SN
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AUGUST 9, 2014

The Dread of Solitude

Exoplanet Recall

Geckos Stick with a Charge

A Toggle for Consciousness

RADIO BURSTS FROM DEEP SPACE

As more flashes are detected, astronomers seek explanations

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VOL. 186 | NO. 3

ScienceNews

22

Feature

News

19

4

Departments

COVER Australia's Parkes Radio Telescope has recorded all but one of the fast radio bursts detected to date.
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CLOCKWISE FROM TOP LEFT: © ROGER RESSMEYER/CORBIS; D. DEHEYN/SCRIPPS INST. OF OCEANOGRAPHY/UCSD; H. IZADI

Listening in on cosmic messages

When astronomy writer Christopher Crockett describes what a fast radio burst is like, he offers a whistle that swoops in pitch from high to low. "If you could hear the signal, that's what it would sound like," he says. He is quick to explain, though, that the eight mysterious pulses detected by two radio telescopes are actually not sounds at all. Fast radio bursts are light waves in the radio frequency range of the electromagnetic spectrum that appear to have journeyed from other galaxies. And, as Crockett explores in his story on Page 22, these unexplained signals may be trying to tell us something.

The entire history of astronomy can be viewed as humans trying to decipher enigmatic messages from space. Go back to the Greeks, who watched the heavens and saw a fixed pattern of stars slowly turning around the night sky. They interpreted that observation to mean that the stars are attached to a large sphere that rotates around the Earth (and not, as turns out to be true, that Earth itself is spinning). But that was through no fault of the stars. The Greeks also noticed the out-of-sync movement of a few stars and named them the "wanderers." When correctly decoded, that was the universe telling us about the planets. Much later, scientists saw that some stars appeared out of nowhere or got dramatically brighter. Those signals revealed the existence of supernovas. Fuzzy stars eventually resolved into the forms of galaxies in all manner of shapes and sizes. Much more recently, astronomers learned to interpret strange bursts of gamma rays as signs of explosive cataclysms far, far away — a lesson that's expected to prove useful for astronomers seeking to understand fast radio bursts.

Yet to be deciphered, these signals represent the latest messages from space with the potential to tell us more about the cosmos. It's part of a continuing story of discovery, another clue in the ultimate mystery. What's out there making all that racket? Searching for answers has already invigorated the imagination of scientists, and I expect the possibilities they've suggested will spark your imagination as they have mine. — *Eva Emerson, Editor in Chief*

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Excerpt from the August 1, 1964, issue of *Science News Letter*

50 YEARS AGO

Clues to Life's Origin

Chemical clues to the origin of life have been found in billion-year-old rocks from Michigan.... Drs. Barghoorn, Schopf and Meinschein found porphyrins related to chlorophyll and hemoglobin, microfossils and optically active hydrocarbons in shale from the Nonesuch formation.... The molecules the scientists have found in the ancient rocks are either identical or very close relatives to those present in young sediments, which are known to consist of former living things. There is hope that the biological compounds just discovered can be used as a geological "clock."

UPDATE: Newer analyses have pushed evidence of life even further back in time. Living organisms tend to preferentially use carbon's lighter isotope (C-12), so the ratio of carbon isotopes can indicate life's presence. In the 1990s, analyses revealed traces of life in rocks from Greenland 3.85 billion years ago. Since then, chemical evidence has been backed up by finds of physical structures that appear to have been created by bacteria 3.49 billion years ago (*SN: 2/8/14, p. 16*).

IT'S ALIVE

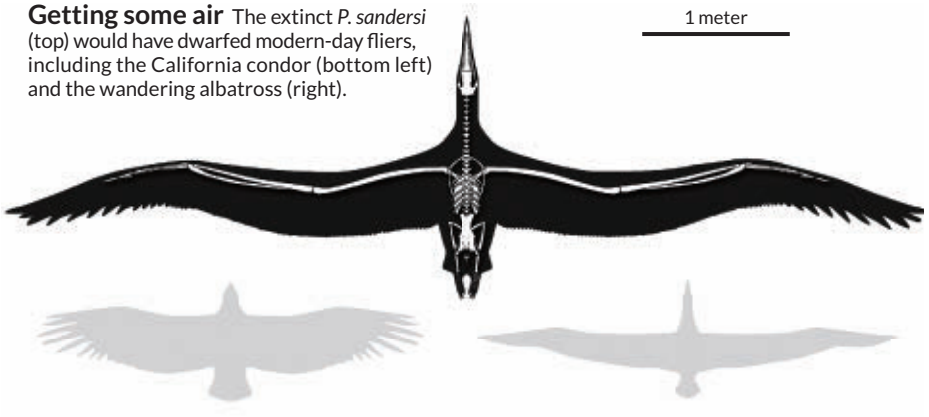
Parchment worms are best pinched in the dark

Parchment worms use their filmy flaps to pump water through the tubes they build around themselves. This one has been removed from its U-shaped home.

THE –EST

Largest airborne bird

A partial skull and a handful of other bones are all that's left of what may have been the largest bird to ever take to the air. Unearthed near an airport in South Carolina, the newly described seabird *Pelagornis sandersi* darkened the skies about 28 million years ago. With a wingspan of 6.4 meters, or about half as long as a city bus, *P. sandersi* vies for the title of biggest flying bird with another extinct species, *Argentavis magnificens*. Scientists previously thought that no albatross-like avian with a wingspan greater than 5 meters could have gotten off the ground. But computer simulations by Daniel Ksepka at North Carolina State University suggest that *P. sandersi*'s long wings reduced drag, allowing it to soar long distances. It's not clear if the big bird also flapped to power its flight, but it could have launched with a running takeoff like a hang glider, Ksepka writes July 7 in the *Proceedings of the National Academy of Sciences*. —*Allison Bohac*



Getting some air The extinct *P. sandersi* (top) would have dwarfed modern-day fliers, including the California condor (bottom left) and the wandering albatross (right).

FROM TOP: ALEXANDER SEMENOV; LIZ BRADFORD

Learn more about parchment worms in a video at **bit.ly/SN_pworm**

Oh go ahead. Squeeze the soft tube of a parchment worm. But gently.

If it's dark, "you will see puffs of blue mucus come out," says Dimitri Deheyn. And the blue is glowing.

How the ocean-dwelling *Chaetopterus* parchment worms create the long-lasting glow — and the soft-but-tough tubes themselves — are still substantial mysteries, Deheyn says.

Parchment worms spend their adult lives inside the U-shaped tubes they create, with just the rounded base buried. They live in sea bottoms around the world, from deep ocean canyons to marine shallows. When Deheyn first shows worms to visitors at his laboratory at Scripps Institution of Oceanography in La Jolla, Calif., sometimes "they are ready to faint because they are not expecting such a weird-looking creature," he says.

Fleshy prongs fan out of the worm's flattened head, and a few pairs of

Parchment worms spend their entire lives in their tubes and can't live long outside them.

gossamer paddles flap like wings near its middle, a motion that pumps seawater through its tube. "They don't bite, they don't sting," Deheyn says. At most, troubled worms secrete a gust of mucus. The puff floats away from the body and "glows for minutes and minutes and minutes." This persistent luminescence wouldn't be surprising in bacteria or fungi, but it is very strange for a worm. Explaining worm-shine's chemistry and function remains a challenge. Depriving the mucus of oxygen — which normally turns off luminescence — has no effect, Deheyn and his colleagues reported last year.

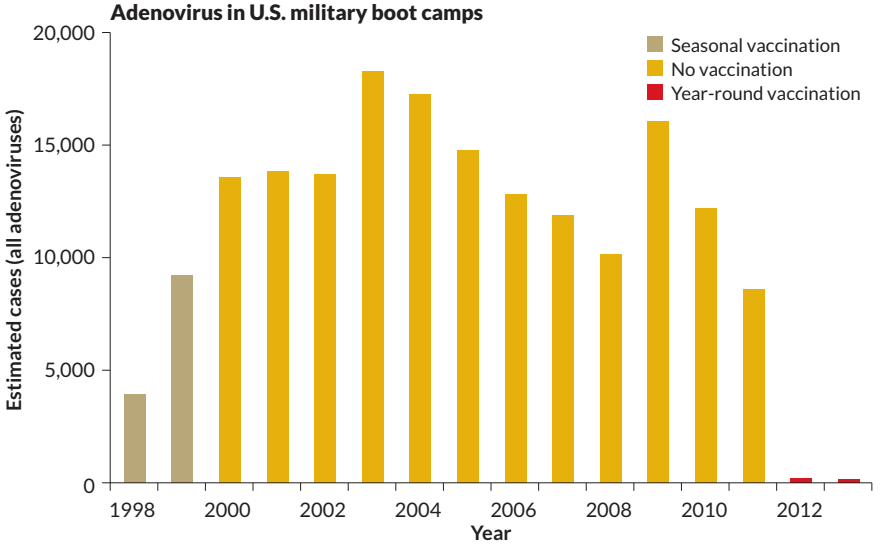
Some biologists have suggested that the worms also use the mucus to construct their tubes, which feel like rolled-up paper. Deheyn has stored some in water for almost 10 years, and they haven't fallen apart yet. In air, they maintain the same responses to various tugging and pressing stresses whether the temperature is –75° Celsius or 250° C, he and his colleagues report July 9 in the *Journal of the Royal Society Interface*. Such stable parchment could come in handy as an alternative to metals and polymers, or maybe even form the basis of a 3-D printable material, he says. If he can figure out how to make it. — *Susan Milius*

FROM TOP: D. DEHEYN/SCRIPPS INST. OF OCEANOGRAPHY, UCSD; J.M. RADIN *ET AL/CLIN. INFECT. DIS.* 2014, ADAPTED BY S. EGTS

SCIENCE STATS

Boot camp bug

The U.S. military has been fighting a battle with a common virus. Adenoviruses, which cause respiratory illnesses including some colds, plague boot camps. In the past, the viruses have infected 80 percent or more of new soldiers, spawning a potentially fatal flu-like illness in some. A vaccine kept the virus in check for two decades but was discontinued in 1996, after a dispute between its maker — Wyeth Pharmaceuticals — and the U.S. Department of Defense. A new vaccine introduced by the DOD in 2011 has cut infections by a factor of 100, scientists report July 2 in *Clinical Infectious Diseases*. — *Nsikan Akpan*



Adenovirus prevalence

Adenovirus infections are common among children, but symptoms are typically mild. Certain variants of the virus, such as adenovirus type 4, cause outbreaks of severe respiratory disease and are found mostly among adults in the military.

4.8
percent
Civilians with adenovirus type 4, 2004–2006

93
percent
Military recruits with adenovirus type 4, 2004–2006

SOURCE: G.C. GRAY *ET AL/CLIN. INFECT. DIS.* 2007

News

EARTH & ENVIRONMENT

Pesticide threatens bug-eating birds

Neonicotinoids' collateral damage may extend beyond bees

Insecticides commonly used on farms may cause a drop in populations of some birds, like the common starling (shown), also known as the European starling.

BY BETH MOLE

Pollinators may not be the only collateral damage from a controversial group of insecticides.

The class of chemicals, called neonicotinoids, is used in agricultural fields worldwide to reduce crop-eating pests. Since neonicotinoids were introduced in the 1990s, researchers have reported unintended harm to bees and other pollinators *(SN Online: 4/5/12)*. But a new study suggests that the deadly chemicals may also cause declines in bug-eating bird populations, a possible sign of cascading effects in the environment.

"The effects could be more widespread in the ecosystem than we thought," says ornithologist Ruud Foppen of Sovon, the Dutch Center for Field Ornithology in Nijmegen.

Foppen and colleagues analyzed Dutch data on water pollution, which can act as a proxy for pesticide use because neonicotinoids travel to waterways in farm runoff. The researchers focused on concentrations of imidacloprid, the most commonly used neonicotinoid for years, which had been measured in 3,947 water samples from 555 locations across the Netherlands from 2003 to 2009. The researchers compared those pollution levels with bird surveys of 15 farmland species, such as common starlings. All of the bird species the researchers analyzed eat insects, nine exclusively.

The researchers found a general pattern: the more imidacloprid in waterways, the greater the downturn in bird numbers over time. In areas with more than 20 nanograms of the chemical per liter of water, bird populations shrank by 3.5 percent per year. The researchers found no link between the decline and other factors, such as land-use changes including changes in crops. The team also saw no link between the drop and bird population declines that had

ATOM & COSMOS

Lab tests mystery of lithium levels

Experiment supports theory of Big Bang element production

BY ANDREW GRANT

An underground experiment has imitated conditions just after the Big Bang to produce the universe's most confounding element, lithium. The experiment's result supports the prevailing theory while reinforcing what scientists call the lithium problem, a discrepancy between theoretical calculations for how much of the element should have been produced 13.8 billion years ago and the amounts observed in ancient stars.

Scientists are confident that all of the universe's lithium, and most of its helium and deuterium (heavy hydrogen), formed just minutes after the Big Bang, when the expanding cosmos cooled enough for protons and neutrons to bind into lightweight atomic nuclei. The theory that describes this primordial element production, called Big Bang nucleosynthesis, successfully predicts the abundances of deuterium and helium that astronomers observe in ancient stars.

