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SIMON PEMBERTON



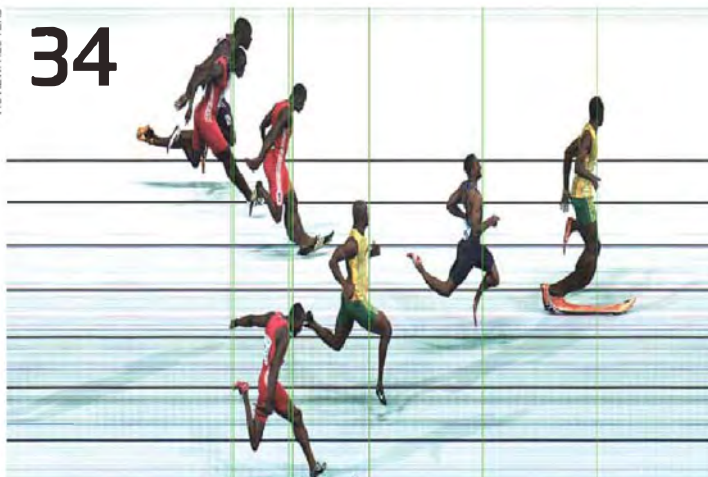
### COVER STORY

## Exploding Earth

How a megadisaster shaped human evolution

Cover image  
Simon Pemberton

HO NEW/REUTERS



## Going to extremes

Just how far can we humans push our physical and mental limits?

KOEN SUYK/EPIC/CORBIS



## Cold winter sun

Solar cycles may be driving Europe's extreme winters

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Tel +44 (0)20 7611 1200  
Fax +44 (0)20 7611 1250

**AUSTRALIA**  
Tower 2, 475 Victoria Avenue,  
Chatswood, NSW 2067  
Tel +61 2 9422 2666  
Fax +61 2 9422 2633

**Editorial & media enquiries**  
Tel 781 734 8770  
jill.heslton@newscientist.com

**Enquiries**  
Tel +44 (0) 20 7611 1202  
enquiries@newscientist.com

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# A 2020 vision for global science

*New Scientist's* poll offers food for thought, says Martin Rees

WE LIVE in a world that is more interconnected – and more vulnerable – than ever before. The fallout from the banking crisis was worldwide. Concerns about infectious diseases have risen and fallen in the public's consciousness, and while no catastrophic pandemic has yet hit us, it is clear that preventive measures require global monitoring and cooperation. There has also been a stronger focus on crises that are less immediate but deeply disquieting: the pressures on energy and resources caused by a larger and more empowered population, and aggravated by anthropogenic climate change. This is the first century when one species, ours, risks irreversibly degrading the entire planet's environment.

The meeting of the world's science academies in January gave *New Scientist* a unique and exclusive opportunity to canvass the opinions of scientists from both developing and developed nations on what they see as the big challenges facing their countries and the world (see page 22 for the results). The three-day conference, hosted by the Royal Society as part of its 350th anniversary celebrations, brought together 103 science academies from around the world – a wealth of international expertise.

Climate change topped the poll of 70 scientists from 62 academies as the issue that was of most concern on a global level; frustration at the limited progress in Copenhagen was still fresh in people's minds. Food security, an issue that the Royal Society

recently identified as particularly significant and investigated in its *Reaping the Benefits* report, also came high on the list. Other environmental concerns were water shortages and loss of biodiversity, both aggravated by population growth.

These were, arguably, predictable but there were surprises too. Participants from higher-income nations showed little concern about water security, despite the fact that it is regularly highlighted as a significant issue. Pandemics came surprisingly low down too,

possibly because swine flu was less serious than feared. The low ranking of terrorism perhaps indicated that, in the developing world, it affects much smaller numbers of people than endemic poverty – even though the latter is far less newsworthy.

At national level, education is highlighted as one of the most significant concerns. This is true for wealthy countries and even more so among the lower-income ones. It is reassuring to see this recognition that science is a long-term investment. Science can not only help solve global problems but is also a key economic driver. Many national governments are acting on that and investing heavily in it. The UK must hope that its next government will not allow science to be left behind.

The poll also contains a warning. In the developed world, the public's perception of science is distinctly ambivalent, despite the extent to which it is the key to our prosperity. Such public doubt should not deflect scientists from facing up to the immense global challenges highlighted in the survey. Scientific organisations must continue to present politicians and the public with a balanced assessment of the evidence in their fields – and, crucially, indicate the level of confidence in their estimates and the range of uncertainties.

We must reiterate that the needs of the world – better food supplies, clean water, adequate energy and equitable policies to preserve ecosystems and the climate – cannot be met without the application of the best available science. But first of all we must enhance our dialogue with politicians and the wider world, and ensure that we sustain the public's trust. ■

DAVID LEVISON/GETTY IMAGES



## PROFILE

Martin Rees has been president of the Royal Society since December 2005. He is also Astronomer Royal, Master of Trinity College, Cambridge, and a member of the House of Lords

## What's hot on NewScientist.com

### TECHNOLOGY Visual tricks appear to quicken downloads

Don't waste money boosting your network speeds: simple optical illusions can make it appear that downloads are happening far quicker

### COLLIDERS Rapper's revenge - particle-physics-style

Fermilab is getting up in the Large Hadron Collider's face. A new rap video has been released that describes the prospects of finding the Higgs boson at the Tevatron collider at

Fermilab in Illinois. The "LHC rapper" known as Alpine Kat, who arguably started the physics-rap genre with her own song in 2008, offers her verdict

### GREEN MACHINE A makeover for the internal combustion engine

Even petrol-heads can make carbon-cutting changes to their behaviour. A new breed of engines promise to make better use of the fuel they consume – a small step towards cutting emissions

### TECHNOLOGY The iPad: touching the future

The revolution might not be televised, but could it be "padded"? Our reporter gets hands-on with the iPad – Apple's latest attempt to redefine what a computer should be

### CULTURELAB Partying on the anniversary of Gagarin's flight

"Yuri's Night" at NASA's Ames Research Center was not your average science-based party. We attended the bash to celebrate Yuri Gagarin's historical journey into space on 12 April 1961,

and also the launch of NASA's shuttle programme, exactly 20 years later

### ZOOLOGER The archerfish masters the science of spitting

From beneath the surface, archerfish hawk jets of water onto prey to knock them down to the surface, where they are devoured. The trick requires eyes adapted for vision in and out of the water

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## LHC is on the right track

IT'S first blood to the massive Atlas detector at the Large Hadron Collider. Just days after the physics programme started, Atlas has reported its first detection of W boson particles.

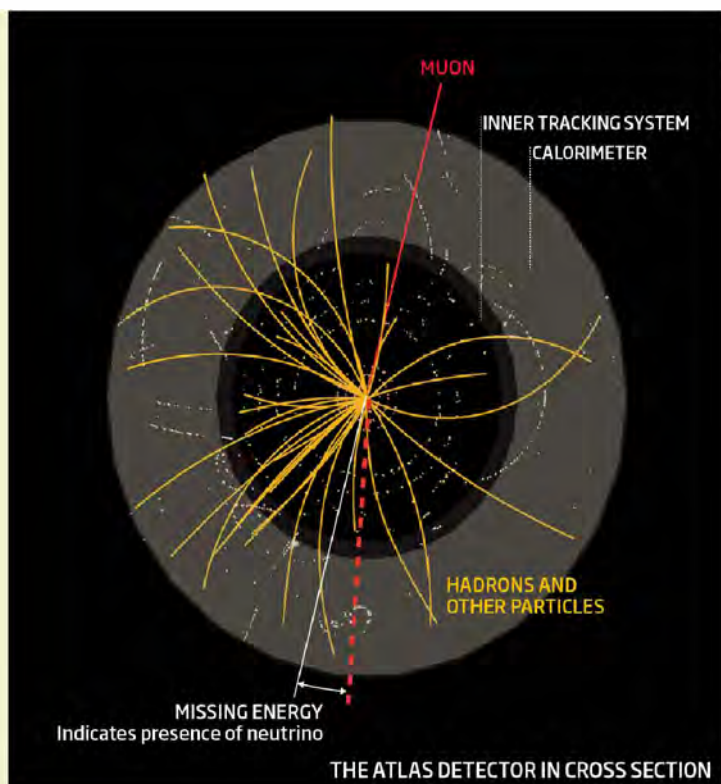
W bosons have been seen at other colliders, but before any of the detectors at the LHC can attempt to discover new particles they must "rediscover" established ones. It is "an excellent sign" to spot the particles so soon, says Fabiola Gianotti, who heads the Atlas team. "It demonstrates that both the LHC accelerator and Atlas work extremely well."

W bosons decay almost instantly into leptons and neutrinos. On two occasions since the machine began collisions at 7 teraelectronvolts last month, the leptons – either a positron

or a muon – have been detected in Atlas's calorimeter and muon chambers. Neutrinos do not interact with the detector, but their presence was inferred from the imbalance of the decay's total momentum – its "missing energy" (see diagram, right).

The detection is interesting in its own right as new particles, such as the Higgs boson, have been predicted to decay into W bosons, says Atlas physicist Andreas Hoecker. "W bosons are really very central."

David Barney, a member of the rival CMS detector collaboration, points to an "element of healthy competition between the two big general-purpose detectors". He says that many interesting events will be needed from both detectors to produce a complete picture.



## Uranium theft risk

IF POLITICIANS are serious about nuclear security, they should start listening to scientists. That's the appeal from scientific groups as world leaders promised better security at a summit in Washington DC this week, but said little about how to achieve it.

At the summit, 47 countries pledged to prevent the theft of fissile material, which could be used to create a nuclear bomb, by securing all stockpiles within four years. Some of the world's estimated 2100 tonnes of plutonium and highly enriched uranium (HEU) are kept in poorly guarded buildings, and there have been 18 known attempted thefts

**"There have been 18 attempted thefts of fissile material documented since 1993"**

since 1993. One crude bomb could cause global economic chaos, a report by nuclear security expert Matthew Bunn of Harvard University warned last week.

Yet there are at present no

agreed standards for what is required to make fissile material "secure", says Ed Lyman, a senior scientist at the Union of Concerned Scientists in Washington DC. The International Atomic Energy Agency has only voluntary guidelines dating from 1999, and efforts to update them in time for this week's summit failed: national nuclear agencies balk at the idea of an outside agency imposing, and possibly verifying, expensive security measures. What has been agreed so far, says Lyman, offers little improvement. For instance, nations are still not required to post armed guards at stockpiles of fissile material.

The American Association for the Advancement of Science and the UK's Royal Society have argued in recent reports that more research could aid international cooperation, as well as improving technology. For example, networks of gamma-ray spectrometers could help to spot smuggled fissile material; shared databases on stockpiles of fissile materials could make it easier to pinpoint sources; and HEU could be replaced as a fuel.

## Laser blasted

THE world's largest laser is meant to spark off a fusion reaction this year – but don't bank on it. So says the US government's watchdog in a critical report about the National Ignition Facility (NIF).

The \$3.5 billion laser array at Lawrence Livermore National Laboratory in California is meant to fire pulses from 192 laser beams to trigger nuclear fusion. NIF physicists have said they hope to reach "ignition" – generating as much fusion energy as is

contained in the laser pulse – at a laser energy of 1.2 to 1.3 megajoules, well short of the machine's 1.8-megajoule capacity.

But the GAO says that many independent researchers think at least 1.8 megajoules will be required, because some laser light could be deflected by the plasma it creates. Firing on full power could also damage high-power optics in the machine, they warn.

An NIF spokesperson told *New Scientist* that staff are confident they can achieve ignition at no more than 1.5 megajoules.

## Health worries over soap additive

THE safety of antimicrobial soaps and toothpastes is under review following concerns that they could interfere with hormones in the body.

Last week, the US Food and Drug Administration said it will re-evaluate the safety of triclosan, which is added to plastics, soaps and toothpastes to kill bacteria and fungi. The agency is not yet recommending that consumers avoid such products.

Over the next year, the FDA will look at evidence that triclosan might

affect the development of the nervous system, in which thyroid hormones play a key role, or the reproductive system. One recent study showed that triclosan lowers levels of thyroid hormones in rats, while a 2008 report found that it boosts the effects of oestrogen and testosterone.

Sarah Janssen of the Natural Resources Defense Council, a US environmental advocacy group, says the announcement is "long overdue".

## Aid gone wrong

DEEP-POCKETED donors are inadvertently encouraging governments to slow their health spending in parts of the developing world.

Government spending on healthcare in developing countries

JUNKO KIMURA/GETTY



Is it legal?

**"For every \$1 of aid, poorer countries cut their own health contribution by nearly 50 cents"**

between 1995 and 2006 doubled to \$18 billion, with one-third of these increases coming from foreign governments and aid organisations.

Christopher Murray's team at the University of Washington in Seattle collected a range of data on health spending and then created a model to describe the relationship between foreign aid and domestic health funding.

Although domestic health spending increased overall, it fell as a proportion of total budgets. Murray's team found that for every \$1 of health aid developing countries received, they cut their own contribution by nearly 50 cents. Sub-Saharan African countries made the deepest cuts.

Meanwhile countries in Asia, Latin America and the Middle East tended to increase their own health spending along with increased aid (*The Lancet*, DOI: 10.1016/S0140-6736(10)60233-4).



May harm more than germs

## Whale on the menu

PROPOSALS to resume commercial whaling have been dealt a blow by DNA detective work showing that restaurants in the US and South Korea illegally sold whale meat from Japan.

In June, Japan, Iceland and Norway are expected to ask the International Whaling Commission (IWC) for permission to resume commercial whaling. They say they can prevent smuggling by matching the DNA

**"Whale meat sold outside Japan came from the same animal as that sold inside, showing it was illegal"**

of whale meat sold in markets to a register of all legally caught whales. But all have refused to make their DNA registers public.

To find out the origin of whale meat being sold outside Japan, Scott Baker of Oregon State University in Corvallis and colleagues secretly took samples from two restaurants, one in Santa Monica, California, and another in Seoul, South Korea. They compared the DNA with that from samples bought in Japan, and found that they came from the same animals – proving that meat from whales hunted in Japan's scientific programme have been illegally sold abroad

(*Biology Letters*, DOI: 10.1098/rsbl.2010.0239). The findings resulted in police raids on the restaurants last month.

Baker says the monitoring system can only work if Japan, Iceland and Norway make their DNA registers publicly available, and hand them over to an independent body like the IWC so routine checks can be carried out.

## Deep volcanic vents

AT 5000 metres beneath the Caribbean waves – where the water pressure is equivalent to the weight of five hefty men bearing down on each square centimetre of rock – a submersible has discovered the world's deepest volcanic rift, spewing water that is hot enough to melt lead.

"It was like wandering across the surface of another world," says Bramley Murton of the international collaboration InterRidge, who filmed the vents from a remotely operated submarine. "The rainbow hues of the mineral spires and the fluorescent blues of the microbial mats covering them were like nothing I had seen before."

The InterRidge team will be exploring the ridge until 21 April, and hopes to dive to 6000 metres. The previous deepest known vent was 4200 metres down on the Mid-Atlantic ridge.

## 60 SECONDS

### Ice triggers tsunami

A massive chunk of glacier plunged into a Peruvian lake on Sunday, triggering a tsunami. The wave breached levees 23 metres high, causing mudslides near the town of Carhuaz, 300 kilometres north of Lima. The mud swept away houses and destroyed a water-treatment plant. Glaciers in the Andes have lost 20 per cent of their volume since the 1970s. Researchers say the trend is linked to climate change.

### Batteries for eggs

Nuclei from fertilised human eggs have been transferred into donor eggs, leaving the old mitochondria behind (*Nature*, DOI: 10.1038/nature08958). Mitochondria are the powerhouses of a cell – by replacing faulty mitochondria with fresh ones in the new egg, it might be possible to prevent mitochondrial diseases from being passed onto children.

### How arsenic kills cancer

Now we know how arsenic trioxide successfully treats 90 per cent of people with a rare blood cancer called promyelocytic leukaemia. The chemical binds to and disables a protein that otherwise prompts the cancer cells to grow and multiply (*Science*, DOI: 10.1126/science.1183424).

### Pollute thy parent

A generation of Earth-like planets seem to be polluting their parent stars. Jay Farihi of the University of Leicester, UK, studied 146 white dwarfs, and found that many had atmospheres rich in heavy elements. These must have come from vaporised rocky planets, Farihi told the National Astronomy Meeting in Glasgow, UK.

### This lady's not returning

An attempt to shake up the venerable Royal Institution, London, by ousting its council and reinstating its ex-director, Susan Greenfield, has failed. Instead, 81 per cent of members voted to retain the council.

# Quiet sun puts Europe on ice

Solar cycles may be conspiring to send northern Europe into a modern-day Little Ice Age



Harsh but fair in the Netherlands

Stuart Clark

BRACE yourself for more winters like the last one, northern Europe. Freezing conditions could become more likely: winter temperatures may even plummet to depths last seen at the end of the 17th century, a time known as the Little Ice Age. That's the message from a new study that identifies a compelling link between solar activity and winter temperatures in northern Europe.

The research finds that low

solar activity promotes the formation of giant kinks in the jet stream. These kinks can block warm westerly winds from reaching Europe, while allowing in winds from Arctic Siberia. When this happens in winter, northern Europe freezes, even though other, comparable regions of the globe may be experiencing unusually mild conditions.

Mike Lockwood at the University of Reading in the UK began his investigation because these past two relatively cold

British winters coincided with a lapse in the sun's activity more profound than anything seen for a century. For most of 2008-9, sunspots virtually disappeared from the sun's surface and the buffeting of Earth by the solar magnetic field dropped to record lows since measurements began, about 150 years ago.

Lockwood and his colleagues took average winter temperatures from the Central England Temperature dataset, which extends back to 1659, and

compared it with records of highs and lows in solar activity. They found that during years of low solar activity, winters in the UK were far more likely to be colder than average. "There is less than a 1 per cent probability that the result was obtained by chance," says Lockwood, in a paper to appear in *Environmental Research Letters*.

Judith Lean, a solar-terrestrial physicist at the US Naval Research Laboratory in Washington DC, says the analysis is statistically robust, and reckons it forms a piece in the larger puzzle of how solar activity influences weather. Often cited by climate-change sceptics as a cause of global warming (see "What are you up to, sunshine?"), the effects of solar cycles have largely evaded the grasp of climate modellers.

**"Northern Europe freezes, even though comparable regions experience unusually mild conditions"**

Lockwood found that when he removed 20th-century warming due to industrial emissions from his models, the statistical link between solar lows and extreme winters was stronger, suggesting the phenomenon is unrelated to global warming. But the sun undeniably has a big influence on weather systems: it is, after all, the energy source that powers them.

"All the little pieces are adding up into something much bigger," says Lean. "People are beginning to realise that European weather is particularly susceptible to solar activity." A study she published in 2008 found that warmer-than-average temperatures were more likely in northern Europe when solar activity is high (*Geophysical Research Letters*, DOI: 10.1029/2008GL034864).

Lean says research like hers and Lockwood's is helping to overcome a long-standing reticence among climate scientists to tackle the influence of solar cycles on the climate and weather. A big clue to the nature of this influence may lie in work published in 2008

## In this section

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- Better to remember what made you sad, page 13

by David Barriopedro at the University of Lisbon, Portugal, and colleagues. They investigated so-called “blocking events” in the mid-latitude jet stream during the winters of 1955-99.

The jet stream brings winds from the west, over the Atlantic, and into northern Europe. Blocking occurs when the meanders in the jet stream become so large that they double back on themselves, halting the prevailing westerly winds and allowing cold north-easterlies to take control (see diagram). Barriopedro found that when solar activity is low, the blocking events move eastwards across the Atlantic towards Europe, effectively opening an atmospheric corridor to the frigid Siberian Arctic.

But how can solar variability influence the jet stream? One finger of suspicion is pointing at the stratosphere, the layer of the atmosphere that lies 20 to 50 kilometres above our heads. There, patterns of winds and temperature are known to be influenced by solar activity, says Lockwood. This is because peaks in ultraviolet radiation emitted by the sun boost ozone formation in the stratosphere, which in turn absorbs more ultraviolet and heats up. The heating is greatest in the region of the

## WHAT ARE YOU UP TO, SUNSHINE?

How much influence solar activity wields over our climate has vexed scientists for centuries. Take the British astronomer William Herschel: in the late 18th century, he compared the price of wheat in England with the number of sunspots and suggested that years with more sunspots produced good harvests, keeping the price lower.

Since the discovery of the 11-year solar cycle in the mid-19th century, many have sought to make links between different elements of solar variability and changes in climate. Here's a snapshot of the arguments and the evidence.

**Cosmic rays:** One persistent claim is that cosmic rays could affect

cloud formation, influencing climate – but most analyses have found little or no correlation. CERN in Switzerland is running an experiment that will provide data about how likely such particles are to cause cloud formation.

**Sunspots:** People have tried to link the number of sunspots during the 20th century with rising global temperatures. But average sunspot numbers have been dropping since the 1920s. Global mean temperatures, meanwhile, have risen over the same period.

**Ultraviolet rays:** Less easy to dismiss has been the idea that changes in ultraviolet radiation from the sun, a quantity closely linked to solar

activity, could influence the climate. Direct measurements only began in 2003. However, average solar activity has fallen over the last two decades while temperatures have risen, making it unlikely that UV radiation is a dominant driver of global temperatures.

**Irradiance:** Measurements of the sun's brightness – an indicator of its energy output – only began in 1977. Irradiance rose between 1977 and 1985, but has been dropping since.

Since about 1985, all the solar factors that could have warmed the climate have been going in the wrong direction, says Lockwood. “If they were really a big factor we would have cooling by now.”

stratosphere nearest to the sun and so a temperature gradient appears across the stratosphere and winds are born.

How this affects the weather below is still debated. Very little is known about the physics that governs the stratosphere, but one pattern that is emerging is that stratospheric “weather” is linked to the troposphere below it – where our everyday weather and currents like the jet stream reside. Edwin Gerber of New York University studies these interactions. He and

colleagues showed in 2009 that upward movements of air in the troposphere can change the patterns of stratospheric winds. These changes, in turn, can be reflected back down to the troposphere and influence weather at the surface of the Earth (*Geophysical Research Letters*, DOI: 10.1029/2009GL040913). “Changes in the stratospheric winds influence the path of winter storms across Europe,” Gerber says.

If researchers can prove that the sun can similarly induce changes

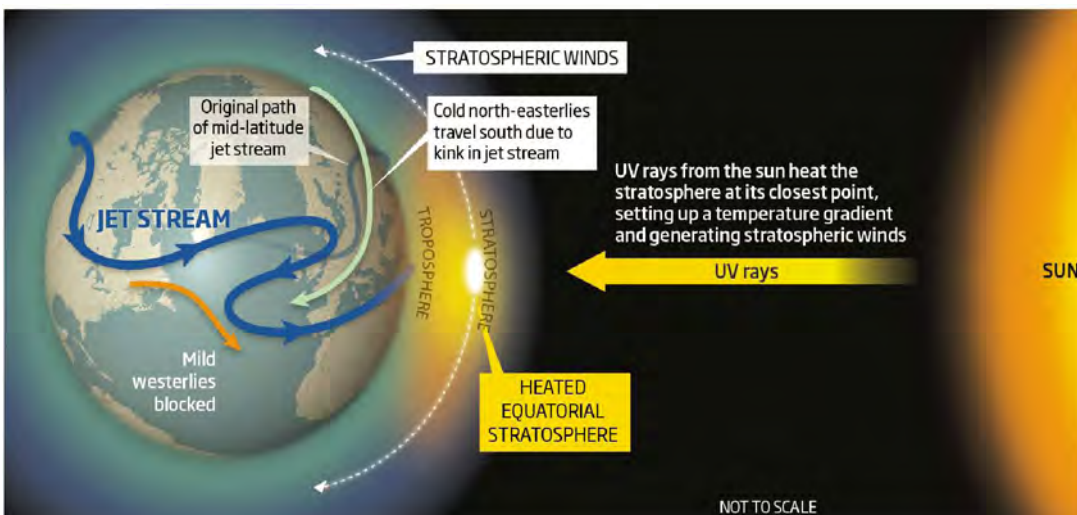
in the troposphere via the stratosphere, which Gerber thinks they will, this could solve one of the biggest puzzles of the Little Ice Age – namely, that it appeared to have been a peculiarly European phenomenon, with other parts of the globe largely spared. The effects of the sun on the stratosphere are not global, says Lockwood. “They change the way the atmospheric energy is distributed around the world rather than change the total amount of energy being put into it.”

Future studies may show that the effects of changes in solar activity can be felt further afield, but for now it seems that Europe is particularly susceptible because it happens to sit under the northern jet stream at a longitude where its meanders can grow into kinks.

Although sunspot activity is gradually returning, astronomers are not expecting it to reach its previously high levels. So if Lockwood is correct, while the general temperature trend in the northern hemisphere will increase in line with global warming over the coming decades, northern Europe can look forward to some more harsh winters. It may be time to buy some decent gloves. ■

## Kinky jet stream

A giant kink is more likely to form in the jet stream when sunspot activity is low. This trend may be linked to changes in stratospheric winds





A black hole in waiting?

## Why neutron stars have a heart of darkness

DARK matter may be prompting black holes to appear spontaneously in the hearts of distant exotic stars. If so, this could hint at the nature of dark matter.

Arnaud de Lavallaz and Malcolm Fairbairn of King's College London wondered what would happen when dark matter—which makes up most of the mass of galaxies—is sucked into the heart of neutron stars. These stars, the remnants of supernova explosions, are the densest known stars in the universe. It turns out

that the outcome depends on the nature of dark matter.

Most of the favoured theories of dark matter suggest each particle of the stuff is also an antiparticle, meaning that they should annihilate each other when they meet. But Fairbairn and de Lavallaz considered a dark matter particle of a different type, which is not also its antiparticle.

The pair calculated what would happen if dark matter particles like these were attracted by the intense gravity of neutron stars.

Because they would not annihilate each other, the dark matter particles would end up forming a smaller, dense star at the heart of the neutron star. If the neutron star were near the centre of the galaxy, for example, and surrounded by an abundance of dark matter, then it would continue to accrete dark matter.

Eventually, the mass of the dark matter star would exceed its “Chandrasekhar limit” – beyond which a star cannot withstand gravitational pressure. The dark matter star would collapse into a black hole. “Then the neutron star won’t be able to survive anymore, and it’ll collapse too,” says Fairbairn.

“It would be pretty catastrophic.”

Their calculations show that if a neutron star collapsed in this way the result would be a burst of gamma rays, which could be spotted from Earth ([arxiv.org/abs/1004.0629](https://arxiv.org/abs/1004.0629)).

Various underground experiments back on Earth have been trying to detect dark matter, using different techniques. While none of the major experiments have seen anything yet, physicists running the Dark Matter (DAMA) experiment inside the Gran Sasso mountain in Italy have been saying for some time that dark matter particles are hitting their detector. Most physicists are sceptical of the DAMA results because it doesn’t sit well with favoured theories on the nature of dark matter.

Fairbairn says that the DAMA experiment could be sensitive to dark matter particles that do not self-annihilate, which might explain why it is seeing something and others are not.

Dan Hooper of Fermilab in Batavia, Illinois, agrees the pair’s scenario is plausible because the existence of dark matter particles that do not self-annihilate cannot be ruled out. “We could look for evidence that neutron stars don’t live very long in regions with a lot of dark matter,” he says. “I find exciting the prospect of using exotic stars as dark matter detectors.” **Anil Ananthaswamy** ■

## ‘Dark sun’ is one of our nearest neighbours

YOU can forget sunbathing on any planet around this star. A dim object less than 10 light years from Earth may be the closest brown dwarf yet found – and it is so cold that anyone on an orbiting planet would see it as a dark sun in a starry daytime sky.

The discovery suggests that brown dwarfs are common, so there could be other seven closer to Earth.

Brown dwarfs have so little mass that they don’t get hot enough to sustain nuclear fusion, which powers stars like the sun. Still, they do shine, in a way: they glow from the heat of their formation, then cool and fade. Philip Lucas of the University of Hertfordshire in Hatfield, UK, and his colleagues detected the lightless star, named UGPS 0722-05, from this infrared radiation.

They think it is only about 9.6 light years from Earth, a bit more than twice as far as Proxima Centauri, our nearest star after the sun. Not since 1947 have astronomers

found a new star so close to Earth.

“Great stuff!” says Todd Henry, a nearby-star researcher at Georgia State University in Atlanta, who was not part of the team. “This discovery is as cool as its temperature.”

The team caution that their estimate of the brown dwarf’s distance is preliminary, but if correct, it is closer than any other known. The previous record-holder is a pair of

brown dwarfs around the star Epsilon Indi, 11.8 light years from Earth.

The new-found brown dwarf breaks two other records as well. It’s the coldest ever seen, with a temperature of 230 °C at most. And it’s the dimmest: it emits only 0.000026 per cent as much energy as our sun ([arxiv.org/abs/1004.0317](https://arxiv.org/abs/1004.0317)).

The object’s feeble radiation output explains why it has only now been spotted, despite its proximity. It was found after surveying just a few per cent of the sky, which implies that many more brown dwarfs are lurking nearby undetected. **Ken Croswell** ■

**“It’s the coldest brown dwarf ever seen, with a temperature of 230 °C at most. And it’s the dimmest”**

# No fear of strangers, no racial prejudice

Andy Coghlan

CHILDREN with a rare genetic condition seem to lack any kind of racial bias, unlike any other children previously tested. These children are also unusually gregarious and unafraid of strangers, leading to the suggestion that fear of people who are different from ourselves underlies racial prejudice.

