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SCIENCE NEWS MAGAZINE
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OCTOBER 1, 2016

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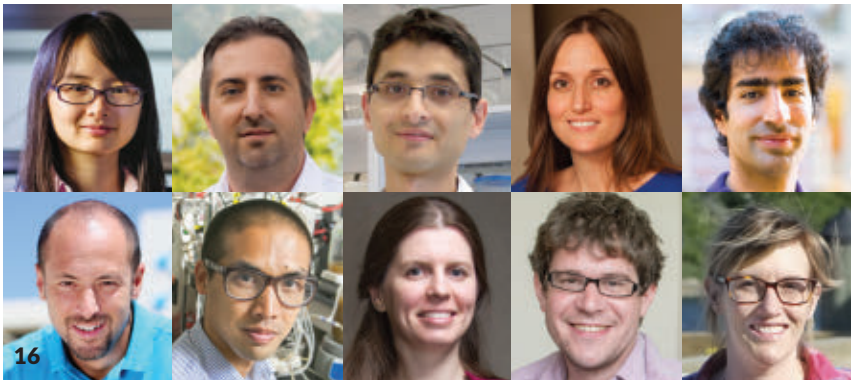

Features

News

Departments

COVER The SN 10, all represented here, were nominated by Nobel laureates and National Academy of Sciences members. *Sam Falconer*

Science relies on work of young research standouts

This issue marks the second year that *Science News* has reached out to science notables and asked: Which up-and-coming scientist is making a splash? Whose work impresses you? Tell us about early- to mid-career scientists who have the potential to change their fields and the direction of science more generally.

This year, we expanded the pool of people we asked. We reached out to Nobel laureates again and added recently elected members of the National Academy of Sciences. That allowed us to consider shining lights from a much broader array of fields, from oceanography and astronomy to cognitive psychology. Another difference this year: We spent time face-to-face with many of those selected, to get a better sense of them both as scientists and as people.

The result, as you will see starting on Page 16, is the SN 10, a collection of stories not only about science, but also about making a life in science. They are stories of people succeeding because they have found what they love, be it working in the lab on new ways to probe molecular structures or staring up to the stars in search of glimmers of the early universe. In my interviews with chemist Phil Baran, I was struck by his drive to do things in new ways, whether devising chemical reactions or developing ideas about how to fund research. (If you can, he says, go private.) Laura Sanders, who met with neuroscientist Jeremy Freeman, was intrigued by his way of seeing a problem (siloed data that can't be easily shared or analyzed) and figuring out solutions, even if those solutions were outside his area of expertise.

Of course, there are many ways to identify noteworthy scientists — and there's plenty more fodder out there for future years. Our approach was to seek standouts, asking who deserved recognition for the skill of their methods, the insights of their thinking, the impacts of their research. Not all of the SN 10's work has made headlines, but they all share something more important: They are participants in building the science of the future.

Notably, many of them do basic research. I think that's because it's the type of work that other scientists notice, even if it's not always on the radar of the general public. But that's where fundamental advances are often made, as scientists explore the unknown.

That edge of what's known is where *Science News* likes to explore, too. Such as the bet-ending, head-scratching results from the Large Hadron Collider, which have failed to reveal the particles that the equations of supersymmetry predict. As Emily Conover reports on Page 12, that means that either the theory must be more complicated than originally thought, or not true, letting down those who looked to supersymmetry to help explain a few enduring mysteries, from the nature of dark matter to the mass of the Higgs boson.

Other mysteries may be closer to a solution, as Sanders reports on Page 6. A new potential treatment for Alzheimer's disease reduced amyloid-beta plaques in patients. It also showed hints of improving cognition. That's standout news, a result built on decades of basic research by many, many bright young scientists. — *Eva Emerson, Editor in Chief*

Science News
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Phone: (202) 785-2255
Customer service: member@societyforscience.org
Editorial/letters: editors@sciencenews.org
Sponsor content: ads@societyforscience.org
Science News (ISSN 0036-8423) is published biweekly by Society for Science & the Public, 1719 N Street, NW, Washington, DC 20036.
Online and iPad access: Activate your subscribing member account, including digital access and the ability to opt out of print, at www.sciencenews.org/activate
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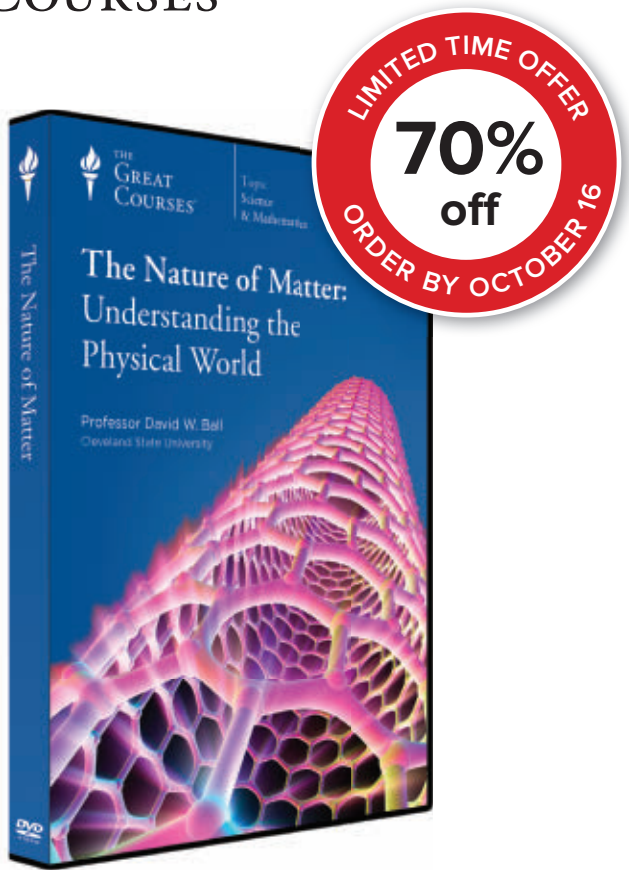

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Excerpt from the October 1, 1966 issue of *Science News*

50 YEARS AGO

New method to measure mass in space devised

A scale for measuring weight in space that does not depend upon the attraction of gravity has been devised.... In [William Thornton's] method, the weight of the mass is determined [by] mechanically oscillating a weight in a tray. The heavier the mass, the slower the oscillation rate. The scale is tied to an electronic unit measuring the time required for five cycles of oscillation. A reference to a chart gives the mass's weight.

UPDATE: Not much has changed. The International Space Station has two spring-based contraptions for weighing in astronauts. An individual rides the Body Mass Measurement Device like a pogo stick — in four or five bounces, it calculates weight. The Space Linear Acceleration Mass Measurement Device uses springs to pull an astronaut; the acceleration reveals weight. In 2012, researchers in Europe experimented with compact computer imaging technology — developed for video games — using photos to estimate mass based on a person's shape and size.

THE SCIENCE LIFE

It took a village for cormorant wing study

Unlike short-winged Galápagos cormorants (below), double-crested cormorants (above) and all other species have a wingspan meant for flying.

Galápagos cormorants are the only flightless cormorant species. Their wings are too small to lift their heavy bodies. To trace the genetic changes responsible for the birds' shrunken wings, Alejandro Burga needed DNA from the grounded bird and from a few related species. For the UCLA evolutionary geneticist, getting the right DNA was a yearlong effort.

After Galápagos cormorants (*Phalacrocorax harrisi*) split off from other cormorants, their wings shrunk to 19 centimeters long and their bodies grew to 3.6 kilograms, not a flying-friendly combination. Burga suspected he would have difficulty getting permission to collect DNA from the endangered birds. So he e-mailed "anybody who had ever published anything on cormorants" in the last 20 years, he says.

He found disease ecologist Patricia Parker of the University of Missouri-St. Louis who had collected blood from Galápagos cormorants in 2000 to monitor the spread of pathogens. Getting to the islands takes special permission, long flights and boat trips, but getting DNA from the meter-tall birds wasn't hard.

"They're sluggish, and they just sit there and look at you," Parker says. She shared DNA that had been sitting in her lab refrigerator for more than a decade. Burga used it to reconstruct the cormorants' genetic instruction book, or genome.

Next he needed comparison DNA from closely related species, such as the double-crested cormorant — a goose-sized waterbird with a broad wingspan. The bird is protected under a migratory bird treaty between the United States and Canada. Since Burga couldn't just trap one and collect DNA, he got creative. He tried to extract DNA from preserved specimens at the Natural History Museum of Los Angeles County, but the genetic material was unusable. The San Diego Zoo sent samples of a too-distantly related great cormorant. An international bird rescue facility in Los Angeles notified him when someone found a dead cormorant on the beach. Burga rushed over, but the bird was a Brandt's cormorant — also too far removed in the family tree to be of use.

One e-mail chain led to Paul Wolf, a U.S. Department of Agriculture wildlife disease biologist monitoring Newcastle disease virus in double-crested cormorants in Minnesota. With a special permit, Wolf removed one double-crested cormorant egg from a nest. The egg was at just the right stage of development — when the wings were beginning to grow — to determine which genes are active during wing development. Two down, two to go.

While on Alaska's Middleton Island studying seabird parasites, Andrew Ramey of the U.S. Geological Survey collected two eggs from pelagic cormorants for Burga.

Burga also enlisted Claudio Verdugo, a molecular epidemiologist at Universidad Austral de Chile in Valdivia. Bird samples can't be transported between countries because of fears of disease spread. So Burga sent chemicals and protocols to Verdugo, who took DNA from another species, the neotropic cormorant, and sent it to Burga.

With DNA from four cormorant species in hand, Burga and his newfound friends learned that the Galápagos cormorants' stubby wings result, in part, from mutations in specific genes that encourage limb growth (*SN: 6/11/16, p. 11*). Burga is now studying how evolution grounded other birds.

— *Tina Hesman Saey*

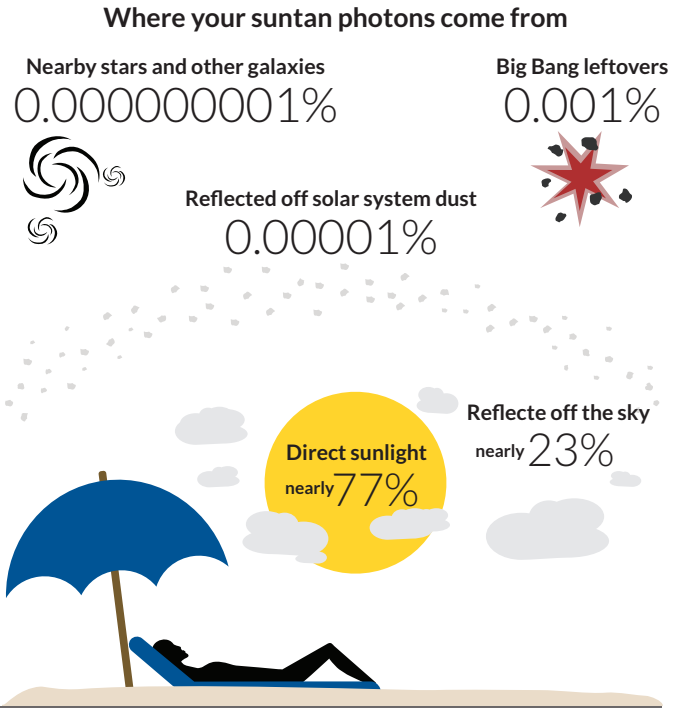
FROM TOP: © LIAM O'BRIEN/INATURALIST (CC BY-NC 4.0); PUTNEYMARK/WIKIMEDIA COMMONS (CC BY-SA 2.0)

SCIENCE STATS

Catching some faraway rays

Your summer suntan is almost entirely locally sourced. But a smidgen of that healthy glow hails not from the sun but from the ultraviolet light of nearby stars and other galaxies: less than one-billionth of 1 percent. Even photons lingering from the Big Bang contribute some: roughly 0.001 percent.

Simon Driver, an astronomer at the University of Western Australia in Crawley, and colleagues calculated these numbers, but not because they're interested in tanning. They were trying to decipher the extragalactic background light, or EBL, a diffuse glow that fills the universe (*SN: 9/7/13, p. 22*). Using galaxy observations from multiple telescopes, they assessed the number of EBL photons, from infrared to ultraviolet, that reach Earth. About half originated with the formation of galaxy cores and supermassive black holes during roughly the first 4 billion years of cosmic history, the researchers report in the Aug. 20 *Astrophysical Journal*. The growth of disks of stars in galaxies since that time accounts for the other half. — *Christopher Crockett*



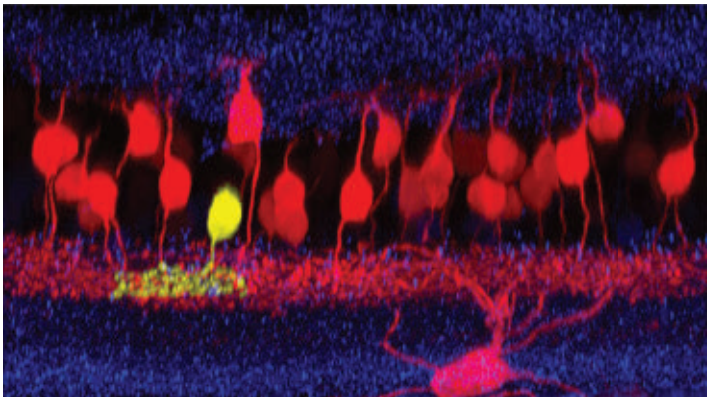
INTRODUCING

GluMI cells are anything but

Despite its name, the newly identified GluMI cell (pronounced "gloomy") is no downer.

It's a nerve cell, spied in a mouse retina, that looks like one type of cell but behaves like another. Like neighboring retina nerve cells that subdue, or deaden, activity of other nerve cells, GluMI cells have a single arm extending from their body. But unlike those other cells, GluMI cells actually seem to ramp up activity of nearby cells as part of vision processing.

GluMIs don't seem to detect light firsthand, but they respond to it, Luca Della Santina of the University of Washington in Seattle and colleagues found. GluMIs are among a growing list of surprising and mysterious cells found in the retinas of vertebrates, the researchers write in the Aug. 8 *Current Biology*. — *Laura Sanders*



In a mouse retina, a GluMI cell (yellow) is tucked among nerve cells with two arms (red), photoreceptors (top, blue) and ganglion cells (bottom, pink).

FROM TOP: T. TIBBITTS; UNIV. OF WASHINGTON

SAY WHAT?

Bagpipe lung \BAGpīp ləng\ n.

An inflammatory lung disease caused by regular inhalation of fungi living inside bagpipes

In 2014, a 61-year-old man died after seven years of a mysterious illness that left him breathless, with a dry cough.

Doctors diagnosed him with hypersensitivity pneumonitis, a rare disease caused by breathing in particles that irritate lung tissues. It's also known as bird fancier's lung, humidifier lung and hot tub lung, among other names. But the patient had no known exposure to birds, nor to household molds that can trigger the disorder.

Two clues intrigued Jenny King, a physician at the University Hospital of South Manchester in England: The patient played the bagpipes daily. And on a three-month trip to Australia, when he left his bagpipes at home, his symptoms disappeared.

King and colleagues found pink yeast, mold and plant fungi living in the instrument's neck, the cap that fits over the reed and in air blown out of the bag. Inhaling the microbes every day could have sparked the patient's disease, the team reports online August 22 in *Thorax*.

Bagpipe, trombone and saxophone players be warned: Musical instruments with moist interiors should be cleaned immediately after use, the authors suggest. — *Meghan Rosen*

BODY & BRAIN

Alzheimer's drug shows promise

In small clinical trial, antibody reduced brain plaques

BY LAURA SANDERS

An experimental drug swept sticky plaques from the brains of a small number of people with Alzheimer's disease over the course of a year. And preliminary results hint that this cleanup may have staved off mental decline.

News about the new drug, an antibody called aducanumab, led to excitement as it trickled out of recent scientific meetings. A paper in the Sept. 1 *Nature* offers a more comprehensive look at the drug's effects.

"Overall, this is the best news that we've had in my 25 years doing Alzheimer's clinical research," study coauthor Stephen Salloway of Brown University said August 30 at a news briefing. "It brings new hope for patients and families most affected by the disease."

The results are the most convincing evidence yet that an antibody can reduce amyloid in the brain, says Alzheimer's researcher Rachelle Doody of Baylor College of Medicine in Houston, who was not involved in the study.

Still, experts caution that the results come from 165 people, a relatively small number. The seemingly beneficial effects could disappear in larger clinical trials, which are under way. "These new data are tantalizing, but they are not yet definitive," says neuroscientist John Hardy of University College London.