Yet the theory does not successfully forecast the universe's current lithium supply (*SN: 9/8/12, p. 14*). Old stars contain one-quarter to one-half as much lithium-7 (made of three protons and four neutrons) as theory predicts and contain 1,000 times more lithium-6 (three protons and three neutrons) than expected.

Before resorting to radical explanations for this discrepancy, scientists want to make sure their theory correctly accounts for how lithium formed in the early universe. So Alessandra Guglielmetti, a nuclear physicist at the University of Milan, and colleagues set out to re-create the universe's production of lithium-6 in the lab.

Using the Laboratory for Underground Nuclear Astrophysics, or LUNA, located beneath the Gran Sasso, a mountain in central Italy, the researchers fired a beam of helium nuclei at a deuterium target. Unlike the sites of earlier, similar experiments, LUNA is shielded from aboveground particles by about 1.4 kilometers of rock. LUNA can also probe energies equivalent to about a billion degrees Celsius, the temperature at which elements probably formed during Big Bang nucleosynthesis.

The experiment created nearly as much lithium-6 as theory predicts, and far less than is observed in ancient stars, the researchers report in a paper published

JOUKE ALTENBURG, RADBOUD UNIV.

started before imidacloprid use.

The team speculates that when high levels of the pesticide spread beyond farms, the chemical kills off many insects, cutting into birds' food supply. But the researchers acknowledge that the pesticide could also kill birds directly.

Although the Netherlands is unique in having such complete datasets of both bird populations and water pollution, the country is not alone in its use of neonicotinoids, the authors say. Researchers have found similar concentrations of the insecticides in other countries, suggesting a widespread threat to birds, the Dutch team reports in the July 17 *Nature*.

Ecologists have suspected that neonicotinoids cause ecological problems for species beyond pollinators, but this is the first study to find direct evidence, says ecologist Dave Goulson of the University of Sussex in Brighton, England. "This moves the debate on quite a bit," he says.

In 2013, the European Commission restricted the use of three neonicotinoids, including imidacloprid, for two years because of concern about harm to bees. The U.S. Environmental Protection Agency has begun reviewing neonicotinoids' effect on pollinators. ■

July 21 in *Physical Review Letters*. "It's a really beautiful measurement," says Brian Fields, an astrophysicist at the University of Illinois at Urbana-Champaign. When combined with similar findings from LUNA and other labs about the production of lithium-7, the result bolsters the Big Bang nucleosynthesis theory.

The finding also eliminates the possibility of a simple solution to the lithium problem. Scientists must now either find errors in measurements of lithium levels in space or come up with ideas for exotic early-universe processes that could account for the discrepancy, Fields says.

Fields and colleagues are exploring the possibility that dark matter, the unknown material that makes up most of the mass of the universe, interfered with lithium production.

"There are ways of introducing mischief in the early universe," he says. ■

HUMANS & SOCIETY

Bones offer insight into Clovis origins

Signs of gomphothere hunting found in northwestern Mexico

BY BRUCE BOWER

Ancient North America's Clovis people, known as mammoth and mastodon hunters of the Great Plains, may have started out as gomphothere hunters of northwestern Mexico.

New finds indicate for the first time that Clovis people killed these now-extinct elephant-like creatures. What's more, Clovis people did so from the culture's early days in a region well south of the best-known Clovis sites. Clovis culture peaked between 13,000 and 12,600 years ago and its members may have been ancestors of today's Native Americans (*SN: 3/22/14, p. 6*).

"The southern Plains and northern Mexico may be where Clovis culture rapidly evolved out of the flexible culture of North America's first explorers," says anthropologist Gary Haynes of the University of Nevada, Reno, who was not involved with the research.

Excavations at a site called El Fin del Mundo, or the End of the World, in Mexico's Sonoran Desert indicate that Clovis folks camped there around 13,390 years ago, making them some of the earliest representatives of that culture, say anthropologist Guadalupe Sanchez of the National Autonomous University of Mexico in Hermosillo and her colleagues.

To the investigators' surprise, the site contained four spearpoints considered the signature of Clovis culture strewn among bones of two gomphotheres, large mammals smaller than the mammoths and mastodons that Clovis people are known to have hunted. Gomphotheres inhabited Central and South America around Clovis times. El Fin del Mundo contains the only evidence of gomphothere hunting by Clovis people, the researchers report July 14 in the *Proceedings of the National Academy of Sciences*.

This spearpoint indicates that Clovis people hunted in what's now northwestern Mexico 13,390 years ago.

INAH SONORA

The new discoveries support a view that Clovis culture originated in the southwestern United States or northwestern Mexico. Only one previously excavated Clovis site, Aubrey in north Texas, is estimated to be as old as the Sonoran site.

If Clovis culture developed in the Great Plains as traditionally thought, that must have occurred much earlier than scientists previously estimated — well before gomphothere hunters inhabited El Fin del Mundo, says anthropologist and study coauthor Vance Holliday of the University of Arizona in Tucson. "Our new data compel Paleo-Indian researchers to think more broadly about the age and origins of Clovis technology."

Although evidence of gomphothere hunting at El Fin del Mundo is exciting, it's unclear when Clovis culture originated, says archaeologist Michael Waters of Texas A&M University in College Station. Estimated ages for El Fin del Mundo and Aubrey each rest on one radiocarbon date. Additional radiocarbon dates for both sites are needed, Waters says.

Sanchez came across the Mexican site in the late 1990s while looking for Clovis and mammoth sites in Sonora. She met a rancher who had noticed an isolated, dry creek bed where large bones poked out of eroding soil. Excavations at the remote site ran from 2007 to 2012.

About 800 meters up a slope from the gomphothere bones, the researchers found remnants of an ancient camp.

Sanchez and colleagues at first assumed they had found mammoths killed by Clovis hunters. But a close analysis of teeth from one animal revealed that it was a gomphothere. ■

A genetic variant that helped people adapt to life on the high-altitude Tibetan Plateau might have come from extinct human relatives called Denisovans.

GENES & CELLS

Tibetan high life aided by old DNA

Extinct hominid passed on extreme-elevation adaptation

BY TINA HESMAN SAEY

Tibetans inherited a genetic adaptation to high altitudes from an extinct group of human relatives called Denisovans, a new study finds.

Researchers have known for years that Tibetans carry a genetic variant in the *EPAS1* gene that allows them to live at extreme altitudes where oxygen is scarce. But how that variant arose has been mysterious. Now researchers report July 2 in *Nature* that the high-altitude version of *EPAS1* almost certainly came from Denisovans or from a related group of extinct humans.

The case is the most compelling yet that humans picked up helpful genetic variants through interbreeding with hominids that have since gone extinct, says Anna Di Rienzo, a human population geneticist at the University of Chicago who was not involved with the research. Human evolution probably contains many other examples of people inheriting advantageous mutations by interbreeding with groups that had already adapted to an environment, she says.

At an elevation of more than 4,000 meters, the Tibetan Plateau has oxygen levels that are 40 percent lower than those at sea level. The *EPAS1* variant helps Tibetans cope with constant oxygen deprivation, an extreme stress on the body, especially during pregnancy. The genetic variant was probably important in allowing people to settle the plateau, says Rasmus Nielsen, a computational biologist and evolutionary geneticist at the University of California, Berkeley who helped lead the work.

Nielsen and his colleagues had previously tried unsuccessfully to pinpoint when the helpful mutation arose. The researchers analyzed a stretch of DNA surrounding *EPAS1* that is 32,700 DNA letters long from 40 Tibetans and 40 Han Chinese, who are Tibetans' close genetic relatives. A distinctive pattern of single DNA letter changes, called SNPs, sets the Tibetans apart.

The signature appeared in two Han Chinese people but, so far, hasn't been found in any other modern human groups. Nielsen's team also compared the DNA with that of Neandertals, but the string of DNA didn't seem to come from them either. "So we just put it aside because we couldn't make sense of the data," Nielsen says.

But then in 2010, scientists announced that a 41,000-year-old finger bone found in Siberia was from a previously unknown group of extinct hominids. The hominids were dubbed Denisovans after the cave in which the fossil was found. When the Denisovan genome became available (*SN: 9/22/12, p. 5*), Nielsen and his colleagues decided to compare the distinctive Tibetan signature with the Denisovan DNA. To the researchers' surprise, the Denisovan DNA held an exact match to a five-SNP signature that Tibetans have. In fact, Denisovans shared 15 of 20 Tibetan SNPs, the team discovered.

Computer simulations of scenarios under which the two groups could share DNA indicated that the most likely explanation for the similarity is that Tibetans inherited the chunk of DNA containing the SNPs or *EPAS1* variant from Denisovans.

Previously, Denisovans were known to have passed a small amount of their genetic heritage to Melanesians and a few other East Asian groups, but the study is among the first to indicate that the genetic legacy could play a role in modern human evolution.

Other researchers agree that Nielsen's group presents convincing evidence that the high-altitude version of *EPAS1* came from Denisovans or a related extinct group.

"They really nailed it that it came from archaic humans," says Pontus Skoglund, a population geneticist at Harvard Medical School. But he's not convinced that Denisovans passed the adaptation directly to Tibetans. Because Denisovans and Neandertals are known to have interbred, and present-day Tibetans carry a fair amount of Neandertal ancestry, Skoglund thinks "there's still a little wiggle room for it to have come from Neandertals."

Tibetans have lived on the plateau for at least 10,000 years and probably already carried the adaptation when they migrated there, says Mark Aldenderfer, an archaeologist at the University of California, Merced. Tibetans probably inherited the adaptation from descendants of Denisovans, he says. But it is not clear where or why the Denisovans or their descendants picked up and kept that mutation, since there are no mountain ranges around Siberia that are high enough to require this sort of adaptation, he says. ■

EARTH & ENVIRONMENT

Microplastics lodge in crab gills, guts

Creatures absorb particles through food and via respiration

BY NSIKAN AKPAN

Crabs sop up microplastic pollution via their food and gills, researchers have found in a laboratory study. The tiny particles can get stuck in the crustaceans' bodies for weeks. Crabs are the first marine creatures known to trap microplastics in their respiratory systems. Researchers don't yet know whether the plastics hurt the crabs.

Previous studies had looked at how plastics affect marine organisms through their diet but not through what they breathe. "For a marine crustacean to actually uptake microplastics through respiration and then retain them in the gills — that's groundbreaking," says marine biologist Phillip Cowie of the University of Glasgow in Scotland.

Crabs are central players in the marine food web. They consume other seafloor dwellers, including mollusks, while crabmeat serves as meals for octopuses, otters and humans.

Microplastics, particles smaller than 5 millimeters across, are pervasive pollutants. They can result from the breakdown of larger plastic chunks and also feature in many personal care products such as toothpaste and soap. "Wastewater treatment facilities do not have the means to capture these microplastics," says marine geochemist Tracy Mincer of the Woods Hole Oceanographic Institution in Massachusetts. "This careful study begins drawing the links between microplastics and the food chain."

Marine ecologist and biochemist Andrew Watts and colleagues at the University of Exeter in England fed mussels fluorescent microplastics. The researchers then fed those mollusks to shore crabs, *Carcinus maenas*. Normal food passes through a crab's digestive tract within two days, but the fluorescent microplastics took as many as 14 days to emerge in the feces, the researchers report June 27 in *Environmental Science & Technology*.

The team then fitted shore crabs with masks that flushed high concentrations of microplastic beads over the animals' gills for 16 hours. Every two days, the researchers changed the water in the crabs' tanks, putting in fresh seawater and measuring microplastics in the used water. Three weeks later, the crabs were still expelling the inhaled pollutants.

"The longer that these plastics reside in these organs, the higher the chance that plastics will be transferred up the food chain from crabs on to other animals," Watts says.

The researchers don't know why the microplastics stay around so long in the animals' bodies. Dissections revealed microplastic beads embedded in the gills' vast network of folds. ■

Shore crabs can hang on to microplastic pollution for weeks, a lab study finds.

D. HAZERLI/WIKIMEDIA COMMONS (CCO 1.0)

EARTH & ENVIRONMENT

Plastic goes missing at sea

Survey of oceans finds far less trash than expected

BY SAM LEMONICK

A global marine survey turned up a tiny fraction of the expected amount of plastic debris, but scientists aren't cheering. Now researchers have to find out where the rest of the oceans' plastic trash went.

Estimates put the amount of plastic entering the world's oceans every year in the range of millions of metric tons. But a research group led by Andrés Cózar, a marine ecologist at the University of Cádiz in Spain, reports in the July 15 *Proceedings of the National Academy of Sciences* that between 7,000 and 35,000 tons of plastic debris floats on the sea surface. That leaves 99 percent of the plastic thought to be in the oceans unaccounted for.

The plastic comes from a variety of sources, including trash floating down rivers, fishing gear lost at sea and tiny beads from cosmetics washed into sewers. The sun, waves and wind break large pieces into smaller chunks, Cózar says, until most plastic is in little floating fragments.

99 percent

Fraction of plastic thought to be in the oceans that scientists didn't find

Cózar's team used data from five ships on global expeditions from 2009 to 2012 that collected more than 10,000 pieces of plastic in fine mesh nets. Using the concentrations of plastic in their samples and in data collected by other researchers, along with wind and current patterns, the team estimated the oceans' total plastic load.

