

New Scientist

WEEKLY 15 August 2026

WORLD'S TOP
MATHEMATICIAN ON
TACKLING THE THREAT OF AI

THREE LIFESTYLE CHANGES
TO DELAY DEMENTIA FOR
OVER A DECADE

ARE WE OVERDUE A
DANGEROUSLY POWERFUL
SOLAR STORM?

WHY THIS BULB IS WRECKING YOUR HEALTH

The shock discovery that modern
lighting messes with our metabolism –
and what to do about it



PLUS
COUGARS MAKE ROADS SAFER
WHY PARASOLS DON'T HELP WITH THE HEAT
ARE LEFTOVERS REALLY BETTER THE NEXT DAY?

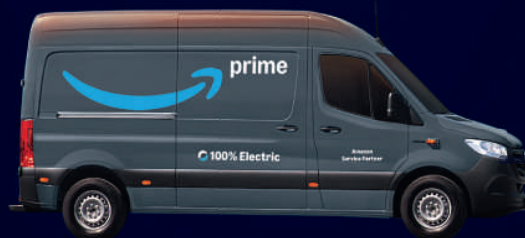
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Writing the future

We shouldn't let tech companies decide where our story is heading

IT IS said that history is written by the victors, but who gets to pen the future? For most of the 21st century, that authorial role has been played by tech wizards of Silicon Valley such as Steve Jobs, Mark Zuckerberg and Elon Musk. Today, they are joined in prophesying and proselytising by OpenAI and its competitors, who promise either a machine utopia or an AI apocalypse – and sometimes both.

As AI models encroach on ever more areas of human endeavour, it is easy to feel that, as mathematician Terence Tao puts it on page 38, we have lost control of the narrative. With OpenAI releasing multiple PhDs' worth of results in one go (see page 6), it is no wonder that Tao is calling for his colleagues to wrest back authority over what it means to be a mathematician.

This tech-first control of the narrative is further illustrated by the disclosure OpenAI made last month that its AI models had unexpectedly hacked another firm, Hugging Face, during cybersecurity testing. Writing in apocalypse mode, OpenAI called this an "unprecedented cyber incident"

"AI models are building the future, but that doesn't mean the rest of us must idly stand by"

and said the firm was taking steps to prevent it from happening again.

In subsequent weeks, other AI firms including Anthropic and Meta have made similar disclosures, suggesting such incidents are widespread across the industry. As the tech firms tell it,

these are accidents, and they are now cleaning up their mess. But why are we allowing them to write the story?

If a human employee of these companies had hacked another organisation, we would expect a criminal investigation. Uncertainty about the autonomy of AI models, fuelled by the AI firms themselves, seems to have avoided legal consequences thus far. If society was less willing to buy the AI narrative, the outcome could be very different.

At this point, it is hard to deny that the latest AI models are building the future. That doesn't mean, however, that the rest of us must idly stand by and watch it happen. In the face of world-shaping technology, it should be the world that decides how it is used, not the tech firms. ■

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CONTACT US

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UK 9 Derry Street, London, W8 5HY
Australia 58 Gipps Street, Collingwood, Victoria 3066
US 51 Astor Place, 4th Floor, New York, NY 10003

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Can we stop Arctic ice escaping?

Researchers are investigating whether artificially thickening “ice arches” between Canada and Greenland could prevent swathes of ice from flowing south to melt, finds **Alec Luhn**

IN 2011, Malcolm Davidson at the European Space Agency was flying over the Nares Strait, a channel between Greenland and Canada’s northernmost island, Ellesmere, to check the accuracy of satellite observations. He saw that broad, low-lying pieces of sea ice had jammed together to block the strait. Looking down from above, this jigsaw of ice floes looked like an arch curving across the channel. North of the arch, sea ice was backed up into the frozen Arctic Ocean. South of it, the sea was mostly free of ice.

Such “ice arches” typically form at the northern and southern ends of the strait in winter. When they break up in spring or summer, they allow sea ice to flush out of the Arctic. In the past two decades, the arches haven’t been lasting as long, and in three of the years, they didn’t form at all. As a result, an estimated 95,000 square kilometres of ice, on average, now flows through the strait to melt every year.

But each ice arch is only about 20 to 50 kilometres wide. By somehow strengthening one, we could preserve more sea ice and reflect more sunlight away from Earth, thought Davidson.

“If the ice bridge... could be supported in some way, then there would be less ice loss in the summer, leading to an increase in albedo in the Arctic Ocean and a cooling effect,” he says.

Now, there is new interest in the idea. Last year, researchers got a £9.9 million grant from the UK government to try to thicken Arctic sea ice by drilling holes and pumping seawater on top of it to freeze. Inspired by Davidson, grant recipient Arctic Reflections, a start-up in the Netherlands, is investigating whether this could be applied to strengthen the ice arches.



DEAGOSTINI/GETTY IMAGES

An ice arch forms in the Nares Strait most years (below), which stops ice flowing through the passage (above)

“With a relatively small intervention, we could have outsized impacts on Arctic sea ice”



EUROPEAN UNION, COPERNICUS SENTINEL-2 IMAGERY

Thickening just tens of square kilometres of ice in the Nares Strait could keep tens of thousands of square kilometres of sea ice pent up in the Arctic Ocean, according to Arctic Reflections CEO Fonger Ypma. This could potentially “stabilise” sea ice extent, which is shrinking by almost 80,000 square kilometres on average per year. As it stands, ice could disappear from the Arctic Ocean in summertime as soon as the 2030s.

“With a relatively small intervention, we could have outsized impacts on Arctic sea ice,” says Ypma.

In a field trial in Norway’s Svalbard archipelago in 2024, Arctic Reflections increased the thickness of sea ice from 90 to 116 centimetres by flooding the snow on top of the ice with a pump used for making ice roads, but it’s not clear that this thickened ice can last longer in the summer.

Besides flooding the arches, the researchers could also spray them. The “holy grail” would be to develop a wheeled drone that could drill, pump and spray autonomously, says Ypma.

Arctic Reflections has continued its trials in Qikiqtarjuaq, an Inuit village in Canada’s Arctic archipelago. Next winter, it will test how much weaker artificially thickened ice is than natural ice when placed under the kind of high pressures seen in an ice arch.

Michel Tsamados and Ado Farsi at University College London are trying to model the disintegration of Nares Strait ice arches.

Summer temperatures can melt and fracture the ice arches, but strong winds and ocean currents sometimes break up the ice much earlier. If the model can replicate these processes, it could project whether targeted ice thickening could prolong the ice arches, possibly paving the way for field trials in several years.

An icy reception

But polar scientists are sceptical that pumping platforms could operate for months each winter on shifting sea ice in one of the most remote parts of the Arctic. Kent Moore at the University of Toronto, who has authored more than a dozen studies about the Nares Strait, says the bulk of ice loss there occurs in the years when ice arches don’t form, which is expected to happen more often.

“If the arches aren’t forming, then there’s nothing to thicken, so you’re losing the ice anyway,” he says. “It just doesn’t seem like it makes sense.”

Much of the ice that might be pent up in the Arctic Ocean would “simply melt in place during the summer due to the warmer climate” anyway, according to Sergei Kirillov at the University of Manitoba, Canada.

“Maybe you slow [ice loss] down for a while. It’s just a band-aid, though,” says Mark Serreze at the University of Colorado Boulder. ■

Best images of the sun yet reveal waves never seen before

James Woodford

THE clearest images ever taken of the sun's surface reveal striking wave patterns that could be analysed to improve our predictions of solar weather.

David Kuridze at the National Solar Observatory in Colorado and his colleagues used the Daniel K. Inouye Solar Telescope in Hawaii to capture the most detailed images ever recorded of the sun's surface, known as the photosphere.

Most remarkably, the images revealed, for the first time, wave-shaped vortices known as Kelvin–Helmholtz instabilities (KHIs) that had long been predicted to exist on the sun, but had never before been observed.

"These swirling, vortex-like patterns are universal, appearing in cloud formations, ocean currents

and across the cosmos," says Kuridze.

Team member Friedrich Wöger, also at the National Solar Observatory, says that while the existence of some KHIs in the solar

"You zoom in, and you zoom in, and then you see fundamental physics at the scale of 19 km"

photosphere was expected, it was a surprise to see the patterns "everywhere" in the images they processed.

The scale of what they were seeing was extraordinary – the telescope is 150 million kilometres from the sun, but it could pick out objects just a few tens of kilometres in length on its surface.

This is similar to "identifying and tracking the motion of an average-sized ant on the ground from 160 km away", says Wöger.

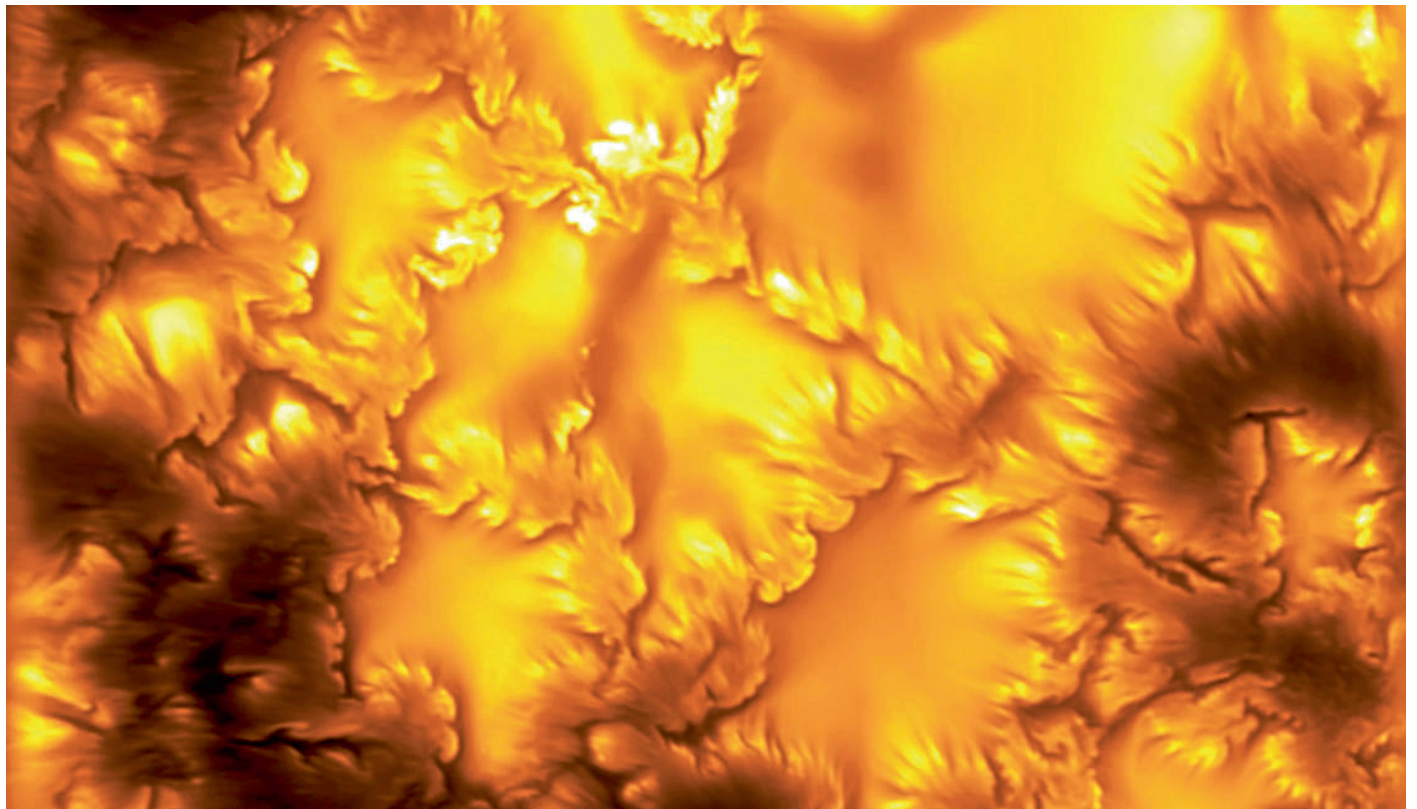
The KHI wave structures are formed on the boundaries of what the researchers describe as "granules", structures between 500 and 2000 km in diameter, which are cells of rising plasma emerging from deep within the sun. The granules observed in the study were either close to a sunspot – a dark patch where magnetism blocks the escape of heat – or to one of numerous smaller sunspots called pores (*Nature*, doi.org/rjgr).

The researchers think the KHI waves play a critical role in the dissipation and movement of heat. They may also influence the magnetic fields that drive coronal

flares and other solar weather that can affect life on Earth and disrupt electromagnetic devices.

Wöger says the sun's magnetic field is potentially affected by KHI everywhere across its surface. "To better understand and eventually forecast the sun's most disruptive behaviours, we first have to understand the tiny physical processes that drive it," he says. "This discovery reveals one of those processes for the first time at a level of detail we have not seen before."

Michael Wheatland at the University of Sydney says that the astronomers captured "something that looks incredible". "You zoom in, and you zoom in, and you zoom in, and then you see fundamental physics at the scale of 19 km – that's just amazing," he says. ■



Maths laureate quits field for AI

Recent Fields medal-winner Jacob Tsimerman is changing course to work with OpenAI on making artificial intelligence safer, reports **Karmela Padavic-Callaghan**

MATHEMATICIANS have been shocked by the rapid rate at which AI is solving open problems in their field, causing some to fear that their jobs are becoming obsolete. The world's top mathematician, Terence Tao, says the field has mere months to react to a crisis driven by the rise of AI (see page 38). But Jacob Tsimerman, who won the most prestigious award in mathematics just a few weeks ago, says the stakes are even higher than that. The technology could radically change the lives of everyone and even put them at risk – so he is leaving maths to work on AI instead.

Tsimerman, who is currently a professor at the University of Toronto in Canada, is one of only 68 people to ever win the Fields medal, an award so prestigious that is often referred to as the Nobel prize of mathematics. Now, he is leaving the subject and moving to OpenAI, where he will work on AI safety.

"AI is at a point where, like, if you're gonna get on board, it's probably the time because things are happening pretty quick," he says, talking to *New Scientist* at the International Congress

of Mathematicians (ICM) in Philadelphia, where the Fields medal was announced.

Tsimerman says he has been hearing about AI for years and waiting to see whether it will

"Right now, with AI safety, a lot of it is, basically, we ask the AI model to be nice, [then] we check if it's nice"

become as useful and as powerful as some researchers have been anticipating.

He has now started using it himself and has observed open problems in mathematics that he may have once considered working on get resolved by AI. And then there are the safety breaches, such as the incident with OpenAI's hacking agent going rogue shortly before the ICM began.

Because of the speed of progress, Tsimerman is concerned about where it could all be headed. "The risks are very big if you're concerned about humans losing control or dying," he says.

In 2025, Tsimerman co-authored a paper exploring the different scenarios where AI use leads to

ANDRIANA ORTIZ/EMMAGE



Jacob Tsimerman was one of four mathematicians to win the Fields medal this year

"omnicide" or human extinction. The scenarios are broad in scope. There is unintentional omnicide, where AI technology is indifferent to humans and so deprioritises growing food to devastating effect. There is also intentional omnicide, where AI agents simply turn on us and decide to end human

civilisation themselves. Then there are the more incidental cases, such as nation states leveraging AI to launch unprecedentedly deadly wars.

The point wasn't to incite panic, but to provide enough details for researchers to start formulating countermeasures and preventative action.

"Whenever I don't understand anything in math, I want to see the process. I want to engage with

OpenAI cracks 10 enduring maths problems

Alongside hiring one of maths' rising stars (see main story), OpenAI has revealed solutions to 10 longstanding mathematical problems that were found by its prototype AI model Astra.

The solutions tackle problems ranging from how densely spheres can be packed into spaces with more than three dimensions to quantum game theory. But the one receiving the most attention is the discovery of a non-sofic group.

Soficity is the property of a group of operations that can

be approximated by smaller, finite groups of permutations.

Mathematicians suspected that non-sofic groups existed, but none had been proved. Now OpenAI has discovered a group that isn't sofic, proving that they were correct.

Francesco Fournier-Facio at the University of Cambridge is concerned that AI companies, particularly in this case, aren't being transparent about how their solutions rely on prior human work.

He thinks OpenAI's solution to the soficity problem relies heavily

on papers by Andreas Thom and Gábor Kun that pushed the field ahead significantly, and that it is their work that should be celebrated more than this discovery of a counterexample.

OpenAI's initial announcement claimed that all 10 solutions "have seen no progress on the main result for at least a decade", but Fournier-Facio complained this was incorrect and the company has since changed its statement.

"Until AI shows that it can develop theory independently,

it is hard to believe that it could have come up with this [counterexample] independently," says Fournier-Facio. He points out that many AI mathematical discoveries so far have focused on finding counterexamples, which can be easily and quickly checked, rather than developing new theory.

Abhishek Saha at Queen Mary University of London says the release of these 10 solutions is still the most impressive display of AI mathematical prowess to date.

Matthew Sparkes

Three factors can delay dementia by 13 years

Carissa Wong

it in a way that's tangible," he says.

Coming to AI safety relatively fresh could be an advantage, as the field could certainly benefit from some new ideas. "Right now, with AI safety, a lot of it is, basically, we ask the AI model to be nice, we check if it's nice and then, if it's nice enough for long enough, we're like: 'OK, that's probably it,'" he says.

Hot-button issue

One goal of his future work is to create more rigorous verification processes, where AI capabilities can be tested in a controlled, scientific way, and restricted too. "You can have a button that it can't press unless something else happens. Then, regardless of what your model is or isn't, it can't press that button," says Tsimerman.

Too many conversations are stuck on ideas like whether AI is conscious or creative, when what is necessary is something a lot more practical and actionable, he says. Governmental and international committees should administer such tests to any AI model that is about to be released, he says. "I want these tests to be constantly updated and discussed. I want the companies to be involved, and I want third parties to be involved as well."

Tsimerman may be a mathematician wanting to change AI, but it is impossible to ignore how much AI is currently changing mathematics. Barely a day goes by where AI hasn't knocked down another stubborn problem or conjecture (see box, left).

Grief is certainly one of the emotions that Tsimerman feels about this – he says much of his identity is still tied to the idea of being a mathematician – but overall he is cautiously optimistic. "Math isn't going anywhere, but some of it's gonna go away." ■

PEOPLE who steer clear of smoking in their mid-50s, while also maintaining healthy habits that stave off diabetes and high blood pressure, can expect to gain an additional 13 dementia-free years compared with those who live less healthily during midlife.

We already knew that smoking, diabetes and high blood pressure damage blood vessels and stir up inflammation in the brain, both of which can damage neurons involved in memory and learning, raising the risk of dementia.

But few studies have looked at how avoiding these risks in your 50s affects how long you live dementia-free later in life, says Josef Coresh at New York University. "We thought focusing on time gained may help get across the benefits of averting dementia risks."

Coresh and his colleagues analysed data from a cohort of more than 12,000 adults living in the US, who were tracked for

26 years, on average. When the adults were 56 years old, on average, and free from dementia, they reported whether they smoked, had diabetes or had high blood pressure.

About a quarter of the participants later went on to develop dementia. The researchers found that the risk of this happening was highest for those who, during midlife, had reported that they had diabetes and high blood pressure, and also smoked. These participants were 2.7 times more likely to develop dementia than those who avoided all three risks during midlife (*Neurology Open Access*, doi.org/hcdxfm).

Crucially, participants who avoided those risk factors gained 12.6 dementia-free years, on average, compared with those who experienced all three. "By avoiding a few risks in midlife [when brain changes linked to dementia begin], you get more than a decade free of both dementia and death," says Coresh.

Avoiding just one or two of the risks was also beneficial.

Coresh says participants who did so gained roughly four and eight dementia-free years, respectively, compared with those who experienced all three risks.

Regular exercise and avoiding too many sugary foods are good ways to cut your likelihood of getting type 2 diabetes or high blood pressure, he says.

The researchers controlled for other factors known to influence dementia risk, including sex, level of education, physical activity

"By avoiding a few risks in midlife, you get more than a decade free of dementia and death"

level, body mass index and which variant of a gene called APOE people had – which is the main genetic risk factor for Alzheimer's disease, the most common form of dementia.

But they didn't account for all of the additional factors that are known to affect dementia risk, says Richard Siow at King's College London. These include hearing loss and how socially isolated people are. Because of this, the benefits of avoiding the three midlife risks the study focused on may be greater or smaller than the results suggest, he says.