Like some other drug candidates for Alzheimer's, aducanumab is an antibody that targets amyloid-beta, a sticky protein that accumulates in the brains of people with the disease. Delivered by intravenous injection, aducanumab appeared to get inside the brains of people with mild Alzheimer's (average age about 73) and destroy A-beta plaques. After a year of exposure to the drug, A-beta levels had dropped. This reduction depended on the dose — the more drug, the bigger the decline in A-beta. In fact, people on the highest dose of the drug had almost no A-beta plaques in their brains after a year.

> "Overall, this is the best news that we've had in my 25 years doing Alzheimer's clinical research."
>
> STEPHEN SALLOWAY

"I know of no other antibody that leads to this degree of amyloid removal," study coauthor Alfred Sandrock of Biogen in Cambridge, Mass., the company developing the drug, said at the news briefing. Scientists have been trying to figure out whether A-beta is a cause, or just a symptom, of Alzheimer's (*SN: 3/12/11, p. 24*). With its potential to reduce A-beta brain plaques, aducanumab may help settle the debate because it will allow scientists to look directly at the relationship between plaques and mental decline.

The bigger concern is whether the drug can preserve thinking skills and memory. The new study was not large enough to address that question definitively. Yet it turned up hints that aducanumab may help.

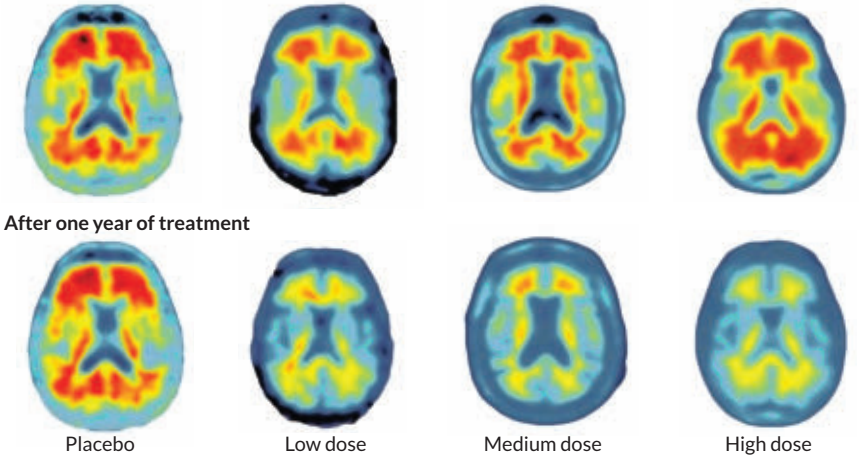
Compared with those who got a placebo, people who took aducanumab showed less decline on standard tests of memory and thinking skills over the course of a year. Better performance seemed to come with higher doses. People who received the placebo lost just under three points on average on a 30-point cognitive test. People on the highest dose lost a little over half a point on average.

"One needs to take the cognitive data with a grain of salt at the moment, given the small number of people," says Eric Reiman, a neuroscientist at the Banner Alzheimer's Institute in Phoenix. But if larger studies show a similar benefit, "it would be a game changer," says Reiman, who wrote an accompanying commentary in *Nature*.

Aducanumab targets several forms of A-beta that make up plaques. Once aducanumab sticks to A-beta, brain cells called microglia come in and remove the buildup, lab experiments suggest.

Twenty-seven people in the study had an adverse drug reaction known as ARIA, marked by changes in brain fluid detected by brain scans. The side effect is often without symptoms, but can cause headaches or more serious trouble in some people. ARIA was more common at higher doses. The larger studies of aducanumab that are under way may help scientists pinpoint the most effective dose with the fewest side effects. ■

Plaque buster In a trial of 165 people, brain scans showed reductions in amyloid-beta plaques (red) in people given the antibody aducanumab compared with people given a placebo. The scans below are from representative study participants.



J. SEVIGNY *ET AL*/*NATURE* 2016

LIFE & EVOLUTION

Fossils claimed to be oldest on Earth

3.7-billion-year-old mounds could signal early microbes

BY THOMAS SUMNER

A melting snow patch in Greenland has revealed what could be the oldest fossil evidence of life on Earth. The 3.7-billion-year-old structures may help scientists retrace the rise of the first organisms relatively soon after Earth's formation around 4.5 billion years ago (*SN: 2/8/14, p. 16*), the discoverers report online August 31 in *Nature*.

Unlike dinosaur bones, the new fossils are not preserved bits of an ancient critter. The Greenland fossils are mounds of minerals a few centimeters tall that may have been deposited by clusters of microbes several hundred million years after Earth formed. The shape and chemical composition of the mounds, called stromatolites, resemble those formed by modern bacterial communities living in shallow seawater, says a team led by geologist Allen Nutman of the University of Wollongong in Australia.

The wavelike mounds of sediment, called stromatolites (marked by dashed lines), inside this cross section of a 3.7-billion-year-old rock may be the oldest known fossil evidence of life on Earth.

Whether or not the mounds were formed by ancient microbes remains inconclusive, says Abigail Allwood, an astrobiologist at NASA's Jet Propulsion Laboratory in Pasadena, Calif. A nonbiological process may have dumped the minerals onto the seafloor, she says. The evidence is "a little bit thin for what you would usually want to see for such an extraordinary claim."

But if confirmed, the fossils demonstrate that sophisticated, mound-building microbial life appeared early on in Earth's history. That early start backs up previous genetic and chemical studies that place the advent of basic life on Earth by 4.1 billion years ago.

The emergence of life on the early Earth would support the possibility that life could have developed on Mars, Allwood says. The early histories of both planets were probably similar from a habitability perspective, she says. ■

MATTER & ENERGY

Bacteria-sized molecules made in lab

Linked cesium atoms could play role in quantum computing

BY EMILY CONOVER

Scientists have created giant molecules — as big as bacteria — that may be useful in future quantum computers.

The molecules of unusual size are formed from pairs of Rydberg atoms — atoms with an electron that has been boosted into a high-energy state. Such electrons orbit far from their atom's nucleus and, as a result, can feel the electromagnetic influence of faraway atoms.

Researchers cooled cesium atoms to nearly absolute zero, hitting them with lasers to form Rydberg atoms that bound together in pairs. These molecules are about one thousandth of a millimeter in size — a thousand times the size of a typical molecule — scientists report in the Aug. 19 *Physical Review Letters*.

"It's fundamentally interesting and important because it's such a curious thing," says physicist David Petrosyan of the Institute of Electronic Structure & Laser at the Foundation for Research and Technology–Hellas in Heraklion, Greece. "The size of these molecules is huge."

This is not the first time such molecules have been created, but whether previous ones were really bound together wasn't clear. "Before, maybe it wasn't clear if this is really a molecule in the sense that it's vibrating and rotating. It could have been just two atoms sitting there with very weak interactions or no interactions," says Johannes Deiglmayr, a physicist at ETH Zurich and a coauthor of the study.

Deiglmayr and collaborators measured the molecules' binding energies, which hold the two atoms together. The scientists also made detailed calculations to predict the molecules' properties. These calculations were "extensive and seemed to match really well with their measurements," says physicist Phillip Gould of the University of Connecticut in Storrs.

The result has practical implications, Petrosyan notes. In quantum computers that use atoms as quantum bits, scientists perform computations by allowing atoms to interact. Rydberg atoms can interact with their neighbors over long distances, and when bound together, the atoms stay put at a consistent distance from one another — a feature that may improve the accuracy of calculations.

Researchers have used rubidium atoms to make another type of large molecule, formed from Rydberg atoms bonded with normal atoms. But these wouldn't be useful for quantum computation, Petrosyan says. They rely on a different type of bonding mechanism. ■

A.P. NUTMAN *ET AL*/*NATURE* 2016

GENES & CELLS

Tasmanian devils can fight off cancer

Genetic tweaks are helping marsupials beat contagious tumors

BY TINA HESMAN SAEY

A few Tasmanian devils have started a resistance movement against a contagious cancer that has depleted their numbers.

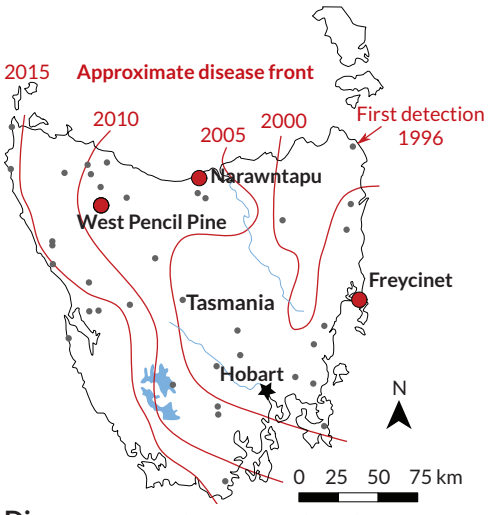
Since devil facial tumor disease was discovered in 1996, it has wiped out about 80 percent of the Tasmanian devil population. Scientists had believed the tumors, which spread when devils bite each other, to be universally fatal. But a small number of devils carry genetic variants that help them survive the disease — at least long enough to reproduce, researchers report August 30 in *Nature Communications*. The finding could be important for the survival of the species.

Previous studies have shown that the tumor can hide from the devil's immune system (*SN: 4/20/13, p. 10*). "What we reluctantly felt was that this was the end for the Tasmanian devil," says Jim Kaufman, a University of Cambridge evolutionary immunologist not involved in the study. Indication that devils are evolving resistance to the tumor "is really the most hopeful thing I've heard in a long time," Kaufman says.

As the cancer spread across Tasmania, Menna Jones and colleagues collected DNA from devils in three populations before and after the disease arrived. Jones, a conservation biologist at the University of Tasmania in Hobart, then teamed up with evolutionary geneticist Andrew Storfer of Washington State University in Pullman. His team examined the devil genetic instruction book, or genome, to see if differences between devils before and after the tumor's arrival could explain why some survived. Scientists had thought that surviving devils just hadn't caught the facial tumor yet because they were too young, Kaufman says. The new analysis indicates that devils surviving the facial tumor have a genetic advantage.

Storfer and colleagues found more than 90,000 DNA spots where a small number of devils have a different base (an information-carrying component of DNA) than most devils. The team looked for genetic differences — single nucleotide polymorphisms, or SNPs — that had been rare before the tumor swept through a population but then became common. Such a pattern could indicate that natural selection was picking out variants that helped devils beat the tumor.

Two regions of the genome in all three of the devil populations contain SNPs that fit the profile. Because all three populations had changes in the two regions, the changes probably didn't happen by



Disease wave Since 1996, an infectious facial tumor that kills Tasmanian devils has spread across Tasmania. DNA from three devil populations (red circles) suggests that some animals carry genetic resistance to the disease.

B. EPSTEIN *ET AL/NATURE COMMUNICATIONS* 2016

EARTH & ENVIRONMENT

Storm unleashes rare seismic wave

Tracking weak tremors could shed light on Earth's innards

BY THOMAS SUMNER

How the seafloor quivers under an intense storm called a "weather bomb" could help reveal Earth's innermost secrets.

Using a network of seismic sensors, seismologists in Japan detected a rare type of deep-Earth tremor originating from a rapidly strengthening cyclone over the North Atlantic Ocean. Tracking how these newfound shakes ripple through the globe will help geoscientists map the planet's depths, the researchers report in the Aug. 26 *Science*.

"We're potentially getting a suite of new seismic source locations that can be used to investigate the interior of the Earth," says Peter Bromirski, a geophysical oceanographer at the Scripps Institution of Oceanography in La Jolla, Calif., who wrote a commentary on the new research in the same issue of *Science*.

Tremors traveling through the ground speed up, slow down or change direction depending on the material they pass through. Measuring these movements from earthquake waves has allowed scientists to gather clues about the structure and composition of Earth's interior.

Some regions — the middle of tectonic plates under the ocean, for instance — don't see many quakes, though. Luckily, weather bombs can generate their own seismicity. Winds can stir up towering ocean swells. When two opposing ocean swells collide, they can send a pressure pulse down to the ocean floor. The pulse thumps the seafloor, producing seismic waves that penetrate deep into the planet.

Scientists had previously detected only one type of seismic wave generated by a weather bomb. Called a P wave, it causes a material to compress and stretch like an accordion in the same direction that the wave travels. Another variety, the S wave, has proved more elusive. S waves formed by storms are often weaker than P waves and cause material to ripple perpendicular to the wave's path. The effect is similar to when one end of a garden hose is jerked up and down, producing waves that travel along the hose's length.

Kiwamu Nishida of the University of Tokyo and Ryota Takagi of Tohoku University in Sendai, Japan, hunted for

chance, the researchers say. There hasn't been enough time for a helpful mutation to arise and spread across the island. So the variants were probably already present in a small number of animals and natural selection (via the tumor) weeded out the individuals that didn't carry them.

Those two genome regions contain seven genes, some of which have been shown to be involved in fighting cancer or controlling the immune system in other mammals. The team isn't sure which genes boost survival or how they work. The variants don't necessarily make devils completely immune to the tumor; the variants may just allow infected individuals to live long enough to pass on their genes, Storfer says. Other genes may also contribute to survival, he says.

Genetics may help researchers better predict how the disease will spread in remaining uninfected populations. Breeding programs could incorporate animals that carry the survival variants to build resistance.

Comparative genomicist Katherine Belov of the University of Sydney says the resistance genes shouldn't be bred into all devils. They need genetic diversity to cope with other diseases and unknown challenges down the line, she says. ■

weather bomb–related S waves using a network of 202 seismic stations in Japan. Typically, the waves are lost within Earth's natural seismic background noise. By combining and analyzing the data collected by the extra-sensitive seismometers, however, the researchers teased out the S wave signals.

The waves originated from a North Atlantic cyclone. That storm produced two types of S waves: SV waves (which shift material vertically relative to Earth's surface and can form from P waves) and SH waves (which shift material horizontally and have less clear origins).

Combining measurements of P, SV and SH waves will "ultimately provide better maps of Earth's mantle and maybe even the core," says Keith Koper, a seismologist at the University of Utah in Salt Lake City. ■

MATTER & ENERGY

New fabric could make cool clothes

Plastic covered in tiny pores lets heat out yet blocks light

BY MEGHAN ROSEN

Plastic cling wrap with nano-sized pores could give "cool clothes" a new meaning.

The material lets heat escape, instead of trapping it like traditional fabrics, Stanford University materials scientist Yi Cui and colleagues report in the Sept. 2 *Science*. It could help people keep cool in hot weather, Cui says, and even save energy by reducing the use of air-conditioning.

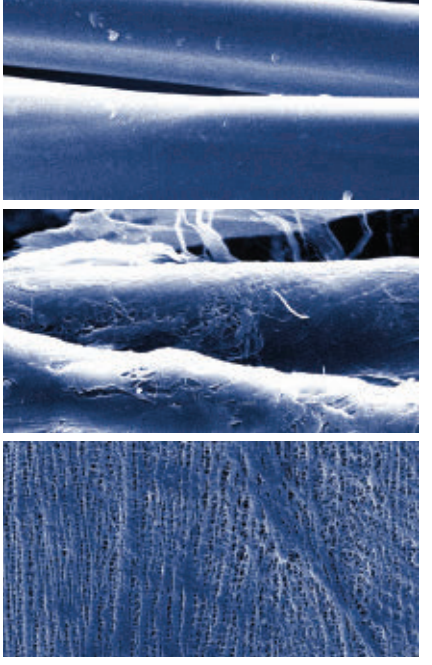
"It's a very bold new idea," says MIT physicist Svetlana Boriskina, who wrote an accompanying commentary. Demand for the new material could be far-reaching, she says. "Every person who wears clothes could be a potential user of this product."

Current cooling devices include wearable fans, which rely on evaporation to cool human skin. But skin also sheds heat in another way — as infrared radiation. Clothing holds this heat close to the body, Cui says. If infrared radiation could instead pass through fabric, he reasoned, people would feel a lot cooler.

But the fabric would have to be transparent only to infrared wavelengths. To visible light, it would need to be opaque. Otherwise, the clothing would be see-through.

Cui found just one material that satisfied both requirements: a commercially available plastic used in lithium-ion batteries. The material, nanoporous polyethylene, or nanoPE, is a cling wrap–like plastic that lets infrared radiation through. But unlike cling wrap, the material isn't clear: It blocks visible light.

Tiny pores speckled throughout the fabric act as obstacles to visible light, Boriskina says. When blue light, for example, hits the pores, it scatters. So do other colors. The light "bounces around in different directions and scrambles together," she says. To human eyes, the resulting color is white.



