

New Scientist

WEEKLY May 12 - 18, 2018

WINDOWS ON THE SOUL

Your eyes really do give away your personality

TOTAL CAR CRASH

Why we all think we're good drivers

SELF-HEALING ORGANS

Fixing hearts and brains from the inside out

CLOUD CONTROL China's audacious plan to fix the weather

MYSTERY OF THE COSMIC DAWN

We've seen the first starlight - and it doesn't make sense



No3177 US\$6.99 CAN\$6.99



Science and technology news

www.newscientist.com

US jobs in science

PLUS HOW MUCH IS A TREE WORTH? / THE QUANTUM NET / KEW RENEWED / MISSION TO MARS / TELLING MONKEYS APART / BEETLE BACKPACKS

LEARN SOMETHING NEW EVERY DAY

Subscribe, save 77% and treat
yourself to a FREE gift

Visit newscientist.com/11293 or call
1-888-822-3242 and quote 11293



**New
Scientist**



New Scientist

Management

Executive chairman Bernard Gray
Publishing director John MacFarlane
Finance director Matthew O'Sullivan
Strategy director Sumit Paul-Choudhury
Human resources Shirley Spencer
Non-executive director Louise Rogers

Publishing and commercial

Customer services manager Gavin Power
Head of data science Kimberly Karman
HR co-ordinator Serena Robinson
Facilities manager Ricci Welch
Executive assistant Sarah Gauld
Trainee PA Emily Perry
Receptionist Alice Catlin

Display advertising

Tel +1 617 283 3213
Email displayads@newscientist.com
Commercial director Chris Martin
 Richard Holliman, Justin Viljoen,
 Henry Vowden, Helen Williams

Recruitment advertising

Tel +1 617 283 3213
Email nssales@newscientist.com
Recruitment sales manager Mike Black
Key account managers
 Martin Cheng, Reiss Higgins, Viren Vadgama
US sales manager Jeanne Shapiro

Marketing

Head of marketing Lucy Dunwell
 David Hunt, Chloe Thompson, Andrew Wilkinson

Web development

Director of technology Steve Shinn
 Maria Moreno Garrido, Tuhin Sheikh,
 Amardeep Sian

New Scientist Live

Tel +44 (0)20 7611 1273
Email live@newscientist.com
Event director Mike Sherrard
Creative director Valerie Jamieson
Sales director Jacqui McCarron
Event manager Henry Gomm
Conference producer Natalie Gorohova

US Newsstand

Tel +1 212 237 7987
 Distributed by Time/Warner Retail,
 Sales and Marketing, 260 Cherry Hill Road,
 Parsippany, NJ 07054

Syndication

Tribune Content Agency
Tel 1 800 637 4082
Email tca-articlesales@tribpub.com

Subscriptions

newscientist.com/subscribe
Tel 1 888 822 3242 or +1 636 736 4901
Email ns.subs@quadrantsubs.com
Post New Scientist, PO Box 3806,
 Chesterfield MO 63006-9953



Volume 238 No 3177

On the cover

- 14 Windows on the soul**
Your eyes really do give away your personality
- 42 Total car crash**
Why we all think we're good drivers
- 38 Self-healing organs**
Fixing hearts and brains from the inside out
- 20 Cloud control**
China's audacious plan to fix the weather
- 28 Mystery of the cosmic dawn**
We've seen the first starlight - and it doesn't make sense
- Plus** How much is a tree worth? (32). The quantum net (13). Kew renewed (44). Mission to Mars (4). Telling monkeys apart (10). Beetle backpacks (13)



Insight China's incredible plan to make it rain 20

Leaders

- 3** It is worth valuing trees, but all deserve our respect. Let's hear it for the belittled field of psychology

News

- 4 THIS WEEK** Robotic digger launched to Mars. Drug based on ketamine tested for depression. Hawaii volcano erupts
- 6 NEWS & TECHNOLOGY**
Creativity and mental health risks. Turing-inspired water filters. The dark side of Colombia's peace. Ultra-fast runaway stars. Politics disrupts sleep. First people in the Philippines. Face recognition app for monkeys. Beetle-borgs take to the skies. A step towards the quantum internet. Your eyes give away your personality. Secret superpower of mistletoe

- 18 IN BRIEF** Giant exoplanet with a tail. Mediterranean diet delays Alzheimer's. Sea spiders on the hunt. Tourism's carbon footprint

Analysis

- 20 INSIGHT** China has started the world's largest weather-control experiment, but will it work?
- 22 COMMENT** Excitement over the male pill is hard to swallow. Can we trust eco labels?
- 23 ANALYSIS** The UK doesn't need its own GPS satellites

Features

- 28 Mystery of the cosmic dawn**
We've glimpsed the first stars turning on - and it doesn't make sense
- 32 Treeconomics** Totting up the value of trees could be the best way to protect them
- 38 Regrow yourself** Fixing hearts and brains from the inside out
- 42 Crash test dummies** Why we all think we're good drivers

Culture

- 44 Missing magic** Kew Gardens' Temperate House is now restored to its former glory
- 46 Coming up** From the end of animals to strange futures, our pick of what's on show

Regulars

- 24 APERTURE**
Historical gynaecological tools
- 52 LETTERS**
Laundering internet identities
- 55 CROSSWORD**
- 56 FEEDBACK**
Uranus pongs
- 57 THE LAST WORD**
The art of timing



BIG QUESTIONS AMAZING ANSWERS

*Explore reality, consciousness,
time, sleep, death and more*

Buy your copy from all good magazine
retailers or digitally. Find out more at
newscientist.com/thecollection

NewScientist

LEADERS

New Scientist

Editorial

Editor Emily Wilson
Deputy editor Graham Lawton
Managing editor Rowan Hooper
Art editor Craig Mackie
Editor at large Jeremy Webb

News

Chief news editor Niall Firth
Editors Penny Sarchet, Jacob Aron, Timothy Revell, Jon White, Chelsea Whyte
Reporters (UK) Andy Coghlan, Jessica Hamzelou, Michael Le Page, Clare Wilson, Sam Wong, (US) Leah Crane, (Aus) Alice Klein

Features

Chief features editor Richard Webb
Editors Catherine de Lange, Gilead Amit, Catherine Brahic, Julia Brown, Daniel Cossins, Kate Douglas, Alison George, Joshua Howgego, Tiffany O'Callaghan, Sean O'Neill

Culture and Community

Editors Liz Else, Mike Holderness, Simon Ings, Frank Swain

Subeditors

Chief subeditor Eleanor Parsons
 Tom Campbell, Hannah Joshua, Chris Simms

Design

Kathryn Brazier, Joe Hetzel, Dave Johnston, Ryan Willis

Picture desk

Chief picture editor Adam Goff
 Kirstin Kidd, David Stock

Production

Mick O'Hare, Melanie Green, Alan Blagrove, Anne Marie Conlon

Contact us

newscientist.com/contact

General & media enquiries

enquiries@newscientist.com

US

210 Broadway #201
 Cambridge, MA 02139
Tel +1 617 283 3213

UK

25 Bedford Street, London, WC2E 9ES
Tel +44 (0)20 7611 1200

AUSTRALIA

Level 11, Suite 3, 100 Walker Street,
 North Sydney, NSW 2060
Tel +61 (0)2 9422 8559



MARIJLANG/LIGHTROCKET VIA GETTY

The giving trees

What is the true value of a tree to us?

BEFORE humans came along with their polished axes and (much later) sawmills, there were as many as 6 trillion trees on this planet. Today there are roughly half that number, with their loss continuing apace in many developing countries. In the Amazon, deforestation has recently surged, after a decade of stability, to make room for cattle ranching and soybeans.

Even in the developed world, where efforts are being made to replant forests, urban trees are often viewed as a nuisance. Dead branches must be cut back and pavements broken by sprawling roots repaired. Trees block

valuable views, shade flower beds and drop detritus on cars. Surely there is no harm in chopping down this one or that?

It probably bears repeating that our survival depends on trees. Along with other land plants, trees supply around half of the oxygen entering our atmosphere (ocean organisms like phytoplankton account for the rest). They also suck up carbon dioxide from the atmosphere. There are plenty of less obvious benefits too, such as the way tree canopies save us energy by shading buildings in summer and diverting away cold winds in winter.

In the world of Dr Seuss there is an angry orange creature called the Lorax who speaks up on behalf of trees. In reality, however unpalatable it may sound, we need an argument that goes beyond fine words.

Enter a branch of economics just for trees: "treeconomics". Cities all over the world are having their trees valued, and the balance sheet of their benefits makes impressive reading (see page 32). These valuations can teach us which species to plant to provide the largest possible benefits. But more importantly, they may help us treat every tree with the respect it deserves. ■

Better than average?

TO A curmudgeon, psychology is the art – not science – of stating the bleeding obvious. Either that, or of jumping to false conclusions. In 2016, Norwegian psychologist Jan Smedslund, a veteran of 60 years' standing, went so far as to argue that his discipline could never be an empirical science, thanks to the sheer impossibility of untangling myriad

influences on human behaviour.

Such criticisms have some merit, but are unduly harsh. Every now and again, experimental psychology produces an insight that truly changes how we think about ourselves. Take the study half a century ago that revealed that a cohort of 50 drivers all rated themselves as above-average – despite being in hospital for self-

inflicted crash injuries (page 42).

It is a finding that, in that best possible way, makes you laugh and then think. The "better than average" effect is now well established in many fields of human endeavour. Avoiding the insidious effects of such cognitive biases is central to improving public safety and helping us all rub along a little better.

So let's hear it for a belittled discipline – and the odd result that truly is better than average. ■



© 2018 New Scientist Ltd, England.

New Scientist ISSN 0262 4079 is published weekly except for the last week in December by New Scientist Ltd, England.

New Scientist (Online) ISSN 2059 5387

New Scientist Limited, 387 Park Avenue South, New York, NY 10016

Periodicals postage paid at New York, NY and other mailing offices

Postmaster: Send address changes to New Scientist, PO Box 3806, Chesterfield, MO 63006-9953, USA.

Registered at the Post Office as a newspaper and printed in USA by Fry Communications Inc, Mechanicsburg, PA 17055

THIS WEEK

Marsquake mission blasts off

The InSight lander will catch tremors and unpick the Red Planet's past

Mika McKinnon, Lompoc, California

EARLY on the morning of 5 May, a trio of spacecraft blasted off for Mars. At least, that's the best explanation I have for the rolling growl that rattled my bones at Vandenberg Air Force Base in California. I never saw the rocket.

InSight – Interior Exploration using Seismic Investigations, Geodesy and Heat Transport – is the latest Mars robot, and the first robot geophysicist destined to land on another planet. Coming along for the ride are the first two cubesats to travel in deep space. Their task is to relay status updates on the lander.

To witness the launch, I headed to Lompoc, a quiet farming community tucked into that strange bend in the California coast that allows rockets to head south without passing over cities. The launch itself was practically flawless. The Atlas V rocket lifted off exactly on time, cruising smoothly before InSight made a clean separation from the booster to continue its journey to Mars. Unfortunately, fog ruined the view – not that it dimmed excitement on the ground.

"This is awesome. I have three spacecraft that just left for Mars," said Farah Alibay, a systems engineer at NASA's Jet Propulsion Laboratory.

Even though the view was underwhelming, the mission won't be. Mars InSight is a lander equipped with the same tools that geologists use here on Earth.

Unlike previous Martian rovers, which studied surface geology, InSight will peer deep into the Red Planet's interior using techniques geoscientists sometimes joke are more dark magic than science. The probe packs a lot of scientific potential into a relatively small



BILLINGALLS/NASA

collection of instruments: a seismometer, a heat-flow probe and a weather station. Even its communications antenna can be used to measure wobbles in Mars's rotation. Like my view of the launch, InSight won't get a direct glimpse of the planet's inner workings, but it will give us a hint of what's going on.

It once made an exhaustive survey of every hole ever drilled on Mars, all no more than a few centimetres deep. InSight's body-double Phoenix, a craft that

"Even the probe's communications antenna can be used to measure wobbles in Mars's rotation"

Flight time from California to Mars will be nearly seven months

landed in 2008, set a record when it scooped down to 18 centimetres beneath the surface. InSight's heat-flow probe promises to go far beyond that. It will hammer a drill 3 to 5 metres below the rust-coloured surface to measure heat escaping from Mars.

That will tell us about thermal conditions on the planet right now, which are related to its seismic activity. Modelling that activity back in time can help us better understand how Mars formed.

It could also give us the story behind Olympus Mons, the largest volcano in the solar system

and a geological sibling to the chain of volcanoes in Hawaii.

Unlike Earth, Mars does not have tectonic plates that occasionally catch and tug to feed volcanoes and spark earthquakes. But it is seismically active, contracting as it slowly cools and sparking small to medium-intensity Marsquakes.

The Viking landers launched in the 1970s carried seismometers, but a combination of poor placement, exposure to the weather and insufficient sensitivity meant they never definitively detected a single Marsquake.

InSight heeds the lessons learned. It boasts the world's highest-sensitivity portable seismometer, an instrument that actually picked up crashing waves in both the Pacific and Atlantic oceans when it was tested in Colorado. The testing could only take place in a vacant room because human breathing is disruptively loud to its keen "ears".

To survive the vibrations of launch, the hostility of deep space, the shock of landing and the gentle but relentless pressure of Mars's thin atmosphere, the seismometer's pendulums are tucked within a protective vacuum chamber. A leak in the chamber was enough to delay the original launch plans in 2016, making Mars InSight's to-the-minute lift-off even more satisfying.

Although I am disappointed that I didn't see this geophysical marvel as it launched, I am relieved it left Earth safely and is cruising to Mars. It will arrive on 26 November, when it will have to survive the terrifying entry, descent and landing on the Red Planet. And there, it will dig down deep. ■



BRUCE ONOH/PARADISE HELICOPTERS/EPFL/REX/SHUTTERSTOCK

Lava flows torch Hawaii

WAVES of lava are threatening properties, roads and forests on Hawaii's Big Island as the Kilauea volcano continues to erupt. The lava is spraying in fountains up to 70 metres high and reaching temperatures in excess of 1000°C.

As *New Scientist* went to press, the eruption had destroyed 35 buildings, including 26 homes. Some 1700 residents had been evacuated.

One of the world's most active volcanoes, Kilauea flared up after 30 April when the floor of the lava lake at its summit collapsed. This sent lava cascading into the volcano's plumbing, fuelling earthquakes including a magnitude-6.9 event on 3 May - the island's most powerful for 40 years.

By Monday, 12 large fissures spewing toxic sulphur dioxide gas and lava had opened up on

Kilauea's slopes, according to the US Geological Survey.

We should expect more fissures and more lava flow, says Jessica Johnson at the University of East Anglia, UK. "But there's unlikely to be an explosion."

Kilauea's biggest known eruption happened in 1790 when magma heated up water underground. The resulting steam created so much pressure that the volcano blew. Today, there are many paths the magma can take to reach the surface without hitting water, making a huge blast less likely, says Johnson.

Even so, the volcano is wreaking havoc. "It's devastating," says Johnson. "The gas is very dangerous, and lava flow has already flowed a kilometre from one fissure, destroying properties."

US death linked to romaine lettuce

FOR weeks, there have been reports of illness across 25 US states caused by *Escherichia coli* bacteria in romaine lettuce. Now the outbreak has claimed its first fatality, in California.

As *New Scientist* went to press, the US Centers for Disease Control and Prevention had reported 121 cases affecting people aged 1 to 88. The *E. coli* strain in question can lead to kidney failure, something that has occurred in 14 of the 52 people who have been hospitalised so far.

A farm in the Yuma region of Arizona supplied whole lettuces to an Alaskan prison where eight inmates fell ill after eating it. But that doesn't account for the rest of the outbreak.

Peter Cassell at the US Food and Drug Administration says the agency is investigating the source of infection in other states. "We are working to identify multiple distribution channels that can explain the entirety of the nationwide outbreak," he says. Yuma has stopped exporting lettuces but, with a 21-day shelf life, some of its crop may still be in circulation.

No secret chamber in King Tut's tomb

A SECOND burial chamber isn't hiding in the tomb of Egyptian pharaoh Tutankhamun after all.

Three years ago, Egyptologists noticed faint lines on the north and west walls of Tutankhamun's burial chamber, pictured below, that suggested there might be a room concealed behind it. Other studies found temperature anomalies in the walls, which seemed to mark hidden doorways.



MOHAMED EL SHAHED/AFP/GETTY

Some archaeologists hoped this apparent chamber might be the burial place of Queen Nefertiti, a wife of Tutankhamun's father. Now, three teams have used different frequencies of ground-penetrating radar to search the pharaoh's burial chamber and found no secret rooms, passages or doorways. They presented their research on 6 May at the fourth International Tutankhamun Conference in Cairo, Egypt.

When the teams combined their data, they concluded that there were no empty spaces beyond the pharaoh's tomb for at least 4 metres.

Ketamine spray for depression?

A NASAL spray containing an ingredient of ketamine has had positive results in a large clinical trial of the drug in people with severe depression.

Developed by the pharmaceutical firm Janssen, the spray contains esketamine, the most potent molecule in ketamine. Normally, ketamine is used as an anaesthetic, but it is also used recreationally.

At a meeting of the American Psychiatric Association in New York on 5 May, Janssen announced results from a trial of esketamine in people who hadn't responded to at least two other depression treatments. Compared with the control group, those who used the spray showed an average improvement of four points on a 54-point depression scale after four weeks of treatment.

The results are less impressive than were hoped for, but may help get the drug approved by regulatory agencies, says Hamish McAllister-Williams of Newcastle University, UK, who wasn't involved in the trial.

NEWS & TECHNOLOGY

Creative people have more mental health issues

ARTISTIC talent may really be linked to a higher likelihood of experiencing mental health conditions, according to a study of people in Sweden.

The Greek philosopher Plato noted that creative people often seemed to possess “divine madness” – a stereotype later applied to Vincent Van Gogh, Salvador Dalí and Edvard Munch. However, good studies on the subject have been lacking.

Now, James MacCabe at King’s College London and his colleagues have pored over the health and education records of the entire population of Sweden, focusing on the mental health of people who had done subjects like art, music or drama at university.

They found that those who had studied an artistic subject were 90 per cent more likely to be hospitalised for schizophrenia, compared with the general population. Such people were also 62 per cent more likely to be admitted for bipolar disorder, and 39 per cent more likely to be admitted for depression (*British Journal of Psychiatry*, doi.org/cn9g). These hospitalisations usually occurred after university, most commonly in people’s mid-

30s. Those with law degrees didn’t have the same elevated risks, suggesting psychiatric conditions are not simply linked to university education, says MacCabe.

The findings are consistent with a 2015 study of 86,000 people in Iceland, which found that artists, musicians and other creative professionals were slightly more likely to have genetic variants linked to schizophrenia and bipolar disorder.

It may be that the same genetic variants that unleash creativity can also trigger mental health conditions, says MacCabe. “Creativity often involves linking ideas or concepts in ways that other people wouldn’t think of,” he says. “But that’s similar to how delusions work – for example, seeing a connection between the colour of someone’s clothes and being part of an MI5 conspiracy.”

People who feel things deeply may have more internal creative inspiration but greater emotional instability, says MacCabe. “Someone who is moved to tears by looking at a painting may have greater artistic sensitivity but also be more vulnerable to depression,” he says.

With membranes, though, there is a trade-off between the flow rate and how much salt they capture.

Inspired by Turing’s only paper on chemistry, Lin Zhang at Zhejiang University in Hangzhou, China, and his colleagues have made membranes that allow water through much faster without sacrificing salt uptake. Made of polyamide plastic, the membranes exploit unusual surface patterns called Turing structures that the legendary codebreaker theorised in 1952. Some are covered with tiny welts or bubbles. Others have longer, ridge-shaped welts that appear stripy when magnified.



DREAMPICTURES/GETTY

Creativity often involves linking ideas that others wouldn’t think of

But the study has some limitations, including the way it used arts degrees as a proxy for creativity. “It’s not ideal because many highly creative people are not studying art,” says Shelley Carson at Harvard University.

Artists shouldn’t feel too

worried because the risks are small, says Jeremy Hall at Cardiff University, UK. In the Sweden study, schizophrenia still only affected 1 in 115 artistic people.

“My advice to artists would be the same as to anyone else worried about developing psychosis,” says Hall. “Don’t smoke cannabis and try to lead a generally healthy life.” **Alice Klein** ■

Turing trick turns salt water drinkable fast

MORE than 300 million people depend on drinking water extracted from the sea, but the desalination process is often inefficient. Now an idea that computing pioneer Alan Turing had nearly 70 years ago is being used to speed it up.

Two basic desalination methods exist: boiling sea water to make water vapour for collection, or pumping it through membranes that extract salt.

To make these bumps, researchers must both speed up and slow down a chemical reaction at the same time – in this case, while assembling long chains of monomeric building blocks to form polyamide. To achieve this, the team added a substance that activated this polymerisation and another that blocked it. Crucially, one diffuses through faster than the other, so polymers form only in some zones, resulting in the bumpy surface.

“The salt removal exploits unusual patterns called Turing structures, first theorised in 1952”

The team put water laced with gold nanoparticles through the membrane and found the gold collected around the bubbles and stripes, indicating the water was passing through these locations. Larger particles like salt are trapped in the uneven surface structures.

The welts are the secret, says Zhang – they remove salt up to five times faster than conventional desalination membranes can (*Science*, doi.org/cn8r). When pitted against 16 commercially available rivals, the membranes with Turing structures outperformed them all. **Andy Coghlan** ■

For daily news stories, visit news scientist.com/news

FIELD NOTES Guaviare, Colombia

The dark side of Colombia's peace

Luke Taylor

AS RAIN lashes down on San José del Guaviare, Angélica Rojas Moncada of the Foundation for Conservation and Sustainable Development breathes a sigh of relief. "Thank God," she says. "There are already three fires burning today. Hopefully this does the trick."

Guaviare province is on the boundary between Colombia's plains and the Amazon rainforest. But over the past century, the forest has been pushed back by a series of economic booms. From rubber to marijuana and coca, new opportunities have eaten into

In Guaviare and neighbouring Meta, 29 forest fires were recorded in April. There were 403 fires in Colombia from the end of 2017 until March 2018. Environment minister Luis Murillo called it a "public calamity".

Farmers have long used controlled burns to fertilise land in the dry season. But the scale of the latest fires is new.

Local experts say the main cause is the power vacuum left by FARC's demobilisation. FARC once held huge areas of the forest, but now there are many competing groups. Some are ex-FARC members who refused to disarm. Others are paramilitary groups that have switched from protecting landowners from the guerrillas to drug trafficking and illegal mining.

In Guaviare, FARC reportedly enforced strict green rules. They fined anyone clearing more than "3 to 10 hectares" of forest, said a source at a local science institute, who asked not to be named for their safety. Trafficking animals was also controlled. But the source told me that since the peace deal, the FARC members had to loosen

Since Colombia's 2016 peace deal, deforestation has increased in Guaviare province



"The FARC enforced limits on the land. With the paramilitaries you can have whatever you can afford"

the Colombian Amazon, with fires clearing the way each time. Now, the forest faces a new threat: peace.

In late 2016, the Colombian government signed a peace deal with Marxist guerrillas called the Revolutionary Armed Forces of Colombia (FARC). It ended a 52-year conflict that left over 200,000 dead and 7 million displaced. It could save many lives and push the nation into a new era of prosperity.

But so far it hasn't been good news for Colombia's portion of the Amazon rainforest.

The Amazon is home to about 400 indigenous groups, as well as many unique species. Colombia's share spans a third of the country. It hosts many of the 849 Colombian species identified by the IUCN Red List as at risk, such as pink river dolphins, jaguars, giant otters and spider monkeys.



CARLOS VILLALBA/REUTERS/VEYNE

their grip, becoming "isolated" and "scared they would be handed in to authorities".

"The FARC enforced limits on the land," says Rojas Moncada. "With the paramilitaries, you can have whatever you can afford."

Hence when FARC demobilised in 2016, annual deforestation rose 44 per cent to 179,000 hectares. Similar losses are expected for 2017 and 2018. Most was lost in areas previously held by FARC.

Local farmers have seized the chance to burn or cut trees. They hope to become landowners when land rights are later formalised. When I visited, I saw patches that had been burned to a crisp, without even salvaging the wood.

Worse, say observers, are "criminal bands" descending on Guaviare from across Colombia. They are grabbing hundreds or thousands of hectares at a time.

Cattle and palm oil are both big business, but illegal activities like coca cultivation, illegal mining and logging pay more. The most "perverse" is speculative clearing, says Rojas Moncada, in the hope the land will be granted under the peace deal.

The government is now under pressure to stop deforestation. In April, Colombia's supreme court

The Colombian Amazon was once protected by FARC guerrillas

recognised the country's section of the Amazon as an "entity subject of rights", like a person. It told the government to do more to save it. Also in April, President Juan Manuel Santos set aside 8 million hectares for national parks and granted Amazonian tribes political autonomy.