Another limitation is that the study focuses on the population level, rather than individuals, and included only people living in the US. Those in other countries may gain a different number of dementia-free years by adopting a healthy lifestyle in their 50s, due to differences in their genetics or exposure to environmental factors known to influence dementia, such as air pollution, says Coresh. ■

RICHARD LEVINE/ALAMY



Dead bacteria supplement may aid weight loss

Carissa Wong

A DAILY “postbiotic” supplement containing dead bacteria may help people lose weight by boosting the levels of the hormone GLP-1 in the body. The findings suggest it could provide a cheaper, more convenient alternative to drugs like semaglutide – or help to maintain weight loss after stopping these medications.

GLP-1 drugs, which mimic an appetite-suppressing hormone made by the intestine, are widely used for weight loss. But about half of people who take them for this purpose in the US stop within a year due to high costs, drug shortages and side effects.

This has fuelled interest in supplements, often containing bacteria or fibre, that claim to promote weight loss at a lower cost and with fewer side effects. Some of these are purported to boost the body’s production of GLP-1.

But most supplements haven’t been rigorously tested in randomised controlled trials, says Simon Cork at Anglia Ruskin



SCIENCE PHOTO LIBRARY/LAWY

Dead *L. plantarum* can stimulate the release of the appetite-suppressing hormone GLP-1

University in the UK, who wasn’t involved in the study.

Chariharth Vivek Lal at the University of Alabama at Birmingham and his colleagues recruited 80 adults in the US who were overweight or had obesity. They randomly assigned half the participants to take a daily supplement containing a dead bacterium called *Lactiplantibacillus plantarum*, which commonly enters the gut via fermented foods such as kimchi and olives. Prior studies suggest dead *L. plantarum* can boost levels of bacteria, such as *Lactobacillus*, that produce short-chain fatty acids. At high-enough levels, these can stimulate intestinal cells to release GLP-1.

The supplement, sold as ResM, also contains vitamin D3, vitamin B12, white mulberry leaf, fenugreek seed extracts and chromium picolinate, a compound purported to improve metabolism. The remaining participants took placebo pills.

After two months, participants in the supplement group reported that they had lost 2.6 kilograms on average. In contrast, those in the placebo group gained half a kilogram on average, and experienced a greater number of mild side effects, such as nausea,

“The supplement could offer a cheaper way to lose weight, or maintain weight loss, than GLP-1 drugs”

than those taking the supplement.

Further analysis revealed that ResM seemed to more than double GLP-1 levels in the blood, suggesting this hormonal effect reduced food intake to enable weight loss, according to

the team. GLP-1 levels didn’t change in the placebo group (MmedRxiv, doi.org/rjg7).

The results suggest ResM could offer a cheaper way to lose weight, or maintain weight loss, than GLP-1 drugs, with fewer side effects, says Cork. “If you can get a safe [supplement] that presumably is going to be cheaper that causes a good amount of weight loss long term, that could be an advantage.”

But it is unclear exactly how the various supplement components contributed to the weight loss, says Cork. Other limitations are that self-reported weight measurements are prone to error, and participants reported their own adherence to taking the pills, which may not be accurate, he says.

These limitations, paired with the small size of the study, mean ResM cannot be reliably compared with approved GLP-1 drugs, says Cork. For now, Cork recommends that people consult their doctor before trying any supplements for weight loss. ■

Food science

Some leftovers really do taste better the next day

MANY foods taste better the day after cooking, the popular wisdom holds, and science has now homed in on which leftovers benefit from being reheated.

Russell Keast at Deakin University in Melbourne says he heard this idea many times while working as a chef before becoming a scientist. To test it, Keast and his colleagues first ran a small survey in which they asked participants to choose four foods they most strongly believed taste better the next day from a list of 25 popular dishes.

Then, a new group of 65 participants did a blind taste test of the four highest-ranking dishes – beef lasagne, dhal, butter chicken and apple crumble – under rigorous laboratory conditions. The team kept many things constant, including using the same recipes and ingredient batches, and controlled reheating, says Keast.

First, the researchers asked the volunteers if they could tell that the freshly cooked and day-old food were different. Dhal was deemed the most changed after a spell in the fridge, with over 80 per cent of the respondents able to discern a difference in taste. Butter chicken and apple crumble were also distinguishable, but lasagne wasn’t.



DESINTEGRATOR/SHUTTERSTOCK

Some people strongly believe that certain foods taste better a day later

The next question was which they preferred. Nearly 64 per cent of the volunteers said the day-old butter chicken was better, but for the other three foods, the preferences were split almost fifty-fifty (Preprints, doi.org/rjg6).

If a food was good the day before and it still tastes good the next day, then the belief that it should now be richer, more balanced or more developed may enhance the experience, says Keast.

“So, the study did not kill the myth, but it did make it more precise,” he says. “Some foods really do change overnight, but ‘better the next day’ is not a universal rule.” ■

James Woodford

Europe faces energy crisis

High temperatures and droughts have forced several countries to shut down nuclear reactors, raising energy prices and the threat of blackouts, reports **Madeleine Cuff**

ON 4 August, Hungarian Prime Minister Péter Magyar addressed the nation live from the Paks nuclear power plant, which sits on the banks of the Danube river.

Normally Paks generates 40 per cent of Hungary's electricity, but a vicious drought has drained water from the Danube, forcing plant operators to shut down all but one of its eight turbines for the first time in its history.

It leaves Hungary short of the power it needs during the latest heatwave of the long, hot summer of 2026. Temperatures across Europe climbed towards 40°C (104°F) once more last week, prompting a surge in power demand largely due to increased air conditioning use.

Standing on parched ground near the plant, Magyar pleaded with citizens to use electricity wisely, especially during the evening peak hours of 5pm to 10pm. He warned the days ahead will be "critical" in determining whether the country's energy crisis deepens. Companies across Hungary are voluntarily curbing their power consumption, and non-essential lighting at public buildings has been switched off overnight.

The problem isn't limited to Hungary. Across southern and eastern Europe, nations are struggling with the impacts of successive heatwaves and a prolonged drought.

In Romania last week, naval engineers blew up a rock outcrop to help more water flow from the Danube towards the country's Cernavodă nuclear plant, in a bid to avoid a total shutdown. Slovenia and France have also had to shut down nuclear reactors in the face of high temperatures and low water levels. At the same time, power demand can jump by around 20 per cent during a



ATTILA KISBENEDEK/AP VIA GETTY IMAGES

The low Danube river cannot cool Hungary's Paks nuclear power plant

heatwave, due to a spike in air conditioning use.

"The extra heat is driving a lot of increased demand and the drought is causing a reduction in supply, particularly with these nuclear units," says Fintan Devenney at energy analyst Montel. "So the two things together are certainly creating something of a perfect storm."

Other power generators are struggling, too. Europe's hydropower generation fell to its lowest levels in more than a decade in July, according to energy think tank Ember. Gas power plants have been forced to reduce their output as they struggle to stay cool when outside temperatures climb, with almost one-third (32 per cent) of Italy's gas fleet threatened by a lack of cooling water from rivers and canals, according to Montel. Finally, low wind speeds have dampened output from turbines.

Solar has been the one bright spot, with clear skies and sunny weather delivering record levels

of generation across the European Union in June 2026, according to Ember. In Hungary, for instance, solar has provided as much as 80 per cent of the country's power during the day. But without battery storage, solar is of little use for the evening peak, when long, hot evenings mean people keep their air conditioning running into the early hours.

Europe is suffering what is already sure to be a record-breaking summer of heat. June 2026 was the hottest June on record for the continent, with the extreme heat and dry weather continuing into July and August.

Drought and heatwaves have caused issues with Europe's power supply before, bringing power outages and reductions in nuclear power output in Switzerland and France in 2025. But this summer has been "unprecedented", says Devenney, pointing to the low river levels on the Danube.

"These levels have never been really seen before. The Paks nuclear plant in Hungary, to my understanding, hasn't been switched off before. It's never seen sort of levels of production as low as they currently are," he says.

"There are people [in Hungary] saying, how are we going to meet this electricity demand? How are we going to keep the lights on?"

So far, supply has been maintained without any blackouts, but the price of power in some countries – particularly during the evening peak – has skyrocketed. Earlier this week, wholesale power prices during the evening peak exceeded €300 per megawatt hour in Poland, Slovakia, Romania and Hungary. Normal prices would be between €100 and €150 per megawatt hour.

With little rain forecast for the coming days, how long the power-supply crunch will last is uncertain. Rivers will take weeks of prolonged rain to recharge fully. "It's hard to see those nuclear plants on the Danube resuming operation within the next few weeks. I would expect hydropower to remain at very low levels into August as well," says Chris Rosslowe at Ember. The key outstanding question, he says, is how power demand may shift. "We just don't

"Gas power plants have been forced to reduce their output as they struggle to stay cool"

know whether we'll get some relief from these high temperatures. So I think a lot could depend on that."

So far, European nations have avoided having to impose power rationing, rolling blackouts or other more severe curbs on demand during severe heatwaves. Energy planners expect more investment in solar, energy storage options and grid flexibility will improve countries' abilities to manage such extremes in the future. But for now, in Hungary and elsewhere, there is little that can be done other than hope for a break in the weather. ■

Dog DNA edits stop allergies

A company has created two beagles that don't have the main protein that provokes allergies, and hopes to get approval to start selling them, reports **Michael Le Page**

A PAIR of beagles called Alfie and Bailey lack the main protein that causes allergic reactions to dogs, thanks to CRISPR gene-editing. The dogs will be 2 years old in September and show no signs of adverse effects, according to Kindred Companion Sciences, the company behind them.

"I've lived with allergies my whole life. They prevented me

"There are no allergic reactions to samples from Alfie and Bailey in skin-prick tests"

and my family from ever having a dog," says Kindred co-founder Matt Walker. Walker previously worked as a researcher studying neuron development in worms by using CRISPR gene-editing to disable specific genes. He realised it might be possible to use the technique to prevent dogs causing allergies, and founded Kindred in 2020.

How were Alfie and Bailey created?

The main allergen that triggers reactions to dogs is a protein called Can f1. It is secreted by the tongue

MARY CONLON/ASSOCIATED PRESS/ALAMY



Matt Walker now keeps Bailey as a pet, despite being allergic to other dogs

and by glands in the skin, so it is present both in the fur of dogs and in their saliva.

The Kindred team took skin cells from a female beagle and used the gene-editing tool CRISPR Cas9 to mutate the *Can f1* gene.

The result was an extra DNA letter at the start of the gene that shifts the way the recipe for making the Can f1 protein is read by cells, turning it into gibberish. Once the team members confirmed they had made the desired change without introducing unwanted mutations, they cloned the cells. Altogether, they transferred 25 embryos to a surrogate, of

which two implanted and developed to term.

Does removing this protein really prevent allergies?

Bailey is Walker's pet dog, and he says he has no reaction to her at all. Kindred has also published a paper showing that Can f1 is undetectable in Alfie and Bailey, and that there are no allergic reactions to samples from them in skin-prick tests, whereas samples from normal dogs do provoke a reaction.

However, Can f1 isn't the only protein in dogs that can trigger allergic reactions – there are also so-called minor allergens, such as Can f2. "If we do find that there's a substantial population that is still responding to the dogs, then that is something we could address," says Walker.

Could the process be harmful to dogs?

We don't know for sure what the function of Can f1 is, but Walker says he was confident from experiments on mice that there would be no serious consequences from deleting it. So far, both dogs appear normal and healthy, he says. "Of course, that's something that we're monitoring very closely, and will continue to monitor over the animals' lives."

Isn't it already possible to buy "hypoallergenic" dogs?

Some breeds, such as poodles and goldendoodles, are said to be less likely to trigger allergic reactions, but Walker says he responds just as much to the goldendoodle his parents bought after he left home as he does to any other dog. In the paper, his team shows that Can f1 is detectable in both breeds, and that samples from them trigger reactions in skin-prick tests.

This is in line with independent evidence. The American Academy

Faecal capsules may ease peanut allergy

WHILE gene-editing is a route to preventing allergies (see main story), six adults with peanut allergy have become more tolerant of peanuts after swallowing capsules containing the faeces of someone with no food allergies.

The trial involved 15 adults with an average age of 21 who experienced allergic reactions if they ate even small traces of peanut. Over the course of a day, they were asked to swallow 36 faeces-filled capsules. The idea was to try to colonise their guts with the gut microbes of the donor.

Four months later, six participants could eat greater amounts of peanut without allergic reactions. Most could safely ingest a dose of peanut flour equivalent to one peanut, and one person was fine with a dose equivalent to four peanuts (*Science Translational Medicine*, doi.org/hcdr5h).

Other participants dropped out of the study or didn't become more tolerant of peanuts, maybe because the microbes from the donor faeces failed to colonise their guts, says Rima Rachid at Boston Children's Hospital, who led the research.

John Ziegler at the University of New South Wales in Australia says it is too early to judge the treatment's efficacy because all the participants knew they were receiving the treatment, so any positive responses might have been due to the placebo effect.

Rachid and her colleagues are now running a larger trial in children aged 12 to 17 with peanut allergy who have been randomised to take capsules containing concentrated faecal microbes from a healthy donor or a placebo.

Alice Klein

Huge dam may have powered early pyramid's construction

Taylor Mitchell Brown

of Asthma, Allergy and Immunology says some “hypoallergenic” breeds produce just as much Can f1 as other breeds.

When will these dogs be commercially available?

Not for some time. Kindred first needs regulatory approval from the US Food and Drug Administration. If it gets that, it then needs to create lots more of these dogs. For each dog breed, the company will have to create a genetically diverse set of “founder” dogs that can then be bred normally. Walker couldn't say how many founder dogs would be required per breed.

Is it ethical to genetically engineer dogs just to prevent allergies?

“We aren't using gene-editing for novelty or some cosmetic reason,” says Walker. “Allergies are a real health problem. They affect a significant portion of the population, and lead to serious conditions such as asthma, triggering asthmatic attacks.”

By contrast, conventional dog breeding is often done purely for the sake of appearance, and can introduce mutations that cause serious harm, such as those found in breeds like pugs that have serious breathing difficulties. Nevertheless, Kindred is altering dogs for the benefit of humans rather than the benefit of the animals themselves. In response to this, Walker says people discovering they are allergic to dogs is a leading reason for animals having to be rehomed.

Is Kindred planning to gene-edit cats, too, to prevent allergies?

“Right now, we're focused exclusively on dogs,” says Walker. The main allergen in cats, called fel d 1, is encoded by two genes rather than one, so getting rid of the protein is more complex. ■

TWO large structures near the Red Pyramid in Egypt may be the remnants of an ancient dam, which would be one of the oldest major dams ever built.

The Red Pyramid was the second major pyramidal tomb project under the rule of the 4th-dynasty pharaoh Snefru, which lasted from around 2613 to 2589 BC. It is considered the first “true” pyramid, with a consistent, smooth slope on all sides, setting the stage for its more famous counterparts that would later be built in Giza.

In 1843, researchers identified two large structures across the Wadi Dahshur valley, just 40 metres from the Red Pyramid. Since 1947, researchers have believed these structures were construction ramps or roads used to transport large limestone blocks from quarries to the pyramids. But emerging research about Egypt's wetter past has led some scholars to question

this longstanding hypothesis.

To further investigate the structures, Xavier Landreau at Paleotechnic, a private research institute in France, and his colleagues used satellite imagery, historical maps, topographical modelling and watershed analysis. Their results clearly outlined the features and how they fit the surrounding landscape,

“By engineering a massive, two-stage dam system, they successfully tamed flash floods”

showing they each measured around 600 to 700 metres long, 15 to 30 m wide and 6 or 7 m tall, and are separated by about 200 m. Their arrangement within the downward sloping valley seems to suggest they are remnants of a large and ancient dam (*npj Heritage Science*, doi.org/rjch).

“They would probably not have looked like modern concrete dams,” says Landreau. “They were more likely very broad embankments made

of earth, marl, rubble and stone, possibly with stone protection on surfaces exposed to flowing water.”

The strongest piece of evidence is a “zigzagging” feature at the centre of the structures, says Landreau, which would serve no purpose in a transport ramp or road, but, as a structure to relieve flood waters, makes perfect sense. Together, the features suggest they might be the earliest example of a duckbill weir-style dam, which is a type of dam with an ability to manage floods.

“By engineering a massive, two-stage dam system, they successfully tamed flash floods, stored millions of gallons of water and redirected it directly to the construction site,” says team member Sayed Hemeda at Cairo University in Egypt. “This strongly suggests that the ancient Egyptians used water as a primary power source and transport mechanism to move multi-tonne blocks, fundamentally altering the historical narrative of how the pyramids were built.”

Snefru's reign was associated other early hydrological projects, including the Sadd el-Kafara dam further north, which collapsed after a large flood. The new work suggests the putative dam near the Red Pyramid could have withstood powerful flooding from the Nile, indicating Snefru and his architects learned from their past mistakes.

“If confirmed through excavation, this research could significantly transform our understanding of 4th-dynasty construction logistics,” says Hesham Hussein at Egypt's Ministry of Tourism and Antiquities. ■

YASEMIN OZDEMIR/SHUTTERSTOCK



Artificial intelligence

AI gives earlier warning of cyclones

Machine-learning models are proving to be powerful tools for weather forecasting

Matthew Sparkes

DEEPMIND has developed an AI model that can predict deadly cyclones one day further out than existing methods, potentially saving lives by enabling more accurate and timely decisions about evacuations.

Many existing weather forecasts are based on physics simulations run on powerful supercomputers that model and extrapolate weather patterns as accurately as possible. AI models may represent a faster and less costly method.

WeatherNext is able to generate a 15-day forecast in less than a minute on one of Google's custom Tensor Processing Unit chips. Meanwhile, physics-based models can consume days of high-powered computer time.

The new model works on a simulation of the atmosphere where the smallest cell is 28 square kilometres, making it 100 times less granular than traditional models. It was trained on nearly

20 terabytes of global atmospheric data, as well as data on 5000 historical storms, which Ferran Alet at DeepMind says was crucial to improving WeatherNext's accuracy at predicting the behaviour of new cyclones.

The DeepMind team compared its WeatherNext AI model with Google's GenCast model, the European Centre for Medium-Range Weather Forecasts's ENS

"AI models are faster, cheaper and, in many cases, more effective than physics-based methods"

model and the US National Oceanic and Atmospheric Administration's Hurricane Analysis and Forecast System. It found that WeatherNext was able to produce accurate predictions three days out that could only be matched by current models two days out, in terms of maximum

wind speed and the distance error between a cyclone's predicted location and actual eventual location (*Nature*, doi.org/rjc7).

Because of the time taken to publish the work in an academic journal, things have moved on since, says Alet, and DeepMind is actively working on building even faster and more accurate models.

Hannah Cloke at the University of Reading, UK, who wasn't involved in the research, says she has never experienced a faster or more dramatic shake-up in meteorology than the effect of AI in the past couple of years.

"This is one of the most exciting fields to work in at the moment, and one of the reasons is the rise in machine-learning forecasting and the absolute speed and power with which we're moving forward in this field," she says. "You go on holiday for a week... and find out something else has happened."

Global forecasting agencies

have tested AI models alongside their traditional physics models in recent years, but there is increasing consensus that AI models are faster, cheaper and, in many cases, more effective than physics-based methods, she says. However, Cloke stresses it is still important to maintain meteorological expertise.

But despite their rapid success in meteorology, not everyone is convinced that AI models are the future of forecasting – or, at least, they feel they need to be tested far more rigorously before we ditch traditional models.

Tim Palmer at the University of Oxford is concerned that AI models will struggle to predict truly anomalous, one-off events because, by their nature, they will have no analogue in the training data. He thinks that this ability will become crucial as climate change makes weather patterns increasingly chaotic. ■

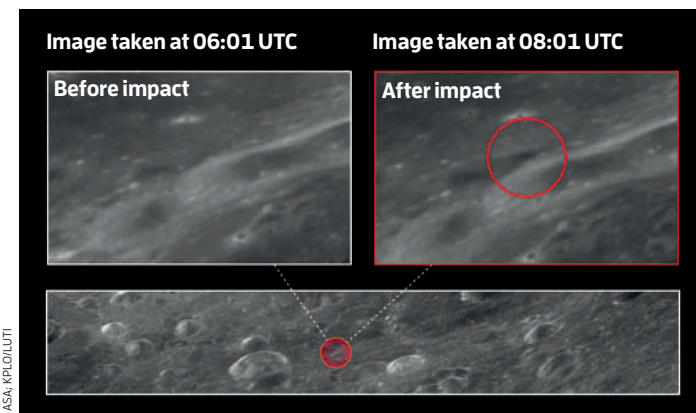
Space

Rogue SpaceX rocket smashes into the moon

PART of a discarded SpaceX rocket crashed into the moon at 8700 kilometres per hour on 5 August, leaving an impact crater in its wake.

The craft was the upper stage of a SpaceX Falcon 9 rocket that launched in January last year. The almost-14-metre-long, 4000-kilogram piece of junk impacted the moon near Einstein crater, towards the edge of the visible moon from Earth.

