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SCIENCE NEWS MAGAZINE
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JUNE 28, 2014

BICEP2's Unsettled Dust

Microbe Wombmates

World's Oldest Pants

E-cigarette Risks Emerge

Mixed Messages

New analyses suggest mammography's benefits have been oversold

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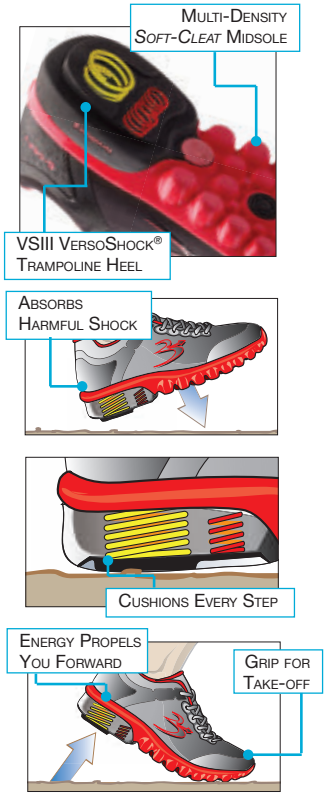

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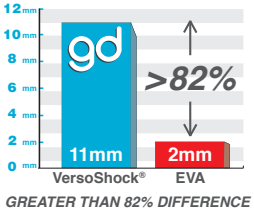

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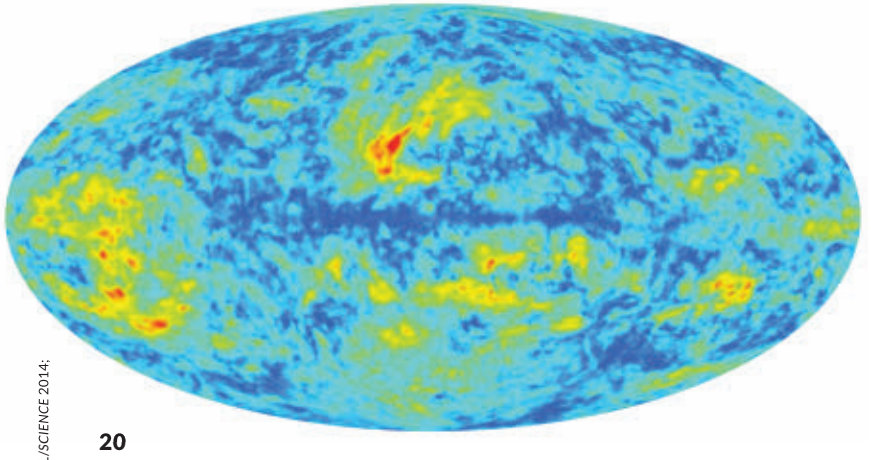

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News

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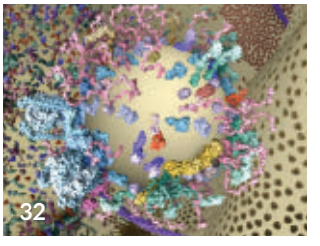

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Departments

COVER Despite popular perceptions, the drawbacks of widespread mammography screening may outweigh its ability to save lives. *Carolyn Sewell*

Scientists struggle to find signals in the noise

Each time I open my e-mail, I scan a long list of subject lines to find the messages that have something important to tell me. Occasionally, I'll miss one and have to go back later to find it. Sometimes I make a different kind of mistake, opening a missive of no consequence. The point is that, even in a simple system like my in-box (OK, not that simple — the current count shows 19,004 unopened messages), detecting the signal from the noise is not always easy.

That theme is at the heart of both feature articles in this issue. In certain women, finding signs of a tumor using mammography can be akin to "finding a polar bear in a snowstorm," readers learn in Laura Beil's story on Page 22. Normal, healthy breast tissue sometimes looks similar to a nascent cancer. This, as Beil details, leads to a huge number of false-positive mammograms, in turn causing unnecessary stress and further testing. Perhaps worth it, if mammography screening saves many lives. But the latest number crunching suggests that, especially for average middle-aged women, mammograms save far fewer lives than we have been led to believe.

As hard as it is to spy tiny tumors reliably, detecting primordial gravitational waves has seemed nearly impossible. But in March scientists with the BICEP2 telescope excitedly announced finding a surprisingly strong signal, apparently the imprints of those gravitational waves, in ancient light known as the cosmic microwave background (*SN: 4/5/14, p. 6*). These waves, it had long been theorized, would have been created in the wake of inflation immediately after the Big Bang. The discovery represented a glimpse of the very beginning of the universe, helping astronomers explore that long lost cosmic history. But now, as Christopher Crockett reports on Page 20, scientists are raising doubts about the true source of the signal. Dust from the Milky Way may be what the scientists are really seeing, not gravitational waves at all.

The answer is still up in the air, literally. Many are counting on the Planck spacecraft to help reveal whether researchers have found a meaningful signal or just very loud noise. Either way the potential value of the gravitational wave signal for understanding the universe is worth the effort, and validates the debate. — *Eva Emerson, Editor in Chief*

SANDY SCHAFFER

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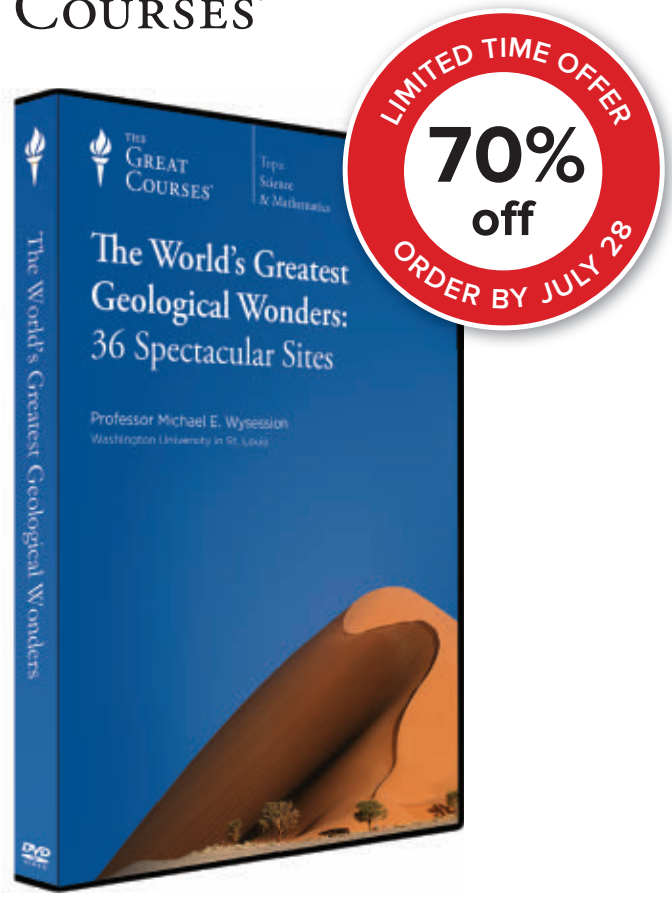

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23. Bay of Fundy—Inexorable Cycle of Tides
24. Hawaii—Volcanic Island Beauty
25. Yellowstone—Geysers and Hot Springs
26. Kawah Ijen—World's Most Acid Lake
27. Iceland—Where Fire Meets Ice
28. The Maldives—Geologic Paradox
29. The Dead Sea—Sinking and Salinity
30. Salar de Uyuni—Flattest Place on Earth
31. Namib/Kalahari Deserts—Sand Mountains
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Excerpt from the July 4, 1964, issue of *Science News Letter*

50 YEARS AGO

Automated Commuting

A way for commuters to have separate automobiles yet leave the driving to computers has been developed at the Massachusetts Institute of Technology.... [Engineers] call the car a Commucar. It could be driven and parked anywhere on any road, but would also be suitable for use under automatic control on special, 60-mile-an-hour main arteries.... The Commucar would be a light, compact, electric auto that would have arms on each side. It could draw power through either arm from an electric siderail while it was on a Commucar throughway. It would also be steered and switched at junctions through these arm-siderail connections.

UPDATE: Engineers have not given up on self-driving cars. Instead of the mostly mechanical approach envisioned in 1964, newer versions run on batteries and use sensors and GPS to go driverless without connecting to tracks or rails. In May, Google revealed a prototype of their first planned self-driving car. The company's test vehicles have logged more than 700,000 driverless miles.

Give roaches a chance. Among the underappreciated beauties are a *Perisphaerus* species (above) and the sky-blue *Polyzosteria mitchelli* of Australia (right).

IT'S ALIVE: NICKY BAY PHOTOGRAPHY; THE -EST: PAWEL MICHALOWSKI/SHUTTERSTOCK, KEATTIKORN/SHUTTERSTOCK

THE -EST

Speediest legs

A sesame seed–sized mite from California can't leap tall buildings in a single bound, and it is definitely not more powerful than a locomotive. But it is quick. New videos have captured the *Paratarsotomus macropalpis* mite skittering along at almost 30 centimeters per second. *P. macropalpis* moves 322 body lengths per second and is now by far the fastest land animal in terms of speed for its size. A human running that many body lengths per second could cover about 2,317 kilometers, or 1,440 miles, per hour. For comparison, Usain Bolt, among the fastest humans in the world, runs 45 kilometers per hour (28 miles per hour) at full speed, and only for short sprints. The cheetah retains its title for fastest animal land speed overall, but for relative speed the animal that comes closest to the mite is the Australian tiger beetle, the previous record holder. Studying the biomechanics of the mite might help engineers develop ultrafast robots and other devices, scientists say. The team announced the mite's new record in April at the 2014 Experimental Biology meeting in San Diego. —*Ashley Yeager*

Relative and land speeds of animals

Animal	Relative speed (body lengths/s)	Equivalent human speed (km/h)	Top land speed (km/h)
Mite	322	2,317	0.9
Tiger beetle	171	1,159	6.7
Cheetah	16	159	98
Greyhound	13	92	68
Human	6	45	45

SOURCES: P. HUDSON *ET AL/J. EXP. BIOL.* 2012, UNIV. OF FLORIDA, CINCINNATI ZOO, SPORTSSCIENTISTS.COM

IT'S ALIVE

The many charms of cockroaches

Yes, the shiny purple-green creature to the left and the sky-blue one to the right are cockroaches. But they do not at all want to live in your house.

Among the world's more than 4,600 or so roach species, "people have tended to concentrate on just the boring pest species," says George Beccaloni, curator of cockroaches and their relatives at the Natural History Museum in London. That's only about 30 annoying species, roughly the same proportion of pests as found among the 5,500 or so known mammal species. Yet people don't squeal, "Mammals, ewww."

A few bad roaches spoil the image of the whole Blattodea order. Most people, Beccaloni laments, "don't know anything about the other very attractive and interesting cockroaches that are out there."

Some roaches are downright beautiful. One *Melyroidea* pretends to be a noxious beetle with a cherry-red head and slim metallic green back. Another mimic, a plump little button of a *Prosoplecta* in the Philippines, is round and red as a ladybug. To fit full roach wings under its dome, it has evolved extreme origami.

Roaches offer their own safari thrills, too. Beccaloni has gone to Madagascar to study the hissing cockroaches, unique to the island just as lemurs are. Males grow two horns and "fight each other like rams," he says.

He has also visited Australia's rhinoceros cockroaches, which can weigh more than a house mouse. Australians finding them lumbering across a highway after a rain have mistaken them for baby turtles. A local naturalist (who promoted his region as home of the world's largest roaches and commissioned souvenir teaspoons decorated with them) went digging with Beccaloni to explore the kinds of burrow a mated pair lives in, sometimes a meter deep.

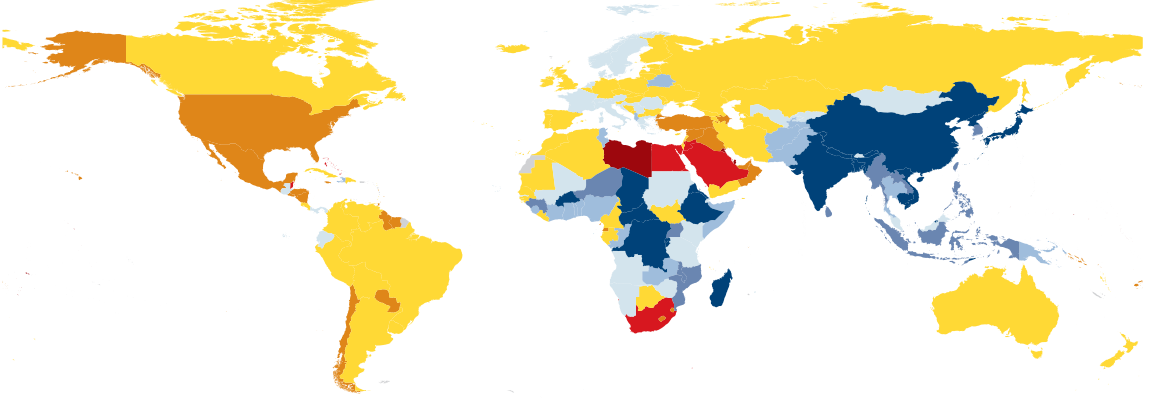
Also, some cockroaches can be caring moms. Instead of just laying eggs and leaving, a *Diploptera* roach carries her developing embryos in an internal brood sac where the walls produce an insect form of mother's milk. A *Perisphaerus* female from Malaysia that lived with Beccaloni as a pet carried youngsters clinging to her underparts. It was hard to see what they were doing, but Beccaloni says that the young's mouthparts, shaped like little drinking straws, were sized to fit into openings at the top of four of mom's legs in what might be an example of insect suckling. —*Susan Milius*

SCIENCE STATS

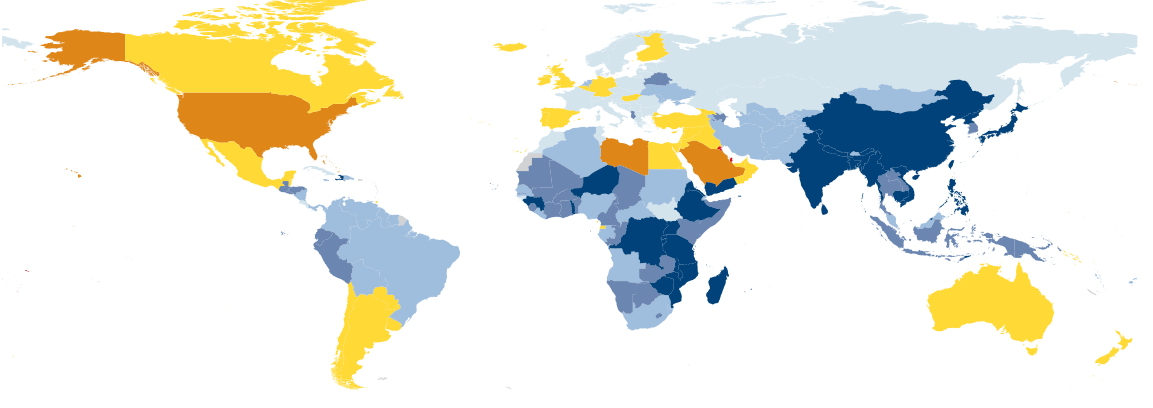
Obesity on the rise globally

Some 2.1 billion people, almost 30 percent of the world's population, are overweight or obese. Data from 1980 to 2013 show that the biggest increases in the prevalence of obesity in women occurred in Egypt, Saudi Arabia, Oman, Honduras and Bahrain, and for men, in New Zealand, Bahrain, Kuwait, Saudi Arabia and the United States.