Traditional textiles like polyester (top) and cotton (middle) trap body heat, but a plastic material called nanoPE (bottom) lets heat escape. Researchers are looking at ways of using the material to make high-tech fabric.

The pores scatter visible light because they're both in the same size range: The diameters of the pores span 50 to 1,000 nanometers, and the wavelengths of visible light range from 400 to 700 nanometers. Infrared radiation emitted by the body as heat has a much larger wavelength, 7,000 to 14,000 nanometers, so the plastic's tiny pores can't block it.

The pores are kind of like small rocks at a beach, Boriskina says. They'll interfere with the motion of small waves, but big waves will wash right over.

Cui and colleagues tested nanoPE by laying it on a hot plate warmed up to human skin temperature, 33.5° Celsius. NanoPE raised the "skin" temperature by just 0.8 degrees (to 34.3° C). "But when you put on cotton, my God, it rose to 37," Cui says. "It's hot!"

The researchers also tried to make nanoPE more wearable than plastic wrap. They coated it with a water-wicking chemical, punched holes in it to make it breathable and layered it with cotton mesh. Now, the team is working on weaving the fabric to make it feel more like traditional textiles.

"Within five years, I hope someone will start wearing it," Cui says. "And within 10 years, I hope most people will be wearing it." ■

POLYESTER AND COTTON: JAMES LOOMIS/UNIV. OF AUCKLAND; NANOPE: Y. CUI GROUP/STANFORD UNIV.

BODY & BRAIN

Cancer moonshot priorities outlined

Panel of experts offers 10 research recommendations

BY LAURA BEIL

President Barack Obama's "Cancer Moonshot" now has a scientific flight plan. It calls for better cooperation among researchers and institutions, aggressive pursuit of immunotherapy and making better use of proven cancer prevention strategies. Called the Blue Ribbon Panel Report, the document was approved September 7 by the National Cancer Institute's advisory board.

Five months in the making, the report's 10 recommendations for research priorities were put together by a group of 28 cancer experts appointed last April. The report is the most specific direction yet for the moonshot (*SN: 4/2/16, p. 20*), launched when Obama announced the intention to make the United States "the country that cures cancer once and for all" in his State of the Union address in January. Vice President Joe Biden, whose son Beau died from brain cancer in 2015, has been leading the charge.

If the vice president formally adopts the recommendations, they could form the foundation for research grants awarded through the National Institutes of Health. But that depends largely on the U.S. Congress providing funding for the moonshot, which has not yet happened.

The report doesn't contain dramatic surprises or veer far off course from current cancer research. That's largely by design. The panel's goal was to come up with a plan to make "a decade's worth of cancer progress in five years" by hastening research in those areas with the most promise, and which stand to affect large numbers of patients. "We want it to be a pushy evolution, not a revolution," says Stan Gerson, director of the Case Comprehensive Cancer Center in Cleveland, who was not on the panel.

Gary Gilliland, president and director of the Fred Hutchinson Cancer Research Center in Seattle, agrees. "The most important concept here with the vice president's efforts is that he can serve as an accelerant at a time when we're at an inflection point in treating cancer," Gilliland says. "Within 10 years, if we don't get to a place where we've got curative approaches to essentially all cancers, then we've failed — and shame on us."

If there is any underlying thread to the report, it is that progress depends on greater cooperation in research and improvements in patient engagement.

For treatment, the report singles out immunotherapy, which harnesses a patient's own immune system to fight cancer. The strategy is widely regarded as one of the most significant advances in cancer care, even though so far only 10 to 20 percent of patients receiving such treatments show a long-term benefit. "When I speak to my patients, I tell them that the greatest risk is disappointment," says David Gerber, a medical oncologist at the University of Texas Southwestern Medical Center in Dallas. Nonetheless, he and others remain optimistic about immunotherapy's potential, and he agrees with recommendations to speed up research. In proposing a dedicated immunotherapy clinical trials network, the report states that current treatments "represent only the tip of the iceberg of what is possible."

> "Within 10 years, if we don't get to a place where we've got curative approaches to essentially all cancers, then we've failed — and shame on us."
>
> **GARY GILLILAND**

Since the moonshot began, Biden has crisscrossed the country, touring cancer research centers, holding photo ops and meeting with doctors. One theme he has stressed at these events, and which is reflected in the panel's report, is the need for better data sharing. Traditionally, raw scientific data remain the property of the institutions and researchers who conduct studies. But this can impede collaboration — between institutions or across disciplines — making it harder to find patterns within genetics and biology that might reveal how cancer appears and grows.

The new report acknowledges the problem: "Our ability to accelerate progress against cancer demands that researchers, clinicians and patients across the country collaborate in sharing their collective data and knowledge about the disease." Among the recommendations is the creation of a National Cancer Data Ecosystem, a one-stop, free collection of data that will allow patients to upload and receive data about their specific type of tumor.

While Obama heralded the moonshot as a path to curing cancer, Gerson would also like to see more scientists take on less flashy issues, such as prevention. "How do we get people to stop smoking?" he says. "We're not doing it well."

The panel did acknowledge the importance of prevention. For instance, the report notes low rates of adoption for the human papillomavirus vaccine, which protects against the virus that causes cervical and other cancers, and for screening for colorectal cancer, or CRC. "If we understood better the reasons these proven cancer prevention strategies are not being widely used and how we could increase uptake," the report states, "we could reduce deaths due to cervical cancer by 90 percent, CRC by up to 70 percent and lung cancer by as much as 95 percent." The authors also note that many people carry inherited genetic risks for cancer and don't know it; improved screening for such genetic predisposition might save lives.

The report will eventually be forwarded to the vice president and the moonshot task force he oversees. But what happens after this year depends largely on Congress. The panel did not say how much the recommendations would cost. In his budget request for fiscal year 2017, Obama asked for $680 million in additional funding to pay for the moonshot. ■

See the full list of recommendations at **bit.ly/SN_CancerMoonshot**

LIFE & EVOLUTION

Dog brains divide language tasks

As in humans, meaning and intonation interpreted separately

BY LAUREL HAMERS

Dogs process speech much like people do. Meaningful words like "good boy" activate the left side of a dog's brain regardless of tone of voice; a region on the right side responds to intonation, scientists report in the Sept. 2 *Science*.

Similarly, humans process the meanings of words in the left hemisphere of the brain and interpret intonation in the right hemisphere. That lets people sort out words that convey meaning from random sounds that don't. It has been unclear whether language abilities were a prerequisite for that division of brain labor, says neuroscientist Attila Andics of Eötvös Loránd University in Budapest.

Dogs are ideal subjects for understanding speech processing because of their close connection to humans, Andics says. "Humans use words towards dogs in their everyday, normal communication, and dogs pay attention to this speech in a way that cats and hamsters don't," he adds.

Andics and colleagues trained dogs to lie still for functional MRI scans, which can reveal when and where the brain responds to a specific cue. The dogs heard recordings of a trainer saying either meaningful praise words like "well done," or neutral words like "such" or "yet," either in an enthusiastic or neutral tone.

Dogs had increased activity in the left sides of their brains in response to meaningful words but not neutral ones. The area on the right side reacted to intonation regardless of the words' meaning.

When the dogs heard praising words in an enthusiastic tone, neural circuits associated with reward became more active. It turns out an excited "Good dog!" might have the same effect as giving a dog a treat. Praise words or enthusiastic intonation alone didn't have the same effect.

Humans stand out from other animals in their ability to use language — that is, to rearrange sequences of sounds to convey different meanings. But the findings suggest that the ability to hear these arbitrary sequences and link them to meaning isn't a uniquely human ability.

"I love these results, as they point to how well domestication has shaped dogs to use and track the very same cues that we use to make sense of what other people are saying," says Laurie Santos, a cognitive psychologist at Yale University.

Humans and dogs have been companions for only about 30,000 years. That's too short for lateralized speech processing to evolve, Andics thinks. He suspects that some older underlying neural mechanism for processing meaningful sounds is present in other animals, too. ■

By training dogs to undergo functional MRI brain scans, researchers learned that dogs and humans parse speech in similar ways.

ENIKŐ KUBINYI

Watch dogs get brain scans at **bit.ly/SN_dogbrains**

BODY & BRAIN

Bacterial bubbles linked to stillbirth

Strep B's toxic sacs cause problems in pregnant mice

BY AMY MCDERMOTT

In pregnant women, a normally benign bacterium emits tiny toxic balloons that can cause premature labor and stillbirth, a new study suggests.

Called Group B *Streptococcus*, the bacterium lives in the vaginas of 20 to 30 percent of pregnant women. Strep B doesn't typically cause problems in the lower genital tract. But in pregnant mice, and perhaps pregnant women, Strep B secretes protein-filled balloons that can travel to the uterus. Those balloons cause inflammation and weaken the amniotic sac, researchers report September 1 in *PLOS Pathogens*.

It's been clear that Strep B can cause problems during pregnancy, but no one knew it can make long-range weapons. The danger is "not just the bug alone," says microbiologist Lakshmi Rajagopal of Seattle Children's Research Institute, "but also something the bug produces."

Using a scanning electron microscope, researchers from the Indian Institute of Technology Bombay detected small orbs budding off of Strep B bacteria. Inside those little fluid-filled balloons, the researchers found corrosive proteins. The scientists also found that, in mice, the balloons can migrate from the vagina into the uterus. There, the orbs trigger cell death, degrade collagen in the amniotic sac (making it more likely to tear) and can cause inflammation, premature birth and stillbirth. Almost all pups of pregnant mice with bacterial balloons injected into their amniotic sacs either died in utero or were born prematurely.

It's unclear why Strep B makes such toxins. They may help Strep B compete against other bacterial species in turf wars, says Anirban Banerjee, a microbiologist and study coauthor. Researchers are working to understand exactly how Strep B and other microbes secrete toxic balloons.

In the meantime, these new findings "emphasize the need to develop an approved vaccine" against Strep B, says Rajagopal. Doctors test pregnant women for the bacterium between 35 and 37 weeks. Strep-positive women take antibiotics during labor to prevent infecting newborns. But the bacteria can quickly return, so antibiotics aren't a permanent fix. Understanding how and why microbes make these teensy weapons could help doctors discover how to block strep infections in the first place. ■

ATOM & COSMOS

LHC finds no signs of supersymmetry

Lack of new particles suggests need to consider other theories

BY EMILY CONOVER

A beautiful but unproved theory of particle physics is withering in the harsh light of data.

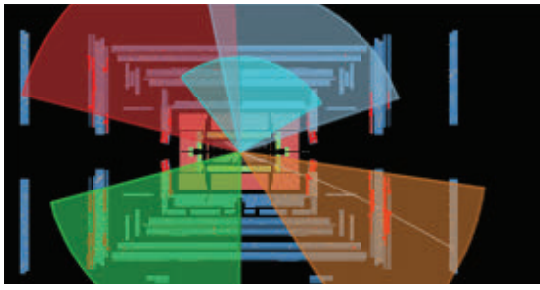
For decades, many particle physicists have devoted themselves to the beloved theory, known as supersymmetry. But it's beginning to seem that the zoo of new particles that the theory predicts — heavier cousins of known particles — may live only in physicists' imaginations. Or if such particles, known as superpartners, do exist, they're not what physicists expected.

New data from the world's most powerful particle accelerator — the Large Hadron Collider, now operating at higher energies than ever before — show no traces of superpartners. And so the theory's most fervent supporters have begun to pay for their overconfidence. On August 22, a group of physicists who wagered that the LHC would quickly confirm the theory settled a 16-year-old bet. In a session at a physics meeting in Copenhagen, theoretical physicist Nima Arkani-Hamed ponied up, presenting a bottle of cognac to physicists who bet that the new particles would be slow to materialize, or might not exist at all.

Whether their pet theories are right or wrong, many theoretical physicists are simply excited that the new LHC data can finally anchor existing ideas to reality. "Of course, in the end, nature is going to tell us what's true," says theoretical physicist Yonit Hochberg of Cornell University, who spoke on a panel at the meeting.

Supersymmetry is not ruled out by the new data, but if the new particles exist, they must be heavier than scientists expected. "Right now, nature is telling us that if supersymmetry is the right theory, then it doesn't look exactly like we thought it would," Hochberg says.

Since June 2015, the LHC, operated by the European particle physics lab CERN near Geneva, has been smashing protons together at the highest energies yet: 13 trillion electron volts. Physicists had been eager to see if new particles would pop out at these energies. But the results have agreed overwhelmingly with the standard model, the established theory that describes the known particles and their interactions.



Physicists at the Large Hadron Collider analyzed this collision as part of their search for supersymmetric particles. In this visualization, rectangles indicate parts of the detector; the five cones indicate jets, or sprays of particles produced in the collision.

It's a triumph for the standard model, but a letdown for physicists who hope to expose cracks in that theory. "There is a low-level panic," says theoretical physicist Matthew Buckley of Rutgers University in Piscataway, N.J. "We had a long time without data, and during that time, many theorists thought up very compelling ideas. And those ideas have turned out to be wrong."

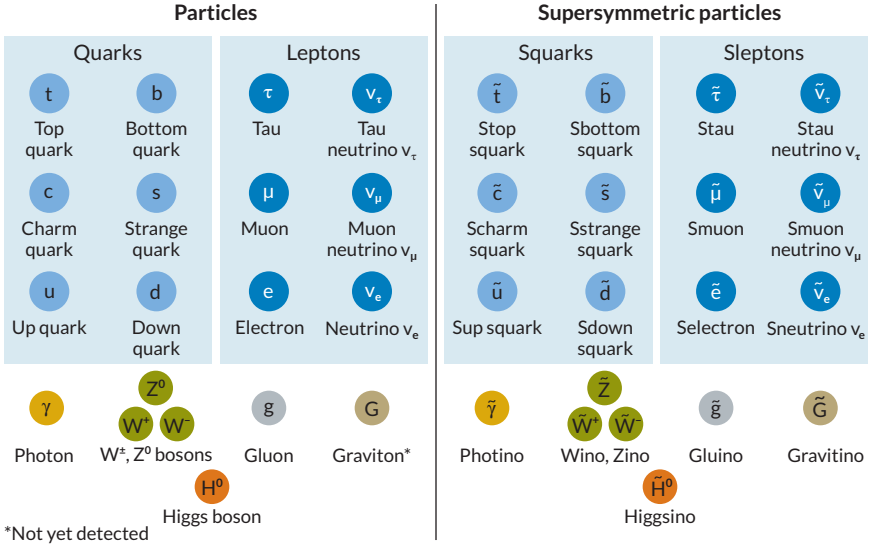
Physicists know that the standard model must break down somewhere. It doesn't explain why the universe contains more matter than antimatter, and it fails to pinpoint the origins of dark matter and dark energy, which make up 95 percent of the matter and energy in the cosmos.

Even the crowning achievement of the LHC, the discovery of the Higgs boson (*SN: 7/28/12, p. 5*), hints at the issues with the standard model. The mass of the Higgs boson, at 125 billion electron volts, is vastly smaller than theory predicts. That mass, physicists worry, is not "natural" — the factors that contribute to the Higgs mass must be finely tuned to cancel each other out and keep the mass small (*SN Online: 10/22/13*).

Among the many theories that attempt to fix the standard model's woes, supersymmetry is the most celebrated. "Supersymmetry was this dominant paradigm for 30 years because it was so beautiful, and it was so perfect," says theoretical physicist Nathaniel Craig of the University of California, Santa Barbara. But supersymmetry is becoming less appealing as the LHC collects more collisions with no signs of superpartners.

FROM TOP: ATLAS COLLABORATION; J. HIRSHFELD

Particle partners Supersymmetry predicts that the known fundamental particles in physics (left) have superparticle partners (right). Experiments at the Large Hadron Collider have yet to find any evidence of these predicted partners.



Supersymmetry's appeal is that it solves three major problems in physics: It explains why the Higgs is so light; it provides a particle that serves as dark matter; and it implies that the three forces of the standard model (electromagnetism and the weak and strong nuclear forces) unite into one at high energies.

If a simple version of supersymmetry is correct, the LHC probably should have detected superpartners already. As the LHC rules out such particles at ever-higher masses, retaining the appealing properties of supersymmetry requires increasingly convoluted theoretical contortions, stripping the idea of some of the elegance that first persuaded scientists to embrace it. "If supersymmetry exists, it is not my parents' supersymmetry," Buckley says. "That kind of means it can't be the most compelling version."

Still, many physicists are adopting an attitude of "keep calm and carry on." They aren't giving up hope that evidence for the theory — or other new particle physics phenomena — will show up. "I am not yet particularly worried," says theoretical physicist Carlos Wagner of the University of Chicago. "We just started this process." The LHC has delivered only 1 percent of the data it will collect over its lifetime. Hopes of quickly finding new phenomena were too optimistic, Wagner says.

