn up an ideal map of dish positions, says Braun. But it might have to shift them if the environmental assessment finds that local habitats or biomes are affected, says Casper Crous, an ecologist who is part of the assessment collaboration.

The overarching plan is to turn South Africa’s SKA site into a nature reserve and a site for long-term environmental research once the telescope is operational, says Crous. So a no-go zone for dishes, for example, “would be kokerboom [quiver tree] populations or ephemeral wetlands — areas that if impacted are unlikely to ever recover,” he says.

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Comments

Comments

There are currently no comments.

Sex matters in experiments on party drug — in mice

Ketamine lifts rodents' mood only if administered by male researchers.

17 November 2017

unoL/Getty

When it comes to lab mice and antidepressants, it's complicated.

Mouse experiments with the popular club drug ketamine may be skewed by the sex of the researcher performing them, a study suggests.

The findings, presented on 14 November at the Society for Neuroscience (SfN) meeting in Washington DC, only deepen the mystery of how ketamine,

which has powerful mood-lifting properties, interacts with the brain. They also raise questions about the reproducibility of behavioural experiments in mice.

Ketamine is best known as a psychoactive recreational drug. But it has caught psychiatrists' interest because of its potential to treat depression within hours. It's unclear exactly how the drug works, however, and many researchers are using animal models to suss out the mechanism.

Polymnia Georgiou, a neuroscientist at the University of Maryland in Baltimore, is one of them. In 2015, a male colleague asked her to run some experiments for him while he was out of town, including a standard way of testing antidepressants called the forced-swim test. In this assay, researchers inject healthy mice with a drug, place them into a tank of water and measure how long they swim before they give up and wait for someone to rescue them.

Antidepressants can cause healthy mice to swim for longer than their untreated counterparts, which is what Georgiou's male colleague found during his experiments using ketamine.

Scents and the brain

But although Georgiou followed his protocol exactly, she found that treated mice did not swim for any longer than mice injected with a placebo. When she and three female and four male researchers investigated this disconnect by performing the experiments, they discovered that the ketamine acted as an antidepressant only when it was administered by men.

Suspecting that scent was involved, the researchers put the animals inside a fume hood so that the mice couldn't smell who was injecting them. This completely eliminated the effect of the ketamine, regardless of the experimenter's sex. When Georgiou and her colleagues placed a t-shirt worn by a man next to the mice in the fume hood, mice injected with ketamine swam for longer than those injected with a placebo. This suggested that male odour was necessary for the drug to work.

The head of Georgiou's lab, neuroscientist Todd Gould, learned that antidepressant researcher Ronald Duman at Yale University in New Haven, Connecticut, was seeing similar effects with female researchers in his lab that were working on ketamine experiments. So Gould asked Duman to repeat Georgiou's swim-test experiment in his own lab. When eight male and eight female researchers injected mice with ketamine, they saw the same results: mice injected by women did not respond to the drug.

Georgiou and her colleagues repeated the experiments with other antidepressants, but the researchers' sex didn't seem to matter. She and Gould suspect that the antidepressant effect is the result of a specific interaction between ketamine and the male odour in the mouse brain .

But other evidence suggests that the sex of the researcher can affect other types of behavioural experiment, not just those involving ketamine. A 2014 paper[1] in *Nature Methods* found that mice were more stressed and less likely to respond to pain when handled by a male researcher. And behavioural neuroscientist Silvana Chiavegatto of the University of São Paulo in Brazil, who was at Georgiou's SfN presentation, says that she has seen the same phenomenon in her lab, where she studies depression but doesn't use ketamine.

Rethinking the model

"I think it's really fascinating, with wide implications for our field," says Adrienne Betz, a behavioural neuroscientist at Quinnipiac University in Hamden, Connecticut. But she cautions that the results are preliminary, and it remains to be seen whether the effect is specific to ketamine and to mice.

Others disagree about the potential implications. Hundreds of papers with female experimenters demonstrate the effects of antidepressants — including ketamine — in mice, says Lisa Monteggia, a neuroscientist at the University of Texas Southwestern in Dallas. Other factors, such as whether the researcher is stressed when he or she injects the mice, might affect the animals' behaviour, she says.

Gould and Georgiou say that their results don’t necessarily invalidate previous studies; they simply show that ketamine experiments in their lab work only when men inject the mice. There is overwhelming evidence that ketamine is a powerful antidepressant in humans. Gould doubts that the sex of the person administering the drug affects how well it works in a depressed patient, but it's never been tested.

He adds that the findings suggest that researchers studying drugs' effects on mouse behaviour should report the sex of the experimenter in their publications to ensure that other labs can replicate the results. “There are a number of factors that influence replicability and are unrecognized — this is one of them,” Gould says. “For us, it is an inconvenient truth.”

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Comments

Comments

There are currently no comments.

Arecibo telescope wins reprieve from US government

National Science Foundation will look for partners to provide extra financial support for Puerto Rico facility.

16 November 2017 Updated:

1. 17 November 2017

Xavier Garcia/Bloomberg/Getty

The massive dish of the Arecibo radio telescope measures 305 metres across.

Nearly two months after Hurricane Maria devastated Puerto Rico, the people

who operate one of the world's pre-eminent radio telescopes — at the Arecibo Observatory, on the northwestern part of the island — are still without reliable water, electricity and phone service at their homes. But their jobs seem to be safe.

The US National Science Foundation (NSF), which funds about two-thirds of the observatory's annual US$12-million budget, has decided to continue operating it in collaboration with as-yet-to-be-decided partners. Over the next 5 years, the agency will reduce its annual contribution from $8.2 million to $2 million, with the rest coming from the unspecified partner institutions.

"This is very good news for the Arecibo Observatory and a huge win for the scientific community in general," says Francisco Córdova, the observatory's director. "There is definitely a sense of relief in the air."

The decision comes as part of the NSF's years-long effort to offload several of its astronomical research facilities to free up millions of dollars each year for future projects, such as the Large Synoptic Survey Telescope that is under construction in Chile.

"We have worked very hard to help bring Arecibo to a state where we still have cutting-edge research there, but with NSF not having to make the same investment that we've made historically," says James Ulvestad, acting assistant director for the agency's mathematical- and physical-sciences directorate.

The current management contract at the observatory will expire on 31 March 2018. Earlier this year, the NSF asked potential partners to come forward with ideas and funding offers to keep science operations going. Now, having made its commitment to continue funding the observatory official, the NSF can move forward with negotiating a collaboration agreement and revealing who its partners will be.

"I'm so happy they made the right decision," says Edgard Rivera-Valentín, a planetary scientist who works jointly at the observatory and the Lunar and Planetary Institute in Houston, Texas. "I'm so happy the observatory stays alive."

Slow recovery

The agency's decision is a welcome reprieve for the roughly 120 Arecibo staff who have suffered and rallied in Maria's wake. Hurricane-force winds blasted Puerto Rico on 20 September, downing power lines and damaging buildings across the island. Torrential rains washed out roads and knocked out water supplies.

At the observatory, which is nestled into the limestone mountains above the city of Arecibo, some of the staff sheltered in place during the worst of Maria. The observatory's concrete bunkers, built by the US government in 1963, weathered the storm with little problem. Still, Maria's winds tore down the 29-metre-long 'line feed' antenna that stretched across the observatory's 305-metre-wide dish, puncturing its aluminium skin in places.

Staff went to work helping to clear roads around the region, and government officials used the observatory's helipad as a distribution point for supplies. The facility's deep well supplied hundreds of local residents who had no other source of clean drinking water.

Within weeks, the Arecibo dish was cleaned up and back to doing science. On 29 September, it resumed taking observations, in a low-power mode that lets the sky drift across the field of view; on 7 November, it resumed pointing the dish at specific areas of the sky. The telescope has already observed a fast radio burst, one of a new class of astronomical phenomena that Arecibo is well suited to study with its enormous dish. Last week, the observing schedule expanded to include work at additional radio frequencies, Córdova says.

But telescope operations are still running off generators, and diesel is a precious commodity on the island, says Nicholas White, senior vice-president for science at the Universities Space Research Association in Columbia, Maryland, which helps to manage the observatory. "That's the biggest constraint — just getting back on the grid," he says.

Without a reliable power supply, the observatory cannot restart its planetary radar, which tracks and characterizes near-Earth asteroids. NASA supplies

$3.7 million — about one-third of Arecibo's budget — for this work.

The NSF estimates that it will take between $4 million and $8 million to fix the hurricane damage at the observatory, Ulvestad says. The agency "intends to repair Arecibo to its pre-hurricane condition", he says.

A long history

The NSF decision makes Arecibo the first of the agency's astronomical facilities to have completed a full environmental-impact review of its operations, with an eye towards divestment. The agency is working through a similar process to potentially divorce itself from the Green Bank Observatory in West Virginia, home to the world's premiere single-dish radio telescope, and several other observatories.

Arecibo occupies a unique place in the history of radio astronomy. On 16 November 1974, it beamed the most powerful intentional message ever sent in the hope of contacting extraterrestrial life. In the same year, it was used in the discovery of the first known binary pulsar, whose change in orbital period provided the first indirect evidence for gravitational waves — the ripples in space-time predicted by Albert Einstein.

"People have been telling us for five years: 'You guys are just out to close Arecibo,'" says Ulvestad. "This is a demonstration that that was not what we were ever out to do."

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Updates

Updated:

Added comments from Francisco Córdova.

Comments

Comments

There are currently no comments.

Improved diagnostics fail to halt the rise of tuberculosis

TB remains a big killer despite the development of a better test for detecting the disease.

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1. 17 November 2017

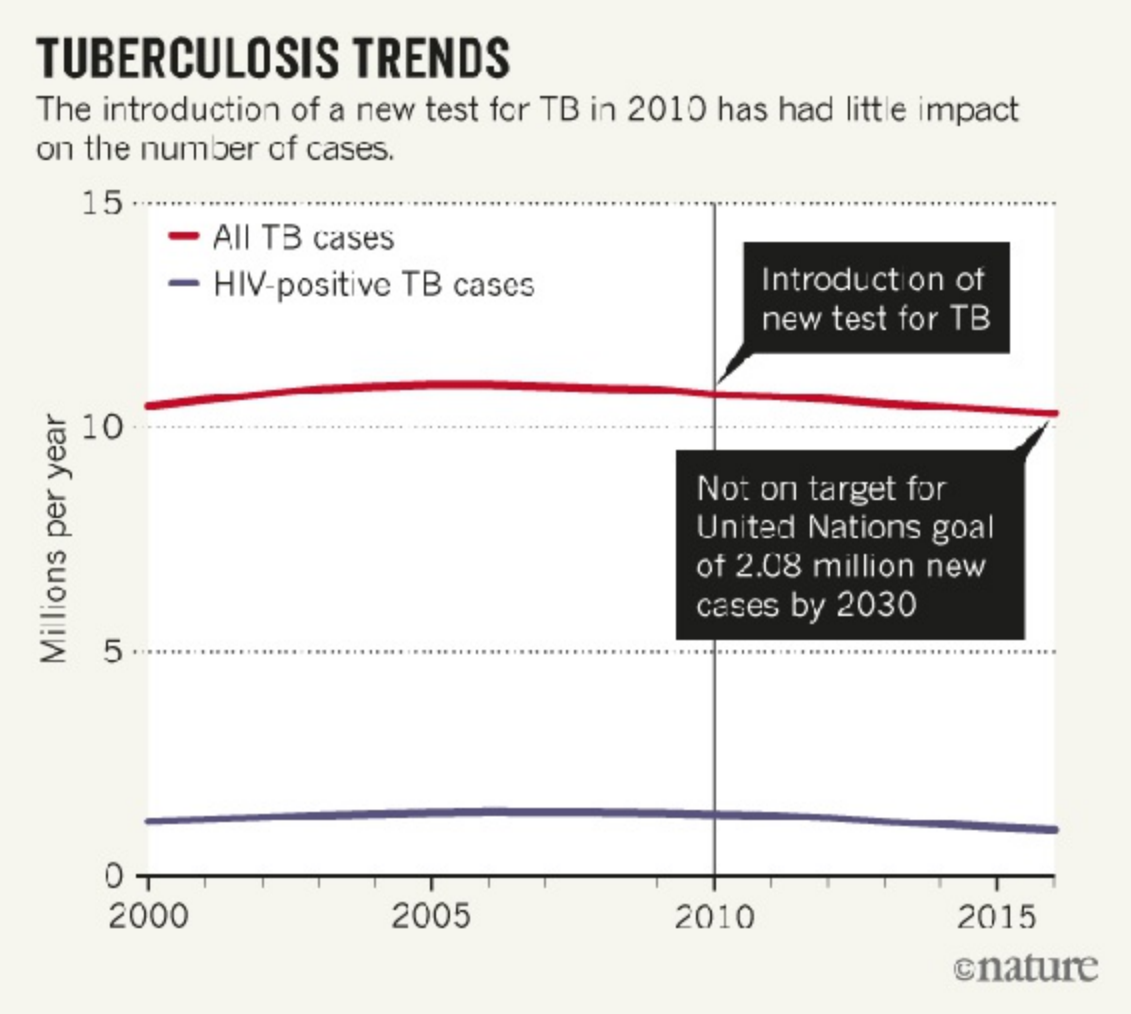
Beawiharta/Reuters

Newly diagnosed tuberculosis patients are treated at a clinic in Jakarta, Indonesia.

Seven years ago, the global community of researchers, health-care workers and activists battling tuberculosis was euphoric. A landmark 2010 trial showed that a new genetic test was highly effective at diagnosing TB, prompting hopes that countries could soon finally control the disease, which killed 1.45 million that year. The World Health Organization (WHO), promptly endorsed the test, called GeneXpert, and promoted its roll-out around the globe to replace a microscope-based test that missed half of all cases.

But the high hopes have since crashed as rates of tuberculosis rates have not fallen dramatically, and nations are now looking to address the problems that cause so many TB cases to be missed and the difficulties in treating those who are diagnosed. In an attempt to turn the tide, health ministers and officials from 100 countries are meeting in Moscow on 16–17 November. And a United Nations General Assembly devoted to TB is scheduled for September 2018. Experts say that the rollout of GeneXpert offers a cautionary lesson — although, in hindsight, an obvious one — in the battle against TB. The tale is a familiar one in global health care: a solution that seems extraordinarily promising in the lab or clinical trials falters when deployed in the struggling health-care systems of developing and middle-income countries.

“What GeneXpert has taught us in TB is that inserting one new tool into a system that isn’t working overall is not going to by itself be a game changer. We need more investment in health systems,” says Erica Lessem, deputy executive director at the Treatment Action Group, an activist organization in New York City.