Obesity prevalence in women, 2013



Obesity prevalence in men, 2013



Prevalence (percent)

- 0–5
- 5–10
- 10–15
- 15–20
- 20–30
- 30–40
- 40–50
- 50–100
- No data

FROM TOP: G. BECCALONI; M. NG *ET AL*/*LANCET* 2014, ADAPTED BY S. EGTS

GENES & CELLS

Healthy placentas are not sterile

Womb microbes resemble those found in women's mouths

BY TINA HESMAN SAEY

The placenta harbors an unexpected collection of bacteria. Its mix of microbes may promote healthy pregnancies or lead to premature births.

Doctors and scientists have long thought that the placenta, which attaches to the uterus and helps nourish the fetus acts as a germ-free barrier preventing bacteria from reaching the fetus, says pediatric infectious disease specialist Anna Bakardjiev of the University of California, San Francisco.

Researchers figured that babies pick up their microbiomes — the collections of bacteria and other microbes that exist in and on them for the rest of their lives — during birth and early childhood.

Last year, however, researchers found that microbes make it to the side of the placenta that fuses to the mother's uterus. And now a team reports in the May 21 *Science Translational Medicine* that it has found bacteria on the baby's side of the organ, near where the umbilical cord originates, indicating that the placenta has a microbiome of its own.

Obstetrician Kjersti Aagaard of Baylor College of Medicine and Texas Children's Hospital in Houston and her colleagues sampled 48 placentas from women who had full-term pregnancies or delivered prematurely. Women who gave birth to premature babies tended to have a mix of placental microbes that differed from the placental microbiomes of women whose pregnancies lasted the full term. The microbes the researchers found tended to be normal residents of human bodies, not disease-causing invaders.

"It's exciting that we're breaking down this dogma that the placenta is sterile," says Bakardjiev, who was not involved in the work. "The question is, 'Why is it not sterile?' "

> "It's exciting that we're breaking down this dogma that the placenta is sterile. The question is, 'Why is it not sterile?' "
>
> ANNA BAKARDJIEV

Bacteria's shortest route to the placenta would be to migrate from the vagina into the uterine cavity, Aagaard says. But she and colleagues found that the placenta has more bacteria usually found in the mouth than ones found in the vagina. The team proposes that bacteria travel from a woman's mouth through her bloodstream to set up shop in the placenta. The finding could help explain why women with periodontal disease or some other infections are at high risk of delivering prematurely.

The researchers also found that *E. coli* bacteria are relatively abundant in the placenta. These bacteria are typically found in the gut and feces. Such microbes may ascend through the vagina and colonize the uterus even before pregnancy, Bakardjiev says.

One weakness of the study is that the researchers didn't compare the placental microbiomes with bacteria elsewhere in the individual mothers' bodies, says Amanda Lewis, a microbiologist at Washington University School of Medicine in St. Louis.

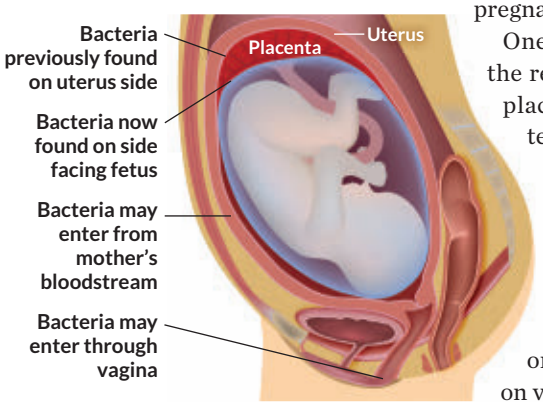
Instead, the team compared the placental microbiomes with microbes found in or on various body sites reported in a major study called the Human Microbiome Project. Lewis has previously linked preterm birth with an infection called bacterial vaginosis. The bacterial profiles the researchers found in the placentas that nourished premature babies are similar to those found in some forms of bacterial vaginosis. Lewis suggests that these microbes could have invaded the placenta not from the mouth but from the vaginas of women with undiagnosed vaginosis. Comparing a mother's microbes with those in her baby's placenta might have revealed that connection.

Giving antibiotics to pregnant women with periodontal disease or urinary tract infections failed to prevent preterm births in other studies, notes Antonio Frias, a maternal-fetal medicine researcher at Oregon Health & Science University in Portland. That failure could indicate that the placenta's microbiome is difficult to alter, he says. "How to change your microbiome effectively is a whole area of research without a lot of answers yet."

It's too early to say whether a particular microbial mix promotes healthy pregnancies. But the new work "is outstanding," says George Saade, director of maternal-fetal medicine at the University of Texas Medical Branch at Galveston. "We really need to pay attention to it." One difficulty is that researchers can access the placenta only after birth. He thinks giving pregnant women blood tests or even collecting their saliva might give clues to which bacteria end up in the placenta. Meanwhile, new techniques for placental imaging might show when the microbes arrive.

Women should maintain good oral health in addition to good overall health if they are pregnant or thinking about getting pregnant, researchers say. ■

Early friendship Babies and bacteria become acquainted during pregnancy when microbes colonize the placenta, new research indicates. An abnormal mix of these friendly microbes may trigger premature birth.



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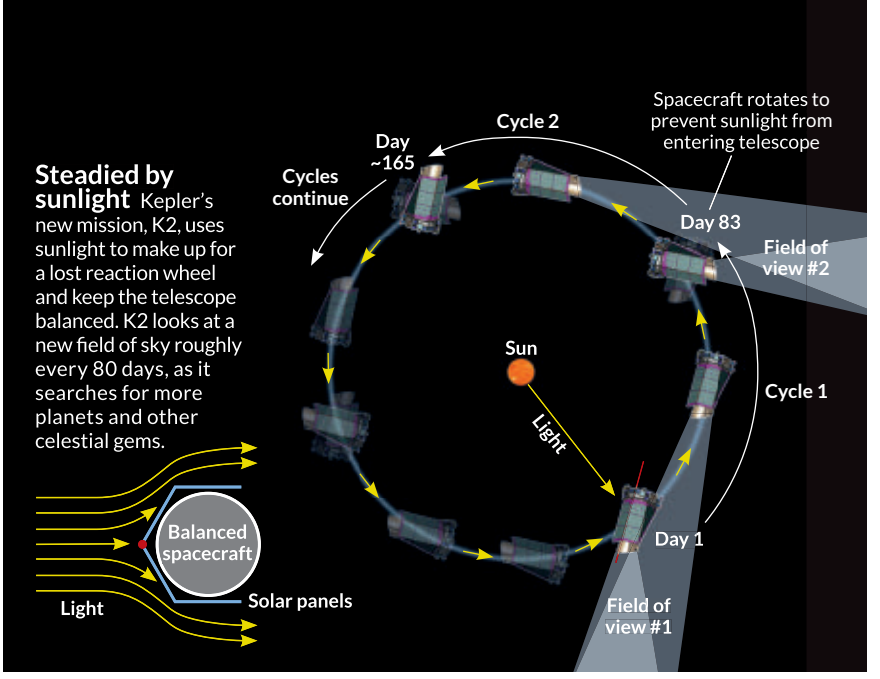
ATOM & COSMOS

Sun shines new life on Kepler space telescope

By balancing on sunlight, planet hunter reinvigorated

BY CHRISTOPHER CROCKETT



Reports of Kepler's death have been greatly exaggerated.

NASA's flagship planet hunter, which netted nearly 1,000 confirmed exoplanets during its four-year mission, is getting a second chance at life with a little help from the sun. The space agency gave the new mission, dubbed K2, the go-ahead to start observations at the end of May.

Kepler was knocked out of commission last spring when the second of its four reaction wheels stopped working (*SN Online: 5/15/13*). The reaction wheels keep the telescope pointed in the right direction; it needs at least three. Once Kepler was down to two wheels, it could no longer sufficiently steady itself.

Shortly after the first wheel failed in 2012, says Steve Howell, project scientist for the Kepler mission, engineers at Ball Aerospace came up with an ingenious solution for continuing on two wheels: Use sunlight to balance the telescope.

One side of Kepler is plastered with solar panels that come together at an angle like a roof on a house. When rain falls straight down on a roof, Howell says, the sides get the same amount of water. If Kepler points the peak of its solar panel roof at the sun, each side gets the same gentle nudge from sunlight and the forces cancel; the light acts like a third reaction wheel to steady the spacecraft.

But in the K2 mission, Kepler can no longer gaze in the same direction it has for the last four years. Instead, Kepler will point along what's called the ecliptic, the band of sky encircling the solar system and aligned with Earth's orbit.

As Kepler trails Earth around the sun, it will now stare at one chunk of sky for roughly 80 days at a time, then turn to face somewhere new. The length of time and where the telescope can look are limited by the location of the sun. If the telescope swings around to a patch of sky too early, sunlight will hit the panels at too shallow an angle to generate sufficient power. If Kepler stares for too long, sunlight could bounce down the telescope tube and blind the planet hunter.

Kepler scientists spent most of last fall testing the idea with the spacecraft. "We had no previous way of knowing if it would work," Howell says. While balancing on sunlight means K2's precision isn't as good as the original mission's, it's enough to continue the hunt.

In fact, during testing, K2 identified three potential Jupiter-sized planets (*SN Online: 6/4/14*). And in January, it detected a previously known exoplanet. The mission has "really turned out to be a lovely combination of science and spacecraft engineering," Howell says.

Ben Oppenheimer, an astronomer at the American Museum of Natural History in New York, agrees: "It's a very clever thing these guys came up with." Oppenheimer chaired NASA's 2014 Astrophysics Senior Review Panel, which was charged with making recommendations about which of the agency's missions to continue funding. "We really felt [the Kepler team] made a very, very good case," he says, adding that Kepler won't limit itself to exoplanets. K2 will add star clusters, galaxies and bodies in our own solar system to the spacecraft's repertoire. "It's going to be a fun romp through the ecliptic," Howell says.

K2 will last for up to three years, depending on Kepler's fuel reserves. The small adjustments needed to keep the solar panels aligned don't use much fuel. A bigger drain is when the telescope swings around to point its antenna at Earth so engineers can download data and upload instructions. Howell says Kepler scientists might be able to conserve fuel by using the remaining two reaction wheels to help shift the telescope. This isn't a new idea: The International Space Station uses its reaction wheels to spin around without thrusters. By driving the spacecraft this way, he says, astronomers could keep K2 running for many years.

That's assuming no other important parts die. "We've had a joking discussion of what do we do with one reaction wheel," Howell says. "So far no great ideas have surfaced."

Pointing along the ecliptic adds poetic symmetry to Kepler's original mission. Since potential planets viewed by Kepler sit in the plane of Earth's orbit, any alien civilizations with telescopes along this path would see Earth the same way Kepler sees them — as a shadow passing in front of the sun. Howell says that NASA has already received one proposal to look at 18 to 20 stars that line up perfectly with the ecliptic. "So someone might be watching us now," he says. ■

W. STENZEL/NASA AMES, ADAPTED BY S. EGTS

GENES & CELLS

Lasers heal damaged teeth

Light stimulates stem cells in mice, spurring dentin regrowth

BY MEGHAN ROSEN

To rebuild teeth, just add laser light.

Zaps from a low-power laser boosted tooth growth in rodents, researchers report in the May 28 *Science Translational Medicine*. The beams of light set off a molecular chain reaction that ended with the regeneration of dentin, the tough inner material of teeth.

The findings may change the way dentists think about treating patients, says stem cell researcher Peter Murray of Nova Southeastern University in Fort Lauderdale, Fla.

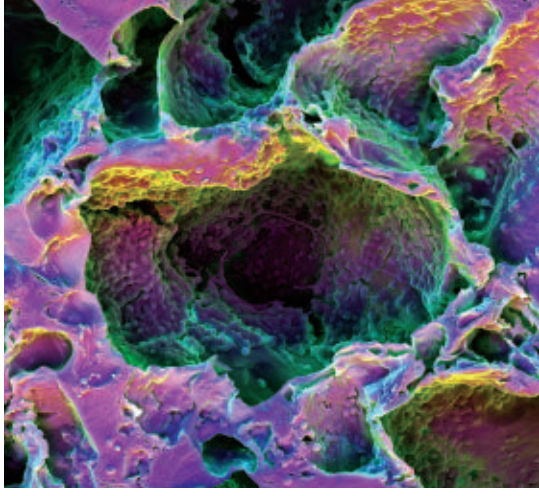
Dentists can use lasers as high-tech scalpels to carve out damaged tissue, slice away overgrown gums or burn off tumors. But scientists have had hints that turning down a laser's power could actually get cells growing.

Light from a low-power laser can spark new growth of heart, skin and nerve tissue, and researchers have speculated that the regeneration involves stem cells, says study coauthor David Mooney, a bioengineer at Harvard University. "But certainly people did not understand how it worked," he says. "We wanted to put all the pieces of the puzzle together."

Mooney and colleagues drilled holes into two molars each in seven rats — down past the enamel and through the tough dentin — to expose the spongy, sensitive pulp at each tooth's core. The team hit the pulp of one tooth in each rat with a five-minute blast from a handheld near-infrared laser and left the other tooth alone.

After filling both drilled teeth and waiting 12 weeks, the team saw knobs of dentin growing in and around the pulps of both teeth. About 20 percent more dentin grew in the laser-treated tooth than in the untreated one.

"It's not re-forming the tooth perfectly," Mooney says. But teeth could benefit from having extra dentin. Damage to dentin by cavity-causing bacteria can leave the pulp vulnerable to microbial attack, which can kill the tooth.



A brief blast of laser light might spur mouse dental cells, shown here in false color growing in a 3-D scaffold, to make dentin, the tough stuff inside teeth.

The laser treatment may work by activating stem cells. In lab tests, dental stem cells from human teeth and dental cells from mice showed signs of turning into dentin-making cells when hit with low-power laser light. Chemicals in the cells absorb the light's energy and morph into reactive molecules that rev up a growth factor protein. The protein spurs dental stem cells into action, which appear to turn into dentin-forming cells, Mooney says. ■

BODY & BRAIN

Feeling less pain may lengthen life

Metabolism improves in mice that lack a sensory protein

BY LAURA SANDERS

Mice with less pain live longer. When the animals lack a certain pain-sensing protein, their life span increases by an average of 10 to 15 percent, scientists report in the May 22 *Cell*.

With age, many people suffer more frequent bouts of pain, says study coauthor Andrew Dillin of the University of California, Berkeley. He and his team wondered about pain's connection to getting older. "We simply just asked, is pain actually driving the aging process or is it part of the process, just going along for the ride?" Dillin says.

The team studied mice genetically engineered to lack the protein Trpv1, a molecule important for sensing pain. Perched on the outsides of nerve cells, Trpv1 senses scalding heat and spicy chili peppers, among other things. It also helps maintain body temperature and influences insulin-producing cells.