Children with Williams syndrome, as this condition is called, have mild to moderate learning difficulties and a distinctive facial appearance. Their most striking characteristic, though, is extreme sociability.

"They don't recognise danger in faces and [they] approach anyone," says Andreas Meyer-Lindenberg of the Central Institute of Mental Health in Mannheim, Germany, whose

team led the new study.

In earlier research on children's reactions to angry faces, his group attributed lack of fear to reduced neural activity in the amygdala, a brain region that processes social threats. Since racial bias in adults has been also linked to overactivity in this area, his team speculated that people with Williams syndrome wouldn't favour their own race because of deficiencies in their ability to process social fear.

To find out, they presented 40 white children, aged 5 to 17, with one white and one dark-skinned cartoon character and asked them to match up the characters with a positive or negative description.

The 20 children who were developmentally normal had the usual biases towards their own racial group, which appear in infants as young as 3 years old. They almost always paired

descriptions such as "kind" and "smart" to the white character and negative descriptions, such as "ugly" and "stupid", to the dark-skinned protagonist. Not so the 20 children with Williams, who were just as likely to praise a dark-skinned character as they were to admonish a white one (*Current Biology*, DOI: 10.1016/j.cub.2010.02.009)

"This is the best evidence yet that racial stereotyping is dictated by social fear," says Meyer-Lindenberg.

Surprisingly, the Williams children displayed the same

**"This is the best evidence we have so far that racial stereotyping is dictated by social fear"**

gender biases as other children, with boys loading praise onto male characters and girls favouring the females.

"These findings are useful because they show that each kind of prejudice is distinctive," says Susan Fiske of Princeton University.

To further explore the link between fear of strangers and racial bias, Meyer-Lindenberg's team plan to scan the brains of children with Williams to see how their amygdalae respond during similar tests of racial bias.

Andreas Olsson of the Karolinska Institute in Stockholm, Sweden, also thinks that a lack of fear could explain why Williams children are unbiased toward other races and so extroverted.

The new paper backs up work in 2005 by Olsson's team, which also found a link between fear and racial bias. Black and white university students were conditioned to associate photographs of black and white individuals with a slight shock. They retained the association longer, even without the shock, if the photograph depicted someone of a different race. This suggests that the students were already fearful of other races.

Yet Meyer-Lindenberg's colleague Andreia Santos stresses that their team's findings do not say whether racial stereotyping is innate or learned. ■

## Do Dartmoor stones have link to Stonehenge?

LITTERED across the hills of Dartmoor in Devon, southern England, around 80 rows and circles of stones stand sentinel in the wild landscape. Now, striking similarities between one of these monuments and Stonehenge, 180 kilometres to the east, suggest they may be the work of the same people.

The row of nine stones on Cut Hill was discovered in 2004 on one of the highest, most remote hills of Dartmoor national park. "It is on easily the most spectacular hill on north Dartmoor," says Andrew Fleming, president of the Devon Archaeological Society. "If you were looking for a distant shrine in the centre of the north moor, that's where you would put it."



Still standing on Stall Moor

Ralph Fyfe of the University of Plymouth and independent archaeologist Tom Greeves have now carbon-dated the peat surrounding the stones. This suggests that at least one of the stones had fallen - or been placed flat on the ground -

by between 3600 and 3440 BC, and another by 3350 to 3100 BC (*Antiquity*, vol 84, p 55).

That comes as a surprise to archaeologists, who, on the strength of artefacts found nearby, had assumed that Dartmoor monuments

like Cut Hill and Stall Moor (pictured) dated from the Bronze Age, around 2100 to 1600 BC. Instead, Fyfe suggests that Cut Hill is from the Neolithic period, the same period that Stonehenge was built.

Unlike Stonehenge, the 2-metre-tall Cut Hill stones lie flat on the ground, parallel to each other and between 19 metres and 34.5 metres apart, like the sleepers of a giant railway track. Packing stones discovered at the end of one of the megaliths suggest at least one of them stood erect at some point, but the regularity of their current layout makes it likely they were deliberately placed that way, Greeves says.

What's more, the stones' alignment with the summer and winter solstices seems identical to that of Stonehenge, Newgrange in Ireland and Maes Howe in Scotland. "It could be coincidence, but it's striking," says archaeologist Mike Pitts. Linda Geddes ■

# Amazon life owes a thing or two to us

Anil Ananthaswamy

DON'T tell Sting, but human activity may not be all bad news for the Amazon. A study of South American savannahs suggests that even before Europeans arrived, farmers were changing ecosystems with a landscaping method previously unrecognised in the region. What's more, the pre-Columbian alterations may have increased biodiversity.

"Human actions cannot always be characterised as bad for biodiversity," says Doyle McKey of the University of Montpellier 2, France. "Some might be good."

McKey and his colleagues came to their conclusion after studying some strange features of the savannahs of French Guiana. These plains are flooded during the rainy season, dry and parched in the summer, and often burned by fires. It was while walking

through this landscape that McKey started wondering about undulations in the terrain. It turned out that they are mounds, mostly about 1.5 metres across and 30 centimetres high. McKey thinks that pre-Columbian farmers made them as beds for crops that drained well in the rainy season. Sure enough, when the team tested the mounds' drainage capacity, they found it was nine times as high as the seasonally flooded savannah.

Once these fields were abandoned between 800 and 400 years ago, plants and animals colonised the mounds, creating a new ecosystem. Specifically, McKey's team found that the leaf-

cutter ant *Acromyrmex octospinosus*, the predatory ant *Ectatomma brunneum* and the Nasutitermitinae subfamily of termites preferred to build their nests on the raised beds. The *Acromyrmex*, which are fungus-growing ants, even transported large quantities of organic matter to their nest. This in turn has caused the plants on the mounds to grow bigger and their roots deeper. The consequent structural integrity of the mounds and their excellent permeability to water has protected them from erosion by flood waters (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0908925107).

McKey expects that the alterations have been beneficial for the biodiversity of the area. "It's clear that a savannah with this heterogeneity will have a higher biodiversity than just a flat savannah," he says.

Besides French Guiana, such mounds can be found in Surinam, Belize, Venezuela, Ecuador, Bolivia and Mexico. The new study is bound to further fuel the debate over whether most of the Amazon rainforest and the associated savannahs are pristine ecosystems. "To my mind, the debate has been too black-and-white," says McKey. "Nature and culture are interacting to produce interesting things, and maybe that is the way this debate should go." ■



MONTEFIORE/BIOSPHEROTIC/STILL PICTURES

Farming isn't all bad

## Entangle qubits for true random number machine

PURE randomness is surprisingly difficult to create, even if you draw on the inherent randomness of quantum mechanics. Now, though, a "true" random number generator is on the cards, which may help create the ultimate cryptographic messages.

Existing quantum random number generators are only as reliable as their parts. For example, some devices send single photons through

a beam-splitter and record the path taken, but a pattern could emerge over time if the beam-splitter comes to favour one direction or the materials degrade. A new number generator produces random strings of numbers without the worry of such flaws, because it relies on the inherently random behaviour of two quantum-entangled objects.

Entangled objects violate the "Bell inequalities", which provides mathematical proof that their behaviour is definitively random. It doesn't matter who made the objects or how, says team member Antonio Acín of the Institute for Photonic

Sciences in Barcelona, Spain.

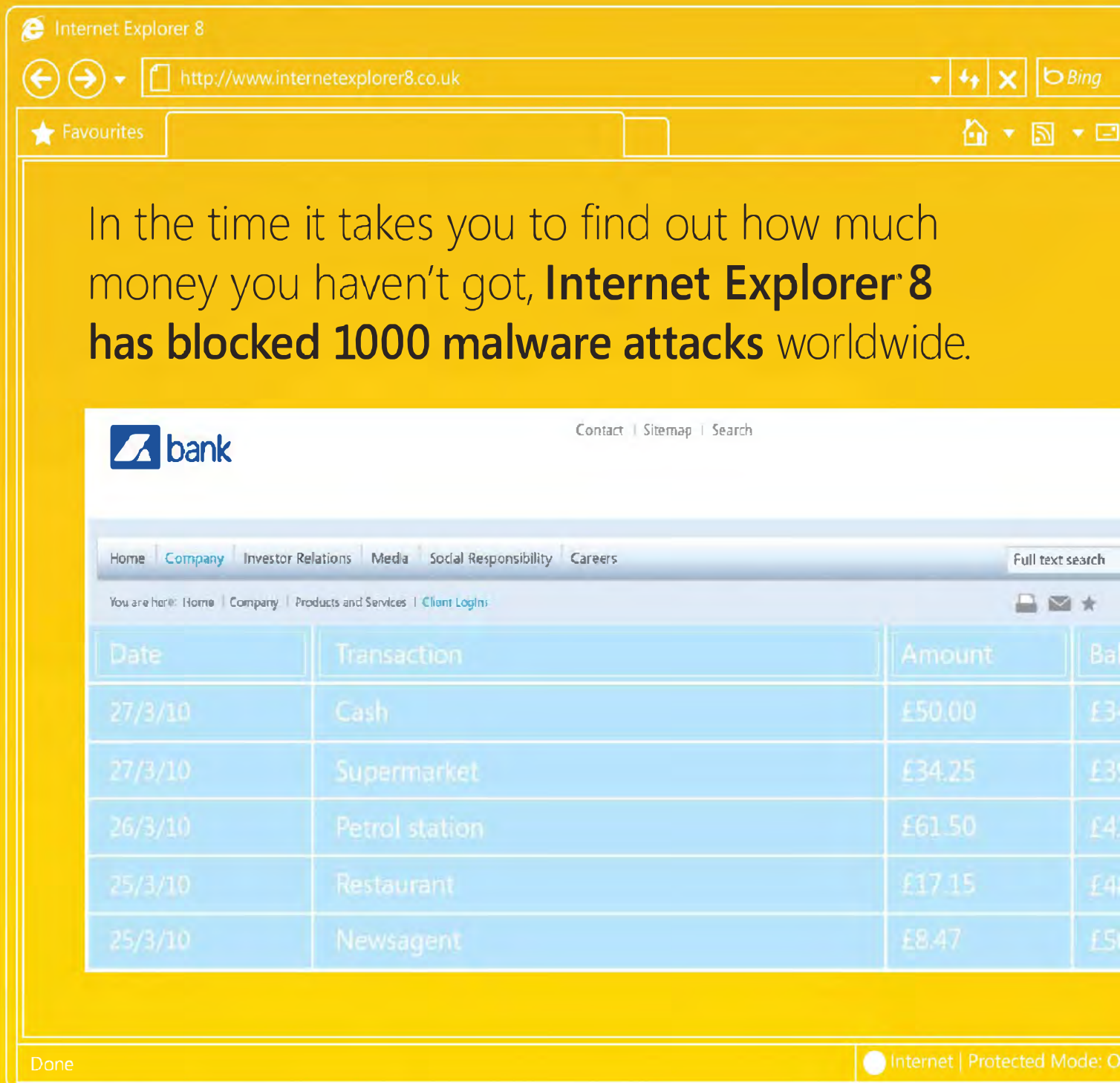
Two ytterbium ion quantum bits or qubits were trapped in separate vacuum chambers. When they each emitted a photon, the interactions between the photons entangled the two ions. The team fed numbers into the device, causing microwave oscillators to turn the qubits in one of two directions. The qubits were then exposed to light, and a random string of ones and zeros was

**"The new number generator relies on the inherently random behaviour of two entangled objects"**

recorded, depending on whether or not they shot photons to a detector. We know that the ions are entangled because they emit photons in the same way.

To remove any chance of human error during measurement, this string was fed into a mathematical formula that removed traces of pattern, but cannot generate randomness itself (*Nature*, DOI: 10.1038/nature09008).

"If the same task can be implemented over some distance, it can lead to device-independent cryptography," says cryptography pioneer Artur Ekert of the University of Oxford. Kate McAlpine ■



The screenshot shows the Internet Explorer 8 browser window. The address bar displays <http://www.internetexplorer8.co.uk>. The page content features a large blue banner with the text: "In the time it takes you to find out how much money you haven't got, **Internet Explorer® 8** has blocked 1000 malware attacks worldwide." Below the banner is the bank's website, which includes a navigation menu with links like Home, Company, Investor Relations, Media, Social Responsibility, and Careers. A table of transactions is visible, showing dates, transaction descriptions, and amounts.

Date	Transaction	Amount	Balance
27/3/10	Cash	£50.00	£34.25
27/3/10	Supermarket	£34.25	£0.00
26/3/10	Petrol station	£61.50	£4.00
25/3/10	Restaurant	£17.15	£4.00
25/3/10	Newsagent	£8.47	£5.00

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## INSIGHT



### Help will be at hand sooner for miners trapped underground

In laboratory tests, Sandia's high-speed drill bored a hole 10 to 15 centimetres in diameter through 30 centimetres of granite in 6 seconds. This means it should be able to penetrate 300 metres of hard rock in under 2 hours.

Unlike the shearing or chipping employed by conventional rotary drills developed for the oil and gas industry, the new drill employs a high-powered pneumatic jackhammer with button-shaped tungsten carbide bits to fracture the rock and break it into a fine powder.

The drill could be available for mine rescues within two years. However, it wouldn't have significantly changed the outcome in West Virginia, where rescue teams were able to drill down in a relatively short time, or China, where many miners escaped through partially flooded mineshafts.

NIOSH has also commissioned Sandia to develop a robotic scout that rescue teams could send into a mine to check for survivors and assess whether it is safe to enter. The plan now is to test it under realistic conditions with a mine rescue team. Finfinger says that if it is to be of any use, "it has to make rescue faster or safer". **Phil McKenna** ■

## Jackhammer drill will go deeper faster to keep trapped miners alive

FATAL coal mine accidents over the past month in West Virginia and China offer a grim reminder of how difficult it can be to reach workers underground when their usual route to the surface is cut off. In many such accidents, even the best rescue technology can fail to get to people quickly enough – so how could it be improved?

When people are trapped below ground, it can often be a race against time for the rescue teams above them to drill narrow boreholes

through which they can lower food and water, blow in oxygen, or suck out dangerous gases such as methane or carbon monoxide.

Though no two mines are alike, it typically takes 10 hours to bore every 300 metres. Conventional rotary drills are limited in how fast they can cut, and they slow right down when drilling through granite or other hard rock. In 2007, a rescue effort at the Crandall Canyon mine in Utah failed after it took about 40 hours to drill 500 metres.

Nine miners and rescue workers died.

A "superdrill" now under development could help. On 30 April, researchers at Sandia National Laboratories in New Mexico are due to deliver preliminary results to federal mine safety officials on a drill that can penetrate hard rock significantly faster than conventional drills. "It can go through granite like it's cutting butter," says Gerald Finfinger of The National Institute for Occupational Safety and Health (NIOSH), the US federal agency that is funding Sandia's research. "In a normal drill operation, you could sit there and read a book and barely see it penetrate."

## First glimpse of mirror neurons in humans

BRAIN cells that may underlie our ability to empathise with others have been detected directly in people for the first time.

Monkey brains have been shown to contain so-called "mirror" neurons, which fire both when the animal performs an action and when it observes others performing that action. Until now, the only evidence that our brains contain similar neurons has been indirect, derived

from functional MRI scans.

Now Roy Mukamel at the University of California, Los Angeles, and colleagues have observed mirror neurons directly in humans. They used electrodes to record brain activity in the medial frontal and temporal cortices of 21 people awaiting surgery to treat epilepsy, while they made – or observed others making – grasping actions and facial expressions.

The majority of these neurons responded only to the observation or execution of an action, but 8 per cent of the cells responded to both (*Current Biology*, DOI: 10.1016/j.cub.2010.02.045). These areas of the

brain are involved in planning and controlling actions, abstract thinking and memory.

Mirror neurons were thought to exist primarily in regions of the brain involved in performing actions, so

### "Mirror neurons were observed directly using electrodes to record brain activity in humans"

their presence in other regions suggests that this is not their only role. Other studies have found that people who appear to have more active mirror neurons also tend to be more empathetic. Marco Iacoboni, another

member of the team and also at UCLA, says his team's results suggest that human mirror neurons provide "a rich reflection of the actions of others".

Alfonso Caramazza at Harvard University rejects this idea. "We should abandon the notion that these neurons are allowing us to mirror another's actions internally," he says.

Both agree that the ultimate test would be to block mirror neurons in animals and see if they no longer comprehend the actions of others. There is no easy way to do this yet, says Mukamel, but optogenetics – the ability to manipulate or block neural activity using light – may one day provide a solution. Helen Thomson ■

# It pays to remember what made you sad

Jessica Hamzelou

FORGETTING your woes might make you feel worse, not better. People with impaired memory feel sad even when they have forgotten what made them sad in the first place – a finding that suggests emotions and memory are not as intimately linked as we thought.

Neuroscientist Justin Feinstein at the University of Iowa in Iowa City showed a compilation of heart-rending clips from films such as *Forrest Gump* to ten people, five of whom were unable to form new memories because of damage to their hippocampus. Ten minutes later, his team tested their memories.

The amnesiacs felt a lingering sadness even though they struggled to remember details of the clips, whereas those with healthy memories felt fine by then (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0914054107). “I am surprised that the emotion lasted so long in amnesiacs,” says Feinstein.

The explanation may be that it is the ability to store and reflect on emotional events that can

“relieve some or most of the sad feelings”, according to Todd Sacktor at Downstate Medical Center in New York City.

Feinstein’s team also showed the two groups funny clips and found a similar pattern of responses, though the difference was less marked. “Sadness lasts longer,” Feinstein says.

The results highlight the

**“People with impaired memory feel sad even when they have forgotten what made them sad”**

importance of being respectful to people with advanced Alzheimer’s disease, Feinstein says. Even if such people do not remember being on the receiving end of insensitive behaviour, they may still feel distressed – and for longer than other people.

It is also possible that using drugs to block painful memories in people with post-traumatic stress disorder may actually hamper their recovery, Feinstein says. “By not having that memory, you might actually prolong the emotional pain,” he says. ■



Sadder if forgotten

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## NewScientist Jobs



## New-found hominid cousin is a brain teaser

NOT only have we found a long-lost cousin, but it now appears that the skull of newly unveiled *Australopithecus sediba* contains a print of its brain. The skull of the young male australopithecine, unearthed in South Africa, is so well preserved that early analysis of X-ray tomographic images taken at the European Synchrotron Research Facility (ESRF) in Grenoble, France, reveals that the brain may have left its imprint on sediment filling the skull. Though tantalising, Paul Tafforeau, a palaeontologist at the ESRF, is cautious about what new insights the imprint may yield.

Brain or no brain, *A. sediba* is significant because its anatomy is the most similar of any australopithecine yet found to the true humans that evolved into us. Two partial skeletons, one of a male child aged 9 to 13 years and the other of an adult female, were dug up in the Cradle of

Humankind world heritage site near Johannesburg by Lee Berger of the University of the Witwatersrand in Johannesburg and colleagues. They are between 1.95 and 1.78 million years old (*Science*, vol 328, p 195).

Though its physical features are the most human-like of any australopithecine yet discovered, *A. sediba* is hundreds of thousands of years younger than the oldest fossils assigned to the genus *Homo*, meaning it is unlikely to be our direct ancestor.

The juvenile is the most complete australopithecine skeleton yet found from the period: it includes much of the skull and large parts of an arm, leg and pelvis. Both hominids were about 1.2 metres tall, with ape-sized brains. "This is the most human-like australopithecine yet discovered," says Chris Stringer of the Natural History Museum in London, who was not involved in the study.

## Nicotine may raise Alzheimer's risk

SMOKING could predispose people to dementia, not protect them as had been suggested. Rats with brain plaques develop further symptoms of Alzheimer's when given nicotine.

In Alzheimer's disease, the brain becomes riddled with amyloid plaques and tangles of tau proteins. Low doses of nicotine reduce the number of plaques in rats, yet little was known about the effect on the protein tangles.

To find out, Yan-Jiang Wang's team at Third Military Medical University in Chongqing, China, injected plaques into the brains of healthy rats and gave some a smoker's daily dose of nicotine for two weeks, others nothing.

All the rats showed early signs of tau tangles and had difficulty navigating a maze, but the rats on nicotine were worse off (*European Journal of Pharmacology*, DOI: 10.1016/j.ejphar.2010.03.029).

## People pick up pepper virus

COULD a plant virus have found a way to infect humans?

It has always been assumed that plant viruses cannot infect animals, and vice versa. But now Didier Raoult at the University of the Mediterranean in Marseille, France, and his team have found RNA from the pepper mild mottle virus in the faeces of 7 per cent of the 304 adults they tested. Those with the virus were more likely to report fever, abdominal pain and itching than those without it (*PLoS One*, DOI: 10.1371/journal.pone.0010041). The team is now looking for direct proof that the virus causes these symptoms.

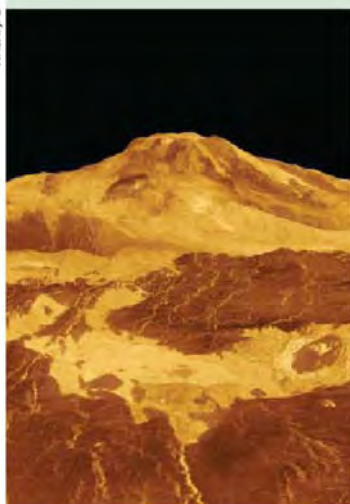
But Robert Garry at Tulane University in New Orleans, Louisiana, doubts that a plant virus could recognise animal cells.

## Volcanic surprises from angry Venus

VENUS's namesake may be the goddess of love, but the planet looks more angry than passionate. Two studies that reveal recent lava and the largest known volcano in the solar system raise the possibility that huge fiery outpourings could still happen there today.

Many planetary scientists had thought Venus's surface was geologically dead. Suzanne Smrekar of NASA's Jet Propulsion Laboratory in Pasadena, California, and colleagues found signs of relatively recent volcanism by measuring the infrared "glow" of solidified lava in three regions in its southern hemisphere. Newer volcanic rock on Venus tends to emit more infrared, because atmospheric gases weather older rocks and change their composition (*Science*, DOI: 10.1126/science.1186785). Pinning down the exact age of the rocks is tricky, but they could be mere hundreds of years old, says Smrekar.

In another study, to appear in *Geology* in May, a reanalysis of a raised oval feature called Artemis suggests it could be the largest known volcanic structure in the solar system. Vicki Hansen of the University of Minnesota at Duluth found signatures of volcanism, such as "wrinkle ridges" caused by lava cooling, across an oval 13,000 kilometres wide. The lava's age is unknown. Artemis is now inactive.



## Nanotube 'black hole' promises exotic new states of matter

AN ARTIFICIAL "black hole" designed to capture wayward atoms could pave the way for an atom trap that will yield previously unknown states of matter.

A team led by Lene Hau of Harvard University has mimicked the death spiral of matter falling into a cosmic black hole. By applying a voltage across a carbon nanotube – a rolled-up sheet of carbon atoms – the team can generate a powerful electric field. This tugs at nearby rubidium atoms which have been chilled to a fraction of a degree above

absolute zero: a positive charge on the surface of the nanotubes attracts the rubidium atoms' electrons, while the positively charged nucleus is repelled.

This polarisation causes the atoms to spiral towards the nanotube, speeding them up until the atoms circle it in just a few trillionths of a second. Eventually each atom's outermost electron detaches and enters the nanotube through a process called quantum tunnelling. The positively charged rubidium ion that it leaves behind is repelled by

the positively charged nanotube and slingshots away (*Physical Review Letters*, DOI: 10.1103/PhysRevLett.104.133002).

Modifications to this set-up could produce a trap capable of keeping a cloud of cold atoms spinning around the nanotube. "One could use the system to make completely new states of cold atom matter," says Hau. It could also be used to detect trace amounts of gas, or be adapted to make precise atom interferometers, which measure small variations in gravity, she says.

## Self-doubt is not uniquely human

THERE goes another sophisticated mental feat once thought to be uniquely human. Apes may be sufficiently self-aware to doubt their own knowledge.

Josep Call of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, put food in one of two opaque plastic pipes and had watching bonobos, chimpanzees, gorillas and orangutans pick the one with the food. If they were made to wait, the apes sometimes forgot where the food was, but by and large they did well on the task.

To test if the apes doubted their own decisions, Call gave them the option to peek into the end of the pipes before they chose one. He found that the apes were more likely to check the pipes if they had to wait before picking one (*Animal Cognition*, DOI: 10.1007/s10071-010-0317-x). Call says this suggests that the apes had begun to doubt their memory.

Earlier studies have shown that apes and other mammals can be aware that they do not know the answer to a test. However, Call claims that the doubt apparently revealed by his trials represents a subtle thought process not previously seen beyond humans.



## Caterpillars walked, then talked

SOME caterpillars drag their back ends along leaves to ward off intruders on their territory. Now it seems this "anal-scraping" – which creates warning vibrations – evolved from walking. It is the strongest evidence that communication signals can evolve from the exaggeration and repetition of routine behaviours.

Jayne Yack of Carleton University in Ottawa, Canada, and colleagues compared the genes of more than 30 species of caterpillar. They found that scrapers tended to be species that have evolved more recently, and that they settle disputes with an

intruder without fighting. Instead, they wiggle their rear, causing oar-like appendages to scrape and drum against the leaf below (*Nature Communications*, vol 1, p 1).

Crucially, both types of species moved their rear segments in an identical way when faced with an intruder. Non-scrapers have prolegs instead of oars, and the wiggle propels them forwards as they fight off an intruder. Yack says this suggests the oars evolved from prolegs, allowing new forms of communication to emerge – and both parties in a dispute to avoid injury.



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Vote with your feet

## Next step for touchscreens

IMAGINE entering your living room and sliding your foot purposefully over a particular stretch of floor. Suddenly your hi-fi system springs into life and begins playing your favourite CD.

Floors you can use like a giant touchscreen could one day be commonplace thanks to a "touch floor" developed by Patrick Baudisch at the Hasso Plattner Institute in Potsdam, Germany. His prototype, named Multi-toe, is made up of thin layers of silicone and clear acrylic on top of a rigid glass sheet. Light beams shone into the acrylic layer bounce around inside until pressure from above allows them to escape. A camera below captures the light and registers an image of whatever has pressed down upon the floor.

Some touchscreens already employ this technique, but the new version offers greater resolution, allowing the

pattern of the tread on someone's shoes to be detected. Baudisch has already adapted it for the video game Unreal Tournament, with players leaning in different directions to move on screen, and tapping their toes to shoot. A virtual keyboard on the floor can also be activated with the feet.

**"The 'touch floor' allows the pattern of the tread on someone's shoes to be detected"**

Baudisch presented the work at the Conference on Human Factors in Computing Systems in Atlanta, Georgia, this week. He admits the system cannot easily be used on existing floors due to the need for underfloor cavities to house the cameras, but says future versions will address this.

## Prolific posters are top of the blogs

WHEN it comes to making friends online it is the quantity, not quality, of your blog posts that counts.

Susan Jamison-Powell at Sheffield Hallam University in the UK studied the popularity of 75 bloggers on the site Livejournal.com. She looked at the number of friends each blogger had, the number of posts they made, the total number of words written and the overall tone of the posts. She then asked the bloggers to rate how attractive they found each of their peer's blogs.

She found that the more words a blogger posted, the more friends they had and the higher their attractiveness rating. The tone of their posts – whether they contained mostly positive or negative comments – had no effect. The findings were presented at the British Psychological Society's annual conference this week.

# 18.6

**kilometres is the altitude reached by NASA's uncrewed Global Hawk aircraft as it studied the air over the Pacific Ocean**

## Gem of an idea for cooler computing

DIAMONDS could be an electronic engineer's best friend, thanks to a new technique that uses slivers of synthetic gems as the basis for superior microchips.

Pure diamond is an electrical insulator, but given the right impurities it becomes a semiconductor. Crucially, it is also the best heat conductor on Earth, so synthetic diamond could make microchips that handle high-power signals but do not require power-hungry cooling systems.

"Diamond-based control modules in electric cars and industrial machinery could lead

to considerable energy savings," says Hideaki Yamada of the National Institute of Advanced Industrial Science and Technology in Tsukuba, Japan.

Yamada's team used a technique called chemical vapour deposition to "clone" synthetic diamonds. Yamada's clones all have the same crystal lattice structure, so when bonded together they form a monocrystalline mosaic.

The team have so far created 25-millimetre-square wafers from six smaller clones and hope to make them big enough for microchip manufacture. The work was presented at a meeting of the Japan Society of Applied Physics at Tokai University in March.