Source: WHO

No game changer

Some 10.4 million people were infected with TB last year, according to a WHO report published on 30 October. More than half of the cases occurred in China, India, Indonesia, Pakistan and the Philippines. The infection, which causes coughing, weight loss and chest pain, often goes undiagnosed for months or years, spurring transmission. The US government and others spent more than US$100 million developing GeneXpert. Yet despite the WHO's ringing 2010 endorsement of the test, the roll-out of GeneXpert, which is manufactured by Cepheid, a company based in Sunnyvale, California (and

bought by Danaher, headquartered in Washington DC, earlier this year), was initially slow.

The machines cost $17,000 each and require constant electricity and air-conditioning — infrastructure that is not widely available in the TB clinics of countries with a high incidence of the disease, requiring the machines to be placed in central facilities. Until the US government together with the Bill & Melinda Gates Foundation and UNITAID, an international organization that aims to lower drug prices, began subsidizing tests in 2012, each cost $16.86 (the price fell to $9.98), compared with a few dollars for a microscope TB test.

Weak health systems

The WHO says that more than 23 million GeneXpert tests have now been purchased in the public sector in 130 countries that are eligible for the discount. But Madhukar Pai, an epidemiologist at McGill University in Montreal, Canada, says that this still represents a relatively small proportion of people suspected of having TB. Most countries use the tests on selected group of people, Pai says. India, for example, offers the test only to people co-infected with HIV.

Even countries that fully embraced GeneXpert are not seeing the returns they had hoped for. After a countrywide roll-out begun in 2011, the test is available for all suspected TB cases in South Africa. But a randomized clinical trial conducted in 2015 during the roll-out found that people diagnosed using GeneXpert were just as likely to die from TB as those diagnosed at labs still using the microscope test[1]. “Just intuitively one would think that finding TB cases earlier would avert TB deaths. The fact that we didn’t find that was surprising,” says Gavin Churchyard, a physician specializing in TB at the Aurum Institute in Johannesburg, South Africa, who led the study. Similar studies in other countries have come to much the same conclusion about GeneXpert.

Churchyard suspects that doctors have been giving people with TB-like symptoms drugs, even if their microscope test was negative or missing, and

that this helps to explain why his team found no benefit from implementing the GeneXpert test. Others have speculated that, by being involved in a clinical trial, patients in both arms of the trial received better care than they would otherwise have done, obfuscating any differences between the groups.

Either way, Churchyard says, his team's study illustrates how broken South Africa's TB treatment system is, a problem echoed across other countries with high incidences of TB. Even with accurate tests, cases are still being missed. Results from the GeneXpert tests take just as long to deliver as microscope tests, and many people never return to the clinic to get their results and drugs; those who begin antibiotics often do not complete the regimen. "What the study really unmasked was that it's not enough to have new technology and introduce it into a weak health system," Churchyard says.

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Corrections

Corrected:

An earlier version of this story have the wrong citation for the 2015 trial.

Comments

Comments

There are currently no comments.

What countries' constitutions reveal about how societies evolve

Analyses of governing documents from 194 countries could help people fighting for human and environmental rights.

16 November 2017

Bettmann/Getty

The right to form unions usually came before child labour protections in a country's constitution.

Timing can be everything when it comes to successfully expanding constitutional rights. Now, a study[1] looking at how constitutions around the world have evolved has revealed patterns that could help people predict the best moment to introduce such changes.

Amendments are generally introduced into a country's constitution in a certain sequence, the authors report in a paper on the preprint server arXiv, and now under review at a journal. In addition, their computer analyses corroborate previously proposed ideas that the addition of some provisions is heavily influenced by the zeitgeist — the dominant social mores of the time — whereas the adoption of others reflects a country's colonial history.

The study validates computational techniques that could be applied to pressing questions about how constitutions reflect and affect societies, says Mila Versteeg, a legal scholar at the University of Virginia in Charlottesville. "These methods might be able to move the ball if applied to the right questions," she says.

Organizations and advocates could use the results to push for policies in a more strategic way, say the paper's authors. "This can be seen as a road map to help get you to where you want to be," says lead researcher Alex Rutherford, a data scientist who was working at the United Nations children's agency UNICEF in New York City when the study was conducted.

The ties that bind

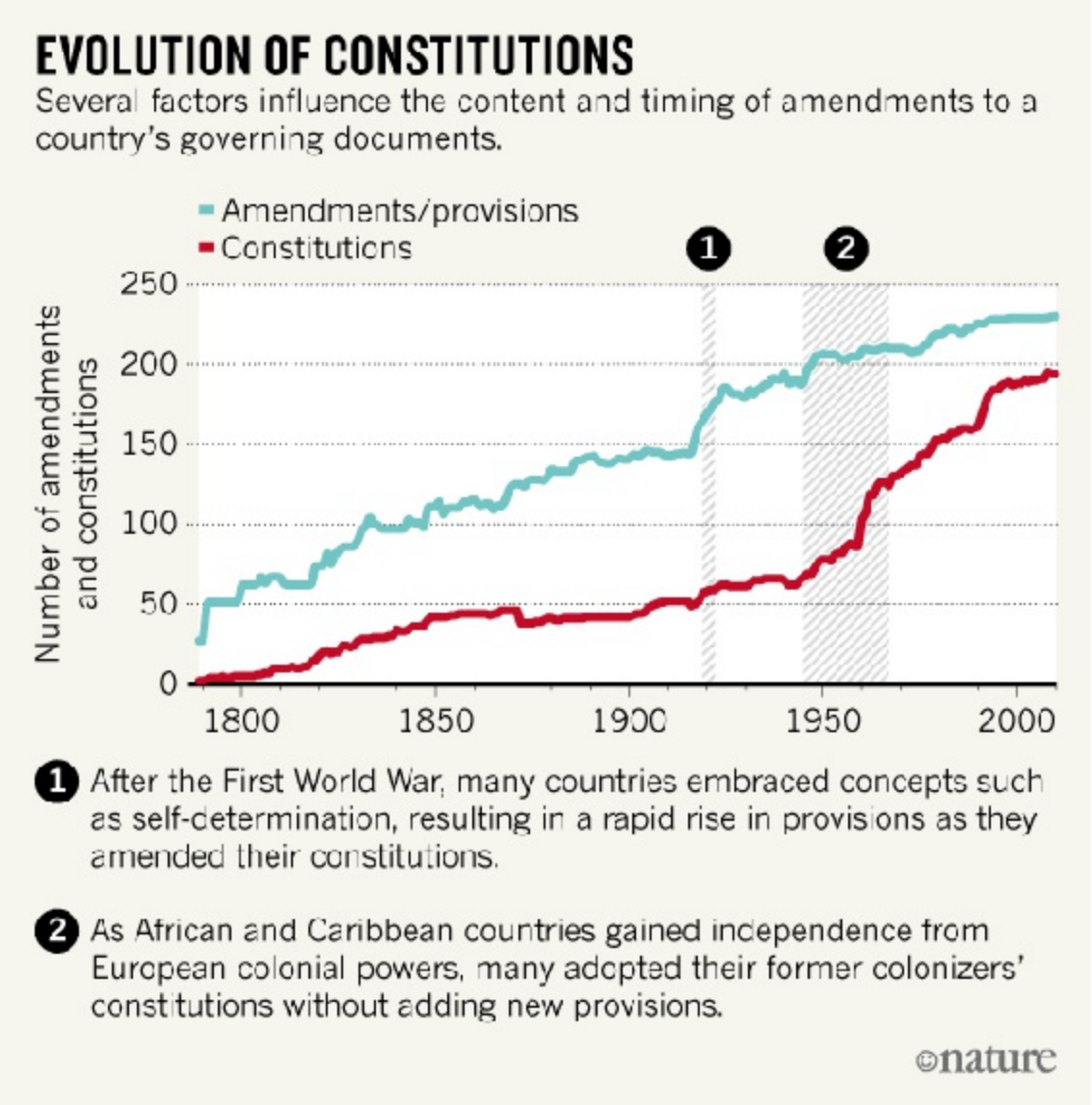
Rutherford and his colleagues used two kinds of computer analyses to look for patterns in provisions from the constitutions of 194 countries. In one, using hand-coded text, they found that the number of provisions increased over time (see 'Evolution of constitutions'). Moreover, the team found that provisions generally appeared in a particular order. Making education compulsory, for example, was usually preceded by the establishment of a right to a free education.

Some of the sequences were less straightforward: the right to form trade unions preceded laws against child labour, for example. This progression

probably reflects the identities of the people who have traditionally scripted constitutions, says Rutherford. Adult men, for instance, seem to have considered their own protections before thinking about others, including those who were unable to push for their own rights, he says. “I think we should protect the most vulnerable first, but this paper says this is not how laws have progressed historically.”

The team then performed a network analysis to identify words that the constitutions had in common and to detect how they grouped together. In some cases, with fundamental provisions such as freedom of religion, clusters included countries that had the same former colonizers.

Meanwhile, amendments such as those prohibiting torture or protecting the environment tended to emerge at specific points in time, regardless of a country’s colonial history. “If you draft a constitution now, you’d be more likely to include a clause on the environment than you would 20 years ago, since we didn’t know much about what was going on back then,” says Rutherford.



Source: REF. 1

Seeds of the future

Constitutional specialists say the team's timeline of provisions seems to be new. "It makes intuitive sense, but I don't think anyone had tried to show it empirically," says David Law, a political scientist at Washington University in St Louis, Missouri. The indexed data that Rutherford and his colleagues used came from the Comparative Constitutions Project, a US-based non-

profit organization partnered with Google. The project hand-codes constitutional texts by turning the words into zeroes and ones.

The credibility of the network approach is boosted by the fact that the analysis of constitutional language came to similar conclusions as previous, less-automated studies. Versteeg suggests that network analysis might next be applied to questions such as what sorts of rights are not well enforced, and whether constitutions can yield subtle clues signalling that a democracy is in decline.

To get at the latter query, Versteeg suggests analysing constitutional texts from democratic countries that have altered their constitutions and become increasingly authoritarian — such as Hungary and Turkey — to find language that gives a ruler more power. Next, researchers could search for these signatures in other countries, such as the United States. “Could we tell when added rights are actually red flags bearing the signs of authoritarianism?” Versteeg asks.

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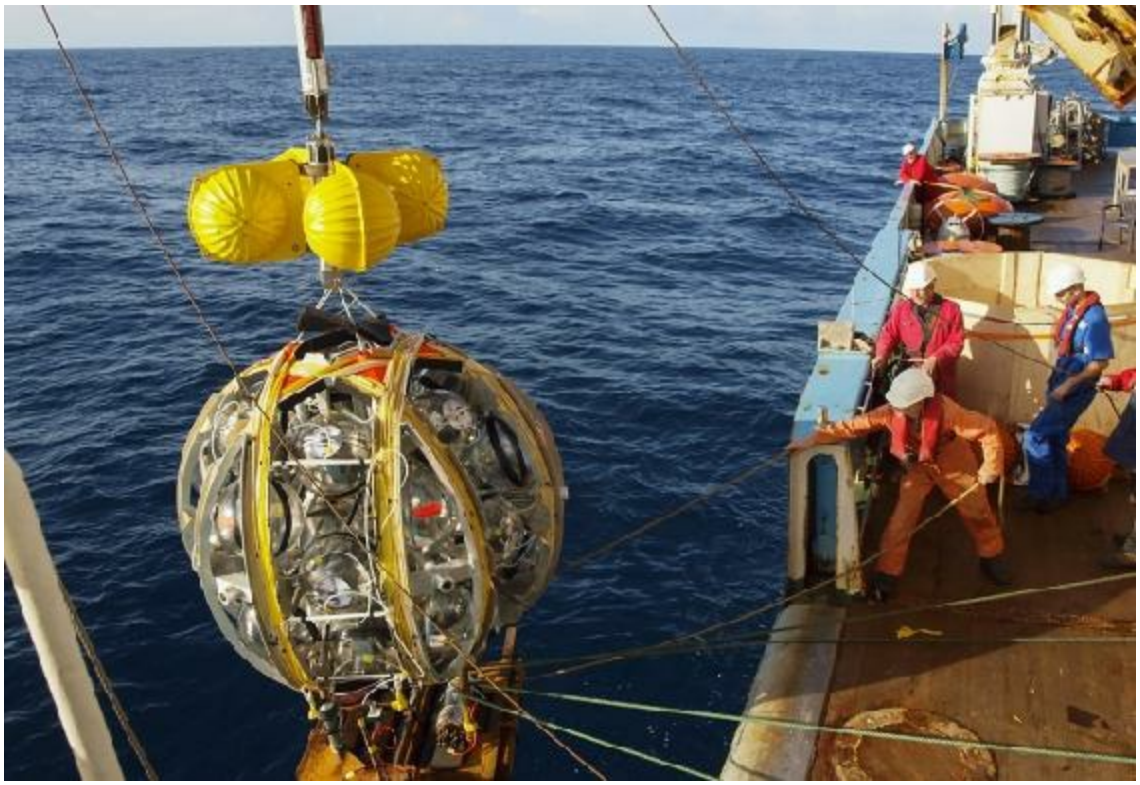
Comments

Commenting is currently unavailable.

Europe sets priorities for hunting cosmic particles

Club of physics funding agencies pushes for projects including a neutrino observatory in the Mediterranean Sea.

16 November 2017



KM3NeT

The KM3NeT neutrino telescope is deploying arrays of light sensors deep in the Mediterranean Sea.

Neutrinos, dark matter and γ-rays top European physicists' wish list for the next decade of efforts to catch high-energy particles from space. The

priorities are laid out in a roadmap for 2017–26, posted online last month by a group of funding agencies from fourteen European countries, ahead of being officially unveiled in January.

Twenty years ago, the field of astroparticle physics barely existed. But some of the major discoveries in particle physics — including neutrino research that earned Nobel prizes in 2002 and 2015 — are now coming from space-focused detectors, rather than through the more conventional venue of atom smashers. It's a field that ties together the largest and smallest scales of physics, says Antonio Masiero, a physicist at the University of Padua, Italy, from the expansion of the Universe to exotic types of nuclear decay: “The beauty of astroparticle physics is that it has no borders.”

The roadmap is the second such exercise by the Astroparticle Physics European Consortium (APPEC), which aims to coordinate funding plans for this fast-growing field. (CERN — Europe’s physics lab near Geneva, Switzerland — the European Southern Observatory and the European Space Agency do this for the continent’s particle-physics, astronomy and space-based facilities, respectively.) APPEC requested input from across the community, and held an open ‘town meeting’ in Paris in April 2016 before a panel of experts, chaired by Masiero, compiled the final document.

Infrastructure ideals

The resulting strategy covers huge observatories all the way down to tabletop experiments. At smaller scales, it urges funding agencies to be open to innovative proposals. But when it comes to the largest facilities, the strategy is to be “resource aware”, says Masiero: focusing on only a few projects and requiring only a modest increase over current funding levels. It’s not a “Santa Claus list”, agrees Frank Linde, a particle physicist at the Dutch National Institute for Subatomic Physics in Amsterdam and former APPEC chair.