Mice lacking Trpv1 appeared normal, except that males fought one another viciously. But the team uncovered a big difference in metabolic health. Mice without Trpv1 processed sugar more effectively than mice with Trpv1. This benefit remained even as the animals aged. Old mice lacking Trpv1 also had more insulin-producing cells, which help metabolize sugar, in their pancreas than older mice with Trpv1.

This link between pain sensation, metabolism and life span is exciting because the same connection may occur in other animals, says molecular physiologist Rochelle Buffenstein of the University of Texas Health Science Center at San Antonio. Evidence from studies on a small subterranean rodent supports the link between pain sensing and life span. Buffenstein and others have found that the naked mole-rat, which lives to the unusually old age of 30 years, lacks a typical pain response.

Favorable metabolic changes that come with a reduced-pain existence might drive life span extension. Male mice that lack Trpv1 lived about 10.6 percent longer than males with the protein, from an average of 937 to 1,036 days. In females, the average increase was about 15.6 percent, from 828 to 957 days.

It's unclear whether metabolic effects alone alter life span or if the experience of pain, and the stress and anxiety that come with it, also contribute.

"All we know is that when we reduce pain," Dillin says, "we increase metabolic health." ■

P.R. ARANY *ET AL/SCIENCE TRANSLATIONAL MEDICINE* 2014

Health risks of e-cigarettes emerge

Vaping pollutes lungs, may protect antibiotic-resistant bacteria

BY JANET RALOFF

Electronic cigarettes, marketed as safer than regular cigarettes, deliver a cocktail of toxic chemicals, including carcinogens, into the lungs, new studies show. Using e-cigarettes may even promote antibiotic-resistant bacterial infections.

Engineers developed e-cigarettes several years ago to provide tobacco users a smoke-free source of nicotine. The devices heat up a liquid that a user inhales, or "vapes." Because e-cigarettes burn nothing, they release no smoke.

"There's no question that a puff on an e-cigarette is less toxic than a puff on a regular cigarette," says Stanton Glantz, director of the Center for Tobacco Control Research and Education at the University of California, San Francisco. But few studies have looked at the vapors' toxicity. So scientists have been circumspect about describing e-cigarettes as safe.

Glantz and his team reviewed data on inhaling vapors and found more risk than scientists had thought. E-cigarettes deliver high levels of nanoparticles, the researchers wrote May 13 in *Circulation*. Those particles have been linked to asthma, stroke, heart disease and diabetes (*SN: 7/18/09, p. 26*). The levels "really raise concerns about heart disease and other chronic conditions where inflammation is involved," he says.

E-cigarettes are no longer niche products. Vaping product sales last year were projected to hit $1.7 billion, report Ii-Lun Chen and Corinne Husten of the Food and Drug Administration in a special May issue of *Tobacco Control*. At least 1 in 5 smokers have tried e-cigarettes, as have 10 percent of U.S. high school students, according to the Centers for Disease Control and Prevention.

The FDA has seen no data establishing that vaping is safe, writes the agency's Priscilla Callahan-Lyon in *Tobacco Control*. She reviewed data from 18 studies on e-cigarette vapors and found that most contain at least traces of the solvents in which nicotine and flavorings had been dissolved. Those solvents, known as lung irritants, can transform into something even more worrisome: carbonyls. Carbonyls include cancer-causing chemicals, such as formaldehyde, and suspected carcinogens, such as acetaldehyde.

Early e-cigarettes didn't deliver the powerful hit of nicotine that burning tobacco does. So engineers developed technology that allows users to increase an e-cigarette's voltage, and thus temperature, to atomize more nicotine per puff.

But the higher temperatures also can trigger a thermal breakdown of the solvents, producing the carbonyls, explains Maciej Goniewicz of the Roswell Park Cancer Institute in Buffalo, N.Y. If users of second-generation e-cigarettes maximize the power on their devices while using vaping liquids containing a solvent mix of glycerin and propylene glycol, formaldehyde levels can reach those found in tobacco smoke, his team reports May 15 in *Nicotine & Tobacco Research*.

Such compounds are mainly a concern if they make it all the way into the lungs. Vapers can inhale huge numbers of very small aerosol particles into the lung's tiniest airways. The median diameter of vaping particles falls around 200 to 300 nanometers, based on unpublished data from Jonathan Thornburg and others at RTI International in Research Triangle Park, N.C. That size "is right in line with conventional tobacco smoke," he says.

The mass of nanoparticles in the vapors is about 3 milligrams per cubic meter of air, he found, or about 100 times as high as the Environmental Protection Agency's 24-hour exposure limit for fine air particles. RTI predicts that 40 percent of these inhaled particles would deposit in the lungs' smallest airways.

In addition to nicotine and solvents, vapors also contain chemical flavorings and food preservatives from the vaping liquid. Although they may be "generally recognized as safe" by FDA, Thornburg says, the designation is based on tests of the compounds when they are ingested. "No one has considered their safety when it comes to inhalation," he says.

E-cigarette vapors can even make dangerous germs harder to kill, Laura Crotty Alexander reported May 18 at an American Thoracic Society meeting in San Diego. When Crotty Alexander, of the VA San Diego Healthcare System, exposed methicillin-resistant *Staphylococcus aureus* (known as MRSA) to e-cigarette vapors, these antibiotic-resistant bacteria proved harder to kill.

"We started these studies so that we could advise ... patients on whether they should try switching to e-cigarettes," she says. "My data now indicate they might be the lesser of the two evils. But e-cigarettes are definitely not benign." ■

More than 250 different brands of electronic cigarettes are available on the market (a few examples shown), and many dozens of solutions are used to generate the devices' vapors.

LIBRAKV/ISTOCKPHOTO

GENES & CELLS

Drug candidate may stop MERS

Chemical disrupts assembly centers of coronaviruses

BY MEGHAN ROSEN

An experimental drug that shuts down construction of virus-making factories within human cells could become a new weapon against MERS and similar respiratory diseases. The chemical, called K22, halts growth of coronaviruses, including the strains that cause MERS and SARS, researchers report May 29 in *PLOS Pathogens*.

K22 is the latest in a slew of drug candidates to counter coronaviruses, for which no proven drug treatments exist. But K22 stands out from the crowd, says Stanley Perlman, a virologist and pediatric infectious disease physician at the University of Iowa in Iowa City.

K22 hits a part of the viral life cycle that no drug candidate has tackled before. "The ideal drug may be something like this," Perlman says.

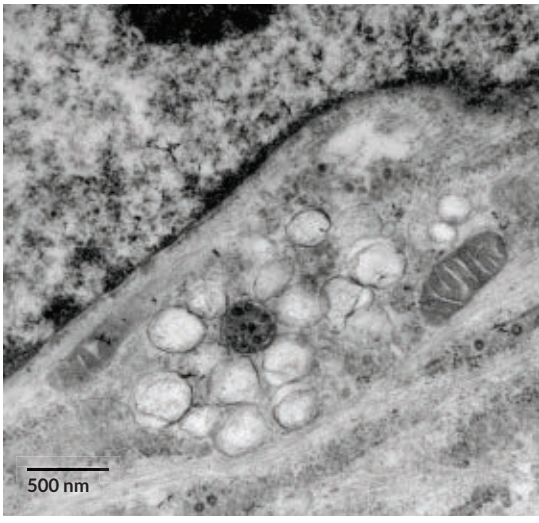
Still, moving the chemical from the lab to the clinic could take years of testing and development, says study coauthor Volker Thiel, a virologist at the University of Bern in Switzerland. "We have no idea how the drug will behave in the body."

And drug companies might not want to spend the money figuring it out, he says — unless there's a huge outbreak.

In 2012, scientists documented the first case of MERS, or Middle East Respiratory Syndrome, in Saudi Arabia. MERS has since infected more than 680 people and killed at least 200 (*SN: 5/31/14, p. 6*). Like SARS before it, which struck more than 8,000 people in a 2002–2003 outbreak, MERS is caused by infection with a coronavirus. Coronaviruses are RNA-based viruses that look like a crown, or corona, under an electron microscope.

These viruses are famous for sneaking into human cells, stealing bits of membrane and erecting tiny chambers for building new viruses. Within cells, the membrane-wrapped virus mills spring up quickly and cluster together like a viral tent city.

In the new study, Thiel, Edward Trybala of Sweden's University of Gothenburg and colleagues infected human cells growing in plastic dishes with a strain of coronavirus that triggers coldlike symptoms in people. The researchers then added each of 16,671 chemical compounds to different dishes and looked for cells that stayed healthy.



After infecting a human cell (shown), coronaviruses hijack membranes from the cell to form their own viral factories (cluster of pale circles in center of electron microscope image; dark circle in middle holds new virus particles). A new drug candidate blocks construction of these factories and halts viral growth.

One compound, the small molecule K22, cut viral infection in half compared with cells not exposed to the drug candidate. Thiel and colleagues think that K22 stops the virus from forming the saclike

BODY & BRAIN

Brain's support cells adjust hunger

Astrocytes have role in controlling appetite in mice

BY LAURA SANDERS

A "stop eating" hormone casts a wide net in the brain. After a large meal, fat cells churn out an appetite suppressant called leptin, which hits the brain's neurons and tickles other kinds of brain cells called astrocytes. In certain situations, these astrocytes help control hunger, scientists report June 1 in *Nature Neuroscience*.

The results feed into a growing set of studies that elevate the status of astrocytes from mere support cells to regulators of important behavior such as eating. "That historical notion that they are cushions for the neurons to feel comfortable or protected is not the case," says study coauthor Tamas Horvath of the Yale School of Medicine.

Scientists already knew that neurons in the hypothalamus, a brain region involved in feeding behavior, can sense and respond to leptin. Mice with neurons insensitive to the hormone overeat and become obese. Other studies have found evidence of leptin receptors, proteins that help a cell detect the hormone, on astrocytes. Horvath and colleagues wondered whether these leptin-sensing astrocytes influence feeding behavior.

The researchers engineered mice with astrocytes in the hypothalamus that lacked the ability to detect leptin. These mice didn't become obese. But when hungry, these mice ate more food than mice with leptin receptors on their astrocytes, Horvath and colleagues found. "To observe the animal in the normal environment, there was not a major difference," he says. "But when you start to push them to metabolic extremes, they have different responses." The astrocytes' role in regulating appetite seems more subtle than that of the neurons, the results suggest.

Astrocytes immune to leptin also looked different. Compared with normal astrocytes, these cells had fewer, shorter tendrils that communicate with other cells. The astrocytes themselves weren't the only cells affected in the altered mice: Neurons that regulate feeding behavior in the hypothalamus,

factories inside infected cells.

When the team looked at drug-treated cells under a microscope to find the tiny sacs, "we saw that they were all gone," Thiel says. "That was exciting for us."

No factories means no new viruses, which stops the infection from spreading to other cells.

Thiel and colleagues were about to publish their findings, he says, but then MERS came along. So the researchers tested whether K22 also blocked growth of the MERS coronavirus. "And it did," Thiel says. "Then we thought, 'If it's inhibiting two coronaviruses, we should test all we have in the freezer.'"

The drug worked against all six of the viruses tested, including the strain that causes SARS as well as viruses that infect cats, birds and mice.

Thiel thinks K22, or similar chemicals that attack the viruses' factories, could be a new type of weapon in the arsenal of potential drugs for fighting coronaviruses. Having different kinds of ammunition is important to prevent drug-resistant viruses from popping up. "It's good to combine drugs and target different steps in the virus's life cycle," he says. "It's the lesson we learned from HIV." ■

the same cells these astrocytes support, showed signs of listlessness.

Tweaking the behavior of these appetite-regulating astrocytes might be a way to treat obesity, Horvath suggests. But the brain's leptin machinery is a problematic target, says neuroscientist Jenni Harvey of the University of Dundee in Scotland. Because fat cells produce leptin, obese people generate higher amounts of the hormone in the blood. Faced with a constant barrage of leptin, the brain's ability to take in the hormone weakens, leading to leptin insensitivity. Adding more leptin wouldn't do any good, she says. "Targeting the leptin system is unlikely to result in a cure for obesity."

The newly described role for astrocytes is interesting, but "it's just scratching the surface," Harvey says. "There are a lot of questions that need to be answered." ■

ROB JOHNSON

EARTH & ENVIRONMENT

Violent storms may shatter sea ice

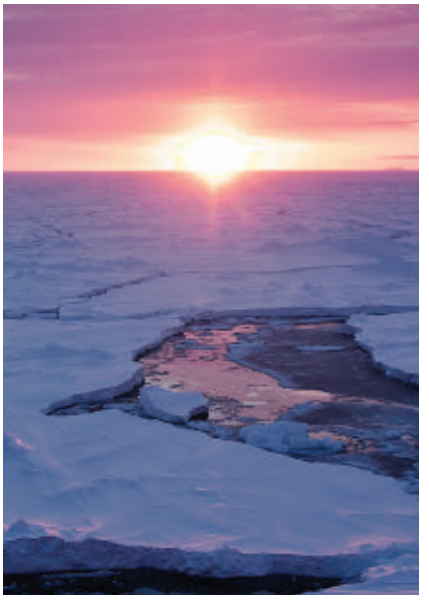
High waves' impact on frozen ocean hints at future trouble

BY BETH MOLE

Towering waves that rise from cyclones can pummel the frigid waters around Antarctica, potentially wrecking sea ice crucial for maintaining global climate. Because researchers predict climate change will bring more and stronger storms worldwide, the thrashing swells threaten to substantially reduce sea ice.

Around Antarctica, sea ice is forming in some places and disappearing in others, says Alison Kohout, a sea ice researcher at the National Institute of Water and Atmospheric Research in Christchurch, New Zealand. Because sea ice reflects the sun's rays and insulates the ocean below, the frozen rafts influence global temperatures, storms and ocean circulation. But, Kohout says, scientists don't know enough about sea ice to predict future changes.

With colleagues, Kohout collected data suggesting that waves from ocean storms may be particularly damaging to sea ice. By collecting observations of ice thickness from around Antarctica and wave-height measurements from five ice-bound sensors off the coast of the southernmost continent, the researchers estimated wave energy. The team then calculated that high waves fueled by distant cyclones could plow through sea ice, packing enough energy to break ice for hundreds of kilometers. The results appear in the May 29 *Nature*.



Strong waves around Antarctica, unleashed by distant ocean storms, may break up packs of sea ice that help maintain global climate.

The waves, Kohout says, "can travel further than previous theory expected." Scientists thought that waves diminish exponentially as they slam into floating ice. In other words, ice closer to the continent should experience a small fraction of the wave's original ramming power. But the new data suggest that storm-generated waves higher than 3 meters weaken linearly as they move across ice, preserving their smashing power for much greater distances.

"The fact that storms have an effect on ice breakup has been known for a long time," says Claire Parkinson, a climate scientist at NASA's Goddard Space Flight Center in Greenbelt, Md. But she says the finding that these larger waves can punch deep into ice fields is important. "Storms could have a bigger impact on the ice cover than had been thought," she says.

Many scientists expect global warming to boost cyclone activity, Parkinson adds, suggesting that high waves will also increase and potentially crush sections of ice.