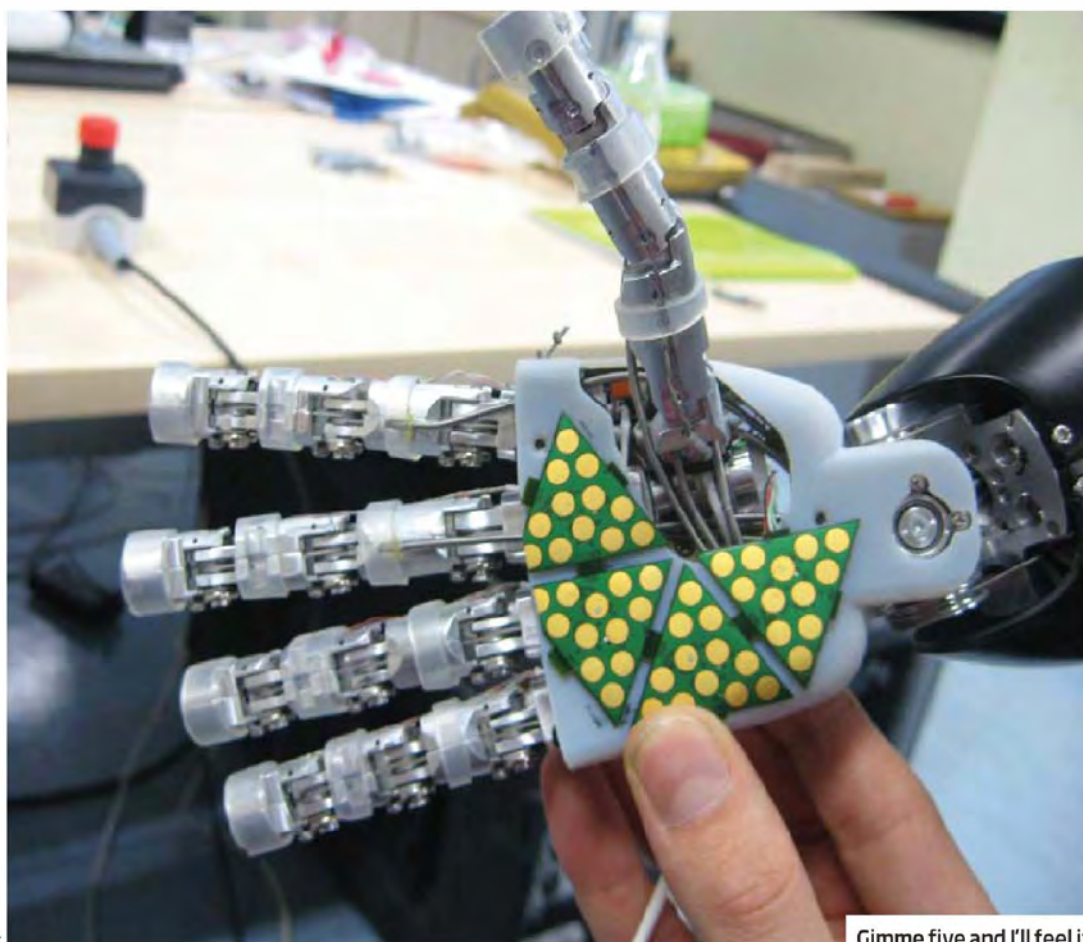


## "Opposition to killing Constellation is growing"

Texan congressman **Pete Olson** insists that there is still a chance to push for NASA's at-risk Constellation programme, which aims to return astronauts to the moon, as the agency's budget is yet to be finalised ([usatoday.com](http://usatoday.com), 9 April)

# Robots with skin enter our touchy-feely world

If humanoid robots are ever to move among us, they will first need to get in touch with the world – and learn to interpret our fuzzy human language



Gimme five and I'll feel it

**Paul Marks**

BEAUTY may be only skin deep, but for humanoid robots a fleshy covering is about more than mere aesthetics, it could be essential to making them socially acceptable. A touch-sensitive coating could prevent such machines from accidentally injuring anybody within their reach.

In May, a team at the Italian Institute of Technology (IIT) in Genoa will dispatch to labs across

Europe the first pieces of touch-sensing skin designed for their nascent humanoid robot, the iCub. The skin IIT and its partners have developed contains flexible pressure sensors that aim to put robots in touch with the world.

"Skin has been one of the big missing technologies for humanoid robots," says roboticist Giorgio Metta at IIT. One goal of making robots in a humanoid form is to let them interact closely with people. But that will only be

possible if a robot is fully aware of what its powerful motorised limbs are in contact with.

Roboticists are trying a great variety of ways to make a sensing skin. Early examples, such as the CB2 robot, built at Osaka University in Japan, placed a few hundred sensors in silicone skin. But now "many, many sensing methods are emerging", says Richard Walker of Shadow Robot, London. Until a lot of robots are using them, it is going to be hard

to say which are best suited for particular applications.

What's more, there are many criteria the skin has to meet, says Metta: it must be resilient, able to cover a large surface area and be able to detect even light touches anywhere on that surface. "Many of these factors conflict with each other," he says.

The iCub is a humanoid robot the size of a child of three-and-a-half years old. Funded by the European Commission, it was designed to investigate cognition and how awareness of our limbs, muscles, tendons and tactile environment fuels the development of intelligence. The iCub's technical specifications are open-source and some 15 labs across Europe have already "cloned" their own, so IIT's skin design could find plenty of robots to enwrap.

The skin is made up of triangular, flexible printed circuit boards which act as sensors, and it covers much of iCub's body. Each bendy triangle is 3 centimetres to a side and contains 12 capacitive copper contacts (pictured). A layer of silicone rubber acts as a spacer between those boards and an outer layer of Lycra that carries a metal contact above each copper contact. The Lycra layer and flexible circuits constitute the two sides of the skin's pressure-sensing capacitors. This arrangement allows 12 "tactile pixels" – or taxels – to be sensed per triangle. This taxel resolution is enough to recognise patterns such as a hand grasping the robot's arm. The skin can detect a touch as light as 1 gram across each taxel, says Metta. It is also peppered with semiconductor-based temperature sensors. This version of the skin will be released in May.

Later, IIT plans to add a layer of a piezoelectric polymer called PVDF to the skin. While the capacitance sensors measure absolute pressure, the voltage produced by PVDF as a result of its deformation when touched can be used to measure the rate

of change of pressure. So if the robot runs its fingertip along a surface, the vibrations generated by friction give it clues about what that surface is made of. Such sensitivity might help it establish the level of grip needed to pick up, say, a slippery porcelain plate.

Philip Taysom, CEO of British company Peratech of Richmond, North Yorkshire, is not a fan of sensing skins based on capacitors, which he says can lose sensitivity with repeated use. Peratech's answer is a stretchy, elastic material it calls quantum tunnelling composite (QTC). This comprises a polymer such as silicone rubber that is heavily loaded with spiky nickel nanoparticles. A voltage is applied across the skin, and when it is pressed, the distance between the nanoparticles within the polymer

diminishes, which results in electrons flowing, or "tunnelling", from one nanoparticle spike to the next in the area being touched. Crucially, the material's electrical resistance drops dramatically and in proportion

### **"Skin has been one of the big missing technologies in the designing of humanoid robots"**

to the force applied, so the touch can be interpreted.

At the Massachusetts Institute of Technology's Media Lab, Adam Whiton is developing a QTC-based sensing skin for a commercial robot-maker which he declines to name. Instead of a tight, conforming skin, Whiton uses a looser covering, more akin to clothing. "We cover ourselves

with textiles when we interact with people, so clothing may be a better metaphor as a humanoid's pressure-sensitive surface covering," he says.

Natural gestures, like tapping a humanoid on the back to get its attention, or leading it by the arm, can be easily interpreted because QTC boasts high sensitivity, he says. But novel skin capabilities could be on the way, too. For example, QTC can also act as an electronic nose. Careful choice of the material's base polymer, says Taysom, means telltale resistance changes can be induced by reactions between volatile chemicals in the air – so it can become an e-nose as well as a touch sensor, able to detect, for example, a gas leak in your home. "This shows we can probably build into robots a lot

of things that our skin can't do. It's another reason not to stick rigidly to the human skin metaphor," says Whiton.

That's not to say our skin isn't a great influence. Shadow Robot will soon start testing a novel human-like touch-sensing fingertip from Syntouch, a start-up based in California. Its fingertip comprises a rubbery fluid-filled sac that squishes just like a real fingertip, and is equipped with internal sensors that measure vibration, temperature and pressure.

Whichever of the emerging technologies prevail, sensing robot skins should help us get along with our future humanoid assistants, says Whiton. "Right now, robots are about as friendly as photocopiers. The interactions skins encourage will make them much friendlier." ■

## **Parlez-vous robot?**

If you've ever tried to direct a lost tourist to their intended destination, you'll know how difficult directing someone that doesn't speak your language can be. Directing robots presents a related challenge.

Typically, robots respond well to precise instruction sets but they are flummoxed if their instructions are given in the fuzzy, everyday language so beloved by humans. Now a team at the University of Washington in Seattle have developed translation software which could enable robots to understand a set of natural-language directions. The technology could make it easier to control robots in situations like search and rescue, where it can be preferable to send a robot rather than a human.

Cynthia Matuszek and her colleagues used the principles of machine translation – commonly used online to translate text of one language into another – to develop a navigation program for robots.

**Safer to tell a robot to look around inside a quake-damaged building**

Machine translation tools are designed to learn from previous efforts, improving their accuracy through experience.

The team first sent a small mobile robot to explore and map portions of two buildings on campus. The researchers then generated random

paths through the maps and asked human volunteers to annotate the routes with natural commands, such as "turn right", or "take the second left" that would have led to successful completion of each path.

Matuszek used these maps to train the navigation program, which

learned to associate the various human commands with specific types of route-finding behaviour.

The navigation program was then run on a virtual robot, which was given natural-language directions for a variety of previously unknown routes through the maps. The virtual robot was able to successfully complete 10 of the 14 direction sets on its first attempt. The results were presented at the International Conference on Human-Robot Interaction in Osaka, Japan, in March.

"I'm glad to see work that is getting back to the original dreams of the field, like having a robot that you can talk with naturally," says Ray Mooney, a machine-translation researcher at the University of Texas in Austin.

He says that previous attempts to give robots instructions have favoured explicit rules for sentence structures, semantics and syntax. He says this "traditional" approach is labour intensive and requires strictly defined commands, making it cumbersome in emergency situations where many robots are deployed. MacGregor Campbell ■



PILAR OLIVARES/REUTERS

## How to create an online museum of everything

HAVE you ever come across an unusual object and wanted to know its history? Soon you might simply be able to retrieve the details on your smartphone.

That's the idea behind a new scheme for creating web pages about physical objects. Its creators say it could change the way we store memories about objects and even places.

The project is based on the concept of the "internet of things"—the idea that physical objects can have an online presence. A simple example of this is a database that keeps track of the stock in a warehouse by listening for signals from the ID chip on each item.

The Tales of Things website, which went live this week, aims to take this idea into a new realm. It allows users to create an entry on the site for any object they like. A basic entry features an image and associated text, but audio, video and other content can also be added. The site then generates a unique two-dimensional barcode,

known as a QR code, for the user to print off and attach to the object.

Anyone then scanning the code with a web-enabled device will see the object's online entry. The team behind the website has so far developed scanning software for the iPhone and devices running the Android operating system.

Linking objects with people's memories of those items could be one of the most interesting uses for the site, says Andrew Hudson-Smith of University College London, one of the five UK academic institutions behind

the project. Museum curators have also expressed an interest in tagging their collections, he says.

The system will be demonstrated at next month's FutureEverything conference in Manchester, UK. Donations to a charity shop near the main

**"The widespread use of smartphones means many people now own devices that can read QR codes"**

conference venue will be tagged and the donors encouraged to tell a brief story about each item, which will be included in the object's Tales of Things entry.

Henry Holtzman at the Massachusetts Institute of

Technology, one of the first researchers to work on the internet of things, says he likes the idea of linking memories to objects. But he questions whether casual users will take the trouble to document items in this way, since the benefits of the site will only become clear once it covers a large number of objects. "How do they get to critical mass?" he asks.

Hudson-Smith says that the widespread use of smartphones will help such projects because many people now own devices that can be used to read QR codes. The possibility of linking an object's entry to its owner's Facebook profile or Flickr images of the item may also draw users to the site, he adds. **Jim Giles ■**

### Telling tales

A do-it-yourself method for cataloguing physical objects online could make museums and galleries a more interactive experience



Create an entry on [talesofthings.com](http://talesofthings.com) to generate a QR code



Attach the QR code to the relevant object



Web-enabled devices with a barcode reader display information about the object

## INSIGHT

### US court ruling on internet regulator's powers leaves key question unanswered

SHOULD the internet treat all data equally, regardless of whether it is part of a multi-gigabyte video file or a short email? A ruling by the US Court of Appeals last week has left the issue as murky as ever.

Nearly two years ago, the US Federal Communications Commission (FCC) censured network operator Comcast for trying to impose restrictions on "bandwidth hogs" who use BitTorrent and other file-sharing software. These systems eat up huge amounts of data capacity, and so can degrade the service to other customers.

The FCC intervened on the basis of



Fast downloading for some means delays for the rest

the "net neutrality" principle that all data should be treated equally, but the Court of Appeals has now ruled that the FCC cannot dictate how internet service providers manage their networks. Confusingly, both sides have declared their support for net neutrality. The FCC reaffirmed its commitment to "preserving a free and open internet", while Comcast says it too "remains committed to the FCC's existing open internet principles".

But the key problem remains unresolved: when large numbers of customers want to access the internet simultaneously, how can traffic be managed in a way that prevents those who are transferring huge multimedia files clogging up the network?

Johan Pouwelse, a peer-to-peer

researcher at the Delft University of Technology in the Netherlands, suggests that a different kind of charging tariff could help. Instead of charging customers on the basis of download speeds, network operators should charge users and content providers according to how much data they download or upload. "They could do that without interfering with traffic, in an entirely net neutral way," he says.

This proposal would be opposed by internet giants such as Google and Facebook, who generate large volumes of web traffic and so could face higher charges. But with high-speed broadband stimulating an ever-growing appetite for bandwidth, some way must be found to fairly share out the internet's limited resources. **Gareth Morgan ■**

inbox (you have new knowledge)



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# Science's global challenge

What do the leading lights of science in nations around the world identify as the most pressing concerns for humanity, and what are the prospects for progress? When the InterAcademy Panel – the global network of the world's science academies – met at the Royal Society in London this year, we asked them to tell us. 70 members of 62 academies, from Albania to Zimbabwe (see flags, above), responded to a *New Scientist* questionnaire. Here are the key results

## 1. Confronting climate change

### Outer rings

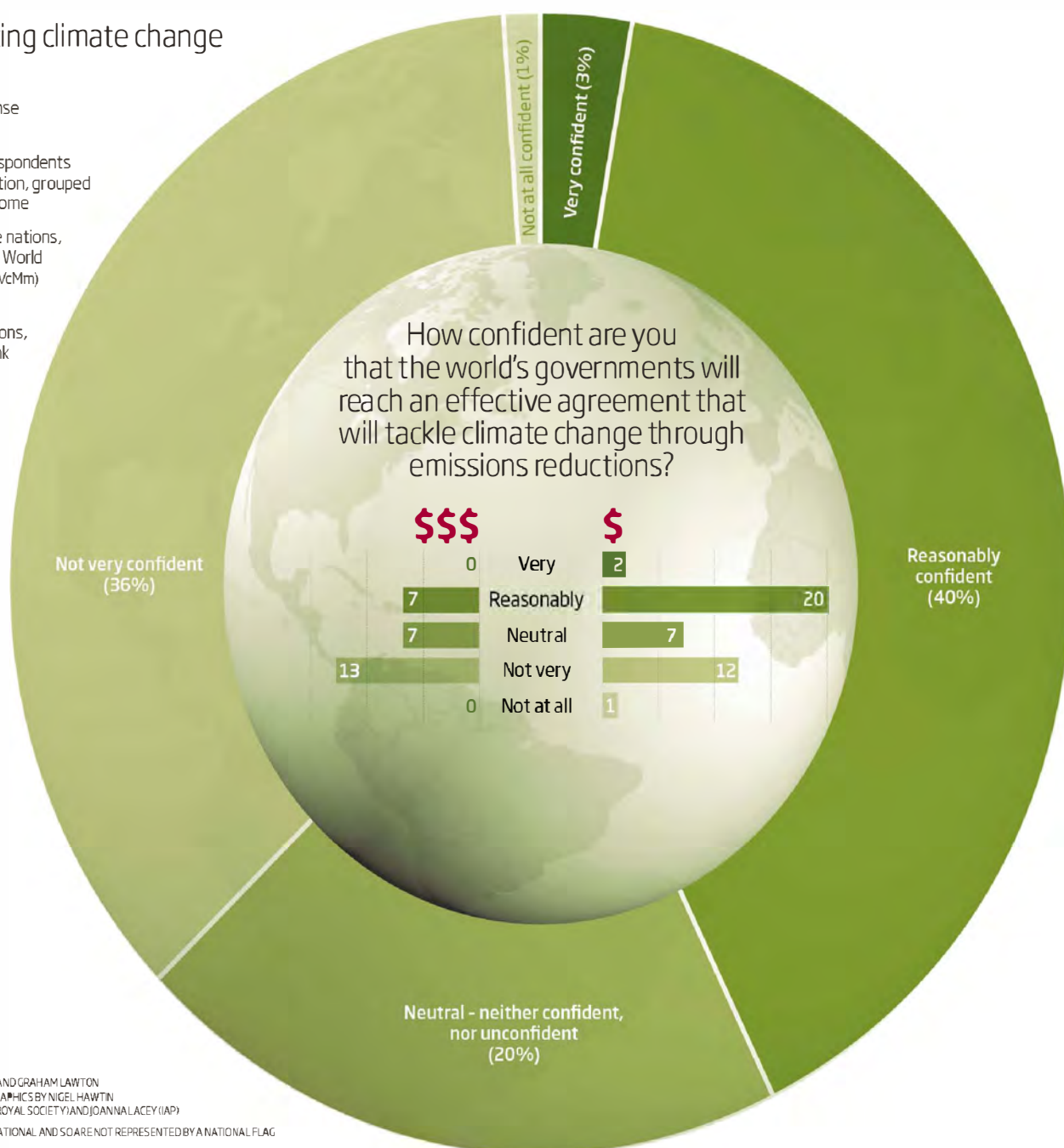
show overall response

### Horizontal bars

show number of respondents who chose each option, grouped by their nation's income

\$\$\$ = High-income nations, based on OECD and World Bank ratings ([bit.ly/rVcMm](http://bit.ly/rVcMm))

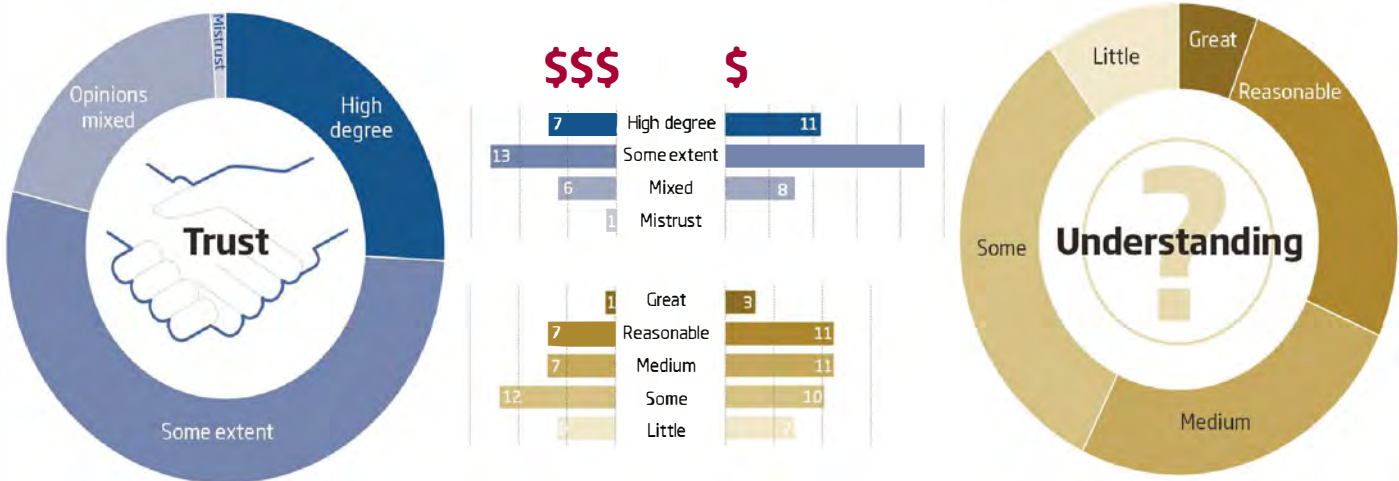
\$ = Low to upper-middle-income nations, based on World Bank ratings



SURVEY BY ROGER HIGHFIELD AND GRAHAM LAWTON  
ANALYSIS BY HENRY GOMM; GRAPHICS BY NIGEL HAWTIN  
THANKS TO ALICE HENCHLEY (ROYAL SOCIETY) AND JOANNA LACEY (IAP)  
SOME ACADEMIES ARE MULTINATIONAL AND SO ARE NOT REPRESENTED BY A NATIONAL FLAG

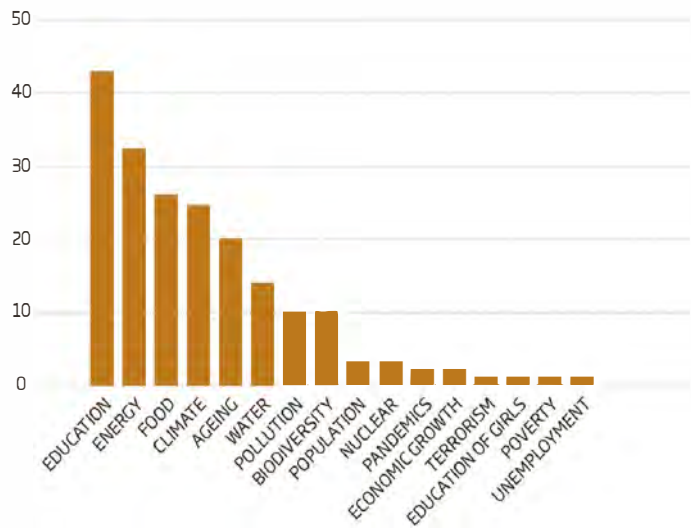


2. What trust and understanding do people in your country have in science?

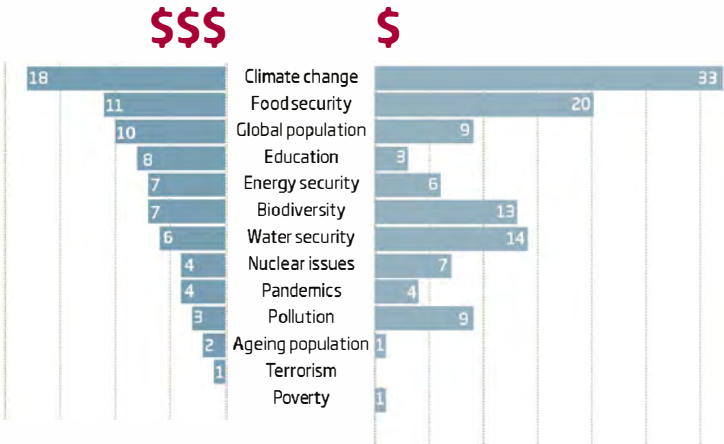
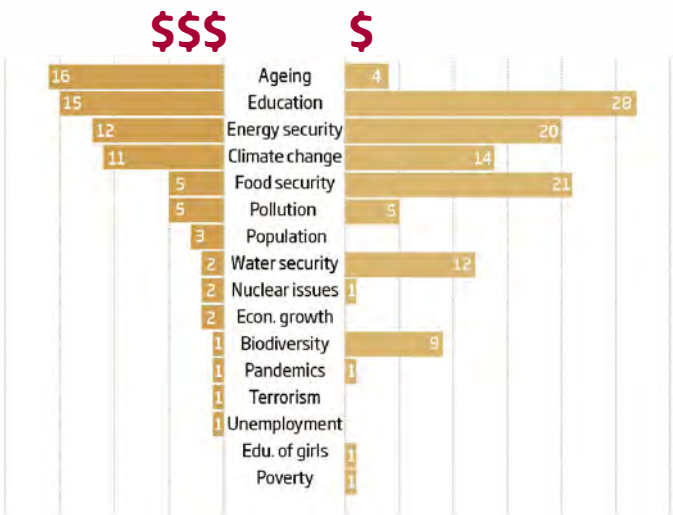
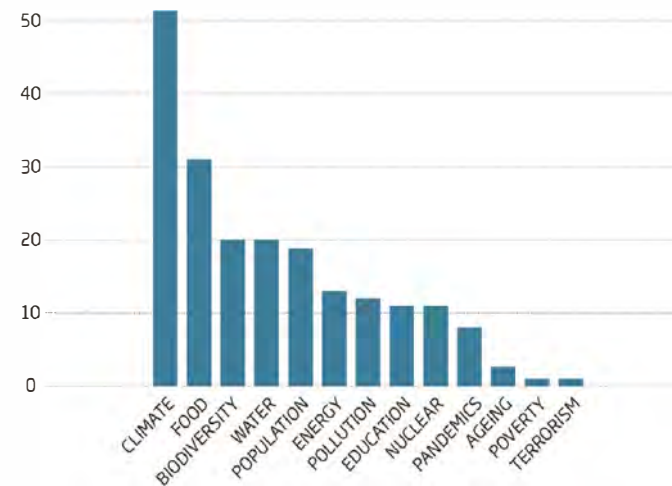


3. Looking ahead to 2020, what three issues concern you most at a national and global level?

National



Global



## Find the cause of pain

From L. S. Illis

You report Beverly Collett and Irene Tracey as calling for pain to be treated as a disease (6 March, p 6). This would be a terrible, retrograde step.

I retired in 1995 after 15 years running a clinic treating patients with intractable neurological pain. It was fascinating. All the patients – and I do mean all – had previously had their pain “treated” by other doctors who had not first made a diagnosis of its cause.

Patients with intractable pain invariably suspect that something nasty is eating away inside them. Imagine the effect that this, combined with the pain itself, would have.

We took a comprehensive history, and after appropriate investigations gave a detailed explanation of the cause of the pain. Even when treatment was not successful in altering the experience of the pain, patients stated that knowing its cause enabled them to relegate it to a

minor aspect of their life, instead of dominating it.

Lymington, Hampshire, UK

## Empathy excess

From Jaques de Boys

Helen Thomson writes that all documented pain synaesthetes suffered traumatic pain before developing the condition: “Many are amputees, and their phantom limb is the site of the pain they feel when faced with another’s distress” (13 March, p 42).

All my life – I am now 64 – whenever I heard about someone being sliced by a sharp object I felt a sharp pain in my circumcision scar. Now I know why. My case may expand the understanding of this phenomenon: unlike most amputees, I was only a week old when I was circumcised and have no conscious memory of it.

It was a routine circumcision performed by a competent doctor, but in late 1945 newborns being circumcised in the UK probably did not receive any anaesthetic. Address supplied, Canada

## Muscular thinking



From Paul Ellis

The idea that you can “let your body do the thinking” may go back further and wider than you suppose (27 March, p 5 and p 8).

When the mathematician Jacques Hadamard was doing the research that formed the basis of his book *Psychology of Invention in the Mathematical Field* in the late 1930s, he asked Albert Einstein about “elements in thought”. Einstein responded: “The above mentioned elements are, in my case, of visual and some of muscular type.”

Perhaps such a kinaesthetic approach to thought is sensible when trying to conceive of the curved space of general relativity. London, UK

From Peter Harrison

As I read of Tobias Loetscher’s finding that when people think of a number smaller than the previous one they look to the left and down, I found myself imagining larger numbers to the left and farther down than smaller ones.

I realised I was subconsciously thinking of a spreadsheet. It seems a lifetime of using tables with headings across the top and down the left has completely obliterated the influences of my early years. Fetcham, Surrey, UK

## Why flap over bats?

From Keith Alexander

In your editorial you repeat uncritically the propaganda that

so many bat conservationists use to try to justify the conservation of their favourite organisms (27 March, p 5).

Some bats do feed on insects, but what is the evidence that they selectively eat insects that damage farmers’ crops? Won’t some insects be beneficial to farmers in being the predators and parasites of those pests? Others may well be pollinators of some of those crops.

Do farmers really cut down their pesticide usage when they see bats flying over their crops? Exeter, Devon, UK

From Matthew Smith

If white nose syndrome is caused by a fungal infection, then it is likely that those few bats that survive will possess traits that make them resistant to the disease. These will go on to breed a new generation of resistant bats.

Bats will beat this disease without the help of humans, as will the ecosystems that may themselves become significantly impacted by the loss of bats.

Let’s be honest: the reason we want to limit the disease is because it may harm us, either through reducing the ecosystem services bats provide or by altering our view of what a “proper ecosystem” should be like. Cambridge, UK

## Sniff at pheromones

From Tristram Wyatt, Department of zoology, University of Oxford  
I agree with Richard Doty that there is not likely to be a human pheromone to make anyone irresistible (27 February, p 28), but that does not mean there are no human pheromones.

Other mammals have small-molecule pheromones. All rabbit pups, for example, respond to their mother’s mammary pheromone, 2-methylbut-2-enal (*Nature*, vol 424, p 68).

In addition to pheromones, mammals have signature mixtures, the complex smells

## Enigma Number 1591

### Pseudo coup

BOB WALKER

All Penny had to do this week was fill in the missing numbers so that each row, each column and each three-by-three square all had each of the numbers 1 to 9. In printing out the puzzle Joe had interchanged some of the three-by-three squares. Penny worked out which and filled in all the missing numbers. What number did Penny place in the small shaded square?

	6			2			9	
8	4			3	4	2		6
		9	8				5	
		3	9	8				7
8	5					3		1
	7			7	3	5		
4	6				4	5		
			3		2		8	4
	3	1	6				7	

**WIN** £15 will be awarded to the sender of the first correct answer opened on Wednesday 19 May. The Editor’s decision is final. Please send entries to Enigma 1591, New Scientist, Lacon House, 84 Theobald’s Road, London WC1X 8NS, or to [enigma@newscientist.com](mailto:enigma@newscientist.com) (please include your postal address).