The largest fraction of plastic pieces were about 2 millimeters across. The abundance of pieces smaller than that dropped off quickly, however, contrary to expectations. The authors suggest a number of places that the missing plastic could have gone. The most likely explanations, Cózar and colleagues say, are that the plastic was broken down by microbes or eaten by fish and other animals.

"I am not surprised by the discrepancy between this estimate and the amount of plastic produced annually," which formed the basis for earlier estimates of plastic trash in the ocean, says Kara Lavender Law, an oceanographer at the Sea Education Association in Woods Hole, Mass. "We know next to nothing about timescales of biodegradation." ■

BODY & BRAIN

Tablet devices help kids with autism speak up

iPads show promise in helping largely nonverbal children talk

BY BRUCE BOWER

Withdrawn children with autism became surprisingly talkative after using chatty iPads in a treatment experiment focused on play and language skills.

Tablet devices featuring icons that can be tapped to produce vocal comments help bring largely silent kids with autism spectrum disorder, or ASD, at least partly out of their shells, say education professor Connie Kasari of UCLA and her colleagues.

For six months, 5- to 8-year-olds with autism used handheld, speech-generating tablet computers, including iPads adapted for that purpose. Up to three months after completing the treatment program, those children spoke to others more often than did kids given tablets halfway through the six months or not at all. The scientists report the findings in the June *Journal of the American Academy of Child & Adolescent Psychiatry*.

By tapping labeled icons on an iPad, largely nonverbal children with autism could generate spoken phrases and comments while playing with others.

About 25 to 30 percent of children with ASD rarely or never talk, even if they undergo years of social training. These individuals are often unable to live independently as adults.

Most previous investigations of speech-generating devices for kids with ASD have reported increases in basic requests such as "I want a snack." In the new study, tablet users communicated more often "not just to respond or express their needs but also to initiate comments in the context of social and play interactions," psychologist Helen Tager-Flusberg of Boston University says in a commentary published with the research.

In the study, a range of social experiences, including iPad-mediated exchanges, seemed crucial in helping nonverbal kids with autism talk, remarks professor of communication disorders Rhea Paul of Sacred Heart University in Trumbull, Conn.

The researchers studied 61 children, who on average began the study with spoken vocabularies of about 17 words. From the start, 31 children used tablets during play sessions with word icons that could be tapped in sequence to make statements about activities — say, "We build rocket." Of the 30 kids who did not receive iPads at the start, six received iPads halfway through the six-month program.

During 20-minute play sessions in the program's last week, tablet users initiated on average nearly 62 statements containing about 33 different words, most of them spoken and the rest generated with the iPad. Nonusers and those who received the iPads late averaged about 40 statements and 26 different words. ■

BODY & BRAIN

Early birth linked to prepregnancy diet

Consuming junk food before conception may harm baby-to-be

BY NATHAN SEPPA

To have a healthy baby, a woman's diet before pregnancy seems to matter. Eating a lot of sugars, fats and take-out foods might increase the likelihood of delivering a baby preterm, Australian researchers report in the July *Journal of Nutrition*.

Preterm birth — before 37 weeks of gestation — increases the risk of infant mortality or health problems later in life. While healthful eating during pregnancy has been associated with a lower risk of preterm birth, the study authors say that their findings now extend this link to the period before conception.

Poor nutrition, says study coauthor Jessica Grieger, a nutrition researcher at the University of Adelaide, may promote inflammation in women and activate hormones such as oxytocin and cortisol that have been linked to preterm birth.

Grieger and colleagues identified 309 women who had recently become pregnant and obtained dietary data from them for the year preceding conception. The researchers scored each woman's diet on three categories: a high-protein diet including fish, whole grains, chicken and fruits; a diet with plenty of vegetables, legumes and whole grains; and one with lots of take-out foods, refined grains, sugars and junk food such as potato chips.

After the women gave birth, the researchers calculated that those scoring high on the high-protein diet were the least likely to give birth preterm. Women with a high junk food score were the most likely. The researchers took into account differences between the women in body mass, tobacco use, asthma, age, socioeconomic factors and ethnicity.

Physician Bo Jacobsson of Sahlgrenska University Hospital in Gothenburg, Sweden, says the possibility that diet before pregnancy affects delivery "seems rational but is not scientifically proven with this study." To establish a clear effect, scientists will also need to control for diet differences throughout pregnancy itself, he says.

Eating patterns before and during pregnancy typically overlap, since most women don't know exactly when they become pregnant and many pregnancies are unplanned. What's more, women don't necessarily change their diet upon learning they are pregnant. Researchers at England's University of Southampton reported in 2009 that newly pregnant women reduced their nicotine, alcohol and caffeine intake but didn't alter their eating habits markedly. ■

MARINA MLADENOVICH

Habitable planets' reality questioned

Star's magnetic activity could have led to false detections

BY ANDREW GRANT

Two planets considered among the most promising for life outside the solar system don't exist, scientists report July 3 in *Science*. The signals embedded in starlight that were attributed to the planets may instead have been caused by the changing magnetic activity of the star, Gliese 581.

Although the study isn't the final word on these enticing yet controversial worlds, scientists say it reinforces the need for meticulous analyses to separate planets' signals from those generated by spots and flares on stars. "This is a big warning concerning the interpretation of [small] signals as being planets," says Stéphane Udry, an astronomer at the University of Geneva.

> "This is a big warning concerning the interpretation of [small] signals as being planets."
>
> **STÉPHANE UDRY**

Located about 20 light-years away in the constellation Libra, Gliese 581 is a small, dim star similar to tens of billions of other stars in the galaxy. Yet it has grabbed astronomers' attention due to claims that two of its supposed six planets are very intriguing. Gliese 581d, discovered in 2007, was the first reported exoplanet on which life seemed plausible (*SN: 5/23/09, p. 11*). Then in 2010, Gliese 581g grabbed headlines when codiscoverer Steven Vogt of the University of California, Santa Cruz said, "The chances of life on this planet are 100 percent" (*SN: 10/23/10, p. 5*).

Since then, a lot of controversy has swirled around the planets of Gliese 581, particularly g. Multiple studies have found no evidence for Gliese 581g, though Vogt's team stands by its claim. Meanwhile, one study questioned the existence of Gliese 581d. Without planets d, g and, farther away, a cooler planet that the new study also dismisses, Gliese 581 would host just three planets, all of which are too hot to support life.

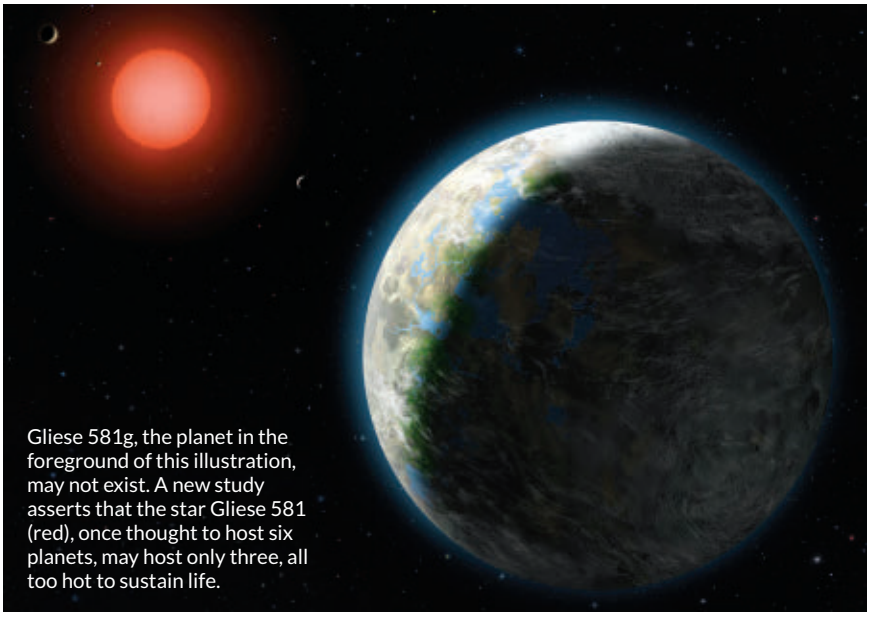
Astronomer Paul Robertson of Penn State says he had no horse in the race when he decided to analyze this confounding star. He looked at data from previous studies using the radial velocity method of planet discovery, in which the subtle tug of a planet's gravity causes the star it orbits to wobble. Astronomers can measure this wobble by studying starlight, which shifts color slightly depending on the direction of the wobble. Robertson set out to determine whether magnetic activity on Gliese 581's surface, a phenomenon similar to sunspots, could obscure some of that light and cause astronomers to incorrectly measure the wobble and perhaps mistakenly detect planets.

Unlike previous groups that had looked at the data, Robertson and colleagues studied light emitted by energized hydrogen atoms as an indicator of Gliese 581's magnetic activity. The researchers found a clear link between the amounts of measured wobble and magnetic activity on the stellar surface. When Robertson and his team removed the signals thought to be from the star's surface, the evidence for three planets became even stronger. But the evidence for three others, including 581d and 581g, disappeared almost entirely.

Robertson says the study is the nail in the coffin for planets d and g. Udry, whose research team discovered 581d, says the evidence is compelling but requires further analysis. Vogt and another scientist who discovered 581g did not respond to requests for comment.

Greg Laughlin, an astronomer at UC Santa Cruz who has not taken sides in the Gliese 581 debate, is skeptical of the study, which he says analyzed only a small portion of the available measurements on the star. "This star has resisted airtight analysis for going on 10 years," he says. "I'm not convinced that the final configuration [of planets] has been published."

Still, astronomers agree that the study highlights the challenges of finding other Earths. With the newest telescope instruments, measurements of radial velocity have become so precise that astronomers need to agree on rigorous tests to separate the signal from the noise. "If you want to be confident you've found an exciting planet," Robertson says, "then you have to do this type of analysis to make sure you're not being tricked by the star." ■



Gliese 581g, the planet in the foreground of this illustration, may not exist. A new study asserts that the star Gliese 581 (red), once thought to host six planets, may host only three, all too hot to sustain life.

LYNETTE COOK

BODY & BRAIN

People find solitude distressing

Study participants chose electric shocks over quiet thinking

BY BRUCE BOWER

Most people prefer to do just about anything, including give themselves electric shocks, to avoid thinking quietly for a mere six to 15 minutes, researchers say.

"The human mind wants to engage with the world, even, it appears, if that involves pain," says psychologist Timothy Wilson of the University of Virginia in Charlottesville.

Thoughts are hard to control and steering them in pleasant directions may be particularly difficult, say Wilson and colleagues. This finding helps to explain the popularity of meditation and other techniques for controlling thoughts and finding rewards in contemplation, the scientists conclude in the July 4 *Science*.

> "The human mind wants to engage with the world, even, it appears, if that involves pain."
>
> TIMOTHY WILSON

Mammalian minds evolved to track external dangers and opportunities, Wilson proposes. Only humans acquired an ability to focus solely on internal thoughts. After earlier proposals that introspection often feels unpleasant (*SN: 12/4/10, p. 11*), the researchers' new study suggests that people go to surprisingly great lengths to avoid being stranded with their own thoughts.

Previous research indicates that particularly creative people generate their best ideas while letting their minds wander. But Wilson's study finds that "for many people, being left alone with their thoughts is a most undesirable activity," says psychologist Jonathan Schooler of the University of California, Santa Barbara.

In six experiments, a total of 146 college students handed over their cell phones and sat alone, thinking, for six to 15 minutes. Most reported afterward that it had been difficult to concentrate and their minds had wandered. Almost half said the experience was at least mildly unpleasant.

Another 44 students reported that they had similar reactions when asked to sit and think alone at home. About one-third admitted to cheating by, say, listening to music or reading. Fifteen students randomly assigned to read or engage in other activities during the home experiment reported enjoying their time much more than did 15 peers told to think quietly.

To verify that discomfort with quiet contemplation applies outside the college crowd, the team recruited 61 adults, ages 18 to 77, at a farmer's market and a church. Thinking alone at home also proved unpleasant for these participants.

In another lab study, students rated various negative and positive sensations, including a mild electric shock. Participants said that, if given $5, they would pay some or all of it to avoid another shock.

Still, when previously shocked people were asked to spend 15 minutes in solitary thought, 12 of 18 men and six of 24 women voluntarily gave themselves at least one shock rather than think quietly. A greater need for novel and intense experiences among men than women may have boosted their rate of self-administered shocks, Wilson says.

Solitary thought helps people to make sense of past experiences, a vital but difficult exercise that may explain the discomfort that people felt in the study, remarks Jonathan Smallwood, a psychologist at the University of York in England. Widespread use of smartphones and computers to deal with boredom may be undermining the capacity for self-reflection, he adds. ■

GENES & CELLS

HIV reemerges in 'cured' child

Girl deemed free of infection in 2013 found to have the virus

BY NSIKAN AKPAN

HIV has resurfaced in a child who was presumed cured of the virus. The discovery spotlights limits in detecting the clandestine germ and raises questions about whether HIV can ever truly be cured, experts say.