But there are three challenges, says César Augusto Rey Angel at the Ministry of Environment and Sustainable Development. The first is to impose the rule of law in the forest. But it is hard to police such a vast, largely uninhabited area; only 10 people were charged for deforestation in the past year.

He also wants to push "rural dwellers to produce sustainably" and convince city dwellers that trashing the forest is "unethical".

To slow deforestation, the government should help farmers more, says Flaviano Mahecha of farmers group Asoprocegua. "We are trying to encourage sustainable farming, but illegal activities are just far more profitable," he says. "We get little help from the state, many earn less than minimum wage, and there is nothing else to do." ■



PLUTOALAMY STOCK PHOTO

Runaway stars to escape the galaxy

Anil Ananthaswamy

AT LEAST two intergalactic interlopers are hurtling through our galaxy at more than 700 kilometres per second. These stars from outside the Milky Way are among almost 30 runaways that have been spotted in a treasure trove of data from the European Space Agency's Gaia satellite mission.

The Gaia satellite has been charting the stars for years in an effort to make the largest 3D map of our galaxy. On 25 April, Gaia released its second batch of data on 1.7 billion stars. For a subset of 7 million, Gaia measured how fast they are moving away from or towards Earth.

Of these, Tommaso Marchetti and colleagues at Leiden University in the Netherlands looked for hypervelocity stars, those travelling at speeds greater than 450 kilometres per second. They found 165 candidates.

The team calculated that

28 have a greater than 50 per cent chance of escaping our galaxy's gravitational pull. "They are basically flying away forever from the Milky Way," says Marchetti.

A handful of these unbound stars have paths that are consistent with having been ejected from the galactic centre, where the gravity of the massive black hole that sits there may

"Some were white dwarfs that were ejected when their companion stars went supernova"

have ripped apart a binary star system, sending one of the pair soaring away.

But half have a more cosmic origin: reconstructions of speeds and orbits suggest they originated outside our galaxy. The most intriguing are two extremely fast stars with velocities in excess of 700 kilometres per second (arxiv.org/abs/1804.10607).

"They have done a really good

Fast stars are whipped to high speed by a black hole or supernova

job of identifying all the possible candidate hypervelocity stars in this subset of stars," says Douglas Boubert at the University of Cambridge. "They have one object which is travelling towards us. Its radial velocity is minus 600 kilometres per second. That is pretty much a certain discovery."

Boubert is part of another team that has analysed the Gaia data for runaway stars, this time white dwarfs that were ejected from a binary system when one went supernova.

This occurs when one dwarf slowly slurps matter from the other, exploding when it reaches 1.4 times the mass of our sun, and flinging its companion into space at more than 1000 kilometres per second.

The researchers, led by Ken Shen at the University of California at Berkeley, found seven possible high-speed white dwarfs in the Gaia data (arxiv.org/abs/1804.11163). They then used ground-based telescopes to study the spectrum of light from these stars and showed that three are very likely to have originated in this way. ■

Political votes mess with our heart rates

ENDURED sleepless nights in the aftermath of the Brexit vote? You weren't the only one. A study of 11,600 wearers of Nokia Health devices shows our biorhythms shift during and after monumental political moments, including the election of Donald Trump and the Brexit vote.

Stress can cause sleepless nights and increase heart rates, but little was known about how this links to big societal changes. "We wanted to add in the quantitative data," says Daniele Quercia of Nokia Bell Labs.

Quercia and his colleagues analysed data from people who wore health monitoring devices, such as smartwatches, in San Francisco and London between April 2016 and April 2017. They found that an entire population's sleeping habits and heart rates, and the collective distance walked, can swing out of sync after big societal events.

The proportion of people in San Francisco who diverged from the general population's norm increased by 30 per cent after the election of Donald Trump, while heart rates rose from an average of 66 beats per minute before his election to 70 beats per minute on election day. Four months later, they still hadn't returned to their pre-voting baseline.

In the aftermath of the Brexit vote, around one in eight people saw their sleep, movement and heart rate shunted away from the average, with overall sleep time dropping by 10 per cent. The changes were more significant than those observed around events such as Christmas and New Year's Eve (arxiv.org/abs/1804.06931).

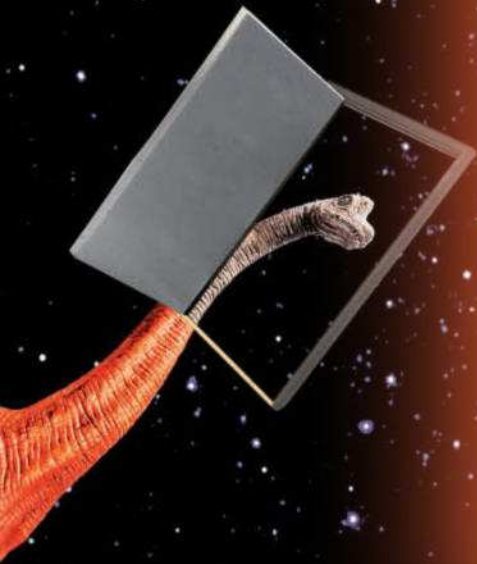
Stress seems to be the likeliest reason for these changes. "When we're stressed, our sleep is one of the first things that gets affected," says Jason Ellis at Northumbria University's Centre for Sleep Research, UK. "You've got more to think about, more to cope with, and so in the short term it's a normal biological reaction." Chris Stokel-Walker ■

WHAT IF TIME STARTED
FLOWING BACKWARDS?



WHAT
IF THE
RUSSIANS
GOT TO
THE MOON
FIRST?

WHAT IF DINOSAURS
STILL RULED THE EARTH?



 New
Scientist

AVAILABLE NOW

newscientist.com/books

NEWS & TECHNOLOGY

Bones may reveal origin of hobbits

Colin Barras

ABOUT 700,000 years ago, ancient humans used stone tools to butcher a dead rhino on the Philippine island of Luzon. The find means our hominin cousins reached the Philippines earlier than we previously knew.

The discovery may also throw new light on the origins of the mysterious "hobbits", tiny hominins that once inhabited the Indonesian island of Flores.

Researchers had previously wondered whether Luzon was colonised by an ancient species of human deep in antiquity. In 2010, a team announced it had found a 67,000-year-old foot bone there. This may have belonged to a member of our species, but its unusual shape hinted that it was from an earlier form of human.

Thomas Ingicco at the National Museum of Natural History in Paris and his colleagues may now have settled the debate.

During excavations on Luzon, they found a near-complete skeleton of an extinct Philippine rhinoceros. Some of the bones are covered in cut marks. The team

also found more than 50 stone artefacts, perhaps used to chop up the carcass (*Nature*, doi.org/cn87).

Modern humans cannot have butchered the animal. Almost all researchers believe that *Homo sapiens* emerged in Africa within the past 500,000 years – long after the 709,000-year-old rhino was killed.

Exactly what hominin did the butchering isn't clear. We know

that a species called *Homo erectus* lived in South-East Asia around this time. It has also been suggested that the ancestors of a mysterious group called the Denisovans colonised some islands of the region.

Nor is it clear how the hominins got to Luzon. There is growing evidence that ancient humans reached remote islands, sparking debate over whether they did so intentionally on watercraft or by accident on rafts of mangroves. Ingicco suspects the latter.

But the key question is what

An ancient rhino bone found in the Philippines - what butchered it?

happened to the hominins after they got to Luzon. The biggest prize would be a link between the Luzon hominins and the hobbits (*Homo floresiensis*), which lived more recently on Flores more than 2000 kilometres to the south.

From a map, it would seem obvious that the ancestors of *H. floresiensis* arrived on Flores by island-hopping from Java. This entails crossing only a handful of straits, each just a few tens of kilometres wide. But some of the currents are treacherous, so crossing without boats would have been difficult.

Instead, some researchers think the hobbits' ancestors arrived on Flores by drifting from northerly islands like Sulawesi and the Philippines. This meant crossing wider expanses of water, but the prevailing currents helpfully flow southwards. The tools and rhino bones are the oldest evidence that hominins occupied the northern islands, strengthening the idea.

"It seems likely that *H. floresiensis*, or rather its ancestor, got to Flores from the Philippines or Sulawesi," says Susan O'Connor at the Australian National University in Canberra.

"A hominin presence in the Philippines about 700,000 years ago is indeed potentially a first step towards solving the mystery of the origin of the Flores hominins," says Ingicco. But he says the evidence is still scanty. ■



КИТКАТРАНОСОН

App learns to recognise primates

AN EXPERIMENTAL app could help conservationists struggling to identify individual primates in the wild.

Although some researchers learn to tell apart primates in the small populations they study in the field, recognising them quickly in other contexts is hard, says Serge Wich at Liverpool John Moores University, UK, who was not involved in the work.

"We put camera traps out or we take pictures, and we don't have an idea if it's the same individual all the time or different ones," he says. This is unlike with other species, such as tigers, which are more easily distinguishable by their markings.

It was this problem that led primatologists to ask Anil Jain at Michigan State University and his colleagues to build a mobile app for identifying primates from photos of their faces.

However, the immediate challenge they faced was a lack of data. "There's no shortage of faces

to train human face recognition systems," says Jain, "but if I want to build a lemur face recognition system, there are a limited number of lemur images."

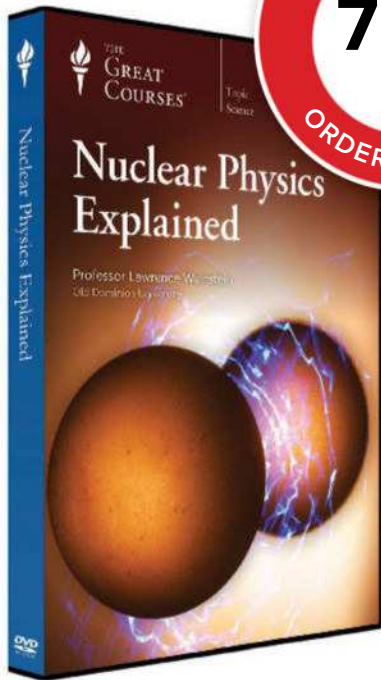
Over a few days, Jain's student Debayan Deb took photographs of the primates at Duke Lemur Center in North Carolina, to produce a data set of 3000 images. The team also gathered thousands of pictures of

golden monkeys and chimpanzees from conservationists.

A neural network learned to distinguish facial features of the primates. It proved particularly good at recognising lemurs (arxiv.org/abs/1804.08790). The system was over 80 per cent accurate even when asked to confirm that it could not identify a particular lemur – because the animal had not been present in the data set it was trained on.

The scores for chimpanzee recognition were lower, says Jain, due to the poorer quality of those photographs. Chris Baraniuk ■

"If I want to build a face recognition system for lemurs, there are a limited number of lemur images"



Discover the Secrets of Atomic Nuclei

Nuclear radiation is everywhere—raining down on you from space, penetrating your body from the Sun, and bombarding you from the food you eat and air you breathe. How worried should you be?

In 24 fast-paced, half-hour lectures, Professor Lawrence Weinstein of Old Dominion University explains the science, history, hazards, applications, and latest advances of a field ordinarily out of reach. In addition to discovering the atomic nucleus; exploring neutrons, protons, quarks, gluons, and radioactivity; you'll learn which kinds of radiation are harmful, which are not, and where it all comes from. You'll examine how nuclear bombs are made, the different designs for nuclear reactors, how cancer radiation treatments have improved, and so much more. Additionally, you'll get expert-led, behind-the-scenes tours of nuclear research facilities. Understand for yourself the science behind living in a Nuclear Age.

Offer expires 05/26/18

THEGREATCOURSES.COM/7NSUSA

1-800-832-2412

Nuclear Physics Explained

Taught by Professor Lawrence Weinstein
OLD DOMINION UNIVERSITY

LECTURE TITLES

1. A Tour of the Nucleus and Nuclear Forces
2. Curve of Binding Energy: Fission and Fusion
3. Alpha, Beta, and Gamma Decay
4. Radiation Sources, Natural and Unnatural
5. How Dangerous Is Radiation?
6. The Liquid-Drop Model of the Nucleus
7. The Quantum Nucleus and Magic Numbers
8. Particle Accelerators: Schools of Scattering
9. Detecting Subatomic Particles
10. How to Experiment with Nuclear Collisions
11. Scattering Nucleons in Singles or in Pairs
12. Sea Quarks, Gluons, and the Origin of Mass
13. Nuclear Fusion in Our Sun
14. Making Elements: Big Bang to Neutron Stars
15. Splitting the Nucleus
16. Nuclear Weapons Were Never "Atomic" Bombs
17. Harnessing Nuclear Chain Reactions
18. Nuclear Accidents and Lessons Learned
19. The Nuclear Fuel Cycle and Advanced Reactors
20. Nuclear Fusion: Obstacles and Achievements
21. Killing Cancer with Isotopes, X-Rays, Protons
22. Medical Imaging: CT, PET, SPECT, and MRI
23. Isotopes as Clocks and Fingerprints
24. Viewing the World with Radiation

Nuclear Physics Explained

Course no. 1369 | 24 lectures (30 minutes/lecture)

SAVE UP TO \$190

DVD ~~\$269.95~~ **NOW \$79.95**
Video Download ~~\$234.95~~ **NOW \$59.95**

+ \$10 Shipping & Processing (DVD only)
and Lifetime Satisfaction Guarantee

Priority Code: 159739

For over 25 years, The Great Courses has brought the world's foremost educators to millions who want to go deeper into the subjects that matter most. No exams. No homework. Just a world of knowledge available anytime, anywhere. Download or stream to your laptop or PC, or use our free apps for iPad, iPhone, Android, Kindle Fire, or Roku. Over 600 courses available at www.TheGreatCourses.com.

NEW
SCIENTIST
DISCOVERY

The science of the Renaissance

Discover the great scientific minds and discoveries of the age on an eight-day cultural adventure across Florence, Pisa and Bologna

7 NIGHTS FROM £1,795 PER PERSON

DEPARTURES:

15 NOVEMBER 2018

Join a group of like-minded, inquisitive *New Scientist* readers on an enlightening eight-day tour of Florence, Pisa and Bologna.

Led by art and architecture expert Andrew Spira, you will wander through echoing churches, study extraordinary museum collections and visit hidden Renaissance buildings. On this distinctive trip, you'll also enjoy a special lecture from *New Scientist's* editor-at-large, Jeremy Webb.

From the Ptolemaic planetarium in the dome of the Old Sacristy, San Lorenzo, to Bologna's Anatomical Theatre, you will be guided through the astronomic, architectural, medical and mathematic discoveries of the period.

The trip includes three evening lectures from our experts and four-star hotels throughout. The itinerary has been curated by *New Scientist* and is packed with insight.

WHAT'S INCLUDED

- › Return flights with British Airways from London
- › All hotels and transfers
- › Entry to museums and tours
- › Expert guide throughout
- › Evening lectures from:



Andrew Spira

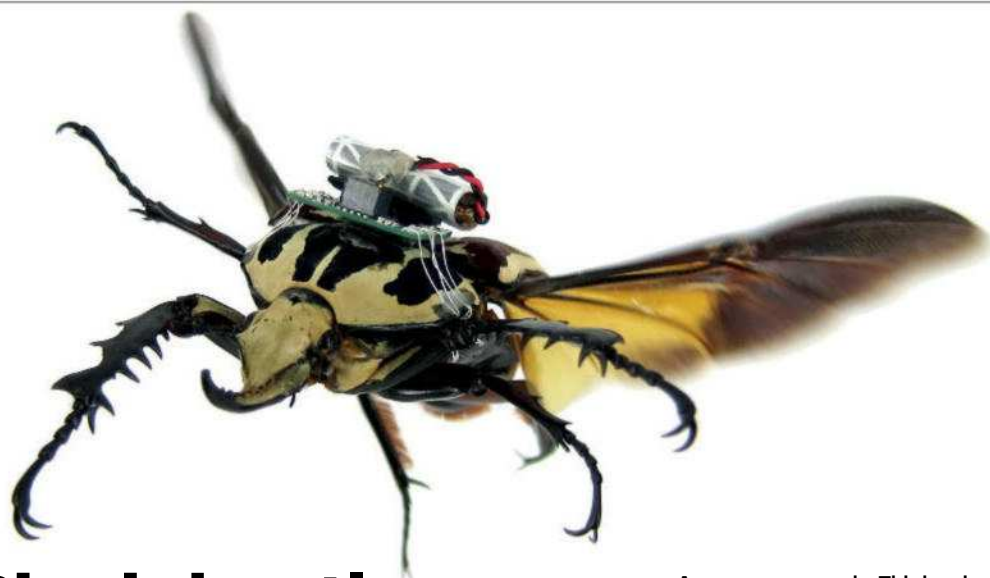


Jeremy Webb

START PLANNING YOUR TRIP

Call now on +44 (0)20 7251 0045
or visit newscientist.com/travel/renaissance





Bionic beetles take to the skies

Sandrine Ceurstemont

HERE come the robo-beetles. Backpacks filled with electronics have been used to create controllable flying bio-robots.

The bionic beetles were made by Hirotaka Sato from Nanyang Technological University in Singapore and his colleagues. They were interested in building tiny flying robots, and using beetles as the starting point let them avoid the incredibly difficult task of making small robotic bodies.

The researchers took male *Mecynorhina torquata* beetles and implanted electrodes into four of their flight muscles. They then administered small electric pulses to steer them left or right. The team had found that the beetles eventually adapted to a continuous pulse, so applying two short pulses lasting 150 milliseconds, with a 50 millisecond rest in between, was most effective for controlling their route. Their acceleration could be also increased by upping the frequency of the pulses. To track the beetles' flight

paths, the researchers used a 3D motion capture system, which could record their position every 200 milliseconds. Through this, they determined that the electrical pulses were 79 per cent accurate in controlling a beetle's position (*Soft Robotics*, doi.org/cn78).

"This is the first demonstration that insect motion can be steered in a desired direction in a consistent way," says Sawyer Fuller at the University of Washington in Seattle. "It shows that truly autonomous, bio-

"It shows that bio-hybrid robots the size of insects are a real technical possibility"

hybrid robots the size of insects are a real technical possibility."

To carry out their research, Sato and his team had to learn how to rear beetles and keep them in good condition. The study did not impact the beetles' 3- to 6-month lifespan, but whether or not invertebrates feel pain is still unclear. Sato says the bionic beetles

A very creepy crawl: This bug is controlled by an electronic backpack

could one day be used for search and rescue. After an earthquake, for example, they could help locate missing people. "If we integrate carbon dioxide and infrared sensors, they could detect living people," says Sato.

Compared with using drones, co-opted insects are better at dealing with turbulence, are easier to control and are much less costly. And they are much less limited by battery life – they just need to be fed. "Their flight time is measured in hours, rather than in minutes as with current drones," says Fuller.

Cockroaches have also been investigated as possible bionic helpers. The critters are particularly good at scuttling through small gaps so could help search-and-rescue teams check through rubble. One project from North Carolina State University used a drone to coordinate a swarm of cockroaches controlled by stimulation of their antennae.

Sato and his colleagues are now looking at how to control the beetles' altitude, as well as how to make them hover in the air. They think the technique could also be applied to a variety of other insects, since most have similar muscle structure and function. ■

Quantum internet goes the distance

SECURE quantum networks could soon stretch between European capital cities, thanks to a new scheme that ups the theoretical limit of the distances such messages can travel.

Quantum key distribution (QKD) is a way of exchanging secret encryption keys using photons, particles of light. Done properly, it is impossible to hack because attempts at interception will disrupt the delicate quantum state of the particles.

But photons can only be sent so far through optical fibres before they scatter, meaning that data rates drop at increasing distance. Now, Andrew Shields and his colleagues at Toshiba Research Europe in Cambridge, UK, have found a way round this.

In regular QKD, the sender (known as Alice) transmits photons, randomly choosing one of two paths that slightly alter a property called phase. They reach the receiver, Bob, who also randomly alters the phase by a different amount before measuring it. The difference between the phases lets them transmit data bits – 0s and 1s – that establish a secret key they can use to encrypt messages to each other.

The team improved this by adding a third party, Charlie, who measures photons from Alice and Bob in the middle and tells them what he sees. "It means you can have effectively twice the distance and achieve the same [data] rate," says Shields. Crucially, Charlie doesn't know the phases used by Alice and Bob and so isn't able to copy their key. That's in contrast to other QKD extensions, which involve "trusted nodes" that rebroadcast the signal – but can also eavesdrop on it.

Shields's team says the scheme is practical with current tech and should make it possible to send about 10 bits per second over distances of up to 550 kilometres via standard optical fibre (*Nature*, doi.org/cn8d). This is a vast improvement: the previous best experiment was able to transmit 1 bit per hour over 400 kilometres of special low-loss fibre. Jacob Aron ■

NEWS & TECHNOLOGY

Eyes give away your personality

Alice Klein

YOU may think you are pretty hard to read, but artificial intelligence can predict your personality just from subtle, unconscious eye movements.

Psychologists have suspected that personality influences how we visually take in the world. Curious people tend to look around more and open-minded people gaze longer at abstract images, for example. Now, Tobias Loetscher at the University of South Australia and his colleagues have used machine learning to study the relationship between eye movements and personality more closely.

They asked 42 students to wear eye-tracking smart glasses while they walked around campus and visited a shop. The students also filled out a questionnaire that rated them on the "big five" personality traits: neuroticism, extroversion, agreeableness, conscientiousness and openness.

The team's machine-learning algorithm found that certain patterns of eye movement were more common in people with particular personalities. For

example, neurotic people tended to blink faster, while open-minded people had bigger side-to-side eye movements and conscientious people had greater fluctuations in their pupil size (*Frontiers in Human Neuroscience*, doi.org/gdb8rj).

Future research may tie these patterns to brain chemistry, says Olivia Carter at the University of Melbourne. Brain chemicals such as dopamine and noradrenaline are known to affect personality as well as blink frequency and pupil dilation, she says.

At this stage, the algorithm only has modest predictive power, being just 7 to 15 per cent better than random chance at predicting neuroticism, extroversion, conscientiousness and agreeableness, and no better at predicting openness.

However, this is probably because it is based on eye-tracking data from only 42 people, says Loetscher. "Machine learning usually requires thousands or millions of data [points] to make highly accurate predictions," he says. "We expect it to get much better."

The potential applications are



CHRIS RAYNEVEY/TEEMAGETTY

wide-ranging, says Andreas Bulling at the Max Planck Institute for Informatics in Germany, who also worked on the study. "Imagine, for example, that smartphones could know and adapt to your personality," he says. That would allow them to support you and give you personalised information at a completely new level, he says.

Other possible applications might be in robot companions for older people, self-driving cars and video games, says Bulling. "These could be so much more

natural and personalised if the personality of the user was known," he says.

However, the technology will need to be regulated to prevent marketers from misusing it, says Carter. The recent Cambridge Analytica scandal revealed that AI was being used to mine Facebook data without users' consent and to target political ads based on personality. "If the same information could be gained from eye recordings, then it could easily be recorded and used without people's knowledge," she says. ■

Plant lives with fundamentally broken cells

A NONDESCRIPT plant has overturned one of the bedrock assumptions of biology. Unlike every other animal and plant ever studied, the mistletoe's cells lack the equipment to make energy. It is unclear how it survives.

Animals and plants are eukaryotes: they are made of cells that are more complex than those of bacteria. All eukaryotic cells hold tiny, sausage-

shaped objects called mitochondria, which are their energy source.

Mitochondria are vital for nearly all eukaryotes. Some single-celled members of this group, such as certain yeasts, have few or none. But multicellular eukaryotes - all plants and animals - entirely rely on their mitochondria.

So researchers were shocked to find the mitochondria of mistletoe (*Viscum album*) are largely disabled.

The key thing mitochondria do is make lots of adenosine triphosphate (ATP). This carries energy, which other parts of the cell use to keep working.

Mitochondria produce ATP using a chain of five enzymes. But mistletoe has wholly lost the first one, Complex I, and the genes that make it. "It's not been believed that any multicellular organism can live without Complex I," says Hans-Peter Braun of Leibniz University in Hannover, Germany.

The other four enzymes were still there. But they were in short supply compared with a control plant

"It wasn't believed that any multicellular organism could live without this enzyme but mistletoe can"

called thale cress (*Current Biology*, doi.org/cn9k, doi.org/cn9m).

"All the other complexes were reduced in abundance by 50 to 80 per cent," says another team member, Etienne Meyer at the Max Planck Institute of Molecular Plant Physiology, Germany. "This means ATP production would drop by a factor of four."