**Answer to 1585** Diving Points: The number is 6290

**The winner** Peter Topping of Largs, Ayrshire, UK

The answer to Enigma 1583, sent in by the winner Paul Stillman, is 24 March and 26 July. We published the wrong answer in our 3 April issue.

unique to each individual, which are part genetic and part acquired. It is this combination of variability and learning that sets signature mixtures apart from pheromones (See my essay in *Nature*, vol 457, p 262).

There may be debate about the statistics of menstrual synchrony in humans, but the physiological evidence that there may be a so far unidentified pheromone in women's underarm secretions that can affect other women, especially their menstrual cycles, still stands.  
*Oxford, UK*

*Richard Doty writes:*

■ In *The Great Pheromone Myth* I showed, case by case, how major claims of the identification of pheromones are not reproducible, or are based on findings in which learning or novelty play the primary role, or point to chemicals that fall short of truly or uniquely mimicking the actual behavioural or endocrine processes observed in normal circumstances.

## Military innovation

*From Ian Gilbert*

Henrik Tschudi proposes that scientists pledge not to do research that would be harmful to life on Earth, taking into account all possible applications (13 March, p 26). This could eliminate most scientific projects.

The internet was invented by the US Defense Advanced Research Projects Agency for

military communications. Battlefield injuries lead to medical advances, funded by the military with the primary purpose of saving soldiers' lives and limbs. Nuclear power technology was originally funded by – you guessed it – the US Department of Defense.

Conversely, the pledge would bar such non-military research as pharmaceutical development, medical technology, automotive and aviation research, and, of course, all computer technology, because the possible applications include military uses.  
*Washington DC, US*

## Neuroscience ethics

*From Martha Farah, Center for Neuroscience & Society, University of Pennsylvania*  
Curtis Bell asks us to refuse to participate in the application of neuroscience to goals that violate human rights and international law (6 February, p 24). This has sparked an important and overdue discussion among neuroscientists concerning the "dark side" of our field.

Cognitive and affective neuroscience have come of age and are now of practical interest in many fields involving human behaviour, including business, education, law and, as Bell reminds us, warfare. But drugs which enhance the effectiveness of soldiers, to give just one example, can also enhance anyone working under fatigue and stress, including soldiers on rescue operations and surgeons on night call.

Like Bell, I am against wars of aggression, but I believe that we should mobilise against them as citizens, rather than refuse, as neuroscientists, to develop technologies that can help peacekeepers and rescue workers. More good can be done by increasing transparency in neuroscience research and by raising awareness among

scientists and the public of its social impact.

*Philadelphia, Pennsylvania, US*

## Free will and blame

*From Martin Hobbs*

As Holly Anderson describes Eliezer Sternberg's book *My Brain Made Me Do It*, both seem concerned about the problem of free will, but then speak of moral responsibility (27 March, p 50).



Confusion between blame and responsibility often muddies the discussion of such issues. If I were to hurt another person I would undoubtedly be responsible.

Whether my choice of action was determined by my genes, my nurturing, my culture, my neurons, God, the devil, or little green men from Alpha Centauri, it would be my hands committing the deed. Regardless of the physical and chemical processes that underlie our choices, our decisions will in some part be determined by our genetics, our nurturing and feedback from previous decisions.

The freedom I have to make decisions is probably quite small – otherwise I wouldn't continue to make the same bad decisions over and over again for most of my life. I don't believe anyone is to blame for their actions; yet I hold them all fully responsible.

Thus I make amends for the times when I hurt others, and would like others to do the same. I would like to live in a society with a legal system that also seeks to do the same, rather

than one intent on punishing people – which seems to be more about appeasing the "moral" indignation of others than finding solutions to society's problems.  
*Brighton, UK*

## Trojan wars

*From Peter Brooks*

You advise readers to click on a link in an email only if it comes from a trusted contact (20 March, p 20). Never click on such links. You should copy the linked address and paste it into a plain-text editor, and learn how to examine it for suspicious signs.

Mostly, it will be harmless. But one time your trusted contact will have had their computer hacked, and it will have sent emails to everyone in their address book. Following the link in that email may take you to a site that in turn hacks into your machine, and makes it send emails to all your contacts.

*Los Angeles, California, US*

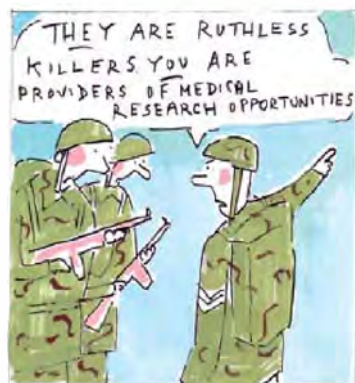
## For the record

- The medical TV drama that included 85 instances of sexual misconduct was *Grey's Anatomy*, not *House* (3 April, p 5).
- The designer of antennas for robot submarines is Jake Piskura, not Piscura (27 March, p 56).
- Edward Witten would be better described as "string theory's leading architect" than as its founder (13 March, p 28). Its founders include Gabriele Veneziano (2 September 2006, p 28) and Yoichiro Nambu and Jeffrey Goldstone (10 April 1999, p 32).

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# Hubble? Phoenix, more like

Twenty years after its launch, the Hubble Space Telescope's spectacular images are a familiar sight. Yet it is incredible that the observatory has survived this long, given the near-death experiences it has faced along the way, says **David Shiga**

LIKE the space telescope he championed, astronomer Lyman Spitzer faced some perilous moments in his career. Most notably, on a July day in 1945, he happened to be in the Empire State building when a B-25 Mitchell bomber lost its way in fog and crashed into the skyscraper 14 floors above him. Seeing debris falling past the window, his curiosity got the better of him, as Robert Zimmerman recounts in his Hubble history, *The Universe in a Mirror*. Spitzer tried to poke his head out the window to see what was going on, but others quickly convinced him it was too dangerous.

Spitzer was not the first astronomer to dream of sending a telescope above the distorting effects of the atmosphere, but it was his tireless advocacy, in part, that led NASA to launch the Hubble Space Telescope in 1990.

Initially jubilant, astronomers were soon horrified to discover that Hubble's 2.4-metre main mirror had been ground to the wrong shape. Although it was only off by 2.2 micrometres, this badly blurred the telescope's vision and made the scientists who had promised the world new images and science in exchange for \$1.5 billion of public money the butt of jokes. The fiasco, inevitably dubbed "Hubble Trouble" by the press, wasn't helped when even the limited science the crippled Hubble could do was threatened as its gyroscopes, needed to control the orientation of the telescope, started to fail one by one.

By 1993, as NASA prepared to launch a rescue mission, the situation looked bleak. The telescope "probably wouldn't have gone on for more than a year or two" without repairs, says John Grunsfeld, an astronaut

who flew on the most recent Hubble servicing mission. Happily, the rescue mission was a success. Shuttle astronauts installed new instruments that corrected for the flawed mirror, and replaced the gyroscopes.

Two years later, Hubble gave us the deepest ever view of the universe, peering back to an era just 1 billion years after the big bang to see the primordial building blocks that aggregated to form galaxies like our own.

The success of the 1993 servicing mission encouraged NASA to mount three more (in 1997, 1999 and 2002). Far from merely keeping the observatory alive, astronauts installed updated instruments on these missions that dramatically improved Hubble's power.

**"The Hubble telescope is really only now reaching its full stride, after 20 years"**

It was "as if you took in your Chevy Nova [for repairs] and they gave you back a Lear jet," says Steven Beckwith, who from 1998 to 2005 headed the Space Telescope Science Institute (STScI) in Baltimore, Maryland, where Hubble's observations are planned.

Along the way, in 1998, Hubble's measurements of supernovas in distant galaxies unexpectedly revealed that the universe is expanding at an ever-increasing pace, propelled by a mysterious entity now known as dark energy. In 2001 the space observatory also managed to make the first measurement of a chemical in the atmosphere of a planet in an alien solar system.

Despite its successes, Hubble's life looked like it would be cut short when in 2004, NASA's then administrator Sean O'Keefe announced the agency would send no more servicing missions to Hubble, citing unacceptable risks to astronauts in the wake of the Columbia shuttle disaster of 2003, in which the craft exploded on re-entry, killing its crew.

By this time, three of Hubble's gyroscopes were already broken or ailing and no one was sure how long the other three would last. Citizen petitions and an outcry among astronomers put pressure on NASA, and after a high-level panel of experts declared that another mission to Hubble would not be exceptionally risky, the agency reversed course, leading to the most recent servicing mission, in May 2009.

No more are planned. The remainder of the shuttle fleet that astronauts used to reach Hubble is scheduled to retire by the year's end. And in 2014, NASA plans to launch Hubble's successor, an infrared observatory called the James Webb Space Telescope, which will probe galaxies even further away and make more measurements of exoplanet atmospheres.

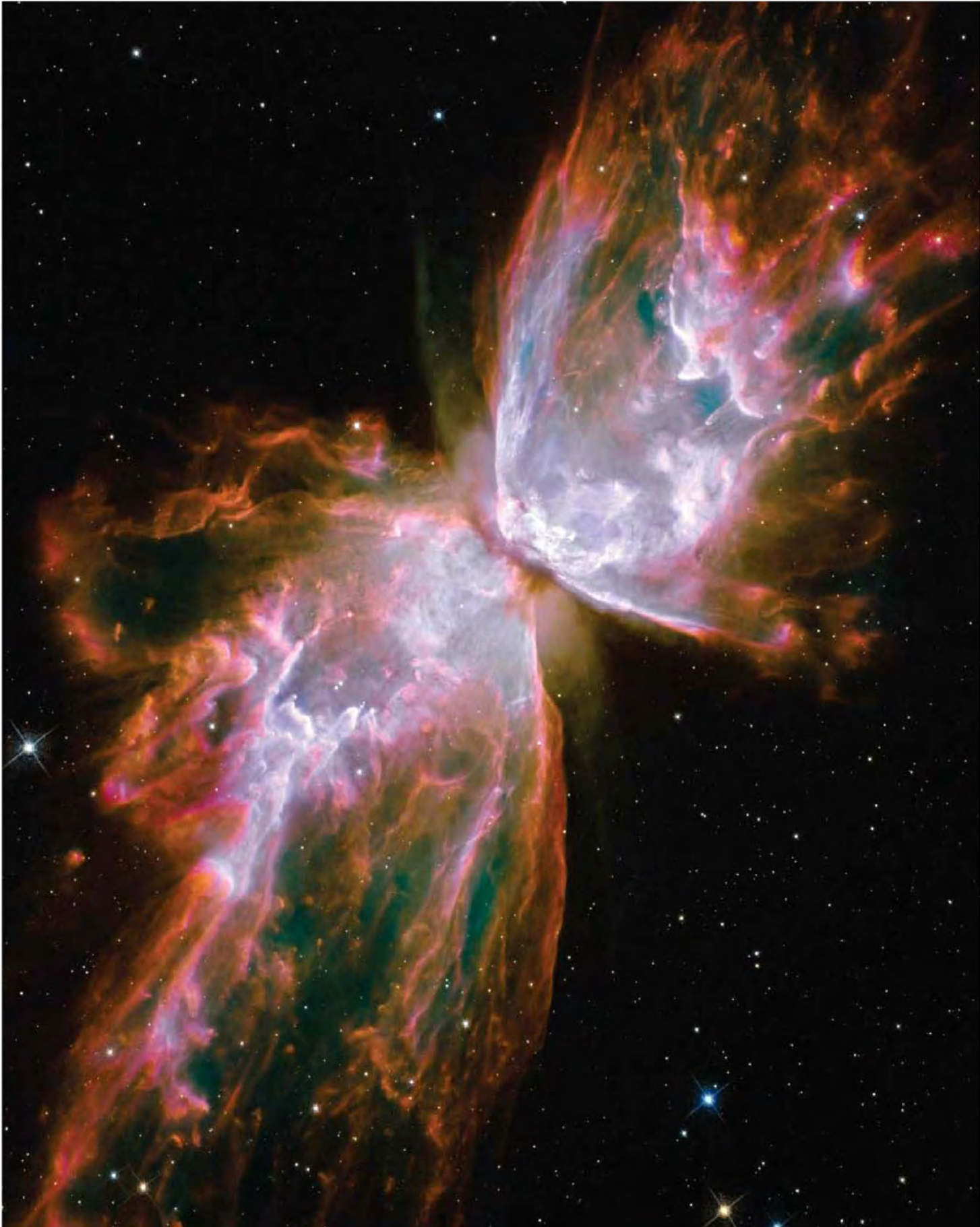
According to Grunsfeld, now STScI's deputy director, plans are afoot for a robotic mission to grab Hubble when it reaches the end of its useful life, nudging it into Earth's atmosphere where most of it would be incinerated. Only the mirror is sturdy enough to survive the fall into an empty patch of ocean.

But let's not get ahead of ourselves – Hubble is far from finished. The instruments installed in May 2009, including the Wide Field Camera 3, which took this image of the Butterfly nebula, 3800 light years away, have boosted its powers yet again. It might have as much as a decade of life left even without more servicing. "It really is only reaching its full stride now, after 20 years," says Grunsfeld.

A key priority for Hubble will be to explore the origin of dark energy by probing for it at earlier times in the universe's history. Hubble scientist Malcolm Niedner of NASA's Goddard Space Flight Center in Greenbelt, Maryland, is not willing to bet on what its most important discovery will be. "More than half of the most amazing textbook-changing science to emerge from this telescope occurred in areas we couldn't even have dreamed of," he says. "Expect the unexpected." ■

## PROFILE

Named after the astronomer Edwin Hubble, the Hubble Space Telescope was launched in April 1990. It was the first space telescope designed to be serviced in space, which is lucky, all things considered



NASA, ESA, AND THE HUBBLE SM4 ERO TEAM

A colossal eruption from the Toba supervolcano rocked early humans. Now a picture of the fallout is emerging from the ashes, says Kate Ravillious

**T**HE first sign that something had gone terribly wrong was a deep rumbling roar. Hours later the choking ash arrived, falling like snow in a relentless storm that raged for over two weeks. Despite being more than 2000 kilometres from the eruption, hominins living as far away as eastern India would have felt Toba's fury.

Toba is a supervolcano on the Indonesian island of Sumatra. It has blown its top many times but this eruption, 74,000 years ago, was exceptional. Releasing 2500 cubic kilometres of magma – nearly twice the volume of mount Everest – the eruption was more than 5000 times as large as the 1980 eruption of mount St Helens in the US, making it the largest eruption on Earth in the last 2 million years (see “Blown away”, page 31).

The disaster is particularly significant since it occurred at a crucial period in human prehistory – when Neanderthals and other hominins roamed much of Asia and Europe, and around the time our direct ancestors, *Homo sapiens*, were first leaving Africa to ultimately conquer the world. Yet with no recent eruptions for easy comparison, the full extent of its fallout and impact on early

humans has been shrouded in mystery.

Now dramatic finds from archaeological digs in India, presented in February at a conference at the University of Oxford, are finally clarifying the picture of the eruption and its effects, and how it shaped human evolution and migration. Further results from the digs may even rewrite the timing and route that modern humans took out of Africa.

The new work portrays a somewhat different view of the eruption from the most popular current theory. Previous computer models of the eruption had suggested the event was truly cataclysmic – very nearly a doomsday for early humankind. With calculations based on the assumption that Toba belched out 100 times more aerosols than the 1991 eruption of mount Pinatubo in the Philippines, and scaling the environmental effects accordingly, the models suggested global temperatures dropped by about 10 °C following the blast. This supports the idea of a decade-long “volcanic winter” and widespread catastrophe (*Journal of Geophysical Research – Atmospheres*, vol 114, p D10107).

To make matters worse, the aerosols would have blocked out life-giving sunlight and absorbed water vapour in the atmosphere, causing a dryer global climate for the next few years. This would have resulted in a rapid decline in tree cover and a concomitant expansion of grasslands, leading to the extinction of many mammals and nearly wiping our ancestors out (*Palaeogeography, Palaeoclimatology, Palaeoecology*, vol 284, p 295). The few primitive humans that did survive the eruption would have had to act fast, quickly adapting their way of life to suit the new conditions, travelling further to find

food and cooperating with neighbouring populations in the battle for survival.

Indeed, the event may have drastically altered the path of evolution for our own species, *Homo sapiens*. Modern humans, who were still thought to be living in Africa, would have been whittled down to just a few thousand breeding pairs scattered in dispersed refugia – creating a so-called “genetic bottleneck” in evolution. As the separate colonies developed independently of one another, they would have sown the seeds for the genetic differences between races once these separate groups eventually left Africa.

Yet this theory has drawn some criticism since it was first put forward 17 years ago, with scholars such as Hans Graf, an atmospheric scientist at the University of Cambridge, believing that the climate change following the explosion has been wildly overestimated.

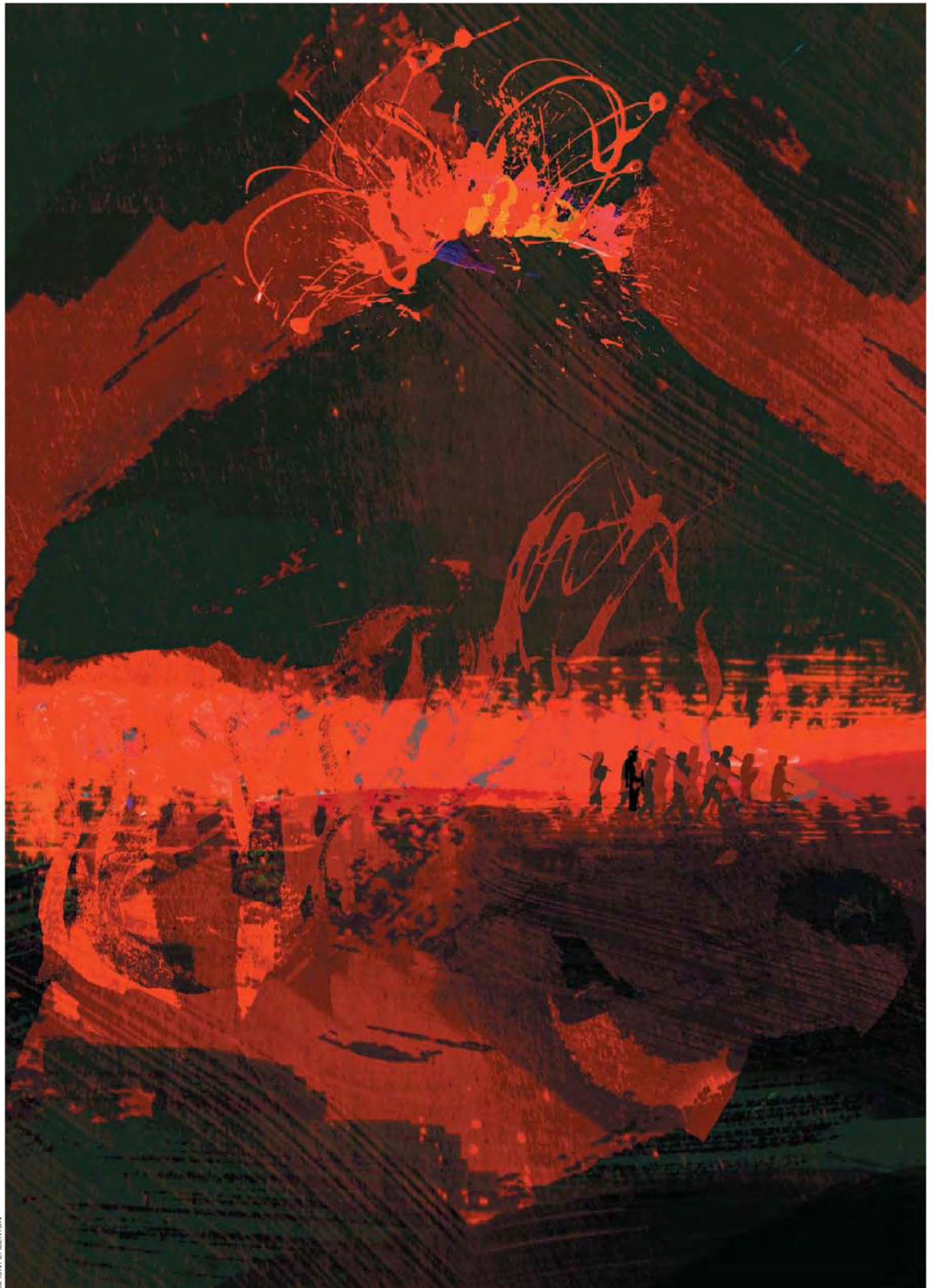
For Graf, the crux of the argument concerns the precise cooling effect of the sulphur dioxide released by the explosion. During smaller eruptions, like that of mount Pinatubo, most of the released sulphur dioxide reacts with hydroxide (OH) ions from water molecules in the atmosphere to form particles of sulphate – a highly reflective substance that bounces sunlight back into space before it can warm the Earth.

Previous estimates had placed Toba's sulphur dioxide production at 100 times that of mount Pinatubo's output. Graf thinks this figure is misguided: recent chemical analyses of Toba's fossilised magma suggests it should be roughly half that. “We think Toba was more of a giant in ash production, not sulphur,” says Graf.

What's more, he says, the atmospheric effect of a super-eruption is incomparable to a ➤

# Exodus

## on the exploding Earth



“Early humans would have had to adjust to colder temperatures after the eruption, economising as resources dwindled”

smaller, typical eruption. Whereas most of the sulphur dioxide from mount Pinatubo would have been rapidly converted to sulphate particles, there simply would not have been enough OH ions in the atmosphere available to react with all the sulphur dioxide released by Toba, delaying the formation of these reflective particles. Even those particles that had formed would have probably clumped together and settled to the ground rather than stay in the atmosphere.

Taking all of this into account, Graf and his colleagues suggest a new estimate of global cooling of just 2.5°C, which lasted for just a few years. According to this model, the effects were also highly regional. In places like India the average temperatures may only have fallen by about 1°C – not such a dramatic climate shift.

This new view is highly contentious. Alan Robock from Rutgers University in New Brunswick, New Jersey, who came up with the original simulations, stands by his original predictions. “Our model showed that extra water would be lofted into the stratosphere because of warming at the top of the troposphere [the lowest layer in the atmosphere], so water would not be a limiting factor,” he says. “We simulate a decade or two of very cold, dry, dark conditions, which would have been difficult for humans to adapt to.”

Yet recent archaeological and geological work in India seems to support Graf’s claims, suggesting the environmental impact of the

The landscape after Pinatubo’s eruption may give a glimpse of what early humans experienced



PHILIPPE BOURSILLER/JH EDITORIAL

## Blown away

The super-eruption that occurred 74,000 years ago in Toba, Indonesia, dwarfs any volcanic eruption in the last 2 million years

Toba: 74,000 years ago (2500km<sup>3</sup> of magma)

super-eruption was much less than previously imagined. Firstly, had there been a sudden deforestation event caused by the cooling and drying of the atmosphere, topsoil no longer anchored by trees would be expected to wash down into valleys, where it would quickly accumulate. "We don't find a rapid influx of soil arriving on top of the ash layers," says Peter Ditchfield of the University of Oxford.

To build further evidence, Ditchfield analysed the ratio of different carbon isotopes – which are each absorbed at different rates by different plants – in ancient plant remains in the Jwalapuram region of southern India and the Middle Son river valley in central northern India, both of which are around 2000 kilometres from Toba. He saw only a slight increase in the carbon-13 isotope after the Toba eruption, which suggests there was just a small increase in grassland environments at this time. "Woodlands weren't obliterated by Toba. We see a diverse range of habitats persisting after the eruption, which would have provided a diverse range of game and hunting opportunities," he says.

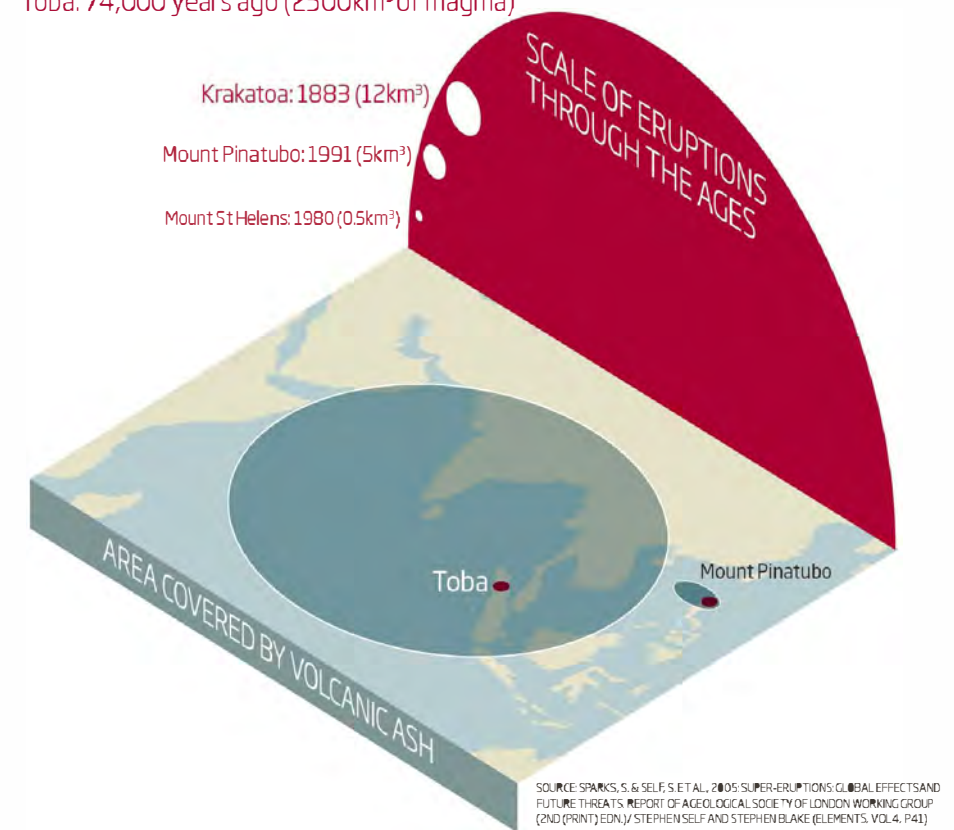
Nevertheless, hominin species living at the time of the eruption would undoubtedly have faced tough conditions. The blanket of ash, for example, would have been quickly washed into the freshwater supplies: Ditchfield found deposits up to 3 metres deep on the valley floors where rivers would once have flowed. And there is no doubt that in the years immediately following the eruption the early humans would have had to adjust to colder temperatures, probably having to economise significantly as food resources dwindled.

## Flight to the refugia

"We are not saying that it wasn't difficult for humans after Toba," says Mike Petraglia at the University of Oxford, who has led the investigations. "We are just saying that we don't think it was a catastrophic change."

The remains of hominin species living at the time of the eruption would shed some light on life during this difficult period, but sadly no skeletons have been preserved in the sediments. "The moist tropical environment is not good for preserving bone," explains Petraglia.

Nevertheless, the tools that they left behind provide a window into their owners' lives. Petraglia and his team have investigated a number of sites at Jwalapuram. One has been particularly fruitful. Labelled Jwalapuram 22, it was probably a hunter-gatherer camp. It has yielded more than 1800 tools, including stone flakes, scrapers, points – the everyday tools for



cutting and scraping – and the stone “cores” left over following tool manufacture. “The surface is just littered with stone tools, and then buried by the Toba ash,” says Michael Haslam, also at the University of Oxford.

Surprisingly, hominin life appeared to continue in the same vein immediately after the eruption, with hundreds more stone tools in the layers immediately above the ash fall. The team uncovered a similar story 1000 kilometres further north of Jwalapuram, in the Middle Son river valley. “We see very little change in tool technology across the Toba ash. They may have had to relocate for a short period of time, but within a generation or so they were back where they were before, making the same kinds of stone tools,” says Chris Clarkson, a stone-tool specialist from the University of Queensland in Brisbane, Australia, who worked at the digs in India.

Again, that's not to say the eruption was an easy ride for the hominins living in India. Jwalapuram and the Middle Son valley may have been special cases – refugia in which hominin populations sheltered when the times got tough. Jwalapuram, for example, is an ancient type of Indian geological formation known as a Purana basin, which contains highly fertile soil and abundant freshwater springs protected from contamination by the surface ash. Such circumstances could have buffered some of the effects of the eruption.

“There are springs popping out everywhere in these basins, they contain plentiful rocks for making stone tools and their vegetation is generally resilient to environmental changes,” explains Ravi Korisetar of Karnatak University in Dharwad, India. Still, the findings present a challenge to the traditional view of Toba as a devastating catastrophe for hominins alive at the time.

Stanley Ambrose at the University of Illinois at Urbana-Champaign is a leading proponent of the catastrophe theory. He says he has observed strong evidence for technological change in south and east Africa following the eruption, which may have resulted from a need to adapt to pressured conditions, and reckons India should be no different. He says that flood erosion may have released some of the tools from the older sediment at the Indian sites, re-depositing them in younger sediments and creating the illusion of continuity. Not so, says Haslam. While he admits the artefacts do show some signs of abrasion, he reckons they shifted only a short distance through the layers of sediment – not enough to skew the dating significantly.

Answering such queries is of the utmost importance, since the new, less-devastating picture of the Toba eruption painted by recent research could have wide ramifications for theories of human evolution and migration. Just how wide depends on which species of ➤

"If the Indian tools were made by *Homo sapiens*, the findings could rewrite the textbooks on human migration from Africa"

human produced the tools found in India. According to the traditional view, modern humans did not arrive in this part of Asia until 60,000 years ago or later, at least 14,000 years after the Toba eruption. Before this time, modern humans are thought to have been confined to Africa, barring one failed dispersal to the Levant – the eastern part of the Mediterranean – about 125,000 years ago.