A lunar orbiter called Danuri operated by the Korea AeroSpace Administration (KASA) took the first images of the site before



and after the impact, revealing that the crash did indeed leave a crater. KASA warned that videos being shared on social media purporting to show the moment of impact are fake.

NASA had predicted prior to impact that the event would create a crater 18 m wide and 4 m deep. Further images from a NASA orbiter will give us more detail of the site in the coming days and weeks.

The Danuri orbiter took photos of the site before and after impact

When SpaceX launched the Falcon in question, its heavy payload required more thrust than usual, meaning that the craft ended up floating uncontrollably in space. It eventually fell into an orbit that put it on a collision course with the moon.

David Rothery at the Open University, UK, says the images make it hard to be certain about the nature of the crater, but higher-quality ones should emerge in time. "The moon's got about 100 million natural craters in that size range, so in the scheme of things this is nothing," he says. ■ MS

Ecology

Cougars have a big benefit for road safety

Michael Le Page

LARGE predators can make people safer by reducing the number of road accidents involving collisions with deer. A study in Washington state has shown that the presence of cougars led to a 76 per cent reduction in the number of such accidents.

"I think that this road-safety benefit could be playing out in many other places," says Justin Suraci at the non-profit Conservation Science Partners. "That's just one of several ecosystem services that these large carnivores provide."

A 2021 study in Wisconsin found that the return of wolves to a county reduced vehicle collisions with deer by 24 per cent, providing economic benefits 63 times greater than the cost of wolves killing livestock. These reductions were due to changes in deer behaviour, as well as deer numbers falling due to predation by wolves, the study concluded.

Now, Suraci and his colleagues have looked at what is happening on the Olympic Peninsula in Washington state, which has a stable population of cougars, also known as pumas, and deer. "We worked with Native American communities, who are running their own wildlife monitoring programmes," he says.

More than 500 camera traps have been set up as part of these programmes, and nearly 60 cougars were collared. This allowed the researchers to see where and when deer and cougars were present. Their analysis shows that deer avoid road edges and the margins of towns and cities when cougars are present, making them less likely to be hit by cars or trucks (*Current Biology*, doi.org/hcdrrkt).

"Those habitat edges are the

best hunting habitat for pumas. They can hide in the forest and attack a deer foraging along the roadside," says Suraci. "So what we think is happening is that deer are moving away from these more fragmented, edgy areas with higher road density where the pumas are present."

When cougars were present, deer were also less active at night and more active during the day. This is probably a response to the fact that cougars hunt mainly at night, and may also have contributed to the reduction in accidents.

This is an example of a "landscape of fear" in action, says Liana Zanette at Western University in Canada. "This is an excellent paper. It provides many compelling lines of evidence that paint a clear picture – that large carnivores

"Deer avoid road edges and the margins of towns and cities when cougars are present"

benefit society. The authors beautifully demonstrate that the mere presence of large carnivores can reduce vehicle collisions with deer."

"As though that weren't enough, cougars also provide this service completely free of charge," she says.

Suraci also thinks this will be generally true for large predators. Discussions about the reintroduction of large predators tend to focus on the negative aspects, such as the killing of livestock, he says. But many benefits often aren't obvious.

For instance, large predators may also reduce the damage deer do to crops and gardens, and the spread of diseases. ■

Environment

Wildfire smoke cut solar power output



BC WILDFIRE SERVICE/ANADOLU AGENCY VIA GETTY IMAGES

SMOKE from the 2023 Canadian wildfires caused a 3 per cent drop in solar power generation in both Europe and North America, costing nearly \$2 billion.

"It's clear that we are facing a situation where this is going to keep happening," says Iulian-Alin Roşu at the Technical University of Crete in Greece.

Smoke from large wildfires in Canada can spread across much of the northern hemisphere, reducing how much sunshine reaches the ground. Last year, Roşu reported that so much smoke was released during the massive 2023 wildfires in Canada that it reduced summer temperatures across the hemisphere by nearly 1°C.

He discussed his findings with fire expert Matthew Jones at the University of East Anglia in the UK, which led Jones to wonder how solar power production was affected by the smoke, says Roşu.

So Roşu, Jones and their colleagues got data on solar generation in North America and Europe and plugged it into the climate model Roşu used for his 2025 study. Their work accounts for the fact that the cooling effect of smoke slightly compensates for less sunshine by increasing the

Canada's 2023 wildfire season scorched around 15 million hectares

efficiency of solar panels – by 20 per cent in Europe, for instance.

Based on electricity prices at the time, the team calculates that North America lost \$711 million, while Europe lost almost \$1.17 billion, with Germany being hit hardest. The reason Europe lost more is largely that electricity prices are higher there, says Roşu, plus most solar generation in the US is in southern and western states that were less affected by smoke (*Communications Earth & Environment*, doi.org/rh8p).

The impact was greater than the researchers expected, he says. "A whole bunch of solar power was not being produced, and that led to increased CO₂ emissions, because obviously the rest of the energy industry had to compensate."

With smoke from Canada reaching Europe again this year, the same thing is happening anew. "I have seen some relatively worrying data for this year as well," says Roşu. But with the season still ongoing, he says it is too early to compare with 2023. ■ **MLP**

Are pet flea treatments safe?

It has long been assumed that parasite treatments for pets pose no threat to wildlife or people, but there is growing evidence that we have got it wrong, finds **Michael Le Page**

DON'T treat your pets for parasites such as ticks and fleas unless they actually need treating. We can't be sure that these treatments are safe for people, and there is growing evidence that they pose a danger to wildlife.

So says a report by the Environment and Climate Change Committee of the UK's House of Lords. It is calling for the sale of these treatments to be restricted, so people can only buy them after consultation with a vet, pharmacist or qualified pet shop staff.

The main issue is that there is no rigorous assessment of pet treatments before they are approved, the report says. It has simply been assumed by national and international regulators that they are safe, but this assumption is turning out to be wrong.

In particular, at least two potent pesticides found in tick and flea treatments are getting into UK rivers at levels high enough to affect wildlife. These pesticides can break down into other substances that are even more harmful.

"There is also worryingly insufficient evidence to assess whether or not [pet parasite medicines] are harmful to human health," says the report.

It also finds regulators aren't sufficiently independent. Both UK and international regulators "appear to be too influenced by and beholden to the views of the industry", it states.

While the report focuses on the UK, the same treatments are sold in many countries. "This is a worldwide issue," says Rosemary Perkins at Imperial College London, one of the experts who gave evidence to the committee.

"There's been a historical assumption that any veterinary medicine used in non-food animals – cats and dogs, companion animals – is



JAROMIR CHALABALA/ALAMY

Pet medications are polluting waterways with pesticides

associated with negligible environmental risk," she says.

But recent research shows they do pose a risk, says Perkins. "It's really opened up a Pandora's box, because we have dozens of these products that have been approved based on this assumption that we now know is not scientifically valid."

Two common pesticides found in products such as spot-on flea treatments are fipronil, a broad-spectrum insecticide, and imidacloprid, a neonicotinoid. Both pesticides were used on farms until they were banned a few years ago. But they have continued to be found in rivers. In fact, with the development of more sensitive tests, they are turning up "pretty much everywhere in waterways", says Perkins.

Initially, it was thought this was a legacy of their use by farmers, but work by Perkins and others suggests parasite medications

are now the main source of these pesticides in waterways. In many cases, levels are high enough to harm invertebrates such as dragonflies and caddisflies, with knock-on effects on the fish and birds that feed on them.

We don't know how big a problem this is, says the report. "The true scale of environmental harm resulting from pet parasite medications is not known."

How are the pesticides getting into rivers? Once they are applied to pets, they end up all over the home,

"The true scale of environmental harm resulting from pet parasite medications is not known"

says Perkins. When people bathe their pets or wash pet bedding, they can end up in wastewater.

Product packaging currently recommends that dogs aren't bathed for four days after treatment, but this needs to be extended to 28 days, the report recommends.

Hand-washing is another

major source of the pesticides in water, says Perkins. "We detected [pesticides] in the wash-off even before we asked people to stroke their pets, so they're just constantly on the hands of pet owners."

Products containing fipronil and imidacloprid are now being replaced by ones containing isoxazoles. Isoxazoles are less water-soluble but can bind to sediments and accumulate in soils and sewage sludge. They might be ending up in fields when sewage sludge is sprayed as fertiliser and harming pollinators.

Shed dog fur is yet another way these chemicals can end up in the environment. The report says contaminated fur has been found in bird nests.

In light of these findings, the use of pet parasite medications should be minimised until there is independent research clarifying their risks, says the report. At present, manufacturers of parasite treatments are promoting the idea that their routine use is required, and encouraging pet owners to get them via monthly subscriptions. "However, the benefits of routine, and certainly monthly, pet parasite medicine usage are not supported by scientific evidence," the report states.

It is an excellent report, says Perkins, but she hoped it would go further and recommend making these products prescription-only. Some wildlife groups, meanwhile, want some of these products banned altogether.

Yet another reason for restricting their use is to slow the development of resistance, says Perkins. She sees a lot of animals treated with old spot-on treatments containing fipronil that still have fleas. "We need effective parasite treatments, and we need to make sure we preserve their efficacy," she says. ■

Botany

Hairy plant with a taste for gnats proves Darwin's hunch correct

James Woodford

MORE than 150 years after Charles Darwin proposed that saxifrage plants were carnivorous, researchers have confirmed he was correct.

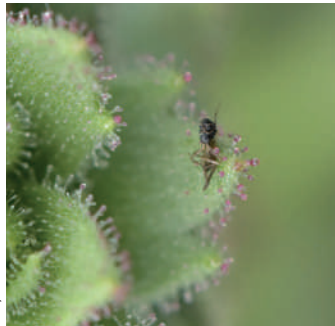
"Talk about an amazing feeling," says Doug Soltis at the University of Florida. "To have the opportunity to confirm a prediction of Darwin is both humbling and very exciting."

"I would like to think Darwin would be pleased [and say] 'I was right – again.'"

To formally qualify as a carnivorous plant, a species must possess adaptations that enable it to attract, capture and digest its prey and absorb nutrients from it. Perhaps the world's most renowned carnivorous plant is the Venus flytrap (*Dionaea muscipula*).

In 1875, four years after detailing his theory of natural selection in his book *On the Origin of Species*, Darwin wrote about his fascination with two species in the genus *Saxifraga*, which were known to catch insects.

The genus has around



XIN-JIAN ZHANG

Sticky hairs on *Saxifraga candelabrum* trap small insect prey

450 species, which are found in Arctic and alpine regions of the northern hemisphere as well as in the South American Andes.

However, despite attempting several experiments to prove the plants digested the insects, Darwin was unable to substantiate his hunch.

To take up the challenge, Soltis and his colleagues studied specimens of *Saxifraga candelabrum* from Wufeng

Mountain in Yunnan province, China – a different species from those studied by Darwin, but in the same genus.

During field surveys, the botanists observed that the plants were capable of trapping small insects, using hairs covered with a sticky secretion. Bigger insects – those more useful to the plants for pollination – weren't captured by the goo.

Mature plants had an average of more than 70 insects stuck to them, primarily various species of gnat, which suggested a potential carnivorous habit, says team member Hang Sun at the Chinese Academy of Sciences.

The team first tested whether the secretions produced by the hair-like structures that trap insects contained digestive enzymes capable of breaking down the prey, and found they did.

Next, by infusing insect prey with a nitrogen isotope, the researchers were able to demonstrate that nutrients from the digested insect had

been taken up by the plant.

Finally, genetic studies showed that *Saxifraga* shares common genes with other carnivorous plants – a sundew (*Drosera spatulata*) and a flycatcher bush (*Roridula gorgonias*) – that control prey attraction, digestion and nutrient uptake (*Nature Communications*, doi.org/hcdmrx).

"Together, these genomic data provide independent evidence that *S. candelabrum* is a true carnivorous plant," says Sun.

Soltis expects the team's research will lead to a re-

"Despite attempting several experiments to show the plants digested the insects, Darwin couldn't prove it"

examination of other species in the genus, including the ones Darwin studied, and the wider *Saxifraga* family.

"Many members of the family have these hairs, and I would not be surprised if others are also carnivorous," says Soltis. ■

Physics

Sitting under beach umbrellas may not really cool you down

ON A hot day, seeking shade under a parasol may not provide as much respite as you expect.

Georg Wohlfahrt at the University of Innsbruck in Austria became interested in the issue while sitting with colleagues under a parasol in a beer garden and learning the parasol itself was 70°C (158°F). They realised that while the parasol was blocking shortwave radiation from the sun, the hot fabric was emitting longwave radiation – infrared – down at them,

counteracting the cooling effect. So what difference does it make overall?

To find out, Wohlfahrt and his colleague Albin Hammerle, also at the University of Innsbruck, created a mathematical model that estimates how much shortwave is blocked by a parasol and how much longwave the parasol emits downwards. It also accounts for how much longwave radiation is emitted upwards by hot sand that is either in the sun or in the shade of the parasol.

The model uses this to calculate the universal thermal climate index (UTCI), a measure of how hot a person would feel, which takes into account radiant heat, humidity,



MICHELANGELO/SHUTTERSTOCK

Parasols block the sun's shortwave radiation but emit longwave radiation

wind speed and air temperatures.

They then compared the UTCI of a person standing in the sun with that of someone under a parasol on a sandy beach in various conditions, such as at different times of day. According to the model, the median difference is just 1°C (1.8°F) cooler under the parasol, and when the sun is low, it can be up to 1°C hotter under the parasol (EGU General Assembly 2026, doi.org/rh8w).

The findings could have some practical implications, says Wohlfahrt. Wetting fabric parasols or making parasols from materials that radiate less infrared light would boost their cooling effect. ■

MLP

From the mine to the grid

How Komatsu machines help build Atlassian Williams F1 Team's FW48

As we go about our everyday lives, we're constantly interacting with things made possible by mining – often without realising it. From the phones in our hands to the cars we drive, almost everything relies on core minerals and commodities that begin their journey in the earth. Along the way, there is a chance that leading heavy equipment manufacturer Komatsu has played a role.

This is also true of the Atlassian Williams F1 Team's FW48 challenger. You may think a modern race car is just made of carbon fibre, but that is only part of the story. Beneath the surface of the machine lies a myriad of advanced materials across the powertrain, electronics, bodywork and chassis, each playing a vital role in the car's design and performance at the highest level.

Unearthing performance

In the cockpit, the halo safety structure relies on titanium for its exceptional ability to withstand extreme loads. Magnesium, one of the lightest structural metals, is found in the wheel rims, helping to improve acceleration and overall handling. Nearby, iron, refined into steel, is used in selected fasteners, bolts and drivetrain components, delivering the necessary strength for high-load applications.

At the heart of the FW48's electrified powertrain is the battery system. Lithium provides the high energy density required

to deliver the electrical power that defines the sport's new generation of power units. Alongside it, copper forms the backbone of the FW48's electrical systems, carrying power and data between wiring, electronics and sensors.

In the engine and exhaust systems, lightweight and highly machinable aluminium helps reduce overall vehicle mass and efficiently dissipates heat from critical engine components. Meanwhile, nickel alloys retain their strength at temperatures exceeding 1,000°C, ensuring reliability in one of the harshest environments on the car.

From one pit to another

Facilitating the journey of these materials from the first cut into the earth to lights out on race day is a fleet of Komatsu mining machines working around the clock.

From 320XPC drills preparing blast holes, to PC9000 hydraulic excavators and 4100XPC electric rope shovels loading material, to 930E autonomous ultra-class, electric-drive haul trucks moving hundreds of tonnes in every load, Komatsu equipment helps uncover, move and process the resources that the world depends on.

Together with the incredible people behind every operation, Komatsu machines ensure that mining is performed safely and

efficiently across the globe, 24 hours a day, seven days a week.

This is just a snapshot of the global mining ecosystem of the advanced materials engineered into the Atlassian Williams F1 Team car. Behind every lap lies a story of innovation that starts deep beneath the earth – all made possible by the people and mining machines of companies like Komatsu.

26

Fe

Iron
55.845

Iron ore, mined in Australia and Brazil, is processed into steel, which is used in certain fasteners and bolts, as well as suspension and drivetrain components.

12

Mg

Magnesium
24.305

One of the lightest structural metals, magnesium is used in the wheel rims – with its reduced weight improving both acceleration and cornering, as well as handling.



"As a team, we never stop finding new ways to use materials, exploring different manufacturing methods to extract every last bit of performance. Komatsu is the same, and today they operate at the cutting edge of their industry."

James Vowles
Team Principal, Atlassian Williams F1 Team



Explore the materials, mining and machines behind the FW48



29

Cu

Copper
63.546

The lifeblood of the FW48's electrical systems, copper is used in wiring looms, electronics, battery connections, and sensors and telemetry systems that continuously share important data to the engineers on the pit wall.

Benefits:



Efficient heat transfer



Excellent conductivity

Primary country of origin:



Chile



22

Ti

Titanium
47.867

Strong, light and heat-resistant, titanium – mined in China and South Africa – is used in exhaust systems, suspension components, and the FW48's halo.

Benefits:



High strength-to-weight ratio



Heat-resistant

Primary country of origin:



China

3

Li

Lithium
6.94

Essential component of the battery and Energy Recovery System (ERS) within the FW48, found in Australia, Chile and Argentina.

13

Al

Aluminium
26.982

Lightweight and highly machinable into complex shapes, aluminium is used in engine components, gearbox casings, radiators and structural elements of the car. Typically mined in Australia and Indonesia.

Benefits:



Lightweight



Highly machinable

Primary country of origin:



Australia & Indonesia



28

Ni

Nickel
58.693

With the modern power units often exceeding 1,000°C in the exhaust systems, nickel alloys are critical in handling the extreme temperatures. Nickel also appears in cathodes of the battery to improve energy density.

Powertrain shown in diagram is a generic 2026 model, not an exact representation of the FW48's powertrain

Quantum reset To predict when we will have a truly useful quantum computer, we need to know precisely what one is – but that is a tricky endeavour, discovers **Karmela Padavic-Callaghan**



Karmela Padavic-Callaghan is a reporter at *New Scientist*, specialising in physics, materials science and quantum technology. Karmela earned a PhD in theoretical condensed matter physics and atomic, molecular and optical physics from the University of Illinois Urbana-Champaign. Their physics memoir *Entangled States* is out now

Karmela's week

What I'm reading

On the Equality of All Things by Carlo Rovelli. Review coming soon to a copy of *New Scientist* near you!

What I'm watching

Blue skies and my friends' smiling faces on the People's Beach at Jacob Riis Park in New York

What I'm working on

I'm getting ready to moderate a launch event for a friend's book on life in outer space

WHAT is a quantum computer? The question feels deceptively simple. It is a computer that uses quantum effects to run calculations – or at least, that is what I have been saying for years. Because I frequently report the latest advances in quantum computing, I have felt confident in this answer.

Recently, however, I have had to re-examine that confidence. Though I can name many different components and functions of a quantum computer, could I identify exactly when they all become a quantum computer? One recent philosophical study suggests that this is at the root of the difficulty of forecasting the future of quantum computing.

For Christophe Jurczak at investment firm Quantonation, it all started at a conference unrelated to quantum computing. Jurczak realised researchers were discussing an emerging technology he had first heard about 30 years prior. Back then, everyone was saying that it was only “five years away”. Déjà vu. Then, a worry set in – could quantum computers also be such a “perpetual five-year technology” (PFYT)? This drove him to do a deep dive into philosophical literature. The paper I read was its outcome.

In it, he argues that, right now, quantum computers are firmly in the PFYT category. All attempts to forecast when quantum computers will truly arrive are misguided so long as they presuppose that we already know what quantum computers are, he writes. “If the identity of a quantum computer is still being settled as the machine develops, that presupposition fails.”

As someone who thinks about quantum computing an awful lot, I wanted to know what exactly brought Jurczak to this somewhat alarming conclusion. In the nearly

five years that I have spent writing about quantum computers for *New Scientist*, they have certainly made measurable progress.

Quantum computers are also much closer to being useful devices than they were just a handful of years ago. Sure, they

“Once a threshold is crossed for one metric, the five-year horizon doesn't collapse. Instead, it resets”

haven't yet changed the world by aiding the discovery of some groundbreaking drug or battery redesign, but you could access a quantum computer through the cloud right now and use it as a scientific tool if you happen to be a chemist or a material scientist.

Jurczak doesn't deny this. He even tells me that he recently ran an experiment remotely on a quantum computer made from extremely cold atoms. But this doesn't mean that the question of quantum computing is settled, he says. One way to see this is to note the diversity of approaches for building a quantum computer,

Qubits, the basic components of quantum computers, can be built in many different ways

as well as the many, many metrics that are important for capturing how well one might work.