Ice-breaking waves need more study, says Julienne Stroeve, a sea ice researcher at the National Snow and Ice Data Center in Boulder, Colo. The thickness of sea ice chunks and how closely they're packed together influence how much damage waves can cause, she says. But because the study focused on young, 1-year-old ice up to 1 meter thick, which is common on the edges of sea ice, the results are probably a good indicator of how big waves will affect sea ice in the future, she says. ■

EARTH & ENVIRONMENT

Nutrients may drop as CO_2 rises

Crops' iron, zinc and protein may fall 5 to 10 percent by 2050

BY BETH MOLE

In addition to mucking up the planet's climate, carbon pollution spewed into the atmosphere by burning fossil fuels may make food less nutritious.

Experimentally elevated levels of carbon dioxide in the air lowered many plants' levels of iron, zinc and protein — required nutrients for human health. Researchers found these changes in the edible bits of grains and legumes such as wheat, rice and soybeans.

Appearing in the June 5 *Nature*, the finding has alarming implications for global health, the authors say. Around 2 billion people already suffer from iron and zinc deficiencies, the authors report, and about the same number get 70 percent of their zinc and iron from these crops.

"That's a really big deal," says public health researcher Samuel Myers of Harvard. "If everyone was getting their dietary iron and zinc from fish, this wouldn't matter much."

Past studies of the effects of changes in atmospheric CO_2 levels on food have generated contradictory results, perhaps because they have been small-scale experiments or conducted in laboratories instead of outdoors.

To get a clear answer, Myers enlisted international collaborators already doing experiments on CO_2's impact on crops. Though each experiment looked at different variables such as yield and water usage, they all used a common method and similar ranges of CO_2 levels. Researchers grew crops outdoors in circles, usually about 3 meters in diameter, and surrounded the circles with vents blowing CO_2. Because the greenhouse gas is denser than air, it stayed near the crops, raising CO_2 within the circle.

Wheat and other crops growing in circles surrounded by vents spewing carbon dioxide (similar to the one shown) suggest that high amounts of the greenhouse gas could lower some foods' nutritional value.

BRUCE KIMBALL/USDA (CC BY 2.0)

Myers' team collected archived samples from 143 experiments that ran from 1998 to 2010 and tested six staple crops on three continents. The experimentally elevated CO_2 levels ranged from 546 to 586 parts per million, levels that scientists expect to see in the atmosphere by 2050. Atmospheric CO_2 now hovers around 400 parts per million.

Myers and colleagues found that wheat, rice, peas and soybeans generally contained around 5 to 10 percent less iron and zinc when grown at the higher levels. The researchers also found that wheat and rice had around 5 to 10 percent less protein. The other two crops analyzed, maize and sorghum, showed little or no response to higher CO_2.

Low levels of dietary iron and zinc can lead to anemia, a weakened immune system, low IQ and reduced energy levels. How low protein in the crops might affect human health is unclear, Myers says.

Also unknown, Myers says, is why the plants have less of the nutrients. He and his colleagues are working to reveal the mechanism.

The impact of CO_2 on food quality is a neglected problem, says agricultural researcher Hans J. Weigel of the Johann Heinrich von Thünen-Institut in Brunswick, Germany. But Weigel cautions that it may be too early to predict whether CO_2 will alter food in ways that affect human health. "Current experimentation causes an abrupt increase of atmospheric CO_2 concentration," he explains. "This does not mimic the consequences of a gradual increase in CO_2," he adds, suggesting that plants may adapt to new conditions over time. ■

ATOM & COSMOS

Sun's sibling spotted

Method to find relatives may point to Milky Way birthplace

BY CHRISTOPHER CROCKETT

One of the sun's long lost siblings could be just 110 light-years away.

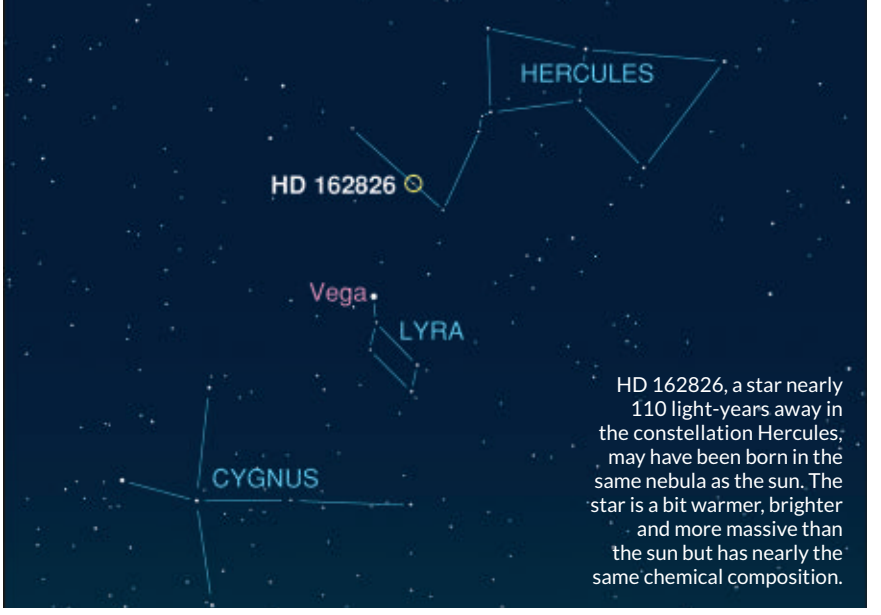
Astronomers have identified a star that might have formed in the same nebula as the sun and at the same time. The star, HD 162826, is a bit warmer, brighter and more massive than the sun. Its discovery is part of an experiment to learn how to identify solar siblings efficiently.

One solar sibling doesn't reveal much. So having a good method to find many siblings should help scientists understand why the solar system is the way it is and figure out where it originated, says experiment leader Iván Ramírez, an astronomer at the University of Texas at Austin. Over the 4.57-billion-year lifetime of the sun, the motions of the stars and relentless tug of the galaxy's gravity tore apart the sun's family.

A solar sibling should have the same chemical composition as the sun, Ramírez and colleagues reasoned, since it was born in the same gas cloud. Using spectra of 30 candidates, the researchers found that HD 162826 was one of a handful whose compositions matched the sun. Ramírez's team narrowed the field to candidates that have followed the sun's motion around the galaxy. Looking back in time, Ramírez says, "most stars separate really quickly and keep going away from the sun." This star, however, seems on a more parallel track.

The star appears to be the right age as well. Based on calculations that use a star's color and brightness to estimate its age, the scientists concluded that HD 162826 is nearly 4.6 billion years old. The findings appear May 8 on arXiv.org in a paper to be published in the *Astrophysical Journal*.

"The fact that these guys found one is not crazy," says Fred Adams, an astrophysicist at the University of Michigan



HD 162826, a star nearly 110 light-years away in the constellation Hercules, may have been born in the same nebula as the sun. The star is a bit warmer, brighter and more massive than the sun but has nearly the same chemical composition.

in Ann Arbor. While nudges from other stars and clouds over billions of years have smeared the birth cluster in a ring around the galaxy, he says, theorists predict that researchers should find a few sunlike siblings in the neighborhood. "It's not a guarantee," he adds, "but it's an interesting possibility."

Astronomers think that the sun formed in a cluster of several thousand stars, which is roughly the number needed to explain the solar system's existence. "The fact that we're here," Ramírez says, limits the size of the cluster. Too big, and radiation from too many massive stars would have destroyed the infant solar system. Too small, and there wouldn't have been enough mass to produce the supernova that provided the planets with heavy elements (*SN Online: 11/11/11*). The nearest analog to the sun's birth cluster, Adams says, is the Orion Nebula Cluster, about 1,600 light-years from Earth.

Finding solar siblings may reveal how solar systems form. In the last two decades, astronomers have discovered over 1,000 stars with planets of varying orbits, sizes and masses. Since birth clusters sculpt solar systems, Adams says, studying such clusters "lets us understand the grander question of how do you produce all the diversity in the solar systems that we see?"

Answering that question will require finding more of the sun's family — and that will take work. The European Space Agency mission Gaia, which is measuring positions and motions of a billion stars, will create a database from which to find candidates. And another project, the Gaia-ESO survey, will get the detailed spectra needed for accurate chemical tagging of over 100,000 of those stars using the Very Large Telescope in Chile. HD 162826 is just the start. "We're creating a road map to find them in the future," Ramírez says. "The fact that we found one was a bonus." ■

I. RAMÍREZ, TIM JONES/MCDONALD OBSERVATORY

HUMANS & SOCIETY

Recessions take a lasting toll on narcissism

Hard economic times deflate young adults' self-regard for many decades

BY BRUCE BOWER

Bad economies levy a tax on narcissism, at least among young adults.

People who came of age during economic recessions report and display fewer signs of extreme self-absorption than those who entered adulthood during relatively prosperous periods, says management professor Emily Bianchi of Emory University in Atlanta.

A strong economy during the late 1980s and 1990s may partly explain reports of rising narcissism rates among U.S. college students of that era, Bianchi proposes May 8 in *Psychological Science*. If so, humility should have begun to reassert itself among young adults who have grappled with the economic recession that began in 2008, she predicts.

Narcissists view themselves as superior in all situations, feel entitled to special treatment and expect to always succeed and be admired and praised (*SN: 8/13/11, p. 16*).

Earlier research suggested that grandiose self-regard gets nurtured in children whose parents overindulge them and shower them with unearned praise. Some scholars suspect that an emphasis on self-esteem in schools and the growth of self-promotion via social media have both cultivated narcissistic youngsters. "My results suggest that national economic conditions affect narcissism at a later, critical life stage," Bianchi says.

"It may be slightly unsettling to imagine that there is a link between, say, the Fed's monetary policy today and Americans' self-absorption a generation or two later," says psychologist Daniel Ames of Columbia University. "But this new work indicates such a link is plausible."

Bianchi evaluated self-reports of narcissistic attitudes and behaviors in two groups of U.S. adults. One sample consisted of 1,572 volunteers born between 1947 and 1994 who completed an online survey. Participants born in the late 1940s and the late 1970s encountered the best economic conditions as 18- to 25-year-olds, as indicated by low average national unemployment rates; those born in the early 1960s and the late 1980s experienced the worst economic conditions.

A second, nationally representative sample included 31,060 individuals, ages 18 to 72, who were interviewed in 2001 and 2002, and again three years later, as part of a larger survey.

Bianchi statistically controlled for a tendency of narcissism scores to decline with age and to be greater in men than in women.

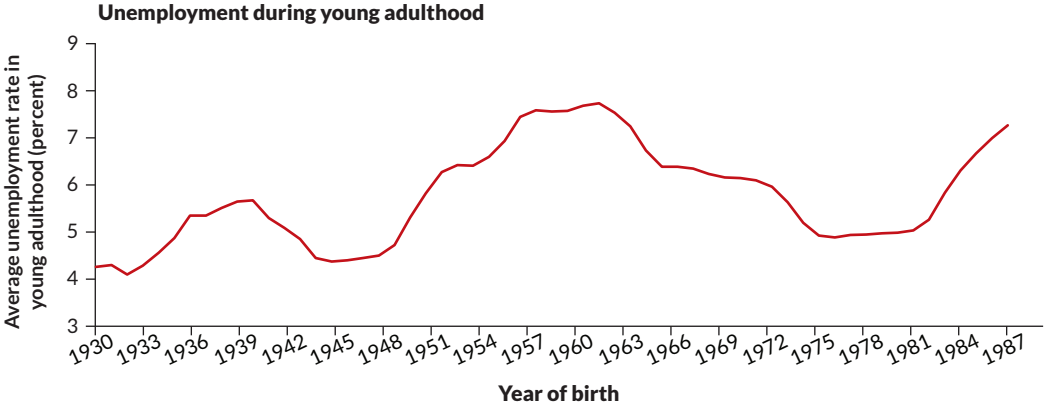
People who came of age in tough economic times felt less special and less entitled than those who had enjoyed the most prosperity on the cusp of adulthood. In the smaller sample, volunteers who entered adulthood in the worst economic climate scored an average of 2.35 points lower on a 40-point narcissism scale than those whose transition to adulthood coincided with the best economic conditions. That difference translated into a lesser likelihood of being excessively confident and self-satisfied, Bianchi says. Further analysis of the smaller sample found no narcissism disparity among participants who were 26 to 33 years old during recessions or upturns.

After consulting income data from 2,095 CEOs of U.S. companies in 2007, Bianchi also found that those who came of age in up economies paid themselves 2.26 times as much in total compensation as their second-in-commands. CEOs who had faced down economies as young adults paid themselves only 1.69 times as much in total compensation as the next-highest-paid employees.

The effects of good or bad economies on young adults' narcissism did not lessen as members of the three samples got older.

Adolescence and young adulthood may be "sensitive developmental periods" for revamping personal values in response to cultural and economic shifts, says Patricia Greenfield, a UCLA psychologist. During the recession of 2008 to 2010, Greenfield and colleagues found, U.S. high school seniors and college freshmen expressed more concern for others and for environmental issues, and were less assured about their school abilities, than were students living in the better economic times of 2004 to 2006. ■

Self adjustments
Adults ages 18 to 25 who faced peaks of unemployment were less narcissistic later in life than those who encountered the best employment prospects, a study finds. The graph shows changes in average national unemployment rates (from a low of 4.28 percent to a high of 7.73 percent) during young adulthood for study volunteers, by year of birth.
SOURCE: E. BIANCHI/ *PSYCHOLOGICAL SCIENCE* 2014



MATTER & ENERGY

Proton's magnetism pinned down

Further analysis may reveal why universe lacks antimatter

BY ANDREW GRANT

A lone proton's magnetism is pretty weak, yet it's reeling in researchers trying to solve one of the biggest mysteries in physics.

A new measurement quantifies the feeble intrinsic magnetism of the proton and sets the stage for a similar test of the proton's antimatter counterpart. By comparing this magnetic property of protons with that of antiprotons, researchers hope to gain insight into why the universe is dominated by matter rather than antimatter.

Scientists have a pretty good handle on the proton, but in recent years they have used increasingly sophisticated equipment to probe the particle's basic properties with unprecedented precision. One such property is the magnetic moment, which describes how a particle responds to a magnetic field. "Each fundamental particle behaves like a very tiny bar magnet or compass needle," explains Stefan Ulmer, a particle physicist at RIKEN in Wako, Japan.

Ulmer and his team used a device called a Penning trap to improve on previous magnetic moment measurements for the proton. The trap consists of a small tube emptied of all matter save for a single charged particle — in this case, a proton. Strong electric and magnetic fields lock the proton in place, allowing the researchers to observe the particle responding to subtle changes in the magnetic fields' strength. The new magnetic moment figure, published in the May 29 *Nature*, has three times the precision of the previous best measurement, which dates back to 1972.

The proton measurement is impressive, says physicist Neil Russell of Northern Michigan University in Marquette. He says the work's most significant contribution is the Penning trap setup: It should also be able to measure the magnetic moment of the antiproton. The 1972 measurement required a low-energy laser fueled by a gas of hydrogen atoms (whose nuclei consist of a single proton each). That laser technique won't work for antiprotons because antihydrogen is difficult to produce and harness. Using electric and magnetic fields, however, researchers should be able to isolate and measure the properties of a single antiproton in a Penning trap. And that's exactly what Ulmer and a team of physicists plan to do within three months using antiproton-producing equipment at CERN, the European particle physics laboratory outside Geneva.