Among the big projects endorsed by APPEC is the Cubic Kilometre Neutrino Telescope (KM3NeT), a double array of deep-sea light sensors being built by a primarily Dutch, French and Italian collaboration. One site, off the coast of Toulon, France, is designed to detect relatively low-energy neutrinos

produced by cosmic rays hitting the atmosphere, whereas the other, off the southern tip of Sicily, Italy, will aim to catch the signature of the highest-energy neutrinos coming from outer space, after they have travelled through Earth. Researchers hope to figure out where these particles come from.

So far, KM3NeT has received one third of the approximately €150 million (US$177 million) in funding it would need for building the full-size detector, says spokesperson Mauro Taiuti, a physicist at the University of Genoa, Italy. The APPEC stamp of approval could help it to win the rest.

Another major piece of infrastructure that garnered support was the Cherenkov Array Telescope, a €300-million γ-ray observatory to be split between Spain's La Palma Island and Paranal, in Chile's Atacama Desert. The two arrays of optical telescopes will seek flashes of blue light produced in the atmosphere when a high-energy photon collides with a molecule of air, creating a cascade of secondary particles across the sky.

In the nascent field of gravitational-wave astronomy, which APPEC also covers, the big priority is the Einstein Telescope (ET), a next-generation triple interferometer that will have light beams running along three 10-kilometre arms in an equilateral triangle, instead of the two perpendicular arms that current detectors use. Like the Japanese interferometer KAGRA — now under construction — the proposed ET would be built underground, to protect it from vibrations ranging from footsteps to falling leaves, says B. S. Sathyaprakash, a physicist at Pennsylvania State University in University Park, who helped to design it.

Dark-matter dash

APPEC also wants Europe to double-down on existing efforts to spot dark matter, calling for a dramatic scale-up of experiments that use tanks of liquid argon and xenon, to look for traces of collisions between these mysterious particles and atoms of ordinary matter. The largest such detectors now contain more than three tonnes of the noble gases, but according to the roadmap they need to be ten times larger.

These searches bet on the theory that dark matter is composed of weakly interacting massive particles, or WIMPs. Some physicists have called for more investment in ‘alternative’ searches for dark matter, for example, looking for particles known as axions. The road map is a “vanilla document, clearly redacted not to ruffle any feathers”, says Juan Collar, a physicist at the University of Chicago in Illinois. “If European programme managers follow this roadmap to the letter, they will turn the dark-matter field into a desert of ideas.”

But Mario Livio, an astrophysicist at the University of Nevada in Las Vegas who has also called for broadening the search for dark matter, counters that concentrating efforts on WIMPs will allow Europe “to build on existing experience and facilities”. Overall, the roadmap is “very reasonable”, he adds. “The programme, if executed as envisioned, will address some of the most exciting questions in astroparticle physics.”

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Comments

1 comment

1. *Pentcho Valev* • 2017-11-16 09:24 PM
   It seems dark matter is the unfortunate result of theoretical impotence: Cosmologists are unable to calculate the rotational curve for a system ESSENTIALLY different from our solar system, e.g. a spiral galaxy, take the solar-system rotational curve as a paradigm and fill the gap between theory and observation with dark matter. Similarly, cosmologists don't know how to model the local interaction between expansion and gravitational attraction (any such model would produce results incompatible with observations) and implicitly obey the following idiotic slogan: Wherever there is gravitational attraction, forget about expansion! Sabine Hossenfelder: "The solution of general relativity that

describes the expanding universe is a solution on average; it is good only on very large distances. But the solutions that describe galaxies are different - and just don't expand. It's not that galaxies expand unnoticeably, they just don't. The full solution, then, is both stitched together: Expanding space between non-expanding galaxies."
https://www.forbes.com/sites/startswithabang/2017/07/28/most-things-dont-actually-expand-in-an-expanding-universe/ Pentcho Valev

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Hazy skies cool down Pluto

Complex chemistry in the dwarf planet’s upper atmosphere may explain one of its biggest mysteries.

15 November 2017

NASA/JHU-APL/SwRI

The temperature of Pluto's atmosphere is only about 70 degrees Celsius above absolute zero.

Pluto’s atmosphere is even more bone-chillingly cold than one might expect 5 billion kilometres from the Sun. New research suggests that’s because of the smog that envelops the dwarf planet.

“Haze is responsible for all the atmospheric cooling,” says Xi Zhang, a planetary scientist at the University of California in Santa Cruz. He and his colleagues describe the findings in the 16 November issue of *Nature*[1].

When NASA's New Horizons spacecraft flew past Pluto in July 2015, it discovered that the atmosphere was about -203 ºC, just 70 degrees above absolute zero[2]. That's around 30 degrees colder than predicted — and a big mystery to planetary scientists.

Figuring out how Pluto's atmosphere works is crucial for understanding atmospheres on other large icy worlds in the Solar System and beyond. "Until we know the reason for the cold temperatures, we can't extrapolate to other seasons on Pluto, much less other bodies," says Leslie Young, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, who was not involved in the study.

Smog blanket

Pluto's atmosphere is made mostly of nitrogen, with smaller amounts of compounds such as methane. High in the atmosphere — between 500 and 1,000 kilometres above the surface — sunlight triggers chemical reactions that transform some of these gases into solid hydrocarbon particles.

The particles then drift downward and, at around 350 kilometres above Pluto's surface, clump with others to form long chemical chains. By the time they reach 200 kilometres' altitude, the particles have transformed into thick layers of haze, which the New Horizons spacecraft saw dramatically blanketing Pluto.

Zhang and his colleagues compared the heating and cooling effects of the atmosphere's gas molecules to those of its haze particles. Earlier studies have suggested that the presence of gas molecules, such as hydrogen cyanide, could help explain why Pluto's atmosphere is so cold[3]. But Zhang's team found that including haze was the only way to get their model to match the temperatures that New Horizons measured as it flew by the dwarf planet.

"The fundamental difference is the size," Zhang says. Molecules are typically less than a nanometre across, whereas the haze particles are several hundred nanometres across. That means that the gas and the haze behave very differently in the way they absorb and re-radiate energy from the Sun. Haze

turns out to both heat up and cool down more efficiently than gas, Zhang says.

“It is a neat idea,” says Sarah Hörst, a planetary scientist at Johns Hopkins University in Baltimore, Maryland.

Scientists probably hadn't thought about haze as the cooling culprit before because the haze layers do not block light, says Tanguy Bertrand, a planetary scientist at the Laboratory for Dynamic Meteorology in Paris who has studied Pluto's atmosphere with his colleague François Forget[4]. “I find this study very convincing,” Bertrand says.

Competing ideas

But other researchers have proposed different ideas about why Pluto’s atmosphere is so cold. Roger Yelle, a planetary scientist at the University of Arizona in Tucson, reported one such approach at a conference in Latvia in September. His team’s model suggests that a combination of hydrogen cyanide, acetylene and ethane gas can cool things down. All three gases are known to exist in Pluto’s atmosphere.

Zhang’s team and Yelle’s team have yet to reconcile their contradictory conclusions. But after it launches in 2019, NASA’s James Webb Space Telescope could test Zhang's proposal. If the haze particles are indeed the main factor cooling Pluto’s atmosphere, they would make the dwarf planet appear relatively bright in mid-infrared wavelengths. Zhang hopes to observe Pluto with the Webb telescope to see if his team is right.

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doi:10.1038/nature.2017.22996

Comments

Comments

There are currently no comments.

African scientists get their own open-access publishing platform

Venture will launch next year and seeks to strengthen continent's science by helping academics share work more quickly.

15 November 2017

Africa's academy of science has announced that it will launch an open-access publishing platform early next year — the first of its kind aimed exclusively at scientists on the continent.

The platform, called *AAS Open Research* and announced by the African Academy of Sciences (AAS) in Nairobi on 15 November, is being created with the London-based open-access publisher F1000, adopting the model of its *F1000Research* publishing platform. *AAS Open Research* will publish articles, research protocols, data sets and code, usually within days of submission and before peer review. F1000 staff will arrange post-publication peer review: the reviews and the names of their authors will be published alongside the papers. The papers will be indexed in abstract databases such as PubMed only after they pass review.

The AAS says that the platform will be especially useful for young African academics, who can face difficulties publishing in overseas journals. Some studies suggest[1] that research from low-income countries is perceived differently from that done in high-income ones, for instance. The portal will cut the time and effort scientists have to put into finding homes for their work, and will make the review process more transparent, the academy says.

Although there are already open-access publishers that focus on Africa, such as AOSIS Publishing, based in South Africa, *AAS Open Research* will be the first to adopt open peer review.

The new platform does carry a caveat, however: it will initially take submissions only from AAS fellows and affiliates (who together number around 400), as well as researchers funded through programmes managed by the Alliance for Accelerating Excellence in Africa. The Nairobi-based body manages grants for African research programmes that come from international funders, mostly targeting health research but also areas such as climate change.

Limiting eligibility to the platform is critical to ensure that submissions are of high quality, says AAS executive director Nelson Torto. Researchers who meet the initial criteria have already been vetted and selected through a rigorous grant-review process, he says. In future, to open up the platform to more researchers, the academy wants to partner with other African research funders whose selection processes are similarly rigorous, Torto adds.

Following a trend

The African venture follows a series of open publishing portals launched with F1000 in the past 18 months, including those set up by the Wellcome Trust in London and the Bill & Melinda Gates Foundation in Seattle, Washington — both large charities that fund scientific research. Research centres including the UCL Great Ormond Street Institute of Child Health and the Montreal Neurological Institute and Hospital in Canada have also teamed up with the firm; the European Commission is considering creating its own open publishing platform for outputs from its main Horizon 2020 research programme.

The AAS will not itself be covering the costs of publishing on the platform. Rather, the academy says, African researchers' grant funders will pay publishing fees directly to F1000: £120–800 (US$160–1,100) per article, depending on length.

Some scientists have raised concerns that publishing on open-research platforms might stop African academics from getting the recognition needed for career advancement that they receive for publishing in conventional journals. In South Africa, for instance, academics are rewarded for publishing

in a list of titles maintained by the country's higher-education department.

"For open publishing to be successful, it will need to be accompanied by changes in the criteria for academic recognition and promotion within African institutions of higher learning," says Salim Abdool Karim, an HIV researcher and AAS fellow in Durban, South Africa.

The risk of publishing on little-known platforms is a concern, agrees Gordon Awandare, a biochemist at the University of Ghana in Accra who will be eligible to publish on *AAS Open Research*. However, the AAS platform will help to chip away at the grip of the big journals, says Awandare, which will be good for African science. "Our approach has always been to spread our research across several platforms, so we will continue to do that."

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Nature
DOI:
doi:10.1038/nature.2017.23018

Comments

1 comment

1. *PROF CHUKWUEMEKA CH AGBAKWURU* • 2017-11-16 06:15 PM
   The African Scientists Open-Access Publishing Platform is a very welcomed innovation to give African Researcher (International & National) the much needed opportunity of making worthwhile intellectual contributions to African and World Development through publishing of their research studies.
   www.mastercomputeragency.net

Puerto Rico struggles to assess hurricane’s health effects

While dealing with their own losses, public-health researchers are regrouping to study the aftermath of Hurricane Maria.

15 November 2017

Mario Tama/Getty

Hurricane Maria, which hit Puerto Rico in mid-September, disrupted water supplies in some areas.

Nightfall sets a hard deadline for a team of public-health researchers in Puerto Rico. Since Hurricane Maria hit on 20 September, leaving large swathes of the island without a reliable power supply, the scientists have

rushed home each night to avoid being in the streets after dark. Many lack running water, and most have limited telephone access.

Yet the team —– co-led by José Cordero of the University of Georgia in Athens — has managed to contact several hundred women to begin assessing whether Hurricane Maria has worsened drinking-water contamination, stress and infectious disease that could harm developing fetuses. This wasn't what the researchers set out to study six years ago when they started a project to assess the impact of pollution on pre-term births. But Cordero's team is one of several research groups have scrambled to quantify Hurricane Maria's immediate health impacts, even as team members struggle to fulfil their own basic needs.

The devastation that Cordero saw on a recent visit to Puerto Rico, his birthplace, shocked him. "I thought I was prepared, but I wasn't," he says.

Even before the hurricane, the island's 18 'Superfund' sites — areas so polluted that the US Environmental Protection Agency deems them hazardous to human health or the environment — posed a potential risk to pregnant women, says Ingrid Padilla, an environmental engineer at the University of Puerto Rico at Mayagüez. Twelve of these sites sit on karst, a geological formation made of porous rock that allows toxic chemicals to flow down from the surface into groundwater.

Padilla's previous research suggests that flooding and other disturbances can quickly bring toxic substances in groundwater back to the surface, and carry them into the water supply. Now, she and her colleagues are collecting hair and blood samples from the research cohort to determine whether pregnant women are being exposed to hazardous chemicals, such as phthalates and chloroform. Since the hurricane hit, the researchers have begun to collect and test groundwater from karst regions and tap water from the homes of people living there.

Other research teams are worried that water that has pooled in hurricane debris could provide a breeding ground for disease-carrying mosquitoes. At the height of the Zika epidemic in 2016, experts debated whether a massive hurricane would destroy mosquito habitat or enhance it, says Carmen Zorrilla, an obstetrician and gynaecologist at the University of Puerto Rico in

San Juan. The evidence is still unclear, she says, and logistical problems may make it impossible for researchers to gather enough data to provide answers.

In some areas where hospitals faced extensive storm damage, the only medical care available is emergency treatment. Screening for the Zika virus is a low priority, and infected adults rarely experience severe symptoms and are unlikely to seek medical treatment.

There are also few labs on the island that can test samples for Zika and other mosquito-borne diseases. Like many Puerto Rican facilities, the US Centers for Disease Control and Prevention (CDC) dengue lab in San Juan lost power during the hurricane and was closed for a week. Diesel generators kept its freezers running to preserve blood and other biological samples, but the lab is still running on generator power and is behind on testing some samples. Shipping delays destroyed reagents that the lab had ordered, since the chemicals were not kept consistently cold during transport.

Lab director Stephen Waterman says that the CDC is collecting data on the incidence of mosquito-borne disease and other hurricane impacts. But its priority is to help US government workers and local communities recognize mosquito breeding grounds, and to provide technical help on efforts to control the spread of the insects. Agency staff would also like to verify reports that leptospirosis — a waterborne bacterial disease that is spread by rats — has sickened dozens of people. “We’re focused on preventing disease,” Waterman says.

Yet the ruined facilities and lack of power continue to tax public-health workers’ ability to know where hazards lie. Take the numerous diesel generators running on the island, which produce visible plumes of grey smoke. Benjamin Bolaños, a microbiologist at the University of Puerto Rico in San Juan, worries that these emissions could harm people with respiratory illnesses, but that the effect will be difficult to quantify. “We are blind because probably the [air quality] monitors were destroyed by the hurricane,” he says.