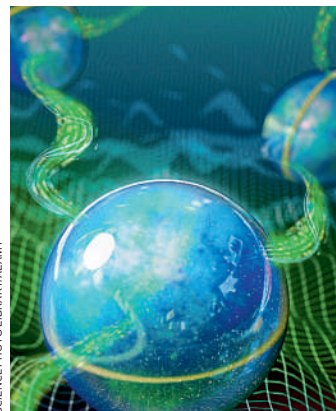
The basic components of quantum computers are called qubits, and they can be built in many different ways, from using extremely cold atoms to tiny superconducting circuits or particles of light. Then, there are the things you may want to measure about your quantum computer: how many qubits it has, how well connected they are, how reliably they can be used for different parts of a computation, how quickly they can be controlled and so on. Perfecting one or even a few of these metrics typically doesn't guarantee that all the others will become excellent too.

Mixed feelings

Having spoken to many people within the field, I have come to recognise a certain mix of excitement and anxiety in how they often speak: celebrating all the components of a truly powerful machine having been proved to work by themselves, while trying to keep at bay the worry about what may happen when they are all put together.

In his paper, Jurczak, together with Brooke Abeles at ENS Paris-Saclay in France, collected data about some of these metrics across the industry and inferred a clear trend – once a threshold is crossed for one metric, such as guaranteeing that a single qubit makes errors less often than once in a thousand times, the five-year horizon doesn't collapse. Instead, it resets. This is a consequence of discovering what a quantum computer is as it is being built.

This was distinctly not the case during the development of conventional computers. Jurczak says sometimes researchers like to compare today's quantum



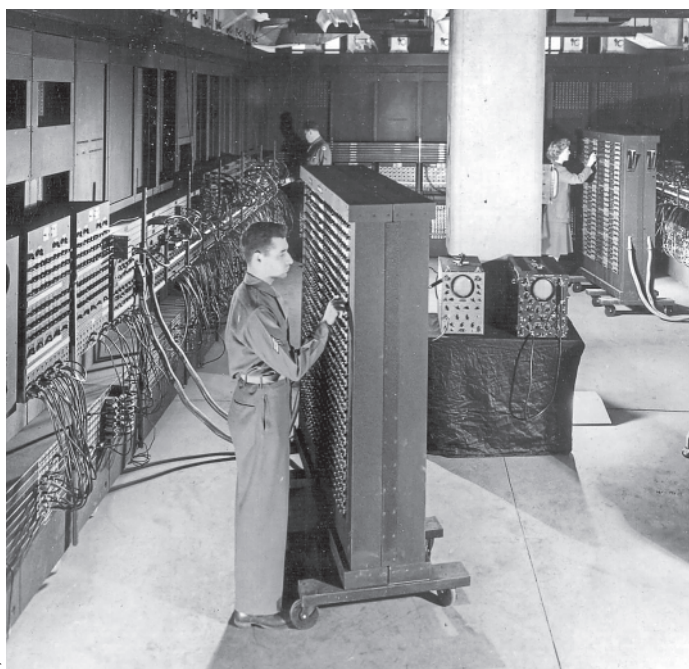
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computers to ENIAC, the world's first programmable general-purpose electronic computer, but building that room-sized digital behemoth was much more of an engineering challenge. "[Classical computing] was a very much more mature ecosystem at the time when it started," says Jurczak. While digging through literature, he found an idea more relevant for quantum computers, originated by the philosopher of technology Gilbert Simondon.

His theory of "technical individuation" says a shifting assembly of elements becomes a coherent "individual" through a process that includes a whole ecosystem, which consists of infrastructure, knowledge and practices maturing through iterative steps of trial and error. A collection of qubits and the devices that control and house them, for example, becomes a quantum computer only through interconnected developments in, for instance, laser and cryogenics systems, the building of special chip foundries, the growth of a specialised quantum workforce and basic research in quantum physics and computer science. Really, the list goes on.

As we talked, I found myself increasingly won over to Jurczak's view. The fact that we don't have a fully useful quantum computer yet isn't a failure of prediction or of the market, but rather reflects the groundbreaking, paradigm-shifting nature of trying to corral the denizens of the quantum world into doing computational work for us. The technology is still too close to scientific discovery to be easily wrangled, easily scaled, easily accelerated by the usual tricks of the economy.

Currently, the quantum computing industry has its sights on reaching "fault tolerance", or building a



The Electronic Numerical Integrator and Computer (ENIAC) was unveiled in 1946

it ought to happen with quantum-computing firms as well, he says. Jurczak thinks AI agents may also help accelerate some of that interdisciplinary work, as they aren't trained in the specialised ways that human researchers are. He and several researchers at the quantum-computing company Pasqal, which he co-founded, have already tested several examples of how such agents could help quantum-computing novices run computations on real quantum hardware. "If you ask me in five years what failure would really be, [it would be] that we still have these silos," he says.

My own physics education was definitely siloed. Because a reporter's job is to take both the broad view and the long view, I have, at times, felt the lack of that training rather sharply. The sheer amount of research in quantum computing is both impressive and overwhelming, and making sense of it has required a different skill set than merely being literate in the mathematics of quantum theory and somewhat conversant in materials science.

To be fair, the next time someone asks me what a quantum computer is, I will almost definitely not be telling them that it is a technical individual in an ever-evolving state of becoming. For anyone who isn't actively trying to shape the fast-growing quantum computing industry, that won't be very helpful. But the next time a paper reporting some narrow yet impressive advance crosses my desk, I will file it away as part of this evolution, reset my personal expectations clock and get at least a little excited about the quantum-computing horizon having just shifted. ■

quantum computer that is so good at catching its own errors that it can reliably run unprecedentedly complex computations. Once this goal is reached, will quantum computers have arrived? Will we know which type of qubit won the quantum-computing race? And what will be the next milestone?

"If you ask me in five years what failure would really be, it would be that we still have these silos"

Though Jurczak says that his framework isn't predictive, it does begin to unravel some of these questions. Almost certainly the horizon will shift again, and not all the machines will be fully individuated. He says he is excited about the possibility of a really heterogeneous quantum-computing system – no specific qubit design will win, they will just find applications they are well

suited for. The question of what a quantum computer is won't be answered by just one device.

Quantum computers won't remain PFYTs forever, but Jurczak speaks about them currently being in that category with excitement. When he says that the constantly resetting horizon represents possibility, I can't help but find that compelling. But what should quantum-computing firms do with this philosophical insight, I asked him. Certainly, they will still have to put out road maps and announce their goals. It's important to have strategies for the next five years, he conceded. "We all want that and that's needed, but think beyond and have a little bit of imagination as well, would be my take," says Jurczak.

One way to achieve that may be to start working with people outside physics. The ecosystem for a quantum computer should be interdisciplinary. AI companies are already hiring across the sciences and humanities, and

Problematic peptides A US drug advisory committee has recommended approval for several experimental peptides. This gives the wrong impression of their effectiveness, says **Grace Wade**

PEPTIDES are everywhere, so much so that wellness spas, massage parlours, chiropractor offices and rehabilitation clinics, particularly in the US but also elsewhere, are offering peptide injections.

Proponents claim they can help combat ageing, heal injuries, dampen inflammation, accelerate weight loss and treat a seemingly endless list of conditions. There is little robust evidence to back up these claims, but that hasn't stemmed people's enthusiasm. Estimates suggest the unregulated market for peptides is a \$100 million to \$3 billion industry.

"Because there's no regulation, it's like a free-for-all," says Alexander Weber at the University of Southern California. That was part of the impetus behind what I found to be a shocking decision by an advisory committee to the US Food and Drug Administration (FDA). It recommended the agency allow select pharmacies to manufacture the compounds and permit doctors to prescribe them.

Peptide injections are being offered at wellness spas and massage parlours

Although this mitigates the risks associated with buying these products on the unregulated market, which has no manufacturing oversight, it sends the unfounded message that these compounds have been demonstrated to be safe and effective.

Put simply, peptides are small proteins. The first commercial peptide drug was insulin in the 1920s. In the past decade, the FDA has approved more than 40 peptide drugs for therapeutic use. This includes semaglutide, the main ingredient in medications like Ozempic and Wegovy, which have transformed the treatment of obesity and type 2 diabetes.

Online retailers now ship peptides directly to doors across the US, UK, Canada and European Union, among other places. But most of these aren't approved drugs – they are experimental compounds meant only for research, says Weber. This puts them in a regulatory grey zone. Because the FDA hasn't yet deemed the compounds safe and effective, doctors can't prescribe them as medications. Yet they can still be bought and sold legally, so long as the supplier doesn't make any

health claims about them. Similar grey areas exist in the UK and EU.

One of the glaring drawbacks of this set-up is the risk of contamination. A *New Yorker* article published in April found that some peptides purchased through one online retailer contained lead, signs of bacterial contamination or a much smaller dose than advertised.

This is probably one of the justifications for the FDA advisory committee's decision. It recommended the agency add six experimental peptides to its compounding list, rejecting only one.

If the FDA accepts the committee's recommendation, it would allow select pharmacies – which adhere to standards around product integrity, safety and purity – to manufacture the compounds. This would bring these six peptides under some regulatory purview. However, such a move would also lend each of these peptides an air of credibility when, in fact, none of them has been tested in a scientifically rigorous way.

Instead, most research comes from animal studies. For instance, Changan David Lee at the University of Southern California and his colleagues have found that MOTs-C, a peptide released during exercise, can help regulate blood sugar and prevent obesity in mice, as well as improve speed. But these studies are a long way off from determining efficacy in humans.

It also isn't clear how these peptides should be administered. "What strength should you use? What frequency? How long do you cycle on and off? None of these things have been elucidated as to what is most effective," says Weber.

It is possible that regulating the manufacturing of these peptides could accelerate research into their effects. But in the meantime, people will be treating themselves as guinea pigs. ■



Grace Wade is a features editor for *New Scientist* focused on all things health. She previously held the role of US health reporter, where she covered the Trump administration, drug approvals and public health

Grace's week

What I'm reading

Famesick: A memoir by Lena Dunham. It is a raw, tell-all autobiography about navigating young adulthood and chronic illness in the spotlight

What I'm watching

Season 3 of Rick and Morty because I can never get enough of Pickle Rick

What I'm working on

A thought-provoking Q&A about the wellness industry



CATHERINE FALLS/COMMERCIALGETTY IMAGES

New Scientist



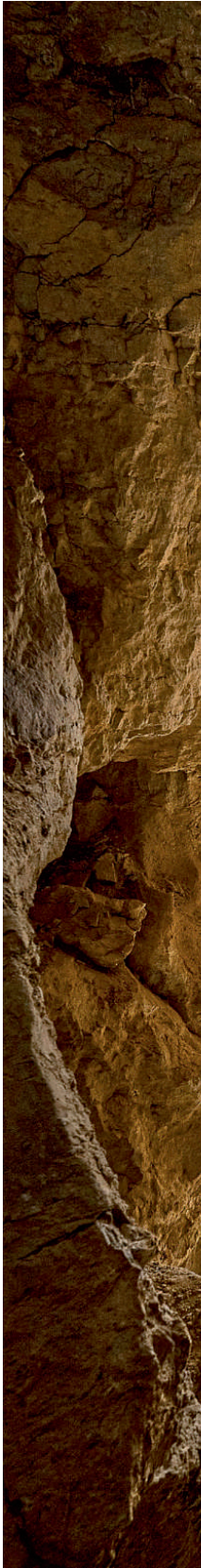
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Buried treasure



Robbie Shone

AT A gathering of the University of Bristol Spelaeological Society in a pub in 2008, caver Charlie Self handed PhD student Gina Moseley a photograph of a cave in a limestone cliff just beyond the north-western edge of the Greenland ice sheet. Thought to be the world's northernmost cave, it had been photographed from a US military aircraft in 1958, but never explored.

Self also gave Moseley a report about calcite flowstone, formed by trickling water, that was found in a cave in north-eastern Greenland. Today, groundwater there is frozen in permafrost, so this flowstone must have come from a warmer, wetter time. A sample could provide a climate record exceeding the 130,000 years captured in Greenland ice cores, Moseley thought.

Starting in 2015, she and her partner, photographer Robbie Shone, mounted four expeditions to Greenland, finally reaching that northernmost known cave. While they didn't find any flowstone there, they did obtain some from caves in north-eastern Greenland that showed the ground there hadn't frozen – and vegetation had even grown – during three periods 5 million and 10 million years ago.

It was a snapshot of a past world, but also a warning. "This occurred in a world with CO₂ levels that we already surpassed several decades ago," says Moseley.

In the top far-left image, expedition member Chris Blakeley stands in the northernmost cave. Below, he explores a cave in north-eastern Greenland named Crystal Palace for its hoarfrost. The near-left image shows him in Keyhole cave, where the team collected two flowstone samples. ■

Alec Luhn

What should I really eat?

Besieged by confusing and contradictory advice on which diets are best for us, **Chris Simms** enjoys a clear-eyed evolutionary view from Daniel Lieberman



Book
Fed Up
Daniel Lieberman
Allen Lane

THE words of gastronome Jean Anthelme Brillat-Savarin, “Tell me what you eat and I will tell you who you are”, may have been published in 1825, but they are just as true today. What we pop in our mouths is crucial to our identity: do you avoid pork, go vegetarian, embrace the Mediterranean diet, eat palaeo, tuck into more or less meat, fat, vegetables, carbs or ultra-processed foods? The claims behind diets and food types are often contradictory, and whatever the choice, food will influence our health, energy and well-being.

Into this chaos comes Daniel Lieberman, an evolutionary anthropologist at Harvard University. In his new book, *Fed Up: What evolution reveals about food, diet and eating well*, he uses his lens on this thoroughly modern agony of choice.

Using archaeological research in early humans, work with



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modern hunter-gatherers and studies on some of our closest relatives, Lieberman shows that the evolved human disposition isn't to stick to a few foods – despite what we might see in populations with historically limited local food options, such as Inuit peoples who relied heavily on fatty meat often from mammals such as seals.

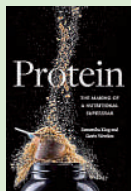
Instead, our non-Arctic-dwelling ancestors adopted a flexible, opportunistic approach, eating whatever was edible where they lived. “Our hunter-gatherer ancestors evolved to become the animal kingdom’s ultimate omnivores,” writes Lieberman. This means humans have a digestive system suited to great

variety. Yet, many foods today are made from a few carbohydrates like wheat and rice, and many diets designed for general health or weight loss promote some food types while prohibiting others.

Lieberman also digs into the science of the most popular diets, trying many of them for two weeks, often with his wife, Tonia. This isn't meant to be serious – it is a tiny sample run over too short of a time to assess health benefits – but it helps turn what could be a dry book into something more humorous and relatable.

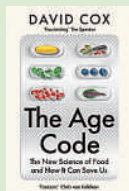
A raw food diet, for example, results in frequent bowel movements and leaves the couple lacking in energy due to a calorie deficit. This and a fruitarian diet aren't really shaped by any ancestral condition, despite what you may have read elsewhere. For example, the fibrous and often bitter fruits that chimps eat are very different from the sweet, sugary varieties we have bred over thousands of years. What's more, Lieberman points out that while

Three great reads on food, health and exercise



Protein: The making of a nutritional superstar
by Samantha King and Gavin Weedon

This is a deep dive into the role of protein in our health – the latest nutrient subject to contemporary obsession. The authors are sociologists specialising in sport, health and the body: intriguing, rather than news you can use.



The Age Code: The new science of food and how it can save us
by David Cox

Can you slow down ageing by changing your diet? David Cox's fascinating book attempts to understand what is accelerating our biological clocks and what we can do about those factors. He also experiments on himself.



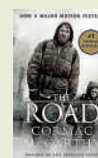
Exercised: The Science of Physical Activity, Rest and Health
by Daniel Lieberman

Most of us struggle to stay fit, because, as Daniel Lieberman shows in his earlier book, we never evolved to exercise: moving our bodies for hours every day was just... life. Clearly, we need a major rethink.



Alison Flood
Head of books
London

Earlier this year, the New Scientist Book Club took on Tim Winton's *Juice*, a brilliant, terrifying tale of a scorched future Australia. Reading it, I knew I would have to



return to a title it reminded me of: Cormac McCarthy's **The Road**.

I first read this in 2006, and loved (if that's the word) its vision of a post-apocalyptic US, all ash, dead trees and horrors. I also admired (a better word, maybe) the film, directed by John Hillcoat, with Viggo Mortensen and Kodi Smit-McPhee as father and son, trekking through this blasted land to the coast. Twenty years on, a little more mature, I found it devastating. McCarthy's portrait of a father, living only for his son, is so tender, so heart-breaking; of a son, born into a nightmare world, just shattering.

I've moved on to *Blood Meridian*, McCarthy's brutal tale set in the 19th-century US and Mexico. A film, also directed by Hillcoat, is in the offing. Since McCarthy and Hillcoat are masters of their craft, I predict it will be great, if I can stomach it.

chimps eat mainly fruit, little makes them as excited as hunting and eating monkeys, and if given the choice, they pick cooked sweet potatoes over raw.

The meat-heavy palaeo diet, which avoids grains, beans and dairy, is based on similarly flawed logic. The real Palaeolithic diet was often a veggie feast, and Lieberman finds little evidence that avoiding foods like whole-grain bread, tofu and brown rice brings promised health benefits. He also investigates the Mediterranean diet, intermittent fasting, vegetarianism, veganism, factory-made liquid foods, diets low in fat but high in carbs and, alternatively, low-carb but high-fat, like the Atkins diet.

It's a whirlwind ride, with Lieberman showing that when any diet excludes food groups, we should worry about missing out on nutrients. Overall, though, vegetarians and vegans tend to fare better than those who eat more omnivorously, for example, by having a lower risk of diabetes, heart attacks and some cancers.

One of the main reasons these diets exist at all is an evolutionary feature that helps us put on weight: we are programmed to seek energy-rich foods, store surplus energy as fat, and hold on to that fat in case food is scarce in the future. Lieberman references examples from trips to study Hadza hunter-gatherers in Tanzania. One morning, they walked from wild beehive to wild beehive, smoking out each brood. In 3 hours, the hunter-gatherers "gorged on more honey than I thought was humanly possible", he writes.

Such cravings mean that simplistic notions of using ancestral diets as targets is best set aside – unless you are likely



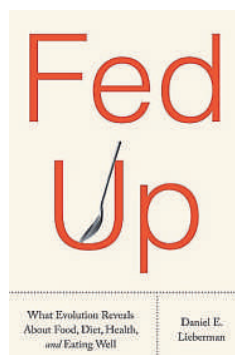
TERRY WHITTAKER/2020/VISION/NATUREPL.COM

The opportunistic feeding habits of the fox may tell us something important

to be relying on stores of fat to tide you over in fallow times or to fuel hunting for food by rather more energetic means than going to the fridge or shop, or ordering delivery.

Lieberman also neatly explains some of the powerful adaptations that stop us losing weight. Strict dieting or skipping meals can trigger the stress hormone cortisol, which as well as making us hungrier, can boost the storage of fat round the abdomen – the opposite of the intended effect.

Adding to modern problems,



well-known evolved responses make us easy targets. Some ultra-processed foods are built on fat, sugar and salt, combined in specific quantities to light up neural pathways that reward you for eating them. As Lieberman says, "They are designed, manufactured, and advertised to be tasty, inexpensive, convenient, and to deliver what we crave."

Fed Up is an excellent and wide-ranging book, with the central message that no one neat idea will be the solution to what we should eat. Lieberman advocates not an ancestral diet, but taking the flexible, ancestral approach to finding food and applying it to our lives. We should, he thinks, seek identity not in a diet, but in an animal: the fox.

The fox has many ways to escape a hunter, but a hedgehog only one: curling into a spiky ball. Hedgehogs would stick to one diet, but the way of the opportunistic fox, says Lieberman, would be to embrace the contradictions in our knowledge about foods and health, and focus on variety while exercising moderation.

Readers wondering, as I was, which diet evolutionary studies would suggest we should eat to stay healthy as we age must wait until the very final page. And unsurprisingly, given official advice, it is lots of fresh fruit and vegetables, unrefined grains, some legumes, nuts, seeds and seafood, with not too much red meat, salt or added sugar, mostly unsaturated fat and no weird chemical additives.

Or, to quote journalist Michael Pollan (as Lieberman frequently does): "Eat food. Not too much. Mostly plants." ■

Chris Simms is a writer based in Somerset, UK

***The Thing* lives!** It's 1987, and detective Georgia Cooke finds mangled bodies at an outback radio research station. TV columnist **Bethan Ackerley** recommends a terrifying slice of cosmic horror



Bethan Ackerley is a subeditor at *New Scientist*. She loves sci-fi, sitcoms and anything spooky. Follow her on X @inkerley



TV

The Killings at Parrish Station

Ben Jenkins
HBO

Bethan also recommends...