Ulmer says the CERN measurement should improve on the precision of the current antiproton magnetic moment measurement by a factor of a thousand. According to the leading theory of particle physics, the antiproton should have the same properties as the proton except for an opposite charge and magnetic moment. The detection of even a minute discrepancy between protons' and antiprotons' magnetic moments would represent a subtle difference between matter and antimatter, and perhaps help physicists figure out why the universe is rich in matter but nearly devoid of antimatter. "Finding a difference would be pretty stunning," Russell says. ■

LIFE & EVOLUTION

Flightless birds' history upset by ancient DNA

KYLE DAVIS AND PAUL SCOFIELD/CANTERBURY MUSEUM

Madagascar's elephant birds — which weighed as much as four people and went extinct several hundred years ago — turn out to be the closest known relatives of New Zealand's chicken-sized kiwi birds (a skeleton shown).

This surprise is "a slap in the face" to a long-standing idea of how flightless birds evolved, says Alan Cooper of Australia's University of Adelaide. Biologists in the 1970s debated whether the kiwi and other flightless ratite birds arose when flightless common ancestors drifted apart by riding on landmasses that fragmented and separated.

In 1992 Cooper raised doubts about that idea when he extracted ancient DNA from specimens of New Zealand's hefty flightless moa, now extinct. As fellow travelers, the moa and kiwi should have been close relatives. But they aren't. The kiwi is more closely related to Australia's cassowary and emu.

Now he and colleagues have extracted DNA from elephant birds (an egg shown) and found that they are the kiwi's closest kin. These two birds' homes weren't near each other as continents fragmented, so drifting doesn't explain the close relationship. Their distant ancestors must have done some flying, the team concludes in the May 23 *Science*. — *Susan Milius*

HUMANS & SOCIETY

Earliest pants worn by horse riders

Oldest known trousers originated in Asia 3,000 years ago

BY BRUCE BOWER

Two men whose remains were excavated from tombs in China put their pants on one leg at a time, just like the rest of us. But these nomadic herders did so between 3,300 and 3,000 years ago, making their trousers the oldest known examples of this innovative apparel.

With straight-fitting legs and a wide crotch, the wool trousers resemble modern riding pants, says a team led by Ulrike Beck and Mayke Wagner of the German Archaeological Institute in Berlin. The discoveries, uncovered in the Yanghai graveyard in western China's Tarim Basin, support previous work suggesting that nomadic herders invented pants to provide bodily protection and freedom of movement for horseback journeys and mounted warfare, the scientists report May 22 in *Quaternary International*.

"This new paper definitely supports the idea that trousers were invented for horse riding by mobile pastoralists, and that trousers were brought to the Tarim Basin by horse-riding peoples," remarks linguist and China authority Victor Mair of the University of Pennsylvania.

Earlier Asians and Europeans wore gowns, robes, tunics, togas or — as observed on the 5,300-year-old body of Ötzi the Iceman — a three-piece combination of loincloth and individual leggings.

A hot, dry climate helped preserve human corpses, clothing and other organic material at the Yanghai graveyard, where more than 500 tombs have been excavated since the early 1970s.

Earlier research from the region had identified a 2,600-year-old individual who wore burgundy trousers probably made of wool.

Mair suspects that horse riding began about 3,400 years ago and trouser-making came shortly thereafter in wetter regions to the north and west of the Tarim Basin. Ancient trousers from those areas are not likely to have been preserved, he says.

Horse riding's origins are uncertain and could date to at least 4,000 years ago, comments archaeologist Margarita Gleba of University College London. If so, she says, "I would not be surprised if trousers appeared at least that far back."

The two pants-wearing men entombed at Yanghai were roughly 40 years old and were probably warriors as well as herders, the investigators say. One man was buried with a decorated leather bridle, a wooden horse bit, a battle-ax and a leather bracer for arm protection. Among objects placed with the other body were a whip, a decorated horse tail, a bow sheath and a bow.

The oldest known trousers, including this roughly 3,000-year-old pair with woven leg decorations, belonged to nomadic horsemen in Central Asia.

Beck and Wagner's group obtained radiocarbon ages of fibers from both men's trousers and of three other items in one of the tombs. ■

M. WAGNER/GERMAN ARCHAEOLOGICAL INSTITUTE

MATTER & ENERGY

Plan for hack-free data encryption

Quantum technique would eliminate snoop checks

BY ANDREW GRANT

A proposed quantum encryption technique would ensure secure communication while removing the painstaking step of checking for potential eavesdroppers. The efficient approach could form the basis of a secure quantum network for exchanging sensitive information.

Computer-generated encryption protects data such as credit card numbers and passwords from would-be snoopers. However, this encryption is breakable, and a hacker can steal information for a long time before anyone finds out.

In 1984, Charles Bennett and Gilles Brassard proposed the first quantum cryptography protocol. The approach calls for a receiver to measure the delicate quantum properties of photons in laser pulses and compare notes with the sender to establish a secret key (*SN: 11/20/10, p. 20*). An eavesdropper can also measure the photons but would leave a trail.

Masato Koashi, a quantum physicist at the University of Tokyo, was irked by the price of detecting a snoop: The sender and receiver have to divulge part of their encryption key to each other. "You cannot be certain about the quality of the final product, so you need a quality assurance measurement," Koashi says. Depending on the amount of data transferred and the integrity of the connection, establishing the key while ensuring nobody is snooping can become difficult or impossible.

Koashi and his colleagues developed a quantum encryption approach that seems to make the potential presence of snoops moot. The scheme, detailed in the May 22 *Nature*, is similar to the 1984 version except that the receiver introduces another layer of protection by measuring two sets of laser pulses and arbitrarily choosing a time delay between measuring them.

The randomness of the photons' quantum properties and the time delay makes it nearly impossible for a hacker to determine the secret key. As a result, the communicating parties have no need to test for eavesdroppers.

Horace Yuen, a quantum physicist at Northwestern University, calls the proposal "a good start." But he warns that physicists have come up with some clever methods for quantum eavesdropping, so he wants proof that the new scheme could ward off all such snooping. ■

LIFE & EVOLUTION

Drab now, female birds had more colorful evolution

Male changes did not drive differences in avian plumage

BY SUSAN MILIUS

Color evolution among grackles and their kin is not about males showing off their fine feathers. It's more about females switching their looks, a new analysis indicates.

Among 37 species of grackles, blackbirds and other icterid relatives, males clearly do flash more diverse feather colors than females do, says Jordan Price of St. Mary's College of Maryland. Bright epaulets on glossy black plumage or shimmering iridescence often gives distinctive looks to males. Females, however, look either generically drab or similar to males.

Male red-winged blackbirds (top left) and male boat-tailed grackles (bottom left) may be flashy, but it's the females (right column) that have made the difference in evolving plumage diversity.

Scientists have long debated whether today's sex differences in bird color arose from evolutionary pressures on drab ancestors for males to look sexy. For the grackle group and probably other species, it's "just not the case," Price says.

He and Muir Eaton of Drake University in Des Moines, Iowa, worked backward along a genealogical tree of grackle relatives to reconstruct the history of male and female color differences.

During that history, male plumage did diversify, the researchers report May 6 in *Evolution*. But female plumage did a lot more changing. Females often went from dramatic to drab and then sometimes went colorful again. The forces of sexual selection on males were not the main story.

"We pay all this attention to males because they're flashy, they're eye-catching," Price says. "But most of the evolutionary action is with females."

Female color change may matter a lot in other kinds of birds, too. The common ancestors of today's New World orioles probably sported colorful his-and-hers plumage. But then some females went dull, a 2008 reconstruction of feather history concluded. And females among fairy wrens also appear to have done a lot of color changing, Price reported last year with other collaborators.

What's different about the new grackle study, Price says, is that Eaton made elaborate bird's-eye–view measurements of feather colors so that researchers could quantify changes. For each species, Eaton took readings of plumage color from 22 small spots on the body and calibrated readings for songbird vision. With four kinds of color detectors instead of humankind's three, many birds see a wider span of the color spectrum (stretching into the ultraviolet) than people can detect, as well as finer distinctions between colors.

The team used these measurements to look at the degree of male-female color differences for today's species and then analyzed a genealogical tree of living birds to work backward to determine the probable pattern of ancestral color changes that produced today's diversity.

In this reconstructed history, females' color changes more overall than males'. The story starts with ancestors sporting fairly similar colorful feathers. When females downplay their plumage for a camouflage look, the change seems to progress at about the same pace as the males' changes. But when females revert to more flashy, guy-type plumage, "they snap back to it really fast," Price says. It's mostly these drastic reversions that make females outrank males as the faster color-changing sex.

The accumulating evidence for the importance of females in plumage evolution is "an exciting drumbeat," says Kevin Omland of the University of Maryland, Baltimore County, who worked on the oriole study. "For too long researchers have ignored female coloration and female song," he says.

Those songs may reveal similar sex-related twists in evolutionary history. Among temperate songbirds, males sing but females typically don't. Yet in March, a reconstruction of vocal differences between the sexes concluded that in the songbirds' common ancestral species, both males and females probably sang. Over time, the females stopped. ■

EARTH & ENVIRONMENT

Carbon dioxide levels hit landmark in Northern Hemisphere

April was the first month in recorded history with average carbon dioxide levels at or above 400 parts per million across the Northern Hemisphere, according to a May 26 announcement by the World Meteorological Organization. Climate scientists first recorded levels that high for the greenhouse gas in the Arctic in 2012 and in Hawaii last year (*SN: 12/28/13, p. 26*), but the rest of the globe had yet to consistently hit the high mark. Researchers expect the entire Earth will experience annual CO_2 levels averaging 400 ppm or higher in 2015 or 2016. The 400 ppm milestone is largely symbolic, representing nearly 150 percent of the CO_2 levels of preindustrial times. — *Beth Mole*

MATTER & ENERGY

Coffee beans sing distinct tune

The snap-crackle-pop of coffee beans could tell automatic roasters when to turn down the heat. Hot beans sing a distinct ditty that reveals their stage in the roasting process, Preston Wilson of the University of Texas at Austin reported in the June *Journal of the Acoustical Society of America*. Java roasters know to listen for some sounds, called "first crack" and "second crack," but until now no one had analyzed the noises, Wilson says. He roasted a small batch of green coffee beans in an electrically heated drum roaster and recorded the crackling sounds. The first crack noises, which sound like popping corn, ring out between 400 and 600 seconds after roasting begins. Those crackles are louder, deeper and less frequent than the second chorus of cracks at 620 to 730 seconds, which snap rapidly like Rice Krispies in milk. Measuring the beans' sounds is a step toward making an automatic acoustic roaster, Wilson suggests. — *Meghan Rosen*

GENES & CELLS

Transplant approach for Parkinson's disease gets boost

Transplanted cells can flourish for over a decade in the brain of a person with Parkinson's disease, scientists write June 5 in *Cell Reports*. Finding that these cells have staying power may encourage clinicians to pursue neuron transplants, a still-experimental way to counter the brain deterioration that comes with Parkinson's. Penelope Hallett of Harvard University and McLean Hospital in Belmont, Mass., and colleagues studied postmortem brain tissue from five people with advanced Parkinson's. The five had received neuron transplants between four and 14 years earlier. In all five people's samples, transplanted neurons showed signs of good health and appeared capable of sending messages with the brain chemical dopamine, a neurotransmitter that Parkinson's depletes. Results are mixed about whether these transplanted cells are a good way to ease Parkinson's symptoms. Some patients have shown improvements after the new cells stitched themselves into the brain, while others didn't benefit from them. The cells can also cause unwanted side effects such as involuntary movements. — *Laura Sanders*

A genetic quirk makes hair blond

Some Europeans have enhancers that make them blond. The enhancer isn't a hair dye but a genetic variation that controls pigment production in hair follicles, David Kingsley of Stanford University and colleagues report June 1 in *Nature Genetics*. Studies had indicated that a genetic variant known as a single nucleotide polymorphism, or SNP, is associated with blond hair in Europeans. Why the variant affects hair color wasn't clear because it is not part of a gene. Now the team shows that the blond-inducing variant lies within a piece of DNA called an enhancer. Enhancers are stretches of DNA typically located far from genes that help control gene activity. Kingsley's team genetically engineered mice to carry the variant and found that they developed lighter colored coats than did mice with the nonblond version of the enhancer. The blond version of the enhancer turns down the activity of a gene involved in pigment production in hair follicles, leading to a lighter color. — *Tina Hesman Saey*

BODY & BRAIN

Parasite protein offers new hope for malaria vaccine

Tanzanian toddlers may have handed scientists the key to kicking malaria. By examining blood plasma of 2-year-olds exposed to the disease, researchers discovered a new vaccine target: a malaria protein recognized by the immune systems of malaria-resistant children. Malaria develops when mosquito-borne parasites invade and then burst out of red blood cells to enter the bloodstream. Jonathan Kurtis of Brown University and colleagues examined blood and disease histories collected from 453 Tanzanian youngsters. Malaria-resistant kids make antibodies that can spot a parasite protein and trap marauding parasites within red blood cells. Imprisoned, the parasites can no longer rampage through the body. When the team injected the protein into mice, the animals' immune systems revved up and churned out the antibodies. After infection with a lethal parasite strain, mice making the antibodies survived about twice as long as those not vaccinated, the team reports in the May 23 *Science*. — *Meghan Rosen*

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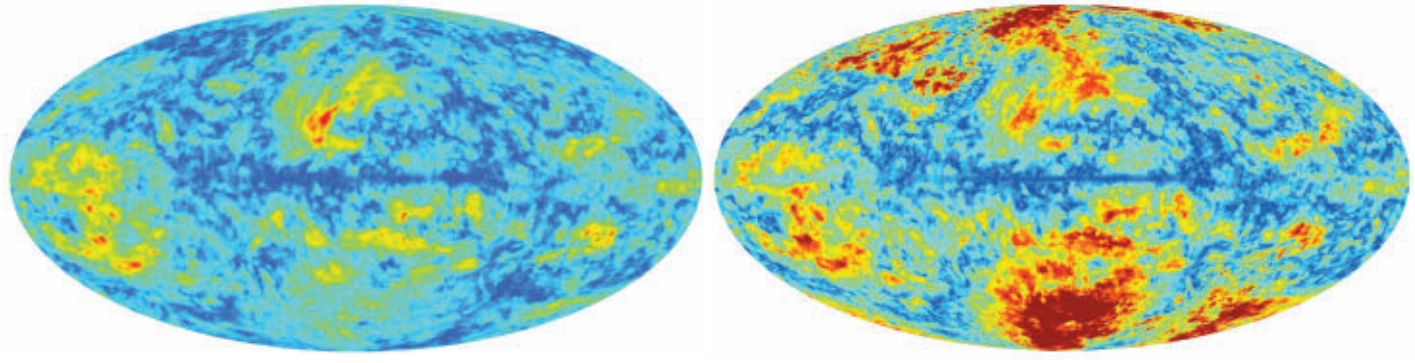
Dazzle or Dust?



The unpredictable glow of galactic dust could undermine the biggest cosmological discovery in years

By Christopher Crockett

On March 17, Lloyd Knox, a cosmologist at the University of California, Davis, joined scientists around the world in celebrating a Nobel Prize–worthy discovery. That day researchers from the Background Imaging of Cosmic Extragalactic Polarization project announced that their telescope at the South Pole, BICEP2, had detected a subtle twirling pattern imprinted on light that had traveled across the universe for 13.8 billion years.