This makes the prospect of more months without reliable power even more frightening. "The kind of work we’re doing is not because it would be interesting to do,” Cordero says. “It has to be done now because a few years

from now, it’s too late.”

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Comments

Comments

There are currently no comments.

China fires up next-generation neutron-science facility

Beam generator puts country in elite company for doing experiments in materials science and other fields.

14 November 2017

Jin Liwang/Xinhua via ZUMAPRESS

Engineers work on an instrument at the China Spallation Neutron Source in Dongguan.

China is revving up its next-generation neutron generator and will soon start experiments there. That will lift the country into a select group of nations with facilities that produce intense neutron beams to study the structure of

materials.

The China Spallation Neutron Source (CSNS) in Dongguan, a 2.2-billion-yuan (US$331-million) centre, will allow the country's growing pool of top-notch physicists and material scientists, along with international collaborators, to compete in multiple physics and engineering fields. Its designers also hope that the facility will lead to commercial products and applications ranging from batteries and bridges to aeroplane engines and cancer therapy.

"It is not only a big step forward for Chinese scientists, but also a significant event for the international scientist community," says Wang Xun-Li, a physicist at the City University of Hong Kong who has been involved in planning the facility.

Beam bombardment

Spallation neutron sources produce neutrons by slamming protons onto a metal target — CSNS uses tungsten. They are more cost effective and safer than other methods, which use nuclear reactors to produce neutron beams. As neutrons have no charge, they can penetrate materials more easily than some other probing methods, and they are more sensitive to light elements such as hydrogen, making them useful for evaluating candidate materials for fuel cells. Similar facilities exist only in the United Kingdom, United States, Japan and Switzerland, and one is under construction in Sweden.

Fujio Maekawa, a specialist in neutron sources at the Japan Proton Accelerator Research Complex in Tokaimura, says that although the CSNS delivers neutrons at a lower density than other spallation sources — which means that experiments will take longer — a planned upgrade will bring it in line with other facilities. And given their scarcity, "neutron users around the world always welcome new sources", he says.

The CSNS will have capacity to host 20 beam lines, supplying as many instruments. Preliminary tests of its first three instruments began on 1 November. "Neutrons arrived at the samples as expected," says Wang

Fangwei, head of the neutron-science division at CSNS. Although debugging might take a couple of years, he expects the instruments to be calibrated and ready for initial experiments by the end of 2017.

Chinese physicists are eager to use the facility to analyse the underlying magnetic properties of materials, an area in which the country has significant experience. Wang Xun-Li says that several planned instruments will give scientists the chance to move to the forefront of fields such as the physics of skyrmions — vortex-like excitations in magnetic materials — and high-temperature superconductivity. “There are a whole bunch of early- to mid-career scientists who are hungry to use the facility for studying magnetism,” says Wang Xun-Li.

Global appeal

Wang Xun-Li thinks that the latest facility will encourage Chinese researchers to remain in the country instead of pursuing careers elsewhere. “In the past, it was common to see Chinese scientists go abroad for these kinds of studies,” he says.

The facility’s first instruments are also attracting international researchers. German material scientist Frank Klose says that the CSNS was a major factor when he and material scientist Christine Rehm, his wife, decided to join the new Guangdong Technion Israel Institute of Technology in Shantou, 400 kilometres east of Dongguan. Klose’s research focuses on designing data-storage devices and sensors that could be used in hydrogen-powered cars. He helped design one of the facility's instruments to investigate the magnetic properties of spintronic devices, which take advantage of the spin of electrons to store data.

But scientists contacted by *Nature* have raised concerns about CSNS’s location, saying that Dongguan lacks services and infrastructure, such as schools and universities, that will persuade top scientists and their families to move there. “I believe CSNS is suffering from a lack of first-grade scientists who actually are based in Dongguan,” says a researcher familiar with the facility, who asked for anonymity because of the sensitivity of the issue.

Potential users have also expressed some frustration that only 3 instruments will be ready this year, despite the facility’s capacity to host 20.

But more instruments are already being built. Shenzhen's government is funding two that are expected to be ready by the end of 2019, including one designed to model high-pressure environments, such as the Earth's core. Mao Ho-Kwang, a geophysicist at the Carnegie Institution for Science in Washington DC, is keen to use it to simulate what happens to materials in high-pressure conditions. “The CSNS instruments will be a great asset for Earth, environmental and energy science, as well as physics, chemistry and material science,” says Mao. “I am very excited, and the whole neutron community is getting very excited too”.

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High-jumping beetle inspires agile robots

Machines could get themselves out of a sticky spot, thanks to an insect that can right itself without using its legs.

13 November 2017

Brian L. Stauffer

Click beetles have a hinged body that can propel them to great heights.

A beetle that can launch itself spectacularly into the air after falling on its back — flipping right side up without having to use its legs — could inspire a new generation of smart robots.

Imagine a rescue robot vaulting its way through a disaster zone riddled with obstacles, or a planetary robot extricating itself from an unexpected tumble on Mars. Each might use a trick or two learnt from the click beetles, a family of insects with the unique ability to catapult themselves out of trouble.

“A lot of robots out there jump using their legs,” says Aimy Wissa, a mechanical engineer at the University of Illinois in Urbana-Champaign. “What’s unique about this is if something breaks, you can still jump without legs and get out of the situation.”

Wissa and her Illinois colleagues, led by mechanical-engineering graduate student Ophelia Bolmin, described the mechanics of jumping click beetles on 7 November at a meeting of the Entomological Society of America in Denver, Colorado. They published early results in the proceedings of a bio-inspired robotics conference in July[1].

So far, the scientists have studied how click beetles manage to store and hold the energy needed to launch themselves into the air. They hope to soon start building prototype machines designed after the beetles.

Snap to it

There are about 10,000 species of click beetles around the world. The insect’s head and body are connected by a hinge that the beetle can slowly arch and then suddenly snap in the opposite direction, jack-knifing its body and sending it into the air with an audible ‘click’. Earlier work has shown that the beetles launch nearly vertically before somersaulting through the air[2].

Ophelia Bolmin/University of Illinois at Urbana-Champaign

Click beetles can launch themselves up with surprising force.

If the beetle lands on its back, it just does the same manoeuvre again. Compare that to an upended ladybird — also known as a ladybug — which has to wiggle around on its back until it manages to roll over far enough and get traction with its legs to flip itself over.

The Illinois team wanted to analyse how the click beetles pull off their acrobatic feat. “We thought we could look at, how do they really jump, how is that energy being released?” says Marianne Alleyne, an entomologist on the team.

Students measured the dimensions of dozens of beetles of four species (*Alaus oculatus*, *Ampedus nigricollis*, *Ampedus linteus* and *Melanotus* spp.), videotaped their jumps with high-speed cameras and analysed the energy required for the beetles to pull the hinge back and then release it. Muscles alone are not enough, because they contract relatively slowly, and so other body parts such as tendons must also be involved, the team says.

How high?

The researchers also measured the force drop as the hinge snapped shut, confirming that it corresponded to the click as the beetle begin to soar skyward. They are now analysing the energies involved as beetles of different sizes make the jump. Click beetles can range from just a few millimetres to a few centimetres long; early results suggest that the bigger the beetle, the higher it can jump, Wissa says.

Other engineers have developed a range of agile robots that can jump using their legs — including one inspired by the Senegal bushbaby (*Galago senegalensis*), which has the highest vertical jumping ability of any animal[3]. Compared with crawling, jumping is a fast and efficient way for small robots to get around obstacles, says Mark Cutkosky, a mechanical engineer at Stanford University in California.

The advantage of the beetle approach is that something could go wrong with the robot's legs, and it could still get out of its predicament, Wissa says. "It simplifies the design a lot."

Any robots inspired by the click beetle would probably have to be quite small — perhaps a few tens of grams, says Gal Ribak, a biomechanics specialist at Tel Aviv University who has studied the beetles' jumps[4]. "Otherwise, the jumping mechanism will require too much energy to lift the body into the air, and the repeated impacts at take-off and landing would result in mechanical damage," he says.

But those constraints might not apply to robots exploring planets other than Earth. On worlds with lower gravity, beetle-like robots could fly high.

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Comments

Comments

There are currently no comments.

Richard
Haughton

Race for quantum supremacy hits theoretical quagmire

It’s far from obvious how to tell whether a quantum computer can outperform a classical one, says Philip Ball.

13 November 2017 Corrected:

1. 14 November 2017

Quantum supremacy might sound ominously like the denouement of the *Terminator* movie franchise, or a misguided political movement. In fact, it denotes the stage at which the capabilities of a quantum computer exceed those of any available classical computer. The term, coined in 2012 by quantum theorist John Preskill at the California Institute of Technology, Pasadena[1], has gained cachet because this point seems imminent. According to various quantum-computing proponents, it could happen before the end of the year.

But does the concept of quantum supremacy make sense? A moment’s thought reveals many problems. By what measure should a quantum computer be judged to outperform a classical one? For solving which

problem? And how would anyone know the quantum computer has succeeded, if they can’t check with a classical one?

Computer scientists and engineers are rather more phlegmatic about the notion of quantum supremacy than excited commentators who foresee an impending quantum takeover of information technology. They see it not as an abrupt boundary but as a symbolic gesture: a conceptual tool on which to peg a discussion of the differences between the two methods of computation. And, perhaps, a neat advertising slogan.

IBM Research

An IBM cryostat wired for a 50-qubit system.

Magic number

Quantum computers manipulate bits of information according to the quantum rules that govern the behaviour of matter on the smallest scales. In this quantum world, information can be coded as quantum bits (qubits), physically composed of objects that represent binary 1s and 0s as quantum states. By keeping the qubits in a coherent quantum superposition of states –

so that in effect their settings are correlated, rather than being independent as in the bits (transistors) of classical computer circuitry – it becomes possible to carry out some computations much more efficiently, and thus faster, with far fewer (qu)bits, than on classical computers.

Both IBM and Google have already developed prototype quantum-computing devices. IBM has made a 5-qubit device available for public use as a cloud-based resource and on 10 November it announced that it had made a 20-qubit device available for commercial users. Its computer scientists also reported on the same day that they had successfully tested a 50-qubit circuit. Google, too, is developing devices with 49–50 qubits on which its researchers hope to demonstrate quantum supremacy by the end of this year[2].

How could anyone know, though, that a quantum computer is genuinely doing something that is impossible for a classical one to do – rather than that they just haven't yet found a classical algorithm that is clever enough to do the job? This is what makes quantum supremacy a theoretically interesting challenge: are there classes of problem for which it can be rigorously shown that quantum computing can do what classical cannot?

Among the favourite candidates are so-called sampling problems, in which in-effect random bits are transformed into bits that come from a predefined distribution. The Google team in Santa Barbara, California, led by John Martinis, has described an experimental procedure for implementing such a sampling scheme on a quantum computer, and has argued that at the 50-qubit level it could show quantum supremacy[2].

Because of this paper, 50 qubits has become something of an iconic number. That's why a recent preprint[3] from Edwin Pednault and co-workers at IBM's Thomas J. Watson Research Center in Yorktown Heights, New York, showing how, with enough ingenuity, some 49-qubit problems can be simulated classically, has been interpreted in some news reports as a challenge to Google's aim to demonstrate quantum supremacy with only 50 qubits.

It's all about depth

But it's not really that. Quantum-computing experts are now finding themselves obliged to repeat a constant refrain: it's not just about the number of qubits. One of the main measures of the power of a quantum circuit is its so-called depth: in effect, how many logical operations ('gates') can be implemented in a system of qubits before their coherence decays, at which point errors proliferate and further computation becomes impossible. How the qubits are connected also matters. So the true measure of the power of a quantum circuit is a combination of factors, which IBM researchers have called the "quantum volume".

This means that the extent to which a quantum-computational task is challenging to perform classically depends also on the algorithmic depth, not just on how many qubits you have to throw at it. Martinis says that the IBM paper is concerned only with small-depth problems, so it's not so surprising that a classical solution still exists at the 49-qubit level. "We at Google are well aware that small-depth circuits are easier to classically compute", he says. "It is an issue we covered in our original paper."

Scott Aaronson, a computer scientist at the Massachusetts Institute of Technology, agrees that the IBM work doesn't obviously put quantum supremacy further out of reach. "It is an excellent paper, which sets a new record for the classical simulation of generic quantum circuits," he writes – but "it does not undercut the rationale for quantum supremacy experiments."

Indeed, he says, the truth is almost the opposite: the paper shows that it's "possible to simulate 49-qubit circuits using a classical computer, [which] is a precondition for Google's planned quantum supremacy experiment, because it's the only way we know to check such an experiment's results." In essence, the IBM paper shows how to verify the quantum result right up to the edge of what is feasible – so computer scientists and engineers can be confident that things are OK when they go beyond it. The goal, Aaronson says, can be likened to "get[ting] as far as you can up the mountain, conditioned on people still being able to see you from the base."

These views seem to sit comfortably with the IBM team's own perspective on their work. "I think the appropriate conclusion to draw from the simulation methods we have developed is that quantum supremacy should properly be viewed as a matter of degree, and not as an absolute threshold,"

says Pednault. “I, along with others, prefer to use the term ‘quantum advantage’ to emphasize this perspective.”

Theorist Jay Gambetta at IBM agrees that for such reasons, quantum supremacy might not mean very much. “I don’t believe that quantum supremacy represents a magical milestone that we will reach and declare victory,” he says. “I see these ‘supremacy’ experiments more as a set of benchmarking experiments to help develop quantum devices.”

In any event, demonstrating quantum supremacy, says Pednault, “should not be misconstrued as the definitive moment when quantum computing will do something useful for economic and societal impact. There is still a lot of science and hard work to do.”

Which, of course, is just applied science as normal. The idea of quantum supremacy sets a nice theoretical puzzle, but says little about what quantum computers might ultimately do for society.

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Corrections

Corrected:

An earlier version of this story erroneously stated that IBM had created a 20-qubit device for public use. It is available only for commercial users, however IBM does have a 5-qubit device for public use.

Comments

Commenting is currently unavailable.

Archaeologists say human-evolution study used stolen bone

Bizarre tale of theft and suspicious packages casts doubt on claims for early-human occupation in northern Europe.

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1. 13 November 2017

Marc Steinmetz

The Untermassfeld site in Germany has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago.

Serious concerns have surfaced about three research papers claiming evidence for one of the earliest human occupations of Europe.

In an extraordinary letter posted to the bioRxiv.org preprint server on 31 October[1], archaeologists allege that the papers, published in 2013, 2016 and 2017, included material of questionable provenance, and that results reported in the 2016 paper were based on at least one stolen bone. Editors at the journals concerned have now published expressions of concern about the papers.