The question is how mistletoe survives. It may use sugar to make ATP by "glycolysis". This is 12 times less efficient as making it in mitochondria, but the parasitic plant may save energy in the long run as it can steal sugars from its host tree. Andy Coghlan ■

NewScientistJobs

INCLUDE THE RIGHT ELEMENTS IN YOUR RECRUITMENT STRATEGY

Reach your ideal chemistry candidate
in print, online and on social media.

Visit newscientistjobs.com and
connect with thousands of chemistry
professionals the easy way

Contact us on
617-283-3213 or
nssales@newscientist.com

Advertising feature

How to beat workplace stress

We need to change the way we think about work and how it influences our lives, says chartered psychologist Rob Archer

WHEN colleagues take time off for illness, most of us assume they have a cold, flu or a stomach bug, perhaps. Few realise that 49 per cent of all working days lost in the UK in 2016-17 were caused by work-related stress, depression or anxiety.

Stress is an insidious problem. Short-term stress, such as working to an imminent deadline, can be beneficial. But if the pressure never goes away, it risks leading to chronic stress, which can bring on significant mental health issues. This, in turn, creates further stress on the employee and their colleagues and families.

There are also consequences for physical health: studies have shown that long-term stress leads to a compromised immune system, contributing to debilitating

"A "flat-line" working style with no variation in intensity helps no one"

headaches, digestive disorders and cardiovascular disease. Very few firms know how to improve this dire situation; in fact, many are unwittingly making things worse. The good news is, we are starting to get a handle on how to beat stress and – even better – prevent it from becoming a problem in the first place.

One of the most important protective factors is a resource known as psychological flexibility. Studies have shown that it has profound effects on mental health and workplace performance, helping people do their jobs more effectively while improving health and well-being. "Psychological flexibility allows people to become more

resilient in their responses to high work demands," says Rob Archer, a chartered psychologist who works with a number of companies and sports professionals to promote health and well-being while improving individual and team performance.

Archer defines psychological flexibility as an ability to let longer-term values and goals, rather than immediate thoughts and emotions, govern decision-making and behaviour. "Primarily, psychological flexibility helps create a different relationship to thoughts and emotions," Archer says. "Some people call it 'unhooking' – they become less powerful as drivers and motivations."

There is strong evidence that it works. A 2004 study in a group of Swedish healthcare workers, for example, found it made a significant difference in absence from the workplace. In the study, workers who reported chronic stress or musculoskeletal pain were split into two groups. Both groups received the standard medical treatment, but one group also participated in sessions designed to improve psychological flexibility through acceptance and commitment therapy (ACT). This group subsequently took an average of 1 day off per year. The group that received standard medical treatment were still taking 11.5 sick days per year on average.

A 2011 study in the US also showed strong effects for ACT interventions among nearly 700 addiction counsellors. Burnout is a big problem in this kind of work, and the researchers found that it can be reduced through strengthening psychological flexibility. Rather than struggling against a workplace and routine that are difficult to



AUROGA PREMIUM/PLAINPICTURE

octopus

A brighter way

"Psychological flexibility helps create a different relationship to thoughts and emotions"

Rob Archer



cope with, the counsellors benefited from learning how to identify, clarify and commit to their work-related goals and values while working within the system. "It helps people to deal with the situations they find themselves in," Archer says. "It's one thing to have a depressive thought about work, and see the thought itself as a problem. It's quite another to see it as a very normal reaction to a very difficult situation. The key is gaining control over your response and behaviour, rather than trying to control thoughts and emotions."

Gaining such perspective can have wide impacts. If immediate demands overwhelm workers, they often start to be hooked away from their values. "Once you lose touch with your values, it can lead to huge risks, both for individuals and organisations," Archer says. "You could argue that the whole of the financial crisis was caused by people being separated from their values."

There's some evidence that psychological flexibility helps leaders and teams too: interventions designed to promote psychological flexibility work for financial traders as well as healthcare workers. In 2012, Frank Bond at Goldsmiths, University of London tested the effects of ACT training in team leaders of financial traders working for an investment bank. In the eight months following the training, the teams led by those who had received ACT training made around £17 million more than those whose leaders had received training in negotiation skills. Significantly, they also reported better mental health.

Better mental health

For Archer, this feels like the future of workplace psychology. But he is keen to point out that the burden of dealing with stress in the workplace must fall on employers too. "An organisation needs to help people deal with the demands placed on them," he says.

Equipping staff with psychological flexibility allows them to get through the tough periods by maintaining awareness of their values and goals – remembering why they got into their job in the first place, say, and what the short-term intense work will help them achieve.

But it's important that these high-intensity stints don't become never-ending, Archer

says: for people to work well, we have to move away from a culture of permanent high performance. "For most people, demands are so high and so unrelenting that recovery isn't built in," Archer says. "We're much better off having demands as a series of sprints than one long slog that never ends."

"Once you lose touch with your values, it can lead to huge risks"

A "flat-line" working style with no variation in intensity helps no one, Archer points out; workers get tired and disengaged, and their performance drops. That means tasks take longer, extending the vicious cycle of underachievement. "People stop enjoying their work and everything's a slog: the flat line leads to burnout eventually," Archer says.

The other big issue is control: when people feel that they are trusted to manage their own workload, stress levels tumble. "The evidence in favour of job control is so overwhelming that any enlightened organisation has to clamp down on micromanagement," he says.

It's an insight that some business leaders are starting to appreciate. Simon Rogerson, one of the co-founders of Octopus Group, is among them. Octopus operates in a number of highly competitive fields and there is a risk its employees can end up paying the price.

"It's up to us as a business to make sure that doesn't happen," Rogerson says. That's why Octopus has begun giving its staff opportunities to gain psychological flexibility in workshops run by Archer for the firm. The results are still anecdotal, but the workshops are having an impact. "Feedback so far has been very positive," Rogerson says. "Attendees tell us there's a lot to be gained from standing up and talking about these things and also from hearing about the experiences of the other people in the room."

Archer hopes this is the start of a shift towards better working environments across a range of sectors. "Giving people the power to solve their own work problems, and helping them to keep their long-term aspirations and values in sight: this is the future," he says.

Find out more at: www.octopusgroup.com

IN BRIEF

KLAUS VEDFELT/GETTY



Mediterranean diet slows onset of Alzheimer's

FOLLOWING a plant and olive oil-rich diet can help delay Alzheimer's disease.

Population studies have previously suggested that people who eat a Mediterranean diet - which also typically includes a lot of fish but only limited red meat, sugar and processed food - tend to be less prone to Alzheimer's disease.

To understand why, Lisa Mosconi at Weill Cornell Medical College, New York, and her colleagues scanned the brains of 70 healthy adults aged 30 to 60, half of whom had been eating such a diet for at least five years.

The Mediterranean diet group had 15 per cent less beta-amyloid, the sticky protein that gradually turns into the plaques found in people with Alzheimer's disease. Their brain cells also metabolised glucose faster - a sign of healthier activity.

Scans three years on revealed that the brains of those on a Mediterranean diet had built beta-amyloid more slowly and showed a slower decline in brain metabolism. From these rates of change, the team calculated that the diet should offer at least 3.5 years of extra protection against Alzheimer's (*Neurology*, doi.org/cn76).

However, this is probably an underestimate, says Ralph Martins at Edith Cowan University in Australia. The study followed relatively young people for only three years, so it may have failed to capture the full benefits.

Tourism is terrible for the climate

TO HELP stop global warming, scrap that round-the-world trip. Tourism has expanded so fast, it now accounts for 8 per cent of the greenhouse gases we release. That is four times previous estimates.

Arunima Malik at the University of Sydney, Australia, and her colleagues estimated the annual greenhouse gas emissions of tourism in 160 countries. They say the industry emits the

equivalent of over 4 gigatonnes (Gt) of carbon dioxide every year.

Previous estimates varied from 1 to 2 Gt per year. The team's figures are higher because, as well as direct emissions from air transit, they also included indirect emissions. These come from food production for tourists eating lavishly while on holiday, hotel upkeep and souvenirs (*Nature Climate Change*,

DOI: 10.1038/s41558-018-0141-x).

What's more, tourism's annual carbon footprint has grown fast, from 3.9 Gt in 2009 to 4.5 Gt in 2013. That may well continue. "We estimate that a business-as-usual scenario will increase the carbon footprint from tourism to 6.5 gigatonnes by 2025," says Malik.

Tourism is growing as people get richer. The US is the biggest source of tourism emissions, but emerging economies like China are catching up.

The worst kind of cold headache

SOME people have adapted to live in polar climates, but at a price. The same gene variant that is thought to help us cope with cold also seems to raise our migraine risk.

Aida Andrés at University College London and her colleagues studied a protein called TRPM8 that controls our response to sensations of cold. The gene for TRPM8 comes in two flavours. Screening genetic databases to see how common each was showed the newer variant to be more common in northerly latitudes (*PLoS Genetics*, doi.org/cn9f).

The TRPM8 gene is also linked to migraine. The older variant may protect against the disorder, while the newer one raises the risk. This may help explain why migraine is more commonly reported in northern countries.

It's not clear why our response to cold might be linked to migraine, but some people do get cold-triggered headaches.

AI editor redraws photos with ease

PHOTOBOMBER begone. Artificial intelligence can remove objects from a picture by imagining how best to fill the gaps left behind.

The system, created by graphics hardware firm Nvidia, was trained on images of human faces, animals and landscapes, for example. As a result, it recognises content in photos that need retouching (arxiv.org/abs/1804.07723). "Honestly, I didn't expect this to work so well," says Bryan Catanzaro at Nvidia.

The technology may be of use to social media firms, keen to boost image and video sharing on their platforms. But it may also interest authoritarian regimes that want to remove out-of-favour people from photos or distort pictures to spread disinformation.

Giant planet has a tail like a comet

A DISTANT, Jupiter-sized planet has a comet-like tail of gas, and within it are signs of the first helium seen in an exoplanet's atmosphere.

Astrophysicists viewed the hot gas giant - called WASP-107b - with the Hubble Space Telescope, which revealed its bizarre architecture. It is nearly the same radius as Jupiter, but has a far smaller mass - more like two or three Neptunes.

The planet's size is due to a puffy atmosphere that has been blown away by the radiation of its star. The planet loses between 0.1 and 0.4 per cent of its atmosphere every billion years. Most of that trails off the side that faces away from its star, where it leaves a translucent tail three to five times the planet's surface area (*Nature*, doi.org/cn5g).

Jessica Spake at the University of Exeter in the UK and her colleagues spotted helium around the planet by looking at the infrared light streaming through its atmosphere as it passed in front of its star.

Helium is common across our solar system, but it hadn't been seen on an exoplanet until now. Similar planets could lose enough of their atmosphere to leave behind a world just a few times the mass of Earth, which could explain the oddball super-Earths found in other planetary systems but not in our own.



Contacts could beam light from your eyes

SUPER-thin laser stickers may one day secure banknotes or even let you beam lasers out of your eyes.

Malte Gather at the University of St Andrews, UK, and his colleagues made 200-nanometre-thick flexible membranes that produce laser beams when light shines on them. They can work both suspended in the air and when they are stuck to objects.

Changing the laser's properties can turn each one into a unique security tag. Gather says the team stuck one to a banknote over a year ago and it still gives the same

spectral signatures and security code that it gave when they first applied it.

The team also put a contact lens with one of their lasers onto a cow's eye in the lab. When excited with a pulsing blue light, the lens beamed a green laser onto a screen 50 centimetres away. The team says these lenses could be used as a wearable barcode to be read by an iris scanner. Though they haven't done it, Gather is confident the contacts would be safe to put in the human eye.

"The intensity of the laser beam and the amount of energy it requires is so low that you can put it in the eye without damaging the eye," he says. "I would be willing to try it."

The membrane is made from an organic semiconducting polymer. It is produced on glass with a polymer layer between the glass and the laser. This layer is water soluble, so once the laser is complete, the stack is dipped in water and the laser floats off the glass (*Nature Communications*, doi.org/cn5f).

Bones contain crystal hands

THE most detailed 3D image of bone ever made has revealed the shape of the crystals it contains.

Our bones are mostly built from the protein collagen and the mineral hydroxyapatite. While the structure of collagen is well understood, how the hydroxyapatite crystals are organised is less clear.

Roland Kröger at the University of York, UK, and colleagues at Imperial College London used electron microscopes to image cross sections of human thigh bones at different angles. They used these to construct 3D pictures.

The images revealed that, at the nanoscale, the crystals are a slightly curved finger-shape. These cluster together to form hand-like patterns, which are themselves pressed on top of each other in twisted stacks (*Science*, doi.org/cn88).

In fact, each level of the mineral architecture features twisting, helical shapes. It was already known that collagen - itself a helical protein - forms twisted fibres in bone. Just as the twisted fibres in a rope give it strength, these helical structures must contribute to the mechanical properties of bone, says Kröger.



TIMOTHY R. DAVYER/POLARICEE2016, COURTESY OF ARCUS

Slow sea spiders catch stunned prey

SEA spiders move at glacial speeds, but they catch faster prey - by waiting for them to knock themselves out.

Many sea spiders are "stealth vampires", says Amy Moran at the University of Hawaii at Manoa. They creep around the seabed in search of immobile prey like anemones. If one finds a victim, it punches small holes in it and sucks up body fluids, often without killing it.

Now Moran and her colleagues have found that some hunt more actively. They studied Southern Ocean giant sea spiders (*Colossendeis megalonyx*), which

are bright orange and have a leg span of 25 centimetres. Around Antarctica, Moran saw them feed on jellyfish and small molluscs called sea butterflies.

To find out how they catch the speedy sea butterflies, the team kept both creatures in tanks. While the sea butterflies mostly float around, they occasionally hit the seabed, which stuns them temporarily. At this point a sea spider would stab the sea butterfly and feed (*Invertebrate Biology*, doi.org/cn73).

The attacks were "very leisurely", Moran says, but "spectacular for an Antarctic sea spider".

China's plan to make it rain

The world's largest ever weather-control experiment is under way in China. Will it work, asks **David Hambling**

CHINA is trying to modify the weather on a grand scale. The nation's scientists want to increase snowfall over an area three times the size of Spain, leading to enough extra meltwater to fight drought and bolster agriculture. The project could have a massive impact – if it works.

The idea is to prompt clouds to release their moisture by seeding them with silver iodide particles. Burner devices placed at the base of ridges on the Tibetan Plateau are designed

China has used mobile rocket launchers for cloud seeding

to produce a powerful updraft of hot air that lofts the particles into the clouds, where they should encourage ice crystals to form and fall as snow.

The researchers estimate this could boost the flow of meltwater to rivers in the region by up to 10 trillion litres a year. This would greatly benefit food production – poor water management caused by droughts and floods, and currently reduces harvests by 20 million tonnes annually (see "Water ways", below right).

The scale of the project is far larger than any previous attempt at controlling the weather.

A report in the *South China Morning Post* says 500 burners have already been deployed, at a cost of \$8000 each, but the total number deployed could eventually reach tens of thousands. China has

"The cloud-seeding scheme could create up to an extra 10 trillion litres of water a year"

tried cloud seeding before, but it was always on a more local level, delivering the particles via mobile rocket launchers mounted on trucks in response to a specific crisis, like a drought, hailstorm or fog, or to ensure favourable

conditions at national events like the Beijing Olympics.

These efforts were not always guided by results and produced few research papers, says Roelof Bruintjes, chair of the World Meteorological Office's Expert Team on Weather Modification. But that is starting to change.

"The Chinese have been doing cloud seeding for a long time, but it's only in the last 10 to 15 years that they've taken a scientific approach," he says. "We are training some of their scientists and we're trying to get them to be more quantitative."

Others remain sceptical that seeding produces any extra snow.



For daily news stories, visit news scientist.com/news

Shiuh-Shen Chien at National Taiwan University says cloud seeding projects are an example of Chinese “authoritarian environmentalism”. They give the appearance of the government responding to the needs of the people and reinforce the state’s apparent power, even if the effectiveness is unproven, he says.

Unclear skies

That isn’t stopping other nations jumping on board. According to the World Meteorological Office, there were 56 countries with cloud seeding projects in 2016, up from 42 in 2011.

Much of this research is sponsored by the United Arab Emirates, which since 2001 has aimed to revitalise the field and improve water security. Sufian Farrah of the UAE Research Program for Rain Enhancement Science says the country is funding cloud chamber experiments, studies of the electrical properties of clouds, and how best to use drones and balloons for seeding.

Experiments in Australia, Wyoming and Idaho, some of which were funded by the UAE, show that the type of cloud seeding China is attempting in Tibet has the potential to improve snowfall, says Bruintjes. “The amount of increase has been estimated to be in the range of 5 to 15 per cent, however there is a lot of natural variability,” he says.

That variation explains why proving the impact of cloud seeding is so difficult. A new drug can be trialled on thousands of patients to smooth out variation and tease out statistical evidence that it works, but running similar trials for cloud seeding is impractical.

However, a small US study published earlier this year was able to show a causal relationship between cloud seeding and snowfall. The team used radar and probes to watch ice crystals form. “This study documents the whole chain of events from end to end,

from seeding to snowfall, for the first time,” says Bruintjes.

Suppose, then, that China’s huge experiment really can help the country’s drought problem. What are the consequences of meddling with the weather? One obvious concern is the potential environmental or health impacts of pumping silver iodide into the sky.

Lab studies of silver iodide suggest large concentrations may slow plant growth, but its use in cloud seeding doesn’t seem to have had harmful effects. That is because the quantities of seeding material are relatively small compared with the amounts already in the environment, says Farrah. According to one estimate, it would take 500 years of seeding to deposit 1 gram of silver iodide in an area the size of a basketball court. Measurements of silver concentrations in water from seeded rain clouds in the US have been well within accepted safety levels.

There is also the question of where the extra water is coming from – does more for China mean less for its neighbours? “Nobody has shown a tremendous negative impact on surrounding areas,” says Bruintjes, but he notes that research on this question is still in its infancy.

If it turns out that cloud seeding steers water across national borders, neighbours will probably need to hammer out deals on how

WATER WAYS

Cloud seeding is just part of a much larger effort to manage China’s huge, and growing, demand for water, says Paul Sayers, a UK-based water management consultant.

Four of the nation’s five most-productive provinces reached critical water-usage levels in 2015, while the amount of Chinese land requiring irrigation has increased by a third in the last 20 years. “Business as usual is not an option,” says Sayers.

The initial response was a series of giant projects like the South-North



IDAHO POWER COMPANY

Researchers in Idaho are using cloud-seeding burners

to share this natural resource. “There’s only so much water,” says Paul Sayers, a UK-based water management consultant. “If you are effectively taking atmospheric water, then that raises issues of water allocation.”

There is precedent for sharing water amicably – rivers that run through multiple countries are subject to international allocation agreements about who can take how much water. Sayers says he is not aware of such discussions taking place over atmospheric water yet.

Any impact large-scale seeding has on neighbouring countries could also be used maliciously. During the Vietnam war in the

1960s, US forces attempted to use cloud seeding to make the Ho Chi Minh Trail impassable, an effort known as Project Popeye. It failed, but a modern version could do better – or rather, worse, if you are on the receiving end.

“If the Chinese can control weather and climate, that is one massively powerful economic weapon,” says Jim Dale, a consultant at meteorology firm British Weather Services.

Following Project Popeye, in 1977 many nations signed up to the Environmental Modification Convention, banning the use of weather modification for warfare. China joined the treaty in 2005.

Such concerns aside, if China really has a working weather-control machine, it could be the start of a water revolution. Farrah says his team will meet with researchers from the Chinese cloud seeding programme this summer to discuss and share information. He believes that we are close to seeing a real impact from the technology. “Cloud seeding could be applied on a large scale within five years,” he says.

Unfortunately, it is not the solution to water shortages everywhere around the world, because it cannot turn a clear sky into a snowstorm. “Nobody can make a cloud,” says Bruintjes. “Thus, if there are no clouds, seeding cannot work.” ■

COMMENT

Birth control equality?

A male pill will be a breakthrough. But can it radically alter who takes responsibility for contraception, asks **Lara Williams**

THERE is fresh optimism about the prospect of a male contraceptive pill. Cue hopes, too, of a more equitable sharing of the birth control burden by men.

Grounds for excitement include the testing, in monkeys, of a pill that can inhibit sperm motility with no apparent side effects. Closer to routine use by men is a hormonal gel. Applied to the arms and shoulders daily, it lowers sperm production by limiting the amount of testosterone made in the testes. Key clinical trials later this year will involve up to 420 couples in six countries. Not far behind is a hormonal pill that has already completed a safety trial in men.

Such news stokes interest because the hunt for a male pill has become the birth control movement's white whale: elusive and seemingly impossible to corner when spotted.



But as hope of a breakthrough rises, let's not forget the growing discontent among women over hormonal contraceptives, and the lamentable record of men on sharing birth control duties.

Women are increasingly ditching the pill. According to a recent survey published in *Cosmopolitan*, 70 per cent of young women have quit using it or are considering quitting. Worry over side effects is the key reason.

While the last big trial of a male hormonal contraceptive was halted after many reports of adverse side effects, women have long wrangled with the multifarious and often gruelling consequences of the pill: nausea, weight gain, breast tenderness and decreased sex drive.

And although women anecdotally reported a correlation between depression and the pill for years, it was not until 2016

Shades of green

Are we deluding ourselves when we shop for eco-friendly stuff, wonders **Fred Pearce**

WHEN shopping, do you check for a logo showing goods were not made at the environment's expense? And if so, do you believe it? In an imperfect world we know there are shades of greenness. But we at least hope such certified purchases will help lift industry standards.

We may be deluding ourselves.

According to a stern new analysis by the Changing Markets Foundation in Utrecht, the Netherlands, these sustainability certificates may be little more than corporate greenwash. Its report says benchmarks are often set too low, and that certifiers are too intertwined with those they police. It argues that rather than

catalysing change, certification is "standing in the way" of progress.

The report focuses on schemes for textiles, fisheries and palm oil, but there are many more.

On fisheries, it worries that certification schemes "place too much emphasis on increasing the number of fisheries participating and the volume of seafood caught, rather than on the quality of participation or outcomes". On textiles, it says they can give an "unjustified green glow" by

"Are green labels on goods a global failing? Or is this criticism throwing the baby out with the bathwater?"

failing to "forbid the use of hazardous pesticides, artificial fertilisers or GM cotton".

So, has the report nailed a global green failing? Or is it throwing the baby out with the bathwater? In my view, the acid test is not the purity of the logos, but whether they can change how industries operate.

And here, the report offers some hope. It concedes, for instance, that fisheries schemes "can and do have some positive impacts". Their existence has "made industry and government regulators more proactive about sustainability concerns". Equally, nobody would say oil-palm

For more opinion articles, visit news scientist.com/opinion

that firmer evidence turned up: a study found women on the combined pill were 23 per cent more likely to be prescribed an antidepressant than those not on hormonal contraception. Yet responsibility for birth control continues to be shouldered largely by women.

Would a male pill change the status quo? Various studies have found around half of men would consider using it. And yet, other studies find men are quite likely to resist condom use, a tried and tested option with no health risks, and that offers a level of parity in responsibility for contraception. A 2012 study found 35 per cent of young heterosexual men used verbal coercion and even aggression to avoid condom use.

Rebalancing contraceptive responsibility requires a constructive conversation around birth control methods. That will in turn require utter transparency about their respective disadvantages and the disparity in who experiences them.

It is clear that a male pill would be a breakthrough for science. Less clear is whether it would be the contraceptive equality breakthrough women hope for. ■

Lara Williams is a writer based in Manchester, UK

growers have altogether stopped chopping down trees, but tropical deforestation has slowed by 50 per cent in recent decades. Something must be going right.

None of this lets consumers off the hook. Green labels do nothing to discourage us from buying more stuff, which arguably is what is needed most of all in a truly sustainable world. But it is surely perverse to see them as part of the problem. They may be imperfect and deserving of robust scrutiny, but on balance, the labels are worth keeping. ■

Fred Pearce is a consultant for *New Scientist*

ANALYSIS Space industry



DPA PICTURE ALLIANCE / ALAMY STOCK PHOTO

UK plans for a GPS rival smack of desperation

Frank Swain

IN THE 17th century, Galileo Galilei upset a lot of powerful people by demonstrating that the universe did not, in fact, revolve around them. Four hundred years later, the European Union satellite navigation system named after him is having the same effect.

This time it is the UK government that has been knocked from its pedestal. With Brexit looming, EU officials in Brussels recently announced that the UK will no longer be eligible to bid for lucrative contracts to build the ground control systems and backup satellites for Galileo, the EU version of the US GPS.

The UK will also be denied access to the encrypted Galileo signal intended for government users. UK ministers were incandescent, threatening legal action to recover the €1.4 billion the country has invested so far in Galileo.

Now it seems that prime minister Theresa May could go a step further: she wants the UK to explore building its own rival system. What's billed as a "taskforce" led by the UK Space Agency will now look at the options.