If you follow this line of reasoning, the tools must therefore be the product of a more primitive species, perhaps the descendants of *Homo erectus*, which first occupied India 700,000 years ago or more. The new evidence would still be significant should that be the case, since the survival of these species would suggest the eruption may not have had a drastic impact on the *Homo sapiens* populations in

Africa either, throwing the "genetic bottleneck" theory of human evolution into doubt.

Petruglia and his colleagues have much grander claims, however. They report evidence that the tools in India were indeed made by *Homo sapiens* – a finding that, if true, would rewrite the textbooks on human migration from Africa (see "Routes out of Africa", right).

Previous evidence would just about allow an earlier migration. Fossil evidence from this period of human prehistory is pretty thin in the ground, so scientists have turned to genetics to retrace our ancestors' footsteps. By analysing the differences in mitochondrial DNA between modern aboriginal populations from different parts of the world, and considering how long it would have taken for these variations to emerge, Martin Richards at the University of Leeds, UK, Stephen Oppenheimer at the University of Oxford and colleagues have calculated that the earliest date for a migration out of Africa would have been 71,000 years ago. That is some 3000 years after Toba blew (*The American Journal of Human Genetics*, vol 84, p 740). Many others go even further, believing the likely date of exit to have been just 60,000 years ago. However, the large uncertainties associated with these techniques give a small probability that a pre-Toba migration may have been possible.

## Indian invasion

In fact, there are other reasons to challenge the established theory of a late dispersal. Some Australian artefacts suggest modern humans made it to that part of the world 60,000 to 50,000 years ago, thousands of years earlier than current theory would allow (*Nature*, vol 345, p 153). And at Kota Tampan, in the Lenggong valley in Malaysia, archaeologists have uncovered a stone-tool culture spanning from 74,000 years to 4000 years ago. Since the tools don't change at all during this period, it would seem they were all produced by the same species of human. A 10,000-year-old *Homo sapiens* skeleton found at Kota Tampan suggests that this species was the modern human.

The tools discovered in India would seem to provide further tentative evidence for a pre-Toba migration. Firstly, Clarkson has spotted a subtle change in the way the tools in India were manufactured about 80,000 years ago (6000 years before the eruption) that may be evidence of a *Homo sapiens* invasion at this time. "They start to make better use of the stone and strike multiple flakes off in a more radial pattern, often

## TODAY'S SUPERVOLCANOES

The term "supervolcano" refers to any volcano capable of throwing out at least 300 cubic kilometres of magma during an eruption. At least one of these beasts explodes every 100,000 years or so, the geological record suggests. One of the most recent was the Toba eruption, 74,000 years ago. A medium-sized super-eruption, releasing 1000 cubic kilometres of magma, would wreak the same devastation as a 1-kilometre-wide asteroid smashing into the Earth. The bad news is that such a super-eruption is five to 10 times more likely than an asteroid strike, according to a 2005 report by the Geological Society of London.

Previous super-eruptions have been linked to mass extinction events, such as the Permian mass extinction 250 million years ago, which wiped out more than 90 per cent of marine species and was associated with an eruption at the Siberian Traps. The eruption of the Deccan Traps in India, together with a meteorite impact, might even have finished off the dinosaurs.

There is no doubt that

Earth will experience more super-eruptions. "It is not a question of 'if' – it is a question of 'when'," says Bill McGuire, director of the Aon Benfield Hazard Research Centre at University College London.

Possible contenders for the next eruption include Yellowstone volcano in Wyoming, the Phlegrean fields volcano west of Naples, Italy, and Lake Taupo in New Zealand. However, there are many other areas where a supervolcano could one day pop up, including Indonesia, the Philippines, several Central American countries, Japan, the Kamchatka peninsula in eastern Russia, and even Europe (the area around Kos and Nisyros in the Aegean Sea might be a supervolcano).

As the recent research into the impact of the Toba eruption reveals, super-eruptions may not necessarily be as catastrophic as we fear. That said, a super-eruption would almost certainly devastate our civilisation. Unlike the humans living when Toba erupted, we depend on globalised trade and food production, with much reliance on air travel and

space-borne communications, all of which would be severely knocked by a super-eruption.

Using similar considerations as they did for the Toba model, Hans Graf and his team at the University of Cambridge predict a Yellowstone super-eruption would cause the global temperature to drop by at least 1°C. Several centimetres of ash would blanket all of North America. Oceans would become even more acidified and plant growth across the globe would be disrupted for several years.

The Geological Society of London's working group went one step further in 2005 when they described the impact of a generic super-eruption. "An area the size of North America or Europe could be devastated, and pronounced deterioration of global climate would be expected for a few years following the eruption. Such events could result in the ruin of world agriculture, severe disruption of food supplies, and mass starvation. The effects could be sufficiently severe to threaten the fabric of civilisation," they conclude. So fingers crossed, everybody.



STEVE TERRILL/CORBIS

The eruption of mount St Helens was 5000 times smaller than that of Toba

from only one side of the core," he explains.

Comparing the patterning he sees on the Indian cores with more than 800 stone cores belonging to both modern humans and other hominins at sites all over the world, Clarkson finds that the Indian cores most resemble the cores made by modern humans in south Africa, south-east Asia and Australia. Meanwhile, the older Indian cores, with a flatter and more circular shape and often worked on both sides, have more in common with cores made by Neanderthals and other non-modern humans. "Tool-making is a skill and it takes a close apprenticeship to learn these methods. This was a cultural behaviour that was taught and passed down the generations," he says.

Further evidence for modern humans ousting non-modern hominins in India at this time comes from the tools themselves, with heavy hand-axes being abandoned for more lightweight tools. Petraglia and his colleagues have also uncovered three possible projectile points from beneath the ash at Jwalapuram 22, two of which are shaped carefully at the blunt end, apparently to enable them to be hafted onto a spear—a tool generally associated with *Homo sapiens*.

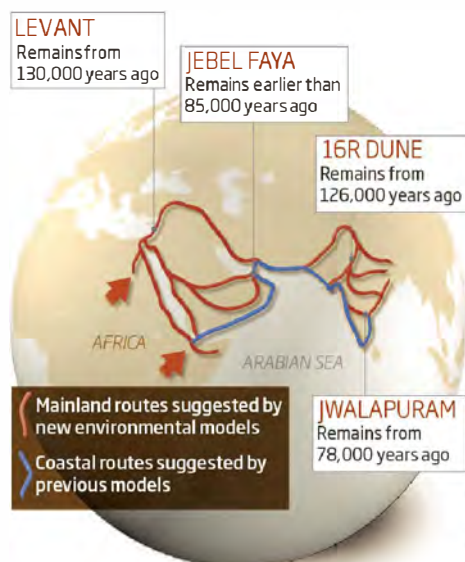
Ambrose is dismissive of the suggestion of modern humans arriving so early in India. "It is completely conceivable that Neanderthals could have made these hafted projectile weapons," he says. But others are more supportive of the idea. Chris Stringer from the Natural History Museum in London thinks it is possible that these tools are evidence of modern human activity, although he doesn't feel the evidence is conclusive. Robin Dennell, an archaeologist at the University of Sheffield, UK, is thoroughly impressed by the research.

"Clarkson's work is excellent. I'm prepared to argue that *Homo sapiens* was in India pre-Toba," he says.

If modern humans really did live in India at this time, what route did they take from Africa to Asia? There is some good evidence that modern humans first attempted to leave Africa across treacherous desert regions into the Levant 125,000 years ago. Archaeologists had previously assumed the venture ultimately failed due to the adverse conditions, and that it was only much later, when humans tried coastal routes, that they succeeded. Petraglia, however, thinks that the wide range of new evidence in India challenges

## Routes out of Africa

Traces of modern humans and new environmental models suggest that *Homo sapiens* migrated thousands of years earlier than the accepted date of ~60,000 years ago



this view. "We're suggesting that perhaps this wasn't a failed dispersal," says Petraglia. "Maybe these people got out across Arabia and over to India after all."

"There could easily have been a core population of *Homo sapiens* in southern Arabia by 100,000 years ago," agrees Dennell, "and that population could then have been the source of populations that subsequently dispersed eastwards across southern Asia."

Evidence in the Thar desert in Rajasthan, northern India, seems to support this idea, with remains suggesting that modern humans were adept at crossing desert regions, hopping from oasis to oasis. "In the Thar desert we find fossilised sand dunes. After cutting them open like cabbages, we have found stone tools inside," says Hema Achyuthan, from Anna University in Chennai, India. Unfortunately, the tools are hard to date precisely, but they do show strong similarities to those found in Jwalapuram and the Middle Son valley.

But here's the killer question: if modern humans did migrate to Asia so early in prehistory, why isn't their journey reflected in modern mitochondrial DNA? Sacha Jones, at the University of Cambridge, thinks she has a solution that may just reinstate Toba's importance in human evolution.

She suggests a double dispersal from Africa, with the first migrants arriving in India pre-Toba around 80,000 years ago and bringing the new tool technology Clarkson observed. Later, more than 10,000 years after the Toba eruption of 74,000 years ago, a second wave of migrants arrived that sounded the death knell for the early pioneers. "This explains the pre-Toba tools we find in India, but it also fits with the genetic data," says Jones. "If the older population were wiped out then no genetic signature would remain."

If this theory reflects the reality, the role of Toba's eruption in human evolution may have been highly significant after all, weakening the first wave of migrants and pushing them into luscious refugia. The later, competitive migrants would have then elbowed their distant cousins off their bountiful land, finishing them off in the process.

It's a tempting proposition that promises to tie up the loose ends of the other theories—though much more archaeological evidence is needed to shore it up. As the digs in India continue, all eyes will be searching for those elusive human remains, perhaps even a skeleton cocooned in the ash, that could settle the score once and for all. ■

Kate Ravillious is a writer based in York, UK

We have an irrepressible urge to push our boundaries and set records. How much further can we go, physically and mentally, before we reach our ultimate limits?

# MAXED OUT

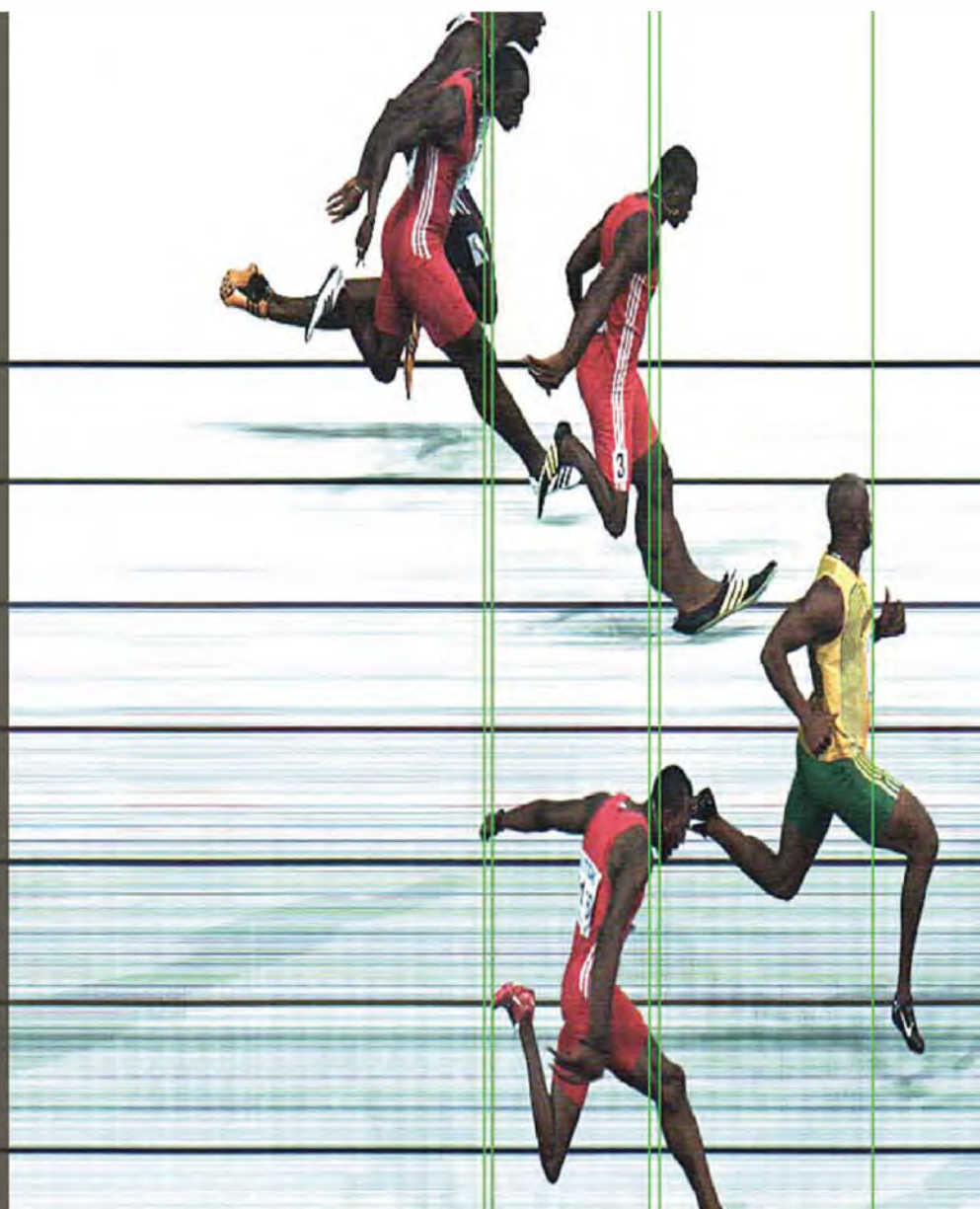
## ABSOLUTE SPEED LIMIT

Last year, Usain Bolt stunned athletics fans when he hacked 0.11 seconds off his previous world record for the 100-metre sprint. But what's the ultimate human speed limit?

Intrigued by this question, Mark Denny at Stanford University, California, decided to work out how fast a human could possibly sprint 100 metres. He examined previous records for various athletics competitions - and greyhound and horse races for good measure - since the 1920s, and found that performances in many events followed a similar pattern, improving steadily until they reached a plateau. Horses in the Kentucky Derby, for example, appeared to approach their speed limit in 1949. Since then any improvements have become minimal and increasingly rare.

Human athletes, too, seem to follow this pattern. Timings for the women's 100 metres approached a plateau in 1977. Male sprinters are still improving, but having constructed a model based on other events, Denny says they too seem on the verge of topping out. He predicts an absolute limit of 9.48 seconds for the 100 metres, just 0.1 seconds under Bolt's current record. "If he keeps on course he will soon come close to the absolute limit," says Denny.

What gives rise to this human speed limit? Denny reckons it's as simple as the athlete's power-to-weight ratio. Beyond a certain point, the benefits of stronger muscles and longer limbs will be offset by the increased energy required to shift the greater load. David Robson



# CONCENTRATE!

It's a challenge that most of us have faced when up against an essay deadline, a late-night crisis in the office or perhaps a long car drive. Just how long can we push ourselves mentally before our brain needs a break?

For people in jobs where concentration is critical, like truck drivers, power-plant operators or airline pilots, a 12-hour shift is the limit for most. But pity doctors: complex surgery can go on for hours longer than that, although the lengthiest operations tend to be

shared by more than one team.

Until 2004, doctors in the UK on weekend shifts used to work from Friday morning to Monday evening – that's 80 hours in total. At best they would snatch a few hours of sleep; at worst, none at all. "You could be working the vast majority of that time," recalls Helen Fernandes, a neurosurgeon at Addenbrooke's Hospital in Cambridge, UK.

Our powers of concentration decline as the hours tick away. We become less efficient, and take longer to make decisions

and to sound the alarm when things go wrong. "Vigilance is one of the areas most sensitive to fatigue," says neuroscientist David Dinges at the University of Pennsylvania in Philadelphia.

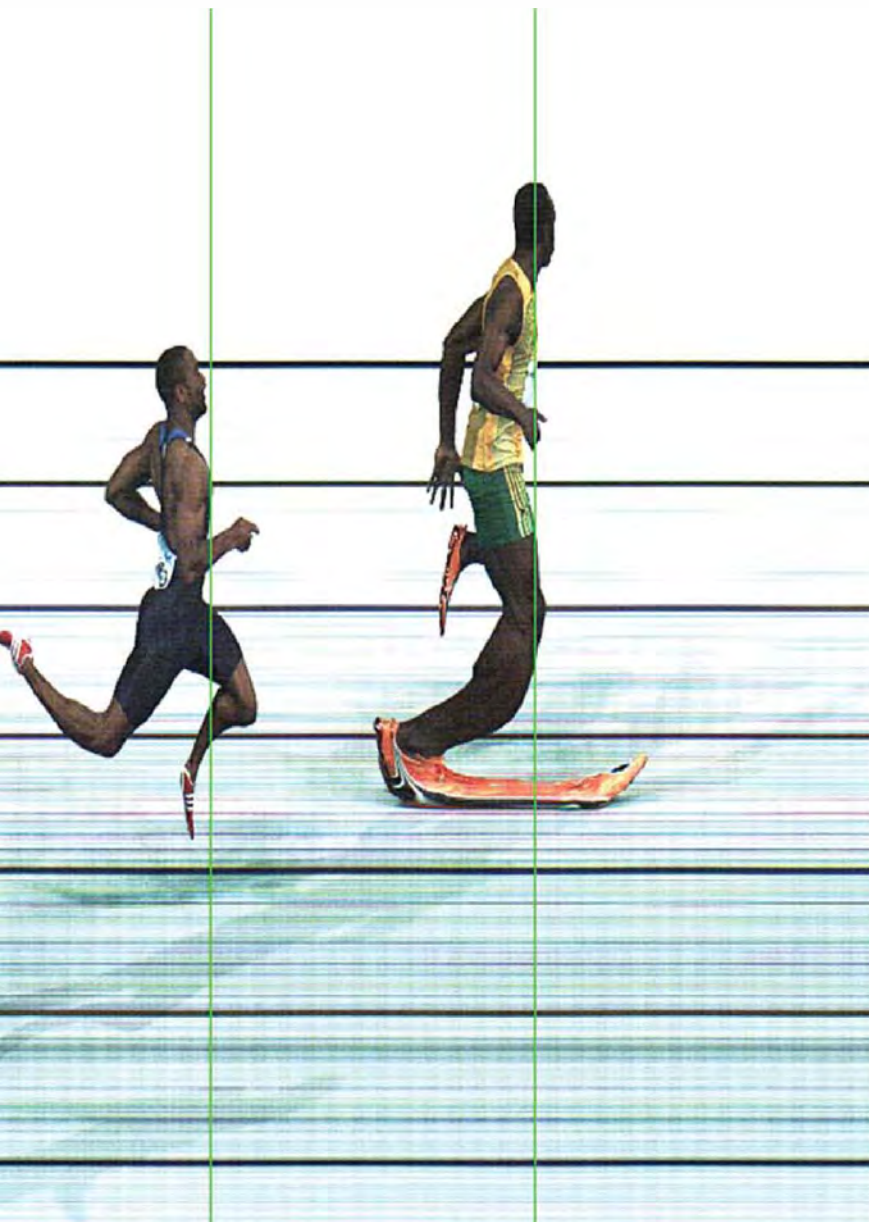
Dinges's team used MRI to study the brains of people doing a vigilance task. As people's reaction times slowed, activity in certain brain areas waned. Dinges found that performance in the test could be predicted from the level of blood flow in the subjects' right fronto-parietal network. **Clare Wilson**

## ABHOR A VACUUM?

Sadly we know how long humans can survive if suddenly exposed to the vacuum of space. Three Soviet cosmonauts died in 1971 when a faulty valve caused their Soyuz 11 capsule to depressurise at an altitude of 168 kilometres, shortly before re-entry into the Earth's atmosphere. Investigations revealed that the cabin pressure dropped to zero for 11 minutes and 40 seconds, until the capsule hit the atmosphere. The crew died within 30 to 40 seconds from hypoxia. "You need both oxygen and air pressure to deliver oxygen to the brain," says Jonathan Clark, a former space shuttle crew surgeon.

It is possible to recover from shorter spells in a vacuum, however. In 1966 a NASA technician was testing a spacesuit in a vacuum chamber when the pressure dropped to the level you would experience at an altitude of 36,500 metres. He passed out after 12 to 15 seconds. The last thing he recalled was the saliva boiling off his tongue; that's because water vaporises at low pressure. He regained consciousness within 27 seconds when the chamber was repressurised to the equivalent of an altitude of 4200 metres. Although he was pale, he suffered no adverse health effects.

When the external pressure reduces, gas bubbles form in the blood, leading to lung damage within minutes. And the nervous system can be damaged within hours due to nitrogen dissolving out of the blood. A sudden drop in pressure can be devastating: air trapped in the lungs explodes within seconds. However, if you approach near-vacuum in a more gentle fashion and with intensive medical care standing by, it is possible to survive up to a minute, says Clark. Valerie Jamieson



Has Usain Bolt reached the ultimate speed a human can run?

David Blaine starved himself for 44 days in a glass box in London

## TOTAL RECALL

Remembering an 11-digit telephone number is hard enough for most of us. Yet one of the current record-holders for a feat of memory, Chao Lu of China, was able to accurately recite 67,890 digits of pi from memory in 2005. But is that a mere drop in the ocean compared to the brain's true capacity?

Our ability to absorb information is vast. In 1986 Thomas Landauer, then at Bell Communications Research in Morristown, New Jersey, looked at studies of how much visual and verbal information subjects stored while examining images and text, and how quickly they forgot it. This led him to estimate that the average adult stores around 125 megabytes of this type of information in their lifetime - enough to store the contents of 100 books the length of *Moby Dick*.

Accurately memorising a long string of digits in the correct order is a more demanding task than memorising ad hoc facts about a text or a picture. To discover the limit of the length of a single memory, it may be more informative to consider the techniques used by the memory champions.

Many of them use a mnemonic method. Before starting to memorise a number, they associate a person or object with each four-digit number from 0000 to 9999. The digits of pi can then be translated into a sequence of these people and objects, which the memoriser links by making up a story. This helps add interest to the random sequence of numbers and pegs down the memory.

Lu takes roughly 1000 hours to memorise 40,000 digits. Assuming this rate would apply no matter how big the memory feat, someone who started memorising a number at the age of 20 and spent 12 hours a day at it, every day, would be able to remember around 8,760,000 digits by their 70th birthday. David Robson



SCOTT BARBOUR/GETTY

## KEEP COOL AND CARRY ON

Humans hate being cold, and for good reason: our long-limbed bodies are exquisitely adapted to lose heat, not to retain it. This makes perfect sense in the intense heat of the African savannah, where humans evolved. Without our technological adaptations to cold - clothing, heating, shelter - that's where we'd all still be living, says Mike Tipton of the University of Portsmouth, UK, who studies human thermoregulation.

Surviving the cold is all about protecting core body temperature. This is usually

at 37 °C, but it takes surprisingly little for it to start dropping. An ambient temperature of 20 °C can induce hypothermia if conditions are wet and windy, says François Haman, a physiologist at the University of Ottawa, Canada.

When cold, the body starts to shiver and shuts down blood flow to the extremities. If core temperature falls by just 2 °C, hypothermia sets in: first we start to lose consciousness, then the heart loses rhythm. Death follows at about 24 °C, when

the heart stops. Usually.

People have been known to survive much lower core body temperatures. Anna Bagenholm survived the biggest drop ever recorded, to 13.7 °C, when she fell into a part-frozen stream and became trapped under ice for 80 minutes.

The constant flow of icy water cooled her body to such an extent that by the time her breathing and heart had stopped, her brain needed very little oxygen in order to survive, giving her the chance of complete recovery. James Mitchell Crow

## NIL BY MOUTH

How long can a human survive without food or water? In theory, when you finally run out of body fat, protein and carbohydrates, your body runs out of energy and stops functioning. Jeremy Powell-Tuck, a retired clinician who fed David Blaine after his starvation stunt in London in 2003, isn't so sure that this is the lethal point. "You're more likely to die before then," he says. Fat people would only be able to survive for longer if they had enough vital water-soluble B vitamins in their system to help metabolise fat stores. So it is possible that a person could die of starvation and still be fat.

The longest recorded starvation was by the Irish hunger-striker Kieran Doherty in 1981, who died after fasting for 73 days. With a supply of vitamins and water, people have been known to survive over a year without eating. "It used to be a very fashionable way of losing weight around 30 years ago," says Powell-Tuck.

With vitamins but without water, survival time is sharply reduced. A human can be expected to survive for weeks without food, but a thirsty person deprived of water would last a matter of days. "It depends on the rate of water loss," says Michael Sawka at the US Army Research Institute of Environmental Medicine in Natick, Massachusetts. Without water, the volume of blood in your body drops, and with it your blood pressure. Blood becomes thicker and stickier, making it harder to pump around the body, so your heart rate increases to compensate. Even in a cool environment, you wouldn't last for more than a week without water. *Jessica Hamzelou*

John Stapp holds the record for surviving the greatest g-force



KEYSTONE/GETTY

## WAKEY, WAKEY

On 28 December 1963, Randy Gardner, a 17-year-old schoolboy in San Diego, California, got up at 6 am feeling wide awake and raring to go. He didn't go back to sleep again until the morning of 8 January 1964. That's 11 days without sleep.

Gardner's 264 hours remains the longest scientifically verified period without sleep, breaking the previous record of 260 hours. It was described in a 1965 paper by sleep researcher William Dement of the Stanford University School of Medicine in California, who stayed awake with Gardner for the final three days.

Gardner experienced mood swings, memory and attention lapses, loss of coordination, slurred speech and hallucinations, but was otherwise fine. His first sleep after those 11 days lasted just 14 hours.

According to Dement, Gardner did not consume any stimulants during his "wakeathon". He did, however, have people around him keeping him awake. Without such help you would be fighting hard to stay awake after 36 hours, and would find the urge to sleep near-irrepressible by 48.

But you'd probably be snatching subtle bursts of sleep even before you finally went to bed: sleep-deprived people slip in and out of "microsleeps" – seconds of sleep that occur without you noticing them, often with your eyes open.

Microsleeps aside, how long could Gardner have gone on for? Nobody knows for sure, but we do know that sleep deprivation is eventually fatal. Rats that are kept awake die after two weeks, less time than it takes them to starve to death.

There are no records of a human having been intentionally kept awake long enough to kill them, but a hereditary disease called fatal familial insomnia suggests there is an ultimate limit. The disease eventually robs victims of the ability to sleep. Death follows within three months. **Graham Lawton**

## MEET THE G-MONSTERS

The swooping, sickening sensations you experience on a roller coaster come courtesy of brief g-forces of up to 5 g. Rides have to be designed so people don't black out.

Our tolerance of g-forces depends not only on the magnitude and duration of the acceleration or deceleration but also on the orientation of our body. We are most vulnerable to a force acting towards the feet, because this sends blood away from the brain. Five to 10 seconds at 4 to 5 g vertically typically leads to tunnel vision and then loss of consciousness.

Fighter jets can pull up to 9 g vertically, and the more a pilot can take without blacking out, the better their chances in a dogfight. Some pilots wear "g-suits" which help push the blood away from their legs and towards the brain. People with the highest g tolerance are known as "g-monsters". "We have had people

who have been perfectly conscious at 6 g," says physiologist Alec Stevenson of UK-based defence firm Qinetiq. Others pass out at 3 g, he says.

Pilots can boost their natural g tolerance by training inside centrifuges, like the one Qinetiq has in Farnborough in Hampshire. They learn to tense their leg and abdominal muscles to push blood to the upper body, and to breathe in a special way, straining hard as if defecating when constipated, to raise blood pressure.

The greatest vertical force anyone has withstood is 31.25 g, although for that the subject, NASA doctor R. Flanagan Gray was in a special water tank that pressurised his body to help him take the g's. US air force pioneer John Stapp holds the record for highest horizontal acceleration, set in a series of rocket-sledge experiments in the late 1940s. In one test he withstood 46.2 g. *Clare Wilson*



"Only a handful of people have made it to the summit of Everest without oxygen"

## LIFTING THE LIMIT

In the heaviest dead lift recorded, British weightlifter Andy Bolton lifted 457.5 kilograms from the floor to his thigh.

Strongmen like Bolton are perhaps five or six times stronger than the average man, who will often struggle to lift 45 kilograms over his head, says Dan Wathen, an athletics trainer at Youngstown State University, Ohio. The record for an overhead lift is 263.5 kilograms.

So what is the maximum weight a human could ever lift? Todd Schroeder at the University of Southern California in Los Angeles thinks we are already close to the maximum. "If you look over time at the records for maximal lifts, they have crept up but are starting to plateau," he says. "Today's weightlifters, including those that use steroids, are near the limit of human potential."

It is the muscles that set the limit. Most failures to lift a given amount do not damage the body: the weightlifter simply cannot overcome a load. But in cases where something does give way, it is usually the muscle fibres that tear, often near the tendon.

Similarly, it is control of the muscles that gives weightlifters their advantage. The body has natural inhibitory mechanisms designed to keep us from hurting ourselves by trying to lift too much. These work by controlling how many muscle fibres are activated at any one time. Weightlifters learn to suppress these signals, enabling them to use a larger fraction of the muscle's potential in lifting.