There is no suggestion that the authors of those papers were involved in theft, but the researchers behind the letter say they are concerned that appropriate questions regarding the provenance of the material appear not to have been asked. They also reject the authors' conclusion that a German site known for animal remains was also home to hominins, ancient relatives of humans, 1 million years ago. The authors have denied the allegations and say they stand by their conclusion.

The letter was initiated by archaeologist Wil Roebroeks at Leiden University in the Netherlands, and Ralf-Dietrich Kahlke, a palaeontologist and head of the Senckenberg Research Station of Quaternary Palaeontology in Weimar, Germany, who leads excavations at Untermassfeld, a fossil site about 150 kilometres northeast of Frankfurt. Their preprint describes repeated disappearances of bones from Untermassfeld, as well as fossils delivered in anonymous packages. The authors of the disputed papers insist, however, that they analysed independent collections of bones and stones, and reject the suggestion that any of it was stolen.

Untermassfeld, which has yielded more than 14,000 large animal fossils dating from between 900,000 and 1.2 million years ago, holds the most complete record of northern European wildlife from this time period. But since yearly excavations began in the late 1970s, no hominin bones or signs of occupation have been found, says Kahlke. Hominins first settled in southern Europe around 800,000 to 1 million years ago, most archaeologists agree, and expanded farther north only sporadically until around 500,000 years ago.

Uncertain origins

One of the first claims that hominins lived near Untermassfeld more than 1 million years ago appeared in a 2013 paper in the journal *Quaternary International*, which contended that rocks from the site resembled stone tools[2]. In a 2016 *Journal of Human Evolution* paper[3], two of the original paper's authors, Günter Landeck at the North Hessian Society of Prehistory and Archeology of the Medieval in Bad Hersfeld, Germany, and Joan Garcia Garriga at the Universitat Oberta de Catalunya in Barcelona, concluded that marks on animal bones from Untermassfeld were made by humans. In 2017, Landeck and Garcia Garriga published further analysis of the bones in another *Quaternary International* paper[4].

There is no suggestion that the other co-authors of the 2013 paper had any connection with the material from Untermassfeld. And after this article was published, Garcia Garriga contacted *Nature* to say that he, also, did not have connections with the material; he said that Landeck had done the analysis, while he himself helped in discussing data and writing up its archaeological implications.

In their papers, Landeck and Garcia Garriga attributed the material, along with hundreds of rock fragments of limestone and chert, to “the Schleusingen collection”, which they stated was recovered by a biology teacher in the late 1970s and early 1980s.

Kahlke says he is personally unaware of a Schleusingen collection and questions whether the material was collected at this time. Rocks like those described in the papers can be found in the vicinity of the site, but he says that animal fossils are concentrated in a small area that has been under excavation since 1978. No other research teams had permission to excavate the site during that time, Kahlke says. But he says that material was routinely stolen from the site — which he reported to the police, most recently in 2012 — until the site and fossil bed were better secured. There is no suggestion that Landeck and Garcia Garriga were involved in these thefts.

Ralf-Dietrich Kahlke

Researchers excavating at Untermassfeld allege that part of a deer bone protruding from the sediment on 28 May 2009 (in box, left) had disappeared several days later.

One fossil that Kahlke considers suspicious is a right limb-bone fragment from an extinct species of fallow deer, described in Landeck and Garcia Garriga's 2016 *Journal of Human Evolution* paper. Kahlke says that the bone in the paper seems to match a piece of deer bone that thieves broke from a larger chunk of sediment at Untermassfeld, leaving part of the bone behind. The bone fragment is present in a photograph taken on 28 May 2009, and missing in a photograph taken several days later. A rhinoceros limb fragment that disappeared from the site in 2012 also closely resembles a fossil described in the 2016 paper, Kahlke says.

Case unsolved

Deepening the mystery, a deer bone fragment was among a jumble of bones and rocks in two packages sent anonymously to a museum near Untermassfeld in March 2014. Ralf Werneburg, a palaeontologist and director of the Natural History Museum Schloss Bertholdsburg in Schleusingen, Germany, recognized the material as originating from Untermassfeld and contacted Kahlke.

Ralf-Dietrich Kahlke

An anonymous package sent to a museum in Schleusingen contained a deer bone fragment (lower bone), which appears to match a fragment left behind (upper bone) after a theft from the Untermassfeld site in 2009. (The fragments are shown pieced together in the view on the far-right).

In Kahlke's opinion, the returned deer bone fragment is the one described in the 2016 paper, and matches up with the piece left behind after the 2009 theft**.** He says that the sixty-three other bone fragments in the packages also closely resemble some of the fossils described in the 2016 paper (the rhinoceros limb bone was not among them), and 11 rock fragments resemble

artefacts in the 2013 *Quaternary International* paper.

Roebroeks and Kahlke's team analysed the material in the returned packages, and concluded that it does not support a hominin occupation at Untermassfeld. They argue that the claimed cut-marks on the animal bones, including the deer bone, were probably caused by rodents or other natural wear, they say, and the rock fragments lack telltale marks typical of hominin tools. They say that it wasn't possible to analyse other material from Landeck and Garcia Garriga's paper because its location is unclear.

Nature exchanged multiple e-mails with Landeck and Garcia Garriga about this mystery and asking for comment on the contents of this article. The researchers responded that most of the material they examined, including the deer bone fragment, was from two private collections amassed in the 1970s and early 1980s, and that much of it came from the same geological layer as Untermassfeld, but not within the site itself. They said that they presumed that some of this material was returned to the Natural History Museum Schloss Bertholdsburg in 2014 by the individual who had loaned it to them. They would not name the individual, but insisted: "We have nothing to do with a stolen bone". They added that they are planning to publish a detailed response to Roebroeks and Kahlke's allegations.

The regional prosecutor's office in Meiningen that investigated the 2009 theft told *Nature* the case had been closed unsolved later that year. A 5-year statute of limitation prevents it from being reopened. The case involving the 2012 theft of the rhinoceros bone was reopened early this year after the *Journal of Human Evolution* paper was published. The prosecutor's office said that an individual, whom it declined to name because of data protection laws, had been found guilty and fined.

Ongoing inquiry

Expressions of concern published on each of the three papers note that the location of the Untermassfeld material "was not stated accurately in the publication", and that the authors have been unable to adequately clarify where it is now. Landeck and Garcia Garriga declined to comment to *Nature*

on the specific details of the notes but said that they plan to publish a response.

Sarah Elton, an anthropologist at the University of Durham, UK, and an editor at the *Journal of Human Evolution*, says that an investigation into the accusations is ongoing. She adds that, as a result of the case, the journal now asks prospective authors to supply complete information about the location of material included in a study, as well as how it was accessed.

Other experts have been shocked by the revelations. “This paper should be retracted, of course,” says Jean-Jacques Hublin, an anthropologist and a director at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, about the 2016 paper. But the concerns go beyond questions of provenance. Hublin says that, like Roebroeks and Kahlke, he does not accept the claim that Untermassfeld contains signs of hominin presence, and he worries that its appearance in prominent journals will cause others to accept the idea, despite the lack of evidence for it.

The debate around Untermassfeld, Roebroeks and his colleagues say, underscores the importance of providing accurate descriptions of the provenance of published material, which is needed to verify claims. The desire to set the record straight about the arrival of hominins to Europe was the primary motivation for the team’s letter, he says. Based on his analysis, Roebroeks argues: “These bones and stones are not indicative of hominin presence.”

With additional reporting by Alison Abbott

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Updates

Updated:

> This article was updated on 13 November to note that expressions of concern have been published on all three papers, and to include a statement made after publication by Garcia Garriga: that he was not involved in analysing the material from Untermassfeld.

Comments

Commenting is currently unavailable.

Lab mice's ancestral ‘Eve’ gets her genome sequenced

Effort aims to help scientists understand how generations of inbreeding have altered the genetics of research rodents.

13 November 2017

Anne Chadwick Williams/Sacramento Bee/ZUMA Press/Alamy

The genomes of lab mice can shift in subtle and unpredictable ways over generations of breeding.

Adam and Eve, a pair of black mice, lived for less than two years and never left their home at the Jackson Laboratory (JAX) in Bar Harbor, Maine. But since they were bred in 2005, their progeny have spread around the globe: the

pair's living descendants, which likely number in the hundreds of thousands. They are members of the most popular strain of mice used in biomedical research, which was created nearly a century ago.

Now, researchers at JAX are reconstructing Eve's genome in the hopes of better understanding — and compensating for — the natural mutations that occur in lab mice over the course of generations. These genetic changes can cause unanticipated physiological effects that can confound experiments. Related substrains of lab mice can differ in their taste for alcohol or their sensitivity to insulin, for example, and researchers suspect that such differences between supposedly identical mice lines have hampered some areas of research.

The scientists who founded JAX created Adam and Eve's breed, which is called C57BL/6, in 1921. To keep the mice as genetically similar as possible, researchers have repeatedly bred brothers with sisters for nearly a century — and sold the resulting offspring to customers around the world. But this strategy created a genetic bottleneck: every generation, between 10 and 30 new mutations pop up and are passed down to offspring. This 'genetic drift' quickly accumulates over the years, says Laura Reinholdt, a geneticist at JAX. The genomes of the C57BL/6 mice that the lab sells today have thousands of genetic differences from the mouse reference genome, which was created in 2002 from three mice from the substrain C57BL/6J. The genome is used as a template for researchers developing genetically modified mice.

Other suppliers have inadvertently created divergent substrains of C57BL/6 mice when they've bought rodents from JAX and bred them over several generations. Although most mutations go unnoticed, some occur in genes that affect a mouse's appearance or physiology. In 2016, mouse supplier Envigo in Somerset, New Jersey, found that C57BL/6 mice at 6 of its 19 breeding facilities around the world had acquired a mutation in a gene related to the immune system. The company notified the researchers that bought these mice, and asked customers to specify which location they preferred to source mice from in the future, given that the company's stocks were no longer identical.

Hidden changes

And although it is easy to spot a mutation that changes fur from black to white, for instance, some changes are discovered only if researchers are investigating a particular trait. A substrain of C57BL/6 mice that the US National Institutes of Health bred for 50 generations are uninterested in alcohol, whereas those bred at JAX's facility display a preference for alcoholic beverages.

In 2005, a team at JAX decided to reset the genetic clock by selling only C57BL/6J mice descended from two chosen mice: Adam and Eve. The researchers froze hundreds of embryos of the duo's grandchildren, enough to last for 25-30 years. Every five generations, the company thaws some of these embryos and raises them to adulthood as new breeding pairs.

"In some ways, the changes that are acquired are insidious and unstoppable," says Michael Wiles, the lab's senior director of technology evaluation and development, who led the project. "We've not stopped general drift, but we've slowed it considerably." Once the stockpiled embryos run out, however, JAX will have to start over with new breeding pairs from a much later generation.

Yet Eve's genome is very different from the 2002 mouse reference genome. In a presentation last month at the American Society for Human Genetics' meeting in Orlando, Florida, JAX computational scientist Anuj Srivastava spoke about the company's effort to reconstruct Eve's genome in high detail, using three different sequencing methods. Wiles says that the genome will be finished by the end of November, and that JAX plans to publish it early in 2018.

Mouse trap

Other mouse breeders have started their own efforts to account for genetic drift. Taconic Biosciences, a mouse distributor in Hudson, New York, restarts its C57BL/6 line every ten generations from its stash of frozen embryos.

Because Taconic has bred its line separately from the JAX line for decades, the Eve genome won't necessarily reflect the genetic make-up of Taconic's mice any more than the current mouse reference genome does.

Ana Perez, Taconic's global director of genetic sciences and compliance, says that the company plans to publish the genome of its own Eve. "From my perspective, each particular breeder should have their own reference genome to follow," she says. Buying mice from different breeders and expecting them to be the same is a fallacy, she adds.

But most researchers don't think about the differences between the various substrains of C57BL/6 mice and how those disparities can affect reproducibility in research, says Cory Brayton, a pathobiologist at Johns Hopkins University in Baltimore, Maryland. "The vendors are pretty good about making the information available, but the awareness is still pretty low," she says. It is impossible to quantify how often experiments or entire research programmes are wasted when researchers realize that their supposedly identical mice have genetically diverged from the ancestor they bought from a vendor, but Brayton suspects it is common.

The Eve genome will be a useful addition for researchers who use animals from JAX, says Brayton, although it won't solve all the reproducibility problems inherent to inbred mouse lines. "If you use [inbred mice] wisely, they can be highly informative," she says. "If you use them stupidly, they may really confound your studies."

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Comments

Comments

There are currently no comments.

World’s carbon emissions set to spike by 2% in 2017

Increased coal use in China appears to be driving the first increase in global greenhouse-gas output since 2014.

13 November 2017

Kevin Frayer/Getty

China, the world’s largest emitter of greenhouse gases, is trying to reduce its reliance on coal.

Humanity’s carbon emissions are likely to surge by 2% in 2017, driven mainly by increased coal consumption in China, scientists reported on 13 November[1–3]. The unexpected rise would end a three-year period in which

emissions have remained flat despite a growing global economy.

Researchers with the Global Carbon Project, an international research consortium, presented their findings at the United Nations climate talks in Bonn, Germany. Countries there are ironing out details of how to implement the 2015 Paris climate accord, which calls for limiting global warming to a rise of 1.5–2 °C. The projected jump in the world's greenhouse-gas output underlines the challenges ahead; if the latest analysis proves correct, global carbon dioxide emissions will reach a record-breaking 41 billion tonnes in 2017.

"We were not particularly surprised that emissions are up again, but we were surprised at the size of the growth," says Corinne Le Quéré, a climate scientist at the University of East Anglia in Norwich, UK, and co-author of the work, which was published in the journals *Nature Climate Change*, *Environmental Research Letters* and *Earth System Science Data Discussions*. To Le Quéré, the question now is whether 2017 is a temporary blip or a return to business as usual. "If 2018 is as big as 2017, then I will be very discouraged," she says.

Several factors caused the world's CO_2 emissions to level out from 2014 to 2016, including an economic slowdown in China, the world's largest emitter; a shift from coal to gas in the United States; and global growth in the use of renewable energies such as solar and wind. Many climate scientists and policymakers had hoped that the pause in emissions growth represented a shift in energy use that would eventually cause global greenhouse-gas emissions to peak — and then decline.

The latest analysis projects that CO_2 emissions in the United States and the European Union will continue to decline — by 0.4% and 0.2%, respectively, in 2017 — although at a slower pace than in recent years. And emissions growth in India is set to slow, rising by just 2% this year, compared with an average of 6% per year over the past decade.

But the picture is very different in China, which produces nearly 26% of the world's output of CO_2. This year, the country's emissions of the greenhouse gas are expected to surge by 3.5%, to 10.5 billion tonnes. The main causes

are increased activity at the country's factories and reduced hydroelectric-energy production, the Global Carbon Project analysis finds.