Experimental physicists, too, maintain that there is plenty of room for new discoveries. But it could take years to uncover them. "I would be very, very happy if we were able to find some new phenomena, some new state of matter, within the first two or three years" of running the LHC at its boosted energy, Tiziano Camporesi of the LHC's CMS experiment said during a news conference at the International Conference on High Energy Physics, held in Chicago in August. "That would mean that nature has been kind to us."

But other LHC scientists admit they had expected new discoveries by now. "The fact that we haven't seen something, I think, is in general quite surprising," said Guy Wilkinson, spokesperson for the LHCb experiment. "This isn't a failure — this is perhaps telling us something." The lack of new particles forces theoretical physicists to consider new explanations for the mass of the Higgs. To be consistent with data, those explanations can't create new particles the LHC should already have seen.

Some physicists — particularly those of the younger generations — are ready to move on to new ideas. "I'm personally not attached to supersymmetry," says David Kaplan of Johns Hopkins University. Kaplan and colleagues recently proposed the "relaxion" hypothesis, which allows the Higgs mass to change, or relax, as the universe evolves. Under this theory, the Higgs mass gets stuck at a small value, never reaching the high mass otherwise predicted.

Another idea, which Craig favors, is a family of theories by the name of "neutral naturalness." Like supersymmetry, this idea proposes symmetries of nature that solve the problem of the Higgs mass, but it doesn't predict new particles that should have been seen at the LHC.

One particularly controversial idea is the multiverse hypothesis. There may be innumerable other universes, with different Higgs masses in each. Perhaps humans observe such a light Higgs because a small mass is necessary for heavy elements like carbon to be produced in stars. People might live in a universe with a small Higgs because it's the only type of universe life can exist in.

It's possible that physicists' fears will be realized — the LHC could deliver the Higgs boson and nothing else. Such a result would leave theoretical physicists with few clues to work with. Still, Hochberg says, "if that's the case, we'll still be learning something very deep about nature." ■

JPL-CALTECH/NASA, SWRI, MSSS

ATOM & COSMOS

Juno sends back first close-ups of Jupiter

Swirling clouds blanket Jupiter's northern and southern poles in the first closeup images of the planet taken by NASA's Juno spacecraft. Such intimate views of Jupiter have never been seen before.

Juno snapped a shot of the gas giant's northern side (shown above) in an August 27 flyby, from a distance of 195,000 kilometers. The prominent bands that ring Jupiter's middle fade at the poles, replaced with hurricane-like whorls. The poles are nearly invisible from Earth, making a specialized space mission like Juno necessary to capture such rare images.

During the flyby, Juno's eight science instruments were furiously collecting data. An infrared camera imaged Jupiter's southern aurora, observing the phenomenon in detail for the first time. And another instrument recorded 13 hours of radio emissions from the auroras.

Juno will study Jupiter's interior, so scientists can better understand what lies beneath the planet's clouds (*SN: 6/25/16, p. 16*). The spacecraft arrived at Jupiter on July 4. Its science instruments were switched off during its approach, making scientists wait for an image. — *Emily Conover*

ATOM & COSMOS

Water plays big role in shaping dwarf planet Ceres

Ice volcanoes, patches of water ice and a slew of hydrated minerals paint a picture of dwarf planet Ceres as a geologically active world — one where water has played a starring role. That's the theme of six papers in the Sept. 2 *Science* that describe data collected by the Dawn spacecraft.

A 4-kilometer-high mountain dubbed Ahuna Mons, with its bowl-shaped summit and ridged flanks, has the appearance of a cryovolcano — one that erupts water instead of magma. The relatively young Oxo crater also appears to be home to splotches of frozen water. Given that ice should last only tens to hundreds of years on Ceres' surface, the patches must be recent additions, possibly exposed by a landslide or impact with a meteorite. The surface is also slathered with a class of minerals known as phyllosilicates — silicon-bearing substances that form in the presence of water — which further support the idea that water has been present throughout Ceres' history.

Ceres is the largest body between Mars and Jupiter. Dawn has been orbiting Ceres since March 6, 2015 (*SN: 4/4/15, p. 9*), studying its geology and composition to better understand the formation of rocky worlds. — *Christopher Crockett*

LIFE & EVOLUTION

Bonobos adept at nut cracking

Bonobos — chimpanzees' sister species — don't get the credit they deserve as tool users.

Bonobos in a sanctuary's protected forests in the Democratic Republic of Congo crack nuts with stones nearly as well as wild chimps in other parts of Africa do, researchers report online August 26 in the *American Journal of Primatology*. Wild bonobos have rarely been observed using tools and have never been reported to pound open nuts with stones (*SN: 9/19/15, p. 22*).

All 18 adult and adolescent bonobos tracked during April and May 2015 cracked oil palm nuts with stones of various sizes that researchers had placed near oil palm trees, says a team led by Johanna Neufuss of the University of Kent in England. Bonobos chose pounding stones well-suited to busting palm oil nutshells. These animals employed 15 grips to hold nut-cracking stones, including 10 grips not previously observed in nonhuman primates. — *Bruce Bower*

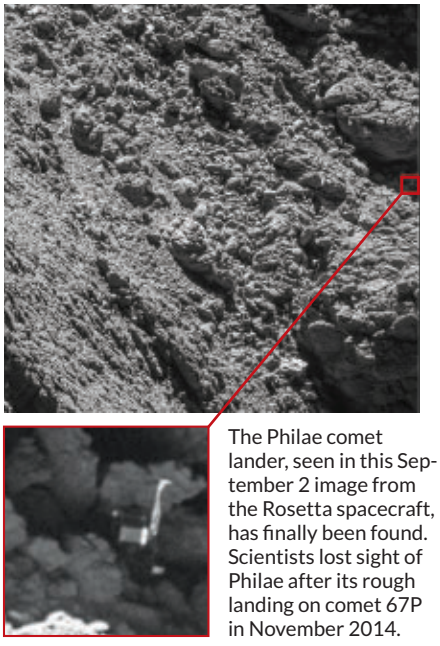
ATOM & COSMOS

Philae lander spotted on comet 67P

Philae has been found, nestled in a shadowy crevice on comet 67P/Churyumov-Gerasimenko. The comet lander, lost since its tumultuous touchdown on the comet on November 12, 2014, turned up in images taken by the Rosetta orbiter on September 2.

Philae is on its side with one leg sticking out into sunlight. Its cockeyed posture probably made it difficult for Philae to reliably get in touch with Rosetta, explaining why scientists had trouble reestablishing communication. The discovery came about a month before the end of the Rosetta mission; the orbiter was scheduled to land on the comet on September 30 and then shut down.

Philae spent just a few days transmitting data from the comet's surface (*SN: 8/22/15, p. 13*). It had a rough landing, bouncing twice before stopping. Sitting in the shadow of a cliff, Philae was unable to use solar power to recharge its battery. Rosetta picked up intermittent communication in June and July 2015. Since January, temperatures on the comet have been too chilly for Philae's electronics; scientists stopped listening for radio signals in July. — *Christopher Crockett*



The Philae comet lander, seen in this September 2 image from the Rosetta spacecraft, has finally been found. Scientists lost sight of Philae after its rough landing on comet 67P in November 2014.

ROSETTA/ESA, MPS FOR OSIRIS TEAM, MPS, UPD, LAM, IAA, SSO, INTA, UPM, DASP, IDA

GENES & CELLS

Genes influence coffee drinkers' habits

Coffee consumption may be in the genes.

Activity of a gene that lowers levels of caffeine-degrading enzymes in the liver is associated with how much coffee people drink, researchers say August 25 in *Scientific Reports*. The more active the gene, called *PDSS2*, the less coffee people drink.

Researchers tracked the coffee-drinking habits of 1,207 people in remote Italian villages and 1,731 people from the Netherlands. The researchers looked for an association between sipping java and people's genetic makeup. The Dutch quaffed, on average, more than five cups of filtered coffee per day; the Italians sipped about two cups of espresso.

In the Italians, 21 genetic variants in DNA surrounding the *PDSS2* gene were linked to coffee consumption, Nicola Pirastu of the University of Edinburgh and colleagues found. The strongest-acting variant changed espresso consumption by 1.09 cups per day. Only five of the variants found in the Italians seemed to alter coffee drinking in Dutch people and did so to a lesser extent.

Given the larger size of the cups, Dutch people consume about three times as much caffeine per cup as the Italians do. Other caffeine-processing genes, such as *CYP1A2* (*SN Online: 4/8/11*), may influence coffee consumption habits at higher caffeine doses, while *PDSS2* limits low-level caffeine intake, the researchers speculate.
— *Tina Hesman Saey*

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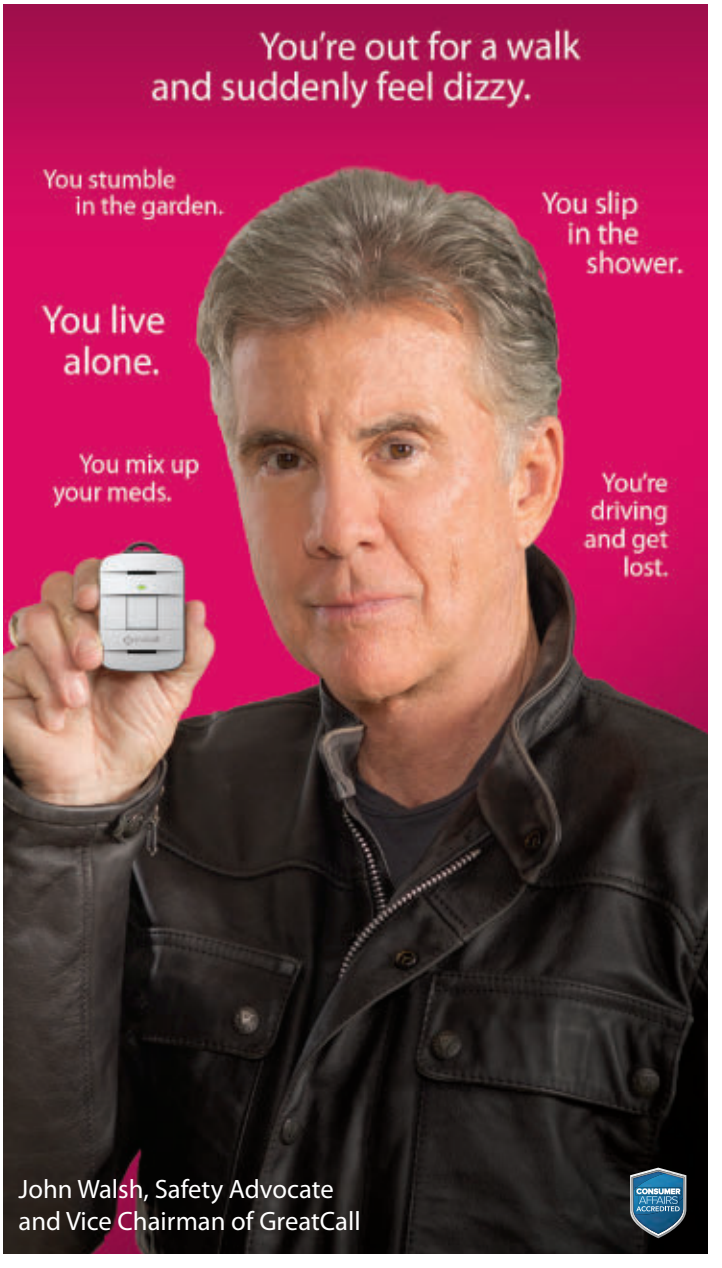

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THE SN 10: Scientists TO WATCH

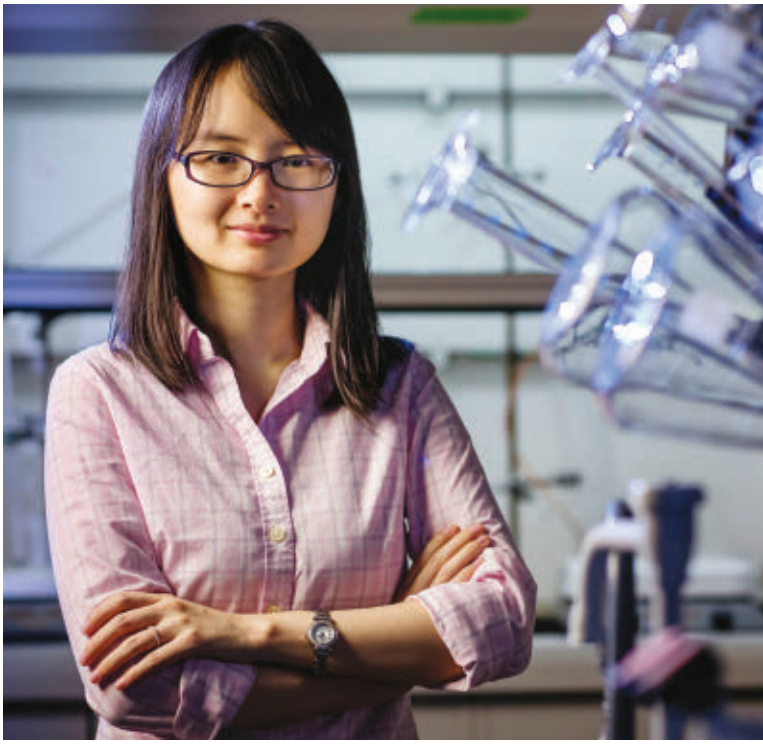
Meet the minds making the next big discoveries

In a recent poll, more than four-fifths of U.S. adults could not name a living scientist. Of those who could, the plurality (40 percent) named Stephen Hawking. (The next highest response was Neil deGrasse Tyson, followed by Jane Goodall.) No offense to the rightfully famous Hawking, but at *Science News* we would like to change these results. Why aren't more scientists, particularly those who are young and accomplished, household names? Where, we want to know, are the Taylor Swifts of science?

You'll find some of them in the pages that follow. For the second year in a row, *Science News* is highlighting 10 early- and mid-career scientists on their way to widespread acclaim. The SN 10: Scientists to Watch includes a laser physicist with laserlike focus, a materials scientist challenging what it means to be alive and a computational biologist willing to get personal with his microbiome, among many others who are making important advances in their chosen fields. Five of the scientists are featured in full profiles here; full stories on the others are at **www.sciencenews.org/SN10**.

Though none of these scientists have recorded hit singles — at least not that our reporting uncovered — all were nominated by a Nobel laureate or recently elected member of the National Academy of Sciences. And all were age 40 or younger at the time of nomination.

These remarkable individuals have diverse personalities and talents: They are tenacious and creative, practical-minded and dreamers. They are lab animals and data heads. Some seek simplicity, others complexity. If there is one unifying trait, though, it would have to be their passion — a quality so cliché among successful scientists that it has to be true. As Marie Curie famously wrote in a letter to her sister, "Sometimes my courage fails me and I think I ought to stop working.... But I am held by a thousand bonds." She did not know, she confessed, whether she could live without the laboratory. — *Elizabeth Quill*



L. BRIAN STAUFFER/UNIV. OF ILLINOIS NEWS BUREAU

Making matter come alive

By Meghan Rosen

Qian Chen, 30
MATERIALS SCIENTIST
UNIVERSITY OF ILLINOIS

In a darkened room, bathed in the glow of green light, materials scientist Qian Chen watches gold nanorods dance. They wiggle across a computer screen displaying real-time video from a gigantic microscope — a tall, beige tube about as wide as a telephone pole.

Chen has observed these and other minuscule specks of matter swimming, bumping into one another and sometimes organizing into orderly structures, just like molecules in cells do. By pioneering the design of new biologically inspired materials, she's exploring what it means to be "alive." Next, Chen wants to get an up-close and personal view of cellular molecules themselves: the nimble, multitasking proteins that work day and night to keep living organisms running.

At age 30, Chen is already racking up high-profile publications and turning some far-out ideas into reality. Her ultimate goal: To mimic the machinery that living cells have already perfected. To create life, or something like it, out of nonliving materials.

"If you can see it, you can start to understand it," Chen said when I visited her lab at the University of Illinois at Urbana-Champaign earlier this year. "And if you understand it, you can start to control it."

Chen didn't always want to be a scientist. Growing up in China, she imagined one day becoming a writer. In middle school, she wrote an award-winning story about a girl who

figures out how to repair the ozone layer. "My idea was to get some material that can be stretched, like the skin of the balloon," Chen says.