Beyond that, the key to success is training, though genetics plays a role. Short limbs favour strength, says Wathen, a former weightlifter, and some people have more muscle fibres than others. Jessica Marshall

## PEAK ENDURANCE

Altitude has strange effects on the body, and it's mostly down to the reduced pressure of oxygen in the air. Cells need oxygen in order to survive. At higher altitudes haemoglobin, the blood protein that transports oxygen from the lungs to cells, cannot absorb oxygen to its full capacity, creating a deficit in the body.

The brain is very sensitive to oxygen levels, which is why headaches and dizziness are the first signs of altitude sickness. With prolonged stays above 5000 metres, muscle mass deteriorates and the risk of fatal fluid accumulation in the lungs and brain increases. Go higher than around 7500 metres and the magnitude of the oxygen deficit can lead to loss of consciousness and, ultimately, death.

What about living at altitude? Well, almost half the population of Bolivia lives in the country's Altiplano region, 4000 metres above sea level. But go much higher and problems kick in. Some Chilean mine workers spend several weeks at a time at 5800 metres, but they probably couldn't reproduce there because altitude temporarily suppresses male

fertility, says Mike Grocott of the University of Southampton in the UK, who studies the physiological effects of altitude.

Most people can adapt to altitude if they take time to acclimatise. A good rule of thumb is that the higher you go, the shorter you should stay. If you were suddenly transported to the summit of Everest (8848 metres) without acclimatising first, you would probably be dead in 2 minutes.

Only a handful of people have made it to the summit without supplemental oxygen. Babu Chiri Sherpa set the record for remaining at the top of Everest without oxygen for 21 hours in 1999. He was probably genetically primed to cope at altitude, says Grocott.

What is the limit beyond which unaided survival is impossible? As it happens, the summit of Everest is pretty close to it. There has been just one ascent without breathing apparatus in winter, when barometric pressure falls and therefore the amount of oxygen drops further than ever, says Grocott. "I'd guess the limit would be about 9000 metres." **Linda Geddes**

Babu Chiri Sherpa stayed at the summit of Everest for 21 hours

TERU KUNIKAWA/CORBIS

## A LETHAL BLUE GLOW

In September 1987, two men entered an abandoned medical clinic in Goiânia, Brazil, and dismantled what they thought was a piece of valuable equipment. Within a day, both were vomiting. Diarrhoea and dizziness struck next. Unbeknown to them, the "scrap" contained a highly radioactive source used to treat cancer patients.

Scrap dealer Devair Ferreira, who bought the source, was intrigued by the blue glow it emitted in the dark. He kept the mug-sized canister of powder in his dining room and invited friends and family around to marvel at it. They

touched the powder and daubed it on their bodies like carnival glitter, taking fragments of the radioactive caesium chloride salt home. Within a month, Ferreira's wife, his 6-year-old niece and two of his employees had died from acute radiation syndrome. In total, 249 people were contaminated.

Radiation doses, measured in sieverts, are calculated by taking into account the type of radiation and the area of the body that has been irradiated. All of the fatalities received between 4.5 and 6 sieverts in a matter of days. That's a huge dose when you

consider that each year we receive an average of 2.4 millisieverts from natural sources such as radon.

The threshold for an early death is around 2 sieverts, and death is highly likely at 6 sieverts, though Ferreira received 7 and survived. He died in 1994 as a consequence of alcoholic liver cirrhosis. No one knows for sure why Ferreira survived the radiation. The most likely explanation is that he spent more time out of the house than his wife. This gave the cells in his body time to repair some of the damage done. **Valerie Jamieson**

## HOLD IT!



Stephane Misfud can hold his breath 10 times longer than most people

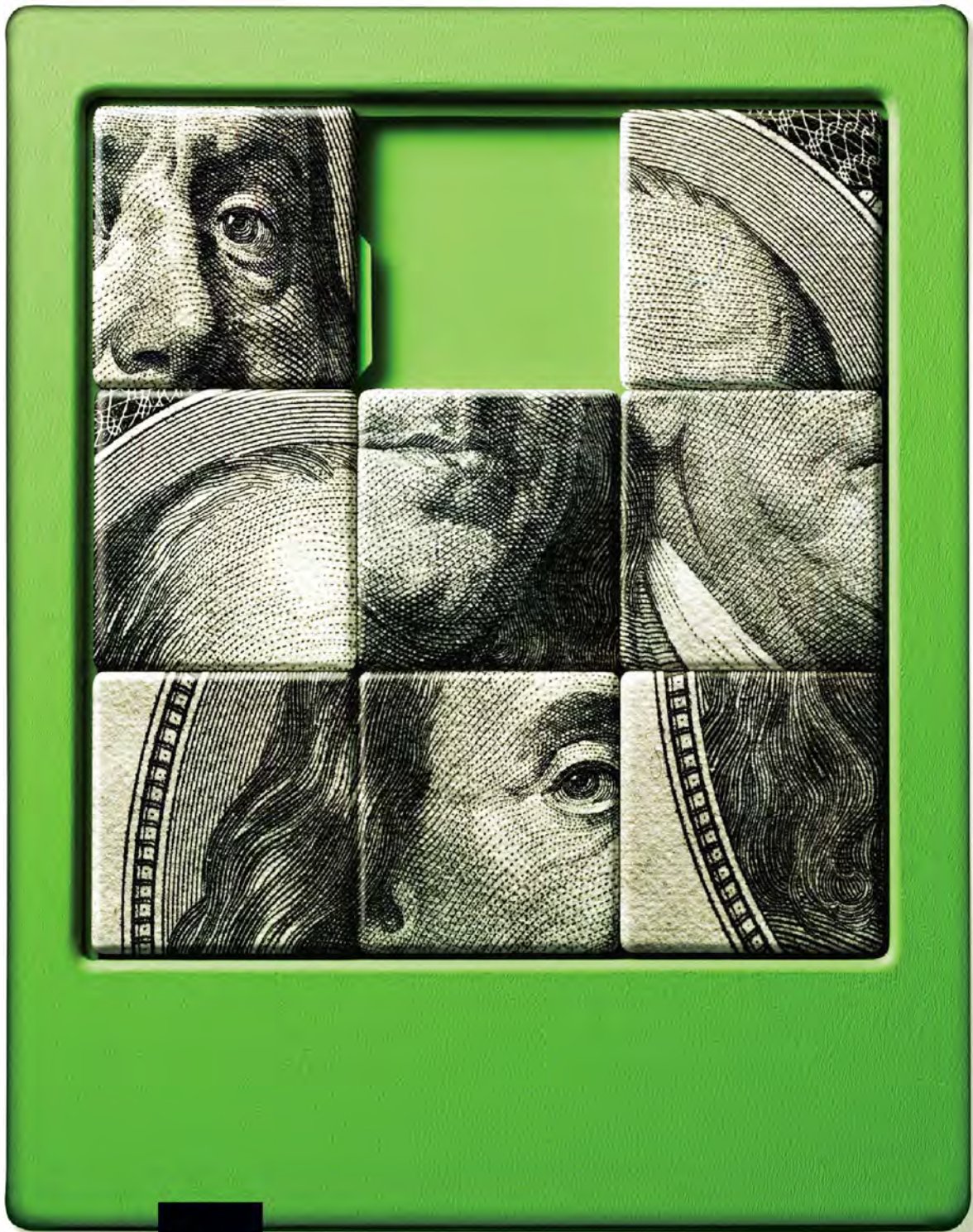
Most people find it hard to hold their breath for more than a minute, so imagine the extreme self-control Stephane Misfud mustered on 8 June last year when he held his breath for 11 minutes and 35 seconds, setting a new world record for stationary breath-holding, or "static apnoea".

Competitors float face down in a chilled pool, not to stop them cheating but to induce the mammalian diving reflex: when your face is submerged in cold water, outer blood vessels constrict, directing blood away from the extremities and towards the heart and brain. Your heart rate slows, reducing the rate at which oxygen is pumped around the body. With training, experienced breath-holders can drop their heart rate by twice that of non-divers upon immersion in cold water.

Hyperventilation before a prolonged breath-hold is also vital. This is because the brain monitors the amount of carbon dioxide in the blood to decide when to trigger the gasp reflex. Purging this CO<sub>2</sub> with rapid deep breathing increases how long you can go before the urge to gasp becomes irresistible. Having large lungs is a natural advantage.

So have we reached the breath-holding limit yet? Not at all, says physiologist Johan Andersson at Lund University in Sweden, who studies the effects of breath-holding in divers. "Elite breath-hold divers expect the limit to be extended to about 15 minutes before record-setting will level off."

They may be dicing with danger, though. Andersson found that static apnoea attempts on dry land caused a brief 37 per cent rise in the level of a protein called S100B in the blood, which is used as a marker for hypoxic brain damage. Andersson stresses that this rise is "well below" the levels seen in actual hypoxia, but warns that those competing in static apnoea events may accumulate damage in the long term. **Sean O'Neill**



“In God we trust;  
all others must pay cash”

Sign on a market stall

# Note perfect

Cash that can't be faked? Quantum mechanics could soon make it a reality, says **Justin Mullins**

**T**HERE is something special about cold, hard cash. Perhaps it is that its value is guaranteed by the government of the day, or that you can stash it under the bed when a banking collapse threatens. Maybe it is the freedom that cash allows: the ability to live without banks or credit cards or taxes.

Quantum physicists think a lot about cash. Not just any old money, you understand. They think about quantum cash. Quantum banknotes aren't like credit cards or dollar bills. They are simply information: a mixture of bits – the 0s and 1s that we use to send electronic transactions – and quantum bits, or qubits, that are governed by the laws of quantum mechanics and can be both a 0 and 1 at the same time.

Since quantum money is just information, it can be stored and transmitted just like a digital picture or a text file. But because it has quantum properties too, it cannot be copied. It is this combination that makes quantum cash so attractive: whoever is in possession of it has exclusive and unequivocal ownership of it, just as with hard, physical cash and unlike a credit card. That is not the only use for quantum cash, though. To physicists,

quantum cash is a toy problem, a sort of test case with which to study the strange properties of quantum mechanics.

Now the theoretical foundations are almost in place that could one day allow quantum cash to become a reality. These techniques could potentially be useful for other applications, too, such as making software impossible to pirate.

The idea of quantum money was first suggested in 1968 by Stephen Wiesner, a physicist then at Columbia University in New York. He envisaged creating a banknote containing light traps that could somehow store a few dozen photons. Being quantum objects, photons can never be counterfeited thanks to something called the no-cloning theorem. This states that quantum objects can never be perfectly copied since any measurement of the original also destroys its ability to be a 0 and a 1 at the same time and forces it to be one or the other.

In Wiesner's scheme, the polarisation of these photons would act as a unique identifier for the banknote. These polarisations would be known only to the bank, so anybody wanting to check the authenticity of the

banknote need only take it to their local branch, which would use its prior knowledge of the polarisations to check it. And since the photon states cannot be copied, neither can the banknote.

Wiesner's original idea has a serious flaw. One important feature of a practical currency is that anybody should be able to authenticate it. That is why the banknotes in your wallet have watermarks, holograms and ink that fluoresces in ultraviolet light – features that allow anybody to be pretty sure that the banknote is real. But with Wiesner's quantum money, you would have to take your quantum cash to the bank every time you want to check it. "That just wouldn't work," says Scott Aaronson, a computer scientist at the Massachusetts Institute of Technology.

Wiesner's quantum money remained little more than a theoretical oddity for 40 years and was pretty much forgotten, though his work on exploiting quantum mechanics for sending secret messages became hugely influential. Then last year, Aaronson proposed a new approach that does away with the banknote and concentrates instead on the stream of information that represents quantum cash.

Talk to cryptographers about protecting information and they will tell you that there are two different kinds of security. The gold standard is "informational security", where mathematicians can prove beyond doubt that a piece of information is secure. An example of informational security is quantum key distribution, a technique that exploits the laws of quantum mechanics to send messages in a way that cannot be

surreptitiously overheard. The security is guaranteed by the laws of physics.

This kind of security is hard to come by, so we usually have to resort to the second type, called “computational security”. Here information is protected by a code that, while not impossible to break, is so difficult to crack that nobody could feasibly do it, even with the world’s most powerful computers. An example is the RSA algorithm, which is widely used to encrypt e-commerce transactions and other forms of communication.

RSA is an example of public key cryptography, in which the method for encrypting messages is simple and made available to anyone. However, the process for decrypting messages is kept secret, so only

significantly. So Aaronson decided to devise a quantum money scheme that was merely computationally secure, and he based it on the kind of asymmetric mathematics behind public key cryptography.

In Aaronson’s scheme, so-called “public key quantum money” is always issued in two parts. The first is the quantum state. This might belong to a group of photons with a particular set of polarisations, which the issuing bank keeps secret. The second part is a circuit (or the plans for such a circuit) that verifies whether the secret set of polarisations is present in something purporting to be quantum cash. Such a circuit would be to quantum transactions what an ultraviolet light is to today’s banknotes. A shopkeeper might keep

“Quantum objects can never be perfectly copied since any measurement simply destroys them”

those in the know can read encrypted messages. The security of public key cryptography relies on a certain kind of mathematical relation, called a trapdoor function, that is asymmetric – easy to calculate in one direction but hard to do in reverse. The most famous example is multiplication. It is easy to multiply two numbers together to get a third, but much harder to start with the third number and work out the two factors used to generate it.

This is exactly what RSA encryption relies on, and the fact that it is always possible to make the starting numbers so big that no computer could factor their product in any reasonable time. Computer scientists call this kind of problem “computationally hard”. RSA encryption may not be impossible to crack but it is so hard to tackle that it is practically impossible.

Wiesner’s quantum bank notes are informationally secure, but making quantum money that anybody can authenticate changes the nature of the problem

a device containing the circuit behind the till to check any quantum money used in a transaction, rather than having to take the money to a bank as in Wiesner’s scheme.

This circuit performs the same role as the trapdoor functions in public key cryptography. The process of verifying the secret using the circuit is easy but the process of working out the secret polarisations of the photons is hard. The security of the scheme relies entirely on the difficulty of this task.

Aaronson gives the example of a thief who has broken into a shop and stolen the quantum verifier. The thief then proceeds

### THE QUANTUM CASH MACHINE

There are significant technological barriers to creating quantum money. One problem is finding a way to send qubits – chunks of quantum information – over the internet in the same way as email. We know how to send qubits from one place to another in the form of photons, but only through single stretches of optical fibre; they cannot be routed from one fibre to another without destroying them. Then there is the fact that, at present, we can store qubits only for microseconds at a time. While it might sometimes seem as though conventional cash can disappear from our wallets faster than this, we will need to be able to store qubits safely for years or decades to make quantum money a practical proposition.

to feed randomly generated quantum states into the verifier, hoping to find one that it accepts. “I proved that a counterfeiter would have to use this box an unfeasible number of times,” he says. “This rules out a large class of ‘brute-force’ attacks against quantum money.”

The devil is in the detail, however. In trying to flesh out exactly how to construct a quantum verification circuit, he and others have run up against one problem after another.

The trouble with computational security is its reliance on the idea that a mathematical process is much more difficult in one direction than the other. While this may seem obvious from all attempts to perform calculations on the chosen task, it is often merely an assumption. So the task for Aaronson and his colleagues is to find a quantum process which we have good grounds to think is asymmetric, and which could therefore form the basis for the security of quantum money. “That’s an entirely new problem in cryptography,” says Aaronson.

### How secure is secure?

Not having an agreed way of making tasks computationally secure makes this problem much more difficult to solve. Aram Harrow, a mathematical physicist at the University of Bristol, UK, agrees. “We need to find a plausible assumption to base the security on, and unfortunately it’s very difficult to show that anything is very computationally hard,” he says.





That hasn't stopped Aaronson and his colleagues trying. Over the last year or so, they have teamed up to form a "quantum money club" to find new ways of making quantum money computationally secure. They then look for weak links in their own work. Together, they have developed several important classes of scheme and then gone on to break each one.

Last summer, Aaronson published one such scheme, claiming the first evidence for quantum money that anyone can verify and only banks can clone. "That one stood for five months," he says. Then a group turned up at his door with a proof it wasn't true. "I did the only thing I could in such circumstances: I joined their paper."

In December, their joint paper breaking Aaronson's own quantum money scheme was published on the physics preprint server ([arxiv.org/abs/0912.3825](http://arxiv.org/abs/0912.3825)). The team behind it has an impressive pedigree and includes theoretical physicist Peter Shor of MIT, who previously developed a quantum computer algorithm that could factor numbers faster than a conventional computer.

The loophole they found in Aaronson's scheme was that the verification algorithm does not make a perfect check on the photon polarisations. So a hacker doesn't need to know the original quantum state to fool the verifying circuit into thinking the secret polarisations are present. To counterfeit this particular form of quantum money, the hacker would only need a state close enough

to the original to pass the test. This is much easier for a hacker to work out, says Andrew Lutomirski, a graduate student in theoretical physics at MIT and one of the group that broke Aaronson's scheme.

All was not lost, however. As well as breaking this scheme, Aaronson, Lutomirski and colleagues put forward a new one which takes a different approach: it produces a quantum state that is secret, even from the bank that created it. This time the bank has a different way of making the quantum states that form the secret part of the quantum money. As part of the "minting" process, the bank measures part of the secret quantum state while leaving

**"It is just as difficult for a bank to create counterfeit quantum cash as for anyone else – unlike conventional money"**

the rest of the state unmeasured. This leaves the unmeasured part with certain properties that work like a quantum watermark. And a verifying circuit can use this subsequently to authenticate the money.

This means the bank can publish a verification algorithm that allows anybody to check the money, but which cannot be used to counterfeit it. Aaronson and Lutomirski call this "collision-free quantum money". The beauty of this public key scheme is that it is just as difficult for the bank to create counterfeits as for anybody else – a property

that even conventional money does not have.

There is a sting in the tail, however. While the members of the quantum money club are pretty sure that collision-free quantum money is computationally secure, they have not been able to prove it.

Despite the failure to nail quantum cash, the efforts to study it have revealed new insights into the behaviour of quantum states. Some members of the quantum money club are using these ideas to explore the limits of what can be known about a quantum state. Quantum mechanics says you cannot measure a state without destroying it, but the team's work on quantum money has shown that it is possible to verify a quantum state is physically present, even though they know nothing about that state. In effect, they are able to get some information about it without destroying it.

Now the quantum money club is exploring what other information can be extracted about a quantum state using verifying algorithms. That is potentially bad news for quantum money: it may be that a verifying circuit will always allow the user to gain enough information about the quantum state to make a counterfeit. However, Shor and colleagues suspect not.

The constant creation and cracking of quantum money schemes is forcing them to the conclusion that a radically new approach is needed. "Much as we wish it were otherwise, it seems possible that public key quantum money intrinsically requires a new mathematical leap of faith," they say in their paper. They have in mind a revolution as big as the one that made public key cryptography possible in the 1970s – though when that new

breakthrough might happen and what advances will set it off is anybody's guess.

Even so, the process of studying this problem is turning out to be fruitful. "It's opening up a whole new area to study," says Harrow. The greatest legacy of the race to create quantum money may not be a new kind of currency, at least not in the short term. Instead, we are getting a better understanding of the fundamental laws of physics. It is a trade-off most would say was worthwhile. ■

Justin Mullins is a consultant editor for *New Scientist*

# Track that trash

What really happens to the stuff you throw away? In an exclusive competition launched last year, 10 readers in the UK won the chance to find out by taking part in the “trash tracking” experiment we ran in collaboration with the Massachusetts Institute of Technology’s Senseable City Lab.

The objects our winners chose to tag and throw away ranged from a plastic bottle to an old computer. The tracking results are now in. While the prototype tracker technology didn’t prove 100 per cent reliable, the cases where it worked give a good indication of how the country’s rubbish is being disposed of. **Joseph Milton** reports

## Tag 987

**Winner:** James Brown

**Item:** plastic milk bottle

**Starting point:** Trantlebeg, Sutherland

**End point:** Grangemouth, Stirlingshire



Do local-authority waste collectors really recycle the plastic waste we diligently separate from the rest of our rubbish? That’s what James Brown, whose Scottish Highland home is far from any recycling centre, wanted to find out. He tagged an old milk bottle and dropped it in his recycling bin. The bottle travelled 400 kilometres, via two depots, to a recycling plant in Grangemouth. In the Highlands at least, it seems that sorting your rubbish is worth the effort.

## Tag 952



**Winner:** Gudrun Gaudian

**Item:** multicoloured leather schoolbag

**Starting point:** Alne, North Yorkshire

**End point:** Northallerton, North Yorkshire

Gudrun Gaudian was curious to find out what would become of a multicoloured leather bag collected from her local school in the village of Alne by Bag2School, a business that buys unwanted schoolbags in the UK and sells them on where they are needed. The bag wound up in a sorting depot outside Northallerton, 35 kilometres away, most probably bound for eastern Europe, where another child may yet use it to carry their school books.

## Tag 990



**Winner:** Vince Sellars

**Item:** electric water pump

**Starting point:** Gleadless, Sheffield

**End point:** Boston, Lincolnshire

What becomes of electrical equipment we leave at recycling centres?

Vince Sellars tagged an old water pump to find out. Normally, the steel from the pump would be separated and recycled in Sheffield, Sellars’s home city. In this case, the tag travelled to Boston, about 130 kilometres away. Perhaps it went with the pump’s plastic parts to a recycling facility in the town.

**Winner:** Shaun Baker  
**Item:** smoke detector  
**Starting point:** Stafford  
**End point:** Liverpool



Shaun Baker wondered if a smoke alarm would require specialised disposal as it contained a radioactive source. However, radiation levels in smoke alarms are too low for them to be classed as radioactive material when disposed of. The alarm was treated as ordinary electronic waste and sent to Liverpool to be shredded. Metal and plastics were separated and the plastics sent on for further recycling. The metal will be sold to refineries for reuse.

## Tag 976

**Winner:** Nick Hunn  
**Item:** car  
**Starting point:** Edgware, London  
**End point:** unknown

Nick Hunn was preparing to scrap his 10-year-old car under the government's scrapage scheme. As the car wasn't in poor condition, Hunn tagged it to see if it really would be scrapped. Sadly, the tracker signal disappeared, so the car's fate remains a mystery.

## Tag 966

**Winner:** Tanya Heasman  
**Item:** cuddly toy  
**Starting point:** Waterloo, London  
**End point:** unknown

Tanya Heasman's children love finding lost toys or "treasure" around the streets of London. They wanted to know what would happen to one of their own treasures if it was left in the street for another child to find. Unfortunately, after being left near Waterloo station, the toy and its tag immediately went missing.

## Tag 950

**Winner:** Alex Dragoi  
**Item:** bicycle  
**Starting point:** Crystal Palace, London  
**End point:** unknown

Alex Dragoi wanted to know what would happen to an unwanted bicycle left for recycling in London, but beyond his home no tracker signal was seen.

## Tag 973

**Winner:** Chris Hamley  
**Item:** computer  
**Starting point:** Marlborough, Wiltshire  
**End point:** Newbury, Berkshire



We often hear stories about our electronic waste polluting the environment in poor countries, so Chris Hamley chose to tag an old computer he was dropping off for recycling. Encouragingly, it did not travel far. Hamley's computer was broken up and shredded 30 kilometres away in Newbury, where the components were separated and the metals sold on to refineries elsewhere in the UK.

## Tag 991

**Winner:** Mark Norman  
**Item:** soft-drink can  
**Starting point:** Chelmsford, Essex  
**End point:** Tilbury, Essex



As an environmental manager at Anglia Ruskin University in Chelmsford, Mark Norman was keen to follow the fate of a soft-drink can collected from the university by waste contractor Green Recycling. After mechanical recovery in Maldon, Essex, the final tracker signal showed the can in Basildon. The company told Norman it was on its way to the docks at Tilbury, probably en route to metal dealer's abroad.

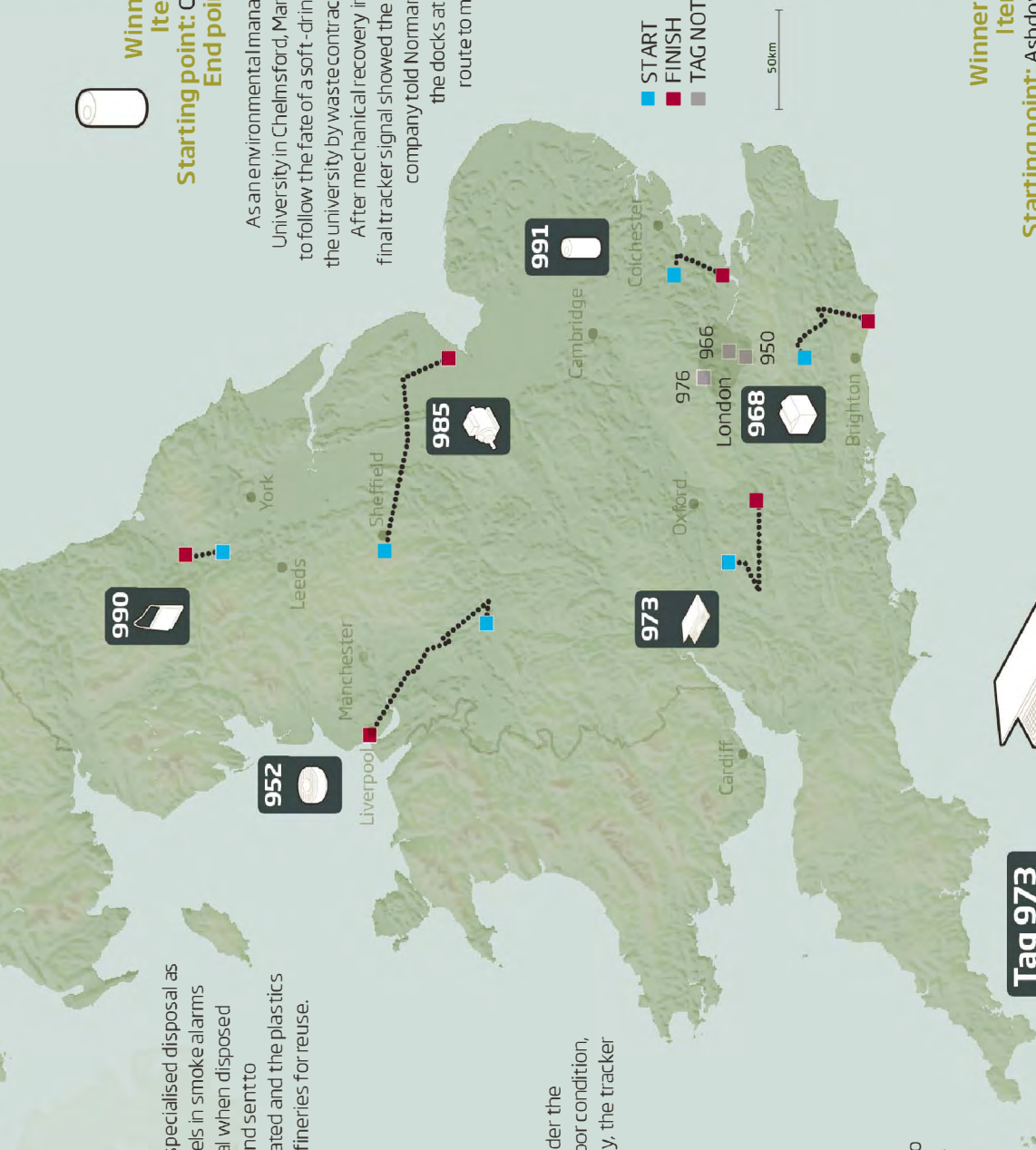
## Tag 968

**Winner:** Jeremy Branfoot  
**Item:** cardboard box  
**Starting point:** Ashdown House School, Forest Row, East Sussex  
**End point:** Seaford, East Sussex



What becomes of all the old boxes picked up in recycling collections? Jeremy Branfoot, a teacher at Ashdown House School, tagged some of their cardboard waste as part of an eco-initiative at the school. After being collected by the council, the tagged cardboard travelled 50 kilometres to Seaford, where it was recycled to make fresh packaging.

Joseph Milton is a science writer based in London.  
 Additional research by Catherine Brahic



# The stage and the drama

Where Richard Feynman saw a godless universe, his friend **Herman Wouk** sees something else

THE physicist Richard Feynman said, "It doesn't seem to me that this fantastically marvellous universe, this tremendous range of time and space and different kinds of animals, and all the different planets, and all these atoms with all their motions, and so on, all this complicated thing can merely be a stage so that God can watch human beings struggle for good and evil—which is the view that religion has. The stage is too big for the drama."

More years ago than I care to reckon up, I met Feynman. I was then out to write a sort of *War and Peace* of War World II, and early on in the moonstruck enterprise I realised that if I were at all serious about it, I had to learn something right away about the atomic bomb. Tolstoy could not consult Kutuzov, the general who drove Napoleon out of Russia, because the canny old one-eyed field marshal was long since dead; but when I started to work on my unlikely notion nearly all the men who had created the bomb were alive, and several of them were at the California Institute of Technology, including Feynman. President Truman, who had been an artilleryman in World War I, said of the bomb, "It was a bigger piece of artillery, so I used it," a striking remark which shows up in my *War and Remembrance* but surely something less than the whole story. So I went to Caltech to talk to

those who knew the whole story.

This may seem monstrously pushy, and no doubt it was. Like many novelists I have spun my books out of my experiences when I could, but in attempting work far outside my own relatively jog-trot existence I have had to pick other men's brains. My World War II service, three years on destroyer-minesweepers in the Pacific, gave me the substance of *The Caine Mutiny*, but taught me

nothing at all about the world storm that swept me from Manhattan to the south Pacific like a driven leaf. When the bomb fell on Hiroshima my ship was a bobbing speck on picket duty in the rough waters off Okinawa, and we had just survived a kamikaze attack unscathed; so I joined heartily in the merriment aboard ship, very glad that I had survived the war and would soon go back to my free civilian life and marry

my sweetheart. As to the larger issues of dropping a whacking new bomb made of uranium on a Japanese city, I was innocent and indifferent. The radio said that our scientists had "harnessed the power of the sun", and that was quite enough for me and for all of us aboard that old four-piper, halfway around the world from home.