The effort highlights nagging uncertainties about greenhouse-gas emissions trends, particularly in China, India and other countries with economies that are rapidly growing and changing, says David Victor, a political scientist at the University of California, San Diego. He is not convinced that government actions — at the national or international level — have driven the recent levelling of emissions. And although emissions are projected to grow this year, Victor says that China is still on a trajectory that would see its emissions peak well before its 2030 target.

Taken together, the projections for 2017 reinforce the notion that the world has far to go before it solves the climate problem, says Glen Peters, a climate-policy researcher at the CICERO Center for International Climate Research in Oslo and a co-author of the Global Carbon Project's 2017 analysis.

"This is basically saying that we are not safe yet," Peters says. "We can't be complacent."

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Comments

Comments

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Nature News

周一, 27 11月 2017

Nature News

[周一, 27 11月 2017]

- **Nature News**

Nature News

Nature is a weekly international journal publishing the finest peer-reviewed research in all fields of science and technology on the basis of its originality, importance, interdisciplinary interest, timeliness, accessibility, elegance and surprising conclusions. Nature also provides rapid, authoritative, insightful and arresting news and interpretation of topical and coming trends affecting science, scientists and the wider public.

- **Nobel laureates demand release of Iranian scholar facing death sentence** [周五, 24 11月 08:00]
  Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.
- **Zimbabwe’s researchers hope political change will revitalize science** [周五, 24 11月 08:00]
  Academics optimistic that the end of Robert Mugabe’s authoritarian rule could boost research and international collaboration.
- **AI-controlled brain implants for mood disorders tested in people** [周三, 22 11月 08:00]
  Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.
- **Lightning makes new isotopes** [周三, 22 11月 08:00]
  Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.
- **Black academics soon to outnumber white researchers in South Africa** [周二, 21 11月 08:00]
  Legacy of apartheid means academia has remained largely white.
- **Hungary rewards highly cited scientists with bonus grants** [周二, 21 11月 08:00]
  Some top researchers prosper in Hungary as country tries to improve its international standing in science.
- **European Medicines Agency to move to Amsterdam** [周一, 20 11月 08:00]
  The European Union’s drug regulatory body will leave London because of the United Kingdom’s Brexit plans.
- **How alkali flies stay dry** [周一, 20 11月 08:00]
  Waxy and hairy covering enables flies to dive underwater without getting wet.
- **UK government announces research-spending hike ahead of budget** [周一, 20 11月 08:00]
  Pledge would raise country’s public research funding to £12.5 billion in 2021–22.

- **Exoplanet hunters rethink search for alien life** [周一, 20 11月 08:00]
  Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.
- **Online software spots genetic errors in cancer papers** [周一, 20 11月 08:00]
  Tool to scrutinize research papers identifies mistakes in gene sequences.

Nobel laureates demand release of Iranian scholar facing death sentence

Letter from Nobel prizewinners denounces plight of Ahmadreza Djalali.

24 November 2017

HAND OUT/Belga/PA Images

Iranian researcher Ahmadreza Djalali has appealed against the death sentence he received on 21 October.

Some 75 Nobel prizewinners have called on the Iranian government to release Ahmadreza Djalali, a researcher in disaster medicine who was

sentenced to death last month. The letter is the latest and most powerful protest against the ruling by the scientific community so far.

The group wrote to Gholamali Khoshroo, the Iranian ambassador to the United Nations, on 17 November, and the letter was made public on 21 November. The Nobel laureates express their concern for the conditions of Djalali's detention; they deem his trial "unfair" and "flawed", and they urge the Iranian authorities to let him return to Sweden, where he lived.

The list includes prominent names such as Harold Varmus, a former director of the US National Institutes of Health, now at the Weill Cornell Medicine institute in New York, and Andre Geim, a physicist based at the University of Manchester, UK. They wrote: "As members of a group of people and organizations who, according to the will of Alfred Nobel are deeply committed to the greatest benefit to mankind, we cannot stay silent, when the life and work of a similarly devoted researcher as Iranian disaster medicine scholar Ahmadreza Djalali is threatened by a death sentence."

Spying conviction

Djalali carried out research on emergency medicine — specifically, on the response of hospitals to terrorist attacks — while based at the University of Eastern Piedmont in Novara, Italy, and at the Karolinska Institute in Stockholm.

He was arrested in Tehran in April 2016 and accused of collaboration with a hostile government. On 21 October this year, Djalali was convicted of espionage and sentenced to death, according to Djalali's wife Vida Mehrannia and Italian diplomatic sources.

Tehran's prosecutor linked Djalali to the murder of several Iranian nuclear physicists. But a document thought to have been written by Djalali has claimed that he was sentenced after refusing to spy for Iran. Djalali's lawyer has appealed against the death sentence and is awaiting the court's decision.

Since the death sentence became public, many organisations have protested against Djalali's treatment. They include: Amnesty International, the human

rights group; senators in the Italian government; the directors of the European institutions at which Djalali worked; and academic groups including the Committee of Concerned Scientists and Scholars at Risk.

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Comments

Comments

There are currently no comments.

Zimbabwe’s researchers hope political change will revitalize science

Academics optimistic that the end of Robert Mugabe’s authoritarian rule could boost research and international collaboration.

24 November 2017

AFP/Getty

Protesters gathered at the University of Zimbabwe in Harare this week, amid political ructions that precipitated the end of Robert Mugabe's 37-year rule.

Scientists in Zimbabwe say they are hopeful that the sudden change of

political power in their country could spell a new era for its beleaguered research system. Those working in the nation hope that the shift will unlock and attract research funds from overseas, while Zimbabwean researchers abroad say that the potential for new order in their country could encourage them to return home.

The authoritarian regime of Robert Mugabe, the 93-year-old who had been president of Zimbabwe for 37 years, ended abruptly on 21 November when he resigned following military and political pressure. Emmerson Mnangagwa, the former vice-president whose firing by Mugabe this month set off the revolt, was sworn in as the country's leader this morning. Elections are expected to be organized next year.

The ructions have been widely celebrated both inside and outside Zimbabwe. The southern African country’s economy has been in free fall for almost two decades since Mugabe fast-tracked a programme of land expropriation, which destroyed investment in its agricultural sector and undermined confidence in the economy. The turmoil led millions — including scientists — to flee the country, many into neighbouring South Africa.

Research roots

Traditionally, much of the country's research has come from ties between Zimbabwe's universities and the agriculture industry, where research and development was considered central to its productivity. Major study areas included maize, land-management and veterinary research. But science became difficult as government funding for research dried up. Last year, the Zimbabwe Academy of Sciences' situation became so desperate that it implored the country’s large diaspora to support the organization.

International sanctions against Zimbabwe have also penalized the country’s students and academics, who have not been able to access international grants, scholarships or buy equipment from foreign companies prohibited from trading with Zimbabwe, says Dexter Tagwireyi, a pharmacist at the University of Zimbabwe in Harare and head of the Zimbabwe Young Academy of Science. If the incoming government has better relationships

with Western countries, such as the United Kingdom and the United States, it could mean that researchers are able to access new sources of funds, he says.

At his inauguration, Mnangagwa said that Zimbabwe was ready to engage with other countries and urged the international community to reconsider their economic embargoes. The African Union, a continental group of nations including Zimbabwe, has been pushing science, technology and innovation as a way for African countries to achieve economic and social development.

The promise of a more democratic government could also attract researchers who have left to return and swell the country's academic ranks. "This change of leader interests me to go back and serve in Zimbabwe as an academic," says a Zimbabwean researcher at the University of Johannesburg in South Africa, who asked to remain anonymous because he was concerned about what his employer might think. The prospect of order in his home country would tempt him to return "at the speed of light", he says, in part because Zimbabwe is not as crime-ridden as South Africa. The sentiment was echoed by several other early-career Zimbabwean scientists in South Africa contacted by *Nature*.

Zimbabwe does not keep official figures on academics, but a 2012 report by the United Nations Educational, Scientific and Cultural Organization said that 1,300 researchers were working there at the time. And despite chronic underfunding, Zimbabwe has consistently produced around 400 peer-reviewed papers a year. (By comparison, South Africa produced 17,246 research publications in 2015.)

"I just hope the new regime will resuscitate the economy and generate significant research funding for higher-education institutions," says Rudo Gaidzanwa, a sociologist at the University of Zimbabwe. "That would boost the research output of academics in state universities."

Key collaborator

South Africa, with its comparatively strong research system, is a major destination for students from around Africa, and a key collaborator for

Zimbabwean scientists. A Web of Science search shows that since 2013, roughly one-third of 1,689 research articles authored by Zimbabwe-affiliated researchers had a collaborator who was based in South Africa.

A strengthened science system in Zimbabwe would benefit the entire region, open the door to greater collaboration and offer a destination for students trained in South Africa, says Valerie Mizrahi, director of the Institute of Infectious Disease and Molecular Medicine at the University of Cape Town in South Africa.

South Africa takes scholars from across the continent, and in many cases the idea of them going home is a pipe dream, because there is often not much to go back to, Mizrahi says. “Zimbabwe has a chance to change that.” Mizrahi, who was born in Zimbabwe but has lived in South Africa for decades, says that the situation is reminiscent of South Africa when apartheid was being dismantled in the 1990s and sanctions were lifted. “Funding flowed into the country,” she says.

Despite the celebrations in Zimbabwe, there are concerns that Mnangagwa’s presidency will not bring enough change. The new leader was a close associate of Mugabe and served in various positions in his government, which was characterized by nepotism and the silencing of opposition voices. “So we are not sure whether they will do things differently or all they wanted was just power to also suppress citizens and loot resources in the country," says Farayi Moyana, a PhD candidate at South Africa's University of the Witwatersrand who is based in Zimbabwe.

The uncertainty means that academics aren't making plans just yet: “There is no hurry to return home,” says a Zimbabwean scientist at Witwatersrand in Johannesburg, who also spoke on the condition of anonymity. Rather, he says, he will let the situation stabilize before making any decisions.

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Comments

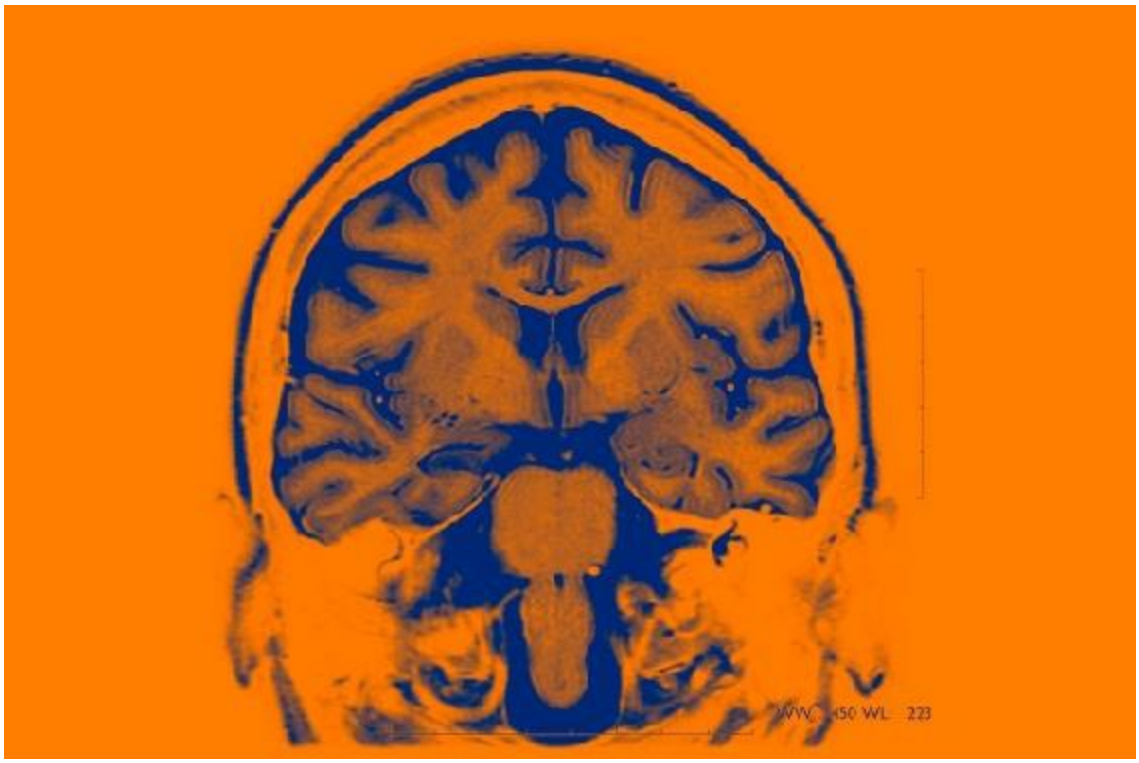
Comments

There are currently no comments.

AI-controlled brain implants for mood disorders tested in people

Researchers funded by the US military are developing appliances to record neural activity and automatically stimulate the brain to treat mental illness.

22 November 2017



BSIP/UIG/Getty

Brain implants are used to treat epilepsy and movement disorders.

Brain implants that deliver electrical pulses tuned to a person’s feelings and behaviour are being tested in people for the first time. Two teams funded by the US military’s research arm, the Defense Advanced Research Projects Agency (DARPA), have begun preliminary trials of ‘closed-loop’ brain

implants that use algorithms to detect patterns associated with mood disorders. These devices can shock the brain back to a healthy state without input from a physician.

The work, presented last week at the Society for Neuroscience (SfN) meeting in Washington DC, could eventually provide a way to treat severe mental illnesses that resist current therapies. It also raises thorny ethical concerns, not least because the technique could give researchers a degree of access to a person's inner feelings in real time.

The general approach — using a brain implant to deliver electric pulses that alter neural activity — is known as deep-brain stimulation. It is used to treat movement disorders such as Parkinson's disease, but has been less successful when tested against mood disorders. Early evidence suggested that constant stimulation of certain brain regions could ease chronic depression, but a major study involving 90 people with depression found no improvement after a year of treatment.[1]

The scientists behind the DARPA-funded projects say that their work might succeed where earlier attempts failed, because they have designed their brain implants specifically to treat mental illness — and to switch on only when needed. "We've learned a lot about the limitations of our current technology," says Edward Chang, a neuroscientist at the University of California, San Francisco (UCSF), who is leading one of the projects.

DARPA is supporting Chang's group and another at Massachusetts General Hospital (MGH) in Boston, with the eventual goal of treating soldiers and veterans who have depression and post-traumatic stress disorder. Each team hopes to create a system of implanted electrodes to track activity across the brain as they stimulate the organ.

The groups are developing their technologies in experiments with people with epilepsy who already have electrodes implanted in their brains to track their seizures. The researchers can use these electrodes to record what happens as they stimulate the brain intermittently — rather than constantly, as with older implants.