The measurement was impeccable, the implications profound. The imprint, the BICEP researchers said, could be made only by gravitational waves, ripples in space triggered when the universe explosively kick-started its expansion a split second after the Big Bang. If the results held up, they would serve as the first direct evidence of that rapid expansion, known as inflation, which was predicted in 1981 to explain the uniform structure of the cosmos (*SN: 4/5/14, p. 6*). "I was euphoric initially," Knox says. "This was a really exciting development."

Once the preliminary rush of excitement waned, cosmologists turned their focus to the details of the analysis — and that's when serious doubts began to emerge. While BICEP researchers insist their signal was imprinted on the universe's oldest light, Knox and other researchers fear that the light came from a more mundane source: interstellar dust in our own galaxy. A growing number of cosmologists now say the potential contribution of dust is so significant that the BICEP team does not have the evidence to claim a discovery.

Dusty data The BICEP team used one map (top left) to estimate the effect of galactic dust on the polarization of light across the sky (red denotes stronger polarization, blue weaker). Raphael Flauger reconstructed a similar map (right) from other sources showing that dust could account for much more of the signal detected by the BICEP team.

"The measurement is exquisite. It's really an amazing technical achievement," Knox says. But "their case that it's not something in our own galaxy is not very strong."

Galactic dust can be a nuisance when trying to study the far reaches of the universe. When stars like the sun reach old age, they belch microscopic rod-shaped dust grains that eventually clump into clouds throughout the galaxy. Those dust particles not only obscure light from more distant objects, but also emit light of their own. Starlight heats the clouds to about 20 degrees Celsius above absolute zero, warm enough for dust to radiate low-energy light in the form of microwaves. That's the same type of light that makes up the cosmic microwave background, or CMB, the ancient light that BICEP2 was designed to measure.

Further complicating things, dust also polarizes light: Dust's elongated shape forces the light waves it emits to align in the same direction. That polarization can take on a twirling pattern identical to the one BICEP researchers sought in the CMB to support the theory of inflation.

BICEP researchers knew their telescope could not tell the difference between sources of light. Confidence in their claim came from the painstaking work they had done to minimize the influence of dust. They pointed BICEP2 toward a part of the sky known to have very little dust. And they probed for light at a frequency, 150 gigahertz, at which the CMB should stand out above the Milky Way's dusty glare (see graph, next page). The CMB puts out most of its energy at about 160 gigahertz; dust radiates predominantly at around 3,000 gigahertz.

Unfortunately for the BICEP team, scientists have only rough estimates of how strongly dust-emitted light is polarized. So when the time came to scrutinize the telescope observa-

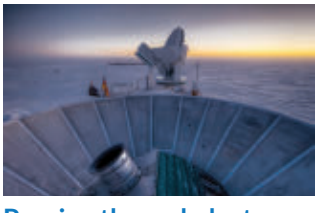
J.-P. BERNARD/PLANCK COLLABORATION; R. FLAUGER

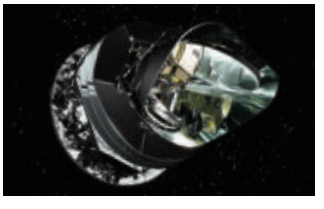
tions and separate CMB from dust, BICEP researchers had to make some assumptions and rely on whatever scant dust data they could get their hands on.

Such data included slides from a 2013 talk given by a researcher affiliated with the space-based Planck telescope, which recorded polarization measurements at seven frequencies of light as part of its mission to map and characterize the CMB across the entire sky. The complete results have yet to be released, but one of the presentation slides showed a preliminary Planck polarization map. BICEP researchers took a PDF of the slide — an elliptical Rorschach inkblot of reds, yellows and blues — converted the image into a grid of numbers based on color, and used the numbers as one way of estimating the dust contamination in their own data.

This slide-scraping maneuver triggered the first serious challenge to the BICEP discovery. In a May 15 presentation, Raphael Flauger, a physicist at the Institute for Advanced Study in Princeton, N.J., suggested that the BICEP data teased out from the slide underestimate how strongly galactic dust polarizes light. After conducting an analysis that included scraping data from other Planck slides, Flauger concluded that without more data there is no way to tell whether the inflation signal would remain after removing the effects of dust. "At the lower end of my estimation, it looks like everything may be OK," he says. "At the upper end, the dust could make up the whole signal."

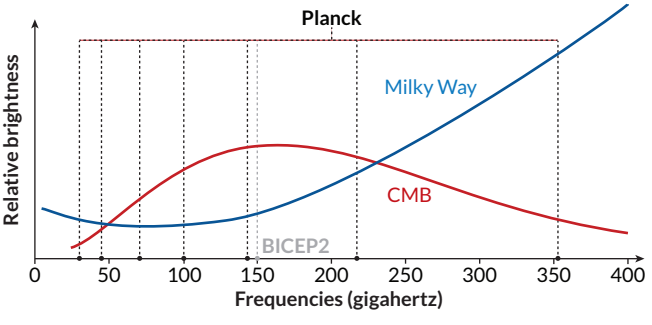
Another independent analysis, this one sans slides, supports Flauger's conclusion. Michael Mortonson and Uroš Seljak, cosmologists at the University of California, Berkeley, combined BICEP2 data with previously released Planck temperature maps that indirectly indicate the amounts of dust-polarized light. Mortonson and Seljak assert, in a paper posted May 22 at arXiv.org, that there is no clear evidence for gravitational waves in the data. "We're not saying that there's definitely no signal from inflation," Mortonson says. "But given the uncertainties, we can't really say either way if it's all dust or all inflation or some combination of the two."





CLOCKWISE FROM TOP LEFT: STEFFEN RICHTER/HARVARD UNIVERSITY; ESA, AOES MEDIALAB; E. OTWELL

Peering through dust BICEP2 (left) measured the polarization of light at 150 gigahertz, a frequency at which ancient light (red, below) of the cosmic microwave background is estimated to outshine light emitted by dust and other galactic sources (blue). Data from Planck (right) could settle the debate with measurements at seven frequencies, shown.



A newly released Planck map of polarization across most of the sky (*SN: 6/14/14, p. 14*) provides more ammunition for BICEP critics. Though the map doesn't include the small area of the sky observed by BICEP2 (that region is still under analysis), Flauger argues that the new map shows stronger polarization, in general, across the sky than BICEP researchers used in their calculations. The map also reveals that regions of the galaxy with low concentrations of dust can emit highly polarized light, Mortonson says. Since BICEP2 observed a low-dust part of the sky, the polarization due to dust may be higher than assumed.

Despite these recent challenges, BICEP researchers aren't backing off. Jamie Bock, a Caltech astrophysicist on the team, points out that BICEP's analysis does not depend solely on the digitized Planck maps. The researchers used six theoretical models of how the dust affects polarization, he says, mostly drawn from older data.

The team also has data from BICEP2's predecessor, BICEP1, which observed the same patch of sky at two frequencies. The BICEP1 data support the assertion that dust contamination in this part of the sky is very low, Bock says. "We stand by our data." The team's paper is under review for publication, and Bock says that its central claim stands.

The real test should come later this year when scientists with the Planck telescope publicly release all of their polarization data, says Bock, who helped design the detectors for both Planck and BICEP2. By piecing together data from all seven frequencies, astronomers should be able to deduce how strongly the BICEP2 observations were influenced by dust.

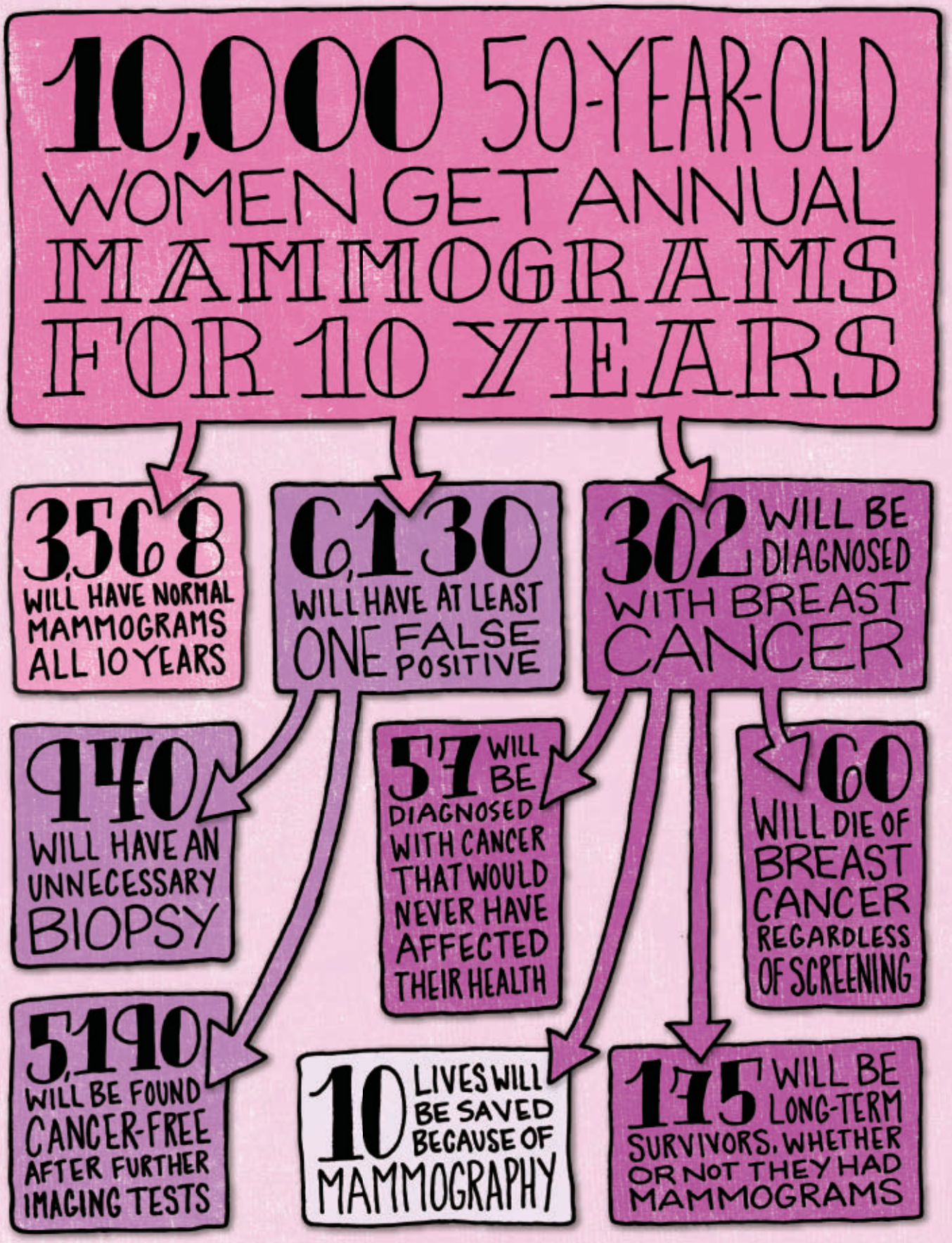
However, some scientists worry that Planck won't be capable of confirming or rejecting the BICEP findings. "Planck was not designed from the start to go after polarization," Knox says. Planck's primary mission was to measure the brightness of the CMB; engineers substantially modified the original design to add the polarization capability.

If Planck can't resolve the debate, other telescopes might help. The Keck Array, a second South Pole telescope run by the BICEP team, is soaking up microwave light at yet another frequency. Keck's sensitivity should surpass BICEP1's, Bock says, and fill in the gaps. Plus, at least half a dozen experiments at other sites are trying to replicate BICEP2's discovery.

For now, the community has to wait for data that can settle the issue. Knox says it's difficult to be patient after all the excitement of the March announcement, but nobody wants to put blind faith in a discovery that could end up as dust in the wind. "It's a claim of such extraordinary significance," he says, "that it's emotionally difficult now to be uncertain." ■

Explore more

- Raphael Flauger, J. Colin Hill and David N. Spergel. "Toward an understanding of foreground emission in the BICEP2 region." arXiv.org. May 28, 2014.



CAROLYN SEWELL

TO SCREEN OR NOT TO SCREEN

After 40 years, mammography's limits becoming clear

By Laura Beil

Philip Strax was just 38 years old when his wife Bertha died from breast cancer. He was, a friend said later, powerfully in love with her, and her death was a blow from which he never fully recovered. He resolved to spend the rest of his life improving the early detection of breast cancer, to keep other women from dying as she had.

That was in 1947, when X-rays, then the primary means of peering into the body's interior, were suitable only for viewing bones. Scans of soft tissues like the breast produced smeary images of little value. Sixteen years passed before technology had matured enough to justify a test run for cancer detection. In 1963, Strax jumped in with a clinical trial at the Health Insurance Plan of Greater New York, recruiting more than 60,000 volunteers. The women were randomly sorted to receive a mammogram or be part of a comparison group of simple observation. Even before the results were known, Strax was convinced of the technology's effectiveness. He opened two clinics in Manhattan, offering scans for breast cancer.

> "We have oversold the benefits of mammography for a long time."
>
> NANCY KEATING

Results of that study, which appeared in the *Journal of the American Medical Association* in 1971, found that screening picked up tumors at an earlier stage than those found without screening, and lowered mortality by 40 percent. (Later analysis revised the number down to 30 percent.) Still, women showed little interest in having their breasts X-rayed until 1974, when First Lady Betty Ford announced she had just undergone a mastectomy. Thousands of women lined up for screening over the next days and weeks. The era of mammography had begun.

No one then could have predicted that an emotionally infused discourse over mammography would persist for 40 years, with seven more large trials, none of which could claim to provide the definitive answer. By the early 2000s, doctors had grown weary of the controversy. A 2002 headline in *Lancet* declared, "Time to move on."

Any hope of doing so faded in 2009, when tempers ignited once again. That year, the U.S. Preventive Services Task Force reversed itself by concluding that women in their 40s need not have mammograms at all. The group even went so far as to say that older women do not necessarily need them annually. Doubts deepened further this year, when a study of almost 90,000 women — one of the largest clinical trials ever conducted — found that mammograms not only offer no benefit to younger women, but pose a risk by increasing detection and treatment of otherwise harmless tumors. In an editorial this spring in the *New England Journal of Medicine*, Swiss authorities called for ending mammography screening altogether.

Scientists still hope everyone can move on. But instead of calling for yet another clinical trial and still more data, some want a shift away from blanket recommendations based on age and toward a view of mammography as an individual choice. If a woman wants a mammogram, she should be able to have it. And if she doesn't, she shouldn't be viewed as someone flirting with death.

"We have oversold the benefits of mammography for a long time," says Nancy Keating, a physician at Brigham and Women's Hospital in Boston.