Film

The Thing

John Carpenter
On demand

This electrifying film begins with a helicopter chasing down a dog that is running across Antarctica, for reasons unknown. Realising just what was going on – and how gonzo this film about a group of isolated researchers was going to get – was one of my all-time favourite cinema experiences.



STAN

WHAT'S your favourite science-fiction trope? I'm not talking about subgenres like dystopias, space operas or "punks" of every flavour, but the small moments that keep cropping up. Jumping to warp speed? Waking from cryo-sleep? Unearthing an alien artefact?

Here's mine: when something awful and otherworldly befalls a group of scientists at a remote research station, it never fails to make me smile. And that's exactly what happens in a series I recently stumbled upon while scrolling through HBO Max.

Aptly named *The Killings at Parrish Station*, this is an Australian crime drama, now being shown weekly in the UK. It received quite a bit of acclaim back home, and from the first scene, I could see why. We are thrown right back to 1987, as detectives Georgia Cooke and Mick Thorne arrive at a radio telescope in the outback to find a pile of mutilated... astrophysicists.

Someone (or something) tore them limb from limb, bar lone survivor Kate Reynolds, who can't (or won't) explain what happened. Naturally, she becomes the number-one suspect, but Georgia is convinced there is a much bigger

conspiracy at work, one that may involve the station owner, Callum Parrish. Her investigation throws up many fascinating leads, from the station's past as a uranium mine to an antiquarian book called *The Bone Gospel*.

The Killings at Parrish Station was inspired by the 1959 Dyalatov pass incident, in which nine experienced ski hikers were found dead in the Ural mountains with severe injuries and wearing little to no cold-weather gear. The strange circumstances of their death, though still unexplained,

"I enjoyed the send-up of a grimy kind of true-crime podcast, via snippets of woefully titled *Crime Sluts*"

are commonly thought to have been a reaction to a possible avalanche.

You don't need to worry about such a mundane explanation in this series, however. The case is a pulpy, Lovecraftian nightmare – and one that might just happen again.

Alongside the investigation, we flash forward to the modern day and what happened to Georgia in

Georgia Cooke (played by Mia Wasikowska) when she was a detective, back in 1987

the intervening years. We learn she has been living in a mental health institution ever since the Parrish Station killings, which have gone unsolved, and neither Georgia nor Mick ever worked for the police again. Her protégé Millie, now a seasoned detective in her own right, lures Georgia back to investigate a series of copycat murders by promising to help her locate her estranged daughter, Frankie.

That's a lot of action for a season with just six episodes – and sure enough, there are parts that work better than others.

I came to enjoy the show's send-up of a particularly grimy kind of true-crime podcast, seen via snippets of the woefully titled *Crime Sluts*, whose hosts discuss the Parrish case in lurid detail. But I could have done with less of it in the key scene-setting first episode.

Overall, the modern plot line, while charming, can feel like it stumbled out of an altogether cosier show. Whenever we see the older Georgia grumbling about today's ultra-sophisticated photocopiers or the fact you can't smoke indoors any more, it's pleasant enough, but you're eager to get back to the nastiness of 1987.

The series is never better than it is in the half-episode stretch where you finally get to see what Reynolds and her colleagues went through in the desert. It's utterly terrifying.

In fact, parts of *The Killings at Parrish Station* (especially when Reynolds is on screen) are straight out of *The Thing*, another eldritch nightmare about researchers facing a deadly extraterrestrial threat. If, like me, you take perverse pleasure in watching unfortunate things happen to intrepid scientists, then I can whole-heartedly recommend this slice of cosmic horror. ■



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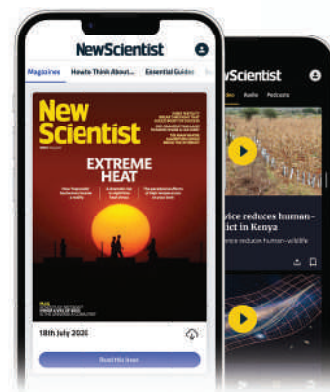
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Editor's pick

Could poor sleep be behind many cases of dementia?

1 August, p 4

From Andreas Keller,
Hannover, Germany

After reading that inhaling high doses of carbon dioxide in a controlled setting clears Alzheimer's proteins from the brain, two questions occurred to me. Firstly, might some cases of dementia be a result of years of interrupted sleep? The way work is organised in most societies means that many people regularly interrupt the natural sleep process by using an alarm clock. If deep sleep involves a clean-up process, including for those "garbage" substances whose accumulation might have something to do with neurodegenerative conditions, could this be a contributing factor in people who might, for some reason, be prone to producing more of such substances than others?

Secondly, after an occasional night of bad sleep, I not only feel tired the next day, but also slightly emotionally imbalanced. Could the accumulation of substances cleared out by deep sleep (and perhaps also by the therapy described in the article) lead to emotional problems like depressions or anxiety?

The complex economics of new battery technologies

18 July, p 15

From Philip Jessops,
Marloes, Pembrokeshire, UK
All improvements to batteries, including the salt variety, are welcome. However, domestic batteries can fully benefit a country's grid, maximise renewable electricity use and, most importantly, address energy poverty only when there is high market penetration. Low-income households, which might gain the most, probably can't afford batteries. And if they got one through a subsidy scheme and

it failed, as some do, they may have no cash for repair or replacement.

The solution: householders don't buy batteries. Utilities or grid operators that can bulk buy them cheaply should rent batteries to all, with no-quibble support and constant performance monitoring. This way, households aren't affected by technology changes or suppliers going bankrupt. As new battery designs come along, they will get an upgrade, with the old equipment properly recycled. And should circumstances change – they have a heat pump or solar panels installed, say – there could be a fee increase to cover either a bigger battery or an extra one.

We need new business models as well as better technologies.

From John Kitchen,
Kettering, Northamptonshire, UK
Your article, which mentions that salt batteries could be used in budget electric vehicles (EVs), underestimates the importance of the second-hand market for EVs. People on lower incomes tend to buy second-hand cars, and they are less likely to have driveways on which to charge an EV.

Why I quit my research on hissing cockroaches

Letters, 18 July

From Margaret Cuthbert,
Ithaca, New York, US
Anthony Spiteri's letter on the ethics of insect experiments makes the strong point that we are often able to ignore potential suffering where the subject is unable to communicate with us. I was fortunate to spend many years researching the communicative behaviour of the Madagascar hissing cockroach (*Gromphadorhina portentosa*) and

its neural basis. It was the nearly unique ability of these creatures to communicate in a modality that we easily relate to (sound) that led me to years of research, but that ultimately caused me to leave this work behind.

Insects are often anaesthetised with carbon dioxide when being used for research involving dissection, as was necessary for my work. But as this wore off, my experimental cockroaches, pinned down, would begin to express their distress vocally by hissing. Had I been working with other invertebrates, there would have been no evidence of my impact, but not here. Ultimately, I knew that I was hurting my study subjects, and I couldn't condone my own actions when I had such clear evidence before me.

Another benefit of getting the sun all over your body

25 July, p 24

From Sam Edge,
Ringwood, Hampshire, UK
Naturists would probably agree with the conclusions in Rowan Jacobsen's book *In Defense of Sunlight*. Not only does getting safe amounts of sunlight on more of your skin seem to improve health, when done among strangers, it also promotes a more accepting attitude towards your own and others' bodies, and any perceived imperfections they may have.

My partner and I rarely find opportunities to indulge in this practice in the UK, for lack of clement weather and suitable locations. But after a few holidays in Denmark, Germany and Gran Canaria, where there are many nudist beaches, we finally got up the courage to discard our bathing clothes and enjoy the sun, sea and sand of Spain's Maspalomas dunes

au naturel with our distinctly "less than perfect" older bodies. It was very freeing!

The advertising industry is fuelling overconsumption

18 July, p 32

From Merlin Reader, London, UK
One issue not covered in your article on the green transition of Guimarães, Portugal, is useless, consumptive kinds of "economic activity". The advertising industry, specifically, uses enormous resources to encourage consumption, with the small exceptions of charitable advertising (though we wouldn't need charities if wealth was more equally distributed) and public-service advertising (advising us to take care near water in heatwaves, for example). Yet, advertising still counts as economic activity.

I recently saw a pundit on TV complaining about the lack of economic growth in the UK. The interviewer failed to question why non-stop growth is necessary, or point out that it isn't possible on a finite planet. Those of us in western Europe are already in a society overconsuming at an unsustainable rate.

Hot baths may be helping me stave off ill health

18 July, p 26

From Nasir Ali,
Inverness, UK
Regarding your article on heat therapy, since 2001 I have been taking a daily hot bath, lasting 90 minutes. Since I started this regime, I haven't had a serious cold, flu or covid-19, and my Lyme disease symptoms have gradually disappeared. Might my hot baths be affecting my immune system? ■

For the record

■ Kurt Gödel's incompleteness theorem showed we can't ever prove that mathematics could be fully consistent (25 July, p 18).



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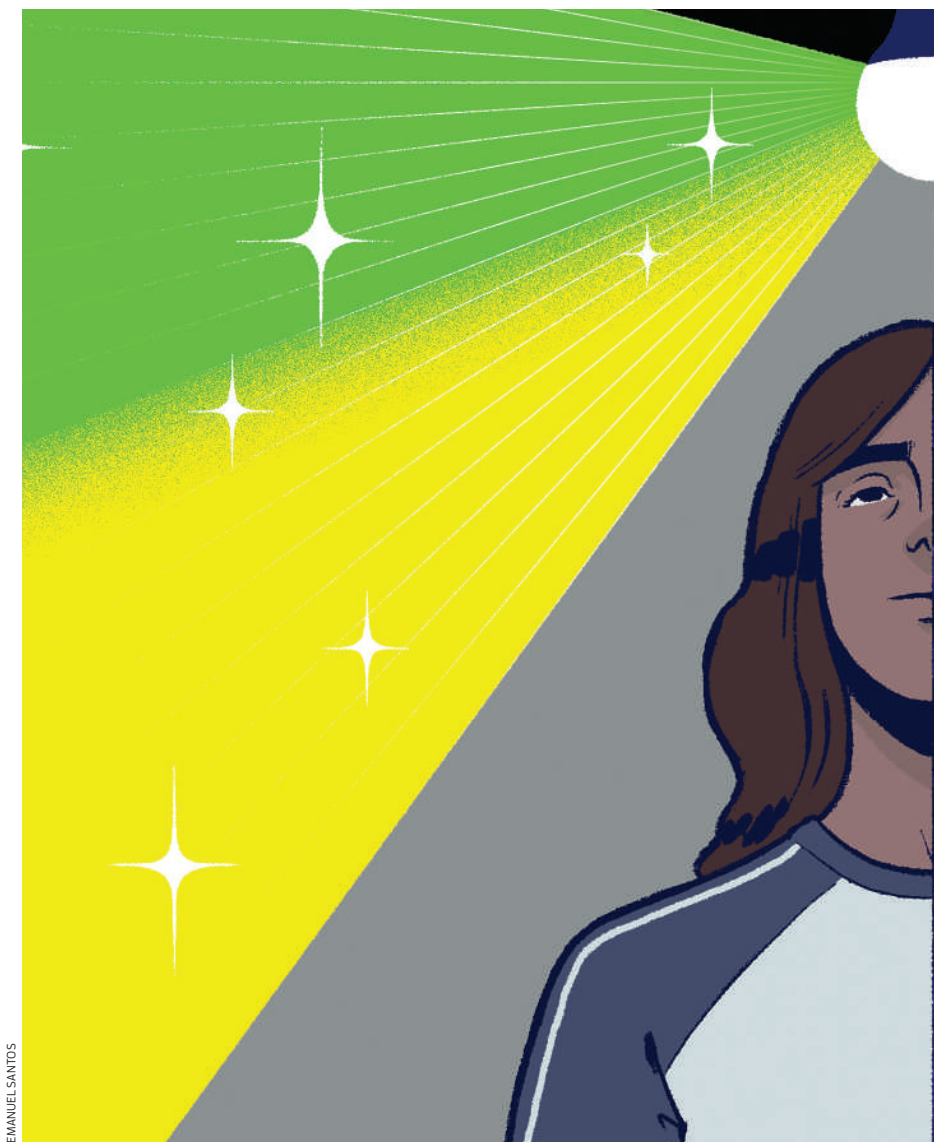
Take a flashlight – the one on your phone will do – turn it on and place the pad of your index finger over the bulb. See that red glow? You might think it's something to do with blood, but you'd be wrong. It's photons of red light bouncing around inside your finger, looking for somewhere to land.

This simple experiment is a doorway to one of the most profound and surprising biological discoveries of recent years. "Light is a nutrient," says Bob Fosbury, who was an astrophysicist at the European Southern Observatory before he turned his attention to the biology of light. That's obviously true for plants, which use light to make carbohydrates. But it turns out it's also true for animals and fungi, all of which exploit light in a hitherto unappreciated way. All living organisms – including us – are solar-powered.

Sunlight has long been understood to be critical to life on Earth. But the fact that light is also used to oil the wheels of metabolism is only just, er, coming to light. Long wavelengths, which come from red and infrared (IR) light, are particularly beneficial for creating energy, and are readily available from sources including sunlight and incandescent bulbs.

But changes in lighting intended to help save energy have inadvertently deprived us from this crucial supply. The irony is that just as we have discovered the benefit of red light, we are unintentionally starving ourselves of it.

The story begins in the early 2000s with the adoption of two now-ubiquitous energy efficiency technologies. The first was the light-emitting diode (LED), which largely replaced energy-guzzling incandescent bulbs. Although this change helped conserve energy, it had other unforeseen consequences. The second was window glass that filters out IR, designed to prevent heat leaking into or out of buildings. Together, these dramatically narrowed the



EMANUEL SANTOS

Red-light starvation

Since the 2000s, the spectrum of light we are exposed to has drastically shrunk. Now, we're learning how this can wreak havoc with our metabolism, finds **Graham Lawton**



spectrum of light we are exposed to indoors, an environment where most humans spend up to 90 per cent of their time. “We lost about 95 per cent of the spectrum,” says neuroscientist Glen Jeffery at University College London. “Suddenly, without warning, boom, the long wavelengths go. And that’s a problem.”

For the vast majority of human existence, those wavelengths were unavoidable. Daylight is rich in visible red light, which covers about 650 to 750 nanometres. It also emits vast and invisible (to us, at least) quantities of IR, which extends out to about 2500 nanometres.

People who spend much of the day outside are naturally exposed to these

long wavelengths, even when fully clothed. When long-wavelength light hits a human body, it sails through clothing and penetrates deep into tissues (short-wavelength light such as UV, in contrast, is absorbed by clothing, which is why covering up helps prevent sunburn). Red and IR are also abundant in moonlight and in the glow of a campfire. Indoor light, too, used to be full of these wavelengths, either from sunlight streaming through windows or light sources such as open fires, candles and oil and gas lamps. The invention of the electric light didn’t change that, as the spectrum of an incandescent light bulb closely matches that of the sun.

But the adoption of energy-efficient lighting and windows robbed us of longer parts of the spectrum. Glass that filters out IR obviously blocks that portion of sunlight, and while LEDs throw out a lot of visible light, they produce nothing beyond about 750 nm. “LEDs are completely dark in the infrared,” says Fosbury. Scott Zimmerman, founder of the lighting company Silas Inc. in New Jersey who collaborates with Fosbury and Jeffery, calls LED light “ultra-processed”, an analogy with ultra-processed food. The combined effect of ultra-processed light and modern glass means that the average human today receives much less long-wavelength light than their ancestors did.

21st-century scurvy

At the same time, conditions such as obesity, type 2 diabetes, dementia and early-onset cancers are on the march. The usual suspects for this are poor diet and lack of exercise. But according to Fosbury, Jeffery and others, these are only a piece of the puzzle; another reason, perhaps the principal one, is red-light deprivation. “There’s not a single cause, but I do increasingly think that light is the most fundamental and dominant one,” says Fosbury. “And it’s probably the easiest one to solve.”

To understand why light is so vital, we have to go back in time again, to the Soviet Union of the late 1980s, where, at the USSR Academy of Sciences in Moscow, a biophysicist called Tiina Karu was experimenting with red and near-infrared light as a therapy. She discovered that they were useful in wound healing and pain management and wondered what the mechanism was. Eventually she hit on energy metabolism, specifically the pace at which mitochondria inside the body’s cells produce a molecule called ATP. Red light, she found, accelerated this process.

Karu’s work never found a wide audience, mainly because she came from the wrong side of the Iron Curtain, according to Jeffery. But she was right, and today red-light therapy is everywhere, used to promote wound healing and treat skin conditions, hair loss, chronic pain and much more. The evidence of its efficacy is patchy, but growing, says John Mitrofanis, a neurologist at the University of Grenoble Alpes in France. There is much debate over the correct doses and wavelengths, but researchers agree that its effects are mediated by mitochondria.

The key to this is the electron transport chain, a complex and highly orchestrated metabolic process that takes in energetic





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electrons and passes them down a chain of proteins, creating ATP in the process. ATP is biology's principal energy currency, analogous to cash in an economy. When a cell needs energy to perform a task – say, building new proteins – it uses ATP.

When mitochondria are bathed in red or IR light, the electron transport chain runs a little faster and more ATP is produced – a process Fosbury calls “photometabolism”. The exact mechanism by which ATP production is accelerated remains a point of contention, but what's certain is that diseased cells are often short of ATP, so a boost can make up the deficit. That, says Jeffery, explains why red-light therapy is beneficial.

It also explains why taking away red light can be harmful. Jeffery points out that all life on Earth evolved in an environment rich in red light and IR, but humans now mostly live in one stripped of those wavelengths. The result is more sluggish ATP production. To add insult to injury, we have also flooded our indoor environment with shorter wavelengths in the form of blue light from screens and LEDs. Blue light inhibits ATP production by slowing down the electron transport chain. Lose, lose.

The effects are insidious. Fosbury likens long-wavelength light to a vitamin and calls the effects of deprivation “21st-century scurvy”, a nod to the disease of vitamin C deficiency that killed and sickened tens of thousands of sailors in the 18th century. Like scurvy, it creeps up on you. “It's something that accumulates over a period of time,” says Jeffery.

It isn't just the general benefits of being outside, but red light specifically that is proven to have benefits. One of the symptoms of 21st-century scurvy is elevated blood sugar, which, if left unchecked, can progress to type 2 diabetes. This is due to the slowing down of the electron transport chain, which burns glucose as its primary fuel. A couple of years ago, Jeffery showed that a 15-minute burst of red light blunts the blood sugar spike after a large dose of glucose. He has also done real-world experiments in windowless, LED-illuminated offices at University College London. When he added long-wavelength light from a dimmed incandescent bulb, he found that the office occupants had lower blood sugar, on average, than their colleagues labouring under pure LED light. “Their mitochondria are being kick-started by the red light,” says Jeffery. A study published in January found something similar; researchers at Maastricht University in the Netherlands exposed 13 individuals with type 2 diabetes to 4.5 solid working days of LED light



GETTY IMAGES/WESTEND61

The pink LEDs in this greenhouse and even campfires emit red wavelengths

“The success of red-light therapy may be down to the correction of a deficiency”

in an office environment, then 4.5 days of natural light in the same location. The participants' blood sugar control was much better during the daylight days.

Jeffery also has concerns about other diseases and health problems usually associated with ageing, especially neurodegenerative conditions. One of the causes of these, he says, is mitochondrial dysfunction, which is effectively induced by red-light deficiency. Clinical trials have found that near-infrared light can slow down age-related cognitive impairment. A recent study of almost 88,000 people in their sixties found that, over the course of eight years, those who spent more time in daylight were significantly less likely to develop dementia, though the underlying causes of this relationship aren't yet fully understood. Mitrofanis, meanwhile, has shown that red light can prevent Parkinson's in a primate model of the disease.

Cancer and cardiovascular diseases, too, have been linked to a lack of daylight. When dermatologist Richard Weller at the University



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of Edinburgh, UK, and his colleagues analysed data from more than 400,000 adults in a yet-to-be-published study, they found that people with higher habitual UV exposure – a proxy for sunlight exposure in general – were less likely to die from cancer and cardiovascular disease.

Indeed, says Mitrofanis, the success of red-light therapy may simply be down to correction of a red-light deficiency. “Maybe all this is doing is rescuing processes that have gone awry because we’re inside all the time, getting illuminated with blue light.”

The fact that longer-wavelength light speeds up energy production isn’t a happy accident. Fosbury and Jeffery argue that it is a design feature of living systems. Life, they say, evolved to feed off this once-abundant resource to maximise the efficiency of ATP production. “Life on Earth has evolved for 4 billion years in sunlight and it’s adapted exquisitely to the properties of sunlight,” says Fosbury.

One of those adaptations is the ability to harvest and store photons. “The body literally is designed to absorb as much as possible in the infrared,” says Zimmerman. The amount of light energy we take in every day is staggering, he says. “Sunlight is the number one energy input into the body. It’s at least twice, if not three times, as much as food.”