The child was born HIV-positive in 2010 and received treatment with standard antiretroviral drugs. The patient's therapy was unexpectedly interrupted 18 months later. But the virus didn't return to detectable levels, leading scientists to declare last year that the child was "functionally cured" (*SN: 4/6/13, p. 14*).

On July 10, researchers at the U.S. National Institute of Allergy and Infectious Diseases announced that the virus had resurfaced in the child's blood after nearly four years of dormancy.

"What we've learned is that you can never be fully certain of HIV eradication," says Daniel Kuritzkes, a Harvard virologist, who wasn't involved in the case.

He explains that surveillance tools lack the sensitivity needed to find HIV in its many hideouts (*SN: 7/26/14, p.12*). The virus lives in immune cells called memory T cells that circulate in the blood. Doctors can easily collect and scan these cells for HIV. But memory T cells also filter into lymph nodes or deep into organs, where the cells become inactive and HIV becomes invisible to standard detection. The virus waits until the T cell reawakens, at which point HIV once again replicates using the cell's machinery.

Memory T cells live as long as eight years, so the potential for viral reemergence always existed for this child, says Marc Foca, an HIV specialist at the Morgan Stanley Children's Hospital in New York City. "Most experts weren't fully convinced that this baby was actually cured," he says.

The child has gone back on antiretroviral treatment, and her viral levels have dropped. ■

EARTH & ENVIRONMENT

Quakes tied to wastewater wells

Fluid injection might have sparked Oklahoma tremors

BY MEGHAN ROSEN

Pumping wastewater underground may rock Oklahoma. Vast quantities of water left over from oil and gas extraction and then injected into disposal wells may have set off a surge of earthquakes that have shaken the state since 2008.

And disposal wells don't just trigger quakes nearby. Tremors can rattle the ground up to 35 kilometers away — much farther than scientists had previously thought, researchers report July 3 in *Science*.

The new study is the most definitive to link Oklahoma's rocketing earthquake numbers to fluid injection, says seismologist Steve Horton of the University of Memphis in Tennessee.

In 2008, a series of small earthquakes began ripping through the land near Jones, a tiny town about 30 kilometers northeast of Oklahoma City. Some of these quakes, known as the Jones swarm, were strong enough to crack sidewalks and drywall. And unlike a typical earthquake, which tears along a single fault, these swarms of tremors spread scattershot across a huge expanse of the state, says study coauthor Katie Keranen, a geophysicist at Cornell University. "They're like a swarm of mosquitoes buzzing all over in a big cloud."

And they've kept coming and coming. Before 2008, only one or two magnitude 3 quakes rumbled through Oklahoma per year. So far in 2014, the state has had more than 200, Keranen says. "We've never seen anything like this before."

To get oil and gas out of the ground, drilling engineers have to pump out water too, she says. And that vast amount of water isn't exactly fresh: It's more like brine. Oil and gas companies get rid of the brine by injecting it into rocks via disposal wells at other sites.

Scientists have suggested that wastewater dumping could set off quakes (*SN: 8/10/13, p. 16*). But in this case, there was one snag: Most wells sat far away from the Jones swarm. People argued that the wells were just too distant to cause the quakes, Keranen says. She wasn't so sure.

Her team created a computer simulation to estimate how far wastewater travels underground and the pressure it creates within the rocks around 89 wells. Too much pressure can stress the faults threading throughout Oklahoma's crust, forcing the ground to shudder.

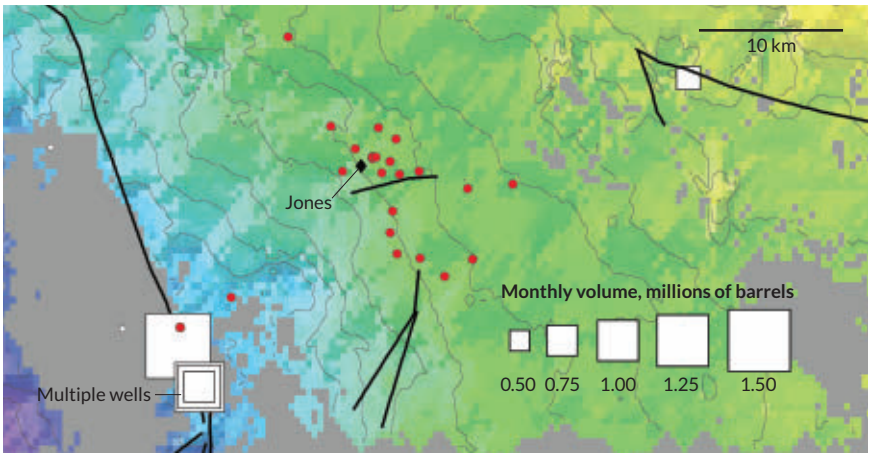
Keranen and colleagues then analyzed ground movement data to pinpoint the origin of thousands of the Jones' swarm quakes that took place from 2010 to 2013. According to the simulation, the pressures spreading from the wells to these earthquakes' origin sites were high enough to kick-start the quakes.

What's more, the main culprits were just four high-volume disposal wells. "We're not saying that every disposal well is likely to cause earthquakes," says Keranen. "But there's a handful that are just absolutely anomalous — disposing of millions of barrels of water a month."

She thinks the findings could help the oil and gas industry pinpoint problem wells and guide future operations.

But even the magnitude 5.6 quake that jolted Oklahoma in 2011 — the largest in the state's history and one that scientists later linked to wastewater injection — didn't prompt new regulations, says geophysicist Arthur McGarr of the U.S. Geological Survey in Menlo Park, Calif. "I think it will take some bigger earthquakes before anything is likely to change."

The new study probably won't convince industry scientists that wastewater injection induces earthquakes, Horton says. Still, he adds, the question is an easy one to answer. "All you've got to do is turn off the wells. If the earthquakes stop, they're induced," he says. "It's that simple." ■



Since 2008, a swarm of earthquakes have rattled Oklahoma near the town of Jones (quakes recorded in 2009, red dots). Injecting wastewater into disposal wells (white squares) may have boosted pressure at faults (black lines), triggering quakes far from the wells.

JUST THE FACTS

Fading emperors

20

percent

Fraction of emperor penguin colonies that may be near extinction by 2100

SOURCE: S. JENOUVRIER *ET AL*/ *NATURE CLIMATE CHANGE* 2014

BODY & BRAIN

Electrode turns consciousness on and off

Woman lost awareness, though appeared awake, when part of her brain was stimulated

BY LAURA SANDERS

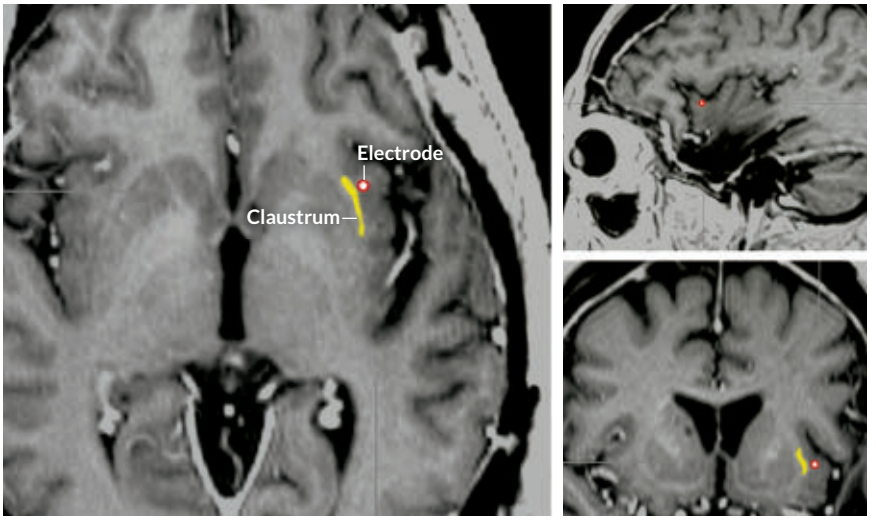
With a zap from a single brain electrode, doctors were able to wipe out a woman's consciousness. As soon as the electrode came on, the woman remained awake but became blank and withdrew from awareness. When the electrode went off, she returned to normal, though she remembered nothing of the experience.

The results provide a tantalizing hint to a question that has plagued thinkers for millennia: How can a hunk of tissue in the skull create subjective feelings and experiences? Today's scientists have attacked this mind-body problem with new theories and experiments designed to tease apart the components of consciousness within the brain (*SN: 2/11/12, p. 22*). The discovery of an on-off consciousness switch may lead to a deeper understanding of how the physical brain creates a mental experience.

The abrupt switch from awareness to its complete absence may be orchestrated by an enigmatic wisp of brain tissue known as the claustrum, scientists propose in the August *Epilepsy & Behavior*. The consciousness-impairing electrode was positioned close to this thin sheet of cells, which forms connections with many other regions of the brain.

If confirmed, the results might ultimately point out ways to rouse people from comas or vegetative states, says study coauthor Mohamad Koubeissi of George Washington University in Washington, D.C.

The results are "exceedingly interesting," says neuroscientist Christof Koch of the Allen Institute for Brain Science in Seattle. Along with Francis Crick, who in the later decades of his life became fascinated with how the brain creates consciousness, Koch proposed that the claustrum plays an important role in awareness. The new finding suggests that the two may have been right. Crick, who died in 2004, would have loved hearing the news, Koch says.



An electrode used to stimulate a brain site near an epileptic woman's claustrum, a thin sheet of cells, appears on these scans shown from various perspectives. When the electrode was on, she seemed to lose consciousness.

In the new study, a 54-year-old woman undergoing treatment for severe epilepsy had multiple electrodes inserted into her brain. Koubeissi and his colleagues were surprised by a big change when they turned on the electrode near the claustrum.

"She appeared extremely confused and she was unable to respond and unable to process any information," Koubeissi says. "When the stimulation ended, she had absolutely no idea anything had happened." It seemed that her awareness had temporarily left her.

In later stimulation sessions, the researchers tested her awareness. She wasn't able to read a word, follow spoken commands or initiate movement while the electrode was on, the team found. If she was in the middle of a task such as repeating a word or moving her tongue or hand in a repetitive way, when the electrode turned on, she would continue for a few seconds before stopping. That indicated that her movement and speech abilities remained intact.

"Her eyes were open and she maintained her sitting posture, but she wasn't able to process any information whatsoever," Koubeissi says.

Because the electrodes were implanted temporarily, researchers had just two days for their tests. During this brief window, the electrode near the claustrum seemed to cause a loss of consciousness each of the 10 times it was turned on. The researchers don't know whether the woman could feel pain in her altered state. However, her unconscious state didn't appear to be the same as that caused by anesthesia. "What you seem to get with this stimulation is a disruption of consciousness but without a disruption of wakefulness," says Anil Seth, who studies consciousness at the University of Sussex in England.

The patient has suffered seizures and has had brain tissue removed. For these reasons, Seth cautions that the brains of other people might not respond similarly to electrode stimulation near the claustrum. "This is not a normal brain that we're looking at," he says.

If confirmed in studies of other people and animals, Koch says, the results would be "a huge step towards a final understanding of the mind-body problem." ■

M. KOUBEISSI *ET AL/EPILEPSY & BEHAVIOR* 2014

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A frozen, rocky planet orbits one of a pair of faint red stars (shown), roughly 3,300 light-years away from Earth, as seen in an artist's illustration.

CHEONGHO HAN/CHUNGBUK NATIONAL UNIV./REPUBLIC OF KOREA

ATOM & COSMOS

Rare planet circles just one of a pair of stars

Odd trio may help test ideas about planet formation

BY CHRISTOPHER CROCKETT

Astronomers have discovered a frozen, rocky planet orbiting one of a pair of faint red stars. Researchers report the discovery in the July 4 *Science*.

It's not the first planet found orbiting one star in a binary, but it is the first to be discovered with microlensing, the temporary brightening of light from a more distant star.

This stellar pair is also much more compact than most other binary systems with planets. And it's the first planet-hosting binary where both stars are M dwarfs, which make up roughly three-quarters of the stars in the Milky Way.

Since roughly half of sunlike stars are part of a pair, such duos are a potentially fertile ground for planet hunters. Planets that orbit binary stars can also help astronomers understand how planets form in unusual environments.

The rocky planet is roughly twice as massive as Earth and is about 3,300 light-years away in the constellation Sagittarius. Its orbit is a bit larger than that of Venus. But unlike Venus, which bakes at around 470° Celsius, the new exoplanet reaches only about −210°. That's because M dwarfs are relatively small and cool. The other M dwarf in the binary is 10 to 14 times as far away from the planet as the sun is from Earth. To an observer on the planet, the companion star would appear as a ruddy point of light about as bright as a full moon.

The new planet was discovered by chance by a project called OGLE, for Optical Gravitational Lensing Experiment. OGLE uses a telescope in Chile to look for stars and galactic debris that pass in front of more distant stars. When that happens, the gravity of the nearer star temporarily amplifies the light of the more distant star. If the nearer star drags a planet along with it, the planet's gravity may briefly distort the starlight as well.

When OGLE first detected a flicker of light in June 2012 and alerted other observatories, the finding appeared no different from the roughly 2,000 other microlensing events that OGLE sees each year. Eventually, eight other observatories around the world watched as the unusual trio drifted between Earth and a third star located roughly 26,000 light-years away.