Galileo's spotty history suggests this duplication of effort is foolish. From the outset, the EU's satellite array struggled to get off the ground. Lambasted as a political vanity project, funding proved difficult to secure.

The US opposed the idea of a competing satellite navigation system, particularly one that any civilian could use - perhaps to launch missiles at US targets. As a compromise, protocols were added that would allow the US (and the EU) to block civilian access to Galileo in crisis situations.

"The reality is that the UK is probably more motivated by happenings on the ground than in orbit"

The system finally switched on in late 2016, heavily delayed and costing more than triple the original budget of €3 billion. There are still four more satellites to launch before the system is completely operational, and a rash of technical problems has hit those already in orbit, including the failure of nine atomic clocks across five satellites.

So why would the UK want to start

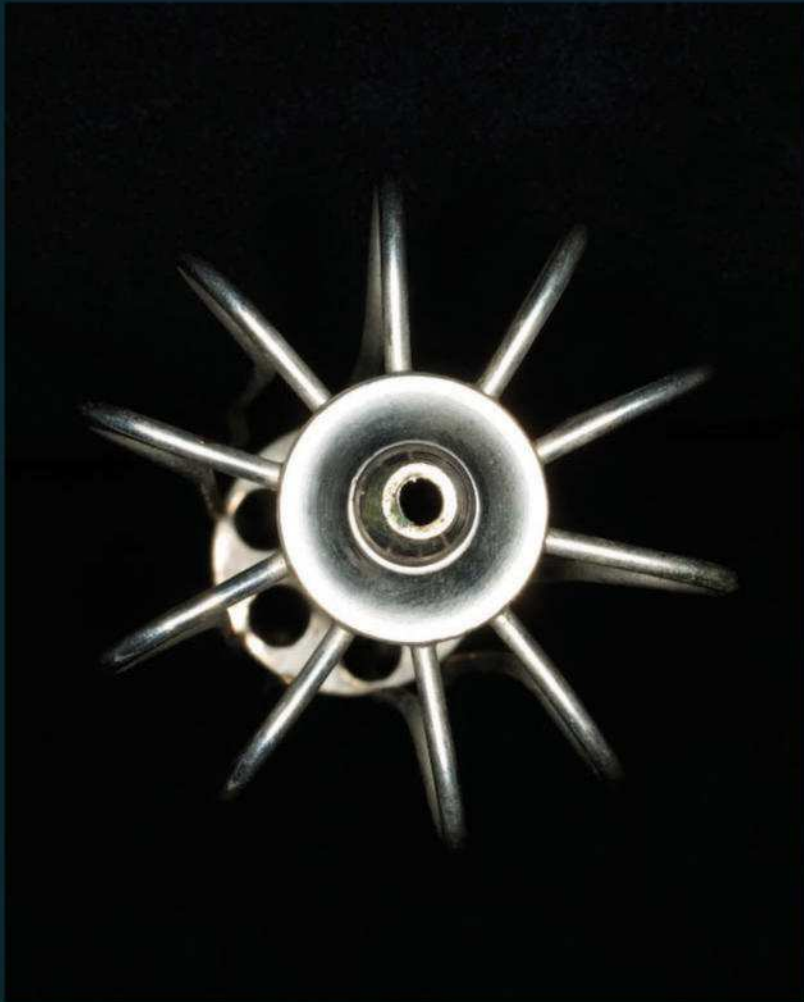
afresh with its own system? Claims that the country's national security will be jeopardised by the EU's obstinacy are overblown: as a NATO ally, the UK already has access to the encrypted GPS signal. It seems probable that the UK can reach a similar agreement with the EU over Galileo post-Brexit.

The reality is that the UK is probably more motivated by happenings on the ground than in orbit. The government's own early projections estimated that Galileo would be worth £14.2 billion to the UK economy between 2013 and 2025, predominantly through satellite manufacture and the wider aerospace industry.

But with doubts circulating over the UK's continued involvement in Galileo, aerospace firms are already relocating to mainland Europe and forming consortiums to bid for the next round of Galileo contracts. In its remaining months as an EU member, the UK can buy time by blocking any new procurements, but it will be fighting a losing battle.

Of course, this satellite row could blow over as part of ongoing negotiations between the UK and the EU. But by the time an agreement for the UK to stay within Galileo is hammered out, it will be too late to coax these firms back. Suggesting that the UK's own lucrative contracts are just around the corner appears to be a desperate tactic to give the impression that despite Brexit, it's business as usual for UK plc. ■

APERTURE



Different designs for specula, used to examine the vagina, from 1880 (right) and the early 20th century (above and centre bottom)



A rubber pessary, which was used to deliver medicine





Forceps (above) from the late 19th century, and a lead nipple shield from 1774



Tools of the trade

THEY may look like instruments of torture, but these devices have been gynaecological staples for hundreds of years.

The images form part of a photo archive titled Parturition that was collated by Rhode Island-based artist Lindsey Beal. To create it, she has spent the past five years visiting historical collections of medical devices used in gynaecology and childbirth.

"The oldest one I have is the lead nipple shield, which is from 1774," says Beal. Pictured bottom right, the shield was used by mothers who were having trouble breastfeeding - until they cottoned on to the fact that the lead was making their babies ill. Modern versions don't look much different, although they tend to be made of silicone.

The two tools to the far left and the one at centre bottom are different models of speculum, a device used to examine the vagina and cervix. Although various iterations have come and gone over the years - including an inflatable model - the speculum in use today has barely changed from its original design, developed by James Marion Sims, who tested it on slave women in the 1800s.

The forceps, pictured at top right, also have a questionable history. While forceps are still used around the world to extract babies during difficult births, the original design was kept secret by its inventors, two brothers who carried the instrument in a huge, coffin-like case so others couldn't steal their design. They also rang a bell while using it to further confuse potential copycats. The original forceps were only discovered 200 years later, hidden beneath the floorboards of the family's old house.

Together, the tools represent the move from childbirth being a midwife-led, home-based affair to a male-dominated hospital practice, says Beal. Jessica Hamzelou

Photographer

Lindsey Beal

lindseybeal.com

CLOCKWISE FROM TOP LEFT: DUKE UNIVERSITY'S HISTORY OF MEDICINE COLLECTIONS, DAVID M. RUBENSTEIN RARE BOOK & MANUSCRIPT LIBRARY, EARLY 20TH CENTURY; DUKE UNIVERSITY'S HISTORY OF MEDICINE COLLECTIONS, DAVID M. RUBENSTEIN RARE BOOK & MANUSCRIPT LIBRARY, C. UNKNOWN; YALE UNIVERSITY'S HARVEY CUSHING/JOHN HAY WHITNEY MEDICAL LIBRARY, C. LATE 19TH CENTURY; THE COLLECTION OF THE BROWN UNIVERSITY'S JOHN HAY LIBRARY RHODE ISLAND MEDICAL SOCIETY COLLECTION, C. 1774; DUKE UNIVERSITY'S HISTORY OF MEDICINE COLLECTIONS, DAVID M. RUBENSTEIN RARE BOOK & MANUSCRIPT LIBRARY, C. EARLY 20TH CENTURY; DUKE UNIVERSITY'S HISTORY OF MEDICINE COLLECTIONS, DAVID M. RUBENSTEIN RARE BOOK & MANUSCRIPT LIBRARY, C. 1880

The world's most
exciting festival of ideas
and discovery

New Scientist Live

20 – 23 Sept 2018
ExCeL London

BOOK YOUR TICKETS NOW

newscientistlive.com

COSMOS
ZONE
SPONSOR



EARTH
ZONE
SPONSOR



MAIN STAGE

A BRIEF HISTORY OF GRAVITY

A LIFE IN BRAIN SURGERY • BLUE PLANET, UNSEEN • WHO ARE WE?
HOW TO BE HUMAN IN THE AGE OF THE MACHINE • THE NATURE OF TIME

THE MANY WORLDS OF QUANTUM MECHANICS • THE SECRET LIFE OF THE TEENAGE BRAIN • THE SIMPLE ROUTE TO BETTER HEALTH

COSMOS STAGE

DEFENDING EARTH FROM ASTEROIDS

EXOPLANETS, ON THE HUNT OF UNIVERSAL LIFE • THE FATE OF THE COSMOS

GRAVITATIONAL WAVES: SIRENS OF THE COSMOS

JOURNEYS INTO PARTICLE PHYSICS • THE DARK SIDE OF THE UNIVERSE

EARTH STAGE

IS HUMANITY CAUSING A MASS SPECIATION EVENT ON EARTH?

HOW PRIMATES AND ELEPHANTS PREVENT CLIMATE CHANGE

PLANET ON A PLATE - HOW FOOD CONNECTS US WITH EVERYTHING

SHOULD WE PRODUCE GENOME EDITED LIVESTOCK? • ANTIBIOTIC DISCOVERY IN THE ABYSS • VOLCANOES: FRIEND OR FOE?

ENGINEERING STAGE

BUILDING BIONIC PEOPLE • FUSION FUTURE

HOW TO WIN THE AMERICA'S CUP • MATHS V SPORT

THE SCIENCE AND ART OF THRILL RIDES • THE WORLD'S MOST POWERFUL LASER

HUMANS STAGE

GUT HEALTH: THE SECRET TO HAPPINESS?

IS AUTISM A GIFT? • OBESITY: WHO IS TO BLAME?

GOOD HALLUCINATIONS? PREDICTIVE BRAINS AND HUMAN EXPERIENCE

PREVENTING AND OVERCOMING CHRONIC PAIN • CAN YOU LIVE FOREVER (AND WOULD YOU WANT TO)?

TECHNOLOGY STAGE

HOW QUANTUM SENSORS CAN IMPROVE OUR LIVES

IMAGING EARTH'S SECRETS USING COSMIC MUONS • MATHS VERSUS AI

SHOULD ROBOTS HAVE RIGHTS? • THE HIDDEN SECRETS OF EGYPTIAN MUMMIES

THE PAST, PRESENT AND FUTURE OF ARTIFICIAL INTELLIGENCE

EXPERIENCES

VR ROLLER-COASTER • SOLVE A WILDLIFE CRIME • POP-UP PLANETARIUM

HUG A BUG • THE FASCINATING WORLD OF FIRE SCIENCE • VR TOUR OF A BRAIN

PLUS MUCH MUCH MORE



STEWART MCBEATH

And then there was light

In February, we glimpsed the first stars turning on – that's only deepened the mystery of the early universe, says [Colin Stuart](#)

IN THE dusty, dry outback of Western Australia there is nothing for miles around but red dirt, unpaved roads and the occasional kangaroo. A journey across this alien landscape is a lesson in solitude – just you and the road, a 4x4 as essential as a sense of adventure. Astronomer Judd Bowman at Arizona State University has been coming here for nearly a decade to visit the Murchison Radio-astronomy Observatory, an old sheep and cattle station repurposed as a place to listen to the universe.

It hardly seems the stage for a scientific revolution, meagre compared with the cathedral-like majesty of machines like the Large Hadron Collider at CERN. Yet what Bowman and his colleagues have discovered here, using a telescope half the size of a ping-pong table, spells trouble for our picture of the early universe.

It could mean that our ideas about dark matter, the mysterious glue that holds the universe together, are all wrong. It could be that gravity, the force that determines how the cosmos evolves, doesn't work how we think it does. Or maybe black holes were eating into the early universe long before we thought possible. One thing is certain: if Bowman's results hold up – and it's a big if – this could be a milestone moment in the history of cosmology.

When Bowman first started jeeping across the outback in 2009, he was chasing the bright lights of the early universe. In the aftermath of

the big bang, the cosmos was full of hydrogen atoms, floating alone in the frigid darkness. As millions of years sailed by, clouds of hydrogen gas started to clump together in ever denser clusters. When their density hit a critical point, the energy of nuclear fusion caused them to emit light – signalling the birth of the first stars in a moment known as the cosmic dawn.

For the past 20 years, astronomers have been on the hunt for a signal from this moment: the turning point when the lights switched on in a dark, infant universe. As the intense light from the first stars excited the

“Some are predicting it could be worth two Nobel prizes”

surrounding hydrogen gas, it primed it to absorb some of the cosmic microwave background – the leftover energy from the big bang – at a very specific frequency. This would be an unmistakable signal of the dramatic epoch of reionisation.

In the race to detect this, Bowman's experiment was far from being the front runner. Most astronomers had plumped for big arrays consisting of multiple radio dishes strung together. The Hydrogen Epoch of Reionization Array experiment in South Africa, for example, is a hexagonal grid of dishes covering an area 300 metres wide.

Bowman, a David to some pretty impressive Goliaths, relied instead on a single table-sized detector with just one antenna.

Taking the road less travelled appears to have paid dividends. In February 2018, Bowman was first to announce the detection of just such an absorption signal using the Experiment to Detect the Global EoR Signature (EDGES) at Murchison. While neutral hydrogen ordinarily absorbs radiation with a wavelength of 21 centimetres, the universe's expansion over billions of years stretched this signal out to 385 cm (see diagram, page 30). Bowman calculates that means the first stars ignited just 180 million years after the big bang, earlier than most astronomers were expecting.

That discovery in itself was enough to send tremors through the world of cosmology. Yet that's only half the story. Although Bowman found the kind of signal everyone was looking for, the absorption was far larger than anything anyone had expected.

With the stakes so high, Bowman was cautious from the outset. Within weeks of switching on the EDGES antenna at Murchison, he knew things were odd. “We assumed something was wrong with the instrument,” he says. Bowman and his colleagues spent two years meticulously checking everything from loose screws to competing signals. Rotating the antenna didn't change anything either. The absorption signal persisted. “Our confidence started to grow,” he says. By last summer, he was treating it as a bona fide detection and ➤

The 21-centimetre stretch

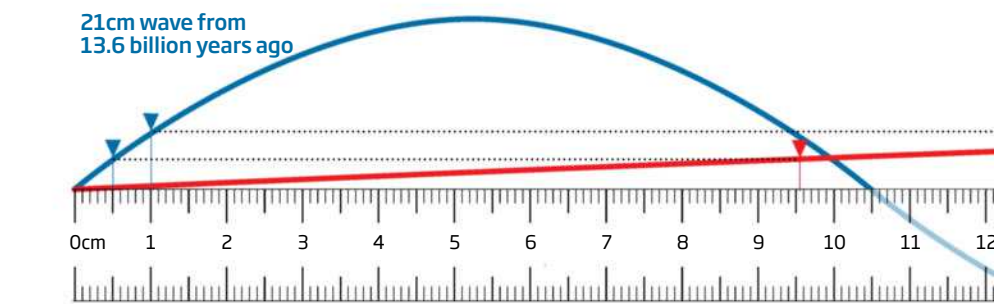
Astronomers search for the light of the first stars by looking for its effect on neutral hydrogen. When excited, hydrogen atoms absorb light at a distinctive 21-centimetre wavelength. As the universe expands, these waves expand with it, allowing us to tell how much time has passed since the hydrogen was excited. Judd Bowman from Arizona State University has picked up a surprisingly strong signal at a wavelength of 385 centimetres. If the signal corresponds to the stretched 21-centimetre radiation, it seems to indicate that hydrogen was absorbing light from the first stars just 180 million years after the big bang, 220 million years earlier than thought.

began sharing his find with a select few colleagues he hoped could help resolve the mystery. One of those he emailed was Rennan Barkana, a dark matter specialist from Tel Aviv University in Israel. "He told me he had found something weird and wondered whether I had any explanation for it," says Barkana.

Barkana mulled it over during a long car journey with his family. He came to the conclusion that the extra absorption was because the hydrogen gas surrounding the first stars was cooler than had been predicted, allowing it to absorb more of the cosmic microwave background radiation. Barkana decided there was only one thing around to cool the gas: dark matter.

Dark matter was put forward to fill a strange role in the universe. Invisible, it makes up the vast majority of all the matter out there, leaving all the stuff we can see – stars, sheep, cattle and 4x4s included – to fill up a paltry 16 per cent. Regular matter is easy enough to hunt for. But dark matter, defined by its very obscurity, is almost impossible to spot. Up until now, the only signs of its existence have been gravitational: slimline galaxies that rolled ponderously around their axes as though carrying invisible bulk. What Bowman has spotted may turn out to be the first independent sign the shadowy stuff is out there. If so, it may prove such a game-changing discovery that it makes our existing dark matter searches obsolete. All this from an experiment only a few metres across in the middle of nowhere.

On the face of it, Barkana's hypothesis of gas-cooling dark matter isn't too much of a stretch. After all, dark matter has been in the universe since its inception. It first crossed our radar in the 1930s, when astronomers found galaxies and galaxy clusters moving faster than we would expect given the mass of their visible matter alone. Since then, similar clues



have come from experiments looking at how light is bent by massive clusters of galaxies. Astronomers observe too much bending given the amount of material we can see in the cluster. However, these are all indirect lines of evidence that involve gravity, causing a growing band of theorists to suggest that gravity itself might vary across the universe, with dark matter being no more than a figment of our imagination.

Bowman's result could change all that. "It's the first direct evidence of dark matter that doesn't rely on gravity," says Barkana. But it's not the dark matter most people expected.

In the late 1980s, astronomers trying to work out what dark matter might be made of turned to particle physicists for help. Based on the available data, they suggested it could take the form of heavy particles that interacted with other matter too weakly to be observed directly. These weakly interacting massive particles

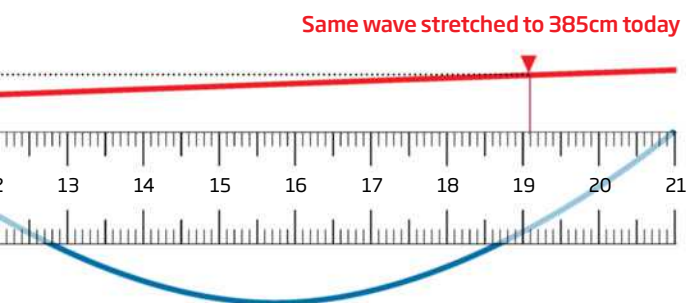
(WIMPs) rapidly became our top dark matter candidate, and in recent years researchers have gone to great lengths to snare one. Experiments have been set up under the Antarctic ice, deep underground in abandoned mines, and strapped to the International Space Station. Atom smashers like the Large Hadron Collider have been searching too. "There's been a very large investment in searching for WIMPs, but they haven't found anything," says Barkana. "It's been getting more and more frustrating."

If dark matter were responsible for the unusually strong signal of the cosmic dawn, then Barkana believes it can't be made of WIMPs. In order to interact with regular matter strongly enough to funnel away heat, it would have to be formed of much lighter particles, and possess a tiny electric charge.

Avi Loeb, an astrophysicist at Harvard University, is both elated and cautious. On the one hand, he thinks two Nobel prizes



The EDGES detector ended a 20-year quest to spot the first stars switching on



"It may turn out to be the first direct sign that shadowy dark matter is out there"

might be on offer: "one for the detection and one for the new physics." That said, he adds, "extraordinary claims require extraordinary evidence". He points out that the signal Bowman was looking for is incredibly faint. Our Milky Way galaxy produces similar signals 10,000 times stronger than the ones EDGES was trying to pick up. Bowman had to model those foreground signals and remove them to see what was left. "I'm worried that this procedure has introduced an artificial absorption signal," Loeb says.

Bowman freely admits the result needs further scrutiny. "We want another team with another instrument to confirm this signal, particularly as what we're seeing isn't what people expected," he says, "but we're excited to see a signal people have waited 20 years for."

Even if the signal turns out to be genuine, it might be too early to mourn the demise of the WIMP. Dan Hooper, an astrophysicist at the University of Chicago, argues that if dark matter is completely made of particles lighter than WIMPs then they would also have interacted with normal matter at the time the cosmic microwave background was released and we would see evidence of that. "It would have screwed up the cosmic microwave background quite severely," he says.

Instead, these new particles have to make up somewhere between one-third of a per cent and 2 per cent of the total composition of dark matter. That's not much wiggle room.

What's more, Sam McDermott from the Fermi National Accelerator Laboratory near Batavia, Illinois, takes issue with Barkana's hypothesised electric charge. He says astronomical observations limit the charge on any light dark matter particle to around one hundred thousandth that of the electron. So not only would ordinary dark matter need to be peppered with just the right amount of lighter dark matter particles, we would also

need them to have just the right electric charge. "It's possible, and we can construct models like that, but it's not something that is easy to orchestrate," Hooper says. He sees that as a reason to be sceptical of a dark matter interpretation of the signal. "It's not a particularly good bet."

Defying gravity

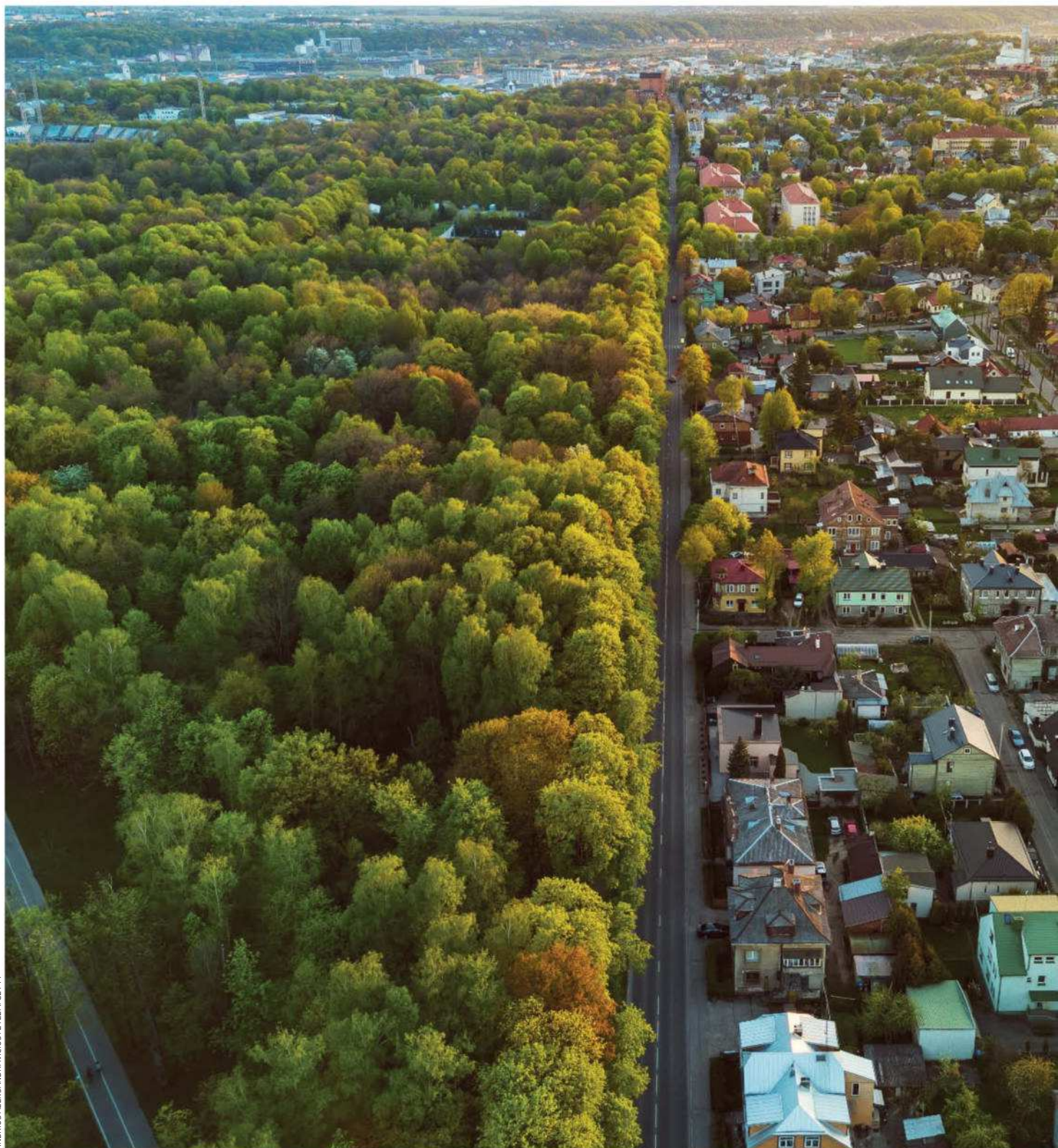
To Stacy McGaugh, an astronomer at Case Western Reserve University in Ohio, it is no surprise that these explanations for the excess absorption run into trouble. He doesn't think dark matter has anything to do with it. "It is very natural without dark matter," he says. McGaugh has been working for two decades on alternatives to dark matter, in particular the idea that the laws of gravity are not the same across the entire universe. Such theories of "modified gravity" have been gaining traction in recent years in response to our inability to find concrete evidence of WIMPs. "With dark matter you expect the universe to expand slowly," McGaugh says, because its gravity applied the brakes. Without dark matter the universe expands more quickly, creating more space between the cosmic microwave background and the first stars. That means more gas between the two and therefore a greater amount of absorption than had been anticipated. "If the signal is real then it's more consistent with this picture than dark matter," he says.