Her interest in inventing new and unusual materials took off years later, in the United States. After graduating from college in China in 2007 — Chen was the first in her family to do so — she headed to Illinois to work with materials scientist Steve Granick.

From the start, Chen stood out. "She made hard things look easy," says Granick, now at the Ulsan National Institute of Science and Technology in South Korea. He recalls one experiment in particular, when Chen performed a feat some scientists thought impossible: She got thousands of tiny beads to form an open and orderly two-dimensional structure — all by themselves.

Chen had been studying colloidal particles, microscopic specks roughly a micrometer in size. People normally think of these particles as a component of paint, not all that interesting.

But Chen had the idea to cover the particles with a kind of sticky coating that acted something like Velcro. When the particles bumped into one another, they stuck together. At first, "It looked like a mess, like a failed experiment," says Granick. "Most graduate students would have just chalked it up to a mistake and gone home."

After a day of knocking around in solution, sticking together and tearing apart, the particles finally settled into something stable. The special coating and the way Chen applied it (capping the top and bottom of each particle) led to a "kagome lattice," something sort of like a honeycomb. Never before had scientists coaxed colloidal particles into such an open, porous framework. Usually, the particles pack together more tightly, like apples stacked on the shelf at a grocery store, Chen says.

That work led in 2011 to a publication in *Nature*: "Directed self-assembly of a colloidal kagome lattice." A week earlier, Chen and Granick had published a different paper in *Science*, "Supracolloidal reaction kinetics of Janus spheres," about particles that self-assemble into a twisting chain, or helix. At the time, Chen was 24.

"Her work is at the leading edge," says Penn State chemist Christine Keating. "She's so full of enthusiasm for science, and energy and creative ideas."

Exactly how such particles might one day be used is still anybody's guess. Some researchers envision self-assembling materials building smart water filters or adaptable solar panels that change shape in response to the sun. But the full range of possibilities is hard to fathom. Chen is "trying to invent the rules of the game," Granick says. "She's laying the groundwork for future technologies."

Her next big focus will take her field from self-assembly 101 to the master class level, by mimicking how biological molecules behave. But first she has to see them in action.

Into the cell

In 2012, Chen traveled west to the University of California, Berkeley to work with National Medal of Science winner Paul Alivisatos on a new microscopy technique.

Scientists today can view the details of proteins and DNA close up under a microscope, but the results are typically still-life images, frozen in time. It's harder to get action shots of proteins morphing in their natural, fluid world. That view could unveil what roles different protein parts play.

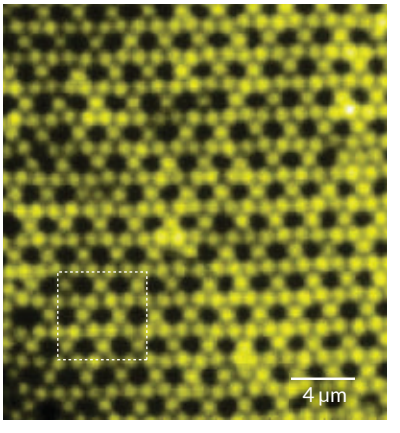
Even a technique that won its developers a Nobel Prize in 2014 (*SN: 11/2/14, p. 15*) — it relies on fluorescent molecules to illuminate a cell's moving parts — can't always reveal the intricacies of proteins, Chen says. They're just glowing dots under the microscope. Imagine, for example, looking at a dump truck from an airplane window. You can't see how the truck actually works, how the pistons help lift the bed and the hinges open the tailgate.

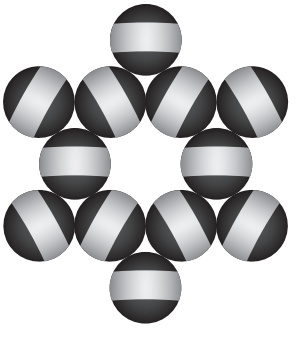
"I use this as inspiration," Chen says, grabbing her laptop and starting up a video that may well be the fantasy of anyone exploring biology's secret world. The computer animation shows molecules whizzing and whirling deep inside a cell. Gray-green blobs snap together in long chains and proteins haul giant, gelatinous bags along skinny tracks. No one yet has gotten a view as clear as this hypothetical one, but a technique Chen is now helping to develop at Illinois could change that.

It's called liquid-phase transmission electron microscopy, and it's a slick twist on an old method. In standard TEM, researchers create subnanometer-scale images by shooting an electron beam through samples placed in a vacuum. But samples have to be solid — still as stone — because liquids would evaporate.

By sandwiching beads of liquid between thin sheets of graphene, though, Chen gets around the problem. It's like

Pattern recognition After a sticky coating was applied, colloidal particles came together in what's known as a kagome lattice (below, left). The striped pattern of the coating led to a specific particle orientation (particles in white box are illustrated at right).



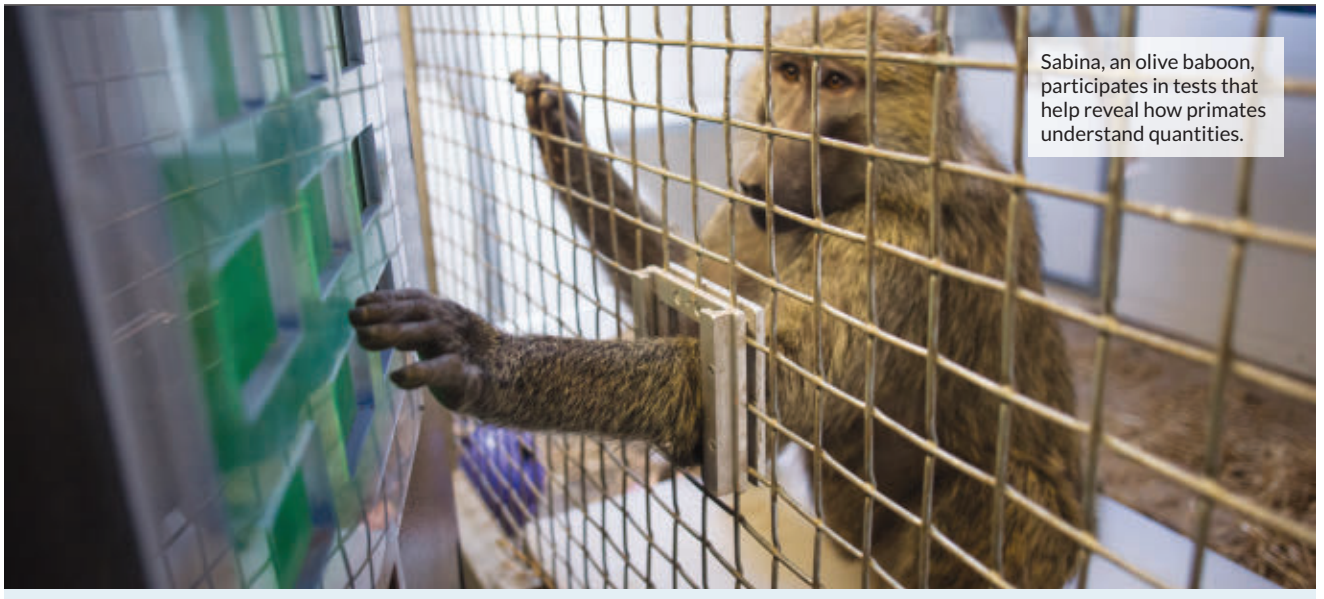


Q. CHEN, SUNG CHUL BAE, S. GRANICK/*NATURE* 2011

putting droplets of water in a plastic baggie. The liquid doesn't dry up, so researchers can observe the particles inside jittering around. Chen has used the technique to see gold nanorods assembling tip-to-tip and DNA-linked nanocrystals moving and rotating in 3-D. Now, she may be on the verge of a big advance.

With liquid-phase microscopy, Chen is attempting to see cellular machinery with a clarity no scientist has achieved before. She is cautious about revealing too many details. But if Chen succeeds, she may be on her way to cracking the code that links biological structure to function — figuring out the parts of a protein, the pistons and hinges, that let it do its specific job. Knowing the structural building blocks of life, she says, will help scientists create them — and everything they can do — out of artificial materials.

"We're not there yet," Chen says, "but that's the big dream." ■



Sabina, an olive baboon, participates in tests that help reveal how primates understand quantities.

BOTH: J. ADAM FENSTER/UNIV. OF ROCHESTER

Bold strategies seek origins of numerical thinking

Jessica Cantlon, 40
COGNITIVE NEUROSCIENTIST
UNIVERSITY OF ROCHESTER

Big question: Jessica Cantlon wants to know how humans understand numbers and how that understanding evolved. Her study subjects are among the most unpredictable — nonhuman primates and children as young as age 3. Both groups participate in behavioral tests that require them, for example, to track relative quantities as researchers sequentially add items to cups. The kids also go into the MRI machine, where Cantlon's team images their brains. "If you have different hypotheses and you want to come up with the perfect experiment that distinguishes them, that is something she is very good at thinking about," says Steve Piantadosi, a computational neuroscientist at the University of Rochester. "She is a great combination of critical and creative."

Claim to fame: In her most attention-grabbing work, Cantlon studied activity in the brains of children while they watched *Sesame Street* clips that dealt with number concepts. An unexpected success, the study showed that monitoring brain activity during everyday types of experiences can yield meaningful data. Kids with activity more closely resembling adults' activity performed better on mathematical aptitude tests. "It was the clearest, cleanest — did not have to come out this way — result," Cantlon says. In another study, reported last year, her team found that baboons keep tabs on approximate quantities of peanuts as researchers increase those quantities (*SN Online: 5/17/15*), a kind of "protocounting" that might offer clues to the roots of human counting.

Backstory: Questions about where humans come from have interested Cantlon for a long time. During college, she went on an archaeological dig in Belize and studied lemurs in Madagascar. After graduation, she observed mountain gorillas in Rwanda, detailing their behavior every 10 minutes. "What they were thinking was something that was constantly on my mind," she says. " 'How are we similar? Are you thinking what I'm thinking?' " Though she might have succeeded in any number of careers, she wanted exploration to be a big part of her life: "I don't think doing a less exotic type of work would have been as satisfying." — *Elizabeth Quill*

Read more full SN 10 profiles at **www.sciencenews.org/SN10**

A gut check gets personal

By Tina Hesman Saey

Lawrence David, 33
COMPUTATIONAL BIOLOGIST
DUKE UNIVERSITY

A Jim Carrey movie inspired computational biologist Lawrence David to change the course of his research. As a graduate student, David saw *Yes Man*, a 2008 film in which Carrey's character is forced to say yes to all propositions.

David thought the movie's message about opening yourself to new experiences, even uncomfortable ones, might make science more exciting than it already was. "Only good things would happen if I loosened up and said yes to everything," he says.

The next day, his graduate mentor at MIT, Eric Alm, was talking about the brand-new science of the human microbiome, the collection of bacteria, viruses and other microscopic organisms inhabiting the human body. What someone ought to do, Alm suggested, is sample a person's feces every day for a year to see whether the microbiome changes. "I had just seen the movie, so I said, 'Well, I guess I have to say yes now,'" David recalls.

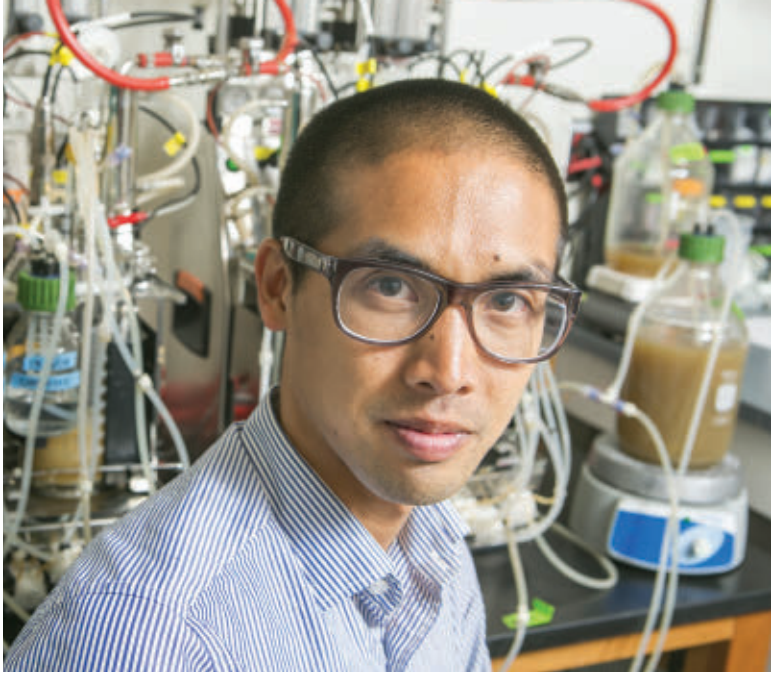
David took Alm's suggestion a step further by chronicling *his own* microbiome, collecting his feces every day in "plastic hats that look like something the Flying Nun would wear." He washed his mouth with a chemical solution and spit into a tube to harvest mouth bacteria, popping all the samples into his refrigerator or freezer until he could get them to the lab. He customized an iPhone diary app so he and Alm, who joined the study, could track 349 different health and lifestyle measures, which included the timing and consistency of bowel movements, sleep quality and duration, blood pressure, weight, vitamin use and mood. They noted, in detail, the foods they ate, symptoms of any illnesses and medications used to treat those illnesses. By the end of the year, David had "10,000 measurements of how two people lived their lives."

David, now 33 and at Duke University, regularly opens himself to new scientific challenges, though they aren't always quite so personal. Before finishing his degree at MIT, he had already initiated one new field of research and delved into several others outside his expertise.

Awards committees and granting organizations have taken note. David has won the Beckman Young Investigator award and the Searle Scholars award, which support cutting-edge work by young scientists. Fresh out of graduate school, he became a junior fellow at Harvard, where he led his own research.

"He has an ability to see what the problem is and just get it done in the most straightforward way possible," Alm says.

David spent most of his graduate student years in Alm's lab writing and running computer code that calculated the ancient birth dates of genes, reproducing the most likely evolutionary histories of gene families and predicting capabilities of ancient microbes. Alone that would have been a nice contribution; many researchers thought untangling those relationships would be too computationally complex, Alm says.



LESLIE TODD/DUKE PHOTOGRAPHY

But to get the full picture, David had to expand into other fields, working with geologists and geochemists to determine whether his predictions made sense in light of Earth's geologic history. In a study that birthed a new field by marrying geochemistry and genetics, he and colleagues discovered that genes encoding oxygen-producing proteins appeared hundreds of thousands of years before oxygen began accumulating in early Earth's atmosphere (*SN Online: 12/21/10*). For a study published in *Science* in 2008, he also delved into ecology, investigating how ocean microbes evolve into separate species without the physical boundaries that would keep them from mixing.

Population flux

The personal microbiome challenge was an unprecedented look at how friendly bacteria change over time and with lifestyle and dietary choices (see Page 32). Long known to play an important role in digestion, the gut microbiome has recently been implicated in health conditions including heart disease, obesity and asthma, and may even influence behavior (*SN: 4/2/16, p. 23*). Many people have suggested that humans and their microbes are so interdependent, they should be considered composite organisms (*SN: 1/11/14, p. 14*).

David, Alm and colleagues presented the results of their study in 2014 in *Genome Biology*. They found that the gut microbiome remains stable for months, but some events, such as travel, illness or changing the fiber content of the diet, can rapidly change the mix of gut microbes. Only a handful of studies have ever been done on this fine of a timescale, Alm says.

A project that would have made others hold their noses "might have been the most enjoyable thing I've done in science," David says. The microbiome analysis relied on computer tools similar to ones he had used as an undergraduate researcher at Columbia University, making it intellectually satisfying.

But the real appeal was how others responded to the work. "People were immediately captivated by the work, and would start to tell me about their own gastrointestinal histories, odd things they had eaten and how that affected the bacteria in their

gut," David says. People sometimes asked his advice on what to eat to keep their gut microbiomes healthy, a question for which he didn't have a clear answer. "There's an irony to this," he says. His voice drops to a whisper as he confesses: "I love junk food.... I shouldn't be a poster child."

Hooked on the microbiome, David began studying other people's bacteria with the help of Peter Turnbaugh, a microbiologist then at Harvard and now at the University of California, San Francisco. By intentionally manipulating people's diets, the researchers found that it takes only a day for a major dietary change, such as a meat-eater going vegetarian, to shift the composition of gut bacteria. The results, which surprised researchers who had thought such shifts would be more gradual, were reported in *Nature* in 2013 (*SN Online: 12/11/13*).