Planets in binaries help astronomers test ideas about planet formation, says Roman Rafikov, an astrophysicist at Princeton University who is not a member of the OGLE team. Planets form in disks of gas and dust that swirl around young stars. Dust sticks together to form rocks, and rocks repeatedly collide to form planets.

A second nearby star, however, might stir up the material and make it more difficult for the rocky debris to build planets.

The disk may be held together, Rafikov says, by permeating gas. The gas would slow down the debris whirling around the young star, which would help it collide and stick. Also, gravity from the gas might keep the disk orderly in the presence of another star.

> Because the planet is relatively close to its own sun, the gravity from the companion star doesn't affect it much.

Once the planet forms, "survival is not that difficult," says Andrew Gould, an astrophysicist at Ohio State University in Columbus and a member of the OGLE team. Because the planet is relatively close to its own sun, the gravity from the companion star doesn't affect it much.

This type of planet, Gould says, could be discovered only via microlensing. And because so many stars live in pairs, he says, a huge population of planets may await discovery.

One of the primary goals of a proposed NASA space telescope named WFIRST-AFTA is to find lots of microlensing events. Scientists hope that WFIRST-AFTA will uncover scores of planets that are largely invisible to other techniques. ■

LIFE & EVOLUTION

Passenger pigeon had ups, downs

DNA from specimens of extinct bird reveals lean times

BY SUSAN MILIUS

Passenger pigeons were so abundant in the 1800s that some flocks may have taken days to fly over a town. Recovered DNA suggests the species went through large swings in number over its history.

SOUTHERN UNIV. LIBRARY ARCHIVES DEPARTMENT

DNA salvaged from the extinct passenger pigeon gives an unexpected backstory to a species famed for sky-filling abundance in the 19th century. The billions of birds reported from two centuries ago were population peaks for a species that had shrunk to modest numbers at times over the course of the last million years. But even the new feat of genetic reconstruction leaves questions about the species' final crash.

DNA coaxed from toe pads of three museum specimens suggests that the breeding population at times numbered only several hundred thousand or even just tens of thousands of birds, says Chih-Ming Hung of National Taiwan Normal University in Taipei. That's at best one ten-thousandth of the number of breeding adults expected in the 3 billion to 5 billion birds estimated from 19th century eyewitness reports.

Hung doesn't dispute those huge 19th century estimates. The DNA results indicate an earlier chapter of modest numbers, probably during Earth's last extensive glacier coverage, he and his colleagues argue in the July 22 *Proceedings of the National Academy of Sciences*.

In a more controversial scenario, he and his colleagues also propose that the pigeons may have had repeated population booms and busts on much shorter timescales.

Hung became curious about passenger pigeon genetic trends after a pivotal conversation several years ago regarding the 100th anniversary this September 1 of the death of Martha, a passenger pigeon in the Cincinnati Zoo and the last known individual of the species.

The newly analyzed museum specimens provide the best picture yet of passenger pigeon genetics, Hung says. From the amount of variation the researchers found in the specimens' DNA, they could work out an approximate number of birds that were passing on their genes, called the effective population size.

Over the last million years, Hung and colleagues found, the typical number of breeding birds averaged about 330,000. A different calculation indicated lower numbers but a similarly small order of magnitude: 170,000 at the population's height to perhaps 50,000 at its worst. The ups and downs over deep history fit with the timing of glacial cycles and with computer simulations of the niches available for the birds as climate changed.

Genetic tests can't detect population ups and downs at the scale of a century, much less decades. But Hung and his team speculate that pigeon food supplies might have driven drastic short-term rises and falls. The birds relied on acorns and beechnuts, both of which can produce bumper crops after a string of sparse years.

In theory, a species that surges in mind-boggling numbers can go extinct quickly, says entomologist Jeffrey A. Lockwood of the University of Wyoming in Laramie. The Rocky Mountain locust (*Melanoplus spretus*) is an example. It savaged wide swaths of cropland during its booms but abruptly went extinct around the end of the 19th century when farmers took over the very specific habitats the locusts needed to breed.

Short-term booms and busts, however, seem unlikely for passenger pigeons, says conservation biologist Stanley Temple of the University of Wisconsin–Madison. He welcomes the genetics showing population ups and downs over the long term, but he doesn't see how short-term food bonanzas would cause fast fluctuations. The birds tended just one nest a year and, with luck, raised one chick. "There is absolutely no way these birds could rapidly increase their numbers," he says. "It would take them probably centuries to increase their population even tenfold, let alone several orders of magnitude."

Hung and critics agree on one point: Natural cycles, either short- or long-term, do not mean that the passenger pigeon cycled into oblivion on its own.

David Blockstein of the National Council for Science and the Environment in Washington, D.C., has described how intensive shooting at breeding colonies contributed to the species' demise by disrupting its reproduction. And ecologist Stuart Pimm of Duke University says, "The basic cause for the passenger pigeon's decline was the destruction of the Eastern forests."

The message, Hung says, is that "the passenger pigeon had repeatedly recovered from population lows over the course of its history." Then came 19th century humans. ■

EARTH & ENVIRONMENT

Dust helped build up the Bahamas

Windblown nutrients may fertilize island-erecting bacteria

BY THOMAS SUMNER

The Bahamas owes its origins to windswept dust from Africa's Sahara Desert, scientists propose June 30 in *Geology*.

The dust nourishes microbes that produce calcium carbonate, the building block of the Bahamas, the team says. Over the last 100 million years, this carbonate has assembled into the Great Bahama Bank, a 4.5-kilometer-thick platform that forms the base of much of the Bahamas.

"Without this dust, the Bahamas might never be there," says geochemist Peter Swart of the University of Miami.

The Great Bahama Bank is still growing outward as fresh carbonate sediment collects on its borders. Other carbonate platforms, such as the Great Barrier Reef, form from the remains of mollusks and reef-building corals. But these shelled and hard-bodied creatures are relatively rare in the Bahamas, so scientists have long puzzled over the islands' origin.

In the 1990s, researchers found evidence of carbonate-secreting microbes called cyanobacteria in whitings — white streaks of floating calcium carbonate that frequently blemish the Bahamas' clear waters. Whitings range in size from a few meters across to larger than Manhattan.

The cyanobacteria appeared to be the most likely source of the region's carbonate, yet the area lacks enough nutrients, especially iron, to support bacterial populations large enough to form the islands.

To unravel the mystery, Swart and colleagues collected 270 seafloor sediment samples from the Great Bahama Bank over three years. Areas with more whitings contained iron-rich sediments, the team discovered, strengthening the argument that cyanobacteria are the region's chief carbonate producers.

Iron-rich dust from the Sahara blows across the Atlantic, and Swart thinks that this may fertilize the Bahamas. The dust may drop into the water, either directly or in runoff from the islands, and fuel the microbes to reproduce and release carbonate. He plans to look for chemical fingerprints in Saharan dust that can prove the Bahamian iron's African origins.

Oceanographer Lisa Robbins of the U.S. Geological Survey in St. Petersburg, Fla., says the explanation fits with other evidence. "Anyone who has a biology background will say, 'Oh yeah, this makes sense.'" ■

Nutrients in windswept dust from the Sahara Desert may feed the microbes that help build up the Great Bahama Bank, seen in this satellite photo of the Bahamas.

JEFF SCHMALTZ/MODIS RAPID RESPONSE TEAM/GSFC/NASA

BODY & BRAIN

Supercold organs stay viable longer

Rats survived after receiving 3-day-old transplant livers

BY NSIKAN AKPAN

"Supercold but unfrozen" is the idea behind a new procedure that tripled the time a rat liver could survive outside the body. If the procedure works similarly well for humans, the method may grant life-saving transplants a passport for traveling across the world, scientists report June 29 in *Nature Medicine*.

Organs quickly stop working once removed from the body. To stay viable, donated organs are stored inside plastic bags filled with a liquid preservative and kept on ice. Still, a human liver lasts only 12 hours, which instills geographical limits between organ donors and recipients.

Prolonging the time frame could save lives. Most researchers have tried freezing organs, but the process damages cells and blood vessels, says study coleader Korkut Uygun, a Harvard chemical engineer. "We wanted to reduce the temperature but avoid freezing at all costs."

So the team chilled rat livers to subzero temperatures without turning their water to ice. The key was finding nontoxic cryopreservatives that maintain cellular architecture. The team settled on two compounds: 3-*O*-methyl-D-glucose, which prevents ice from forming inside cells, and polyethylene glycol, which does the same for the exterior. Uygun is seeking U.S. Food and Drug Administration approval for use of the chemicals as cryopreservatives in humans.

To prevent injuries associated with disconnecting an organ from its nutrient supply, the researchers relied on an experimental technique called machine perfusion. The method circulates fluids in an organ to simulate nutrient flow. The team performed machine perfusion during organ cooling, while adding one of the cryopreservatives. Once the organ reached –6° Celsius, the team soaked it in the other preservative. Machine perfusion was used again during thawing to prep the organ for transplantation.

A rat liver usually lasts up to 24 hours outside the body. But supercooled livers were viable after being stored for three to four days. Rats that received a 3-day-old supercooled liver survived for at least a month; survival dropped to 58 percent for recipients of 4-day-old livers. Each part of the procedure — the preservatives, supercooling and machine perfusion — was essential, as survival rates dropped to zero when the team altered any step.

Rats are a long way from humans, says Peter Friend, director of England's Oxford Transplant Centre. But, he adds, "there is more potential in cold preservation than we had previously realized." ■

LIFE & EVOLUTION

Gecko adhesion takes electric turn

Study challenges explanation for lizards' supersticky feet

BY NSIKAN AKPAN

Clinging upside down to polished surfaces is simple for geckos, but scientists' grasp of the forces underlying this adherence just became murkier. Researchers report that the adhesiveness of gecko feet is aided by static electricity, contrary to long-held beliefs.

The misconception over gecko adhesion dates back to 1934, says Yale University chemical engineer and study coauthor Hadi Izadi. A German scientist named W.D. Dellit wondered whether gecko adhesion was explainable by electrostatic forces, the differences in electric charge that build up between any two surfaces. Dellit beamed X-rays on the air surrounding reptiles' toes as they stuck to a metal wall. The X-rays ionized the air, neutralizing any charge on the wall's surface, Izadi explains.

Anything attached to the wall via electrostatic forces should have fallen, yet the lizards remained. So researchers ruled out electrostatic forces and moved on to other ideas. Over a decade ago, a pair of studies asserted that geckos owe their stickiness to van der Waals forces (*SN: 7/15/00, p. 47*). These are the weak interactions between molecules that naturally exist between any touching surfaces, such as a smooth windowpane against a gecko's setae — little toe hairs that are responsible for the lizard's freakish grip (*SN: 8/31/02, p. 133*).

But scientists may have been too hasty in ruling out electrostatic forces, Izadi says. The gap between a smooth surface and a gecko's setae is too small for destabilizing air ions to pass through, which wasn't known in Dellit's era. So his X-ray experiment probably didn't counteract electrostatic forces that may have helped the geckos stick.

Electrostatic forces play a role in gecko adhesiveness, a new study finds, despite 80 years of belief to the contrary.

Izadi compared how the footpads of tokay geckos (*Gekko gecko*) stuck to two polymer surfaces. One surface consisted of Teflon AF, a material related to the nonstick cookware coating, while the other was made from a silicone rubber dubbed polydimethylsiloxane.

Because of their chemical makeup, both substances should have had similar degrees of van der Waals interactions with the geckos' setae, and therefore the animals should have clung similarly to both surfaces, Izadi says. But when the researchers gently pulled a lizard's foot away, the footpads stuck to Teflon AF with twice as much strength as they did to polydimethylsiloxane, Izadi and his colleagues report July 9 in the *Journal of the Royal Society Interface*. Because the adhesions were very different, the team concluded that van der Waals forces don't fully explain how geckos stick to walls.

Next, the researchers examined whether electrostatic forces could account for this discrepancy by measuring the charge between each polymer surface and the geckos' feet. The geckos' toe pads and the polymer surfaces were electrically neutral before touching. But when they came in contact, electrons jumped from the gecko foot to the polymers, leaving the foot positively charged and the polymers negatively charged. The team also ruled out water-governed capillary forces.

"Electrostatic interactions are the dominant forces, and they are not something that scientists can ignore," Izadi says.

But some scientists remain skeptical. Electrostatic forces may contribute to gecko adhesion on some surfaces, but the claim that they are dominant is probably incorrect, says biologist Kellar Autumn of Lewis & Clark College in Portland, Ore. He led the team that first demonstrated van der Waals forces as the primary source of gecko stickiness. He points out that geckos can adhere to surfaces where electric charges don't accumulate, such as bare steel. "These observations demonstrate that contact electrification is not required for strong adhesion," he says.

Electrical engineer Ronald Fearing of the University of California, Berkeley, who studies geckos, agrees that van der Waals forces must still play a role. "Of course," he says, "you may just find situations where the electrostatic becomes larger than van der Waals forces." ■

Geckos' toes have a remarkable ability to cling to vertical flat surfaces. A new study questions the leading explanation of how the lizards pull off the feat.