There is another way to explain the enhanced absorption signal without the need to dispense with WIMPs or to invoke modified gravity. "The assumption is that it's only the cosmic microwave background being absorbed," says Gil Holder, a theoretical astrophysicist at the University of Illinois. "But if there were additional radio waves kicking around at that time then those would

also be absorbed by the cold gas and that would enhance the signal." And there is a hint that might be the case. Almost a decade ago, the ARCADE 2 experiment found an excess of radio waves in a survey of the sky. Even today that excess has no accepted explanation. According to Holder, if only 1 or 2 per cent of that excess was around when the first stars lit up that could explain the strength of the signal picked up by EDGES. However, he says, it would require some new astrophysics to explain where the extra radio waves came from. One possibility is primordial black holes, roaming the universe long before the standard theory of cosmology predicts. "So the only question is whether that's more or less plausible than dark matter interacting with strange properties," he says. "I think that's a personal choice between how weird astrophysics can be compared to how weird particle physics can be."

First things first, the strength of this absorption signal is so unexpected that physicists are still playing catch up to try to establish whether it is genuine. That revelation could come by December. Should a discovery be confirmed, only then will attention turn to working out whether dark matter really is responsible – and for that we need a much bigger collection of radio dishes to create a 3D image of the hydrogen gas. "If the origin of the cooling has to do with dark matter you would get a very different 3D map compared with if it's associated with extra radio waves," says Avi Loeb. As it happens, our best bet is the Square Kilometre Array, currently under construction in South Africa and Australia, on the same remote site as Bowman's own tabletop experiment. It seems this may not be the last time our picture of the universe is shaken up from the dusty outback. ■

Colin Stuart (@skyponderer) is an astronomy author based in London



ANDRIUS ALEKSANDRAVICIUS / EYEM/GETTY



TREE ECONOMICS

Totting up the true value of urban trees could be the best way to protect them – and us, says Simon Osborne

THE Broad Walk is one of London's leafiest avenues, stretching between two corners of Hyde Park. On a cold but sunny spring day, it is a welcome escape from Park Lane's noisy traffic, luxury hotels and car showrooms.

I'm taking a walk with Ian Rodger, who manages trees for the city's Royal Parks. "These were planted in about 1860," says Rodger, gazing up at the giant London planes on either side of the path. Their canopies spread out high above him and fuzzy fruits fall occasionally from clusters in the branches.

The Victorians planted thousands of these trees because they thrive in any soil and their flaking bark and glossy leaves made them impervious to the soot and smoke of the industrial revolution. But as we have learned to our cost, their roots can spread widely, disrupting roads, pavements and buildings. "What the Victorians didn't know was how bloody big they get," says Rodger.

Nor could they have appreciated the true value of the trees, beyond their hardiness and handsomeness. In fact, that is something we are only just coming to fully appreciate. Recently, a band of "treeconomists" have begun to put a fair price tag on trees, accounting for the services they provide, from keeping our buildings cool to preventing skin cancer. The results are sometimes startlingly large – and can help people like Rodger plead the case for our cities' trees.

When trees hit the headlines, it is often in the context of deforestation. But in most developed countries, forests have actually

been advancing over the past few decades (see map, page 36). And the trend shows no signs of abating. Take the Republic of Ireland: about 11 per cent of the country is covered by trees and the government aims to increase that to 18 per cent by 2046. In March, the UK began planting a forest of 50 million trees, which will arc from Liverpool to Hull in the north of England. The UK government estimates it could generate £2 billion for the rural economy through tourism and employment.

However, those trees come at a cost. From sapling to old age, they must be constantly looked after. That is particularly true in cities, where ageing or diseased branches can fall on people and property, and roots can break up pavements. In some places, that financial burden is hard to bear. The local authority in the UK city of Sheffield has generated protests and national headlines with its chainsaw massacre of 5500 trees, with another 12,000 at risk of being felled. In March, a newly ordained vicar was among those arrested as she protested the felling of a mature lime tree nicknamed "The Duchess".

The easy argument often made in favour of trees is that they are ineffably lovely. But that doesn't cut much ice when set against the cost of upkeep and repairs. What is important is the trees' economic benefits. Calculating those, it turns out, is a rather vexed question.

It's not just disputes between councils and residents where the value of trees is important to know. Imagine a situation where a builder damages a tree during construction and is ➤

IT GROWS ON TREES

They say you know a tree by its fruit, but perhaps its price tag is more instructive still. A wave of studies is beginning to work out the monetary value of the roles trees play in our environment, aided by a piece of software called iTree. Such valuations let people plead the case for their upkeep in urban areas

Anatomy of a London tree

London has 8.4 million urban trees providing a range of services that would otherwise cost the city

Canopies

shield buildings from the sun in summer and winds in winter, reducing the cost of heating and cooling

£260k PA

Photosynthesis

locks up carbon that would otherwise contribute to global warming

£4.8m PA

Leaves and bark

absorb polluting chemicals like nitrogen oxides, sulphur oxides, carbon monoxide, ozone and particulates

£126m PA

Roots

trap rainwater that would otherwise end up in sewers or overflow into rivers

£2.8m PA

£147m

The worth of carbon stored in London's trees, based on the cost of removing it from the atmosphere

£6.12b

The cost to replace all the trees in London

£43b

The value of London's trees as an amenity in the landscape

Urban forests

Many cities qualify as forests, under the UN definition of a contiguous area with greater than 10 per cent tree cover

City	Coverage	Most common
London	14%	Sycamore English oak Silver birch
Glasgow	15%	Ash Hawthorn Alder
Toronto	20%	Norway maple Sugar maple Manitoba maple
Barcelona	25%	London Plane Monterey cypress Chinese privet
Washington DC	28%	American beech Callery pear Tulip tree

Carbon suckers

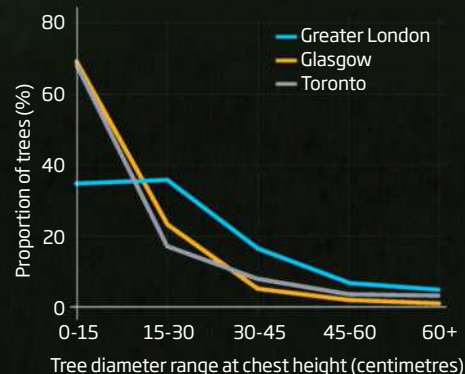


Trees for the future

Valuing urban forests can help us plan for the future. One value of trees is their ability to store carbon, which makes them useful for fighting climate change. In London, poplars store the most (see left), suggesting planting more could maximise this benefit.

The biggest trees provide us with the most benefits, from shade to absorbing pollution. But cities have few of these giants (see right). Increasing their number could boost our environment and wellbeing.

Big up the trees



SOURCE: VALUING LONDON'S URBAN FOREST

Chainsaw massacre: Some 17,500 trees could be felled in Sheffield

pursued in court for damages. Or where a tree falls and the owner wants to make an insurance claim.

It was situations like these that set Chris Neilan trying to value the benefit of trees more accurately. He began his career as a tree surgeon in the 1970s. Back then, councils counted the number of trees they planted, but not the number that survived long term. Neilan and his colleagues knew that most of the saplings died, often from under-watering or damage from mowers and strimmers. "There was a joke at the time," he says, "plant a tree in 73; plant some more in 74."

When he started working for Epping Forest District Council just outside London in the late 1980s, Neilan was called to give evidence in a court case involving a young oak that a developer had failed to protect in front of a row of new houses. That entailed giving the oak a value.

He could have used an existing method developed by a British forester named Rodney Helliwell, which focused on a tree's aesthetic contribution to a landscape. This typically generated values and thus fines in the hundreds of pounds. Neilan thought that seemed too low.

He began developing a new method, which attempted to capture trees' worth as an amenity, taking into account their attractiveness and how they accentuate or diminish a sense of place. Now called Capital Asset Value for Amenity Trees (CAVAT), it starts by multiplying the cross-sectional area of the tree's trunk by a unit price – currently £15.88 –



FAR LEFT: WELLS; SHUTTERSTOCK; LEFT: JASON BATTERHAM/GETTY

that relates closely to what the tree costs to buy, and which goes up with inflation. This gives a basic value based on its size, which is then augmented in several steps that take into account the tree's species, visibility to the public, local population levels, the size and condition of the leaf canopy, the suitability of the species for its site and the tree's life expectancy. "When I described the tree's true value, the developer was fined exactly that sum – which was about £12,000," says Neilan.

But scientists have long known that trees have far more to offer us than pleasant feelings. Around the turn of the century, organisations like the World Bank and the UN Environment Programme pushed for a

rigorous valuation of the merits not just of trees, but of rocks, rivers, soils and sediments too. The result was the landmark Millennium Ecosystem Assessment of 2005, which put a price on the services humans gain from nature, ranging from direct benefits like food and water to supporting services like the pollination of crops by insects and the absorption of carbon dioxide by plants.

Some say nature is priceless; that valuing it in financial terms ties it to an economic system that has only threatened it. Yet incentivising conservation with cash can work. In 1997, Costa Rica began a scheme that paid landowners to preserve forests rather than clear them to make way for profitable crops. The amount they received was based on the value of the services provided by the forests. This seemed to aid conservation: from around 1980, the country's forest cover was either in decline or stable, but between 2000 and 2005 it increased by about 2 per cent.

Around the same time, David Nowak was developing a piece of software that catalogued the benefits of trees in more detail than ever. Nowak, who works for the United States Forest Service in Syracuse, New York, released iTree in 2006. Unlike CAVAT, with its focus on amenity value, iTree attempts to price up the environmental services trees provide. It combines local weather and pollution data with tree metrics – including trunk girth, species type, canopy size and sunlight exposure – to calculate the value of the services the trees provide. These range from the pollution they remove from the air to the carbon they store, and the run-off into the sewage system they prevent by soaking up rain. Where it is relevant, more data can be

PRICE MY TREE

It's all very well hearing that trees in the abstract are worth a handsome sum. But what about those we see from our office windows or sit under to eat our lunch; how much are the individual trees that matter to us worth? If you live in the US, that's not so tough to answer.

Take the big old tree next to *New Scientist's* Boston office. To find out the value of its environmental services, the first step is to fire up MyTree, an app based on the same databases that power iTree, the software being used to value trees across the world (see main story). The program needs to know the tree's species and its trunk

diameter at chest height. An internet search revealed the tree is probably a Norway maple. And wrapping it with a tape measure showed it had a diameter of



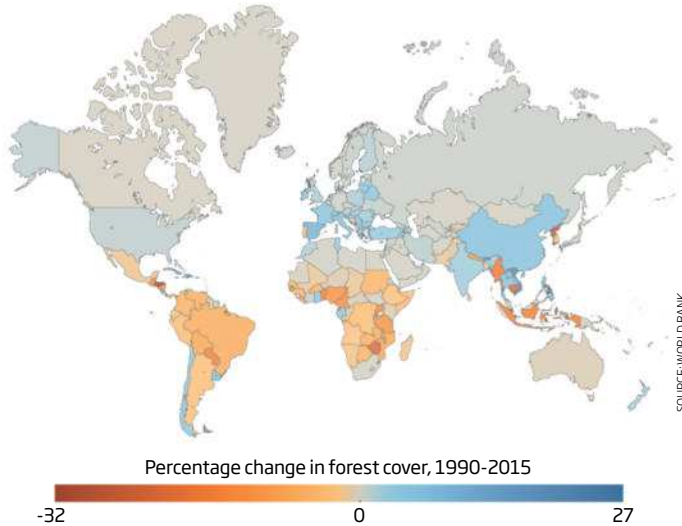
GOOGLE MAPS

about 110 centimetres.

A little more information is needed, including the distance between the tree and any nearby buildings. When those estimates are in, the app flashes up a list of the tree's benefits. It turns out this maple intercepts more than 23,000 litres of rainwater a year, which would otherwise cost \$49 in sewer capacity. It also saves the area \$47 in energy costs by keeping buildings cool. And it removes almost 1.4 kilograms of pollution, such as ozone, nitrogen dioxide and sooty particulates, from the air each year, worth \$4.67. That adds up to about \$100 of benefits – and it looks pretty good too.

GREEN DIVIDE

While some countries are felling trees, others are planting them. In some cases, even neighbouring countries have headed in opposite directions



included in those calculations, for example to take account of where ultraviolet radiation is highest, and which trees are best able to filter it out and reduce the risk of skin cancer.

Nowak imagined iTree would only be used by forest managers, but it seems to have caught the public imagination. In Milwaukee, an influential 2011 advertising campaign included billboards that put iTree-generated price tags on trees, challenging passers-by to think differently about their surroundings. These days there is a version of iTree that anyone can use to estimate the value of any tree in the US (see "Price my tree", page 35).

Over the past few years, Nowak has helped value the trees in many US cities, with armies of volunteers measuring trunks and recording species. But his most recent work is more ambitious. It used algorithms to crunch data from satellites and aerial photography and estimate the value of all the trees in the US.

The study focused on four core benefits trees provide: soaking up air pollution, storing carbon, saving money on energy by shading buildings in summer and cooling them in winter, and avoiding the emissions associated with the production of that energy. Totting these up, Nowak found the grand total was \$18.3 billion a year – about \$3 a tree on average. One reason the figure is rather low is that rural trees provide less valuable benefits to humans, simply because there are fewer people around.

Elsewhere, it is a different story. Back in Hyde Park, Rodger and I are joined by Kenton Rogers, a consultant at Treeconomics, a social enterprise based at the University of Exeter, UK. He pulls a report out of his satchel. Working with Forest Research, part of the UK's Forestry Commission, Treeconomics has used iTree and CAVAT to calculate the worth of urban trees across the UK and Rogers has got the results for Hyde Park.

A crew of park staff and volunteers spent weeks during the three summers to 2015 auditing the park's 3174 trees, including 1188

"Tree valuations can help us plan the urban forests of the future"

planes, the dominant among 104 species. According to the iTree estimates, their environmental services are worth £208,916 per year. The bulk of this – about £183,000 – is the "social damage" cost of the pollution the trees prevent, a standard metric that accounts for trees' benefits to human health and the environment.

But that is before you include the CAVAT valuations. Because the park is in such a densely populated area, and because the trees are large, visible and highly suited to their setting, the amenity value of all the trees there

is huge: £52,378 on average for each London plane. "And it's worth every penny," says Rodger as he looks up.

Tree valuations are starting to spread. As well as several cities in the UK, groups akin to Treeconomics have used iTree to value urban trees in Toronto, Barcelona and Mérida in Mexico among other places. This is giving us a richer picture of urban trees than ever before (see "It grows on trees", page 34).

The next step, says Nowak, is to use the valuations as a way to forecast the value of services different trees will provide in the future. That gives us a tool to help plan tomorrow's forests.

This is already possible, to an extent. An offshoot of Nowak's program, called iTree Species, allows an urban forester to rank the environmental services desired in a new planting scheme, including reducing air pollution, wind and ultraviolet light. After plugging in these characteristics, alongside the hardiness required to cope with local geography and weather, and the predicted mature size of the tree, the software produces a ranked list of recommended species. "It's becoming a more intelligent system," says Nowak.

Taken further, systems like this could be used to ensure any new planting scheme delivers a clear return on investment. Get that right, and disputes over the value of trees like the ones in Sheffield could be a thing of the past.

In the meantime, arborists hope that tools like this will improve trees' status. "If a lamp post falls down or is damaged, people expect it to be replaced – it should be the same for a tree," says Kieron Doick, head of the Urban Forest Research Group at the UK Forestry Commission. The difference between the two is that trees get larger and provide more value as they get older, meaning they need to be preserved, not replaced.

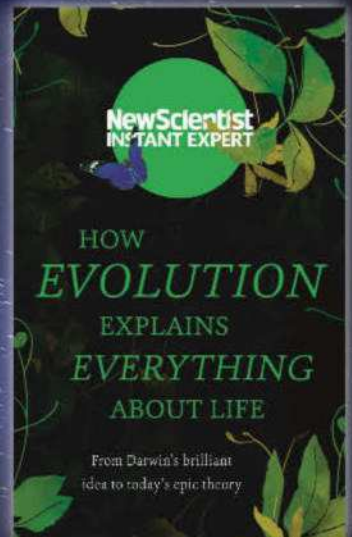
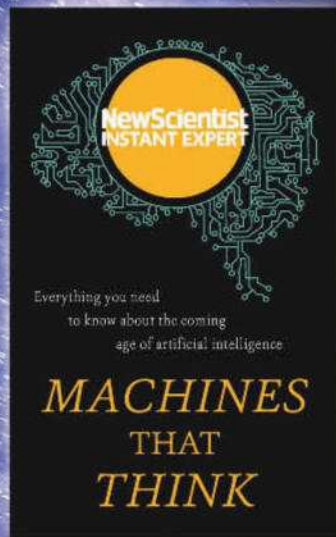
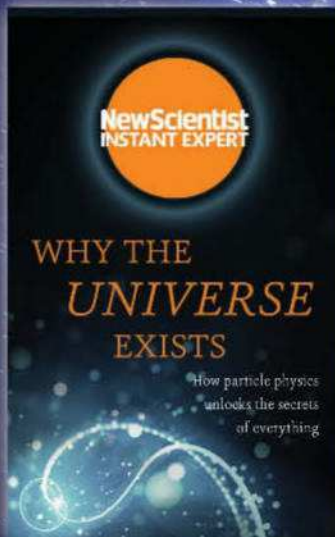
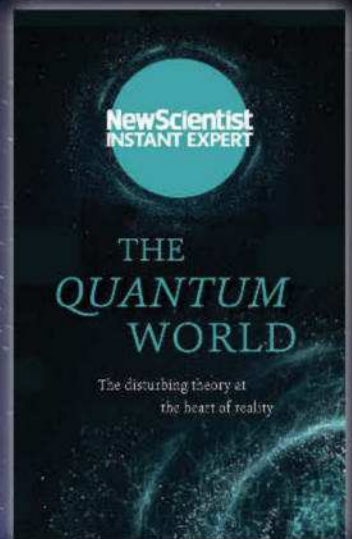
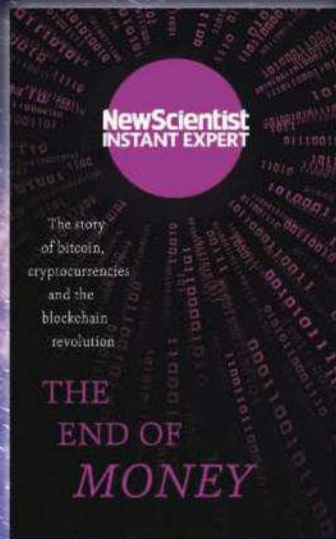
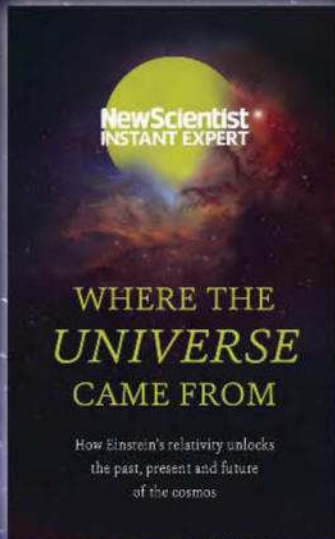
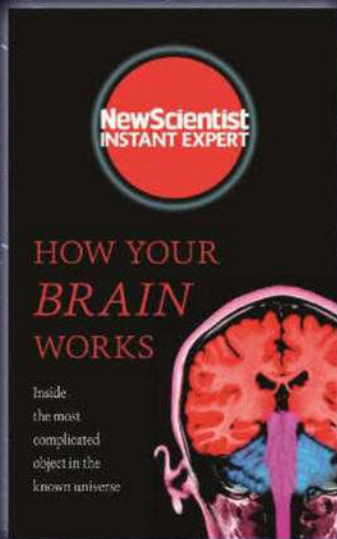
In Hyde Park, where the £52,000 planes cast long shadows over tourists cycling past, Rodger knows that not everyone likes the idea of valuing nature. "I do think it's a sad indictment of today's society that everything seems to have a value," he says. Trees have been his professional passion for 25 years. But like the other tree lovers seeking to evaluate them, he has come to believe in the practice.

"You can talk about the loveliness of trees until you're blue in the face," says Neilan. "But it doesn't get you extra money when some wretched contractor trenches through the root system." ■

Simon Usborne is a writer based in London

INTRODUCING THE New Scientist INSTANT EXPERT SERIES

DEFINITIVE, ENGAGING AND ACCESSIBLE GUIDES TO
THE MOST IMPORTANT SUBJECTS IN SCIENCE.



Regrow yourself

Can we persuade our cells to repair damaged organs from within, asks Philip Ball

WHAT becomes of the broken-hearted? In cardiac medicine, the answer is usually brutally straightforward: they die. Heart disease is the leading cause of death worldwide and there is often precious little we can do about it. Pacemakers bring some relief and transplants work, but there are nowhere near enough donated hearts to go around. And unlike skin and liver cells, heart muscle cells can't remake themselves. Once they get damaged or die, they are gone forever.

Lab-grown stem cells, once the great hope for mending hearts, have disappointed. But over the past few years, cell biologists have been quietly exploring an alternative approach. Rather than growing cells in a dish and transplanting them, they want to switch their identities inside the body, so that we can heal ourselves from within.

That might sound rather fanciful. But cells are proving more malleable than we ever imagined, and now plans are being drawn up for the first human clinical trials to see if we can repair damaged hearts this way. If we can perfect the tricks needed to safely switch cell identity in situ – and it is a big if – we should be able to repair tissues ravaged by all sorts of conditions, from diabetes to dementia.

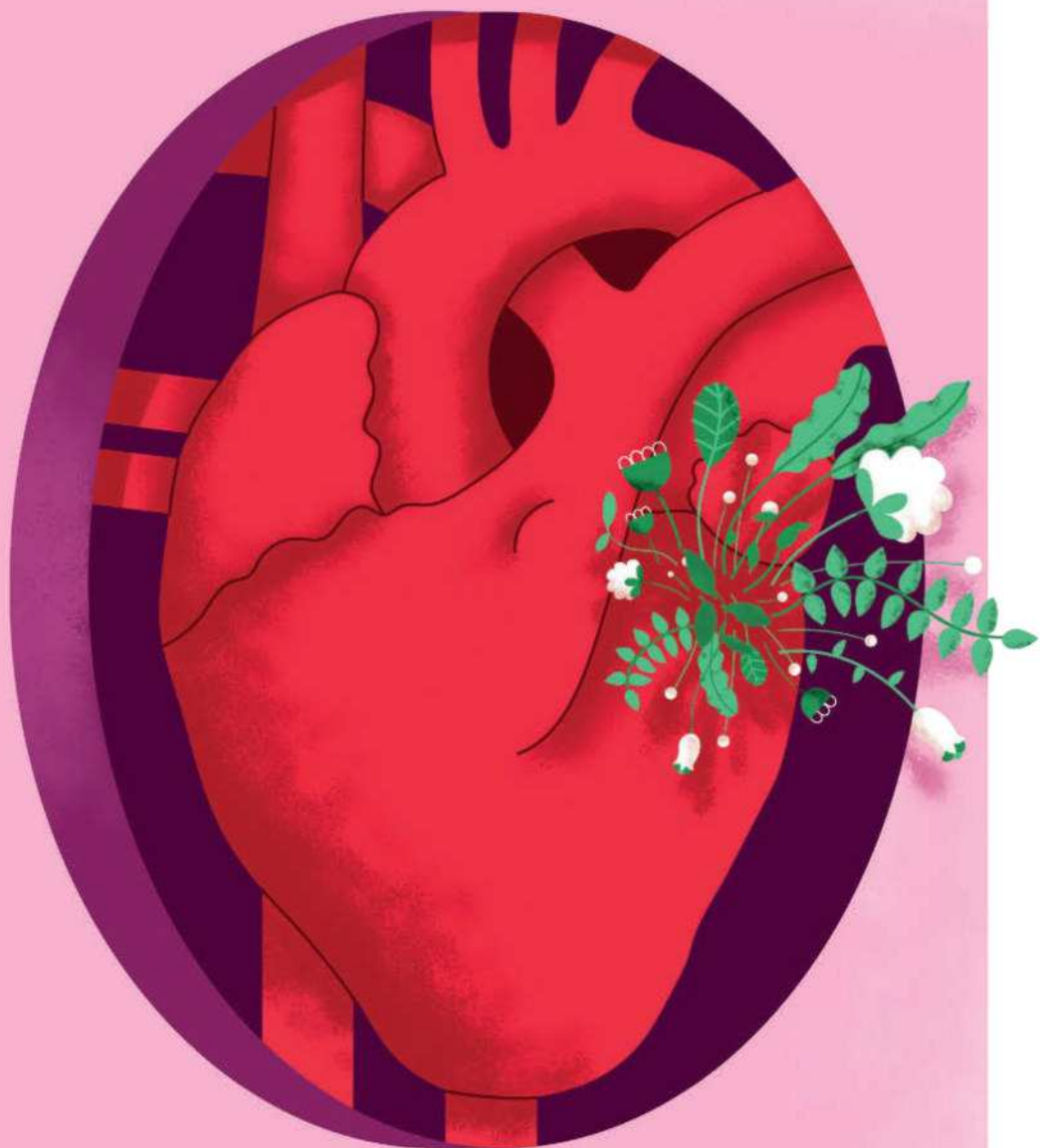
For a long time after biologists worked out how a featureless cluster of identical cells can become the rich diversity of parts that comprise a body, they generally assumed that adult cells were stuck with their fates. Once

embryonic stem cells, capable of becoming any tissue type, had differentiated into skin cells, heart muscle cells, neurons or whatever, there seemed to be no turning back.