The Caltech scientists received me cordially, and talked freely



## PROFILE

Herman Wouk is the Pulitzer prize-winning author of *The Caine Mutiny* and other novels. *The Language God Talks* is published this month by Little, Brown and Company

about their adventures in working on the bomb. I remember one physicist telling me, for instance, how he drove to the Trinity test site in New Mexico with the dread plutonium core in the back seat of his car. But to a man, one after another, they warned me so earnestly not to try to see Richard Feynman that I began to think of him as a human plutonium core. However, I had nothing to lose so I did try, and somehow I found myself in his office, talking to a lean guy in white shirtsleeves, with long hair and a sharply humorous countenance calling to mind a bust Voltaire. It didn't go well at first.

"You know," he said, as I groped

From afar, Richard Feynman seemed as dangerous as plutonium

to explain my purpose, "while you're talking, you're not learning anything." So I blurted out baldly, any old way, my vision of a fiction work throwing a rope around the whole global war. As I spoke, an enigmatic look came over that strong face, something like remote tolerant amusement. "Well, that's the sort of thing genius reaches out for," he said, and he took over the conversation.

In swift strokes Feynman brought the entire Manhattan project to life, the excitement and the perils alike, mentioning that once in a laboratory corridor he passed uranium materials stacked so carelessly that a chain reaction was within a whisker of going off. His main point was that the whole enterprise was gigantically messy, and that the atomic bomb was by no means at a frontier of science. He put it so: "It wasn't a lion hunt, it was a rabbit shoot." There was no Nobel prize, that is to say, in the concept or the calculations; it was just a challenge, if a huge one, to audacious innovative technology and brute industrial effort.

This formidable fellow walked out of the building with me, and said as we were parting: "Do you know calculus?" I admitted that I didn't. "You had better learn it," he said. "It's the language God talks."

As a Columbia undergraduate, imbibing the Greek philosophy, comparative religion and general humanism of the noted core

### "I've been stashing false starts on the answer offered by the Bible to the grand 'Why?' of the child"

curriculum, I rode the subway to the Bronx once a week to study the Talmud with my grandfather. The Talmud is a hard grind in Aramaic, and to lighten up things I would now and then venture an agnostic prod at some tender point of our faith – say, Joshua's stopping the sun and moon. Grandpa would respond with good-natured scorn, stroking his full beard, "Where are you



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creeping with your lame paws?" It was more pungent in Yiddish, but you get the idea.

That question has been occurring to me as I write these words. Disqualified as I have described myself for getting into these deep murky waters – no academic credentials to speak of, no mathematics beyond half-forgotten algebra – where am I creeping with this venturesome causerie?

Fair question, reader, so let me invite you into the workshop of an old author still creating stories, my work, my intermittent despair, and my lifelong fun. With a new novel recently publishing and another on the stocks, I have stepped back from my desk, drawn breath, and glanced around the shop for overlooked items. One folder labelled *A Child's Garden of God* lies to a side, more scuffed than most, in which for years I've been stashing false starts on the answer offered by the Bible (insofar as I can grasp it) to the grand *Why* of the child and of stumped agnostics. No wonder I have kept putting it off! A big bite.

Newton summed up his lifework: "I know not what I seem to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell, whilst the great

Wouk (second from left) in a 1953 TV show with Ethel Waters (far left), Grace Kelly and Charles E. Wilson

ocean of truth lay all undiscovered before me."

It was this child having fun on the beach who came upon the smoother pebble called the calculus (oddly, the word means "pebble"), enabling thinkers after him to venture far out on that ocean of truth, toward a distant shore of final theory which, as they keep learning to their gloomy puzzlement, ever recedes. Isaac Newton not only found Feynman's "language God talks", he also mastered God's Bible, a fact that embarrasses some scientists. Newton put Feynman's dictum on calculus, which he called "fluxions", in plain words suited to his own faith: "God created everything by number, weight, and measure." An agnostic paraphrase for our day might be: "All that is truly knowable is knowable only by numbers, weight, and measure." Or as James Jeans put it, "God is a mathematician."

Is the stage really too big for the drama, as Feynman asserted? I believe it's possible to disagree, and that is the theme of my book. ■

Taken from Herman Wouk's *The Language God Talks: On science and religion*, reprinted with permission of Little, Brown and Company



# False economy

Are we doing more harm than good in trying to be environmentally friendly consumers?

*Green Gone Wrong* by Heather Rogers, Verso/Scribner, £16.99/\$26

Reviewed by Peter Aldhous



I LIVE in the San Francisco Bay Area, the epicentre of smug green consumerism, where self-proclaimed environmentalists

drive to wholefood shops to load their fuel-inefficient hybrid SUVs with too much organic produce. They should read Heather Rogers's stories and weep.

Rogers travelled a long way to investigate the emerging green economy. Her destinations included supposedly organic sugar-cane plantations in Paraguay and tracts of rainforest in Borneo that are being felled to produce palm oil for biofuel.

Having flown all over the globe, Rogers did not try to salve her conscience by buying "carbon offsets", which are supposed to negate air miles by funding tree-planting or renewable electricity projects in developing countries. When you

read her account of the problems with auditing these schemes in India, you'll understand why.

*Green Gone Wrong* is primarily a fast-paced travelogue, which leads to some loose ends and an uneven structure. In India, for instance, we are told that a carbon-offsetting project is "perhaps" composting ash into organic fertiliser, "but I saw no trace of it". (Having done my share of "touristic" journalism, I've experienced similar difficulties: on a flying visit, it is hard to tell whether you're looking at part of the problem, or part of the solution.)

The section on housing, meanwhile, is dominated by a glowing account of developments in Germany that put more power into the grid than they remove. I would like to have seen more discussion of whether or not this is because green housing is intrinsically easier to get right than green agriculture.

I wanted a synthesis, not a succession of anecdotes. In this regard, another problem is Rogers's apparent distrust of quantitative analysis. For example,

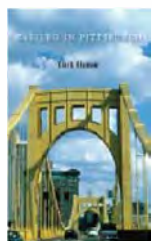
she dismisses analysis of the total greenhouse emissions over the production cycle of a food as often failing to capture the realities of how crops are grown in distant lands. Maybe so, but without quantitative rigour, we are forced to lean on assumptions that may be as ill-founded as those this book demolishes.

Rogers seems to view nuclear power as bad and small farms as good. But can we develop a low-carbon economy without a nuclear component, and does a local farmers' market result in higher or lower greenhouse emissions per kilo of produce than a food industry that achieves economies of scale by hauling much larger quantities of food, even if the distances are greater? A true green economy can be built once we have the answers to these and other equally tricky questions.

## Statistically confused

*Galileo in Pittsburgh* by Clark Glymour, Harvard University Press, £20.95/\$27.95

Reviewed by Jo Marchant



AFTER a career involving everything from building Mars robots to predicting wildfires to teaching courses on Freud, science philosopher Clark Glymour invites us to share his accumulated wisdom.

The resulting essays cover a dizzying range of topics, but Glymour has a central theme: that while statistics and computers have made science more powerful, they have also made it easier than ever for data to be misunderstood and abused. "We have not yet quite absorbed the complexity of our own science or what our uncertainty about it means for practical policy," he writes.

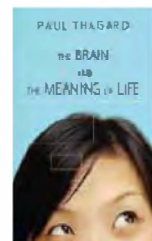
The title essay draws parallels

between the trial of Galileo and the accusations of scientific misconduct faced by University of Pittsburgh statistician Herbert Needleman over his lead-toxicity data. While this comparison is unconvincing, what could have been a tedious collection of musings turns out to be a sharp and thought-provoking book.

## Biological theology

*The Brain and the Meaning of Life* by Paul Thagard, Princeton University Press, £20.95/\$29.95

Reviewed by Amanda Geffer



PAUL Thagard's book is a thoughtful and well-researched attempt to answer that most fundamental existential

question: why not kill yourself? Or, to give it a positive spin, what gives life meaning?

Thagard lays out detailed arguments that reality is knowable through science, that minds are nothing other than material brains and that there are no ultimate rights and wrongs handed down by a supernatural being. Religious ideas such as free will and immortality have been undermined by science – and so, some might think, has the possibility for absolute statements about the meaning of life. Thagard says otherwise. He believes that achieving goals in love, work and play make life meaningful, not as a matter of philosophy but as a matter of biology.

For instance, animals that lack social bonds are unhealthier than those who enjoy close relationships, so pursuing goals in love makes life meaningful because it satisfies vital biological needs. By connecting moral questions to objective facts about the universal structure of brains, Thagard hopes to pave the way for a morality that is rooted in science rather than religion.





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# Finding that perfect partner

As we continue to unravel the secrets of cancer, and with the promise of personalised treatments on the horizon, **James Urquhart** finds out what it takes to be a perfect match for cancer research

“DEDICATED, passionate about science, loves numbers and solving life’s mysteries – seeks a rush of excitement.” No, *New Scientist* isn’t running a lonely hearts column. But if we were, an ad like this might catch the attention of admirers from an unexpected quarter. That’s because it mentions attributes that are highly sought after by cancer researchers hoping to find someone who wants a rewarding career in their field.

These aren’t the only useful traits for uncovering cancer’s secrets. “You need to have strong personal motivation – you don’t do it for the money,” says microbiologist Nina Salama. She runs a lab at the Fred Hutchinson Cancer Research Center in Seattle, one of 65 labs designated as “comprehensive cancer centres” by the National Cancer Institute (NCI) in the US. “Cancer is a really interesting and important problem.

It’s something worth being passionate about.”

Salama’s passion lies in picking apart the genes of a gut-dwelling bacterium called *Helicobacter pylori*. The microbe causes chronic inflammation in the stomach that can lead to ulcers, and in the 1990s it was linked to stomach cancer – the second most deadly cancer after lung cancer. Salama is studying *H. pylori*’s genes to decipher the biochemical chatter between the bacterium and its host. She hopes this will explain how gastric cancer develops and lead to better diagnostic techniques and drug treatments.

Over in the UK, new drugs are Gert Attard’s concern. A physician by training, he opted to pursue a career in cancer research after his grandfather died of colon cancer. He now works at the Institute of Cancer Research in

Sutton, evaluating new ways to treat prostate cancer. When not in the lab, Attard teaches and works at The Royal Marsden, a specialist cancer hospital nearby. "Big advances desperately need to be made, and are being made, so it's a very exciting period to be doing cancer research," Attard says. "We are reaping the rewards of 40 years of good research, with true benefits being seen for patients after so many years of frustration."

One promising drug Attard's lab is working on is abiraterone, a treatment for prostate cancer that works by blocking the production of testosterone. Early clinical trials suggest it could be used to treat up to 80 per cent of patients with the most aggressive and drug-resistant form of the disease.

But success in this field doesn't come easily, Attard says. "You have to have an ability to cope with disappointment because for every successful lab result there are a hundred failures." Coping with the disappointment comes from dogged persistence and belief in your ideas, he says, and the reward when you get it right makes it all worthwhile. "Expect amazing highs when results go well."

## Teaming up

There is a growing emphasis on collaboration with researchers from other fields, Salama says. "Being able to work with a team where people have different areas of expertise and being able to communicate across those groups is increasingly important," she says, adding that this will improve the quality of research.

It was an interest in interdisciplinary science that landed Franziska Michor of the Memorial Sloan-Kettering Cancer Center in New York City her dream job. Armed with enthusiasm and a background in evolutionary biology and mathematics, she hopes to make a difference in the fight against cancer by leading one of the 12 Physical Sciences – Oncology Centers dotted around the US.

The centres were launched last year by the NCI, which awarded substantial grants to leading US cancer institutes to initiate collaborations involving the physical sciences and oncology. The idea is to expand our knowledge of how physical laws govern the emergence and behaviour of cancer.

"Using this convergence of different fields to come up with all sorts of new ways of looking at cancer is really interesting – and it's a lot of fun too," says Michor. Under the NCI initiative, her lab is receiving an \$11 million grant over five years to work out

## Janet Shipley Case study



**Janet Shipley works on molecular cytogenetics at the Institute of Cancer Research in**

**Sutton, UK. She studies how proteins are expressed in tumours with a view to discovering genetic markers for cancer and potential therapeutic targets.**

**How did you get involved in cancer research?**

I've always been interested in biology and had a deep fascination

for trying to understand why we are the way we are. There is much to discover, especially why it goes wrong in diseases like cancer.

**What's the best motivation someone in your field can have?**

The almost obsessive pursuit of trying to understand and discover new things. This, combined with the ultimate objective of helping people with cancer, provides me with powerful motivation.

**How has the field changed in recent years?**

The map of the human genome and an understanding of the role of

gene products has provided a new framework for research. There has been a massive increase in the available information that has to be factored into each study, which requires computational skills and the ability to take a more collaborative approach.

**What advice would you give an up-and-coming researcher?**

Think carefully – you have to be highly committed and not afraid to work extremely hard. The old adage of 99 per cent perspiration and 1 per cent inspiration is certainly true for this line of work.

the evolutionary dynamics of cancer. Since mutations play a role both in cancer and in evolution, and since evolution can be modelled mathematically, Michor's approach could yield some fascinating results.

Michor's lab is developing a number of mathematical models for different cancers, including one to understand how lung cancer cells mutate to become resistant to drugs, and another to determine the sequence of mutations that can give rise to a brain tumour. By collaborating with other labs, Michor can translate her predictive models into animal and cell line models and can test them by genetically engineering those systems.

## Making it personal

Mathematical modelling is just one approach to understanding how the development of each type of cancer is unique to individuals. If we can discover the pattern of genetic mutation in cancers, then personalised treatments will become possible. Leading the effort are ambitious projects such as the NCI's Cancer Genome Atlas, which uses genome analysis techniques to catalogue these mutations.

The Cancer Genome Project (CGP) at the Wellcome Trust Sanger Institute in Hinxton, UK, has also made significant breakthroughs.

**"Experiments churn out vast amounts of data, so programming skills and an analytical bent are desirable"**

In December last year, it reported the first genetic sequences of lung and skin cancer cells, revealing every mutation these cells had acquired over their lifetime. By comparing the genetic make-up of diseased and healthy cells in individuals, the project was able to identify the mutations that had caused cells to turn cancerous.

"If you have the genomes of individual patients, simple blood tests could be developed to detect cancer-specific gene mutations, because cancer cells leak DNA into the blood," says Mike Stratton, a co-leader of the CGP. This could point the way to suitable personalised treatments. Sequencing an entire genome is still very expensive, but Stratton hopes that advances in technology could soon make it an everyday diagnostic tool.

Even so, current technology already allows even small labs to explore the expression of tens of thousands of genes in a single experiment, whereas 10 years ago working on a single gene at a time was the norm. This means experiments now churn out vast quantities of data, so programming skills and an analytical bent are also highly desirable skills.

"Within five years what we will know about the genetic processes which underlie all cancers will be transformed," predicts Stratton. "It's an extraordinarily exciting time to be entering cancer research." ■

James Urquhart is an intern at *New Scientist*



## Molecular Genetics, Structure Function Proton-Coupled Folate/Antifolate Transporter

A postdoctoral position is available for studies on the structure-function, molecular genetics, and biological/pharmacological properties of the proton-coupled folate transporter (PCFT) recently cloned by this laboratory (Cell 127:917, 2006) and the mutations that are the basis for the autosomal recessive disorder, hereditary folate malabsorption. PCFT mediates intestinal folate absorption and transport of antifolates into tumor cells, particularly in an acid microenvironment. Candidates should have a strong background in molecular biology and/or physiology/electrophysiology/ homology modeling and a track-record of productivity during their doctoral training. Email resume and the names of three references to:

I. David Goldman, MD, (i.david.goldman@einstein.yu.edu), Departments of Medicine and Molecular Pharmacology, Albert Einstein College of Medicine Cancer Center, Jack and Pearl Resnick Campus, Bronx, New York 10461



## Faculty Position, Pharmacology and Toxicology Dartmouth Medical School

The Department of Pharmacology and Toxicology in collaboration with the Norris Cotton Cancer Center at Dartmouth Medical School and Dartmouth Hitchcock Medical Center seeks candidates for a tenure-track or tenured faculty position at the rank of Assistant, Associate or Full Professor. Our goal is to recruit an established investigator and cancer/molecular biologist with expertise in the broadly defined area of molecular therapeutics with strengths in specific areas such as intracellular signaling, genome maintenance and stability, drug discovery and/or structural biology using modern experimental model system. Candidates should have a Ph.D., D.V.M. and/or M.D. degree(s), an outstanding academic record and an externally funded research program. Additional information is available on the departmental and Cancer Center websites: <http://dms.dartmouth.edu/pharmtox/> and <http://www.cancer.dartmouth.edu/>.

Applicants should submit, in electronic PDF format, a curriculum vitae, statement of research interests and accomplishments, record of extramural grant support and contact information, including email addresses for at least three references to: [pharmacology.and.toxicology@dartmouth.edu](mailto:pharmacology.and.toxicology@dartmouth.edu). Review of applications will begin immediately and will continue until the position is filled. Dartmouth is an Affirmative Action/Equal Opportunity Employer. Women and members of minority groups are strongly encouraged to apply.

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May 12, 2010

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- Strong project leadership experience on projects that have produced clinical candidates
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Postdoctoral Positions for M.D.s, D.V.M.s, Ph.D.s, and J.D.s

The National Cancer Institute (NCI), a major research component of the National Institutes of Health (NIH) and the Department of Health and Human Services (DHHS), is recruiting for postdoctoral positions in three program areas: The Center for Cancer Research (CCR), The Division of Cancer Epidemiology and Genetics (DCEG), and The Cancer Prevention Fellowship Program (CPFP). Candidates for all three programs must have a doctoral degree (M.D., D.V.M., Ph.D., J.D., or equivalent) and have less than five years postdoctoral experience.

One of the world's largest cancer research centers, the **Center for Cancer Research (CCR)** utilizes the breadth of its researchers to foster interdisciplinary programs and facilitate translational research. The CCR website at <http://ccr.nci.nih.gov> offers detailed descriptions of its 54 basic research laboratories, clinical branches, programs, and close to 300 Principal Investigators. Also provided are links to important information, including postdoctoral position openings. Candidates may apply online at <http://generalemployment.nci.nih.gov> or by email to [velthum@mail.nih.gov](mailto:velthum@mail.nih.gov). The **Division of Cancer Epidemiology and Genetics (DCEG)** conducts a national and international program of population, family, and laboratory-based studies to elucidate the environmental and genetic determinants of cancer. DCEG is staffed by a faculty of world-class epidemiologists, geneticists, biostatisticians, physicians and others who are committed to excellence in epidemiological research. The DCEG website at <http://dceg.cancer.gov> provides detailed descriptions of its diverse research portfolio as well as links to important information, including how to apply.

The **Cancer Prevention Fellowship Program (CPFP)** offers a three to four year postdoctoral training program in cancer prevention and control. Program features include: 1) A tuition-paid opportunity to obtain a Master of Public Health (MPH) degree during the first year; 2) Mentored cancer prevention research opportunities in areas of epidemiology, biostatistics, laboratory, clinical, and social and behavioral sciences at the National Cancer Institute or the Food and Drug Administration; and 3) Participation in the NCI Summer Curriculum in Cancer Prevention as well as professional development courses. Postdoctoral candidates must be US Citizens or Permanent Residents (or be an applicant from the Ireland-Northern Ireland-NCI Cancer Consortium). The CPFP website at <http://www3.cancer.gov/prevention/pof> provides detailed program and application information. Applications for the CPFP are accepted online from May 1, 2010 through September 1, 2010 for entry into the program in June 2011.

The CCR, DCEG, and CPFP share a commitment to training individuals from a variety of health and biomedical disciplines to become leaders in cancer research. Stipends are competitive and commensurate with experience.



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Washington University School of Medicine is one of the top five US medical schools based on NIH grants. The Division of Oncology and the Genome Center here are using next-generation genome sequencing on human cancers (Ley TJ, et al. Nature 456:66-72, Nov. 6, 2008 and Ding L, Ellis MJ, et al. Nature April 15, 2010).

Dr. Ron Bose in the Division of Oncology studies protein kinase mutations in breast cancer. The ideal candidate for post-doctoral position in the Bose lab will have very strong background in molecular biology, such as PCR-based gene cloning, viral vectors, or making stable cell lines, be a dedicated and hard-working scientist, and have strong publications.

**E-mail your CV and names of three references to**  
***rbose@dom.wustl.edu.***

For further information:

<http://hematology.im.wustl.edu/faculty/bose/boseBio.html>

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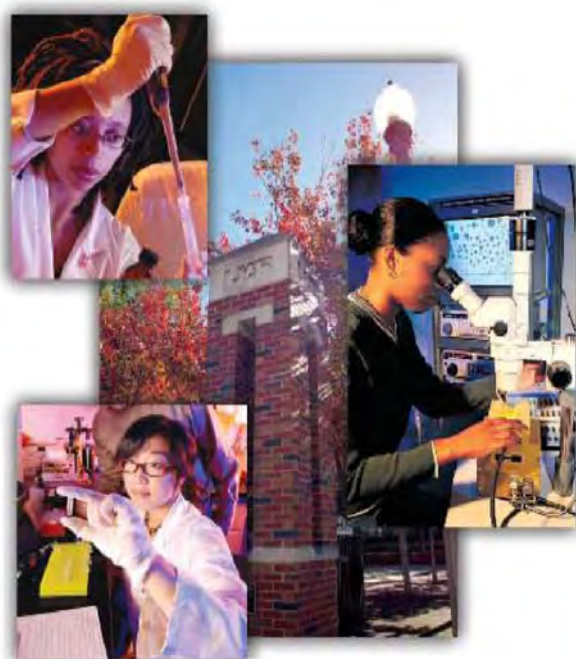
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# UAB THE UNIVERSITY OF ALABAMA AT BIRMINGHAM



The University of Alabama at Birmingham (UAB) is one of the premier research universities in the US with internationally recognized programs in AIDS and bacterial pathogenesis, bone biology and disease, cancer, diabetes and digestive and kidney diseases, free radical biology, immunology, lung disease, neuroscience, trauma and inflammation, and basic and clinical vision science among others. UAB is committed to the development of outstanding postdoctoral scientists and has been consistently ranked in recent years as one of the top ten locations among US universities for training postdoctoral scholars.

UAB faculty are well funded [20th overall in NIH funding], utilize multidisciplinary approaches, and provide excellent research training environments that can lead exceptional candidates to entry level positions in academia, government or the private sector. Full medical coverage (single or family), competitive salaries/stipends, sick leave, vacation, and maternity/paternity leave are offered with every position. Depending on the source of funding, other benefits may be available.

Birmingham is a mid-size city centrally located in the southeast near beaches and mountains and enjoys a moderate climate for year round outdoor activities and a cost of living rate lower than most metropolitan areas.

The city's rapid growth in its infancy in the late 19th century earned it the nickname "The Magic City," but the magic didn't stop there. Come and experience the magic for your self!

Visit our web site at [www.postdocs.uab.edu](http://www.postdocs.uab.edu) under Postdoctoral Opportunities to view posted positions. Send your CV and cover letter to the contact name for those positions for which you are qualified and which interest you.

University of Alabama at Birmingham, Office of Postdoctoral Education, 1530 3rd Avenue S., 171 Shelby, Birmingham, AL 35294-2182, 205-975-7020/975-7021.

UAB is an equal employment opportunity employer.





## HEMATOLOGY/ONCOLOGY FACULTY POSITIONS

The Division of Hematology/Oncology of the Department of Internal Medicine and the University of Michigan Comprehensive Cancer Center invite applications for faculty positions in two areas.

The first position is for candidates with an interest in genitourinary cancer clinical research. The desired candidates should have documented expertise in the design and execution of Phase I and II clinical trials to test novel therapeutic agents targeting genitourinary cancers. The selected candidate will join an established Program in Genitourinary Oncology at the University of Michigan Comprehensive Cancer Center which includes over 30 faculty from 10 departments with annual direct funding of \$6M. The Program has a robust translational research focus in all GU cancers for which there are specific multi-disciplinary clinics and tumor boards. Other areas of research interest include characterization of GU cancer stem cells, and development of novel combined modality therapies of GU cancers involving immunotherapy, chemotherapy, and radiotherapy.

The second position has a focus on clinical research in hematopoietic cell transplantation as a treatment modality for hematologic malignancies. Candidates should have documented expertise in the evaluation and management of patients with malignant hematopoietic disorders and hematopoietic stem cell transplantation. Selected candidates will be members of an established clinical and translational research program in hematologic malignancies within the University of Michigan Comprehensive Cancer Center, which includes 34 faculty members with \$6.3M in research funding.

Applicants (who must be either U.S. citizens or permanent residents) must be board certified or eligible in internal medicine and hematology and/or medical oncology. Faculty track and rank will depend upon prior experience.

Candidates should submit a curriculum vitae, a list of three references, a concise statement of research goals, and a letter of application to **Kathleen A. Cooney, MD, Chief of the Division of Hematology/Oncology, Department of Internal Medicine and Associate Director for Faculty Affairs, University of Michigan Comprehensive Cancer Center, 7216 CC, 1500 E. Medical Center Drive, Ann Arbor, MI 48109-5948; e-mail: kcooney@umich.edu**

*The University of Michigan is an equal opportunity/affirmative action employer and encourages nominations and applications from women and minority candidates.*

BN ImmunoTherapeutics



## Clinical Scientist/Assistant Medical Director

The Clinical Scientist position is responsible for activities to support the clinical and translational development of poxviral based immunotherapy products for cancer. BN-ImmunoTherapeutics (BNIT) is developing active vaccine based immunotherapies in collaboration with the National Cancer Institute. BNIT is located in Mountain View, CA, and is a subsidiary of Bavarian-Nordic (<http://www.bavarian-nordic.com>).

### Specific responsibilities include:

Assisting with writing and researching of clinical protocols and clinical study reports, data management and scientific evaluation of clinical and immunological data, updating Investigators Brochures, IND filings, and Annual Reports as well as working on translational immunology studies.

### Requirements:

PhD, or MD. Excellent written and verbal communication skills. Strong computer literacy skills. Understanding of and experience with industrial drug development. Oncology experience preferred.

We offer a competitive compensation package including stock options, healthcare benefits and a 401(k) plan.

**Qualified candidates please send your CV to:**  
BN ImmunoTherapeutics, Inc. at [hr@bn-it.com](mailto:hr@bn-it.com)

## Postdoctoral Researchers



## The Department of Cancer and Cell Biology



## University of Cincinnati

Vibrant and rapidly growing department seeks skilled and confident postdoctoral researchers. Multiple funded positions are available—many with new faculty recruited from high-profile laboratories. Visit our website to learn more about research opportunities:

<http://cancerbiology.uc.edu/postdoc.aspx>

*An affirmative action/equal opportunity institution*



## Faculty Positions in Cancer and Stem Cell Research

### Cancer Genetics

As part of the University Cancer Research Fund initiative, the UNC Lineberger Comprehensive Cancer Center, the Carolina Center for Genome Sciences and the Department of Genetics at UNC Chapel Hill are continuing expansion with new faculty recruitment (rank open) in the area of Cancer Genetics. The successful applicant will establish a vigorous research program and contribute to on-going efforts to dissect the genetic and biological bases of cancer susceptibility and development. Priority will be placed on individuals applying systems biology approaches in relevant mouse models.

Applicants should have a PhD or MD/PhD degree. Applicants should apply online at <http://jobs.unc.edu/1002165> and attach a cover letter, curriculum vitae, and a statement of research interests (maximum 2 pages). Four letters of recommendation should be sent as email attachments to:

Cathy Cornett [ccornett@med.unc.edu](mailto:ccornett@med.unc.edu)

### UNC at Chapel Hill Stem Cell Initiative

The University of North Carolina at Chapel Hill invites applications for academic positions (rank open) in Stem Cell Biology. These faculty positions reflect a continuing expansion of the stem cell initiative housed in the UNC Center for Stem Cell Biology and Regenerative Medicine. Each successful candidate will be expected to develop a vigorous, externally funded research program based on fundamental questions related to the biology of embryonic or adult stem cells. Specific areas include: 1): Research exploring the molecular regulation of embryonic stem cell pluripotentiality and differentiation, including genomic remodeling and nuclear reprogramming. 2): Active research programs focused on defining the potential of both embryonic and adult stem cells in the treatment of diseases.

Applicants should have a PhD or MD/PhD degree. Applicants should apply online at <http://jobs.unc.edu/1002061> and attach a curriculum vitae and cover letter. Four letters of recommendation (hard copy) should be sent to:

Dr. Larysa Pevny, Director, Center for Stem Cell Biology and Regenerative Medicine

UNC at Chapel Hill

8109b Neuroscience Research Bldg, Campus Box #7250

Chapel Hill, NC 27599-7250

Application deadline: open until filled.

*The University of North Carolina at Chapel Hill is an equal opportunity/ADA employer. Women and minorities are encouraged to apply.*

## Postdoctoral Fellow in Cancer Systems Biology

Postdoctoral position at Microsoft Research New England in Cambridge, MA, to work on a joint project with the Computational Biology Center at Memorial Sloan Kettering Cancer Center, New York, and Politecnico di Torino University, Italy.