FROM TOP: DAVID CLEMENTS/WIKIMEDIA COMMONS; H. IZADI

EARTH & ENVIRONMENT

Gravity variations foretell flood risk months in advance

Small gravitational tugs from water-logged river basins could give scientists a big advantage in predicting devastating floods. J.T. Reager and colleagues from the University of California, Irvine looked at data from GRACE, a duo of NASA satellites that detects small changes in Earth's gravity. As a river basin soaks up water, the satellites record a stronger gravitational pull. Wetter ground is more liable to flood when hit by a surge of rain or snowmelt. The researchers studied GRACE data collected during the months before the May–July 2011 catastrophic flooding along the Missouri River (above right). The region's gravity increased leading up to the floods, the researchers report July 6 in *Nature Geoscience*, and the uptick could have been used to predict the flood risk five months in advance. Field measurements of snowmelt and soil moisture offer at most two months of warning. — *Thomas Sumner*

LIFE & EVOLUTION

Duck-billed dinosaurs roamed the Arctic in herds

Duck-billed dinosaurs were the wildebeests of the ancient Arctic. Around 70 million years ago, the plant-eating reptiles probably lived in multigenerational herds — just like modern grazers, a dinosaur track site in Alaska suggests. The tracks, a jumbled bunch of large and small footprints, are the first solid sign that duck-billed dinos settled together year-round in the polar region, which at the time probably had a climate similar to that of the modern Pacific Northwest. The animals "weren't just accidental tourists in this area," says paleontologist and study coauthor Anthony Fiorillo. "They were thriving." In 2007, Fiorillo and colleagues discovered thousands of tracks clustered in a soccer field–sized patch of mountain in Denali National Park and Preserve. Measurements of the tracks, three-lobed footprints that dapple the rock like a layer of sunken leaves, suggest that dinosaurs ranging from youngsters to adults shared a similar stomping ground, the team reports June 30 in *Geology*. — *Meghan Rosen*

NORTH DAKOTA NATIONAL GUARD/FLICKR (CC BY-NC-SA 2.0)

BODY & BRAIN

Frequent marijuana use may affect dopamine response

People who use marijuana heavily appear to have blunted brain responses to dopamine, a chemical messenger associated with pleasant feelings and rewards. This diminished response might help explain why some people abuse cannabis (*SN: 6/14/14, p. 16*). Nora Volkow, director of the National Institute on Drug Abuse in Rockville, Md., and colleagues studied 24 heavy marijuana users. On average, these people smoked nearly five joints a day, five days a week and had been using marijuana for a decade. These users had weaker responses to the stimulant methylphenidate, a treatment for attention-deficit/hyperactivity disorder, than did nonusers, the scientists report July 14 in the *Proceedings of the National Academy of Sciences*. Users reported a less intense "high" from methylphenidate, which increases dopamine in the brain. Bodily responses were also blunted: In users, the stimulant didn't affect pulse rate and diastolic blood pressure as strongly. The dampened dopamine response might lead to marijuana cravings, the team writes. — *Laura Sanders*

MATTER & ENERGY

Diamonds under pressure impersonate exoplanet cores

Researchers have squeezed diamonds to a record-setting pressure — 14 times higher than the pressure inside Earth's core. The compressed diamonds' properties could reveal the extreme conditions deep inside Neptune-like exoplanets, which may have diamond cores, the team reports in the July 17 *Nature*. To constrict diamond, the least compressible known material, Ray Smith of Lawrence Livermore National Laboratory in California and colleagues powered up the world's largest laser, located at the National Ignition Facility (*SN: 4/20/13, p. 26*). Smith's team focused 176 laser beams on hair-thin layers of gold and artificial diamond to induce pressure waves. The gold layers disperse heat, Smith says, helping avoid a problem that can mean diamonds aren't forever: As pressure mounts, diamond can liquefy. The team also found that an initial small pressure wave helps prevent melting later during the gradual ramp-up of the compression to 50 million times Earth's atmospheric pressure at sea level. The entire process lasted 20 billionths of a second. — *Thomas Sumner*

GENES & CELLS

Two genes clear up confusion over psoriasis and eczema

A test might prevent thousands of skin disease misdiagnoses by simply checking two genes, scientists report in the July 9 *Science Translational Medicine*. Both eczema and psoriasis produce itchy red patches that look similar, even under the microscope. Accurate diagnosis is crucial because treatments for one can exacerbate symptoms of the other, says Kilian Eyerich of the Munich University of Technology. Disease-specific genes could differentiate the two, so Eyerich and colleagues compared tissue samples collected from 24 people afflicted with both psoriasis and eczema. After sequencing RNA from the samples, the team discovered that differences in activity levels in 15 genes could distinguish psoriasis from eczema. The researchers screened the two best classifier genes, *NOS2* and *CCL27*, among a different group of patients, 16 with psoriasis and 18 with eczema. The two-gene test discriminated between the disorders in every case. — *Nsikan Akpan*

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Searching for Distant Signals

A handful of brief radio bursts have astronomers puzzling over their origin — and looking for more

By Christopher Crockett

Duncan Lorimer wasn't looking for an eruption of radio waves from another galaxy. He and his student David Narkevic were mining old data from Australia's Parkes Radio Telescope for oddly behaving pulsars, the rapidly spinning cores of dead massive stars. Instead, they found a strange burst of radio noise recorded in 2001 that appeared to originate well beyond one of the satellite galaxies that orbit the Milky Way.

The signal was so intense that it briefly overwhelmed the telescope. "It took me a while to come to terms with it," says Lorimer, an astrophysicist at West Virginia University in Morgantown. "I knew it was unusual, but I just wasn't able to grasp the whole gravity of the situation." In 2007, Lorimer wrote in *Science* that the burst "represents an entirely new phenomenon."

Just one signal was a curiosity. But in 2011, astronomer Evan Keane, who was at the Jodrell Bank Centre for Astrophysics in Manchester, England, reported a second one, also in archival data from Parkes.

Then in 2013, a team led by Dan Thornton, another Jodrell Bank astrophysicist, snagged four more in archival data from 2011 and 2012. The bursts came from points all around the sky (*SN: 7/27/13, p. 8*). Each one blasted out radio waves: electromagnetic waves with much lower frequencies than infrared and visible light. Named fast radio bursts, or FRBs, the observations had a few things in common: They were bright, they were brief, and they seemed to be coming from very far away.

Thornton's discovery set the field ablaze. The radio bursts appeared to be the calling card of some exotic, cataclysmic event outside of the Milky Way. Intriguingly, if these signals were truly racing through the space between galaxies, then they may have encountered — and be able to tell the story of — half the missing matter in the universe (see Sidebar, Page 27).

The more astronomers look, the more FRBs they find. Eight fast radio bursts have been reported so far, with another dozen or so yet to be published. This new cosmic mystery is the kind of thing astronomers find irresistible: an exploration of the unknown, and a reminder of how little we know about the universe.

"There's a race on," says Dale Frail, assistant director for the Very Large Array in Socorro, N.M., "a friendly scientific race." Astronomers are dusting off old telescopes and refurbishing others. Radio observatories around the globe are scanning the skies to figure out what these bursts are — and where they come from.

"People are finding them, but they don't know what they mean," says Keith Bannister, an astronomer at CSIRO Astronomy and Space Science in Marsfield, Australia. "There are big arguments about whether they're real or not, whether they're very local or very distant." Speculation about the origin of fast radio bursts runs from the mundane to the exotic. "There are probably at least twice as many theories as there are FRBs at the moment," Lorimer says.

> "There are probably at least twice as many theories as there are FRBs at the moment."
> DUNCAN LORIMER

Of blitzars and magnetars

With the scant data that are available, astronomers are narrowing down the possibilities. Each FRB arrives as a single pulse, which leads people to think that the bursts are probably caused by eruptions or implosions. While FRBs are powerful enough to be seen from other galaxies, they're not as energetic as an exploding star. And they last for only a few milliseconds, so the source has to be relatively compact, roughly as wide as Texas. Keane, now at Swinburne University of Technology in Hawthorn, Australia, favors two ideas, both involving dead stars.

When a massive star explodes, its core stays behind. Within the core, a struggle ensues between the crushing force of gravity and the outward push of subatomic particles. If the core weighs more than a few suns, gravity wins, and the core collapses into a black hole. If the core is smaller, neutrons keep gravity in check, and the core survives as a neutron star.

If the core is rotating very fast, says Keane, it's possible to be heavy and still be a neutron star. Pushing back against gravity, the rotation keeps the core stable. But everything that spins eventually slows down. When the overweight neutron star slows enough, it implodes in an event known as a blitzar. Theoretically, the collapse could generate a radio pulse that looks like an FRB.

Or the bursts could be eruptions from a magnetar, Keane says. Magnetars are neutron stars with

Most of the fast radio bursts seen to date have been recorded by the Parkes Radio Telescope (left) in New South Wales, Australia.

YURY PROKOPENKO/GETTY IMAGES

Possible sources

Erratic pulsars
As the rapidly spinning core of a dead star ages, its steady radio pulse might become sporadic. But FRBs are much brighter than known pulsars.

Annihilating black holes
As it slowly leaks energy, a black hole may eventually vanish, possibly in a puff of radio waves. But probably too dim for an FRB.

Flaring magnetars
Highly magnetic neutron stars occasionally release pent-up energy at all frequencies of light. They're about the right amount of energy.

Blitzars
As a spinning overweight neutron star slows, it might implode, releasing a burst of radio waves. But it may be too infrequent to cause the predicted 10,000 FRBs per day.

Colliding neutron stars
Two neutron stars spiraling together might briefly emit radio waves just before they merge, though not frequently.

Supernovas
The shockwave of an exploding star could blast out radio waves if tangled in the magnetic field of an orbiting neutron star.

Flaring stars
Some stars erupt and discharge brief bursts of radio energy. But the radio waves probably can't escape the dense plasma surrounding these stars.

Extraterrestrials
Not likely. The signals look too much like natural phenomena to be alien-made.

For an interactive map of radio telescopes searching for FRBs, visit **bit.ly/SN_FRB**

The only FRB not seen at Parkes was detected with the Arecibo radio telescope in Puerto Rico, the largest operating single dish telescope on Earth. The Arecibo discovery bolsters the idea that the signals originate in deep space.

DAVID PARKER/SCIENCE SOURCE

a magnetic field around 1 million billion times as strong as Earth's. Astronomers have seen similar bursts from magnetars in our galaxy — the brightest one hit Earth in 2004 and blinded the Swift space telescope, even though it was pointed in a different direction at the time *(SN: 2/26/05, p. 132)*.

There are ways to tell the two apart: Magnetars repeat, blitzars do not. "You can only destroy a neutron star and make a black hole once," says Keane. Magnetars also radiate light at much higher frequencies, such as gamma rays; blitzars, on the other hand, would probably emit only low-frequency radio light. For now, the more common magnetars seem the more likely suspect of the two.

To figure out if blitzars or magnetars — or something else entirely — make sense, astronomers need to know how far away these bursts are. Estimates of distances depend on knowing what the light encountered on its way to Earth. As light crosses space, it plows through plasma, gas clouds where electrons roam free. How easily the light navigates around the electrons depends on the light's frequency. High-frequency light passes through with relative ease; low frequencies take a bit longer.

If something blasts out radio waves, all the frequencies leave as a group, but they don't arrive together at their destination. A radio telescope will see the higher radio frequencies before the lower frequencies. The result, if you could hear it, might sound like a slide whistle. The delay between arrival times indicates how much stuff the light stumbled upon on its way to Earth.

Astronomers can use the number of electrons encountered by the radio waves as a proxy for estimating the distance that the light traveled. Count up the electrons: If the light ran into more electrons than astronomers expect exist between Earth and the edge of the Milky Way, then the signal must originate outside of our galaxy. Astronomers only have theoretical calculations to estimate how many electrons should be floating about in space, but the five bursts detected by Lorimer and Thornton met far more electrons than can reasonably fit within the Milky Way.

> "There are big arguments about whether they're real or not, whether they're very local or very distant."
>
> KEITH BANNISTER

Keane's burst, however, is different. That FRB passed through the plane of our galaxy and shot through the Scutum star cloud, a window in the interstellar dust. The gap allowed CSIRO's Bannister and colleagues to peer deep into the galaxy and directly measure how many electrons sit between Earth and Keane's burst. They reported

in the May 1 *Monthly Notices of the Royal Astronomical Society* that this burst most likely originated from within the Milky Way. If they're right, then the Keane burst might be an erratic pulsar or an annihilating black hole. It may also mean that FRBs are two distinct but similar phenomena: one from our galaxy and one from farther afield.

Here or there

Then again, the bursts may not be coming from space at all.

After the first FRB was reported, Sarah Burke-Spolaor, a Caltech astrophysicist, and colleagues went digging through old Parkes data. They found another 16 bursts that closely resemble the other FRBs with one key exception: They appeared to originate from within Earth's atmosphere, based on the way they hit the telescope. Another group recently saw five similar bursts at the Bleien Radio Observatory near Zurich. In both cases, the bursts typically arrived late in the morning, which means these local radio blips appear to be tied to Earth's daily rhythm. Even more so than FRBs, their origin has scientists baffled.