But in 2006, Shinya Yamanaka, then at Kyoto University in Japan, showed otherwise in spectacular fashion. He transformed adult mouse cells back into a stem-cell-like state by inserting a cocktail of proteins called transcription factors. These work by changing which of the cells' genes are expressed, switching the cells to a "pluripotent" state in which they are able to differentiate into any tissue in the body. A year later, Yamanaka repeated the trick with human cells, a breakthrough that earned him a share of the Nobel prize for medicine in 2012.

Switching fates

Yamanaka's induced pluripotent stem (iPS) cells promised a new era of medicine. They provided a means to skip over the ethical quagmire associated with acquiring stem cells from discarded embryos. They also offered an abundant source of therapeutic cells that the immune system shouldn't reject because they could be grown from the transplant patients themselves. The hope was that cells, tissues and perhaps entire organs would soon be grown in the lab from mature cells from a patient, before being transplanted back to repair injury or cure disease. ➤



REGAIN YOUR BRAIN

Adult brains can't produce enough new brain cells to repair damage caused by stroke or to arrest the progression of neurodegenerative disorders such as Alzheimer's and Parkinson's disease.

That's why the ability to transform adult cells into other cell types inside the body is so appealing (see main story). If we can convert other types of brain cell directly into neurons and other nerve cells inside the brain and spinal column, there would be no need to transplant lab-grown cells, which don't tend to integrate with surrounding tissues. It would also bypass the need to drill a hole in the skulls of patients, which is how the researchers behind the most advanced stem-cell therapies for stroke managed to deliver new cells into the brain.

Animal studies are proving promising. In 2013, a team led by Malin Parmar at the University of Lund in Sweden transformed glial cells, which are abundant in the brain, into neurons in rats. A year later, Chun-Li Zhang at the University of Texas Southwestern Medical Center and his colleagues showed that glial cells can be transformed into neuron-forming cells called neuroblasts inside the spinal cords of adult mice.

So far, no one has managed to get new nerve cells to coordinate their activity with the existing network, so they don't help restore nerve function. It is also hard to know whether you are making the right kind of neuron. If such obstacles can be overcome, however, the technique could help us treat spinal column injuries, stroke damage and perhaps even neurodegenerative diseases.

More than a decade after Yamanaka's discovery, however, iPS cells have yet to deliver. Only a handful of stem-cell therapies have been approved by the US Food and Drug Administration – for several blood disorders, including leukaemia, and skin growth after burns – and all of those make use of embryonic stem cells, not iPS cells.

The failure has been felt acutely in the world of cardiology. "No cell-based therapy is close to being approved for heart disease," wrote Roberto Bolli, a cardiologist at the University of Louisville in Kentucky, in response to the latest high-profile failure in February last year. "A rising tide of skepticism has bedeviled the field, leading some critics even to question whether clinical studies should continue."

To some extent that's not surprising. The promise was undoubtedly overhyped to begin with, and it usually takes a long time to get from discovery to clinical use. But there are several reasons why iPS cells haven't made the grade. For one thing, there are still questions about how closely they resemble real stem cells, and so how versatile and safe they are. Then there is the fact that lab-grown cells, once transplanted, struggle to integrate with surrounding tissue.

"You don't need to wipe the slate clean to change the identities of our cells"

Some organs are more amenable to transplantation after in vitro growth because they don't have to integrate, says Deepak Srivastava at the Gladstone Institutes in San Francisco. Insulin-producing pancreatic cells, for instance, can make this hormone anywhere in the body, he says. "But others, such as heart cells, have to integrate closely, so attempts to transplant them after in vitro growth haven't been so successful."

The setbacks spurred Srivastava and others to start exploring an alternative approach that doesn't involve grafting lab-grown cells. The idea is to exploit the plasticity of cells like never before by transforming them inside the body rather than reverting to a pluripotent state first. And you have to do this directly, because iPS cells made inside animals have a tendency to turn cancerous.

Srivastava was the first to demonstrate such "direction conversion" of heart cells in 2010, when he and his colleagues used just three transcription factors to transform mouse heart fibroblasts, which make up some of the

fabric of the organ, to beating heart muscle cells or cardiomyocytes. It was a big surprise, says Srivastava: "Initially there was great scepticism that a small group of factors could switch cell fate." Later, his team went one better by getting those cells to beat in a coordinated fashion, just as in real cardiac muscle. In 2013, they pulled off the trick in human cells too.

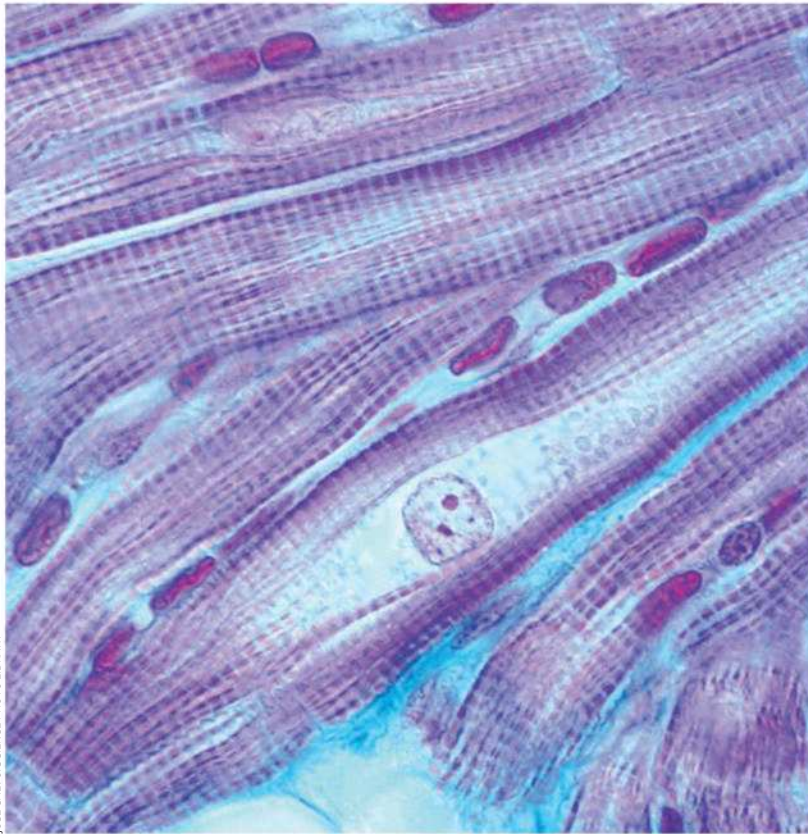
Clearly, then, you don't need to wipe the slate clean to transform cells. The trouble is, Srivastava and his colleagues only did all this in cells grown in a Petri dish, where it is easy to deliver the reprogramming agents and control the environment in which they grow. But to avoid the complications associated with transplantation, we need to do it inside the body. This is where things get trickier.

We already have the means to deliver genetic material encoding the proteins needed for transformation, using methods developed for gene therapy. Typically, the genes are delivered by a virus that does not integrate any of its own DNA into target cells' genomes.

Several groups have now used such methods to directly convert cells inside animals. In 2008, for instance, a team led by Douglas Melton at the Harvard Stem Cell Institute transformed ordinary pancreatic cells in mice into insulin-producing beta cells, those destroyed by an autoimmune response in people with type 1 diabetes. Sure enough, the converted cells produced insulin – an encouraging proof of principle.

But making insulin-producing cells is probably one of the easier hurdles to clear for in vivo cell reprogramming. Even if you make them from liver cells, as Jonathan Slack, then at the University of Minnesota, and co-workers have done, the switching required is relatively minor because the two types of cell come from the same precursor cells in the growing embryo. What's more, these beta cells don't have to fully assimilate with the cells around them to produce insulin.

The same cannot be said for heart muscle cells, says Srivastava – they need to coordinate their pulsing activity with the rest of the heart. Nevertheless, in 2012, his team managed to reprogram mouse heart fibroblasts into muscle cells in vivo with three transcription factors. The mice had suffered a heart attack, producing scar tissue that impaired cardiac function. But a couple of months after the treatment, their hearts had begun to recover: some of the scar tissue had been converted into beating heart muscle cells and the organ's ability to pump blood had improved.



JOSE CALVO/SCIENCE PHOTO LIBRARY

Heart muscle cells don't naturally regenerate, but they can be made from other cells

virus-free alternatives, most notably the use of small synthetic molecules instead of genes to do the reprogramming. Srivastava's team, for example, has converted human cardiac cells with small molecules of this kind. The long history of using such compounds as drugs should make it easier to get them through the regulatory system, says Stanger.

On the other hand, the screening process to find the right molecules is expensive, and we don't yet know how to deliver them to the right spot for long enough. But Juan Carlos Izpisua Belmonte of the Salk Institute in La Jolla, California, thinks this approach can bear fruit in the near future. "These chemicals could be administered in creams or injections to rejuvenate skin, muscle or bones," he says.

San Francisco-based Tenaya Therapeutics, spun out of work done at the Gladstone Institutes, is already forging ahead with gene-based reprogramming. According to chief scientific officer Tim Hoey, the company is aiming to switch cells in vivo with genes delivered by viruses, to restore function in hearts that have lost cardiac muscle after a heart attack. Hoey says preclinical studies are under way in animals to determine safety and efficacy ahead of possible human trials.

In the meantime, Srivastava has been pursuing what could be an even better way to repair tissue from the inside: not by repurposing existing cells, but by stimulating the growth of new ones. Earlier this year, he and his colleagues found they could trigger the multiplication of cardiomyocytes in adult mice with yet another mixture of genes, this time ones normally involved in regulating the "cell cycle" that governs proliferation during the gestation of the fetus.

When the team injected the genes into adult mice with damaged hearts, the animals generated fresh heart muscle, something that would never normally happen. Srivastava says it is the first time anyone has been able to get adult cells to start dividing anew with sufficient efficiency to make the approach seem viable for clinical use.

The implications could be profound. If this approach could be made to work for humans too, then ultimately it may not be necessary to repair and replace tissues by putting existing cells to new uses. No changes of identity would be necessary. We could simply persuade our broken hearts, and perhaps even our degenerating brains, to grow again. ■

Philip Ball is a science writer based in London. His latest book is *Beyond Weird* (Bodley Head)

Intriguingly, the three proteins that did the trick here don't work on cells in a dish, which suggests that surrounding tissues in the body can make in vivo reprogramming more effective. "There's a general feeling that reprogramming does work better in vivo," says Slack, now at the University of Bath, UK.

It is not entirely clear why, but Sheng Ding at the Gladstone Institutes suspects it could be due to cells that surround the ones being altered supplying chemical or mechanical signals that help the process along. That, he says, is the kind of advantage conferred by the tissue regeneration that occurs naturally in animals such as salamanders, which can famously regenerate entire limbs.

There seems to be no fundamental reason why this reprogramming process can't work in humans, too – and not just for heart disease (see "Regain your brain", left). The questions now are how and when that will happen. Ultimately, like any experimental medicine, there are lots of boxes to tick before we can test this new direction in cell reprogramming in humans – and plenty of potential pitfalls.

One obvious concern is that, once injected into the body, gene-tweaking proteins might run amok, drifting away from the place they are supposed to work and transforming other cells elsewhere. In theory, this off-target meddling could happen, says Srivastava, but people don't tend to see it in experiments on

animals because "everything has to be just right" to reprogram cells. "The experience of gene therapy indicates that it is very hard to get enough genes into even the target tissue, so off-target effects may not be a big risk," says Slack.

The way you deliver those genes brings its own risks, though, and gene therapy does have a chequered past. The most notorious failure was the 1999 trial in which an 18-year-old called Jesse Gelsinger died after reacting to the virus he was injected with. The tragedy left the field in limbo for years. And although researchers have since demonstrated that a new generation of viral vectors are safer, leading to a resurgence of clinical trials of gene therapy for otherwise intractable diseases, there are still legitimate fears.

New growth

"If you have to change cell fates by injecting viruses, that automatically puts you in a more daunting regulatory regime," says Ben Stanger at the University of Pennsylvania in Philadelphia. "What might the virus do?" That is part of the reason why none of the in situ reprogramming breakthroughs over the past few years have led to clinical trials. Melton, for instance, has chosen instead to pursue iPS cells as a treatment for type 1 diabetes.

It is also why people are keen to explore

CLASSIC EXPERIMENT

CRASH TEST DUMMIES

In the 1960s, two researchers set out to study driving skills. They stumbled upon something much more important, says **Graham Lawton**

IN 1965, a pair of psychologists from the University of Washington handed a questionnaire to 50 carefully selected motorists in the Seattle area. It focused on driving skills, but Caroline Preston and Stanley Harris weren't trying to find out how good the drivers were. They already had a pretty clear handle on that. They wanted to know how good the drivers thought they were.

The questionnaire was straightforward. It asked the drivers to rate their abilities from 0 to 9, with 0 being "very poor" and 9 being "expert". Preston and Harris probably expected the drivers to rank themselves nearer to zero than to 9. To their surprise, they found the exact opposite.

Given who these drivers were, that was very, very odd.

Back in the 1960s, traffic fatalities were a growing problem in the US. Around 36,000 people died in 1960, 39,000 in 1962 and 46,000 in 1964. Road crashes were the leading cause of death in children and young adults – and were costing a fortune.

A good deal of research into their causes was being done, mainly on vehicle design and traffic engineering. But a few researchers were becoming interested in the psychology and behaviour of drivers. That is what attracted Preston to the problem. She may have been seeking to discover some psychological trait that could be used to reduce the accident rate, but instead she inadvertently began a

revolution in our understanding of the human mind that continues to unfold more than half a century later.

The 50 drivers were not run-of-the-mill motorists. All were chosen because they had recently been involved in an accident. And not just "involved" – they were behind the wheel at the time.

Their crashes were not trivial prangs or scrapes. They were serious enough to land them in hospital. "Multiple injuries... were the rule", the psychologists noted. In 28 cases, the driver had written off their own car, six had written off somebody else's vehicle and three had actually killed somebody. Preston and Harris often had to wait for the drivers to regain consciousness before asking them any questions.

Self-belief

Once cleared to get to work, the psychologists interviewed the subjects about their driving history and their accident, ran personality and attitude tests, and made discreet enquiries about their drinking habits. Then they asked about driving ability.

Nothing really stood out, except for the drivers' self-belief. Despite being in hospital with self-inflicted injuries, all 50 judged their driving ability to be above average – "much closer to the expert than to the poor driver area of the continuum".



AP/REX/SHUTTERSTOCK

Not only that, when asked how they were driving at the time of the crash, most said they were doing just fine, thank you. A few admitted to "less than usual driving efficiency" and 21 to drinking some alcohol before their crash, but 34 said their driving was "normal", "good", "100%" or even "extra good". And they largely denied any responsibility for the accident. Only 15 admitted that they were directly to blame, even though the police reports confirmed that 34 of them were.

When Preston and Harris dug into the drivers' pasts they found a trove of guilty secrets. Six had been banned from driving at some point; 11 had failed a driving test; 29 had citations for two or more traffic violations; and 11 had been prosecuted for negligent, reckless or drunk driving.

"The omens... had been gathering for some



In 1969, a car came off the road and landed in the front room of Mr and Mrs Striffolina's New York home

chagrin or complaint". What Preston and Harris discovered would have been considered delusional.

Preston soon moved on to other questions, becoming a distinguished gerontologist. She remained at the University of Washington for the rest of her long career and retired in 1984. Harris seems to have disappeared off the scene altogether.

But even as their research was fading into obscurity, other psychologists started to discover similar anomalies. Business leaders and management students were found to hold unrealistically positive views of their own competence. College professors frequently believed they were better-than-average teachers. It was the same wherever they looked – a phenomenon that became known as the better-than-average effect.

“Despite being in hospital, all the drivers judged their ability to be above average”

Unrealistic positivity is now considered a fundamental feature of human nature. Almost everybody inflates their self-worth and downplays or ignores their faults. People often take credit for their successes while blaming failure on external forces, and expect the future to be rosier than their past. Ironically, people also claim that they are less likely than average to hold an inflated opinion of themselves.

Far from being delusional, these beliefs are seen as a hallmark of good mental health. They enable us to be happy and contented, care for others and engage in productive work. People who don't hold them are called “depressive realists”.

The better-than-average effect remains the quintessential example of this tendency. “Arguably, it is the most well-used and best-validated index of self-enhancement,” says Constantine Sedikides at the University of Southampton, UK, a leading researcher in what has become one of the most productive and surprising areas of psychology.

Preston and Harris have never received the recognition they deserve for discovering the better-than-average effect. Their jaw-dropping research is sometimes cited but remains little more than a cult classic. But we shouldn't be too concerned for them: they probably felt pretty good about themselves regardless. ■

Graham Lawton is deputy editor of *New Scientist*

time,” Preston and Harris observed drily.

Clearly these drivers were not among the elite. Many were incompetent, and had ample evidence of this available to them. And yet most still thought they were quite something. What planet were they on?

It turned out they were on exactly the same planet as everyone else.

As part of the same study, Preston and Harris recruited 50 control drivers who were similar in every way except for not having had an accident. If they anticipated finding differences, they were largely disappointed. On almost every score, the two groups were indistinguishable, including the 0-to-9 scale.

For the apparently safe drivers to have rated themselves among the elite might have been expected. But for all 100 subjects to do so – including 50 who clearly were not – defied

statistical plausibility. Not everyone can be better than average. What was going on?

The research was published in the *Journal of Applied Psychology* (vol 49, p 284), and then ignored. That was probably no surprise. Preston and Harris had set out to discover what made drivers accident-prone, but found almost nothing. In other words, they had produced the kind of null result that often gets forgotten about.

On top of that, it went against the grain of psychology at the time. For most of the 20th century, having a realistic view of the world and oneself was considered to be the bedrock of good psychological health. For example, Abraham Maslow, the acknowledged expert on mental well-being, wrote in 1950 that “healthy individuals find it possible to accept themselves and their own nature without

CULTURE

Kew's missing magic restored

Returning the Temperate House to its former glory has also given it a role as a refuge for rare plants, says **Stephanie Pain**

The Temperate House, Royal Botanic Gardens, Kew, UK, reopened 5 May

IN THE world's largest Victorian glasshouse, a heavily laden trolley is heading my way, one man pulling from the front, three more steadying its load. On board is a tree I don't recognise. It is horizontal, which doesn't help, but to me it looks a bit like a palm with a Mohican, the stout trunk topped by a mass of long, spiky leaves.

"It's a grass tree from Australia," says horticulturist Scott Taylor. "I can never spell the name," he confesses, seeing me poised to make a note of it. "Has anyone got the label?" he yells. Someone has: *Xanthorrhoea johnsonii* – Queensland. The tree trundles past on its way to a newly dug hole in "Australasia", where it will be upended and manoeuvred gently into what will be its home for the next century or more.

We are in the Temperate House at the Royal Botanic Gardens, Kew, the largest survivor of the era of grand glasshouses. It is an unseasonably hot day ahead of the official opening, with blazing sunshine and a brilliant blue sky – the perfect conditions to see how £41 million and five years of restoration have transformed the leaky, decaying building into the architectural treasure it once was, while reinventing the interior as a 21st-century refuge for some of the planet's rarest plants.

For the contractors, it is a chance to make up for time lost to the worst winter weather in decades. For Taylor, it is a day of mounting tension: his role in this mammoth project has been to oversee the removal of the overcrowded plants, some so tall they hit the roof, and then direct the installation of 10,000

"The Temperate House, begun in 1860, is big and chunky, more utilitarian than glamorous"

specimens, some returning veterans, others vigorous youngsters grown from seeds or cuttings. Among his charges are exceptional plants, some as old as the Temperate House itself. For everyone working on the project, time is running scarily short.

"The Temperate House is

unique because of its size, age and complex history," says Andrew Williams, Kew's director of estates, who has overseen the project from the start. "Now it has a new lease of life and people will be able to see how special it is."

He's right. I have been visiting Kew for decades and the Temperate House has always suffered by comparison with the Palm House. Both were designed by Decimus Burton, the master of glasshouse architecture, in very different styles. The Palm House, completed in 1848, is all elegant curves created from iron and glass, while the Temperate House, begun in 1860, is big and chunky, more utilitarian than glamorous.

As for the plants, the Palm House provided a trip to the tropics: a steamy atmosphere packed with exotica. The plants in the Temperate House didn't



The revamped glasshouse is set to rival the elegant Palm House

capture the imagination in the same way. The restoration should change all that, elevating the great glasshouse to the same iconic status as the Palm House.

The mid-19th century was the heyday of plant exploration, when specimens were flooding into Kew. This posed a problem for its first director, William Hooker. Once he had his Palm House, he began to campaign for another glasshouse for plants from cooler climates with marked seasons, but that wouldn't survive an English winter. These were arriving daily from South Africa, northern India, southern South America, Australia and New Zealand. Only when he had such a glasshouse would "the national establishment be perfect", he argued.

For more books and arts coverage, visit news scientist.com/culture



GARETH GARDNER/KEW

To persuade the government to fund it, he promised to keep down costs. Utility was key, he told Burton: use brick not stone, wood not iron for the rafters, and cheap pine window frames in a straight, sloping roof. The central part of Burton's glasshouse opened in 1863, but lack of money meant the outer wings had to wait another 40 years.

At 195 metres long, the finished glasshouse was twice the size of the Palm House and undeniably impressive. But the cheeseparing took its toll: the ironwork corroded, paint peeled, timbers rotted and windows leaked.

During the massive restoration project, 69,000 pieces of the building were removed and cleaned, repaired or replaced, including 15,000 panes of glass. The aim, says Williams, was to restore the greenhouse to its original state, remedying

problems caused by previous restoration and introducing modern technology. Ironically, while digging a trench to install more heating, the team found they were simply turning back the clock. There had originally been heating in the same place, but it was removed in the 1970s.

"Once plants were chosen to showcase botanical wealth, now they highlight our dependence on them"

In Victorian times, too, Kew's gardeners could open windows high in the roof with hand-operated cranks. Many windows were sealed up in the 1970s. Now they open again, but with a higher-tech control system. Light pours in through the gleaming glass and rainwater is harvested to feed the plants.

The first change returning

visitors will spot is the gleaming new paintwork, no longer hospital-bright white, but soft, creamy white. There is no record of the original, so why this colour? "It doesn't show the dust," says Williams. More importantly, the paint lasts: it is the stuff used on North Sea oil rigs, has a 25-year lifespan and can be painted over. "There will be no need for a major refurbishment for another 100 years or more," he says with obvious relief.

The building certainly looks fit for another century, but what of the plants? As well as more light and better ventilation, the beds have all been emptied and refilled. "We have replaced all the soil – 1300 cubic metres – with a special mix developed here in the 2000s," says Taylor. Staff at Kew now know things their predecessors didn't, he adds, "more about the conditions in which these plants

thrive and how tall some will grow, so we know the best places to plant them".

You can still stride the world in 195 metres, moving from the warm and dry climate of the Mediterranean to the cool, moist interior of a temperate rainforest, but where once the plants were chosen to showcase the world's botanical wealth, now they highlight our dependence on plants – and how so many species are at risk of extinction.

Individual plants tell important stories. *Dombeya mauritiana*, a tree from Mauritius, was assumed extinct, until Kew horticulturist Carlos Magdalena found one in the island's highlands and took cuttings. Kew is now the only place in the world that has this tree in cultivation.

Then there is the red angel's trumpet (*Brugmansia sanguinea*) from South America, already settled in and blooming. "This species is relatively common in cultivation, so people think it's safe," says Taylor. "But it's extinct in the wild because its natural habitat has disappeared." *Erica verticillata* highlights Kew's role in saving plants. This South African heather was thought extinct until 1984 when a few plants were rediscovered and Kew set about resurrecting it.