Mood map

At the SfN meeting, electrical engineer Omid Sani of the University of Southern California in Los Angeles — who is working with Chang's team — showed the first map of how mood is encoded in the brain over time. He and his colleagues worked with six people with epilepsy who had implanted electrodes, tracking their brain activity and moods in detail over the course of one to three weeks. By comparing the two types of information, the researchers could create an algorithm to 'decode' that person's changing moods from their brain activity. Some broad patterns emerged, particularly in brain areas that have previously been associated with mood.

Chang and his team are ready to test their new single closed-loop system in a person as soon as they find an appropriate volunteer, Sani says. Chang adds that the group has already tested some closed-loop stimulation in people, but he declined to provide details because the work is preliminary.

The MGH team is taking a different approach. Rather than detecting a particular mood or mental illness, they want to map the brain activity associated with behaviours that are present in multiple disorders — such as difficulties with concentration and empathy. At the SfN meeting, they reported on tests of algorithms they developed to stimulate the brain when a person is distracted from a set task, such as matching images of numbers or identifying emotions on faces.

The researchers found that delivering electrical pulses to areas of the brain involved in decision-making and emotion significantly improved the performance of test participants. The team also mapped the brain activity that occurred when a person began failing or slowing at a set task because they were forgetful or distracted, and found they were able to reverse it with stimulation. They are now beginning to test algorithms that use specific patterns of brain activity as a trigger to automatically stimulate the brain.

Personalized treatment

Wayne Goodman, a psychiatrist at Baylor College of Medicine in Houston, Texas, hopes that closed-loop stimulation will prove a better long-term treatment for mood disorders than previous attempts at deep-brain stimulation — partly because the latest generation of algorithms is more personalized and based on physiological signals, rather than a doctor's judgement. “You have to do a lot of tuning to get it right,” says Goodman, who is about to launch a small trial of closed-loop stimulation to treat obsessive–compulsive disorder.

One challenge with stimulating areas of the brain associated with mood, he says, is the possibility of overcorrecting emotions to create extreme happiness that overwhelms all other feelings. Other ethical considerations arise from the fact that the algorithms used in closed-loop stimulation can tell the researchers about the person’s mood, beyond what may be visible from behaviour or facial expressions. While researchers won't be able to read people's minds, “we will have access to activity that encodes their feelings,” says Alik Widge, a neuroengineer and psychiatrist at Harvard University in Cambridge, Massachusetts, and engineering director of the MGH team. Like Chang and Goodman’s teams, Widge’s group is working with neuroethicists to address the complex ethical concerns surrounding its work.

Still, Chang says, the stimulation technologies that his team and others are developing are only a first step towards better treatment for mood disorders. He predicts that data from trials of brain implants could help researchers to develop non-invasive therapies for mental illnesses that stimulate the brain through the skull. “The exciting thing about these technologies,” he says, “is that for the first time we’re going to have a window on the brain where we know what’s happening in the brain when someone relapses.”

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Comments

Commenting is currently unavailable.

Lightning makes new isotopes

Physicists show that thunderstorms trigger nuclear reactions in the atmosphere.

22 November 2017

Magalie L’Abbé/Getty

A lightning storm illuminates clouds over Kagoshima, Japan.

A streak of lightning in the skies over Japan has generated positrons — the antimatter equivalents of electrons — and radioactive carbon-14, confirming a theoretical prediction, according to a paper published in *Nature* on 22 November[1].

Since the 1990s, orbiting observatories designed to observe the heavens have

also detected flashes of γ-rays coming from Earth, which were thought to have their origins in atmospheric phenomena. To investigate this theory, Teruaki Enoto, an astrophysicist at Kyoto University in Japan, and his collaborators set up an array of γ-ray detectors close to the Kashiwazaki-Kariwa nuclear power plant. Winter thunderstorms in Japan are famous for their spectacular lightning, he says, and the low clouds make these relatively easy to observe.

On 6 February, the detectors sensed an unusual event. A double lightning bolt just off the coast shot out an initial, one-millisecond spike of γ-rays, with relatively high energies of up to 10 megaelectronvolts. This was followed by a γ-ray afterglow of less than half a second. Then there was a telltale signal — γ-rays concentrated at 511 kiloelectronvolts of energy, which lasted for about a minute. Physicists say this is the unmistakable signature of positrons annihilating in a puff of energy as they hit electrons in the surrounding matter.

Together, the three waves of γ-rays point to a photonuclear reaction first proposed[2] a decade ago by Leonid Babich, a physicist at the Russian Federal Nuclear Center in Sarov. Lightning can accelerate some electrons to almost the speed of light, and the electrons can then produce γ-rays. Babich proposed that when one of these γ-rays hits the nucleus of a nitrogen atom in the atmosphere, the collision can dislodge a neutron. After briefly bouncing around, most of the neutrons get absorbed by another nitrogen nucleus. This adds energy to the receiving nucleus and puts it in an excited state. As the receiving nucleus relaxes to its original state, it emits another γ-ray — contributing to the giveaway γ-ray glow.

Meanwhile, the nitrogen nucleus that has lost one neutron is extremely unstable. It decays radioactively over the next minute or so; in so doing, it emits a positron, which almost immediately annihilates with an electron, producing two 511-keV photons. This was the third signal, Enoto says. He suspects that his detectors were able to see it only because the briefly radioactive cloud was low, and moving towards the detectors. This combination of circumstances might help to explain why the photonuclear signature has been seen so rarely. Enoto says that his team has observed a few similar events, but that the one described in the paper is the only clear-

cut event so far.

Babich also predicted that not all of the neutrons dislodged from nitrogen by a γ-ray are absorbed. Some of them instead will trigger the transmutation of another nitrogen nucleus into carbon-14, a radioactive isotope that has two more neutrons than ordinary carbon. This isotope can be absorbed by organisms; it then decays at a predictable rate long after the organism's death, which makes it a useful clock for archaeologists.

The main source of the carbon-14 in the atmosphere has generally been considered to be cosmic rays. In principle, lightning could also contribute to the supply. But it is not clear yet how much of the isotope is produced in this way, says Enoto, in part because it's possible that not all bolts initiate photonuclear reactions.

"I agree with their interpretation of their data," says physicist Joseph Dwyer of the University of New Hampshire in Durham. But, he adds, Enoto's team's explanation does not solve all puzzles related to positrons in the atmosphere. In particular, the photonuclear reaction does not seem to match an event Dwyer observed in 2009 from a research aeroplane. His detector spotted a signature of positrons only for a fraction of a second — too short to originate from nuclear decay, he says. Also, his detector saw no initial flash in that case. "If it was there, it should have been very obvious."

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Comments

Commenting is currently unavailable.

Black academics soon to outnumber white researchers in South Africa

Legacy of apartheid means academia has remained largely white.

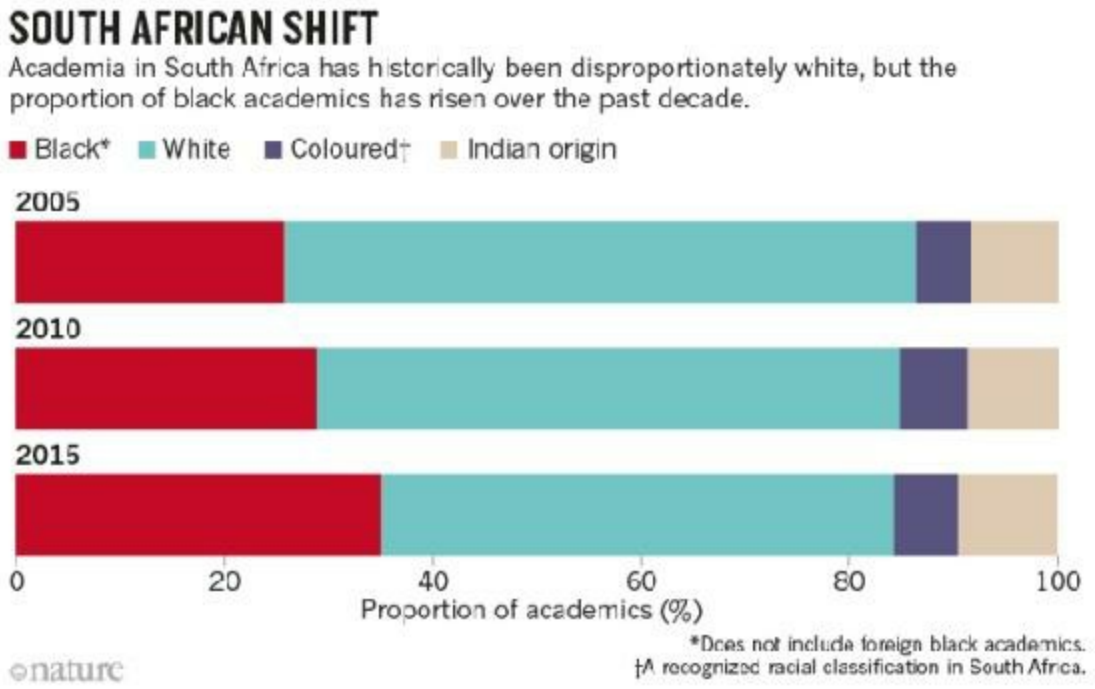
21 November 2017

There will soon be more black academics in South Africa than white ones, a study of demographic data suggests.

Although more than 80% of the country's population is black, its academic sector has remained disproportionately white — a legacy of the apartheid era.

But over the past decade, the proportion of black South African researchers has risen steadily: from 26% in 2005 to 35% in 2015, according to the study, which was published[1] in *Higher Education* last month. The proportion of white academics decreased by more than 10 percentage points over the same period, to 49% in 2015 (see 'South African shift').

"Our research shows that transformation is taking place and there are strong indications that it will accelerate in the future, particularly in the next decade," says David Hedding, a geomorphologist at the University of South Africa in Florida, Johannesburg, and co-author of the paper.



The authors suggest that in the next decade, more than 4,000 researchers — about 27% of the country's academics, and most of them white men — will retire, which should create opportunities for younger researchers. Black researchers could outnumber white ones some time between 2020 and 2025, they say.

Hedding says that it's not possible to attribute the change to a specific policy, but that the government should keep doing what it is currently doing. However, he thinks the country should focus more on nurturing PhD candidates and enticing them into academia. He and his co-author, geoinformatics specialist Greg Breetzke at the University of Pretoria, also note that black women, the country's largest demographic, remain significantly under-represented in universities, accounting for just 14% of academics in 2015.

Charles Sheppard, director of management information at Nelson Mandela University in Port Elizabeth, agrees that South Africa must focus on generating local PhDs. At the moment, it produces more doctorate-holders who hail from other African countries than from the home nation, he says. "We need to work harder on getting this right," he adds.

The latest study is the most well thought out, most evidenced-based and least anecdotal to address this complex problem yet, says Zeblon Vilakazi, deputy vice-chancellor at the University of the Witwatersrand in Johannesburg. “This is a step in the right direction,” says Vilakazi.

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Comments

Commenting is currently unavailable.

Hungary rewards highly cited scientists with bonus grants

Some top researchers prosper in Hungary as country tries to improve its international standing in science.

21 November 2017

Richard Wareham Fotografie/Alamy

Hungarian commissioner for research and innovation József Pálinkás has designed grants that reward research excellence.

Earlier this year, cell biologist Attila Reményi was facing his toughest decision since returning to his native Hungary a decade ago. With his

generous start-up funding about to run out, should he downsize his lab?

Then, in June, the government's National Research, Development and Innovation Office (NRDNI) put out a call for five-year basic-research grants of up to 300 million Hungarian forints (US$1.18 million) each for highly cited scientists such as Reményi. "It came out of the blue," says Reményi at the Hungarian Academy of Sciences (HAS) Research Centre for Natural Sciences, Budapest, who learnt on 13 November that he was among 12 winners.

But for NRDNI president József Pálinkás, the Frontline Research Excellence grants are the result of years of work. They are part of a plan to create a long-term, systematic plan of grants and rewards to encourage researchers in all fields to strive for world-class publications and to tempt Hungarian scientists working abroad to return. In a country whose leaders are coming under increasing criticism for autocratic and xenophobic tendencies, scientists say that the situation for science has never been rosier.

Under Viktor Orbán's nationalist government, this small, post-communist country has been steadily falling on *The Economist* magazine's Democracy Index. Last year, several foreign members of the HAS resigned, citing the failure of the academy to protest against what they saw as anti-democratic moves by the government. HAS president, mathematician László Lovász, responded that the academy is not a political organization. Scientists in the country are noticeably reluctant to comment publicly on politics, and several young researchers told *Nature* they fear that criticizing the government might compromise their careers.

Yet within this troubled political environment, Pálinkás, a physicist, has spent the past few years quietly persuading the government that basic science matters as much as product-focused research. Shortly after becoming president of the HAS in 2008, he created the Momentum system of start-up funding — one-time, five-year grants of up to 50 million forints per year — to encourage Hungarian scientists to set up independent labs back home. Reményi was a Momentum recipient in 2013.

In 2015, Pálinkás left HAS to become the founding director of the NRDNI, where he designed a system of regular grants to help ensure that returnees

stay after the start-up money runs out. The frontline grants are a key part of this, giving the recipients salaries equivalent to the European Union average, which is two-and-a-half times higher than the salary that a scientist would normally earn in Hungary. Around 50 of these grants will eventually run each year. The programme is modelled on European Research Council grants, but with a twist: only those who have published a paper in the past five years that counted among the top 10% most-cited papers in their discipline are eligible to apply. This approach “creates a lot of tension in the community, but without such serious selection science won’t work well,” says Pálinkás. To further encourage scientists to aim for quality over quantity, last year he introduced another reward for high-impact publication: researchers who within two years have a paper among the top 5% most highly cited in their field automatically receive a one-off payment of 20 million forints.

Hungary has a long tradition of research and outperforms other former communist countries in the EU on many measures. It has won more European Research Council grants and was the only country this year to win two Teaming grants: prestigious EU awards to create centres of excellence in 15 mostly eastern European countries in partnership with a western European research organization. It has also made some large investments, most generously in the Hungarian Brain Research Programme, launched in 2014, which has received 18.5 million forints up to 2021 and enabled many principal investigators to start their own labs. A 3-billion-forints programme has just been agreed in quantum technology. Five new programmes in areas including artificial intelligence and water research will be added next year, thanks to a 3% increase in the NRDNI budget, agreed in principle this month.

Hungary’s research performance still lags behind that of science-strong western European countries, however, and at 1.2% of gross domestic product, its research investment is well below the EU average of 2%. To support its scientific ambitions, Hungary has heavily invested its EU structural funds — subsidies to poorer regions — in expanding research infrastructure. The country’s scientists fear that when the current round of these funds runs out in 2019, these major investments may go to waste.