Burke-Spolaor named these atmospheric bursts perytons after a mythological winged elk that casts the shadow of a human, appearing as something it is not. Perytons make some astronomers hesitant about FRBs. Shri Kulkarni, also from Caltech, wonders if FRBs are just perytons that are very high in the atmosphere. An FRB beyond about 20 kilometers above Parkes, he says, may look like it came from another galaxy.

Laura Spitler's recent detection may help. The astrophysicist from the Max Planck Institute for Radio Astronomy in Bonn, Germany, found a seventh FRB, reported in the August 1 *Astrophysical Journal*, within 2012 data from the Arecibo radio telescope in Puerto Rico. At 305 meters across, Arecibo is the largest operating radio dish on the planet. Based on Arecibo's enormous size, Kulkarni says this burst must be at least 400 kilometers away, about the altitude of the International Space Station and beyond the bulk of Earth's atmosphere.

Spitler's burst also puts to rest any concern that FRBs are a quirk of the Parkes telescope. But it doesn't resolve the issue of whether they arise in the Milky Way or not. Like Keane's burst, Spitler's signal sits in the plane of the galaxy. "My thought is that we're currently looking at three different populations," says Burke-Spolaor: bursts within Earth's atmosphere, within the Milky Way and in other galaxies.

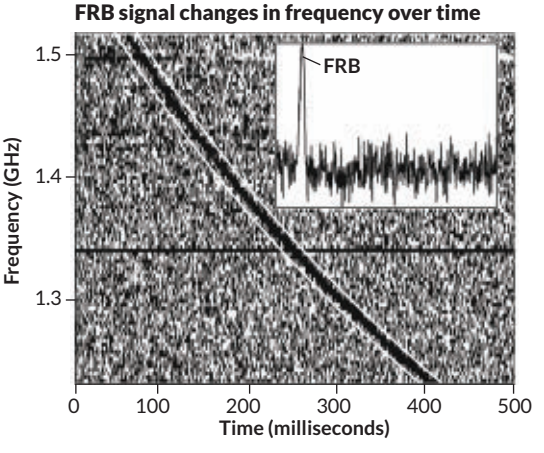
Familiar territory

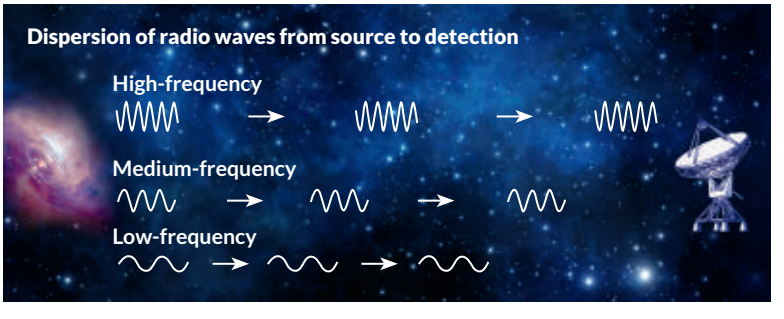
Astronomers have been down this road before. To ferret out the true nature of FRBs, scientists just need to look at how they solved the mystery of gamma-ray bursts.

In the 1960s, the U.S. Air Force launched a family of satellites to scrutinize the skies for gamma rays — the highest-energy, highest-frequency light — produced by illicit nuclear weapons tests. The satellites recorded 16 flashes, only none were coming from Earth and no one knew what they were. Almost three decades later, NASA launched the Compton Gamma Ray Observatory to look for more. By the end of the mission, Compton tallied about 2,700 bursts coming from every direction in the sky. Even then, astronomers still weren't sure exactly what produced the flashes or how far the light had traveled.

Finally, in 1997, the Italian-Dutch BeppoSAX satellite detected a gamma-ray burst and hours later caught an associated X-ray flash. Within days, telescopes on the ground saw a fading glow

Delayed light In a plot (top), the "Lorimer burst" looks the way a slide whistle sounds: The high frequencies arrive first, followed by a sweep to lower frequencies. (Inset shows the light burst's brevity, just a few milliseconds long.) Space plasma slows down low-frequency radio waves more than higher frequencies (illustrated at bottom), so they reach the telescope at different times.
SOURCE: D.R. LORIMER *ET AL/SCIENCE* 2007





NASA/CXC/ASU/J. HESTER ET AL; NIENORA/SHUTTERSTOCK; ADAPTED BY M. ATAROD

The mile-long Molonglo Telescope near Canberra, Australia, is getting a technological facelift so it can take a quick follow-up scan if the Parkes telescope picks up a new burst.

of visible light that seemed to sit on top of a galaxy. Astronomers quickly measured the spectrum of the visible light, which they used to calculate the distance to the burst: at least 9 billion light-years from Earth.

Astronomers now know that there are at least two subsets of gamma-ray bursts: explosions of massive stars and collisions between neutron stars in other galaxies. The key to cracking the mystery was the real-time detection and rapid follow-up from telescopes at other frequencies of light, which let researchers pinpoint the galaxy where the burst originated. The same should work for FRBs, Bannister says: Quickly and accurately locate a burst "and then you hit it with as many telescopes as you can, and see what you find."

Gearing up

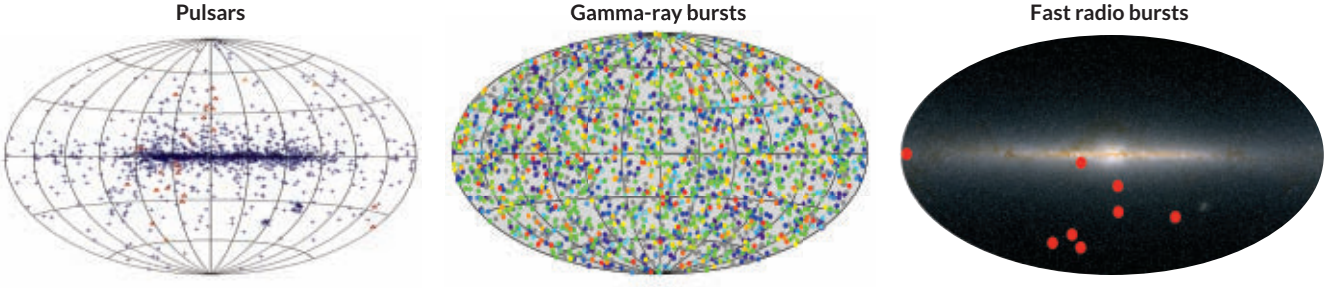
Right now, the locations of FRBs in the sky are fuzzy. The bursts that Parkes sees could be coming from any one of tens of thousands of galaxies. But what it lacks in precision, Parkes makes up for in size. It's a large telescope — 64 meters across. It can collect a lot of light and detect fainter bursts. And with 13 receivers each looking at a different patch of sky, it can cast a relatively wide net.

Keane is using Parkes for a project called SUPERB — the SUrvey for Pulsars and Extragalactic Radio Bursts. ("You've got to have a catchy acronym," he says.) SUPERB is trying to do for FRBs what BeppoSAX did for gamma-ray bursts: quickly alert other observatories when a burst goes off. The infrastructure to do this already exists, thanks to the gamma-ray community. As soon as SUPERB sees a potential FRB, it sends an electronic alert to other telescopes, which then reposition themselves to look for a fading afterglow.

One of those telescopes is the Molonglo Observatory Synthesis Telescope, a mile-long radio antenna in Australia. Matthew Bailes, also at Swinburne, is overseeing an effort to refurbish and update the 47-year-old facility with modern electronics, including a direct fiber-optic link to Parkes. When SUPERB sees a burst, it will send

Sky maps

Mapping signals on the sky can offer clues about where the signals originate. Pulsars (left) concentrate in the plane of the Milky Way, because most of the ones we see sit in our galaxy. Gammaray bursts (middle) come from everywhere, which means they're parked in other galaxies. Fast radio bursts (right) seem to mostly avoid our galaxy, a hint that they may come from very far away.



CLOCKWISE FROM TOP: © ROGER RESSMEYER/CORBIS; J. CARPENTER, T.H. JARRETT/2MASS, R. HURT, C. CROCKETT; G. FISHMAN ET AL/BATSE, CGRO, NASA.; GREEN BANK TELESCOPE, WEST VIRGINIA UNIV.

a virtual and immediate heads-up to Molonglo.

A detection at two observatories separated by hundreds of kilometers, Bailes says, would be a striking confirmation of a deep space origin for FRBs. Not only would there be two eyewitness accounts, but two telescopes working together can triangulate a position much better than a single dish. Also, he hopes to win a bet with his colleague Kulkarni, who thinks fast radio bursts are not real. "It would be a lot of fun to make him pay up," he says.

Other radio observatories also want in. Astrophysicist Casey Law of the University of California, Berkeley is hunting for FRBs with the Very Large Array — 27 radio dishes separated by up to 36 kilometers across the Plains of San Agustin in New Mexico. By precisely noting the arrival times of radio signals at all 27 dishes, astronomers can pinpoint a burst to a single galaxy halfway across the visible universe, Law says. Another group is searching with the Very Long Baseline Array, a facility that takes the VLA concept and extends it to 10 radio telescopes scattered from Hawaii to the Virgin Islands. The telescopes are virtually linked to create an antenna more than half the width of Earth. Whereas the VLA can narrow the origin of an FRB down to a specific galaxy, the VLBA might see where within that galaxy the burst came from.

Despite predicted FRB rates as high as 10,000 per day, the VLA and VLBA teams don't expect to find many bursts — one or two at most. The VLBA, for example, can see only about a full moon's worth of sky at one time, and it takes a lot of moons to cover the sky. But astronomers need only one event to know if a burst is coming from another galaxy.

If there are more FRBs out there, radio astronomers will find them. Many other observatories across the United States, Australia and elsewhere are gearing up to catch them as quickly as possible. Both Arecibo and West Virginia's Green Bank Telescope are building new equipment, including high-end video game microprocessors to do the number crunching, so they can conduct their own searches. And new facilities like the Murchison Widefield Array in Western Australia are hunting over large swaths of sky at very low frequencies. Each telescope has its strengths and weaknesses. Some see more of the sky but can see only the brightest bursts. Others are extremely accurate but, with a narrow field of view, take a long time to find just one.

"It's been a roller coaster for everyone," says Burke-Spolaor, "intrigue, curiosity and also frustration." The only way to sort out the confusion is to look, and the entire community is stepping up. "Everywhere I go," Keane says, "people are saying, 'Hey, I have a telescope. I'd like to help.'"

If current estimates are correct, an FRB goes off somewhere in the sky once every 10 seconds. We've just become aware because we now have the tools to see them. "It's like there's this incredible symphony going on above our heads," Lorimer says, "and we just can't quite figure it out yet." He pauses. "But we will." ■

Weighing the universe

Bright signals coming from across the universe can help scientists probe the space between galaxies. And that might help solve a cosmological conundrum: Where is half the matter in the universe?

Astronomers use light from quasars, cores of distant galaxies that blast out more radiation than normal, as one way to find hidden atoms. As the light crosses the cosmos, it passes through gas clouds. Each cloud imprints its chemical signature on the spectrum of light from the quasar. By tallying up all the atoms the light encountered on its multibillion-year journey, astronomers can estimate how much matter was floating about in the early universe.

But when astronomers look around the present universe, about half the atoms seem to have gone missing.

Astronomers think the missing matter is in the intergalactic medium, or IGM, an expanse of plasma that fills the darkness between galaxies. Unfortunately, the IGM is sparse, which makes it difficult to study. A room filled with the plasma would contain just two electrons — and nothing else. At such low densities, the plasma barely emits any light. And light is one of the few tools astronomers have for studying the universe.

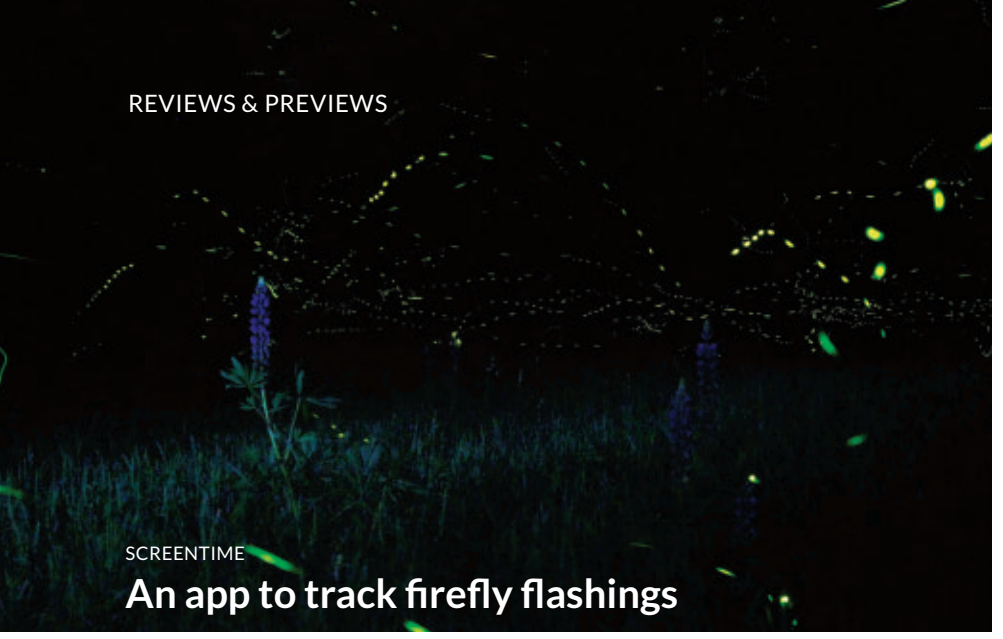
Astronomers use the light from quasars, illustrated here, to estimate the number of atoms in the universe.