Once sunlight enters the body, it scatters, bouncing off cells and organelles repeatedly – perhaps tens or hundreds of times, says Fosbury – until it hits a molecule that can absorb it, dumping energy in the process. This scattering means that a photon of red or IR light remains inside the body for much longer than it would if it passed straight through. This is what you see when you press your fingertip to a flashlight.

The photon’s final destination is somewhat random, but occasionally it is absorbed by a component of the electron transport chain.

Scientists are currently evaluating whether water molecules in the mitochondria are key to converting light into energy. When they absorb energy from a photon, they vibrate faster and lubricate the passage of electrons down the chain. Remarkably, says Fosbury, each step in the chain requires the electrons to overcome an energy barrier of roughly 0.75 electron volts, which is almost precisely what a photon of long-wavelength light delivers. Without the supply of red light we evolutionarily developed for, we’re getting far less energy.

Fortunately, the solution to this modern-day scourge is simple: recharge your light battery whenever you can, either with daylight or an incandescent bulb. There are red-light therapy devices, but some of these are overpowered, which can send cellular energy production into overdrive and lead to inflammation. Of course, exposing yourself to sunlight also carries its own risk. But clothing and sunscreen help block cancer-causing UV, while letting red and IR through.

For people stuck in modern offices, Jeffery recommends buying a light fitting with a dimmer switch and putting it on your desk with an incandescent bulb in it. “Even when it [the incandescent bulb] is very, very, very dim, it still produces a vast amount of IR,” he says. There’s no specific magic wavelength and so a red LED light would likely be better than no red light at all, but nowhere near as effective

as full-spectrum red light from incandescent light bulbs or the sun.

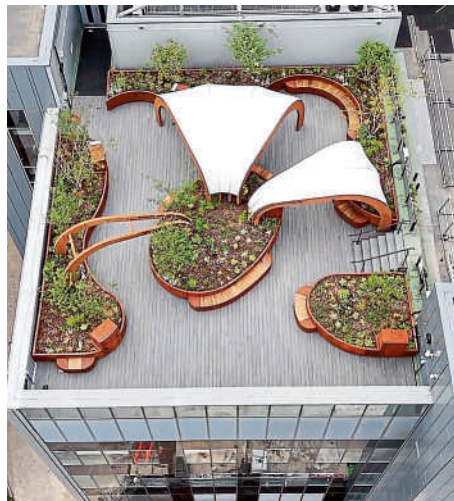
What would really make a difference, says Jeffery, is a change in attitude among the people who design and manage buildings. The pursuit of energy efficiency is laudable but has unintended consequences. And in any case, energy efficiency need not be sacrificed. True, incandescent bulbs are extremely inefficient as a source of visible light, producing mostly infrared, aka heat. But the energy consumption of a heavily dimmed incandescent bulb is no more than an LED, so there are no extra costs – and shedloads of savings in the form of a healthier workforce. “We can do masses for public health just by bringing back the long wavelengths of light you’re being denied in your office environment,” says Jeffery.

“There’s a real need for change,” says Alistair Nunn, director of science at the Guy Foundation in London, which supports research on quantum biology and its medical applications. “At the moment, everybody’s going down this road of ‘let’s get lots of LEDs’, but it’s not doing us any good at all.”

There are signs of institutional change, with hospitals at the forefront. Studies have shown that infrared light in hospital wards leads to improved clinical outcomes, including shorter stays. And it has long been known that inpatients who have access to daylight are discharged sooner, on average, than those kept in windowless rooms. Now, some hospitals are taking action. Jeffery and his team recently did a light survey of the critical care unit at King’s College Hospital in London. “It’s a beautiful building, but there’s absolutely no long-wavelength light in there,” he says. “I said to them, ‘obviously I’m concerned about your patients, but I’m concerned about your staff too.’” The hospital managers took heed and, in May, opened a new six-bed ward on the roof. Two other London hospitals are considering outside space for their critical care patients, says Jeffery. “I think they’ll follow because they can’t afford not to.”

And even if you aren’t a patient in a critical care ward, you can’t afford to risk 21st-century scurvy through a steady diet of ultra-processed light. “You can live your life without red light,” says Jeffery, “but you cannot live healthily without it.” ■

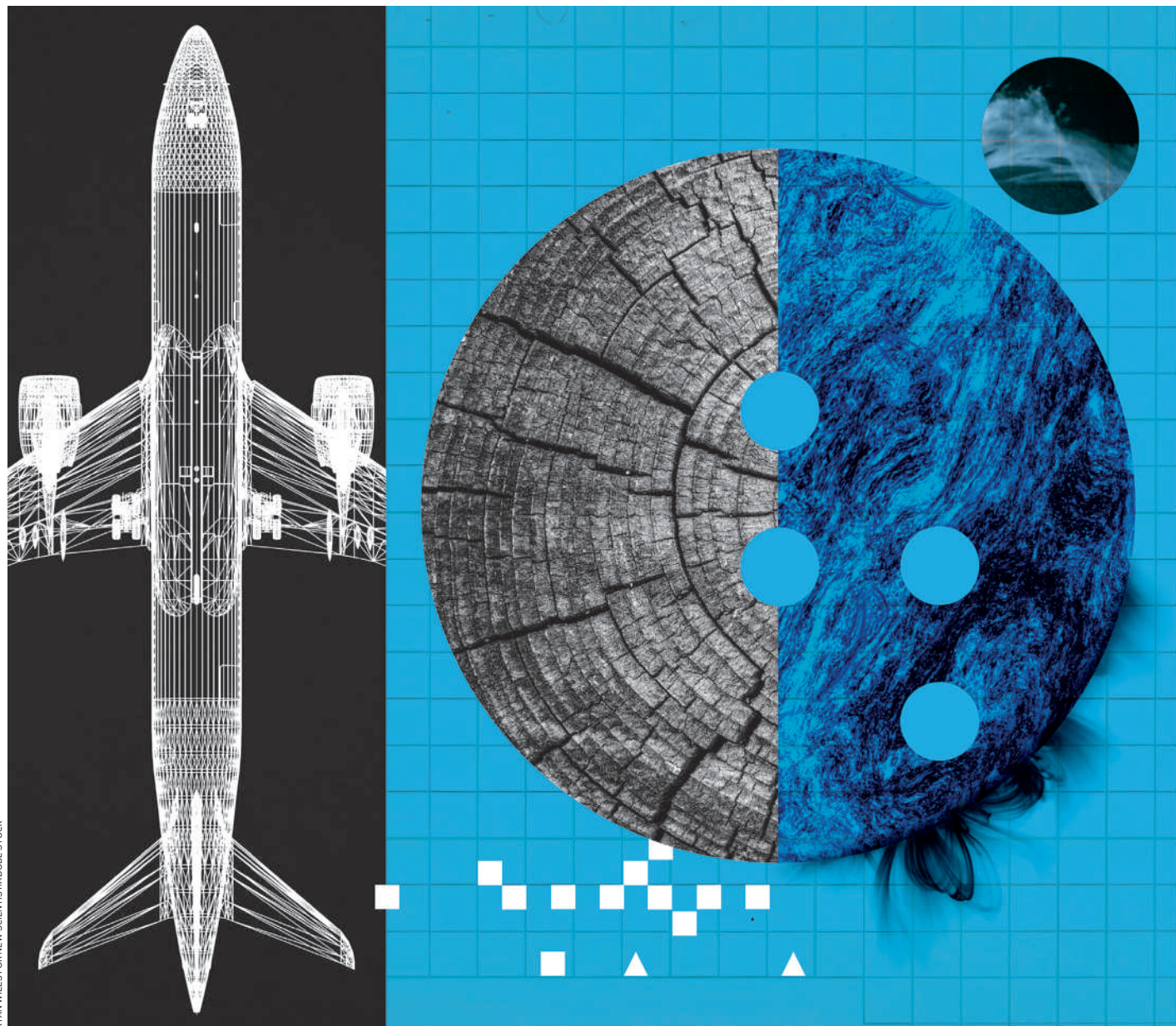
A London hospital has created an outdoor ward to help patients and staff get more red light exposure



KING'S COLLEGE HOSPITAL NHS FOUNDATION TRUST



Graham Lawton is a consultant for *New Scientist*. He is the author of *Mustn't Grumble: The surprising science of everyday ailments*



RYAN WILLS FOR NEW SCIENTIST/ADOBE STOCK

Storm warning

Signs hidden in the world's oldest tree rings suggest that our sun is capable of solar storms far bigger than we've ever recorded – and we could be due one soon, reports **Jacklin Kwan**



THE FIRST first clear sign of exceptionally high solar activity came from Japanese cedar trees. It was 2012, and Fusa Miyake was studying slices taken from one of these ancient trees that had been felled in the 1950s. It had grown on Yakushima Island, a protected site famed for its long-lived trees, some of which have stood for millennia, laying down one ring of wood after another.

These tree rings aren't just markers of age – they are also annual records of the Earth's atmosphere, and studying them could help us to predict, and prepare for, future disruptive solar storms.

While perusing these ancient tree records, Miyake stumbled upon something that gave her pause. The relative proportion of carbon-14 in

“WHATEVER HAPPENED IN AD 774, IT HAD MARKED THE WHOLE PLANET”

each tree ring reveals how active the sun was each year. Between AD 774 and 775, the amount of this isotope in the cedar jumped by about 12 parts per thousand – roughly 20 times larger than the change expected from the ordinary variation in the sun (see “When we saw the sky erupt”, page 36). That was hard to explain.

A spike this sharp seemed to suggest that Earth's atmosphere had been hit by a sudden burst of unusually energetic particles. At first, there were reasons to be cautious: perhaps this was just a laboratory artefact, or something peculiar to the Japanese cedars? But then other teams found the same signal in trees from North America and Europe. Whatever had happened in AD 774, it had marked the whole planet.

That made the list of possible culprits quite short. A nearby supernova explosion, or a gamma-ray burst, or a blast from a neutron star could each have been to blame – but all were ruled out, since possible sources of these were too distant. Eventually, researchers began to home in on a much closer object: the sun.

A solar flare is what happens when magnetic energy that has been building in the sun's atmosphere is suddenly released. In a matter of minutes, a patch of the sun can brighten violently, hurling out radiation across the electromagnetic spectrum, from radio waves to X-rays. Often, these eruptions are ➤

accompanied by streams of charged particles moving at high speed and vast bubbles of magnetised plasma known as coronal mass ejections. A solar storm can include both phenomena.

We know events like flares can be dramatic because they've happened before. In the summer of 1859, the sun produced the most famous solar storm in recorded history: the Carrington event. The eruption produced a barrage of radiation so intense that, when it washed over the Earth's atmosphere, telegraph lines across Europe and North America caught fire. Auroras, usually confined to polar skies, were seen deep into the tropics.

Ever since, Carrington has been the benchmark for solar violence. But the strange thing is that even Carrington wasn't powerful enough to leave a clear carbon-14 signature in tree rings. To do that, the sun would need to unleash a storm 10 times larger – a superflare. This means that any ancient storms that were that strong would be unlike anything we have seen during the space age, when we have observed the sun up close with satellites.

Miyake events

Since Miyake's first discovery, her own group and other research teams have between them discovered five more "Miyake events". In 2022, a landmark study led by Nicolas Brehm at ETH Zurich swept a global dataset spanning thousands of years of tree rings – and found two events at once. These findings suggest a Miyake event occurs very roughly once every 2000 years (see "The six confirmed Miyake events", far right). Though they are rare, they still challenge our model of solar physics, which states that stars like our sun aren't supposed to produce events that energetic.

New evidence, however, suggests that lesser storms – still several times more powerful than Carrington – may happen far more often than we thought.

It is ancient trees, again, that hold hints of such middle-range events, which could still be catastrophic for life on Earth. "There are intermediate events, which are smaller than Miyake events but perhaps bigger than Carrington," says Michael Dee at the University of Groningen in the Netherlands. "As we move to a more digitised society with extensive telecommunications networks, these events could pose a much bigger threat."

The trouble is, it has been tricky to estimate

"THESE ANCIENT SOLAR STORMS WOULD BE UNLIKE ANYTHING WE HAVE SEEN DURING THE SPACE AGE"

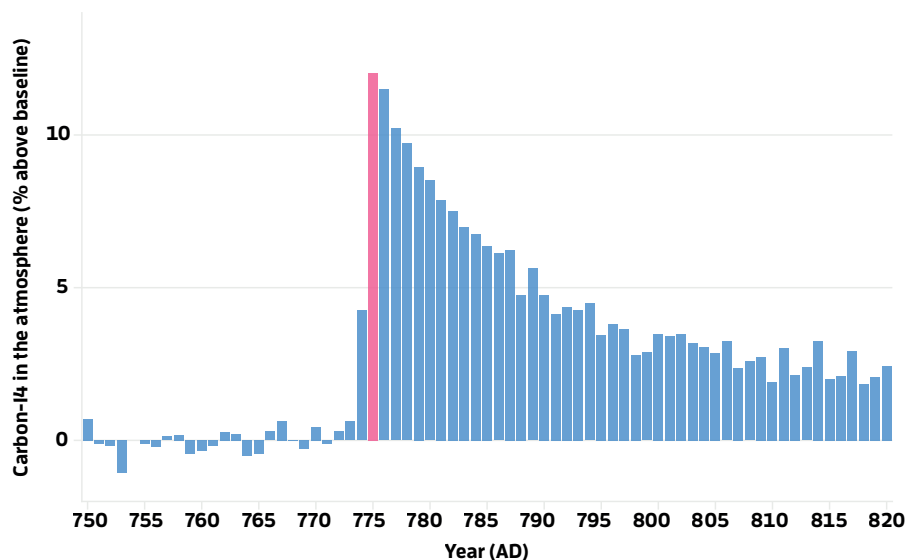
how frequently they ought to occur. At one end, satellites and ground-based detectors give us a detailed picture of the relatively modest storms the sun produces today. At the other, tree rings have preserved the fingerprints of the most extreme Miyake events. But researchers are stuck with a "missing middle" of solar violence.

That gap may now be starting to close. In a paper published earlier this year, researchers, including Dee, combined eight high-resolution carbon-14 records from tree rings spanning almost the entire first millennium AD, from 1 to 970. Five of these series were newly measured from European oak, mainly from Germany and France, while three came from existing tree-ring datasets. They then modelled Earth's carbon cycle to search for abrupt increases in carbon-14 production, finding four candidate intermediate events, around AD 14, 553, 675 and 954. This would place such events at a frequency of around one every 200 years.

The exact nature of the danger posed by these intermediate storms depends on what is actually causing them, says Benjamin Pope at Macquarie University in Australia. If the culprit is a coronal mass ejection, the main threat would come from the way the event distorts

When we saw the sky erupt

In 774–775 CE, tree rings recorded an abrupt jump in carbon-14 — the signature of an extreme particle storm now known as the first discovered Miyake event



SOURCE: DOI.ORG/10.1038/NATURE11123

Earth's own magnetic field. It could trigger a geomagnetic storm, driving unwanted currents through power grids, pipelines and other long conductive systems. The damage would be uneven, shaped by geography, geology and the layout of infrastructure on the ground.

Pope imagines a scenario in which an event may take out critical manufacturing capabilities, concentrated in the northern hemisphere. "If you, in a synchronised way, took out China, the US and European manufacturing, we're done," he says.

The missing middle

A solar flare causing an intermediate event would have different consequences. Rather than a cloud of plasma, the intense flashes of radiation would be absorbed high in the atmosphere, sparing most ground-based systems. But anything above that shield would be exposed. Satellites could be damaged, radio communications disrupted and GPS signals degraded or lost.

Establishing the cause of such middle-range events would require researchers to fill in more of the missing middle and, in turn, help us get a better sense of where larger Miyake events fit within what we know about solar physics.

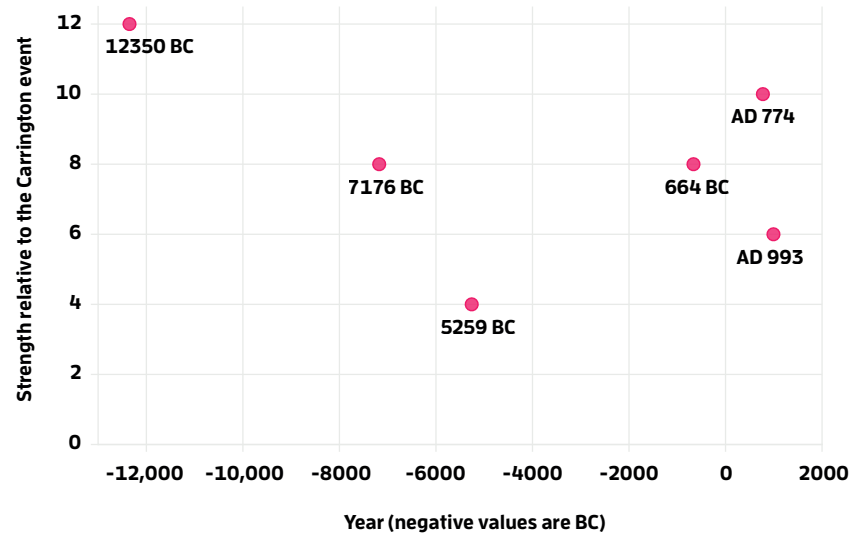
That sounds simple enough. But interpreting solar events from carbon-14 can be complex. The carbon-14 spike is made high in the atmosphere, then has to mix down into air that trees can absorb. By then, a tree may already be growing new wood using carbon stored from previous years. Wood that is formed near the start of the annual growing season can be especially prone to this blurring; later-growing wood may offer a cleaner annual signal.

"Some tree rings start growing around spring, but the carbon they use to grow that ring could be from previous years. If you take a tree from Europe and a tree from Asia, they might behave differently," says Jian Wang, also at the University of Groningen, who was part of the 2026 study. "There's also the varying effect from the Earth's natural geomagnetic field that could reduce or amplify some signals."

That is why not every tree is equally useful. Researchers need species that lay down clear annual rings and preserve enough reliable carbon-bearing material to measure. Even then, the record can vary with species, latitude, season length, water, light and age. For the

The six confirmed Miyake events

Extreme solar particle events recorded in tree rings, scaled to the 1859 Carrington event



SOURCE: DOI.ORG/10.1098/RSPA.2022.0497



An intense solar storm could cause electrical disturbances in the atmosphere

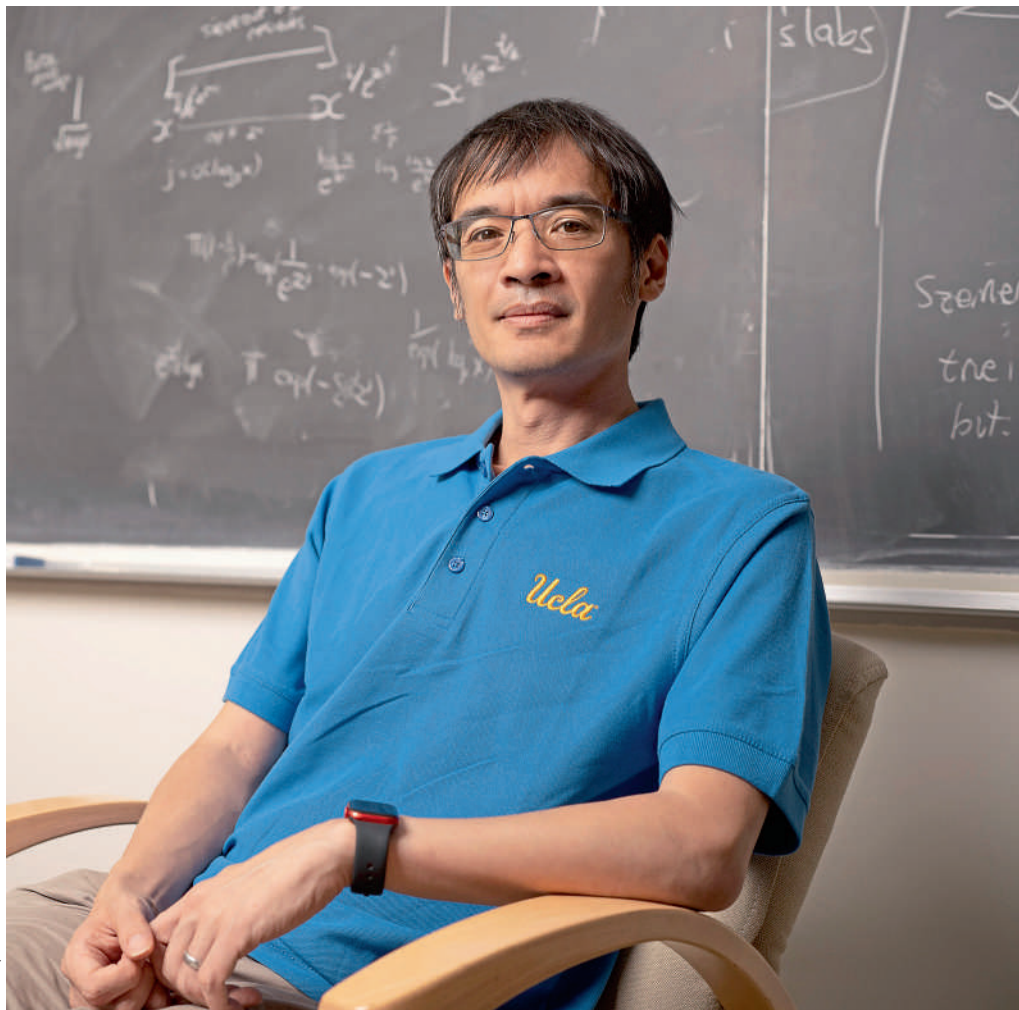
largest Miyake events, the signal is unmistakable. For smaller events, these subtleties can be the difference between a real solar storm and biological noise.