When he arrived at Duke in 2013 to start his own lab, David had a strong track record of developing computational tools to analyze complex datasets, says John Rawls, a microbiome researcher at Duke. But what makes David special isn't just that he's a good computer coder. "What sets him apart is his ability to incorporate technology and concepts from engineering into his work," Rawls says.

Most labs that study the microbiome start with animal studies. But David began with a machine — an artificial gut for growing and manipulating intestinal microbes donated by human volunteers. The contraption consists of multiple growth chambers bristling with plastic tubes. Inside, what David has called "the world's nastiest slurry" (a fecal sample from a donor) ferments in conditions similar to those in the intestines. One tube feeds into what looks like a dome hair dryer from a beauty salon. That's a concession to neighboring researchers who complained about the pungent smell.

When graduate student Rachael Bloom joined the lab, David persuaded her to try a completely different way of growing bacteria from feces, designing chips with channels that separate out bacteria into microscopic drops of liquid. In just a few minutes, Bloom can create what are essentially thousands of tiny petri dishes, each with a single bacterium. Neither student nor mentor had any experience with the "microfluidics" technique, but David encouraged Bloom to try, and even be open to failure. "In retrospect, that could be really dangerous," says Bloom, "but I have learned so much."

David's aptitude for engineering shows up at home, too. To keep his two preschool children from getting up too early, David rigged LED lights on a timer. The kids have to wait for the lights to go off before getting out of bed. His wife, a psychologist, reinforces the good behavior with a treat.

David says he "tends to be an optimist," and just assumes his team will find a way over or around any hurdle. "He's very adventurous. He's very creative," says Turnbaugh. "He's one of the great people in microbiome research who is thinking outside the box and not just following a template."

David has a simple explanation for why he continues to say yes to projects outside his comfort zone: "I'm easily fascinated." ■

Jeremy Freeman, 30
NEUROSCIENTIST
HOWARD HUGHES MEDICAL INSTITUTE, JANELIA RESEARCH CAMPUS

JAMES KEGLEY/HHMI

Brain studies tackle big data

Big question: Jeremy Freeman wants to understand how the brain works. His influential papers have provided clues to how people spot objects in a crowd, methods to build giant maps of the brain's nerve cells and elegant insights into how nerve cells let us see and touch. But he is equal parts neuroscientist, computer coder and data visualization whiz. As a group leader at Janelia Research Campus, Freeman develops computer programs to make sense of mountains of data. He wants to do science *and* improve the way science is done. "We talk about complexifiers and simplifiers," says Corey Ziemba, a neuroscientist at New York University. "Jeremy is an extreme simplifier."

Claim to fame: Freeman and colleagues have developed a computer program called Thunder, a streamlined way to analyze big datasets. With Thunder, data that used to be crunched overnight can be whipped into shape in a few minutes. With this nearly instant feedback, an experiment can be changed iteratively, guided by the results of the previous test. Another program, called Binder, lets researchers easily share their results and the way they analyzed their data. Scientists used Binder to release data from the LIGO experiment, which made headlines earlier this year for detecting gravitational waves (*SN: 3/5/16, p. 6*). Journalists at BuzzFeed have, through the program, invited others to see and explore their analysis of U.S. refugee data.

Strategy for success: "A lot of the systems in science now are from the past," Freeman says. "They're built on very slow ways of sharing information, through journal articles. We need to move it forward." This desire to make sharing easier didn't come from an expert coder who realized he could make a difference. Instead, Freeman saw clunky inefficiencies and wanted to fix them so badly that he decided to learn to code. "I forced myself to learn the ropes," he says. "I deliberately put myself into really challenging situations. I get in way over my head and I figure out how to crawl out." — *Laura Sanders*

Uniting math and mess

By Susan Milius

Aneil Agrawal, 41
EVOLUTIONARY GENETICIST
UNIVERSITY OF TORONTO

Aneil Agrawal, his rangy frame at ease on a black metal street bench, is staring into some midair memory and speaking about disgust.

"I was first exposed to the idea of theoretical biology as an undergraduate and I actually hated it," he says. "I loved biology and I liked math — it was like two different food types that you like but the two of them together are going to be terrible."

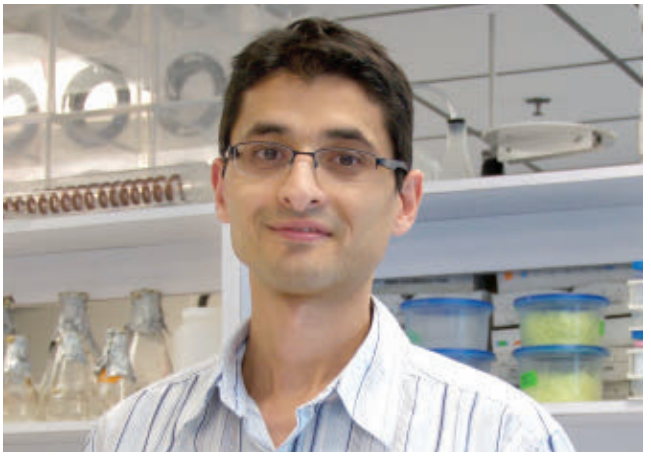
Since then, he has remained a fan of the two foods, and his distaste for combining them has turned into enthusiasm strong enough to build a career on. Agrawal, now a 41-year-old evolutionary geneticist at the University of Toronto, both builds mathematical descriptions of biological processes and leads what he describes as "insanely laborious" experiments with fruit flies, duckweed and microscopic aquatic animals called rotifers.

The rotifer *Brachionus calyciflorus* is difficult to work with but ideal for studying the factors that favor sexual versus asexual reproduction.

Often experimentalists venturing into theory "dabble and do some stuff, but it's not very good," says evolutionary biologist Mark Kirkpatrick of the University of Texas at Austin. Agrawal, however, is "one of the few people who's doing really good theory and really good experimental work."

Two of the themes Agrawal works on — the evolution of sex and the buildup over time of harmful mutations — are "very deep and important problems in evolutionary biology," Kirkpatrick says. Agrawal and colleagues have made a case for a once-fringe idea: that an abundance of harmful mutations can invite even more harmful mutations. Agrawal's work has also provided rare data to support the idea that the need to adapt to new circumstances has favored sexual over asexual reproduction. Why sexual reproduction is much more common among complex life-forms has been a long-standing puzzle in biology.

Life's complexity appealed to Agrawal from childhood; he remembers days playing among the backyard bugs and frogs in suburban Vancouver. At first, he imagined his grown-up life out in the field, "living in a David Attenborough show." As he grew older though, he discovered he was a lab animal: "I was more interested in being able to ask more precise questions under more controlled circumstances."



FROM TOP: L. BECKS; DIANA TYSZKO/UNIV. OF TORONTO

Sally Otto, now president-elect of the Society for the Study of Evolution, met Agrawal in the 1990s when he was an undergraduate at the University of British Columbia in Vancouver. He returned to Vancouver in 2003, after earning his Ph.D., to do experimental work and "beef up his ability to do theory," she says. She cosupervised his postdoctoral effort. Agrawal "picks up theory very quickly," Otto says. Knowing a huge amount of math to begin with is less important than having insight into what math to learn. The first alluring ideas about how to approach a puzzle often don't work out, she says, so "there's a certain doggedness — you have to really keep at it."

Agrawal needed some time before he came around to theoretical biology. It disgusted him, he says, because he expected it to take the rich variety out of biology. "The reason many people, including me, were attracted to biology was because it's not boxes and triangles," he says. "It's complicated and interesting." At first he thought modeling a biological process mathematically "sterilized it." But he eventually found that mathematical description could "help to clarify our thinking about the wonderful mess of diversity that's out there."

Lab animals

At the street bench, Agrawal muses about how he tends to "think quantitatively." His father has a Ph.D. in engineering, but "we weren't the kind of family that had to do math problems at the dinner table." He laughs. "Though I do that to my own kids." His success so far is mixed, depending in part on whether he catches his two sons, ages 10 and 7, in the right mood.

Agrawal also thinks intensely, possibly another secret to his success — he has received more than half a dozen awards and prizes, including the 2015 Steacie Prize for Natural Sciences. The bench where we've settled is only half a block from the conference center in Austin, where Evolution 2016, the field's biggest meeting of the year (*SN: 7/23/16, p. 12*), has hit day four of its five-day marathon. Agrawal gave one of the first talks, a smooth, perfectly timed zoom through a recent fly experiment. He is a coauthor on five more presentations, along with chairing one of the frenetic sessions where talks are compressed into five minutes. By this point, many of the 1,800 or so attendees are showing strain — wearing name tags wrong side frontward, snoring open-mouthed in hallway chairs or flailing their arms in conversations fueled by way too much caffeine. Agrawal, however, seems relaxed, listening quietly, staring off in thought, speaking in quiet bursts. This guy can focus.

One of his early theory papers studied mutation accumulation.

Previous work had suggested that microbes in stressful environments, compared with microbes lapped in luxury, are more likely to make mistakes in copying genes that then get passed on to the next generation. Agrawal wondered whether cells that are stressed for another reason — an already heavy burden of harmful mutations — would likewise be more inclined to build up additional mutations. He calls this scenario "a spiral of doom."

The idea intrigued him because he suspected that sexual reproduction would do a better job of purging these mutations than asexual reproduction. "What I found in doing the theory was that I was exactly wrong," he says. The sexual populations would end up with more, not fewer, mutations.

Though the theory part of the paper turned out well, the journal *Genetics* rejected it — there was hardly any experimental evidence that the scenario would arise in the real world.

Agrawal published the paper elsewhere in 2002 and, when he began setting up his own lab at the University of Toronto, he returned to the idea. In the years since, he and colleagues have published a string of papers adding evidence to the argument. They have found, for example, that fruit flies burdened with misbegotten genes lag in growth and struggle to keep their DNA in good repair. The idea is no longer airy speculation, says Charles Baer, who's checking for mutation accumulation in nematodes at the University of Florida in Gainesville.

Chrissy Spencer, a postdoc during the early years of Agrawal's mutation studies, points out that a vital skill of a good experimentalist is just knowing intuitively whether a species is right for a certain kind of test. Agrawal has that knack, for better and for worse. For some studies on the evolution of sex, Agrawal eventually turned to rotifers. The stubby little cylinders with a circlet of hairy projections around their mouths can reproduce either sexually or asexually, so they're great for testing what factors favor one over the other. Rotifers, however, are also "finicky," he says. His students have cared for them, sometimes for months, only to have them all die for no discernible reason, sometimes before generating any data.

Having the practitioner's inside view of experiments and theory may help Agrawal, but it also has its costs. "There are better theoreticians out there and there are better experimentalists," he says, and he wishes at times that he was more solidly in one camp or the other. He pauses and then, a biologist to the core, says: "That's my niche." ■

Melissa Omand, 36
OCEANOGRAPHER
UNIVERSITY OF RHODE ISLAND

Tech-savvy seafarer tracks carbon

Big question: Melissa Omand wants to know how the dining and dying of microorganisms and other mechanisms such as currents move carbon and nutrients through the ocean. In a breakout paper, published last year in *Science*, she reported that eddies can pull carbon — from the waste and remains of phytoplankton — deep below the surface, a previously undescribed phenomenon. "The ocean has a huge capacity to absorb excess carbon dioxide in our atmosphere," Omand says. But as the planet warms, atmosphere and ocean might interact differently. Scientists need all the information they can get to understand the effects of climate change.

Claim to fame: Last year Omand became the first chief scientist to remotely lead a cruise of the research vessel *Endeavor*. While her team was on the ship, she oversaw the research effort, sometimes working 16-hour days, from a dark room at the University of Rhode Island's Inner Space Center, a sort of NASA mission control for oceanographers. "She doesn't let many obstacles get in her way," says Colleen Durkin, an oceanographer at Moss Landing Marine Laboratories in California. "That's one of the fun things about working with her. She's willing to try new things." In studying the oceans, Omand has harnessed data from satellite imagery, robotic gliders and even turned her old iPhone into an underwater camera.

Backstory: In her teens, Omand worked as a canoe guide, exploring the rivers and lakes in and around Toronto. "That was absolutely the root of my interest in earth science and environmental issues," she says. After studying physics at the University of Guelph in Canada, including work on Mars rovers, Omand was lured back to the water by a University of Victoria professor. "He showed me demonstrations of what happens to dye in a rotating water tank," she recalls. "I was hooked by that." The churning of water appealed to Omand for the same reason physics did: "I found it very satisfying that all these problems boiled down to a few underlying rules and equations." — *Thomas Sumner*

URI PHOTO BY JOE GIBLIN

X-ray laser might become science's Swiss army knife

By Alexandra Witze

Tenio Popmintchev, 39
LASER PHYSICIST
UNIVERSITY OF COLORADO BOULDER

Experimental physics is not for the fainthearted. One tiny error — or a concatenation of many — can keep a complicated experiment from working smoothly. Fortunately, Tenio Popmintchev has the tenacity for it.

Popmintchev, a laser physicist at the JILA institute at the University of Colorado Boulder, thinks nothing of running an experiment for 72 hours straight, or spending years tinkering with a finicky set of high-powered lasers, or shipping the entire setup to Vienna to re-create the experiments with collaborators there. A commitment to detail drives Popmintchev's rising career, says his adviser and mentor Henry Kapteyn. "Tenio is not intimidated by what might go wrong in an experiment, and is very good at identifying and investigating the unknowns that might be holding an experiment back," Kapteyn says.

At age 39, Popmintchev has already played a key role in inventing the first tabletop X-ray laser, which uses short pulses of light to illuminate the nature of matter. Its bright beams promise to probe everything from the movements of electrons and atoms within DNA to the folding of proteins in extraordinary detail. It would be relatively cheap and multipurpose, a Swiss army knife made of light that many researchers could use. "The same kind of revolution that happened with lasers in the 1960s is happening now in X-ray science," Popmintchev says.

He began his drive toward physics early, while growing up in the town of Kazanlak in central Bulgaria. He was planning to study mathematics until a high school teacher cannily told him that physicists were the best mathematicians of all. And with that, the teacher had a fresh recruit for the national physics Olympiad team.

Popmintchev went on to take honorable mention in an International Physics Olympiad in ninth grade and a bronze medal in 11th grade. He still speaks about that teacher fondly. "We used to solve problems the whole day long," he says. "It was a lot of fun."

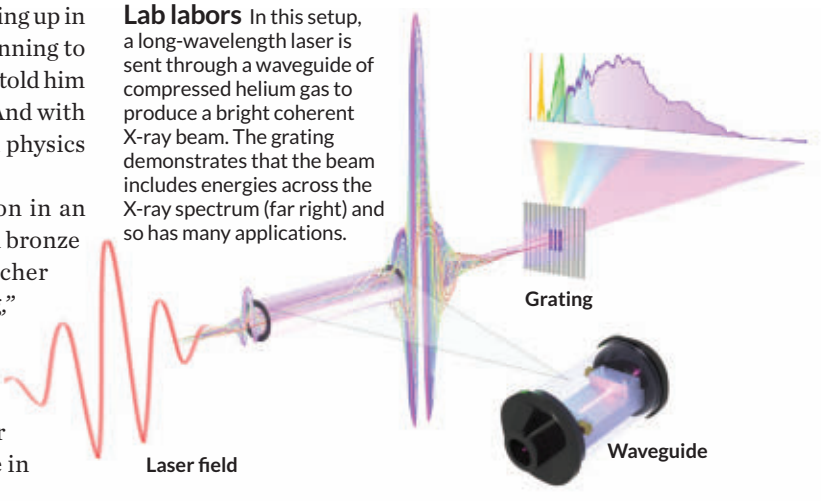
In college, he started to explore the world of lasers with a physicist who had trained under the same teacher. They worked on infrared lasers for cosmetic surgery, and Popmintchev found his niche in coaxing the best out of experimental equipment. For his Ph.D. work, Popmintchev moved to one of the world's top labs for studying ultrafast lasers, established in Boulder by Kapteyn and his collaborator and wife, Margaret Murnane.

Like a strobe light revealing the motion of dancers under a disco ball, ultrafast lasers can "freeze" atoms and molecules by illuminating them with every flash. Kapteyn and Murnane's group uses lasers that pulse on the order of attoseconds, or billionths of a billionth of a second. "One attosecond is to a second as a second is to the age of the universe," Popmintchev says. That superfast stop-motion means that scientists can glimpse atoms and molecules interacting with one another.

Popmintchev's research aimed to push these frontiers past the usual wavelengths and into the higher energies of X-rays. Unlike infrared or ultraviolet light, X-rays can penetrate objects to reveal internal structure, like dental X-rays highlighting cavities. But making enough X-rays, with enough power, can require enormous, billion-dollar machines that accelerate electrons to high speeds.