The project goal is to apply techniques from statistical physics, and newly developed algorithms, to analyze a rich set of genomic, epigenetic, molecular profiling and patient data from several extensive clinical studies, including The Cancer Genome Atlas. This position represents a unique opportunity to develop and apply new computational methods to problems such as the discovery of candidate markers for early screening or disease prognosis, the understanding of cancer pathogenesis and the development of personalized therapies. Deep expertise in algorithm development or statistical physics, and demonstrated creativity in biological research required. This position might be especially suitable for a recent Ph.D. from an interdisciplinary graduate program that emphasizes strong quantitative skills together with cell, developmental or cancer biology. The position is initially for two years and is based in Cambridge, MA, at Microsoft Research New England, but will require frequent travel to MSKCC in New York, and occasional travel to Torino, Italy.

To be considered for employment for post-doctorate opportunities, you will require your CV, your publications list, a research statement, and at least three letters of recommendation. To express your interest in applying, contact [irenem@microsoft.com](mailto:irenem@microsoft.com), Business Manager of Microsoft Research, New England.

Microsoft®  
**Research**

## Position with Tenure

### Department of Symptom Research

The Department of Symptom Research is seeking an established clinical or basic scientist to contribute to a multidisciplinary effort examining the mechanisms of symptom expression and developing novel biobehavioral methods of symptom management. Symptoms of interest include pain, fatigue, emotional distress, disturbed sleep, neuropathy, and other symptoms that limit cancer treatment tolerability, cause significant distress, and impair cancer survivorship. This scientist will lead a multidisciplinary team that includes basic, behavioral, and clinical scientists.

The candidate must be willing to develop projects within the context of this multidisciplinary research approach, which includes both animal and human studies and randomized clinical trials. The program is well-funded with program project and other NIH and industry grants. We expect candidates with a record of funded research and significant research accomplishment, both of which are required for a tenured faculty appointment in a major academic research institution. This position is available in early 2010.

Applicants should submit curriculum vitae and names of three references to:

Charles S. Cleeland, PhD

Chair, Department of Symptom Research

Division of Internal Medicine

The University of Texas M. D. Anderson Cancer Center

1400 Pressler Drive, Unit 1450, Houston, Texas 77030

Email: [mrodgers@mdanderson.org](mailto:mrodgers@mdanderson.org) • Phone: 715-745-8174

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CANCER CENTER  
*Making Cancer History®*

M. D. Anderson Cancer Center is an equal opportunity employer and does not discriminate on the basis of race, color, national origin, gender, sexual orientation, age, religion, disability or veteran status except where such distinction is required by law. All positions at The University of Texas M. D. Anderson Cancer Center are security sensitive and subject to examination of criminal history record information. Smoke-free and drug-free environment.

# NewScientist Jobs

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East Coast Office  
225 Wyman Street  
Waltham, MA 02451  
Email [NSSales@NewScientist.com](mailto:NSSales@NewScientist.com)  
Phone 781734 8770  
Fax 720356 9217

West Coast Office  
201 Mission Street, 26th Floor  
San Francisco, CA 94105  
Email [NSSales@NewScientist.com](mailto:NSSales@NewScientist.com)  
Phone 415908 3353  
Fax 4155436789

Calls may be monitored or recorded for staff training purposes

## BIOLOGY

### Biotechnology Davis Site Lead (001JU)

Monsanto

CA - California

A successful candidate for this role will bring sufficient scientific and people leadership to ensure continued technical contribution from the site. Scientifically the individual should demonstrate leadership in a discipline of plant biology or plant transgenic engineering.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400750815**

### Research Agronomist (001JM)

Monsanto

MO - Missouri

The successful candidate will conduct laboratory, greenhouse and field agronomic and plant assessment and tissue production studies necessary to support worldwide registration, commercialization and monitoring of agricultural crops.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400750395**

### Seed Technician II (001HT)

Monsanto

IA - Iowa

We currently have opening for a Seed Technician. Seed Technicians are involved in a number of facets of seed production within a location. This may include crop production, conditioning, maintenance, packaging, or warehousing. This position will be located at our Storm Lake site.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400750730**

### Biobanking Project Leader

Novartis Institutes for  
BioMedical Research (US)  
MA - Massachusetts

Provide strategic and operational leadership of the Novartis Strategic Sample Acquisition / Biobanking Project. Define the vision and ensure its implementation in close collaboration with key stakeholders and the Steering Committee.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400748130**

### Carbon Cycle 2.0 Campaign Manager

Lawrence Berkeley National  
Laboratory

CA - California

Renewable energy sources such as bio-fuels and artificial photosynthesis. Energy efficiency at home, at work, and around the world. The ability to observe, probe and assemble materials atom by atom. Climate change research, environmental science, and the connections between them.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400750763**

### Computational Chemistry and Biology Opportunities at D. E. Shaw Research

D. E. Shaw Research

NY - New York

Extraordinarily gifted computational chemists, biologists, and other computational scientists are sought to join a New York-based interdisciplinary research group that is pursuing an ambitious, long-term strategy aimed in part at fundamentally transforming the process of drug discovery.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400752860**

### Director/Assoc. Dir, Portfolio Planning

Genentech

CA - California

This position reports to the head of Pipeline and Portfolio Planning in Global Product Strategy. The Director will lead a team to support the Oncology Disease Biology Area

(DBA) and governance committees to optimize development plans by partnering with Project and Lifecycle teams and functions, and providing portfolio insight and analytics.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400750856**

### Early Candidate Medical Director, Bone

Pfizer US

PA - Pennsylvania

Contributes to ensuring strategic alignment between the Specialty Business Unit and corresponding Research units in defining product concepts and by supporting POM/POC development paths and participating in Disease Area Working Groups at the direction of the TA Lead.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400749628**

### Early Career Scientists and Engineers: Computational Biochemistry Research Group

D. E. Shaw Research

NY - New York

Extraordinarily gifted early career scientists and engineers are sought to join a New York-based interdisciplinary research group pursuing an ambitious, long-term project aimed in part at fundamentally transforming the process of drug discovery.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400752859**

### EPIDEMIOLOGIST (RESEARCH ASSOCIATE IV), Alberta, Canada

Alberta Cancer Board

AB - Alberta

The Epidemiologist is part of an established research support team which currently includes several MSc trained epidemiologists and statisticians, as well as database and data collection programmers,

research assistants and grant administrators.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400748870**

### Industrial Post Doctoral Position - Neuroscience

Pfizer US

CT - Connecticut

Michael J. Fox Foundation funded post-doctoral position is available in the Neuroscience Research Unit at Pfizer, located in Groton Connecticut, to investigate potential substrates of LRRK2 and their role in Parkinson's Disease.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400749637**

### Postdoctoral fellowship in Maternal and Child Nutrition, Division of Nutritional Sciences

Cornell University

NY - New York

The successful applicant will have a PhD, MD or equivalent degree and a record of accomplishment in a related science (nutritional, biological, chemical or social), public health, epidemiology or medicine, and will be committed to a career of research in Maternal and Child Nutrition.

**For more information visit**  
[NewScientistJobs.com](http://NewScientistJobs.com) Job ID:  
**1400750766**

### POSTDOCTORAL POSITION IN IMAGE ANALYSIS/ COMPUTATIONAL NEUROSCIENCE

Washington University School of  
Medicine, St. Louis  
MO - Missouri

Our lab is dedicated to studying the mechanisms of synaptic transmission at individual synapses and the role of synaptic plasticity in information processing. Several current projects have translational emphasis on dysfunction in information processing in neurological disorders such as

mental retardation and Alzheimer's.  
**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400748876**

### Postdoctoral Research Fellow

Genentech  
 CA - California  
 The successful applicant will have broad knowledge of cell biology and/or immunology and initiate a research project to investigate the relationship between cellular signaling pathways and epithelial cell biogenesis, or the cell biological mechanisms underlying the function of dendritic cells.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400750780**

### Postdoctoral Research Fellow

Moffitt Cancer Center  
 FL - Florida  
 One fully funded post-doctoral position is available to study the role of tumor suppressor genes and signaling molecules in oncogenesis, angiogenesis and tumor metastasis especially in context of lung cancer.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400750733**

### Postdoctoral Research Position

University of Tennessee  
 Memphis Health Science Center  
 TN - Tennessee  
 The ideal candidate for this position would have the following capabilities: intermediate to advanced skills with the use of AFM in imaging and indentation of living cells; a background in engineering; proficiency in Matlab and other computational software; experience in cell culture and microscopy; ability to work in a diverse and multi-disciplinary environment.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400751184**

### Principal Scientist

Genentech  
 CA - California  
 Serving Research and Discovery

at Genentech, this outstanding laboratory conducts groundbreaking proteomic research using state of the art instrumentation, primarily mass spectrometers but including n-terminal sequencers, protein and peptide separations technology, and enzymatic and chemical manipulations.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400747959**

### Program Leader

Pioneer Hi-Bred  
 IA - Iowa  
 Accountable for the success of the assigned program(s). Ensure the program is linked to the Enterprise strategy and business plans. Own and be accountable for a comprehensive understanding and accurate communication of the status of a program at any one point in time

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400750481**

### Research Assistant - Boston - Children's Hospital

Children's Hospital, Boston  
 MA - Massachusetts  
 A Research Assistant Position is available in the Division of Immunology at Children's Hospital, Boston to participate in studies of allergic pathogenesis. Previous experience in cellular and molecular immunology and mousework is desirable but not required.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400750431**

### Scientific Associate II, Developmental & Molecular Pathways

Novartis Institutes for BioMedical Research (US)  
 MA - Massachusetts  
 Perform duties of molecular/in vivo biologist in Developmental and Molecular Pathways Department within the Exploratory Pharmacology Unit. Conduct molecular biology experiments including molecular cloning, cell and tissue culture, transfection, infection, RNA isolation, and Northern, Western and Southern

### The University of Washington Department of Bioengineering Tenure Track Position in Pharmacometrics

The Department of Bioengineering and the School of Pharmacy at the University of Washington invite applications for a tenure track position in the area of Pharmacometrics. The primary appointment will reside in the Department of Bioengineering, School of Medicine, with a joint appointment in the Department of Pharmaceutics, School of Pharmacy.

Applications are sought at all levels including Assistant, Associate or Full Professor. Ph.D., PharmD or M.D. degrees are required. Applications must be submitted electronically at <http://www.engr.washington.edu/facsearch/?dept=BioE>. Applicant review will begin April 2010 and continue until the position is filled. All positions are contingent on the availability of funding.

*The University of Washington is building a culturally diverse faculty and strongly encourages applications from women, minorities, individuals with disabilities and covered veterans. The University of Washington is the recipient of a 2006 Alfred P. Sloan Award for Faculty Career Flexibility and a 2001 National Science Foundation ADVANCE Institutional Transformational Award to increase the advancement of women faculty in science, engineering and math. The University is an Equal Opportunity, Affirmative Action Employer.*

blotting.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400748126**

### Scientist - Neuroscience

Genentech  
 CA - California  
 This individual will lead a small team that will use molecular, genetic, imaging and/or biochemical techniques to investigate the molecular mechanisms of nervous system disorders and to participate in drug discovery projects.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400747963**

### Scientist, Electrophysiologist

Genentech  
 CA - California  
 We have an opening for a talented electrophysiologist to join our Biochemical Pharmacology group as part of the small molecule drug discovery program in our South San Francisco location. The successful candidate will be responsible for providing support for specific projects in the neuroscience and immunology indications using in vitro electrophysiological techniques.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400747961**

### Senior Computational Biologist

Genentech  
 CA - California  
 We are seeking a highly motivated individual to help with analysis of next generation sequencing data in

basic and applied research work that will enhance our understanding of cancer and other diseases.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400750782**

### Senior Engineer, Biologics MSAT (Fill-Finish)

Genentech  
 CA - California  
 The successful candidate will also be responsible for providing ongoing technical support for manufacturing processes across the Genentech/Roche network.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400752840**

### Senior Research Associate - Microbial Pathogenesis

Genentech  
 CA - California  
 The successful candidate will utilize a wide range of in vivo and in vitro approaches to understand the molecular pathogenesis of infectious diseases and mechanisms amenable to therapeutic intervention.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400751255**

### Senior Research Scientist, Target Refinement

Pfizer US  
 MA - Massachusetts  
 As a core member of the Target Refinement team, simultaneously execute and deliver multiple Target Refinement projects from biochemical assay development through data generation and



### Editor: Trends in Cell Biology

We are seeking to appoint a new Editor for Trends in Cell Biology, to be based in the Cell Press offices in Cambridge, MA.

As Editor of Trends in Cell Biology, you will be responsible for the strategic development and content management of the journal. You will be acquiring and developing the very best editorial content, making use of a network of contacts in academia plus information gathered at international conferences, to ensure that Trends in Cell Biology maintains its market-leading position.

This is an exciting and challenging role that provides an opportunity to stay close to the cutting edge of scientific advances while developing a new career away from the bench. You will work in a highly dynamic and collaborative publishing environment that includes 14 Trends titles and 12 Cell Press titles. You will also collaborate with your Cell Press colleagues to maximize quality and efficiency of content commissioning and participate in exciting new non-journal based initiatives.

The minimum qualification is a PhD in a relevant discipline, and post-doctoral training is an advantage. Previous publishing experience is not necessary – we will make sure you get the training and development you need. Good interpersonal skills are essential because the role involves networking in the wider scientific community and collaboration with other parts of the business.

To apply, please submit a CV and cover letter describing your qualifications, research interests, current salary and reasons for pursuing a career in publishing at:

<http://reedelsevier.taleo.net/careersection/51/jobdetail.ftl?lang=en&job=CEL00005>

No phone inquiries, please. Cell Press is an Equal Opportunity Employer.

Applications will be considered on an ongoing basis until the closing date of Friday, April 30th.

analysis with the goal of gaining a better understanding of how to design more effective biotherapeutic drugs against the proposed target.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400750728**

### Senior Scientist, RNA Therapeutics

Roche  
NJ - New Jersey  
Working within a multi-disciplinary team, the candidate will be responsible for the design and execution of rodent and non-human primate models of inflammation. He/she will actively research and implement disease pathways and biology in these assays, including potential biomarkers that may be translated to the clinical setting.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400748920**

### Translational genomics faculty - New York City -

### Medical School

Mount Sinai School of Medicine  
NY - New York

The Institute is investing aggressively to develop interdisciplinary research programs, employing cutting-edge genomic technology, statistical genetics, population genetics, genetic epidemiology, and genetic medicine expertise to advance the understanding of common genetically-linked diseases and to improve health outcomes.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400752691**

### US Team Lead, Infectious Disease, MD

Pfizer US  
PA - Pennsylvania  
Lead the development of strategies and tactics to support US medical product needs, and ensure delivery of US Medical Plans for the Infectious Disease assets. Oversee and coordinate medical input into brand strategies and tactics

ensuring US regional medical needs

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400750818**

## CHEMISTRY

### Prin Scientist (Chemistry)

Genentech

CA - California

The qualifications of a Principal Scientist (Chemistry) at Genentech are comparable in terms of scientific experience, creativity and accomplishment to those of a Lab or Division Head in a leading biotechnology or pharmaceutical company with a minimum of 13 years Process Chemistry experience in the field of drug discovery and/or development.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400747964**

### Sr Scientist (Chemistry)

Genentech

CA - California

The successful candidate will accomplish our mission through innovation and teamwork, collaboration with strategic partners, creative problem solving and use of state-of-the-art technology.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400747953**

## CLINICAL

### Medical Director (MD) gRED

Genentech

CA - California

The Medical Director will act as a clinical representative to a number of cross-functional teams responsible for the selection of clinical candidates, formulation of the clinical development plans and the design, implementation, monitoring, analysis, and reporting of studies conducted within one or more programs.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400748951**

### Pathways IHC Research Associate (BS/MS)

Novartis Institutes for BioMedical Research (US)

MA - Massachusetts

The Pathway Biology 4 (PB4) Unit of the Developmental and Molecular Pathways (DMP) department is looking for an experienced associate with histology techniques & immunohistochemistry skills to provide scientific & technical expertise for the discovery and validation of disease relevant targets and pathways in the oncology field.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400748129**

### Research Scientist

Pioneer Hi-Bred

PR - Puerto Rico

Works insure that high quality DNA marker data is produced in a timely manner in support of Pioneer crop breeders. Supervise and evaluate employees' performance as part of effectively managing laboratory.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400747949**

### Senior Research Associate

Pioneer Hi-Bred

IL - Illinois

Provide leadership organizing and directing seed handling activities to fulfill requirements for nursery and field experiments according to available objectives, resources, and procedures while exercising independent judgment and discretion.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400747944**

### Sr Scientist (Technology)

Genentech

CA - California

We are seeking a bright Sr Scientist/ Sr. Scientific Manager to join the Small Molecule Pharmaceuticals group at Genentech supporting clinical candidate selection, preclinical and clinical development for our exciting and growing pipeline.

**For more information visit**  
**NewScientistJobs.com Job ID:**  
**1400747965**



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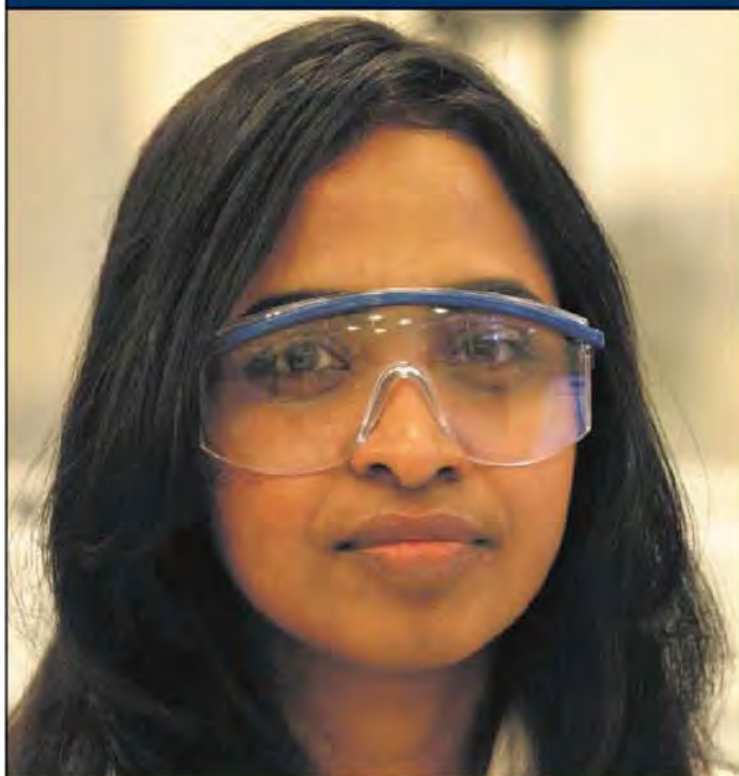
### Looking to hire top scientific talent?

Engage jobseekers and get response through our new targeted email services! Our customer service team is available to meet your evolving needs. Contact us today!

Email: [NSSales@NewScientist.com](mailto:NSSales@NewScientist.com)  
Phone: 781.734.8770

# NewScientist Jobs

## Fortune World's Most Admired Companies list 2009



I want to do  
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in a **supportive**  
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**You can at AstraZeneca.** We're a global pharmaceutical leader that has developed some of the world's most recognized – and influential – pharmaceutical brands.

Our employees make our work possible through creative thought, dynamic energy, and a team approach to problem-solving. The work of our employees improves lives.

AstraZeneca embraces diversity, innovation and collaboration – pushing the boundaries of conventional thought to make our ideas come to life.

**[www.AstraZenecaCareers.com](http://www.AstraZenecaCareers.com)**



AstraZeneca 

# NIAID needs you because the world needs us!

The National Institute of Allergy and Infectious Diseases (NIAID), one of the largest institutes of the world-renowned National Institutes of Health (NIH), conducts and supports a global program of basic and applied research to better understand, treat, and ultimately prevent infectious, immunologic, and allergic diseases. NIAID is a world leader in innovative research and scientific discovery in areas such as HIV/AIDS and other sexually transmitted infections; malaria and other tropical diseases; pandemic and seasonal influenza; illnesses caused by potential agents of bioterrorism; and many more.

A talented, motivated, and diverse workforce is NIAID's greatest asset, and we are always seeking qualified candidates to fill open scientific and business management opportunities. Join a group of dedicated professionals who are leading the way toward important medical discoveries.

**Advance your career while making a difference in the lives of millions!**

NIAID offers several opportunities for an array of career stages and types of research, including training and fellowships for students and postdocs to gain valuable education and research experience, as well as positions for established M.D.s and Ph.D.s both in its labs and overseeing NIAID's many grantees.

Join NIAID now and you will have the benefit of working with highly trained staff who seek new and improved ways to understand abnormalities of the immune system, develop novel treatments, and discover preventive approaches for a variety of diseases.



NIAID

National Institute of Allergy and Infectious Diseases

To learn more about NIAID and how you can work in this exciting and dynamic environment, visit us on the Web at [www.niaid.nih.gov/careers/cgns](http://www.niaid.nih.gov/careers/cgns).

## Help Us Help Millions



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National Institutes of Health



National Institute of Allergy and Infectious Diseases  
Proud to be Equal Opportunity Employers



PAUL McDEVITT

THANKS to John Purser for drawing our attention to the "Selfhelp silent subliminal CDs" produced by a company called Sprudio in California. According to the website [sprudio.net/silent.html](http://sprudio.net/silent.html), "Just because your conscious can't hear this silent subliminal doesn't mean your subconscious can't also."

You can use the CDs to learn a foreign language, improve your sporting skills, give up smoking or alcohol, or tone up your extra-sensory perception. An added benefit "is that you cannot get bored of listening to the same music over and over again, and no one around you knows that you are listening to subliminal".

While assuring us that "You cannot consciously hear anything on this 'audio' CD", Sprudio adds, confusingly: "We recorded our silent subliminal a little loud to give consumer confidence that the subliminal is there and not just silence. While playing silent subliminal try to not use high volume, [it] will be like someone screams into your

brain bypassing the ears."

John is moved by this. "Ahh, loud silence. I remember that from my teaching days."

We, meanwhile, wonder if the heirs of John Cage, composer of the infamous "silent symphony" 4'33", are going to sue for infringement of copyright.

WE ARE pleased to see that science is well represented among the contenders for the Diagram prize for the oddest book title of the year. The top titles for 2009 were announced last month by UK magazine *The Bookseller*, which organises the prize.

Overall winner, with 42 per cent of the 4500 public votes cast, was *Crocheting Adventures with Hyperbolic Planes* by Diana Taimina. This beat off competition from *Afterthoughts of a Worm Hunter* by David Crompton, *Governing Lethal Behaviour in Autonomous Robots* by Ronald Arkin and *The Changing World of Inflammatory Bowel Disease* by Ellen Scherl and Maria Dubinski.

The less obviously scientific *What Kind of Bean is this Chihuahua?*

by Tara Jensen-Meyer and *Collectible Spoons of the Third Reich* by James Yannes came second and third, respectively.

Horace Bent, custodian of the prize at *The Bookseller*, admitted that his personal favourite had been the spoons book, but went on to acknowledge that: "The public proclivity towards non-Euclidian needlework proved too great for the Third Reich to overcome."

Philip Stone, the prize administrator, said he thought that "what won it for *Crocheting Adventures with Hyperbolic Planes* is that, very simply, the title is completely bonkers."

The Diagram prize has been running since 1978. Its inaugural winner also had a scientific theme: it was *Proceedings of the Second International Workshop on Nude Mice*.

WHAT'S in a "quango"? Feedback carelessly stated that the acronym stands for "quasi-autonomous governmental organisation" (6 March). We were about to put our hands up and correct that to "non-governmental" when we discovered that others expand it to "quasi-autonomous national governmental organisation" and yet others to the more tightly controlled "quasi non-governmental organisation". We think some kind of body should be set up to consult widely and decide this important matter. It should be non-governmental, and it should be fairly autonomous.

THE Massachusetts Institute of Technology sponsors an annual energy conference, which this year was titled "Opportunities, pathways, and solutions" and was held in a downtown Boston hotel. The web page describing the conference site gave detailed directions for driving there from north, south, east or west, but said nary a word about a mass-transit train line that runs by the hotel. As the much-missed US cartoon character Pogo once said: "We have met the enemy and he is us."

THE safety advice on the package of an Aim 'n' Flame multipurpose lighter that Laurie Walsh bought for his gas cooker warned:

"Danger—extremely flammable, contents under pressure. Do not place near fire, flame or sparks."

Laurie is trying to work out how to use the lighter without disobeying the warning.

READER Dan Ellis alerts us to a sign on Academy Street in Franklin, Tennessee, that tells traffic to "Stop" and then informs underneath: "Cross traffic does not stop." Dan says he understands that very upset traffic might not be willing to stop, but what happens if it is only slightly annoyed? Will it merely slow down a little?



AMONG the safety instructions for the child's scooter that Anuruddha Jaithirtha bought, two stood out. One was: "This product is not meant to be used on roads." The other was: "This product is not designed for off-road use."

FINALLY, global warming has done its bit for world peace, Feedback hears. Rising sea level in the Bay of Bengal has submerged New Moore Island, resolving a long-standing dispute between India and Bangladesh, which had both claimed it.

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

"Up to £3000 minimum trade in," proclaims a car seller's advert in Chris Elliott's local newspaper. "I have no idea what this means," says Chris

## Bolt in the blue

This photo was taken by my neighbour in Tucson, Arizona, facing west at sunset. What is the peculiar light phenomenon?

■ The mysterious light in the photo appears to be that of a relatively small, out-of-focus object close to the lens, which has been caught by the flash of the camera. We know it isn't a shaft of light from the sun for a number of reasons: the reddish sun is over on the far left of the photo, beneath the light; the cloud is too thick to have a hole in it; and the angle of the light is wrong.

The scene is relatively dim, and with an automatic camera the lens would be wide open and the flash automatically chosen. The illuminated object is probably darkish and angled towards the camera – you can see perspective, or depth of field, at work as the object appears to narrow towards



an out-of-focus disc rather than as a point. These can be seen in photographs when they are close to a camera's flash.

It is clear that a flash was used, otherwise the foreground wouldn't be so bright, and that the object is moving, which is why it looks like a streak. The fading part of the streak corresponds to the fading of the flash, showing that the object is moving down and to the right. The size of the orb is related to its distance from the lens, its brightness and the total amount of light reflected. As the orb is bright, the object must have been fairly large and reflective.

Given the direction of its motion and the dark clouds, the most obvious possibility is a raindrop in a strong wind, maybe one of the first drops of a storm. Just above the central bush there is another suspiciously bright

dot, which could be another raindrop, a little farther away but still out of focus.

*Jan Willem Nienhuys  
Waalre, The Netherlands*

## Ear wiggling

I am fortunate enough to be able to wiggle my ears. However, I can only wiggle both at once, not one at a time. Why?

■ Bilateral symmetry is the default mode for movement. Infants suck, cry and wave their arms symmetrically and must eventually learn to do things one-sided. I have heard youngsters complain that they can't wink: when they try, they close both eyes. Even as adults, it is easier to do mirror-writing with your left hand if you simultaneously write the same word with your right. I, too, could once wiggle my ears only both at once. With practice I learned to wiggle one at a time, an accomplishment of no value to anyone – until now.

*Spencer Weart  
Hastings-on-Hudson, New York, US*

■ Some combined bodily actions share neural channels, which prevent independent action. It is hard, for example, to direct your eyes independently. Physically it should be possible, but your mental control specialises in binocular coordination.

As a rule, independent direction of sensory organs is suited to detecting prey or danger, while symmetrical sensing permits

precise measurement.

Most primates use their ears to supplement binocular vision or for direction finding. This means that not many need to move their ears much and hardly any need to move them independently; instead they move their heads.

Correspondingly, visual ear signals such as twitching, vital to most carnivores and many herbivores, hardly figure in the social behaviour of primates, especially the anthropoids. Our legacy is generally symmetrical.

*Jon Richfield  
Somerset West, South Africa*

■ In order to wiggle one ear at a time, practice is needed in front of a mirror. That is how I learned the art. By grinning forcefully and widely, the ears are made to move. If you concentrate on finding the muscles that move the ears, you can operate them without grimacing. Then practise moving each ear by itself. What use does this skill have? It impressed teenage girls, up to a point, and a by-product was the smoothing out of wrinkles on my forehead.

*Brian Colless  
Palmerston North, New Zealand*

**"The cloud is too thick to have a hole, and the angle is wrong. The light shaft is not coming from the sun"**

the right, the end farthest from the lens. I can get a nearly identical effect by holding an angled toothpick close to a camera lens in a similar situation.

*David Shelton  
Victoria, British Columbia, Canada*

■ The bright light is an orb: a small object so close to the camera lens that it appears as

## This week's question

### SPLIT TIMES

Why does cold weather dry my skin out? Generally things dry out more slowly the colder it is, yet as soon as winter arrives my hands become so dry the skin splits.

*Bernard Marie  
Lille, France*

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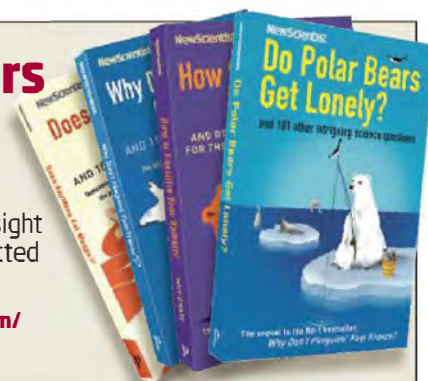
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