Fast radio bursts may help. If they originate in other galaxies, they must pass through the IGM. By measuring a burst, says Jean-Pierre Macquart, an astrophysicist at the Curtin Institute of Radio Astronomy in Perth, Australia, you can account for every particle the light encountered en route to Earth. If astronomers can find a lot of FRBs, he adds, they might solve a problem they've been struggling with for years. — *Christopher Crockett*

Explore more

- S. Burke-Spolaor and K. Bannister. "The galactic position dependence of fast radio bursts and the discovery of FRB 011025." arXiv:1407.0400. July 2014.

M. KORNMESSER/EUROPEAN SO. OBSERV./SCIENCE SOURCE



SCREENTIME

An app to track firefly flashings

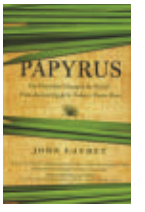
A firefly flashing at dusk is an iconic sign of summer. Now you can enjoy these light shows and contribute to science at the same time with a firefly tracking app.

There are around 2,000 species of these luminescent beetles, which light up the twilight with yellow, greenish or amber light. Scientists at Clemson University in South Carolina are concerned that firefly populations might be in decline. To amass a database of firefly occurrence and habitats, the team designed Firefly Counter, an app that lets citizen scientists worldwide collect data on lightning bug populations.

Just download the free app, available for iPhone and Android, to your smartphone (if you don't have one, an online version is available). When the sun sets, sit down outside. Make a circle with your hand and hold it in front of one eye. Then count how many fireflies flash within the circle over 60 seconds. Once you've counted, fill in your tally, location and type of habitat. The app will also ask you to characterize the flashes to narrow down the firefly species. After entering the data, you can check the app's map to see results from other people in the area. — *Bethany Brookshire*

BOOKSHELF

Wild Connection
Jennifer L. Verdolin
Animals' courtship rituals and sexual behavior hold some interesting parallels for human relationships, an animal behavior researcher suggests. *Prometheus, $18.95*



Papyrus
John Gaudet
The plant used to make ancient paper has a special place in history but should not be relegated to the past, an ecologist says. *Pegasus, $28.95*

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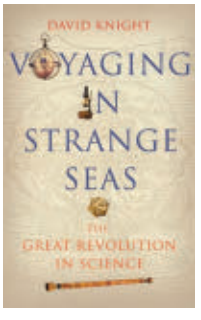


BOOKSHELF

Voyaging in Strange Seas

The Great Revolution in Science

David Knight

It would take longer to count all the books that have been written about the history of science than it would to read any one of them. So if you've read some of them, you might wonder whether it's worth reading yet another.

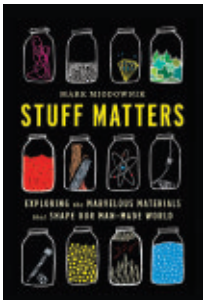
It is. Knight's fresh look at the Scientific Revolution tells the story of modern science's birth — and adolescence — from angles that usually go unexplored.

For Knight, a professor emeritus of science history at Durham University in England, the Scientific Revolution was not confined to the 17th century — it spanned three centuries, roughly from the voyage of Columbus to the French Revolution. It wasn't just about physics and astronomy, and it wasn't isolated from what else was going on in the world.

And it was not just the product of a few men with now-famous names. True, Copernicus, Galileo, Kepler and Newton get their credit, but they're just part of one chapter about how mathematics and telescopes overturned the ancient perspective on Earth's place in the heavens. Speaking of heavens, the role of religion in motivating the Scientific Revolution gets a deserved chapter as well. Knight also examines the rise of scientific societies, the new science's role in medicine and practical applications from clocks to canals, and the voyages of discovery that enlightened the sciences of geography and natural history. He ends with the 18th century's revolutionary developments in understanding electricity and chemistry.

Along the way you meet literally hundreds of the men (and occasional woman) who contributed to science's voyage to modernity. The names go by like a blur, but they convey the sense that science was built not just by giants, but by a society that learned to appreciate the nature of knowledge and its applications to life. It's a story worth telling (and reading) once again, even if other versions have already been told.
— *Tom Siegfried*
Yale Univ., $35

To learn more about Firefly Counter, visit **bit.ly/SN_fireflyapp**



BOOKSHELF

Stuff Matters

Exploring the Marvelous Materials that Shape our Man-Made World

Mark Miodownik

To capture tiny flecks of comet dust whizzing through space, NASA scientists on the 1999 Stardust mission turned to silica aerogel. Aerogel's fine, glassy skeleton brought cosmic particles traveling at 18,000 kilometers per hour to a dead stop without damaging them, trapping the raw components of the solar system and transporting them home for study. It's also an incredible insulator, since its porous structure puts up an effective barrier to heat. Not bad for something that's 99.8 percent air.

"I have spent the vast majority of my time obsessing about materials," writes Miodownik, an engineer and materials scientist. He's not kidding: His book showcases his passion for all kinds of stuff, from exotic aerogels and carbon nanotubes to more mundane matter like paper, metals and plastics.

Some materials are so commonplace that it's easy to take them for granted, like the layer of chromium oxide that renders a stainless steel spoon tasteless and prevents it from interfering with the flavors in your soup. Others have a hint of science fiction about them. Concrete embedded with calcite-producing bacteria, for instance, may one day support buildings that can fix cracks as they appear.

Explaining why glass is clear or how diamonds form means delving into atomic properties and quantum mechanics. But Miodownik distills the difficult physics and chemistry down to a reader-friendly tour of the human-made world, enlivened by his sense of humor and his enthusiasm for the subject. Whether or not the book inspires an obsession as deep as the author's, it does bestow a greater appreciation for the stuff of everyday life. *—Allison Bohac*

Houghton Mifflin Harcourt, $26

Sometimes called "frozen smoke," silica aerogel can protect skin from an open flame because its airy structure makes it a great insulator.

JUNE 28, 2014

SOCIAL MEDIA

Thoughts on pants

A pair of 3,000-year-old wool trousers featured in **Bruce Bower's** story "Earliest pants worn by horse riders" (*SN: 6/28/14, p. 16*) looked a bit familiar to some readers.

"So glad he hung on to those; that fashion's bound to come back in sometime this millennium."
@safzoro on Twitter

"These pants look like my son's laundry but a little cleaner."
@AshleySKane on Twitter

"I think I had a pair of pants like that in the '80s."
Heisenberg, in a comment on the *Science News* website

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Scrutinizing screening

Guidelines for breast cancer screening are being questioned as new research reveals the pitfalls of mammography as a screening tool. ***Laura Beil*** *discussed false positives, overdiagnosis and other concerns regarding cancer detection in "To screen or not to screen"* (SN: 6/28/14, p. 22).

Readers responded passionately, sometimes angrily, to the idea of reducing screening recommendations or doing away with mammograms altogether. As with many health care debates, talk turned quickly to money. "So it is OK to spend multibillions examining space noise so 'something' might be found, but not to X-ray a human female for a few dollars so that something possibly life threatening might be found?" asked **J.D. Vaught**.

Mariana Tupper took umbrage at the statement that mammography harms lives. "It is important to distinguish between the test and the interpretation," she wrote. "How we understand the results, and what we choose to do about them, are perhaps the riskiest part of having a mammogram."

Many readers agreed with doctors cited in the article who emphasize allowing women to make informed choices, but some lamented the lack of screening options. "I will always choose more information over less, so yes, I want to know what's going on in my body and I'll decide how to deal with it after doing my own research," wrote online commenter **K2**. "What disappoints me is that after all these years, mammography is still the mainstream way to screen for breast anomalies." While other imaging techniques, like MRI and ultrasound, can detect tumors in special cases, there is currently no good alternative to a mammogram.

"There is no perfect screening test," wrote online commenter **dkopans**. "Mammography is not the ultimate answer to breast cancer, but it is saving lives today and women should not be denied access to its benefits." In the end, each woman has to weigh the options. "Always good to know stats, but I think I'd still test," tweeted **Grace Nyakabau**.

Crops and climate change

More carbon pollution in the air could mean lower levels of iron, zinc and protein in staple crops like wheat and rice, ***Beth Mole*** *wrote in "Nutrients may drop as CO_2 rises"* (SN: 6/28/14, p. 12).

The startling finding calls for a plan B, said **Mark S**. "Iron and zinc are fairly inexpensive as food additives. Since it's clear that nothing is going to be done about climate change until it's too late, maybe the countries that benefit most from the status quo could set up a program to provide supplemental nutrition to those countries that need it most."

But online reader **Dan Midgett** urged people not to jump to conclusions based on the researchers' work. "We're not considering plant health here. Other studies have shown that elevated levels of carbon dioxide are great for the majority of plants that grow greener and better at gas levels several times higher than current provided they have the water and other basic nutrients to do so."

Evaluating the self-absorbed

Young adults' self-regard takes a blow in hard economic times. People coming of age in bad economies feel less entitled to special treatment than those reaching adulthood in a financial boom, ***Bruce Bower*** *reported in "Recessions take a lasting toll on narcissism"* (SN: 6/28/14, p. 14).

The finding implies that there might be yet more social impacts of the financial climate, e-mailed **Henry Jones**. "If recessions cut down on excessive self-regard, do they have an opposite, and much less desirable, effect at the other end of the scale, i.e., more cases of very low self-esteem?"

Online reader **arobustus**, however, reminded everyone that correlation is not causation, and that the researchers are assuming that the economy does in fact have an effect on narcissism. "Could it be that increases in narcissism, due to some unknown cause, in their turn cause economic downturns later as the self-absorbed proceed to muck things up?"

M. WAGNER/GERMAN ARCHAEOLOGICAL INSTITUTE

Wonders of the northern lights

Tens of kilometers above the icy waterfalls surrounding Iceland's Kirkjufell Mountain, Earth's magnetic field drags electrons from the sun to their visually stunning demise. The zooming particles collide with nitrogen and oxygen in the upper atmosphere, an interaction that produces a brilliant blue-green light show called an aurora.

Photographer Nicholas Roemmelt captured this scene on a moonlit night in March. The shot won him third prize in the "Beauty of the Night Sky" category of the recent International Earth & Sky Photo Contest.

While scientists know the basics of how auroras form, many aspects of the lights elude explanation. On March 3, NASA launched a rocket into the heart of an aurora shining above Venetie, Alaska, to measure the particles and electric fields at work. By combining the rocket's data from its 10-minute flight with observations from the ground, researchers received an unprecedented look inside the northern lights. NASA hopes the mission will illuminate mysteries such as the origin of auroral curls, which look like cream swirling in a cup of coffee. — *Thomas Sumner*

DR. NICHOLAS ROEMMELT PHOTOGRAPHY

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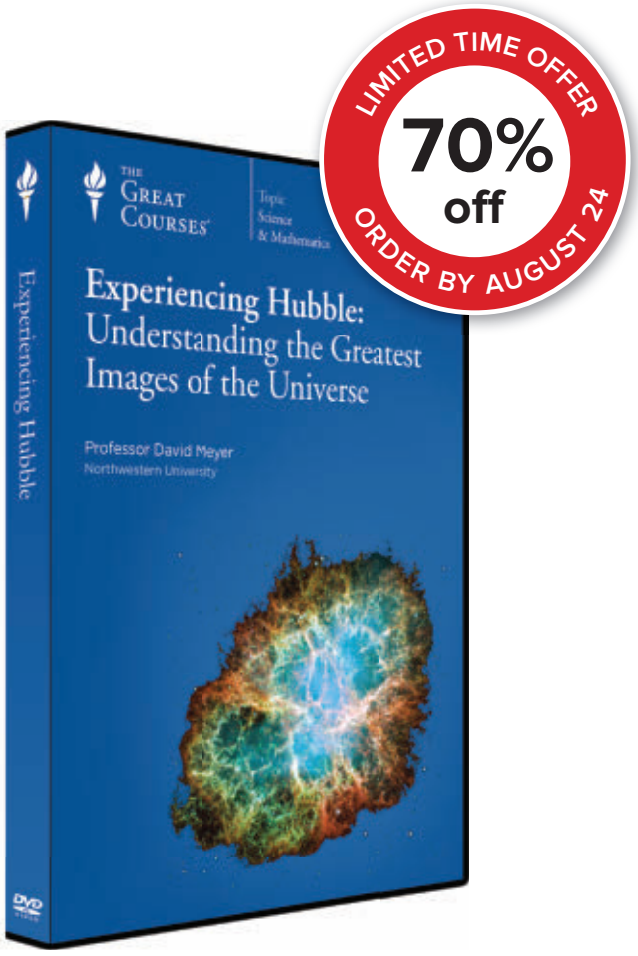

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