Popmintchev wanted to find a way to make X-ray lasers accessible to more scientists. He turned to a method called high-harmonic generation, which was discovered in 1987 when researchers noticed that under certain conditions their lasers efficiently generated shorter wavelengths of light. The technique had been used mainly with ultraviolet lasers, but Popmintchev and colleagues realized that infrared lasers could be coaxed to produce X-ray pulses if they were sent beaming through pressurized gas.

So he built a cylinder that could fit in the palm of a hand and contains helium gas at 50 times atmospheric pressure. When laser light hits the high-pressure gas, it strips electrons off the helium. Each electron accelerates away from and then back toward its charged helium atom. When the electron crashes back into the helium, it releases extra energy gained from this acceleration as higher-energy X-rays. By tweaking the pressure of the gas and the intensity of the laser, Popmintchev could get the X-ray emissions to move in phase with one another,



Lab labors In this setup, a long-wavelength laser is sent through a waveguide of compressed helium gas to produce a bright coherent X-ray beam. The grating demonstrates that the beam includes energies across the X-ray spectrum (far right) and so has many applications.

FROM TOP: STEVEN BURROWS/JILA; T. POPMINTCHEV *ET AL*/*SCIENCE* 2012

producing a coherent beam that his team could control with exquisite precision.

Researchers had not thought they could do such a thing with high-harmonic generation. But Popmintchev persisted, tinkering with the lasers until they did what he wanted. Trillions of atoms shone together in X-ray harmony. He got not only his Ph.D. but also a paper in *Science* in 2012.

Today his team includes another Popmintchev — his younger brother Dimitar. Both of them went through the same physics schooling in Kazanlak, then at the university in Sofia. Tenio is the older brother who made his mark first, known for his frequent collaborations with others. Dimitar is quieter and prefers to work on his own. Dimitar and Tenio work and live together, around the clock. "He is a great scientist and a great brother," Dimitar says.

For now, the Popmintchev brothers are working on ways to beef up their lasers' performance and power. In *Science* in December, they described a way to tweak high-harmonic generation to produce X-rays even more efficiently. Perfectionists do not rest on their laurels.

Popmintchev is now leaving Boulder to start up laboratories at the University of California, San Diego and in Vienna. Eventually he hopes to make the tabletop X-ray laser a possibility for any lab — an accessible, affordable X-ray microscope for nanotechnology, biology and other applications. "This will be one of the ultimate light tools," he says. "This is like your personal X-ray laser that you can modify the way you want." ■

Shortest route to success

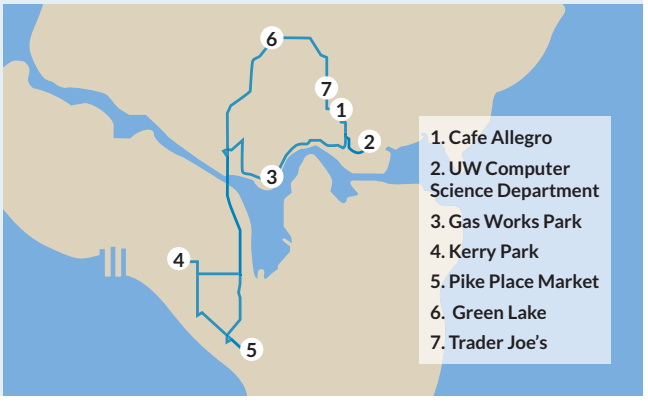
Shayan Oveis Gharan, 30
THEORETICAL COMPUTER SCIENTIST
UNIVERSITY OF WASHINGTON

Big question: It's a problem that sounds simple, but the best minds in mathematics have puzzled over it for generations. A salesman wants to hawk his wares in several cities and return home when he is done. If he's visiting only a handful of places, it's easy for him to schedule his visits to create the shortest round-trip route. But the calculation quickly becomes too complex as the number of destinations increases. Shayan Oveis Gharan has made record-breaking advances on this "traveling salesman problem" by working on approximate solutions — routes that, though slightly longer than optimal, can be calculated in a reasonable amount of time. The quandary has real-world importance: Companies like Amazon, for example, want to ferry goods to many destinations in the most efficient way.

Strategy for success: By identifying connections between seemingly unrelated areas of mathematics and computer science, Oveis Gharan has brought new tools to old problems. "If you want to build a house, you need to have a sledgehammer and a level, a wrench, tape measure," he says. "You need to have a lot of tools and use them one after another." He stocks his toolkit with the latest advances in fields with obscure-sounding names, including spectral graph theory, polyhedral theory and geometry of polynomials. In a recent study, he applied a solution from a long-standing problem originating in quantum mechanics. "He is relentless," says Amin Saberi of Stanford University. "He just doesn't give up."

Backstory: Growing up in Iran, Oveis Gharan discovered a natural appreciation for challenging puzzles. In middle school, he acquired a book of problems from mathematics Olympiad competitions in the Soviet Union. As a student, "I tend to be one of the slower ones," he says, noting that he was usually not the first to grasp a new theorem. But within a few years, he had plowed through the 200-page book. After attending Sharif University of Technology in Tehran, Oveis Gharan headed to Stanford for his graduate studies, where he spent over a year cracking just one thorny facet of the traveling salesman problem. — *Emily Conover*

A Seattle tour For a tour of seven destinations, there are 360 possible routes. This map shows the shortest route (measured in travel time) between seven Seattle locations that Shayan Oveis Gharan visits. SOURCE: GEBWEB.NET/OPTIMAP



FROM TOP: DENNIS WISE/UNIV. OF WASHINGTON; E. OTWELL

Stellar archaeologist digs a young universe

By Christopher Crockett

Anna Frebel, 36
ASTRONOMER
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Anna Frebel can't explain her fascination with the stars. It'd be like explaining why "berry purple-pink" is one of her favorite colors. "They are just a part of me," says Frebel, an astronomer at MIT. "What's going on with them and what they can tell us — there is something magical."

Frebel's fascination has led to the discovery of at least three record-breaking stars. Dating back roughly 13 billion years, the stars — all within the Milky Way galaxy — might be elders from the second generation of stars ever formed in the universe. She has also found that one of the tiny galaxies flitting around outside the Milky Way might be a fossil that has survived from not long after the Big Bang. The light from these ancient relics encodes stories about the birth of the first stars, the assembling of galaxies and the origin of elements essential to creating planets and life as we know it.

"Anna has a really good track record of finding these amazing things," says Alexander Ji, one of the three graduate students Frebel mentors at MIT. "She's always finding things that change our understanding of the universe."

As a young girl living in Germany, Frebel wanted to be an astronaut, but she passed on that dream when she learned about the centrifuge that whips trainees around to simulate launch acceleration. Not for her. She instead studied physics and astronomy, first at the University of Freiburg in Germany and then at the Australian National University in Canberra. Since then, Frebel, now 36, has earned a reputation as a "stellar archaeologist," with the patience and perseverance to search through the universe's most ancient debris.

Only someone with a galaxy's worth of patience could sift through the tiny rainbows of light, the spectra, produced by thousands of stars, handpicking the specimens that might preserve clues to the conditions shortly after the first stars lit up the universe. And only a persistent person would spend more than two years pointing Australia's 2.3-meter-wide Advanced Technology Telescope at 1,200 of the most promising candidates ("105 stars per night was my record," she says) and eventually, with observations from other telescopes too, land on one star that was, for a while, among the oldest known.

She was first drawn to this research after hearing astronomer Norbert Christlieb, then a visiting researcher at the Australian National University, talk about his work on old stars. "It hit me: Oh my God, this project combines all my interests," Frebel says. There were stars, chemistry, nuclear physics and the periodic table. "There are so many, for me, cool topics that come together."

In combing through her stars, Frebel was looking for ones

BRYCE VICKMARK

that contained hydrogen and helium — but little else. Most heavier elements up to iron are forged in the cores of stars, where atomic nuclei smash together. As the universe aged, its inventory of atoms such as carbon, silicon and iron steadily increased. The earliest stars, however, came on the scene when there were far fewer of these pollutants floating around.

Her efforts paid off in 2005 with a star branded HE 1327-2326, reported in *Nature* as the most pristine star known at the time. "She found one that took us closer back to the beginning of time as we know it," says Frebel's Ph.D. adviser, astronomer John Norris of Australian National. "It became clear to us early on that she was quite gifted."

Her gifts netted her the Charlene Heisler Prize in 2007, given by the Astronomical Society of Australia for outstanding Ph.D. thesis. She has since won several recognitions, including the Annie Jump Cannon Award in 2010, given to notable young female researchers by the American Astronomical Society, for her "pioneering work in advancing our understanding of the earliest epochs of the Milky Way galaxy through the study of its oldest stars."

Carbon seeding

The geriatric stars that Frebel finds are not perfectly pristine; they preserve in their atmospheres the chemical makeup of interstellar gas that had been seeded with a smidgen of heavy

elements from the explosions of stars that came before. Chemical abundances in many of these stellar fossils are out of balance compared with modern stars. The fossil stars have much more carbon relative to iron, for example — carbon that had to have come from the debris of that very first crop of stars.

Frebel worked with theorists to show that excess carbon could have allowed successive generations of stars (and planets) to form, reporting the work in 2007 in *Monthly Notices of the Royal Astronomical Society Letters*. "I've always been interested in understanding the main message of the data," she says, which leads her away from the telescope to computer simulations and theory. In this case, the message is that carbon "might have been the most important element in the universe."

Gas needs to be cold, around −270° Celsius, just a few degrees above absolute zero, to clump and form stars. And carbon is an excellent coolant; its electrons are arranged in such a way to let it efficiently radiate energy. The first generation of stars didn't have carbon's help. They were probably slow to form and ended up as gargantuan fluffy orbs hundreds of times as massive as the sun. But once those stars exploded and seeded the cosmos with carbon, Frebel's data suggest, subsequent generations of stars formed that would have looked more like the stars we see today.

Frebel likens her studies to watching her young son learn to walk and talk. "My overall interpretation is that the universe was still trialing things."

Before she became a parent, she regularly went to one of the twin Magellan telescopes, 2,380 meters above sea level in the Chilean Atacama Desert. On long nights, while waiting for the telescope to soak up light from a star tens of thousands of light-years away, Frebel would feel the pull of the night sky. "I just lie on the ground and stare into the sky and get lost in the universe," she says.

In recent years, Frebel has expanded her repertoire to include a horde of teeny galaxies that orbit the Milky Way and also serve as archaeological sites. "Now we can use not just one star," she says. "We can use the entire galaxy as a fossil record." One of these runts, called Segue 1, appears to be a remnant from the cosmic dawn and might be typical of the pieces that assembled into large galaxies like the Milky Way.

Frebel and her student Ji discovered that another dwarf galaxy, dubbed Reticulum II, contains clues about one of the mechanisms responsible for creating most of the elements heavier than iron. A long-ago smashup between two neutron stars once bombarded the gas in Reticulum II with neutrons, producing atoms, such as uranium, that can't be formed in stellar cores. Similar run-ins in other galaxies might have helped build up the universe's stockpile of heavy elements.

Frebel plans to continue her quest to understand the origin of atoms, stars and galaxies. Though the celestial bodies she studies are ancient, "my days never get old," she says. ■

MACARTHUR FOUNDATION

Chemistry gets a good name

Phil Baran, 39
CHEMIST
SCRIPPS RESEARCH INSTITUTE

Claim to fame: With more than 100 papers to his credit, Phil Baran designs quicker chemical routes to concocting large, complex molecules that are used in everything from fragrances to flavorings and pesticides, and are hugely important in the drug development pipeline. It's like cooking, but more precise and finicky. Just recently, he has developed a 14-step recipe for ingenol and reduced the steps required to make phorbol from 40 or more to just 19. Derivatives of both molecules have antitumor activity. "His productivity is nothing short of remarkable," says Andrew G. Myers, a Harvard synthetic chemist. Baran has the sense that people (unjustly) think of *chemistry* as a bad word, taking for granted all the ways we rely on it every day.

Strategy for success: Baran's philosophy is to hew closely to the way nature makes molecules. Sometimes this means recombining old techniques in new ways; sometimes it means inventing new strategies. In January in *Science*, for example, his team described a new technique to add "spring-loaded" carbon-carbon and carbon-nitrogen bonds to certain kinds of ringed molecules important for drug discovery. His field once targeted molecules as a tour de force of pure chemical prowess, but the pathways were complicated and costly. "I'm less interested in proving that something can be made chemically," he says. "We want to invent new chemistry that will be useful."

Backstory: "I have always found playing with chemicals an escape of sorts," Baran says. He doesn't recall ever being that interested in science as a child, and was not a motivated student until he found science as a high school sophomore. His high school chemistry teacher indulged his interest in reactions by letting him drop in to the lab and do experiments. He earned his doctorate at age 24, working in the lab of synthetic chemist K.C. Nicolaou, a giant in the field. "I was an animal," Baran says. "I had a singular purpose." He started running his own lab two years later. — *Eva Emerson*

The Long, Long Life of Trees
Fiona Stafford
YALE UNIV., $30

BOOKSHELF

Author takes readers on walk through the woods

Trees do much more than slurp carbon dioxide out of the atmosphere and release life-sustaining oxygen: They provide fruit, nuts and other foods, as well as the raw materials for everything from fence posts to pharmaceuticals. And they've inspired poets and myth-makers, among many others. Buddha found enlightenment under a tree; so did Isaac Newton.

In *The Long, Long Life of Trees*, Fiona Stafford — an author, radio host and University of Oxford literature professor — explores the science and symbology of 17 common trees. Her list includes familiar species, such as apple and oak, as well as lesser-known trees, such as hawthorn and horse chestnut.

The book is chock-full of fascinating scientific and historical tidbits. For example, thin rods made of birch are flexible individually but strong when strapped together in a bundle, or fasces. Political parties from the Roman era to the fascists of the mid-20th century adopted this emblem of strength in unity.

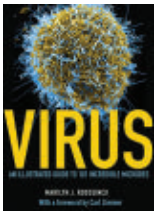
The strength and durability of wood from the elm made it the perfect rot-resistant material for ship paddlewheels, coffins and even water pipes, Stafford notes. Too bad Dutch elm disease, caused by a fungus that blocks water circulation within the trunk, ravaged these trees in parts of Europe and North America during the last century. Elms once offered shade in parks and village greens throughout the United Kingdom, for instance, but now survive only in scattered and isolated locales.

The book's title refers not only to the longevity of individual trees — some of the oldest yews in England were alive when Stonehenge and the pyramids at Giza were built — but also to the long history of trees on Earth. One species on Stafford's list, the holly, has been around about 100 million years (the earliest known trees evolved hundreds of millions of years before that). Long before grasses appeared on the scene, trees were providing food for dinosaurs and the raw materials for future coal mines.

Today, tree bark provides crucial ingredients for everything from aspirin (thanks, willow!) to cancer-fighting Taxol (ditto, yew!). Britons also rely on the fast-growing willow, which can stockpile heavy metals from polluted groundwater, to help clean up tainted soil at abandoned industrial sites, Stafford notes.

An engaging book from cover to cover, *The Long, Long Life of Trees* is a wonderful walk through the woods. — *Sid Perkins*

BOOKSHELF



Virus
Marilyn J. Roossinck
This well-illustrated guide provides an introduction to the biology of viruses and history of virology, as well as singling out 101 of these infectious agents to profile in more depth. *Princeton Univ., $35*

Dinosaurs
Darren Naish and Paul Barrett
In addition to reviewing the history of dinosaur studies, two paleontology experts offer up-to-date insights into dino anatomy, ecology, behavior and evolution. *Smithsonian Books, $29.95*

Buy Books Reviews on the *Science News* website include Amazon.com links that generate funds for Society for Science & the Public programs.

Reflecting on two years at the Society
A conversation with Maya Ajmera

It's hard to believe two years have flown by since I joined Society for Science & the Public as CEO and publisher of *Science News*. When I arrived, the pressure was already on. After 20 extraordinary years with Intel as the title sponsor of the Society's flagship competition — the Science Talent Search (STS) — we were in pursuit of a new partner.

We have to do more to engage all students with STEM education.

After an amazing response to our STS search, we were able to share great news this past May when Regeneron became just the third sponsor in the nearly 75-year history of STS. By committing $100 million to support the Science Talent Search and other Society programs through 2026, Regeneron — founded by STS alumni George Yancopoulos and Leonard Schleifer — made the largest commitment we've ever received from a single organization. Beyond sponsoring STS, Regeneron's investment in outreach and equity — $30 million dollars over 10 years — will allow the Society to do so much more to engage all students in this country with STEM education.