Downsides of screening

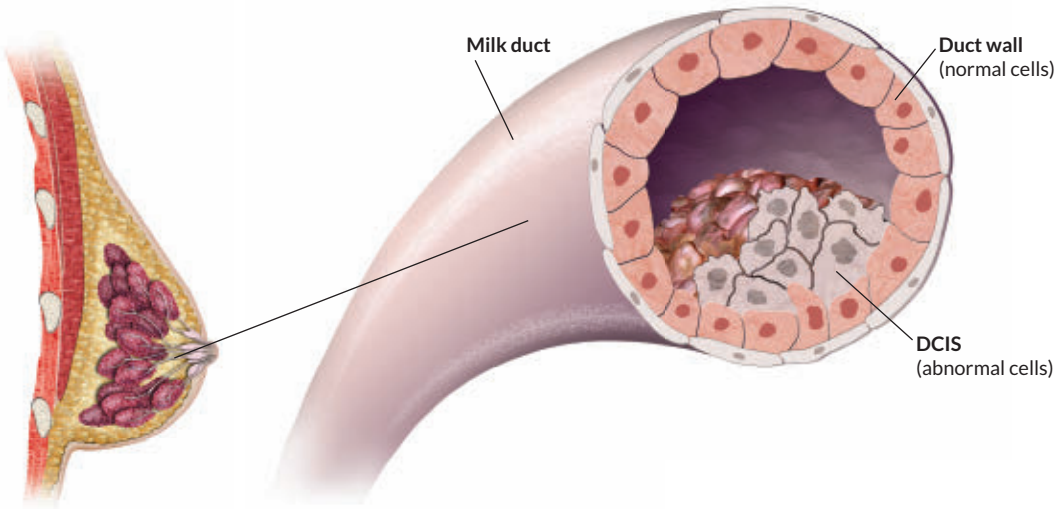
On the surface, mammography seems to make sense: detect tumors while they are still small and more easily conquered. "It is extremely intuitively appealing," says Barnett Kramer, director of the division of cancer prevention at the National Cancer Institute in Rockville, Md. "And a violation of common sense when clinical trials contradict that intuition."

The problem with common sense is that it doesn't usually take into account the downsides of cancer screening. And they exist: A test can wrongly say you have cancer when you don't. It can wrongly say you don't have cancer when you really do. It can find cancers that would never have been life-threatening, subjecting you to the side effects of treatment with zero benefit. And when mammography does detect life-threatening cancers, the knowledge is useful only if

One test, many results Brigham and Women's Hospital researchers Nancy Keating and Lydia Pace have estimated the odds of all possible outcomes from annual mammograms.

40
percent
1971 estimate of how much mammography screening can reduce mortality from breast cancer

15 to 20
percent
2014 estimate of how much yearly mammography reduces breast cancer mortality



Danger or not? Ductal carcinoma in situ, or DCIS, is one of the biggest dilemmas of mammography. In about 80 percent of cases, DCIS will never spread and poses little risk. When found on a mammogram, it is often treated aggressively.

15
percent
Factor by which mammograms may lower mortality from breast cancer for women in their 40s and 50s

32
percent
Factor by which mammograms lower mortality for women in their 60s

treatment before a palpable lump develops actually improves survival.

"We all want a simple answer. We want to get our mammogram and have everything turn out fine," says Keating. "It's my job to help my patients understand this is not a perfect test. Mammography has limitations, and they are greater than what we have led people to believe."

This spring, Keating and colleague Lydia Pace tried to systematically weigh the pros and cons of mammography in an article in the *Journal of the American Medical Association*. They started by outlining the benefits, concluding that overall, yearly mammography lowers the risk of dying from breast cancer by about 15 to 20 percent. They offer a range rather than a precise figure because their findings are based on combining eight large clinical trials, some of which have found minimal benefit, while others have found a substantial reduction in mortality.

> "The fact that the benefits aren't huge makes this a hard debate."
>
> **ERIC WINER**

One reason for mammography's limited effectiveness is that even annual screening can miss the most dangerous, fast-growing tumors. Women who get annual mammograms still die of breast cancer, in far greater numbers than those whose lives are saved.

The studies themselves also have problems. The pace of advances in treatment could render the results of a clinical trial obsolete even before the study is through.

It's important to point out that the benefit estimate from mammography varies by age. The younger a woman is, the less she stands to gain because her overall risk of cancer is low. As a woman ages, her risk for cancer rises, and so does the value of mammography. So while regular mammograms might lower the risk of death from breast cancer by about 15 percent among women in their 40s and 50s, the benefit to women in their 60s is a 32 percent reduction in mortality.

In the *JAMA* report, the numbers are laid out this way: If 10,000 women in their 40s were to get regular mammograms, an estimated 30 breast cancer deaths would occur despite screening, with around five deaths prevented. For 10,000 women in their 60s, that number rises to 90 deaths despite screening, but about 42 lives saved.

The small difference for younger women lies at the heart of the controversy. "Although I personally think that there's a role for mammography, the fact that the benefits aren't huge makes this a hard debate," says Eric Winer, director of the breast oncology center at the Dana-Farber Cancer Institute in Boston, and scientific adviser for Susan G. Komen for the Cure. Even if you have to screen 10,000 women to save five lives, he points out, the value is profound for those five.

But many of the other 9,995 women will pay a price. At some point about 61 percent of women in their 40s and 50s will have a false-positive result. They will be summoned for more imaging or a biopsy because a mammogram found something suspicious, and then they'll be found cancer-free. Or they will be diagnosed with a cancer that would never have posed any threat to them, and suffer all the trauma and side effects of a treatment that they did not need. This is the drawback of

NICOLLE RAGER FULLER

screening. Healthy women can get lumped into the category of sick, or possibly sick, just because they had a test.

False positives are so common with mammograms that "if you choose to participate, you should assume this is going to happen to you," Keating says. Researchers have been trying to quantify the effects of false positives, to help women better understand the whole package that comes with a mammogram. Even when further testing comes up clean, some studies have suggested that the stress of following up on an ominous mammogram is so great that women who undergo it are less likely to return for future screenings.

A study published in June in *JAMA Internal Medicine* was more encouraging, finding that the anxiety of a false positive was transient, and that in fact the relief from a clean report made women more likely to keep getting screened. The lead author of that study, Anna Tosteson of the Dartmouth Institute for Health Policy and Clinical Practice, says she hopes that more understanding about false positives will help further the movement toward informed choice. "It's really a phenomenally common experience," she says, and the frequency itself may help women realize that even if they get a call to come back, the chances of a cancer diagnosis are still remote.

A sea of uncertainty

But unlike a false positive, some types of overdiagnosis can have lasting effects. Most worrisome is the detection of a problem that, left undiscovered, would never have amounted to any danger. It is "the most concerning potential harm of mammography screening," Keating and Pace wrote in *JAMA*. "However, substantial uncertainty exists around its magnitude." They put their best estimate at about 19 percent of cancers identified.

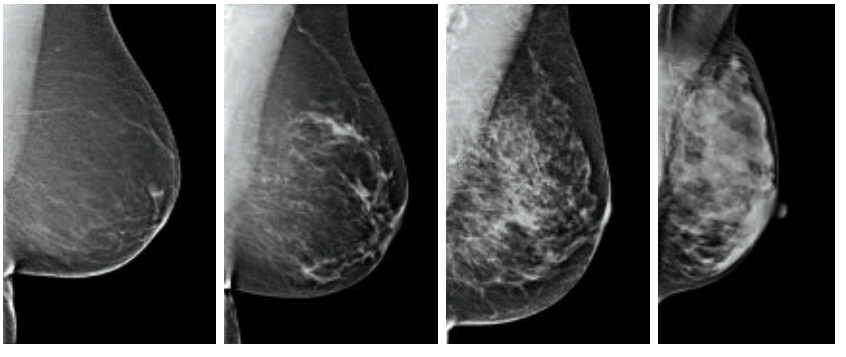
Nowhere has the issue of overdiagnosis been more vexing than with the case of DCIS, or ductal carcinoma in situ, which is abnormal tissue that is inside a milk duct in the breast. It has not invaded other parts of the breast and may never do so. It has the potential to become invasive (although estimates vary on how often), but when confined to the duct the condition is not life-threatening. Women who receive a DCIS diagnosis find themselves in a sea of uncertainty, with no way to know whether these tiny clumps of suspicious cells are the first buds of a tumor. So the vast majority of the time, DCIS gets treated with surgery, and often with radiation and other treatments that can themselves cause heart damage and other health problems. An increasing number of women with DCIS are choosing double mastectomies. "Everyone agrees it's overtreated," Winer says of DCIS.

Advocates of informed decision making for mammograms say that women must be able to weigh the risk of false positives and overdiagnosis against the odds of finding cancer early. The choice must be rooted in a better understanding of their actual risk for breast cancer.

While "1 in 8" has been the battle cry, and has done much to increase the awareness of breast cancer, it is an often-misunderstood figure, says Kramer of the National Cancer Institute. It does not mean that every eighth American woman alive today has breast cancer, or will even get it in the next decade. In fact, the 10-year breast cancer risk for a woman in her 40s is only about 1.5 percent depending on family history, rising to 3.5 percent for a woman in her 60s. A "1 in 8" lifetime risk applies only to a girl just born, who, from the other side of the equation, has a 7 in 8 chance of never having breast cancer.

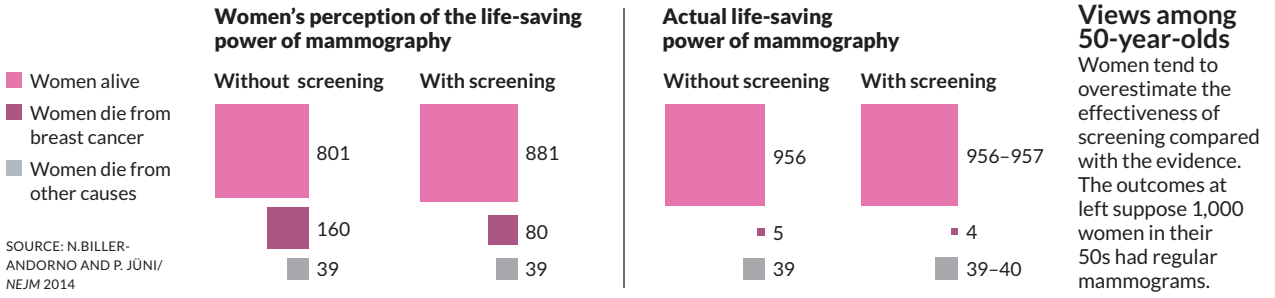
Yet evidence shows that women tend to severely overestimate their risk. In the May 22 editorial in the *New England Journal of Medicine*, representatives of the Swiss Medical Board note they were "disconcerted by the pronounced discrepancy between women's perceptions of the benefits of mammography screening and the benefits to

61
percent
Fraction of women in their 40s or 50s who receive a false-positive result after 10 years of annual mammography screening



Whiteout On a mammogram, tumors appear white, and so does denser breast tissue, which is why finding tumors in dense breasts is often compared to finding a polar bear in a snowstorm. (Shown are tumor-free breasts of increasing density, from left to right.)

AMERICAN COLLEGE OF RADIOLOGY



be expected in reality." They point out data suggesting that 50-year-old American women predict that out of 1,000 women, 160 of them would likely die of breast cancer in the next 10 years without screening, and that mammography could reduce this number by half. In truth, the researchers say, evidence indicates that five out of 1,000 50-year-olds are likely to die of breast cancer within a decade, and screening could drop this to four.

The Swiss researchers and others point out that all the assumptions about harms and benefits could be based on flawed data. The clinical trials used in evaluating the benefits of mammography began decades ago — which poses a problem of how applicable these studies are today. The quality of mammography technology used in a large Canadian trial was largely disparaged in February when the study, appearing in *BMJ*, reported that mammography offered no improvement in mortality rates for women ages 40 to 59. A statement issued by the Society of Breast Imaging and the American College of Radiology said the machines used in the study were secondhand, and rendered cloudy images. Writing in April in *Cancer Control*, a journal published by the Moffitt Cancer Center in Tampa, Fla., Jennifer Drukteinis and John Kiluk further seized on this point, charging that "the equipment used for mammography screening was of poor quality and was not state-of-the-art at the time, a fact that may account for the low percentage of cancers detected by screening."

Kiluk also believes that judging mammography by mortality alone is unfair because it does not take into account quality of life. Women diagnosed at an earlier stage will likely face gentler treatment. "At the end of the day, their survival is the same, but who would you rather be?" he says. "To me, there is no debate."

Yet just as screening technology has improved, so has therapy — which some say lowers the value of mammography further. "Treatment is much more effective now than it was 30 years ago," says Keating, which reduces the urgency of finding cancers before they can be felt as lumps. With better therapies, a slight difference in size matters less.

Uphill battle

But no movement toward individual choice can occur unless doctors change the way mammography is presented to patients. "Doctors are trained from day one that screening works," Kramer says. "There is some evidence that women aren't informed at all about the harms, or don't recall being informed about the harms. They learn a lot more about the benefits."

Education and informed choice will require more time than most doctors have, and many are not so inclined to make room for it, Winer says. "The strongest proponents are also people who make their living performing mammograms," he says, which makes it fundamentally difficult for them to acknowledge that there are women who don't benefit. The conflict of interest from doctors is not just about money, Winer says. "They very sincerely want to reduce mortality from breast cancer."

> "Doctors are trained from day one that screening works."
>
> BARNETT KRAMER

Just as Philip Strax did. Reflecting on his life to a journalist in 1988, he said the breast is a marvelous and complicated creation "if only the goddamn thing wouldn't get into trouble." He continued publishing into the 1990s and was a tireless advocate for mammography until his death in 1999. "Mass screening is the only means we have to save the lives of many women with breast cancer," he wrote. He was right. Mammography can save lives. It can also harm them. The choice women now face is whether they are willing to make their own decision. ■

Explore more

■ N.K. Stout *et al.* "Benefits, harms, and costs for breast cancer screening after U.S. implementation of digital mammography." *Journal of the National Cancer Institute.* June 2014.

S. EGTS

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– Carol K., Benbrook, TX

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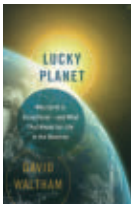
SCREENTIME

Get a bird's-eye view of lawns with YardMap

Wild animals, especially birds, aren't confined to wild spaces. They creep into backyards, hop through parks and crawl through any bit of green space they can find. Scientists at the Cornell Lab of Ornithology would like to know more about those not-so-wild spaces so that they can learn how bird species use the full range of habitats in North America. Their new citizen-science project, a website called YardMap, lets people quickly and easily make free maps of verdant places such as their home or a local cemetery, marking out lawns, trees and other landscape features over a satellite view. Researchers use map data matched with bird sightings, which can be submitted using the eBird tool on the site, to study the impact of backyards on migrating birds as they crisscross North America. Tools on the YardMap website help users learn more about how planting practices can attract more birds and other wildlife. — *Sarah Zielinski*

BOOKSHELF

Nothing
Jeremy Webb, ed.
Researchers and science writers tackle the science of nothingness, from what came before the Big Bang to the placebo effect.
The Experiment, $14.95



Lucky Planet
David Waltham
Earth is not only special but probably unique in its ability to support life, an astrobiologist and geophysicist argues.
Basic Books, $26.99

The Drunken Monkey
Robert Dudley
The author's research on the evolutionary roots of alcohol consumption informs this review of the social and medical effects of alcoholism. *Univ. of California, $34.95*

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History of invisible ink

280–220 B.C.
Philo of Byzantium
The Greek engineer pioneers an early ink derived from gallnuts (oak tree growths). It is the first ink requiring a reagent to reveal its words.