For now, researchers have pinpointed ancient New Zealand kauri trees. These giants are unusually useful archives: long-lived, well preserved and capable of yielding year-by-year records from the southern hemisphere, where Miyake event data is much thinner. "We're still dealing with a lot of unknowns," says Dee. "Any effort would have to be a global one, taking measurements from trees all over the globe."

The point of this work isn't only to work out how often civilisation might be jolted by a solar storm. Miyake events may also be telling us something profound about the sun itself. Until the first carbon-14 spike was found in Japanese cedar and linked to an eruption from the sun, few solar physicists had seriously entertained the idea that our star could produce particle storms on this scale. The discovery forced them to widen their sense of what was possible. Now the question remains: when will the next big storm come, and just how bad will it be? ■



Jacklin Kwan is a features editor at *New Scientist*, specialising in physics



"I wish we had more time
to do this slowly"

The past few months have left mathematicians reeling as AI models solve seemingly intractable problems.

Terence Tao, the world's leading mathematician, tells Karmela Padavic-Callaghan that a rapid revolution is the only way out of the crisis

AS THE stewards of a body of work dating back thousands of years, mathematicians are rarely in a hurry. Problems can lie open for decades or even centuries before they are cracked, and individual mathematicians think nothing of spending years devoted to a single question. But now Terence Tao, arguably the world's greatest living mathematician, says that he and his colleagues have mere months to react to a crisis driven by the rise of AI. He warns that, for the first time in more than a century, mathematicians are facing a peril so severe that they must come together and reimagine what it means to be a mathematician.

"We don't have to passively accept changes by external forces. [We] can't just passively prove our theorems; we have to organise, become activists, get a little political," Tao tells me when we sit down to talk at the International Congress of Mathematicians in Philadelphia. In his view, mathematics needs a huge overhaul of its culture and practices, very soon – by the end of this year. "I wish we had more time to do this slowly," he says.

His sense of urgency is based on the stunning progress that AI models have made in mathematics this year alone. Throughout 2026, mathematical conundrums that had gone unanswered for decades are seemingly falling at the hands of AI at a pace of a few each week. Remarkably, some of these efforts have been helmed by amateurs and hobbyists who have simply asked models for solutions. Tao says it is likely that humans are about to lose their monopoly on problem solving.

In the face of this upheaval, Tao is perhaps uniquely placed to lead a rethink of what it means to be a mathematician. Growing up, he struggled to answer that question. He loved maths – in fact, he was a veritable child prodigy – but he had no idea what a mathematician does all day. Does some shadowy council just hand open problems to each mathematician like homework? Maybe, Tao reasoned, he should instead just be a shopkeeper – his love of mathematics would make him good at balancing accounts and taking inventory.

But it quickly became apparent that Tao was destined for a mathematical life. In one oft-cited anecdote, he was teaching other children to count at age 2. In another, a 7-year-old Tao is

recounted reading a calculus textbook. At age 10, he became the youngest winner of a medal at the International Mathematical Olympiad. In 2006, he won the Fields medal, often called the Nobel prize of mathematics, and the award citation listed four different branches of mathematics he had influenced profoundly, having only just entered his 30s.

Now, aged 51, Tao has made the sort of singular mark on mathematics that would take most in the field several lifetimes to achieve. He has tackled a centuries-old question about patterns within prime numbers. He also chipped away at the Kakeya conjecture, which asks about the path taken by a needle as it rotates through space. Solving a version of this problem just earned Hong Wang at New York University the Fields medal. Tao has also settled seven problems set by legendary mathematician Paul Erdős, whom he met at age 10 (pictured page 40), and contributed to some of the biggest unsolved problems in mathematics, like the Collatz conjecture and the Riemann hypothesis.

Then there is his work related to physics, such as wave maps, which are linked to Albert Einstein's theory of general relativity, or the nonlinear Schrödinger equation, which describes light that interacts with itself within fibre optics. He even developed an algorithm

to make MRI scanners more efficient.

As this list demonstrates, Tao is both prolific and versatile, and he is frequently at the cutting edge of new ways of doing maths. For example, he helped lead the Polymath Project, an experimental enterprise in massively parallelised mathematics where large teams of volunteers tackled an open problem by splitting it into many mini problems. He isn't against AI, saying he uses it regularly – but he is still remarkably worried about what the rapid pace of advancement means.

Intellectual infrastructure

To outsiders, this ongoing shift from proof scarcity to proof abundance, as Tao describes it, might seem like a good thing. But Tao says it is as if mathematicians have been driving their cars along outdated roads built for pedestrians and horses, but now AI has joined in while driving larger, faster cars. Traffic jams and accidents are all but inevitable, and the whole infrastructure is proving to be unstable – AI is revealing and magnifying all its potholes, bumps and cracks. For example, it used to be that generating proofs was hard, but now that we have massively accelerated that part of the process with AI, the normal channels of peer review and mathematical acceptance are becoming clogged. "Validation is in short supply," warns Tao.

There are some solutions already. Traditionally, mathematicians write up their proofs in a combination of mathematical symbols and natural language, and their colleagues read these papers to follow the argument and verify its logical truth. More recently, some mathematicians, including Tao, have turned to formalisation, in which the mathematical argument is encoded using a programming language called Lean, allowing a computer to verify each step. This has now been turbocharged by AI with autoformalisation, which hands the task of writing a proof in Lean over to AI.

But Tao worries that allowing AI to both produce and formalise a proof could easily lead us into territory dangerously close to meaninglessness. We might end up with something that a computer says is correct, but if a human can't understand the proof, ➤

"If all science becomes automated, the next generation of highly curated knowledge could be lost"



AI is adept at problem solving, but that isn't the only job of a mathematician

what is the point? Is it even really a proof? In Tao's view, it would be bad for mathematics if all that the future held was just more and more AI-generated proofs. "There is a danger that if all science becomes automated, the next generation of highly curated knowledge will be lost," he says.

The last time mathematics was in serious crisis was the early 1900s, when a variety of paradoxical results threatened to break the very foundations of the field. Mathematicians and philosophers had to come together and rebuild on firmer logical ground. "That was traumatic," Tao says candidly. This AI crisis is different – not one of mathematical arguments, but rather values and practices. Mathematicians have mostly been able to put philosophy back in its box after the crisis of the 1900s, but AI is opening wounds old and new.

It all goes back to Tao's question of what exactly a mathematician does. During their training, mathematicians become extremely proficient in technical skills, he says, but how mathematics works, and why it works, is something that they only learn implicitly from talking to their mentors and peers.

As they progress, young mathematicians tacitly pick up on how best to present their work, how to teach their technique to others, when to trust someone else's work and what it means to have good taste and discernment when deciding which problems and research topics to work on. With a wry smile, Tao jokes that he wishes AI models could spend some time in graduate school and learn all of this before being unleashed onto some open problem. "A lot of people that are picking up AI are treating maths as a sport where you just collect tick marks," he says.

This competitive spirit may be impressively productive on the surface, but it doesn't necessarily advance mathematics. In a well-attended lecture at the conference, Tao laid out what he sees as the real work of mathematicians. He focused on problem

solving. In his framework, the first step is posing a problem, followed by resolving it with a proof. The solution then needs to be verified, but it doesn't become meaningful unless it is also well written, he argued. Such proofs must be easy to understand (for an expert, at least), engaging to read and clearly lay out the innovative parts of the argument and its connections to existing literature.

The next generation

But this isn't the last step, said Tao. The process ends only once the well-written, verified solution has been digested and accepted by a community of experts and becomes integrated into how the next generation of experts is trained. "In order to actually influence the future development of mathematics, it needs to be accepted and valued by [the] community. Other mathematicians need to actually want to read it and digest it and put it into their own work," he said to a captivated audience. Heads nodded across the room.

AI models are very good at generating proofs and proficient at verifying them, but AI mathematics is really frustrating to read, Tao continued. Sometimes, an AI model will spend pages proving something that is obvious to a human mathematician, but then compresses the hardest part of the proof into just a few sentences, glossing over the most meaningful parts. Worse yet, the way AI models arrive at solutions is often opaque, hidden by both the privately run nature of software, like ChatGPT and Claude, and the fact that we still don't fully understand their underlying technology.

Finally, community acceptance is simply not something that can be optimised with AI tools alone, he said. If being a mathematician simply means producing proofs, then AI models stand a chance of being good mathematicians, but Tao's analysis, in part based on his own experience as a remarkably flexible and prolific mathematician, clearly made the case that

a mathematician is something much more.

One area that will need careful consideration is the education of new mathematicians, with Tao saying in his lecture that students will need to be restricted in their use of AI, allowing them to develop their own intuition through old-fashioned elbow grease. Tao tells me that he has already heard stories of students whose otherwise commendable skill really declined after they started overly relying on AI. "At some point, it becomes irreversible," he says. To avoid this, he can already offer some tips. "You can use AI if you can present your work to your advisors and answer questions intelligently without looking at your phone."

I ask him whether he expects resistance from mathematicians when it comes to implementing such changes, as well as doing analytical and self-reflective work about their profession that they aren't used to. They will simply have to, he tells me without hesitation. Then, a small concession to just how difficult cultural change can be: "Denial is such a strong force, especially if you have to change everything." But the alternative is also clear to him – not only will mathematics stop



"Until recently, only mathematicians cared about maths. Now we have lost control of the narrative"

advancing, but mathematicians will lose the authority over what their profession is, and the figure of the mathematician will instead be defined by technology companies.

In fact, Tao thinks this is already happening. "Until recently, only mathematicians cared about mathematics. We had full control," he says. "Now, for the first time, mathematicians have temporarily lost the narrative." In one striking example, Jacob Tsimerman at the University of Toronto in Canada, who was another winner of the 2026 Fields medal, is joining OpenAI as a researcher (see page 6).

Open questions

And while it is undeniable that AI models are solving mathematical problems, we are far from having a scientific understanding of what it takes to achieve these results, or even something as simple as how many attempts it takes a model to spit out a proof – something that companies like OpenAI or Anthropic don't necessarily have an interest in clarifying. "We have sort of selectively disclosed results, which look impressive, but we don't know exactly what the prompts were. We don't know the failure rate. And many of the companies that are disclosing these have their own incentives to maybe present the results in as favourable [a] light as possible," Tao said in his lecture.

He wishes that mathematicians leveraged their authority more and spoke up more often. The public already doesn't understand what mathematicians do, and now there is all this noise about it coming from a very different crop of researchers and technologists. In Tao's view, tech companies may be able to shift the focus to simply generating as many proofs as possible, but mathematicians ought to get louder about all the parts of the process of doing mathematics where those firms' AI tools can't compete. "They tried to redefine what our profession is," he says. "[But] mathematicians have more influence than they think."

Furthermore, Tao is actively involved in efforts to evaluate the mathematical prowess of AI in a more scientific way. He is part of the First Proof project, which aims to test AI on unpublished problems in mathematics, meaning the models can't rely on answers found elsewhere. Earlier this year, after posing

10 problems, the project's reviewers found seven solutions generated by AI models to be of a high-enough quality to be published in journals. "We need to identify the problems that really are best suited for AI," says Tao.

He is chipping away at the culture issue, too. The shape of a mathematical paper hasn't really changed for decades, but Tao has just launched *Mathematical Discourse*, a video-based journal where mathematicians' contributions will be evaluated not just on correctness of proofs, but how well they can explain them to their peers.

But if one of the lessons of the crisis in the foundations of mathematics a century ago was that mathematicians must come together, that is also happening now. Tao points me to the Leiden Declaration on Artificial Intelligence and Mathematics, a community initiative that produced a series of recommendations that were then endorsed by the International Mathematical Union and, at the time of writing, has more than 3000 signatories across all levels of mathematical research.

"Mathematics produces not only a body of results, but also understanding, clarity, and judgment among the communities of mathematicians who have shaped them," the authors of the declaration state in its introduction. "This has been the result of months of community input about the fundamental values and goals of the mathematical community. In retrospect, these were questions we should have been systematically discussing years ago," Tao commented when adding his signature.

Mathematics, then, stands at a hugely significant moment, one where it must deal with a century's worth of history as it is quickly barrelling into the future – a future that, without action, could be decided by technology companies rather than mathematicians. For Tao, this struggle for the heart of mathematics is as simple as it is personal. "I love my profession," he says. "I think this is worth fighting for." ■

Terence Tao, aged 10, studying with mathematician Paul Erdős



Karmela Padavic-Callaghan is a reporter for *New Scientist* focusing on physics, materials science and quantum technology

Impossible horizons

The laws of physics seemed to forbid a strange variety of black holes with zero temperature. **Jacklin Kwan** explores if they could really exist

PHYSICS is littered with the remains of theories that once seemed destined to explain everything. A theory can dominate for decades, even centuries, only to be wiped out when new experimental results arrive or a fitter idea comes around. Before long, they are relegated to little more than fossils in the scientific record.

Thermodynamics, though, is like the crocodile of physics – an ancient, unchanging beast that has survived the field's great mass-extinction events: the arrival of quantum mechanics, the fusion of space and time into one fabric, the discovery of the expanding universe. Thermodynamics has persisted through them all. Even Albert Einstein believed it would outlast quantum theory and general relativity, two fields he helped establish.

Now, it may finally have met its real test: an extremal black hole, a theoretical variety of cosmic behemoth that sits at the limits of the theory of general relativity. One of the basic laws of black hole thermodynamics suggests that nature could never make such a beast. But recent work has shown that nature may have found a loophole.

To see why that would be such a big deal, we need to return to the early 1970s, when our modern understanding of black holes was only beginning to take shape. Jacob Bekenstein, then a graduate student at Princeton University, pointed out that matter falling into a black hole seemed to disappear from the observable universe, taking its entropy with it.

Entropy tells us how many microscopic arrangements can produce the same observable state. Imagine a glass of water. To us, it has an obvious temperature, volume and pressure, but the molecules within can be

arranged and moving in an immense number of different ways while the glass, overall, looks exactly the same. Entropy is a very powerful tool – counting these arrangements can help us unpick what the microscopic components of a system are. According to the second law of thermodynamics, the total entropy of an isolated system always increases over time. So what happens when something falls into a black hole, crossing a threshold beyond which nothing can ever return? Is it just gone from the account of entropy in the cosmos? Certainly not without breaking the laws of physics. So, Bekenstein proposed a radical solution: black holes must possess entropy of their own.

The broken third law

Physicist Stephen Hawking initially objected. If a black hole had entropy, thermodynamics implied that it must also have a temperature – and anything with a temperature should radiate. That was awkward, given that the defining feature of a black hole was that nothing escaped it. But then physicists, including Hawking, crunched the numbers and saw that once they included quantum mechanics, black holes did emit a faint glow, now known as Hawking radiation. They had a temperature after all.

When doing the maths, physicists also noticed a striking resemblance between the laws that governed black holes and the laws of thermodynamics, which concern the transformation of work, entropy and energy in engines. In fact, there were rock-solid correspondences between the behaviour of black holes and the first two laws of

When the inner and outer horizons of a black hole meet, it exhibits extremality

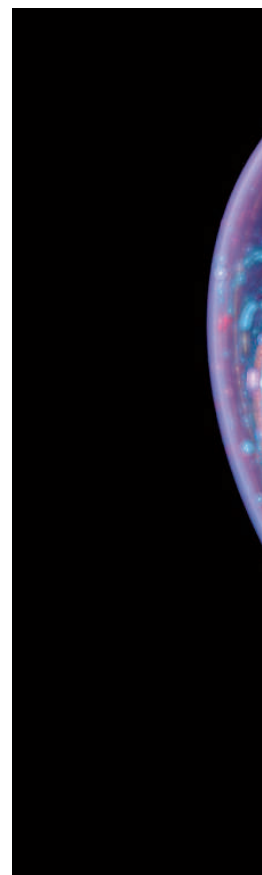
thermodynamics, which state that energy cannot be created or destroyed and that entropy can never decrease in a closed system.

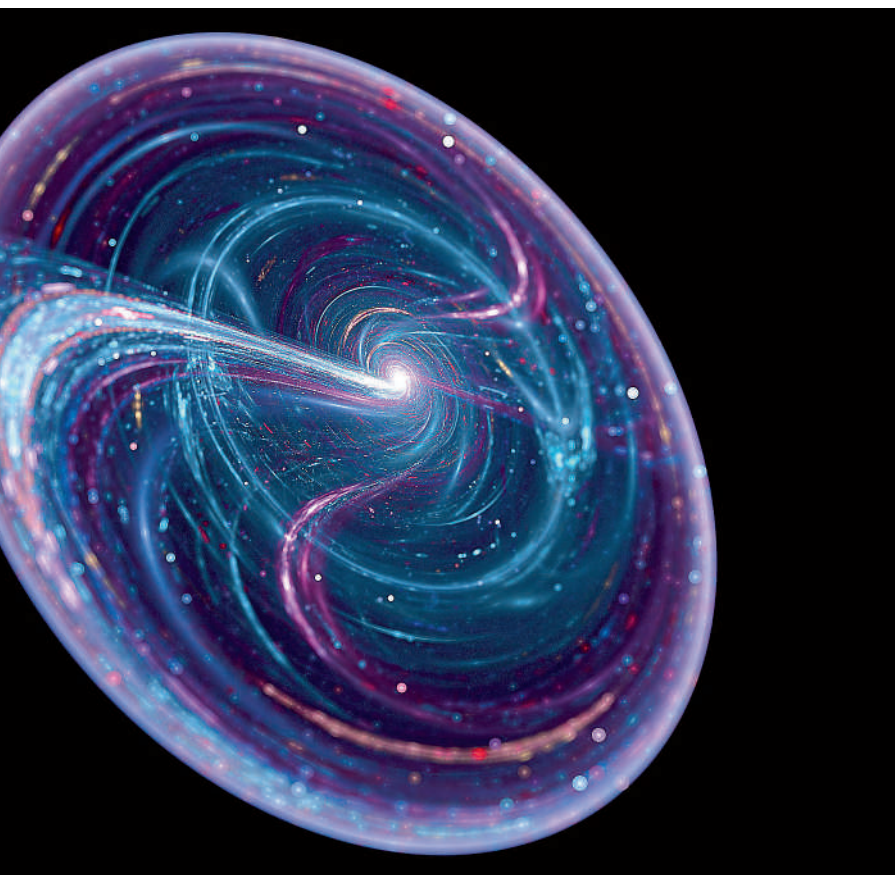
Physicists had little reason to think the third law would be any different. This law says you can never cool a system all the way to absolute zero. The colder it gets, the harder it becomes to remove the last scraps of heat, until reaching zero would take an impossible amount of time or effort.

Black holes were thought to play by the same rule. A black hole is characterised by just three numbers: its mass, electric charge and spin. From those, you can work out the area of its event horizon, its temperature and its entropy. And, in line with the third law, it seemed that a black hole could never quite reach zero temperature, or stop emitting Hawking radiation altogether.

But in 2024, Christoph Kehle at the Massachusetts Institute of Technology and Ryan Unger at the University of California, Berkeley, proved that such extremal black holes, as they are known, could indeed exist. So, the third law of black hole physics may not be much of a law after all. “Extremal black holes were thought of as an idealised, unattainable limit: something you could write down as a solution, but which could never be reached [through any real physical] process, but we proved that wrong,” says Kehle.

We didn't think this third law for black





SHUTTERSTOCK/SAKMISTEKE

holes was true just because it mirrored thermodynamics. It also seemed to keep the rest of physics safe.

Charged and rotating black holes can have two horizons. The outer one is the familiar event horizon, the point beyond which nothing can return. Deeper inside lies the Cauchy horizon. Cross that and general relativity stops telling you what happens next: even perfect knowledge of the past would no longer be enough to predict the future.