Regeneron's investment will help us greatly expand a new program we started shortly after I joined the Society — *Science News* in High Schools. The program not only provides a great resource to students and teachers, but also addresses the second biggest challenge of my tenure: The fact that, like all media companies and newspapers, we were learning that there's no secret sauce for addressing the radical shifts in publishing business models impacting *Science News*. But *Science News* in High Schools is one innovative approach that's working.

The program provides 10 copies of *Science News* to a high school's science department, free digital access to sciencenews.org (including our extensive archive) for all students in the sponsored school and an educator guide to help shape classroom experiences around our exceptional science content. In a survey following the pilot program, teachers called *Science News* in High Schools a valuable resource and expressed huge appreciation for the program and our early sponsors. Now Regeneron has carved out $2 million per year for the next 10 years to grow the program, allowing up to 4,000 more high schools to participate. My dream is that *Science News* will reach every high school in the country so that new generations of students are inspired by science.

LINDA DOANE

SOCIETY UPDATE

The reason *Science News* in High Schools is so powerful is the same reason that so many of you have been reading the magazine for years: our journalists. *Science News*, led by Eva Emerson, is home to an extraordinary and creative group. I'm proud to say we're one of the few science newsrooms left in the country, which makes it all the more important for *Science News* to survive. We need to continue to provide accurate, timely and important scientific stories so crucial to our future, our children's future, and to the future of our democracy.

That future starts with kids discovering their interest in science. And that's why I'm so pleased that *Science News for Students* — written for students in middle school on up and packed with great features for teachers and students — is now its own digital product. Take a look at sciencenewsforstudents.org. It's a gorgeous site that we hope will get millions of students reading about science.

With the help of many generous funders, the Society has been able to launch and grow several other important new programs. The Advocate Grant Program provides support and a cash stipend to mentors of underserved students doing STEM research. Advocates help students learn about and complete applications for science research competitions, allowing them to gain the benefits of participating in local and national events.

HANNAH MAXWELL

We're one of the few science newsrooms left in the country … we have to survive.

The Research Teachers Conference brings together 200 research teachers from across the country for an all-expenses-paid weekend of professional development in Washington, D.C. Experienced research teachers lead sessions on topics such as how to guide students in writing a research report, increase the participation of underserved students in research, and recruit scientist mentors to support student work.

STEM Action Grants allow the Society to support innovative nonprofit organizations such as ProjectCSGirls, which was founded by 2015 STS alumna Pooja Chandrashekar. We look forward to supporting social entrepreneurs who provide STEM opportunities to young people.

And STEM Research Grants enable teachers to expand and enhance their independent research programs for students by providing one-time funding for special purchases or other needs, such as lab equipment. Special consideration is given to teachers working with underserved students.

These students are the future of our STEM talent pipeline in the United States and the world.

In addition to STS, the Society's other competitions made news as well. Last year, the Broadcom Foundation renewed its sponsorship of our middle school science competition, the Broadcom MASTERS, for six more years with a significantly higher budget. Broadcom MASTERS students are the future of the STEM talent pipeline in the United States and the world. We're starting to see the fruits of Broadcom MASTERS in our other competitions as alumni compete in the Intel International Science and Engineering Fair (ISEF) and STS. It was thrilling to meet this year's Broadcom MASTERS International delegation at Intel ISEF.

Intel ISEF 2016 was incredible. Over an amazing five days in Phoenix, more than 1,750 finalists from more than 77 countries, regions and territories competed for more than $4 million in awards. In 2017 we'll be introducing a new program — the Intel ISEF Commons — which will connect colleges and universities with Intel ISEF competitors, the next generation of talent in STEM.

Together, we've achieved so much over the last two years and we couldn't have done it without you — *Science News* subscribers. You care so deeply that when we asked you to go above and beyond to become members of or donors to the Society, you responded with enthusiasm and generosity. We owe you an enormous debt of gratitude and we hope you will be part of our work for years to come. We've heard from many of you that reading *Science News* inspired you to become an engineer or a scientist. We want the next generation of readers to feel the same way. — *Maya Ajmera*

AUGUST 6, 2016

Juno gets up-close and personal

The Juno spacecraft's first picture of Jupiter since arriving at the planet shows the gas giant with three of its moons — Io, Europa and Ganymede — **Christopher Crockett** reported in "Juno snaps its first pic of Jupiter" (*SN: 8/6/16, p. 16*). Check out a closeup photo of Jupiter's north pole on Page 13 of this issue and listen to the planet "sing" online at bit.ly/SN_Jupiter.

JPL-CALTECH/NASA, SWRI, MSSS

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Cosmic mismatch

Researchers used supernovas, cosmic microwave background radiation and patterns of galaxy clusters to measure the Hubble constant — the rate at which the universe expands — but their results were mismatched, ***Emily Conover*** *reported in "Debate persists on cosmic expansion" (SN: 8/6/16, p. 10).*

Reader **J.R. Kennedy** thought that light-dimming space dust and debris might explain the discrepancy.

Gas and dust in space can have an impact on the brightness of standard candles — objects with known brightness such as type 1a supernovas and some variable stars, **Conover** says. But astronomers correct for those discrepancies in their measurements.

In the absence of gas and dust, a candle's apparent brightness should decrease in relation to its distance from Earth. "But if there's dust in the way, it can make the candle dim more than that," **Conover** says. "However, this intervening material doesn't dim the candle quite in the same way as distance does. It will dim the shorter, bluer wavelengths of light more than the redder ones. Astronomers can look for this effect to identify the impact of dust and correct for it." So the mismatch stands.

Great escape

High-speed video captured how the offspring of red-eyed tree frogs prematurely break free from their eggs when in danger, ***Helen Thompson*** *reported in "Under threat, tadpoles make early escape" (SN: 8/6/16, p. 32).*

Online reader **myndflyte** wondered if early hatching had any long-term developmental effects on the tadpoles.

There's definitely a trade-off involved in hatching early to escape a predator or some other threat, **Thompson** says. Past work by tree frog researcher Karen Warkentin, now at Boston University, shows that red-eyed tree frog embryos grow tails and mouthparts in the last few days of their roughly weeklong incubation. Those that hatch earlier, up to four days if threatened, tend to be underdeveloped with smaller bodies and shorter tails. "In the short term, this developmental deficit puts early hatchlings at greater risk of getting eaten by pond shrimp and fish than their older brethren," **Thompson** says. "But there's also evidence to suggest that early hatchers compensate down the line and grow at higher rates as tadpoles."

More to the story

Although the death rate from motor vehicle crashes in the United States has declined since 2000, the country still tops 19 other high-income nations in motor vehicle deaths, ***Alex Maddon*** *wrote in "U.S. still leads in fatal motor vehicle crashes" (SN: 8/6/16, p. 5).*

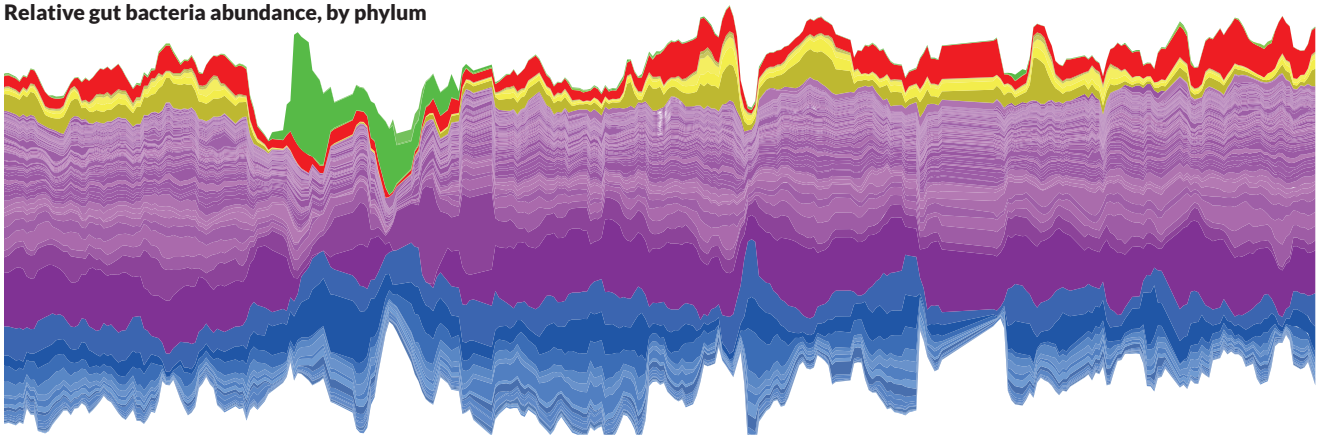
Some readers took issue with the conclusions presented and thought the researchers should have measured fatalities per miles driven instead of per population. "Using a per capita metric makes the U.S. look unsafe when the opposite is true," **John Underwood** wrote. "Since Americans drive more miles per year than the other countries in the chart, we will have the highest fatality rate per 100,000 population."

It's true that fatalities per miles driven changes the ranking. Using the measure "per 100 million vehicle miles traveled," the United States drops to fifth place, says Deputy Managing Editor, Features **Cori Vanchieri**. When the researchers looked at deaths per 10,000 registered vehicles, however, the United States still topped the list. The researchers' overall message is that the United States could further reduce crash deaths if seat belt use goes up and alcohol-impaired driving and speeding go down.

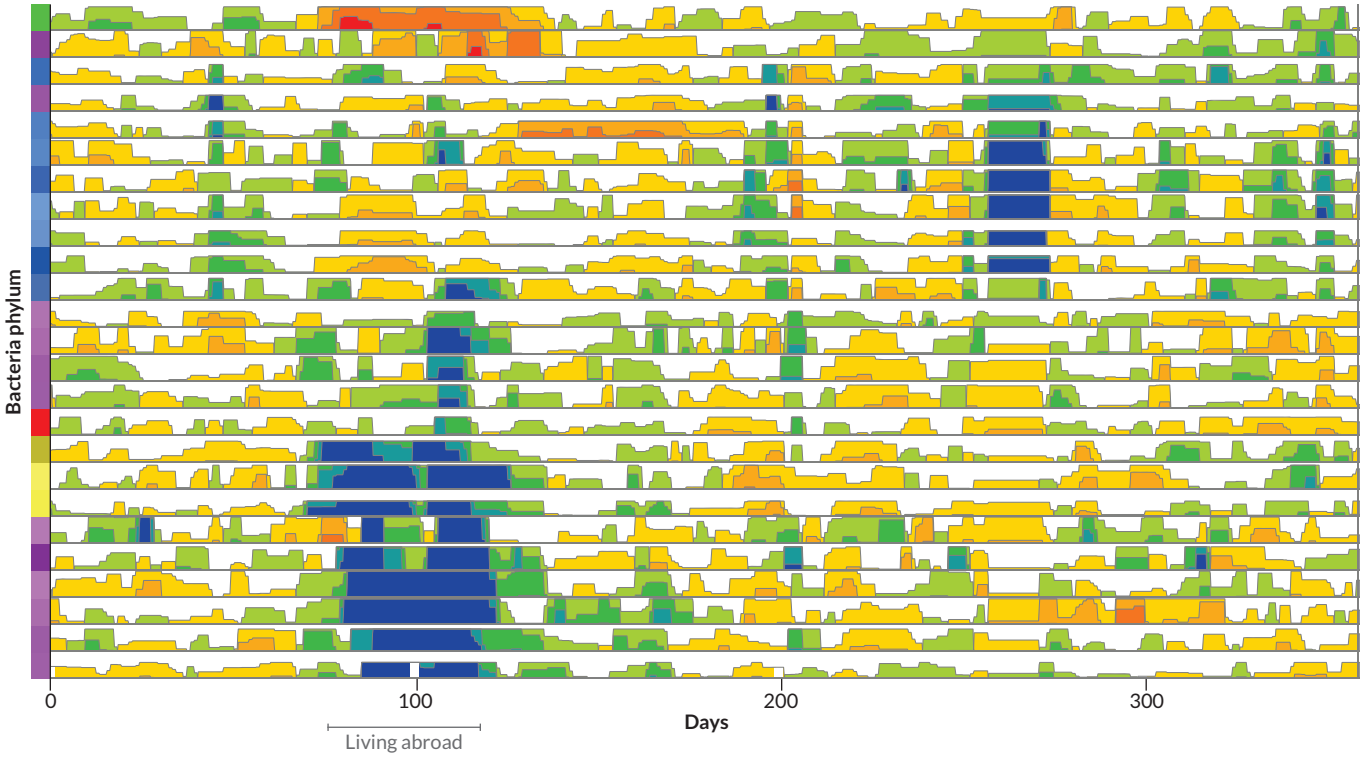
Clarification

"Under threat, tadpoles make early escape" (*SN: 8/6/16, p. 32*) states that the tree frog embryos gape their mouths to stretch out their egg membranes. Not all embryos gape their mouths, and ultimately, an enzyme secreted from the embryo's snout breaks open the membrane.

Relative gut bacteria abundance, by phylum



Change in gut bacteria abundance, by bacteria type



Bacteria phylum

- Proteobacteria
- Tenericutes
- Actinobacteria
- Firmicutes
- Bacteroidetes

A year in the life of a microbiome

Where you live and what you eat can rapidly affect the types of friendly bacteria inhabiting your body. To see how the microbes that inhabit the mouth and intestines change over time, Duke University computational biologist Lawrence David zealously chronicled his microbiome for an entire year. (For more on David and this experiment, see Page 19.)

A stream plot (top) shows the ebb and flow of phyla of bacteria in his gut over time. The thickness of each stream indicates a bacterial group's relative abundance in daily fecal samples. David peered closer at the data in a horizon plot (bottom; colored squares at left indicate the phylum of the bacteria represented in each row). He first determined each type of bacteria's normal abundance in his gut, then calculated how much they differed from the median abundance. Warmer colors (red, orange, yellow) indicate that bacteria in that group increased in abundance, and cooler colors (blue, green) indicate a decrease in abundance. Living abroad from day 71 to day 122 had a dramatic — but short-lived — effect on David's microbiome. — *Tina Hesman Saey*

L.A. DAVID *ET AL/GENOME BIOLOGY* 2014

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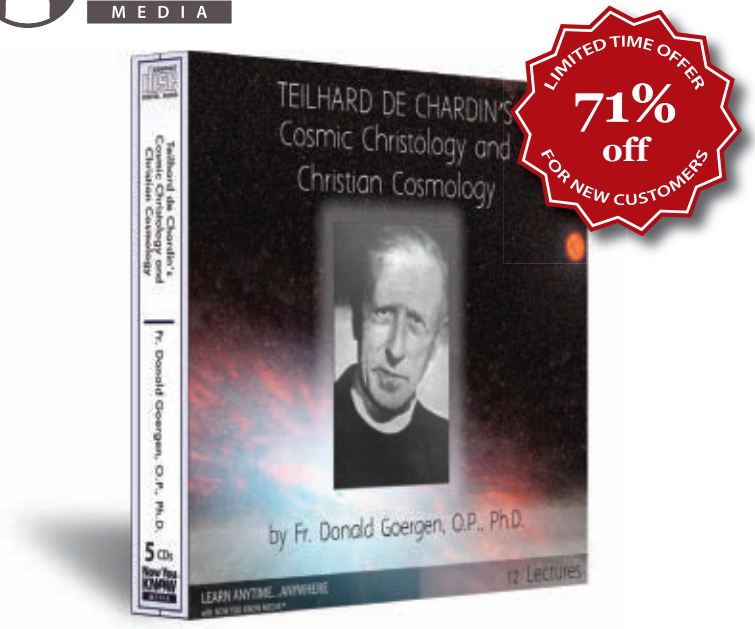

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It's the summer of 1944 and a weathered U.S. sergeant is walking in Rome only days after the Allied Liberation. There is a joyous mood in the streets and this tough soldier wants to remember this day. He's only weeks away from returning home. He finds an interesting timepiece in a store just off the Via Veneto and he decides to splurge a little on this memento. He loved the way it felt in his hand, and the complex movement inside the case intrigued him. He really liked the hunter's back that opened to a secret compartment. He thought that he could squeeze a picture of his wife and new daughter in the case back. He wrote home that now he could count the hours until he returned to the States. This watch went on to survive some harrowing flights in a B-24 bomber and somehow made it back to the U.S. Besides the Purple Heart and the Bronze Star, my father cherished this watch because it was a reminder of the best part of the war for anysoldier—the homecoming.

He nicknamed the watch *Ritorno* for homecoming, and the rare heirloom is now valued at $42,000 according to *The Complete Guide to Watches*. But to our family, it is just a reminder that nothing is more beautiful than the smile of a healthy returning GI.

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