Pálinkás says that to avoid this, he will request a doubling of the national research budget in 2019. And despite the political challenges, Hungarian

scientists seem optimistic: “The situation for science is better than it has been before,” says Reményi. Immunologist Adam Dénes returned from the United Kingdom in 2012 to start his own lab at the HAS Institute of Experimental Medicine in Budapest, a move he describes as a “political, philosophical and career challenge”. But for now, he says, “the pluses are more than the minuses.”

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Comments

Comments

There are currently no comments.

European Medicines Agency to move to Amsterdam

The European Union’s drug regulatory body will leave London because of the United Kingdom’s Brexit plans.

20 November 2017

Aurore Belot/AFP/Getty

A man crosses a canal in Amsterdam.

After more than a year of uncertainty, the new home of the European Medicines Agency (EMA) is finally clear. The European Union member states chose Amsterdam from among 19 candidates, after a secret ballot on 20 November.

The transition is expected to be relatively smooth because more than 80% of staff indicated in a survey earlier this year that they would be prepared to relocate to Amsterdam with the agency.

Slovakian capital Bratislava had also been a hot favourite among commentators, most particularly because Slovakia does not yet host any EU agency. However, only 14% of the staff said they would be prepared to go there. In an interview with *Nature* last month, EMA executive director Guido Rasi said that a catastrophic loss of staff on such a scale might have crippled the agency.

The EMA, with its 900 or so employees, is responsible for determining the safety and efficacy of therapies and licensing them for marketing in the EU. It also monitors adverse reactions to marketed treatments. And it has been fundamental to the development of harmonized EU-wide regulations on 'advanced therapies' for serious diseases such as cancer — including treatments involving biological molecules, stem cells or cells that have been genetically manipulated.

In an analysis of the various bids in September, the EMA said that any transfer could result in delays to the approval of new medicines and a slowing down of some public-health initiatives such as those to tackle antimicrobial resistance. But full recovery could be expected in two to three years, it said.

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Comments

Comments

There are currently no comments.

How alkali flies stay dry

Waxy and hairy covering enables flies to dive underwater without getting wet.

20 November 2017

Floris van Breugel/Caltech

More than 150 years ago, American writer Mark Twain described how flies enter Mono Lake in California then “pop up to the surface as dry as a patent office report”. Now scientists have identified how they do so.

The alkali fly *Ephydra hians* can crawl down the side of the lake to depths of 8 metres and remain submerged for 15 minutes before emerging unscathed. Not only can it achieve this unusual feat, it does so in a lake whose waters are so alkaline and so salty that they support only algae, bacteria and brine

shrimps.

Diving bubble

Now two biologists at the California Institute of Technology in Pasadena have worked out how the fly creates the bubble of air that surrounds it during the dive. Floris van Breugel and Michael Dickinson filmed flies entering a solution that mimics the sodium-carbonate-rich conditions of the lake. The flies are covered in hairs that are coated in a waxy substance that repels water. As they enter the water, an air bubble forms around their entire bodies, apart from their eyes. Not only is this bubble protective, it also provides the flies with breathable oxygen.

The scientists found that the flies had a denser coat of hairs than other species that were unable to stay dry underwater. They also found that the waxy substance that coats these hairs contained smaller hydrocarbons than those of other species. They think that these two traits combine to help prevent *E. hians* from getting wet, in particular as it emerges to the surface through the negatively electrically charged air-water interface created by the conditions in the lake. The researchers report their findings in the *Proceedings of the National Academy of Sciences*[1].

There are other shore flies of the same family (Ephydridae) that crawl underwater to lay eggs, but not in such hostile conditions, says van Breugel. He hopes to compare alkali flies from different lakes around the world.

During the annual autumn migration, there can be as many as 2 million birds at Mono Lake at any given time, says van Breugel, and the flies are an important source of food. “This story is a beautiful example of how tiny interactions can have global ecological effects, because Mono Lake is such an important habitat for migratory birds,” he says.

“Van Breugel and Dickinson's paper not only provides an insightful and detailed explanation of underlying mechanisms for this behaviour, it is also an elegant bit of insect natural history,” says Stephen Marshall, an entomologist at the University of Guelph in Canada.

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Nature
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doi:10.1038/nature.2017.23027

Comments

Comments

There are currently no comments.

UK government announces research-spending hike ahead of budget

Pledge would raise country’s public research funding to £12.5 billion in 2021–22.

20 November 2017

The UK government seems to be making good on its promises to increase research spending significantly over the next decade.

In an announcement on 20 November, the government said that it would boost public spending on research and development (R&D;) to £12.5 billion (US$16.5 billion) in 2021–22, an increase of £500 million on what is planned for the year before. The hike builds on a surprise announcement made last year, when politicians promised yearly increases in research funding until 2020.

According to the London-based Campaign for Science and Engineering (CASE), the increase puts the United Kingdom on track to hit a government target to raise combined public and private spending on R&D; to 2.4% of gross domestic product (GDP) by 2027.

That would be a huge uptick in spending for Britain: the most recent figures show that the country spent just 1.7% of its GDP on R&D; in 2015, compared with 2.9% in Germany and 2.8% in the United States.

Hitting the target will also require private investment in R&D; to rise, and some researchers had wondered whether the United Kingdom would rely on private spending to boost its budget past 2020. But writing in the *Times* newspaper to accompany the announcement — which came two days before

the release of Britain's annual budget — Prime Minister Theresa May confirmed that the government planned to increase its public spending on R&D; year on year.

"This gives confidence that the government's plan is to keep rising public R&D; investment on target over the next ten years to reach parity with our international competitors," said Sarah Main, director of CASE. "We seem to have turned a corner. Government is matching its long-term ambition with concrete investment."

The latest money forms part of the government's Industrial Strategy, a range of policies aimed at boosting the economy across the country. Full details of the strategy will be published on 27 November, but May added in her article that it would include ways to encourage UK leadership in artificial intelligence, big data, clean energy and self-driving cars.

Journal name:
Nature
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Comments

Comments

There are currently no comments.

Exoplanet hunters rethink search for alien life

Astronomers expand ideas of how chemistry and geology could affect chances for life on other worlds.

20 November 2017 Corrected:

1. 20 November 2017

Laramie, Wyoming

M. Kornmesser/ESO

The exoplanet Ross 128b orbits a cool dwarf star at a distance that could allov the world to have liquid water.

Steve Desch can see the future of exoplanet research, and it's not pretty. Imagine, he says, that astronomers use NASA's upcoming James Webb Space Telescope to scour the atmosphere of an Earth-mass world for signs of life. Then imagine that they chase hints of atmospheric oxygen for years — before realizing that those were false positives produced by geological activity instead of living things.

Desch, an astrophysicist at Arizona State University in Tempe, and other planet hunters met from 13-17 November in Laramie, Wyoming, to plot better ways to scout for life beyond Earth. Many are starting to argue that the standard definition of habitability — having liquid water on a planet's surface — is not the factor that should guide exoplanet exploration. Instead, the scientists say, the field should focus on the chances of detecting alien life, should it exist.

"Planets can be habitable and not have life with any impact," Desch told researchers at the meeting.

It turns out that water worlds may be some of the worst places to look for living things. One study presented at the meeting shows how a planet covered in oceans could be starved of phosphorus, a nutrient without which earthly life cannot thrive. Other work concludes that a planet swamped in even deeper water would be geologically dead, lacking any of the planetary processes that nurture life on Earth.

"Habitability is not only about finding the signature of an alien life form taking a deep breath," says Elizabeth Tasker, an astronomer and exoplanet researcher at the Japan Aerospace Exploration Agency's Institute for Space and Aeronautical Sciences in Sagamihara. It's also about how a planet's geology and chemistry interconnect to create a welcoming or hostile environment, she says — complicating the search for extraterrestrial life.

Surf and turf

Astronomers have catalogued thousands of exoplanets, of which more than a dozen are potentially habitable. The most recent, announced on 15

November, is Ross 128b, which is 3.4 parsecs (11 light years) away from Earth. It resembles the target that scientists have spent decades hunting: an Earth-sized planet orbiting a nearby star, probably at the right distance to allow liquid water.

Most of these planets have some qualities that stop them from being true Earth twins. Ross 128b orbits a cool dwarf star rather than a Sun-like host, for instance. But Tasker says the usual metrics that scientists use to rank how habitable a world is, such as its location relative to its star or how closely it resembles Earth, are misguided[1].

To figure out how to parcel out valuable observing time, some scientists suggest targeting planets that, like Earth, are thought to have a mix of ocean and land. That's because worlds with nothing but water on their surfaces may not have key nutrients available in forms that can support life — if it is based on the same chemistry as life on Earth.

“We have this stereotype that if we have oceans, we have life,” says Tessa Fisher, a microbial ecologist at Arizona State. But her recent work contradicts this idea. Fisher and her colleagues studied what would happen on an “aqua planet” with a surface that is almost or completely covered by enough water to fill Earth’s oceans five times.

On Earth, rainwater hitting rocks washes phosphorus and other nutrients into the oceans. But without any exposed land, there is no way for phosphorus to enrich water on an aqua planet over time, Fisher reported at the Laramie meeting. There would be no ocean organisms, such as plankton, to build up oxygen in the planet’s atmosphere, she says — making this type of world a terrible place to find life.

Wet blanket

The wettest planets would run into a different sort of trouble, says Cayman Unterborn, a geologist at Arizona State who analysed the planet-wide effects of having as much as 50 Earth oceans’ worth of water. The sheer weight of all that liquid would exert so much pressure on the sea floor that the planet’s

interior would not melt at all, Unterborn found.

Planets need at least some internal melting to sustain geological activity, such as plate tectonics, and to provide the right geochemical environment for life. In this case, Unterborn says, “too much water is too much of a good thing.”

Water-rich worlds are easy to make. Many planets are likely to have formed far from their parent star, Tasker says, in chilly temperatures where they could have coalesced from fragments of rock and lots of ice. If such a planet later migrated closer to its star, the ice would melt and cover the surface in vast oceans. Some of the seven small planets orbiting the star TRAPPIST-1, which is 12.6 parsecs (41 light years) from Earth, are thought to have substantial water on their surfaces[2].

Instead of instinctively studying such water worlds, Tasker says, astronomers need to think more deeply about how planets have evolved through time. “We need to look carefully at picking the right planet,” she says.

The James Webb Space Telescope is set to launch in 2019. Once in space, the telescope will spend much of its time studying potentially Earth-like worlds. Researchers have already begun to analyse how oxygen, methane or other ‘biosignature’ gases in exoplanet atmospheres might appear to the telescope’s view[3].

Towards the end of the Laramie meeting, attendees voted on whether scientists will find evidence of life on an exoplanet by 2040. They were not optimistic: 47 said no and 29 said yes. But a greater share was willing to bet that life would be found on another world in the 2050s or 2060s.

That's presumably enough time to work through the debate over which worlds are the best to target.

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Corrections

Corrected:

This story misstated the outcome of the vote at the Laramie meeting as 47% no to 29% yes. In fact, the result was 47 votes yes, 29 votes no.

Comments

Commenting is currently unavailable.

Online software spots genetic errors in cancer papers

Tool to scrutinize research papers identifies mistakes in gene sequences.

20 November 2017

Two scientists have rolled out a program that spots incorrect gene sequences reported in experiments — and have used it to identify flaws in more than 60 papers, almost all of them studies of cancer.

Jennifer Byrne, a cancer researcher at the Kids Research Institute of the Children's Hospital at Westmead in Sydney, Australia, and Cyril Labbé, a computer scientist at the University of Grenoble Alpes in Grenoble, France, made public an early version of the program, called Seek & Blastn, in October and now they want other researchers to test the program and help to improve it. They then plan to offer it to journal editors and publishers as an addition to the tools that most already use to check papers, such as software

to detect plagiarism.

Byrne has been working on identifying errors in human cancer papers since 2015, when she noticed problems with five papers on gene function in cancer cells. The authors of the papers described performing a common experiment in which they inactivated a gene using a short targeted nucleotide sequence, to observe its effects on tumour cells. Byrne was familiar with the gene because she was part of the team that reported it in 1998. And she realized that the papers reported using the wrong nucleotide sequences for the experiment they claimed to conduct. Two of these papers have since been retracted. Another two are expected to be retracted on 21 November.

Experimental errors

After noticing similar errors in another 25 papers, Byrne and Labbé developed the Seek & Blastn tool to discover more papers with incorrectly identified nucleotide fragments. The software extracts nucleotide sequences from uploaded papers and cross-checks them against a public database of nucleotides, called the Nucleotide Basic Local Alignment Search Tool (Blastn).

“Seek & Blastn tries to find mismatches between the claimed status of a sequence — what the paper says it does — and what the sequence actually is,” says Byrne. A mismatch is flagged, for instance, when a sequence described as targeting a human gene doesn’t find a match in the Blastn database. Sequences described as non-targeting that do have a match in the Blastn database are also detected.

So far, the program detects only misidentified human sequences, says Labbé, but the pair hope to develop it to check sequences from other species, such as mice. The program also struggles to pick up misidentified sequences if the description is unclear in the original paper. This can cause the program to miss some mistakes and to flag papers that have no errors, so all papers put through the software should also be checked manually, he says.

The pair say that they used Seek & Blastn to detect mismatched sequences in

another 60 papers. Many of these manuscripts have other problems, such as poor-quality images, graphs and large chunks of overlapping text, all of which make some of the papers “strikingly similar” to each other, says Byrne. With the help of colleagues, they are now manually checking the papers.

Although some errors are minor or accidental, Byrne says the majority of the mismatches they have detected in papers may invalidate the results and conclusions. When you see these incorrectly identified sequences, she says, “you do get concerned about how the results were produced and whether the results in the paper actually reflect the experiments that were done”.

In a 2016 study[1] in *Scientometrics*, Byrne and Labbé reported 48 problematic papers, including the 30 papers that had incorrectly identified nucleotide fragments. These were all written by authors from China. The duo did not publicly identify the papers, apart from the five papers from 2015, but privately contacted journal editors, Byrne says. Many of the editors have not responded, she says. But three more papers have been retracted. In total, the pair have identified incorrect sequences in more than 90 papers.

Automated tools such as Seek & Blastn are most valuable if they are used to promote good scientific practice and encourage scientists to avoid errors in the first place, rather than just catch people out, says statistician David Allison at Indiana University in Bloomington, who has spotted many papers with substantial errors. Such tools could also help to quantify error rates in particular journals and fields, he says.

Matt Hodgkinson, head of research integrity for open-access publisher Hindawi in London, which retracted two of the papers from its journal *BioMed Research International*, says he could see publishers using Seek & Blastn as part of the article-screening process. “It would depend on the cost and ease of use, whether it can be used and interpreted at scale,” says Hodgkinson. Staff or academic editors would also need to check the output, given the risk for false positives, he says.

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