Alongside such critically endangered species are important historic specimens, such as the South African cycad *Encephalartos woodii*, which has been at Kew since 1899. This venerable specimen was grown from an offshoot of the only one ever found in the wild, which died in 1916. It's not just old, it's huge at over 3 metres tall, with a massive canopy. Getting it safely out and in again was a Herculean task.

Given the enormous scale of the project, what was the biggest challenge? "The doors," Taylor replies. "They were designed for people." ■

Stephanie Pain is a consultant for *New Scientist*

Working the crowds

As real animals disappear, **Simon Ings** explores art's response

Animals & Us, Turner Contemporary, Margate, UK, from 25 May to 30 September

THE kids will love it, of course. Still, there is something very slightly creepy about Turner Contemporary's first crowdfunding venture. Assuming the gallery can get the cash together – and we still have until 15 May to put our money where our imagination is – it will be letting a polar bear loose to wander the seaside town of Margate, UK.

Although Paula's 20-day visit is scheduled for the height of summer, she (and we) will be perfectly safe, because Paula isn't a real polar bear. She is in fact a life-size puppet, on loan from Greenpeace.

The organisation has been transporting her everywhere from Washington DC to Finland and

Laura Ford's hallucinatory work, *A King's Appetite*

New Zealand to encourage public conversations about climate change. What better symbol could there be? Having lost much of their sea-ice habitat to climate change, in May 2008 polar bears were listed as a threatened species in the US under the Endangered Species Act.

Paula is a witty and charming provocation, but her appearance

"Us moderns must travel a great imaginative distance to connect with other species"

as part of Turner Contemporary's summer show *Animals & Us* raises darker questions. Will Paula's artfully choreographed presence among Margate's beach crowds remind us of the extinction event even now gathering about her species? Or will she simply serve to distract?

After all, teddy bears are one thing, but what does it mean to puppeteer a friendly bear

that's physically virtually indistinguishable from its fierce, predatory original? And as species after species disappears, will we come to accept puppets in their stead, in some ghastly real-world retread of the original *Blade Runner*?

Animals & Us promises to pose difficult questions like these in a range of playful and charming ways as it explores the relationship between animals, artists and other varieties of human. Historical objects, from Egyptian artefacts to a medieval Christian bestiary, provide context, but it is the contemporary and 20th-century art that takes centre stage.

In prehistoric times, humans distinguished themselves from the animals around them by depicting them as prey, as spirits, even as gods. Contemporary works by Laura Ford and Raqib Shaw reflect this patrimony, playing with anthropomorphism, myth, fable and human-animal hybrids.

But the bald fact is, us moderns must travel a great imaginative distance to connect with other species. There is a chilling, elegiac quality to Mishka Henner's aerial photographs of Texan cattle feedlots, and also to Candida Höfer's photographic series *Zoologischer Garten* that shows zoo animals in their artificial environments.

With the death of Sudan, the last male northern white rhinoceros, and with 38 per cent of all known species on the verge of extinction, *Animals & Us* is bound to offer a timely and not altogether comfortable re-examination of how we coexist and connect with other living species – or rather, how we fail to. ■



LAURA FORD, A KING'S APPETITE PHOTO INGEL GREEN

COMING UP

Our picks of what's on show

11 May to 13 January 2019

At Cooper Hewitt In New York (the only dedicated design museum in the US), *Saturated: The Allure and Science of Color* explores the elusive, complex phenomenon of colour perception.

From 12 May

The Future Starts Here (at London's V&A, that is) with 100 objects that seem straight out of science fiction, though they are all real enough, produced by research labs, universities, designers' studios, governments and corporations.

17 May to 16 September

"All the better to eat you with, my dear..." Vampires, tooth fairies, barber-surgeons and dentists make an appearance at *Teeth*, the Wellcome Collection's summer exhibition in London.

24 May to 11 November

Charles Dickens: *Man of Science* at London's Charles Dickens Museum promises to reveal the author's friendships and links with Charles Darwin, Ada Lovelace, Florence Nightingale and more.

22 June to 30 September

How do living things survive in outer space, on the bottom of the ocean or inside volcanoes? And how might humans emulate them? *Life at the Edges* poses some extreme questions at Dublin's Science Gallery.

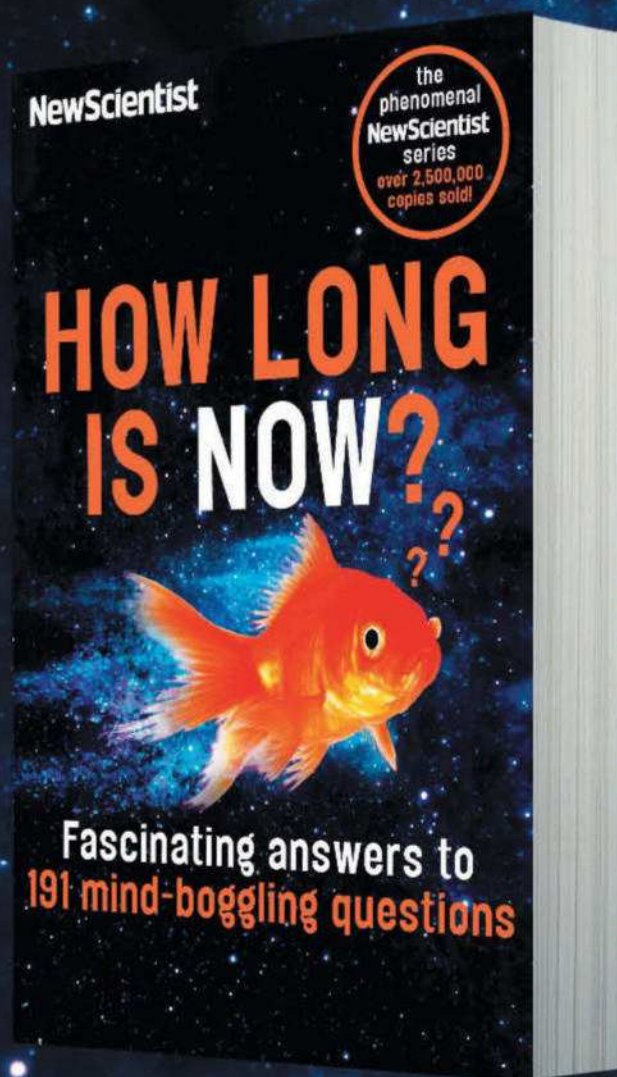
2 to 8 July

Their full programme has yet to be released, but expect a free, week-long festival celebrating the cutting edge of UK science at the Royal Society's Summer Science Exhibition in London.

6 & 7 July

FutureFest in London promises alternative visions and bold solutions to this era's big challenges. Four years in, and they haven't solved them yet? Must try harder!

WHY ARE DOGS' NOSES WET?



From gravitational waves to goldfish memories, explore some of the world's most **mind-bending** phenomena in the latest book from NEW SCIENTIST.

NewScientist



2018 SACNAS

The National Diversity in STEM Conference
San Antonio, Texas | October 11 - 13



Whatever your goals are in STEM, we want you to know they are possible. The SACNAS conference consistently provides a unique intersection of cutting-edge science, *familia*, motivation, and opportunity for students and scientists at all levels.



SACNAS is an inclusive organization dedicated to fostering the success of Chicano/Hispanic and Native American scientists, from college students to professionals, in attaining advanced degrees, careers, and positions of leadership in STEM.



Keynote
Speakers



Multidisciplinary
Sessions



Exhibit Hall



Research
Presentations



Cultural Events

Learn more and register at 2018sacnas.org

#SACNAS2018



POSTDOCTORAL RESEARCH FELLOW/ASSOCIATE

A position is available to study the regulation and function of guanylyl cyclase/natriuretic peptide receptor in *Npr1* gene-targeted mice *in vivo*. The project involves investigation of renal and vascular inflammation, fibrosis, and hypertrophy by characterizing the functional genomics in *Npr1* gene-targeted mice. Experience in the *in vivo* studies in mice and in any one of the areas of expertise, including hypertension, diabetes, and/or vascular dysfunction is preferred. Strong background in molecular biology and/or confocal microscopy is desirable. The successful applicant will be expected to have motivation and vision to develop independent research program. Opportunities are available for academic career advancement.

Send resume and three references to kpandey@tulane.edu

**Tulane University Health Sciences Center,
1430 Tulane Avenue, New Orleans, LA 70112.**

An Equal Opportunity/Affirmative Employer.



WORK WITH A TEAM WITH THE GUTS TO LEAP AHEAD.

Redefine Regulatory Affairs

At Sanofi's Global Regulatory Affairs, we're ushering in a bold new era of regulatory affairs - one that is rooted in collaboration, driven by creativity, and inspired by tomorrow. As strategic partners with our diverse Sanofi businesses, we build regulatory strategies and timely execute our targets while establishing constructive relationships with health authorities and key stakeholders worldwide. We're harnessing cloud-based systems and advanced technology to amplify the impact of our ambitious teams. We are talented change agents who think deeply and act boldly. We are leaders who aspire to revolutionize regulatory affairs - to explore, to innovate, and to push boundaries. This reinvented global regulatory team operates at the very heart of Sanofi - underpinning all we do, shaping policy, and fueling our entire company's direction. A top-ranking player in the life sciences industry, we operate worldwide, striving to transform scientific innovation into dynamic healthcare solutions.

Are you looking for an opportunity to contribute to an agile, global regulatory team? To impact a broad and diverse portfolio of hundreds of products? To drive change at a company that is 100% full-scale all-in committed to transforming its technology base and reimagining the role of regulatory affairs? Apply to join our regulatory team and discover all that you can empower.

Sanofi, Empowering Life.

Apply now at

<https://jobs.newscientist.com/job/1401646703>



STAKE YOUR CLAIM

WWW.UNCC.EDU



Research Assistant Professor, Data Science

DEPARTMENT OF BIOINFORMATICS AND GENOMICS
COLLEGE OF COMPUTING AND INFORMATICS

The Department of Bioinformatics and Genomics at UNC-Charlotte invites applications for a Research Assistant Professor, data sciences. UNC-Charlotte's Department of Bioinformatics and Genomics program encompasses two major sites. In addition to a brand new \$35M state-of-the-art bioinformatics building on the University's main campus, the Center has the leadership role in bioinformatics for the nearby North Carolina Research Campus (NCRC) at Kannapolis (<http://www.ncresearchcampus.net>). The NCRC is a \$1.5B, 350-acre biotechnology research park that is home to the research programs of a large number of private biotechnology companies, as well as those of seven NC research universities and several health care organizations. This position, based at the NCRC, will use data science approaches and bioinformatics to develop new methods and algorithms for data integration and representation to assist in the analysis of large-scale, high-throughput, multi-omic datasets. The position will also lead creation and implementation of secure data management solutions for research prototypes and technology solutions being developed. They will work in collaboration with other faculty and industry partners at the NCRC on extramurally funded research.

RESPONSIBILITIES:

Qualified candidates will:

- Have extensive experience with developing databases (relational and graph) and analytical software through work experience and/or publication record
- Be fluent in multiple computing languages
- Be able to effectively utilize large-scale, multicore, high-memory compute clusters to solve large-scale life-science problems
- Have comfort working both independently and as a part of a team
- Enjoy working with students at the undergraduate and graduate level
- Have excellent communication skills

REQUIREMENTS:

This is a non-tenure track 12-month faculty position at the rank of Research Assistant Professor. The successful candidate must hold a Ph.D. in Bioinformatics, Computer Science, or related field. The candidate must also be a U.S. citizen or Green Card holder to comply with U.S. export policies.

COMPENSATION:

We offer a competitive salary, state of the art facilities and a chance to have a significant impact on the emerging discipline of personalized nutrition and human health.

HOW TO APPLY:

Applications must be made electronically at <https://jobs.uncc.edu>, position # 001065 and should include vitae, at least 3 references, and a letter of interest. Informal inquiries can be made to the Search Committee Chair, Cory Brouwer (Cory.Brouwer@uncc.edu).

For additional information, please visit our website at
www.bioinformatics.uncc.edu

*The University of North Carolina at Charlotte is an
EOE/AA employer and an ADVANCE Institution*

Editors:

Physical Sciences, Biomedical Sciences, Humanities (work-from-home)

Cactus Communications is a leading provider of scientific communication services to more than 198,000 clients across 116 countries.

We engage a team of highly skilled editors who are experts in various academic fields. CACTUS is honoured to be ranked 12th (after a screening of more than 47,000 companies) on the 2017 list of Top 100 Companies for Remote/Freelance Jobs (<http://www.forbes.com/sites/laurashin/2017/01/31/work-from-home-in-2017-the-top-100-companies-offering-remote-jobs/#d3da81240163>).

We are currently looking to hire editors on a contractual work-from-home basis in the Biomedical Sciences, Physical Sciences and Engineering, and Humanities.

Editors typically devote six to eight hours a day.

WHAT YOU WILL DO

- Edit manuscripts such that the final text is in standard scientific English and is free of unclear or unidiomatic sentences
- Adhere to job-specific guidelines and format manuscripts according to the target journal when required
- Understand client and industry requirements and adapt your working approach accordingly
- Meet deadlines (which are driven by client deadlines)

Desired skills and experience

What you need

- A Post Doc/PhD/Masters/Bachelor's degree or expertise in one or more specialized subject areas in Medicine, Life Sciences, or Physical Sciences (detailed subject-area list below) OR
- A Master's degree in Economics and Statistics/Business and Finance/Psychology and Psycho-social Healthcare
- Excellent editing skills and attention to detail (prior editing experience would be great)

Please send us your resume and mention 'New Scientist' and 'assured volume of work'.

WHY THIS IS A GREAT OPPORTUNITY

- You can telecommute from anywhere. You will also have the flexibility to keep your own work hours as long as you meet the deadlines.
- Assured volume of work. You will receive a considerable amount of work, and accordingly, you can be assured of a predictable income from CACTUS each month. You can choose to do from 60,000 words to more than 120,000 words.
- You will develop an understanding of the finer points of editing.
- You will have access to articles on the latest industry trends and publication and writing tips on our learning and discussion platform.
- You will gain an inside view into research carried out worldwide.
- You have the potential to earn above USD 3000 per month.

Apply Now via Email:

freelancepositions@cactusglobal.com

1

STEADY INFLOW OF ASSIGNMENTS

With over 200,000 clients we can provide numerous assignments to freelancers who consistently deliver quality work.

2

SYSTEMS AND PROCESSES

With an efficient workflow-management system and dedicated in-house personnel, we ensure that you are able to deliver your work in a hassle-free manner.

3

FLEXIBILITY

Creativity strikes at all hours, be it late afternoon or early morning. A freelance position will give you the opportunity to work whenever you can, wherever you can.



Together, we make the difference.

At Bristol-Myers Squibb, the power of science is enhanced by the passion of our people to discover, develop and deliver medicines that have the potential to transform the lives of patients.

We hire the best people and enable them to pursue meaningful work, develop their unique potential and build a career path that matters.

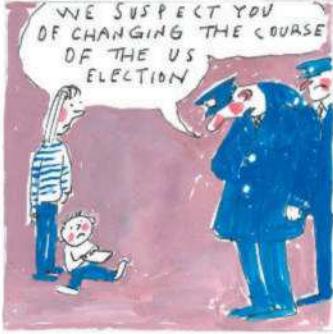
Meet our recruitment team at the 2018 ASCO Annual Meeting to discuss Immuno-Oncology career opportunities.

Join us. [bms.com/careers](https://www.bms.com/careers)



EDITOR'S PICK

Internet identification is no kind of panacea



From Andrew Main,
London, UK

Sally Adee says that proposed systems to tie all internet activity to real-world user identities "would solve the problem of hauling someone known only as 'Haxxor420' into the dock" (31 March, p 22). But any such system would have holes, ones which those

intent on criminal activity would not hesitate to exploit.

A very obvious hole is that devices belonging to innocent users are routinely made to enact the will of nefarious remote parties, for example by tricking the user into installing malicious software.

Any activity by a compromised device will naturally be tied to its owner, with no glimpse of the identity of the actual criminal. Such laundering of identities has been impeding investigations for as long as there have been computer networks.

Mandatory user identification would hardly be noticed by villains. At most, its effect would be to end anonymity for law-abiding users, to the detriment of human rights, and to provide online companies with yet more personal data to abuse.

More ideas about the origins of patriarchy

From Daniel Hackett, London, UK
Your special report on patriarchy goes some good way towards raising the profile of science in what appears to have been the province of social science (21 April, p 34). How far the magazine has come! Gendering pressure is administered in patriarchal societies through households even before infants are socialised. All, including mothers, need to recognise their gender biases: these are systemic in our societies, despite all we have legally in place.

From Caryl Roberts,
Tattenhall, Cheshire, UK
Your excellent report gives many explanations for the profusion of patriarchal societies and asks: how did we get here? Part of that was an enormous change that

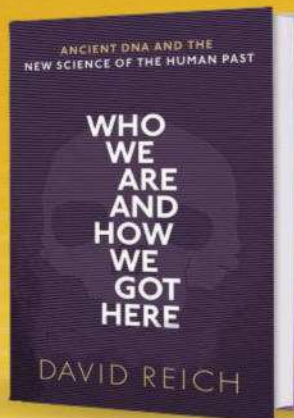
occurred within Western society in the early 4th century.

Up until then, in the early days of Christianity, women and men were equally involved: women as well as men could be bishops, say theologians Helen Bond and Joan Taylor. Then Constantine became Emperor of Rome and thought Christianity might be the means to control and unite the empire. He needed a masculine, military-style religion, so the women were airbrushed from church history.

From Gerald Dorey,
Oxford, UK

My wife, Jennifer Darnley, has suggested to me that one major reason for the development of patriarchal communities was the realisation that sex is required for a pregnancy, and that children were not in fact created spontaneously by the magical powers and choices of women

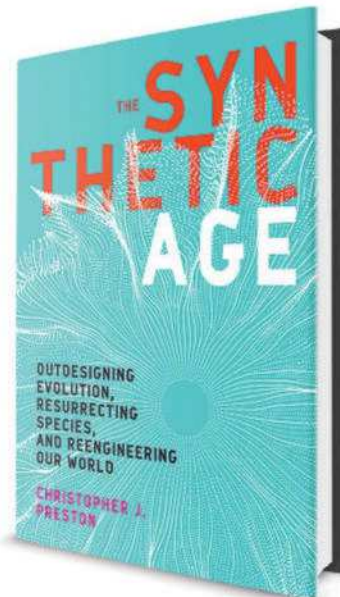
THE NEW SCIENCE OF ANCIENT DNA REVOLUTIONISES WHAT WE KNOW ABOUT OUR PAST



DAVID REICH TELLS THE STORY FROM THE FRONTLINE OF RESEARCH

£20 www.oup.com/uk

OXFORD
UNIVERSITY PRESS



What does it mean when humans shift from being caretakers of the Earth to being shapers of it?

Buy at
mitpress.mit.edu/syntheticage

“Don't hold your breath waiting for such a ban to happen in the US”

Melissa Liechty responds to the news of a European Union ban on neonicotinoid pesticides outdoors, to save bees (5 May, p 7)

alone. This switched the power balance towards men by creating an awareness of familial relationships and dependencies. In turn, this reinforced the benefits of settled agriculture and increased awareness of animal and crop-breeding techniques.

From Bill Johns, Crays Pond, Oxfordshire, UK
Anil Ananthaswamy and Kate Douglas relate the origins of patriarchy to patrilocality: women moving to their spouse's place. Indeed, research into the history of one English county shows that the elder sons of landowners remained with the land. But the men of working-class families travelled to find work and women remained in their village of birth.

And it was once considered effeminate for a man to read and write, so as recently as after the

second world war, it was good etiquette for women to conduct all correspondence on behalf of the family. They were also expected to take responsibility for its finances. My mother, as did her mother and generations before, kept money in a neatly divided box with all transactions recorded in a notebook. My father handed over all his cash, to which my mother added anything she might have earned.

Beyond a certain point wealth is superfluous

From Peter Seligman, Melbourne, Australia
Like Mark Sheskin, I do not maintain that current extreme levels of inequality are reasonable (31 March, p 28). But I observe that beyond a certain level of wealth, assets become barely recognisable as personal wealth (28 July 2012,

p 40). People can have lavish lifestyles and extend these to their family, but there is a limit to the personal jets, mansions and jewels one can command.

Beyond that, wealth is just data – the actual ownership is immaterial. Factories, mines and oil wells produce the goods and make profits, but their owners are so saturated with wealth that it makes no difference to their life. They may provide employment and produce value in the same way; but they could be state-owned and no one's life would be different.

We're not so sure statins are a good idea for us

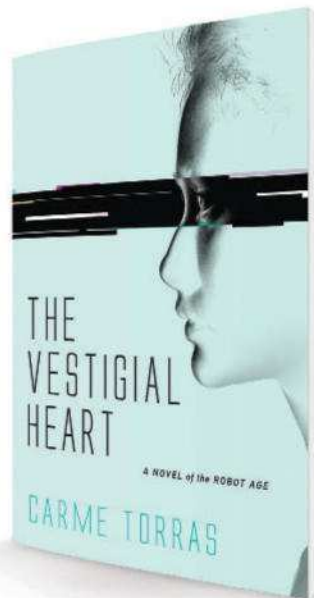
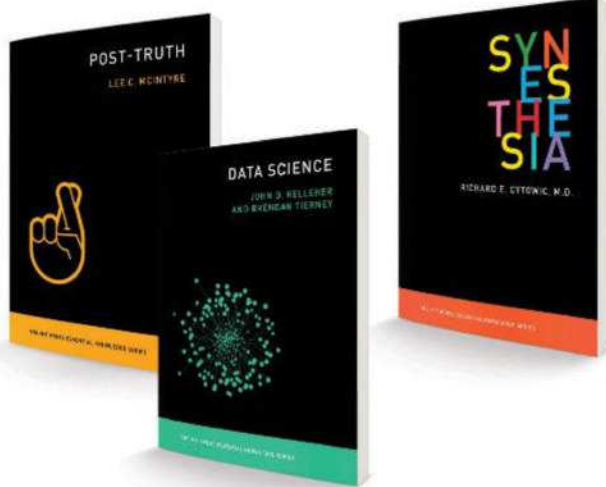
From David Holdsworth, Settle, North Yorkshire, UK
Anthony Warner extols the virtues of statins and argues that they should routinely be taken

to reduce cardiovascular disease, which kills one in three globally (21 April, p 24). But the longer we live, the more likely we are to get cancer. Anyone who loves science and rationality will thus deduce that taking statins increases the risk of dying of cancer.

A neighbour who is a family doctor told me of a survey asking how colleagues would prefer to die. The favoured option was a heart attack halfway up a mountain. Choose how you would like to die and live your life accordingly, but where euthanasia is illegal, taking statins seems not entirely rational.

From Sally Stokes, Silver Spring, Maryland, US
I realise that Warner's article is labelled “Comment” and does not purport to enlighten us on recent research, and that as a blogger and author he is entitled to his

The MIT Press Essential Knowledge series offers concise, accessible overviews of compelling topics every 21st century citizen should know about.



A thirteen-year-old girl wakes up in a future where human emotions are extinct and people rely on personal-assistant robots to navigate daily life.

A novel of the robot age written by a leading researcher in robotics and artificial intelligence.

Available at mitpress.mit.edu/essential

Buy Now at mitpress.mit.edu/vestigialheart

opinion about fad diets and antivaxxers. But his sweeping remarks about those who may have an "anti-statin point of view" are infuriating, not so much because I disagree with him but because he offers no solid evidence.

I have refused statins because of the side effects I experienced, even on a very low dose. I have also taken part in university-led studies that confirm that such side effects are real and interfere with quality of life.

The editor writes:

■ We have covered statins and the controversy over their side effects in depth. See Michael Brooks's report on "cholesterol wars" (11 February 2017, p 28).

Humanity is at root a migrant species

From Henry Collins, Sydney, Australia

Andy Coghlan reports research and discussion about when our ancestors left Africa and arrived in various places around the world (14 April, p 10). An important

aspect of being human is that we are a migratory species.

Migration has sustained our existence for most of human history and has carried ideas and technical innovation to all parts of the world. More recently, the rise of nationalism and the institution of hard borders have tried to control and curtail movement, primarily for economic purposes.

The ever-increasing number of migrants seeking a better life should be regarded not as a problem, but as an opportunity for countries to refresh their populations and improve their economies.

So where does the energy come from?

From Nick Thomas, Revelstoke, British Columbia, Canada

Michael Marshall reports proposals for converting carbon dioxide into useful products (17 March, p 34). I am sceptical.

Let's start with converting CO₂ to synthetic fuel. In reversing the combustion process you need to put in at least as much energy as you once got out. In practice,

given inefficiencies, you need far more. You could use renewable energy resources, but there are almost certainly better ways of using them.

And as for making carbonates by reacting CO₂ with calcium oxide: this is made by thermal decomposition of carbonates – releasing CO₂. Doing this in the cement industry produces about 10 per cent of global human CO₂ emissions.