1 B.C.
The Art of Love
Ovid's manual of seduction claims that "a letter too is safe and escapes the eye, when written in new milk: touch it with coal-dust, and you will read."

600
Arab cryptology
The Arab empire breaks ground with the use of lemon-based ink revealed through heat, the preferred method of German spies during World War I.

1563
Giambattista della Porta
The Italian scholar publishes the first secret writing manual for a general audience, inspiring a few Royal Society founders to dabble a century later.

BOOKSHELF

Prisoners, Lovers, and Spies

The Story of Invisible Ink from Herodotus to al-Qaeda

Kristie Macrakis

Pig's bladder, gypsum, fig sap, alum and onion juice — there's no eye of newt among invisible ink recipes, but blood of dormouse is fair game. By the end of science historian Macrakis' nearly 3,000-year accounting of secret messages, she's all but thrown in the kitchen sink (and the cauldron).

If you're asking whether it's science or sorcery chronicled in these pages, there's a chemical explanation for every reaction here. A quick jump to the back of the book reveals a cookbook of secret recipes that once floated spy rings and sunk empires.

But to simply scrawl lemon juice on paper, heat and reveal those secrets without learning the craft's murky history would skip centuries of fascinating subterfuge. This is a science, the author makes clear, that is far more than the sum of its formulas. The book devotes most of its pages to the

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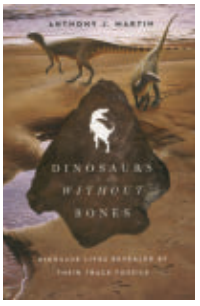

BOOKSHELF

Dinosaurs Without Bones

Dinosaur Lives Revealed by their Trace Fossils

Anthony J. Martin

When people walk into a museum's dinosaur hall, what makes them gasp in awe are the incredibly huge bones. An adult *T. rex*, which could be up to 12 meters long, had teeth the size of bananas. A humerus, or upper arm bone, of the largest (thankfully vegetarian) long-necked sauropods is by itself bigger than the average adult human.

Though paleontologists have learned extraordinary things about dinosaurs and their evolution from bones, there's a lot that skeletons and skulls can't divulge. More revealing, and in many places more common, than bones are trace fossils that don't contain any remnants of body parts. Detailed study of these indirect fossils, called ichnology (think *CSI* meets *Jurassic Park*), provides a wealth of information about how dinosaurs may have behaved.

Dinosaur tracks like this one, probably from a small ornithopod in Australia, are just one of many kinds of trace fossil.

Author and ichnologist Martin takes readers on a spellbinding tour of the myriad types of trace fossils that dinosaurs left behind during their 165-million-year reign. The most familiar, if not the most common, are footprints and trackways. While the size and shape of an individual footprint helps identify the type of creature that made it, analyses of a trackway (a series of impressions made at the same time) can tell researchers about the animal's gait and walking speed — and even whether the track-maker was limping due to deformity or injury.

Similarly, tooth marks on bones provide clues about who was eating whom. If the wounds show signs of healing, the bite marks were obviously made by an unsuccessful predator, not a scavenger. Coprolites, or fossil dung, often include remains of a meal but may also contain burrows of insects and other small creatures — reminders that dinosaurs were members of thriving ecosystems, not merely loners romping across barren landscapes.

Trace fossils include the arcane as well — everything from resting traces (aka "butt prints") and burrows to eggs and nests, which provide keen clues about dinosaur reproductive biology and whether or not parents provided care for their hatchlings.

Filled with wry humor and tales of Martin's fieldwork, conducted across the globe, *Dinosaurs Without Bones* is a nuanced tutorial. He superbly and thoroughly explains how paleontologists-cum-forensic-scientists interpret the subtleties of traces locked within rocks for millions of years. These tales bring science, as well as creatures long dead, to vibrant life. — *Sid Perkins*
Pegasus Books, $29.95

1705
On the Key to the Cabinet of the Secret Treasure Room of Nature
The book describes bismuth-cobalt inks that appear in bright colors when heated, but are invisible when cool.

1776
Revolutionary War subterfuge
A founding father's brother keeps George Washington's spy ring from being detected by the British. James Jay, brother of John, went to the grave with his secret formula.

1914–1945
Ink arms race
WWI "lemon juice spies" are followed by WWII microdots (information the size of a sentence period) and a pneumonia-microbe solution read by an antibody reagent.

Present
DNA microdots
Nucleotide sequences arranged to spell out a message fit in a sentence period. The encoded strand lies within a group of decoy sequences.

stars of secret writing such as the lone chemist who went to the grave with his ink recipe; the cape-wearing, Inquisition-defying founder of the Academy of the Secrets of Nature; and the Enlightenment-era scientists who traded secret formulas like gold for goods.

Macrakis offers a frank rendering of her occluded subject matter. Where one might expect romantic musings befitting invisible ink's literati — Christopher Marlowe and George Washington to name a few — or cold chapters of chemistry lessons, the author keeps her writing firmly rooted in the traditions of history. She pulls from assorted archives a wealth of documents, stories and declassified intelligence that was hidden right up to this book's undertaking.

Along the way, she takes readers on a tour through many familiar moments in history, but seen in a new way, by looking through the veil of secrecy. The insider's view reveals the essence of the human relationship to information. In a species where just possessing the record of an idea can be a matter of life and death, both the need for privacy and the need for intel play out through the centuries. Thanks to secret writing, lives are ruined, saved, emboldened and lost to the world. But the lesson remains the same: Be careful what you say, and how you say it. — *Bryan Bello*
Yale Univ., $27.95

PEGASUS BOOKS

MAY 17, 2014

Tracing ancient genes

Prehistoric Europe was home to hunter-gatherers until migrating farmers muscled them out. Genetic information teased from ancient skeletons is helping scientists reconstruct this saga, as ***Tina Hesman Saey*** *reported in "Written in bone"* (SN: 5/17/14, p. 26).

Sometimes, untangling genetic history can be a little one-sided. Researchers often rely on mitochondrial DNA, passed on only from the mother. As **Debra Baker** noted, this presents a problem: "Couldn't the lack of similarity of mitochondrial DNA among the different groups arise because they all were matrilineal?" she asked in an e-mail. "Instead of group isolation as suggested by the article, there could have been interbreeding, but the child would have remained in the mother's group."

It's entirely possible that social structures could influence the results when looking at genetic data from just one parent, says **Saey.** "That's why scientists prefer to study the whole genome, or nuclear DNA, when they can. Ancestral contributions from both parents are apparent when you look at the entire genetic picture, as some of the studies mentioned in the story have. Nuclear DNA has been hard to get, but increasingly scientists are extracting more and better DNA out of ancient fossils. Expect to see more in-depth examinations of prehistoric people and their relationships in the future."

Antimicrobial advice

In "Triclosan aids nasal invasions by staph" (SN: 5/17/14, p. 12), ***Beth Mole*** *reported that a common antimicrobial component of hand soaps boosts the stickiness of a disease-causing bacterium, allowing it to better cling to human proteins.*

The troubling finding calls for more research, wrote **John Turner**. "Now that we've learned that low-level triclosan exposure can actually enhance the adhesion and competitiveness of staph bacteria on surfaces in the body, isn't it time we checked what it's doing in, say, our toothbrushes? Often formulated of triclosan-containing plastics and smeared with triclosan-containing toothpaste?"

Until scientists gather more data, practical advice on hand-washing is in order: "Soap and hot water, folks. You don't need all that fancy stuff that only builds up resistance, and apparently, infectious snot," wrote reader **Jan Steinman**. "In a pinch, a bit of vinegar works wonders, too."

Musings on mammal milk

Naked mole-rat milk contains more water than other rodents', possibly to keep the young hydrated in arid habitats. ***Susan Milius*** *touched on the variety of mammal milk in "How to milk a naked mole-rat"* (SN: 5/17/14, p. 4).

Milk proved to be a hot topic for discussion among readers. "I would think the aquatic species' fat content may have to do with needing the high calories for warmth, and increasing fat layers in young to maintain that warmth," wrote **Anthony Kerwin**. "It would be interesting to see how the relationship would bear out for just terrestrial mammals, or even among similar species in different climates."

Biologist **Wendy Hood** of Auburn University in Alabama replies: "Marine mammals need to fatten quickly to survive in an aquatic habitat. In fact, the hooded seal has to be ready to forage for itself in the cold arctic waters after just four days of suckling. In that period of time, the pup doubles in mass — that change is mostly due to deposition of fat." She adds, "Smaller species require more energy relative to their size than a larger species, so higher milk fat — in the case of a mouse — gives the pups more energy to support the energy demands of growth. It's interesting that naked mole-rats are so different, but the lower-fat milk is in part explained by the lower energy requirements of naked mole-rats relative to other rodents."

Correction

The web link provided in "Outgoing Congressman Rush Holt calls scientists to action" (*SN: 6/14/14, p. 4*) contains an error. The correct link is: bit.ly/SN_holt

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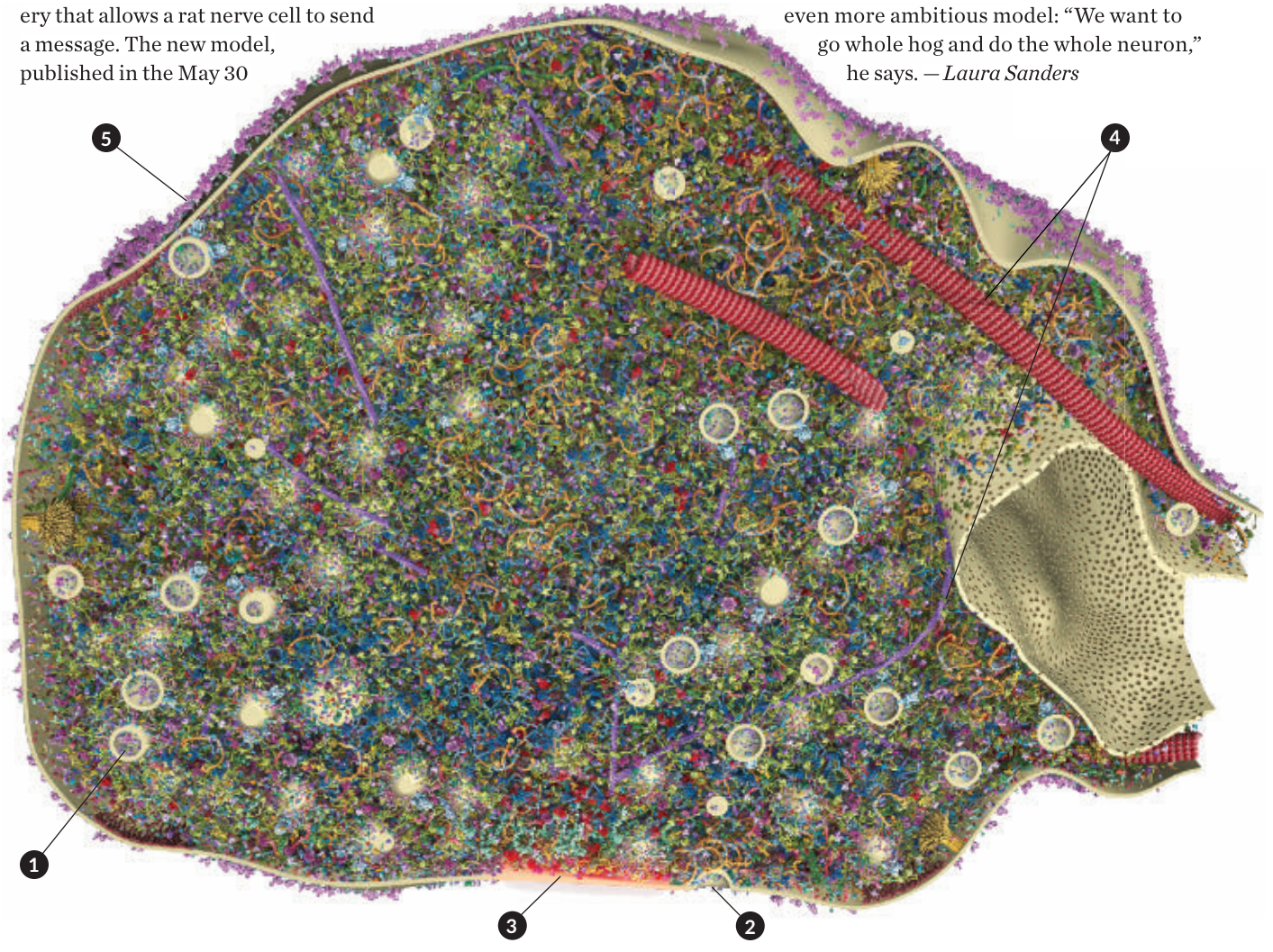
A new view of a nerve cell's dispatch center

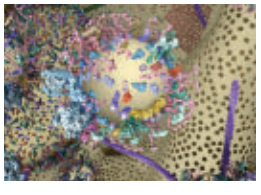
Brains run on constant streams of chatter. The roughly 85 billion nerve cells in the human brain converse by sending messages via molecules called neurotransmitters. These chemical conversations allow the brain to think, remember and feel, but the details of how those messages move remain mysterious.

To get a closer look, researchers led by Silvio Rizzoli of the University of Göttingen Medical Center in Germany created a 3-D visualization (below) of the cellular machinery that allows a rat nerve cell to send a message. The new model, published in the May 30 *Science*, reveals the roles of proteins in the synaptic bouton, a structure at the tip of a nerve cell's message-sending axon.

The model provides a clearer view of how nerve cells communicate. The team found, for example, that the synaptic bouton has an abundance of proteins that help send vesicles packed with neurotransmitters to the surface of the cell, but proteins that help retrieve the used vesicles are scarce.

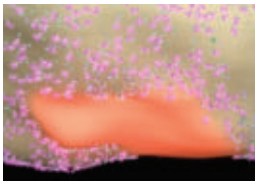
Rizzoli and his colleagues plan on building an even more ambitious model: "We want to go whole hog and do the whole neuron," he says. — *Laura Sanders*



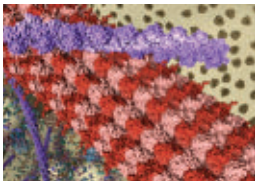


1. A synaptic vesicle, about 42 nanometers wide, is loaded down with chemicals that serve as signals between nerve cells.

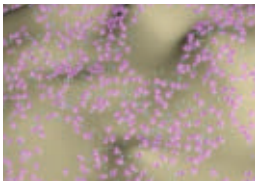
2. After fusing with the bouton's outer membrane and releasing its contents, a vesicle gets recycled back into the bouton.



3. Vesicle melding is concentrated in the active zone (orange), a place where specialized proteins congregate to help the vesicles release their payloads.



4. Microtubules (red) and actin filaments (purple) help give the synaptic bouton structure and move cargo around inside the neuron.



5. The Alzheimer's–related APP protein (purple) decorates the outside of the bouton's membrane, where the protein may play a role in nerve cell communication.

ALL: B.G. WILHELM *ET AL*/*SCIENCE* 2014

See video of the 3-D model at **bit.ly/SN_bouton**

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