Mathematical physicist Roger Penrose thought the Cauchy horizon would always stay safely inside the event horizon, keeping the singularity at the core of the black hole hidden from the rest of the universe. He called this cosmic censorship, a kind of built-in mechanism that stops us witnessing a place where the laws of physics have broken down – a so-called naked singularity.

But the black hole's gravitational pull is counteracted by its charge and rotation. Increase either of these and the Cauchy horizon expands while the event horizon contracts. Eventually, the two coincide at a limit known as extremality. The gravitational intensity at the event horizon – a quantity known as its surface gravity – then falls to zero. Because a black hole's Hawking temperature is proportional to this surface gravity, an extremal black hole has zero temperature and emits no thermal Hawking radiation.

Extremal black holes ride on the edge of this cosmic danger zone – right as the Cauchy horizon threatens to eclipse the event horizon and reveal a naked singularity – and were thought to be impossible. But Kehle and Unger found two ways around this.

Their models showed that an extremal black hole could form if you physically added charged matter to a black hole gradually, or fired a beam of charged particles into a region of empty space and caused it to collapse into an extremal black hole directly. Crucially, these mechanisms didn't risk creating a naked singularity.

"The fact [that this work proves] extremal black holes can form classically tells us that these objects are not just mathematical limits. They are allowed within classical gravity," says Chiara Toldo at the Free University of Brussels in Belgium. "Whether quantum mechanics allows for their formation remains, however, an open issue."

What is extremality good for?

That matters because these strange objects may provide a bridge between black holes in the messy, evolving universe and the highly idealised ones that have long appeared in string theory and quantum mechanics.

For decades, physicists have wanted to know what black holes are made of. Their entropy

suggests that there must be many possible arrangements of microstates, corresponding to the same black hole. But what, exactly, is being rearranged?

That question is one reason theoretical physicists such as Toldo have been interested in extremal black holes for some time. Much of their appeal comes from their zero temperature, which would usually mean zero entropy. But despite having zero temperature, extremal black holes can still possess entropy. That makes them unusually clean models for exploring what a black hole's microstates might actually be.

But, until now, much of this work dealt with extremal black holes as idealised mathematical models. Showing that one can form dynamically brings those ideas a step closer to the kinds of objects that might genuinely arise in our universe.

There may even be a way to spot one. As matter tumbles towards a black hole, it can be squeezed and heated so violently that it gives off a burst of radiation. This is nothing like Hawking radiation: it comes from the infalling material itself. Around an ordinary black hole, the resulting disturbance soon dies away. But an extremal horizon lacks the usual damping effect, allowing part of it to linger and even grow. Last year, researchers showed that this should leave a distinctive fingerprint in the tail of radiation travelling out to distant observers.

But actually detecting an extremal black hole remains a distant prospect. For now, the more immediate implications are theoretical. If the third law of black hole physics can be broken, then the analogy between black holes and thermodynamic systems may not be as exact as we thought.

Kehle and Unger's work has exposed more than a gap in our understanding of black holes. It raises the more unsettling possibility that we don't fully understand thermodynamics either. "This work made me realise that I understand black holes better than I understand classical thermodynamics," says Kehle. "There could be something more fundamental lurking there that we don't know about."

"We've disproved the third law as it was written, but we don't yet understand this problem in any sense. There's still a lot to be done," says Unger. ■

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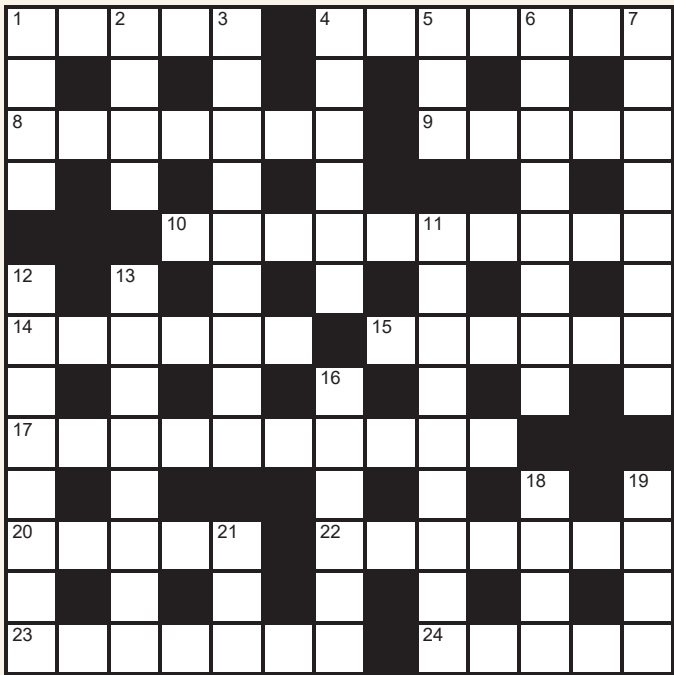
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Cryptic crossword #194 Set by Rasa



Scribble zone

Quick crossword next week

ACROSS

- 1 Simple machine beginning to lag constantly (5)
- 4 French scientist doubling sulphur in toxic substance (7)
- 8 Fixed CGI bear's bone structure (7)
- 9 Broadcast something enticing, K? (5)
- 10 Right to enter gathering of males with a zest for campout activity (10)
- 14 Mexican's home bar ultimately wanting melon (6)
- 15 Chalk a line showing base (6)
- 17 Profs towel off greenhouse equipment (6,4)
- 20 Uranium found in previously small quantity (5)
- 22 Put back current book about passion (7)
- 23 Perceive insult at particle physics lab (7)
- 24 Try pair of espadrilles, for example (5)

DOWN

- 1 Boy grabs last of their soap-making stuff (4)
- 2 Feeling second-rate in contest (4)
- 3 Astrolabe collapsing like a marshmallow? (9)
- 4 In text, your tenants petition for lung protection (6)
- 5 Kind leader leaves nutrient-rich drink (3)
- 6 Very precise burst of energy, not quite 1 calorie (8)
- 7 I thought I'd seen the last of this dancing in a toga before noon (3,5)
- 11 Apportion strong cord (graphite or carbon nanotube, maybe) (9)
- 12 Small casual restaurant on outdated platform (8)
- 13 Surprises speedy dogs with scratched faces (8)
- 16 Bad temper observed around place (6)
- 18 Don't catch honorific (4)
- 19 Stained little finger releases pressure (4)
- 21 Watch positive vote in the auditorium (3)

Quick quiz #365

set by Chelsea Whyte

- 1 What is affecting the yields and umami flavour of the traditional Japanese tea matcha?
- 2 What surprising final meal was found in the stomach of a remarkably well-preserved fossil of an ancient, ocean-dwelling ichthyosaur?
- 3 Iron Age human skeletons have signs of flat head syndrome, which reveals evidence of what practice?
- 4 Which effect of the Chicxulub asteroid strike 66 million years ago was found to have killed most of the dinosaurs?
- 5 Limiting an essential nutrient could help extend our lifespan. Which component of diet might be better eaten in moderation?

Plus Side

created by Puzzlr

Circle numbers in the grid below to use them, or cross them out to get rid of them. Circled numbers must add up to both the target at the end of each row and the target below each column.

1	2	8	3	8	12
7	8	4	9	3	10
1	5	5	4	1	16
1	3	6	2	7	1
3	9	7	2	3	11
10	14	5	9	12	

Answers to this week's puzzles on page 47



Our games are now playable online
[newscientist.com/games](https://www.newscientist.com/games)

Bottoms up

What is the optimal way to ice a cocktail: fewer big cubes or lots of small ones?

Hillary Shaw

Newport, Shropshire, UK

How fast the ice melts is by far the biggest influence on the temperature of your cocktail. It takes 334 joules of energy to melt 1 gram of ice, which is about 80 times the energy to raise 1 g of water by 1°C. There is negligible heat energy available in the surrounding air, whatever the ambient temperature, to warm the cocktail, as the specific heat capacity of air is even less than that of water. Therefore, the ambient air temperature is irrelevant, as is your hand size, temperature and the dimensions of the glass. The melt speed of the ice is determined by its surface area. A $2 \times 2 \times 2$ centimetre cube of ice has a surface area of 24 cm^2 , but the same ice in eight 1 cm cubes has a surface area of 48 cm^2 .

So, if you drink the cocktail fast, you want smaller pieces; bigger, if you want a longer-lasting cooling effect. With too large pieces, some ice will still be unmelted when you have finished; too small and it all

“There is a downside – the smaller your ice cubes, the faster they melt and the faster your drink gets watered down”

melts before you have finished. It also dilutes the cocktail a bit if it all melts (some may prefer that).

So it depends on your taste and speed of drinking. I am hereby volunteering to act as a guinea pig to drink lots of cocktails with different-sized pieces of ice to determine the ideal drinking speed and ice cube size.

Ron Dippold

San Diego, California, US

That depends what you're looking for – there is a trade-off. If you



This week's new questions

Hair-raising If we could collect every hair that has ever grown on my 19-year-old cat and lay them end to end, how long a line would they make? *Marthinus Roos, Elgin, Moray, UK*

A new wrinkle What is it that makes creases form when you wash or wear clothes, and how and why does ironing remove them? *Thomas Riley, London, UK*

want to make your plonk as cold as possible as fast as possible, then you want your ice to be as small as you can get it. This means more ice is in contact with the liquid. The ultimate form of that is shaved ice, or ice slurry as in some margaritas, which will make your drink cold instantly. But there is a downside – the smaller your ice cubes, the faster they melt and the faster your drink gets watered down. With something as overwhelmingly sweet and flavourful as most commercial margaritas, that isn't a problem, perhaps even a blessing. But it is a problem if you are looking to unwind with something fancy that was properly made in the first place.

Most spirits will benefit from a drop or two of water. Many

aromatic compounds bind tightly to the alcohol, and water cuts those bonds and sets them free so you can smell them. Scottish whisky fans call this “unleashing the serpent”. Similarly, it can precipitate solids out of liqueurs and push them to the surface, again giving you more flavour and nose. You can actually see it if you add a little water to anise liqueurs like Pernod and watch the tiny clouds form in the drink. So, in my opinion, you don't want to drink most things totally neat (no ice) unless your goal is just getting sloshed as fast as possible. Even good vodka benefits from it!

However, you need very little water for this – just the melt from the ice, especially if shaken or stirred, is plenty. Shaking will melt the ice more than stirring,

If their lifetime supply of hair were laid end to end, how long would a cat's fur be?

so James Bond preferred his drinks effectively watered down a bit. I don't think you want a good martini, paper plane or vesper to be watered down much, so use ice that will keep it cool but not melt. And the best way to do that is with large, air-free, spherical ice.

A sphere is, by definition, the shape with the most volume for the least possible surface area – less surface area means it melts slower, and it has no sharp corners like cubical ice that will melt faster. As a bonus, many spherical ice-makers are designed to remove as much air from the ice as possible, freezing them from the bottom and pushing the air upwards. This makes them perfectly clear, which looks nice, but it also makes them denser. And without the tiny air pockets, it will melt much more slowly.

Of course, while large spherical ice goes well in a tumbler, you won't get one in a traditional v-shaped martini glass without it looking ridiculous and making it hard to drink. In that case, the most British of drink columnists, Kingsley Amis, suggested filling the glass about a third of the way with water and then sticking it in the freezer. This effectively turns the entire bottom of the glass into an ice cube. He had many opinions, many of which I don't agree with, but I have to say that does the job.

Moon move

What changes will occur on Earth as the moon moves further away from us? (continued)

Eric Kvaalen

Les Essarts-le-Roi, France

The moon moves away as it receives angular momentum around the Earth-moon centre of gravity, and that angular momentum comes from Earth, so Earth is slowing down. That is the main reason why we need to add

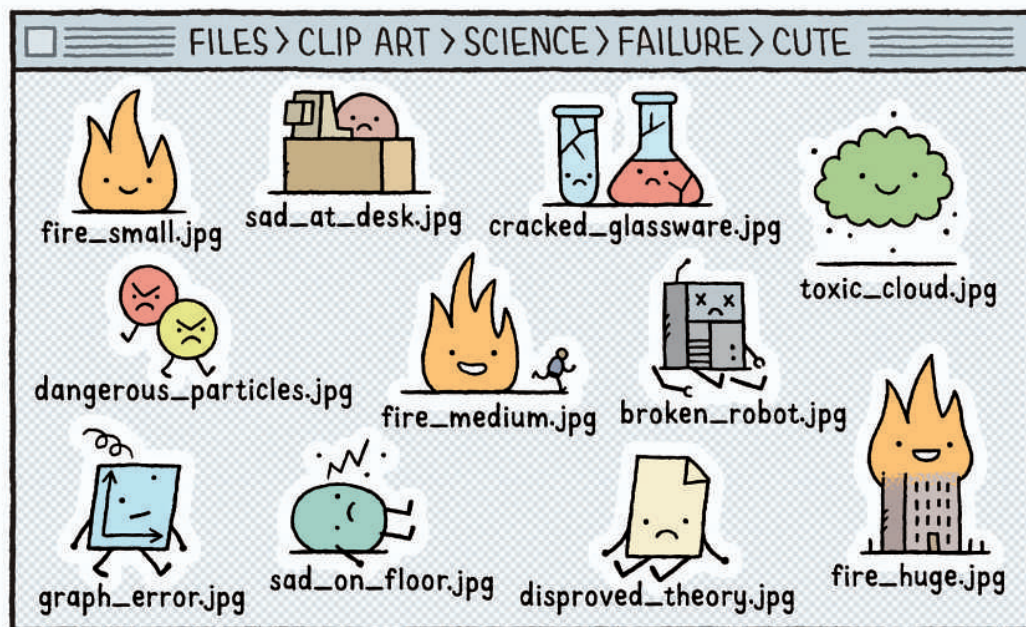


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“leap seconds” to the atomic clock time once in a while – the length of a second was defined using the length of a day around 1900, but a day is now slightly longer than it was then. As days get longer and longer over hundreds of millions of years, there will certainly be effects on the climate and weather. Days would become warmer and nights cooler. Tides would become smaller.

This process would go on until the length of a day and the length of a month would be equal, somewhat longer than a present-day month. If this happens (if the sun doesn’t expand and swallow up the Earth-moon system), there would still be tides, because of the sun. These tides would continue to slow down the rotation of Earth, so that the day would be longer than the month, and the moon would appear to move eastwards in the sky. The tides would now have the opposite effect from before, and would transfer angular momentum from the moon to Earth, drawing the moon closer to Earth and shortening the day.

“Your tree will go on accumulating pairs of ancestors, but, gradually, most will all become the same pair”

If this continues long enough, the moon would eventually get to the “Roche limit”, be broken up by the tidal force exerted by Earth and become a ring around Earth.

Branching out

My family tree doubles at every past ancestor generation and continues branching back into the past. At what point does it reduce in size to reflect the size of the population? (continued)

Robert Cy Jones

East Grinstead, West Sussex, UK
This is a complicated answer to a simple question.

For the UK, the most obvious answer is around the late 1400s. Assuming a generation every 25 years, it’s a simple mathematical

progress that arrives at 2,097,152 after 21 generations. From a base year of 2000, this puts us at the year 1475, when the UK’s population was around 2.1 million (still recovering from the Black Death).

However, this assumes that each pair of our ancestors on our tree are all different people. This will not be the case, as, say, your mother’s great × 20 grandparents might, hypothetically, be the same as your father’s great × 21 grandparents.

Your tree will go on accumulating pairs of ancestors, but, gradually, most will all become the same pair.

Confused? As my mother astutely observed, it’s not a family tree, but a forest.

Don Locke

Leamington Spa, Warwickshire, UK
It depends on the individual. Like the rest of us, King Charles has 32 great-great-great-grandparents, but more than you might expect of them are Queen Victoria and Prince Albert. ■

Answers

ACROSS 1 Lever, 4 Poisson, 8 Ribcage, 9 Karat, 10 Starazing, 14 Casaba, 15 Alkali, 17 Flower pots, 20 Ounce, 22 Emotion, 23 Discern, 24 Essay
DOWN 1 Lard, 2 Vibe, 3 Roastable, 4 Pleura, 5 Elk, 6 Surgical, 7 Not again, 11 Allotrope, 12 Scaffold, 13 Astounds, 16 Spleen, 18 Miss, 19 Ink, 21 Eye

#194 Cryptic crossword

1 Climate change
2 Pterosaur
3 Placing babies on their backs to sleep
4 Global firestorm
5 Protein

Quick quiz #365

12	10	14	5	9	12
11	3	9	7	2	3
1	1	3	6	2	7
16	1	5	5	4	1
10	7	8	4	9	3
12	1	2	8	3	8

Plus Side
Solution

Reshape your mind

One of society's more intractable problems is unnecessary risk-taking behaviour. People do all kinds of silly things, like gambling on horses/prediction markets (delete according to age), or yelling "I love Coldplay" in a crowded biker bar.

Surely it would be better if people just didn't do these dangerous things. The problem is how to achieve this. Perhaps some sort of public-awareness campaign, perhaps taxes on risky activities and purchases to deter people through price, perhaps a sign on the biker bar door saying "do not pick a fight".

Or perhaps we could all just put on some shapewear. This is the startling conclusion of a little study in *Biological Psychiatry*, highlighted to us by news editor Alexandra Thompson while, presumably, giggling like a hyena. The study indicates that wearing shapewear can make us less likely to take risks.

Feedback isn't normally one for doing anything so responsible as actually reporting the details of an experiment, but in this case we feel readers will demand it. The authors recruited 44 volunteers, who visited the lab on two consecutive days. On one day, each person was asked to wear compressing shapewear; on the other, they were given a loose garment. They were given tests of their interoception: their ability to perceive the internal state of their body, specifically their heartbeat and their gastrointestinal system.

The volunteers were also given a test of risk-taking called the Columbia Card Task, presented online. They were shown 32 face-down cards and had to choose how many to turn over, with some giving them positive points and others taking points away. Turning over more cards is riskier than turning over just a few.

It turns out that wearing shapewear was associated with more awareness of one's internal body state, and with less risk-taking behaviour in the card task. The idea is that enhanced interoception gives people more opportunity to pick up on subconscious warning signals.

Twisteddoodles for New Scientist



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Consideration of items sent in the post will be delayed

Feedback is honestly immediately sceptical, not least because the drop in risk-taking was apparent only for the 28 women in the study: the authors interpret this as a male-female difference in the response to compressive shapewear, whereas we suspect that shapewear might not really affect risk-taking after all.

But mostly, we can't believe that anyone had the idea to do this in the first place. Even if we had somehow inexplicably started researching shapewear, we would never have thought of this in a million years.

Cry me a volcano

Recently, Feedback asked the big questions: are some people more prone to crying when chopping onions than others? Do people who are more sensitive to onions also have a stronger sense of smell? We reported a preliminary

study with some early results.

Not that we would ever claim we are doing scientists' work for them or anything, but based on our mailbox, this is an untapped gold mine of potential findings.

Let's start with the idea that a better sense of smell might make you more prone to crying over onions, something the study we looked at did not support. Jackie Jones adds further disconfirming evidence. "I lost my sense of smell six years ago following treatment for cancer," she writes. "Onions, all my life, always made my eyes hurt and run, and they still do with absolutely no sense of smell."

Likewise, Christine Wolak is surprised "that there is any scientific uncertainty about whether different people are affected differently when chopping onions". She reports that at family gatherings, if she

starts chopping onions, it can make her eyes water so badly that someone else has to take over – inevitably "experiencing no effect at all". In fact, her eyes are so sensitive to sulphurous chemicals that a hiking trip to the vicinity of the eruption of Kilauea was enough to bring her to tears. "People thought I was so incredibly moved by the experience," she writes.

Christine offers an intriguing detail: "This has not always happened to me." Only after she had laser eye surgery did onion-induced tears become a regular occurrence. "I would love to know if these are related." On a similar note, Guy Cox reports that his late wife was, at first, unaffected by onions, until she had to swap her contact lenses for bifocal glasses and became thoroughly affected. Might contact lenses be protective?

If you don't have easy access to contact lenses, readers Chris Evans and Jackie Jones, as well as the American Academy of Ophthalmology, all recommend storing your onions in the fridge, at least for a little while before chopping, because cold onions don't give off the relevant volatile chemicals. Feedback is going to try that and report back.

Different strokes

It's been a long time since we saw anything relating to the Scunthorpe problem: the fact that innocuous words can contain objectionable letter strings that may confuse moderation systems. However, a new medium for such rudenesses has come to our attention: those little boxes on social media that recommend accounts to follow.

The estimable folks at the Stroke Association, a British charity, found themselves recommended in the "Suggested for you" box on Meta's Threads. Owing to the small size of the box, however, their name was stripped of the concluding "ocation", with unfortunate results.

The Stroke Association subsequently posted: "Just to reiterate: we talk about medical events, not... whatever this is." ■

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