The editor writes:

■ The idea is indeed to use renewable energy, especially to make hard-to-substitute liquid fuels for certain uses.

Trauma and rewriting memories of childbirth

From Jan Horton, West

Launceston, Tasmania, Australia

Jessica Hamzelou writes about memories being encoded into recognisable patterns in the brain, and how this might have therapeutic uses (14 April, p 6). I was once on a trolley outside the operating theatre awaiting an elective caesarean, when another

woman emerged having just had hers – while awake to see it. Naturally I asked how it went, and she gave me a truly terrifying and graphic description. A nurse intervened, and I headed in for my operation.

The next day I was (very gingerly) able to visit her and asked for more detail. She told me a totally different story: it was the most wonderful experience of her life, full of joy and love, and that she didn't notice being cut at all.

I asked nurses and midwives about this. All agreed that the experience of being awake during a caesarean can be searing, but the memory changes completely within 24 hours. So, however these memories are overwritten, could the process be used after other traumatic experiences?

A police caution is not 'being let off'

From John Rowlands,

Rhosybol, Anglesey, UK

You mention a man being "let off with a caution" (Feedback, 14 April). A police caution requires an admission of guilt, and becomes part of a person's criminal record. Cautions must be disclosed and can be taken into account in sentencing for other offences. Granted, the let-off misconception is widespread. I have seen barristers flicking through reference books to check the status of cautions.

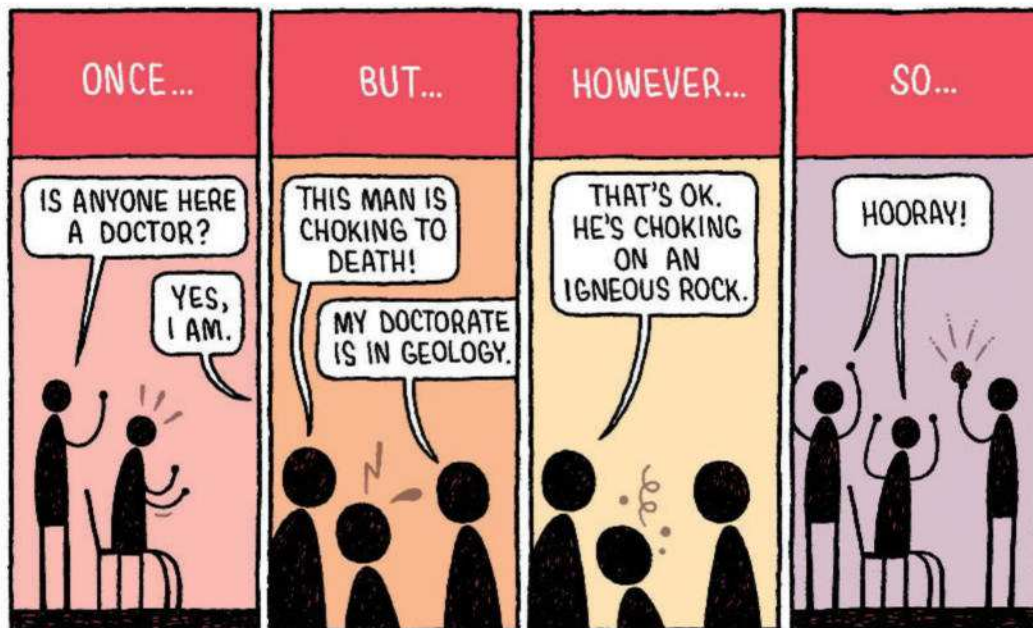
For the record

■ Coming of age in New York: Margaret Mead in fact studied at Columbia University (28 April, p 42).

Letters should be sent to: Letters to the Editor, New Scientist, 25 Bedford Street, London, WC2E 9ES Email: letters@newscientist.com

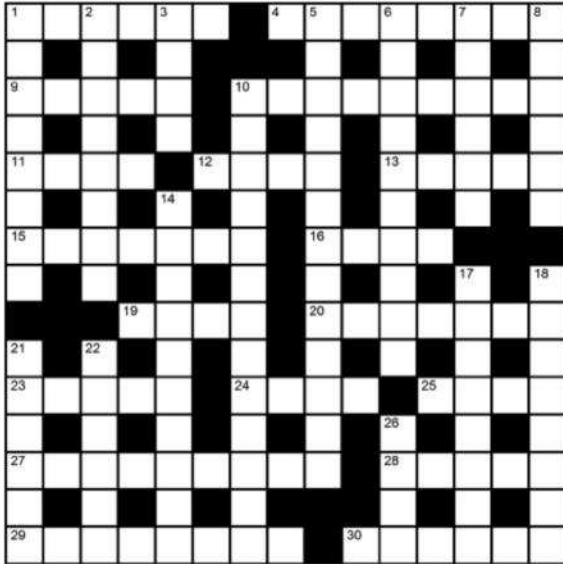
Include your full postal address and telephone number, and a reference (issue, page number, title) to articles. We reserve the right to edit letters. New Scientist Ltd reserves the right to use any submissions sent to the letters column of *New Scientist* magazine, in any other format.

TOM GAULD



CROSSWORD

Compiled by Richard Smyth



Crossword No18

ACROSS

- 1 ___ fly, parasite of the genus *Hypoderma* (6)
 4 Extending from one corner to the opposite corner (8)
 9 Radio detection and ranging (5)
 10 Term for a molecule of Buckminsterfullerene (9)
 11 Otto ___ (1879–1968), Nobel Prize-winning German chemist (4)
 12 Prefix denoting unusual size or length; Austin car of the 1970s (4)
 13 Compound containing at least one atom of O and one other element (5)
 15 Moment at which an aircraft or spacecraft achieves flight (4-3)
 16 Fifth letter of the ICAO phonetic alphabet (4)
 19 Time period equal to 3,600,000,000,000 nanoseconds (4)
 20 Turn to stone; (of organic material) fossilise (7)
 23 Laboratory work surface (5)
 24 Salt of a fatty acid, with many domestic applications (4)
 25 The LGM-30 Minuteman or RS-28 Sarmat, for example (4)
 27 Computer program for recording skeletal remains (9)
 28 Precise; rigorous; accurate (5)
 29 Part of the University of California, home to the cyclotron (8)
 30 High-definition optical disc format (3-3)

DOWN

- 1 In physics, a theoretical structure connecting separate points in space-time (8)
 2 Phenomenon observed when light is increased in wavelength (8)
 3 Constellation in which Vega is the brightest star (4)
 5 One of the six classical machines; slope or ramp (8,5)
 6 Plant whose growth is inhibited by salinity (10)
 7 Vitamin B₃ (6)
 8 Flowering plants of the genus *Lilium* (6)
 10 Measure of wind speed devised in 1805 (8,5)
 14 Using only a single colour (10)
 17 Sir Clive ___ (b. 1940), UK consumer electronics pioneer (8)
 18 Quality in geometry that may be rotational, reflectional or helical (8)
 21 Take in (energy, moisture or nutrients, perhaps) (6)
 22 Life-stage of an insect (6)
 26 ___ Labs, US research company now owned by Nokia (4)

Answers to Crossword No17

ACROSS: 1 SOLARIS, 5 TV MASTS, 9 NAGRA, 10 PETRI DISH, 11 PYRETHRIN, 12 HYPER, 13 TITOV, 15 OESTROGEN, 18 TOMOGRAPH, 19 TALEB, 21 YEARS, 23 CORPUSCLE, 25 SCHEMATIC, 26 BIOTA, 27 NODULES, 28 NON-ZERO. **DOWN:** 1 SUNSPOT, 2 LOGARITHM, 3 REACT, 4 SUPERNOVA, 5 TITAN, 6 MEINHARDT, 7 SCIPP, 8 SAHARAN, 14 VIGESIMAL, 16 SPHERICON, 17 GALACTOSE, 18 TRYPSIN, 20 BEEFALO, 22 APHID, 23 CITES, 24 URBAN.

GALAXY ON GLASS

Spectacular wall art from astro photographer Chris Baker



Available as frameless acrylic or framed backlit up to 1.2 metres wide. All limited editions

Special Offer for New Scientist Readers, free delivery worldwide! Simply type the word scientist in the promo box on check-out. *Limited period only.*



redmolotov.com 0121 559 2685. Ethically sourced. Up to 5XL. Free UK postage on orders over £50

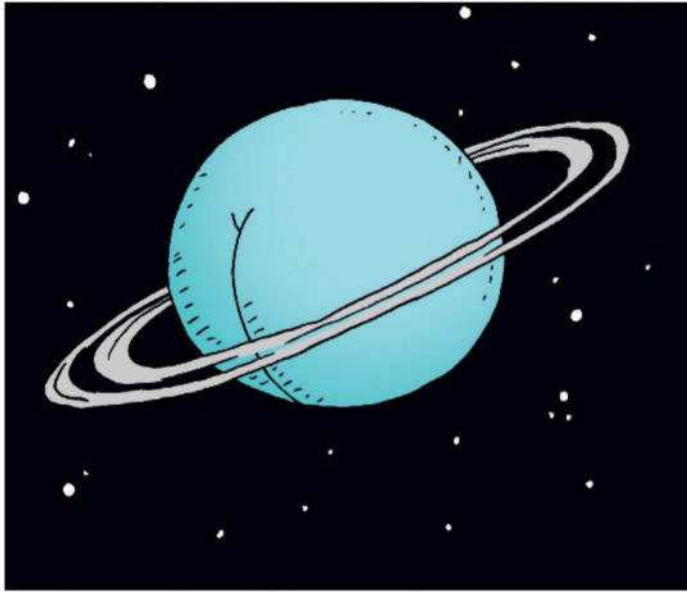
A-Z of Scientists

Just £14.99 each

I LIKE TO PARTY AND BY PARTY I MEAN READ BOOKS

"Facts do not cease to exist because they are ignored"
Aldous Huxley

...to save time, assume I know everything...



ASTRONOMERS have confirmed that Uranus smells like farts. The sixth planet's odour - or, more precisely, the chemical composition of its atmosphere - has long been the subject of debate among space scientists.

Using the 8-metre Gemini North telescope on Hawaii's Mauna Kea peak, Patrick Irwin at the University of Oxford and his colleagues analysed infrared light reflected by the planet. They found that the upper atmosphere's swirling clouds were rich in hydrogen sulphide, one of the chemicals that gives rotten eggs - and farts - their characteristic pong.

Although it makes up only a small fraction of the gas you expel from your behind, hydrogen sulphide is a major contributor to its smell. Feedback's esteemed colleagues reported previously that eating potatoes, bananas, artichokes and asparagus might help to reduce hydrogen sulphide production in the gut, leading to less pungent emissions (22 October 2016).

Visitors to Uranus will have more to worry about than the stink, though:

"Suffocation and exposure in the -200°C atmosphere made of mostly hydrogen, helium and methane would take its toll long before the smell," says Irwin.

TRADING at a European stock market was briefly interrupted after computers at a data centre were paralysed by a loud noise.

The DigiPlex centre in Väsby, Sweden, hosts the Nasdaq Nordic trading exchange, serving eight nations in northern Europe. On the morning of 18 April, a fire alarm accidentally triggered its fire suppression system.

As with many data centres, DigiPlex relies on a high-pressure blast of inert gas to drive out oxygen from at-risk rooms, suffocating the blaze and sparing the computers any water damage.

Unfortunately, the squeal of the venting gas was so loud that it destroyed almost a third of the Nasdaq Nordic servers, knocking the exchange offline.

To make matters worse, reports the Finnish *Helsingin Sanomat*,

there weren't enough servers in the country to replace them, so new ones had to be flown in from abroad. Talk about a foreign exchange.

STRAIGHT men underestimate their partner's sexual advances, while straight women overestimate them - but it doesn't seem to be a problem.

Kiersten Dobson at the University of Ontario, Canada, and her colleagues surveyed straight couples, all of whom had been together at least three months, in two groups. They were questioned on how often they or their partner initiated sex, what those cues entailed, and levels of satisfaction within the relationship.

In the first group, men accurately judged the frequency of their partner's advances, while women overestimated them. In the second group, women were more accurate, but men underestimated their partner's advances.

The researchers note that sexual satisfaction was higher for those who perceived frequent advances, even when actual advances were low. It seems in matters of the bedroom, it's the thought that counts.

FAKE views! That photo of an anteater sniffing for prey at a termite mound full of firefly larvae was apparently just too good to be true.

Marcio Cabral's prizewinning entry to the 2017 Wildlife Photographer of the Year competition was belatedly disqualified after judges were shown evidence that the anteater was a taxidermy specimen. The competition rules state that "entries must not deceive the viewer or attempt to misrepresent the reality of nature".

Anonymous sources pointed out that a stuffed anteater very similar to the one in the photo is on display at an entrance to Emas National Park, Brazil, where the photo was taken.

Five scientists who investigated independently concluded that the resemblance was unlikely to

be a coincidence. Cabral denies having faked the scene.

AS A child in the 1960s, Moira Redmond says she was an avid reader of newspapers. But she noticed something eerie: whenever there was a report of someone being murdered or dying in an accident, it would often be accompanied by a photo of the victim. But the shot would be fuzzy and unclear compared with pictures of politicians or sports stars.

"It didn't occur to me that the papers were having to make do with whatever rough snapshot the surviving relatives could come up with," writes Moira.

"So I came to the conclusion that after a person dies, existing photos of them start degenerating too, looking



less and less clear. This fuzziness, obviously, was actually caused by the subject's death."

Moira thinks this might be a good plot for a horror story. Feedback will be keeping a photo of ourselves to hand in future, just to make sure we're still alive.

A NEW, environmentally friendly power plant has been unveiled in Chernobyl, to mark the anniversary of the world's worst nuclear accident. The BBC notes that "a new solar plant has been built there, in the shadow of the reactor which exploded in 1986".

Peter Jones writes: "I would have thought it would have been better on the south side."

You can send stories to Feedback by email at feedback@newscientist.com. Please include your home address. This week's and past Feedbacks can be seen on our website.

Brian Darvell catches a whiff of nominative determinism in *The Telegraph*: "Arthur Bouquet, an American horticulturist, claimed that just 50 per cent of today's roses have a noticeable scent"

The art of timing

Why are the dates when we switch between summer and winter times (for example, swapping between Greenwich Mean Time and British Summer Time in the UK) placed so asymmetrically around the solstices? (Continued)

■ Hillary Shaw's response to this question says that, by using Greenwich Mean Time in winter, the UK is "minimising accidents caused by travelling in the dark" (16 December 2017). The evidence points the opposite way.

Between 1968 and 1971, there was a trial in which British Summer Time was maintained all year. Analysis of accident data showed an 11 per cent reduction in casualties during the affected hours in England and Wales, and a 17 per cent fall in Scotland.

The Royal Society for the Prevention of Accidents estimates that since the trial "more than 5,000 people have died and more than 30,000 received serious injuries in the UK on the roads, for no reasons other than entrenched prejudice and lack of political will".
Ian Cairns
Seaford, East Sussex, UK

■ British Summer Time was introduced in 1916 and had nothing to do with travel to work. It allowed agricultural workers to labour into the evening on the estate farm or their allotments to aid the first-world-war effort.
Eileen Holttum
Edinburgh, UK

Spiralling backwards

If there's no friction in space, why do the arms of spiral galaxies sweep backwards?

■ The short answer is: differential rotation. Stars in a spiral galaxy, which includes a flat disc with a central bulge, orbit about its centre. Those further from the centre have longer orbits and therefore longer orbital periods, even though their velocities are similar to or greater than those of stars closer in. This results in more distant stars lagging behind.

But this raises further questions. Why do most galaxies have spiral arms in the first place? And why, given the much greater age of galaxies (often at least 10 billion years) compared with the typical orbital periods of their stars (a few hundred million years), have the spiral arms not wound up completely and disappeared? The answers to these questions are only partly understood.

It seems certain that spiral arms aren't fixed structures, but rather result from compression waves that travel through the galaxy's disc.

Stars and gas clouds pile up within a wave to create a spiral arm – and the compression of gas clouds triggers the formation of more stars – but they can move in and out of the arm as they orbit. The arm is hence a pattern representing the pressure wave, whose rotation is independent of that of the stars.

An analysis of Hubble Space Telescope images suggests that galaxies initially had an irregular structure that could take a few billion years to settle down. Galaxies destined to be spirals gradually developed a disc appearance with a central bulge, but then required some kind of gravitational force to drive the pressure waves needed for spiral arm formation. Possibilities are the presence of companion galaxies or a bar-shaped concentration of mass extending from the central bulge. About two-thirds of spiral galaxies, including our Milky Way, contain such bars.

Once a pressure wave has formed, the gravitational force of all the stars and gas in the disc helps limit the spiral arm's tendency to wind up. A wave may also be able to reflect off the central bulge and set up a more stable standing wave. But it remains unclear how long spiral arms can last. In some galaxies, they may survive billions of years, while other galaxies might go through cycles of displaying spiral arms that wind up, but later produce new arms triggered by new pressure waves.

Richard Swifte
Darmstadt, Germany

■ As a matter of fact, there is friction of sorts in space, both from electric and magnetic fields, and from traces of matter. It might be minute by our usual standards, but on galactic scales it is quite important.

Such friction, however, has

little to do with the shape of galactic arms. Any cloud of matter giving rise to a galaxy almost inevitably has a net rotation, and includes a lot of objects travelling in various directions.

Any object on an outward trajectory in its orbit within an arm tends to lag, and the further out it goes, the slower its angular velocity, lagging still further. Conversely, objects falling inwards tend to gain on objects further out.

"There is friction of sorts in space, from electric and magnetic fields and from traces of matter"

They orbit faster when further in because they are under more intense gravitational attraction. So inward, outward and constant orbits all increase the sweep of "trailing arms".

Jon Richfield
Somerset West, South Africa

This week's question

SKI SLOPE CATWALK

During the Winter Olympics, TV commentators said it is advantageous for ski jumpers to be light because they will travel further. But being light is seen as a disadvantage for slopestyle snowboarders. What's the difference? And what effect do the snowboarders' baggy clothes have on performance? Would they do better in body-hugging ski suits?

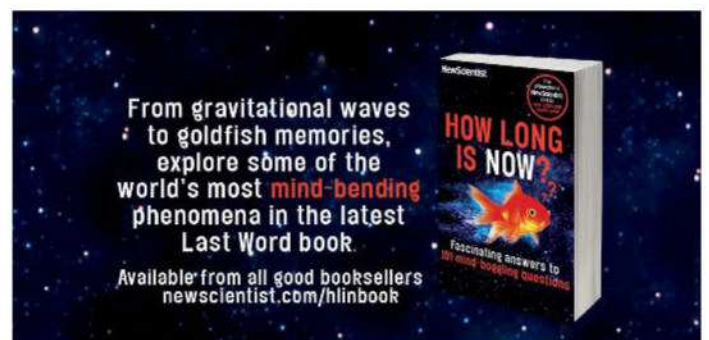
Megan Elliott
Gateshead, Tyne and Wear, UK

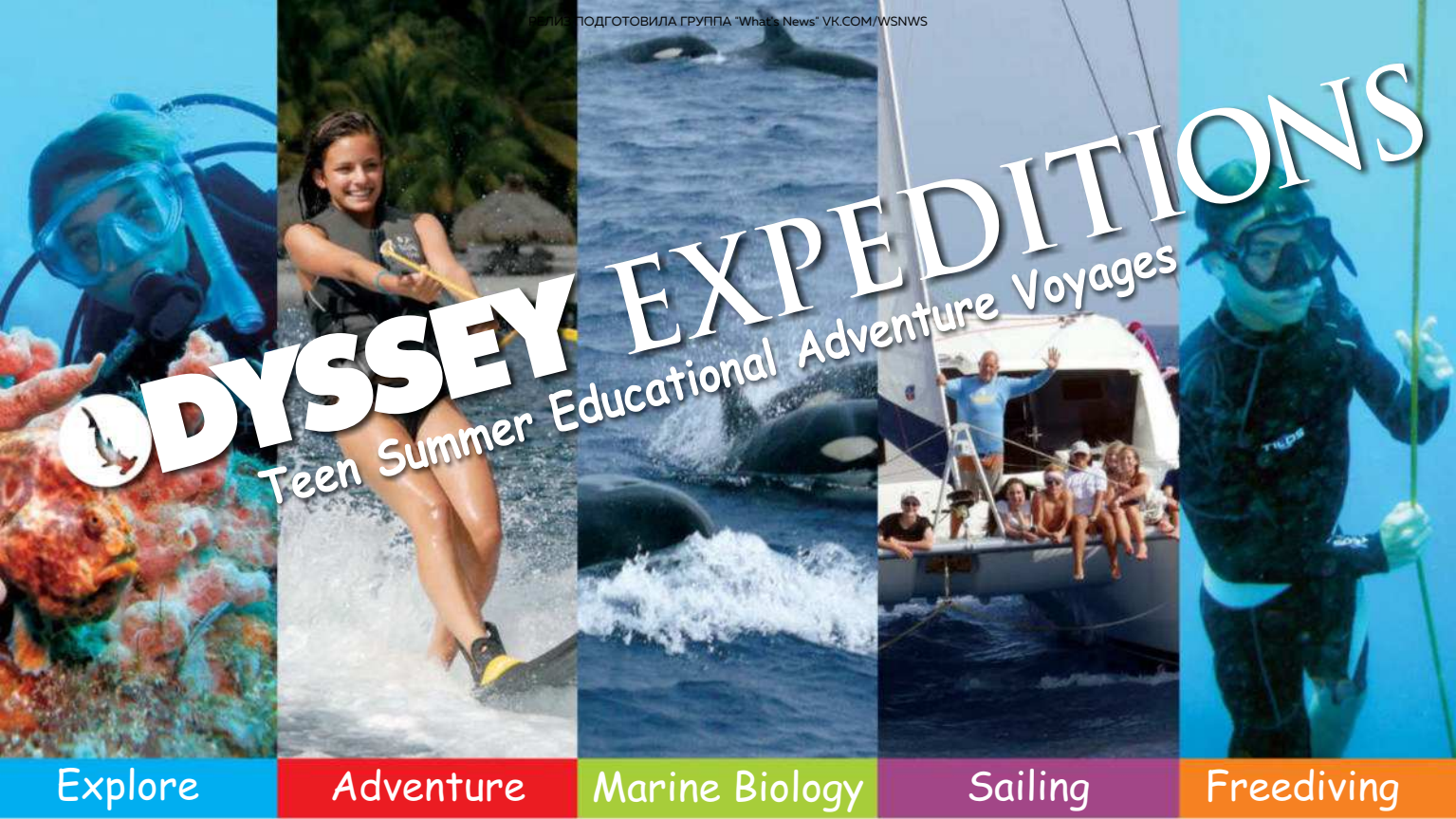
We pay £25 for every answer published in New Scientist. To answer a question or ask a new one please email lastword@newscientist.com. Questions should be scientific enquiries about everyday phenomena, and both questions and answers should be concise. We reserve the right to edit items for clarity and style. Please include a postal address, daytime telephone number and email address.

You can also send questions and

answers to The Last Word, New Scientist, 25 Bedford Street, London, WC2E 9ES.

New Scientist Ltd retains total editorial control over the published content and reserves all rights to reuse question and answer material that has been submitted by readers in any medium or in any format and at any time in the future. All unanswered questions and previous questions and answers are at newscientist.com/lastword/





ODYSSEY EXPEDITIONS

Teen Summer Educational Adventure Voyages

Explore

Adventure

Marine Biology

Sailing

Freediving

Summer Tropical Marine Biology Voyages for students ages 13-21 aboard sailing catamarans in the British Virgin Islands and Windward Islands (*St Lucia to Grenada*).

- **Berths available for summer 2018**
- 21-day voyages in June, July, & August
- All inclusive tuition \$5990*
- No experience necessary
- Students earn multiple PADI SCUBA & Freediving certifications (*Open Water, Advanced, Rescue, Night, Wreck & more*)
- Dive 30+ premier sites - fully supervised
- Watersports, island hikes, service projects
- Earn 2-5 hrs. college credit
- Learn underwater & drone photography
- Live-aboard & sail a 48-foot catamaran
- Onboard Marine Biologists teach fun, hands-on marine science courses
- Coral reef conservation research projects and environmental service opportunities

Give your teenager the opportunity of a lifetime to learn from award winning and published scientists, photographers, mariners, and professional educators on a voyage of discovery. Help them to explore beautiful Caribbean islands and reefs, learn marine biology, sailing and more and earn useful certifications. Odyssey Expeditions provides unique and inspiring learning experiences for teens in a safe, supervised environment and challenges them to be *'Ambassadors to the World's Oceans'*.

**New Scientist readers Save 20% off tuition on any remaining 2018 berth with savings code 'NewScientist20'*

Odyssey Expeditions
teenodyssey.com
352-400-4076

