Nosing in on COVID-19 | Life on Venus?

Science News

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ OCTOBER 10, 2020 & OCTOBER 24, 2020

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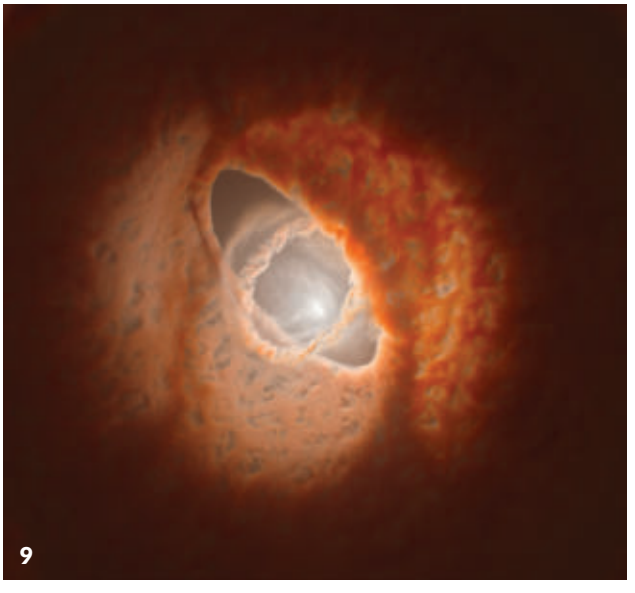
ScienceNews

Feature

News



Departments

COVER This year's crew of scientists to watch were inspired by *Jurassic Park*, charismatic flatworms and a mission to Mars. *Jeff Rogers*

SN 10, CLOCKWISE FROM TOP LEFT: ELI BURAKIAN/DARTMOUTH COLLEGE; CALTECH; BILL COTTON/COLORADO STATE UNIV.; L. BRIAN STAUFFER/UI NEWS BUREAU; STOWERS INSTITUTE FOR MEDICAL RESEARCH; STANFORD MEDICINE; TEXAS TECH UNIV.; SARAH DIEFENDORF; CALTECH; P. SHANAHAN; OTHER PHOTOS, FROM TOP: GLENN BARTLEY/ALL CANADA PHOTOS/ALAMY STOCK PHOTO; L. CALÇADA/ESO, S. KRAUS *ET AL.*, UNIV. OF EXETER

Seeing a bright future for science in these innovators

One of the many joys of being editor in chief of *Science News* is learning about remarkable work being done by younger scientists. This year's SN 10: Scientists to Watch honorees, who are profiled in this issue (Page 22), are tackling some of the biggest challenges facing our world.

The search for the next SN 10 class starts in early January, when we contact Nobel Prize winners, members of the National Academy of Sciences and previous SN 10 honorees and ask for nominations. With those recommendations, we do our own research, checking out scientists' CVs, publications and websites.

That portfolio then goes to *Science News* writers who cover those beats. We ask our writers to help us narrow down a very long list of people, all of whom are doing significant science and worthy of recognition. The aim is to find people who are making important discoveries, approaching a big problem with novel insights or shaking up their field.

I get to join in the next phase, when a small group of editors makes the final very difficult decisions. Once we've chosen the 10 finalists and double-checked their eligibility, we assign reporters to write short profiles. That's no easy task; these researchers are so interesting we could write a very long story on each of them. But our goal is to offer a lively introduction, rather than a tome. We still take pains to put each scientist's work in context. "The 'why' is interesting," says Elizabeth Quill, *Science News*' special projects editor and leader of this effort. "Why something as seemingly simple as the size of the proton is hard to know is a fascinating concept."

I loved learning about Phiala Shanahan (Page 31), a 29-year-old theoretical physicist at MIT who was shocked to discover while a graduate student that scientists disagreed on the size of the proton. That drove her to become adept at calculating the influence of gluons, which help keep protons intact. I'm inspired by Zhongwen Zhan (Page 28), a 33-year-old seismologist at Caltech who wants to put fiber-optic cables to work as an earthquake early warning system. And since I have relatives in Oregon struggling with terrible air pollution caused by wildfires, I'm grateful for Emily Fischer, a 39-year-old atmospheric chemist at Colorado State University who built a collaborative network of researchers to study the enigmatic components in wildfire smoke, which are surprisingly not well known (Page 29). It's an urgent mission at a time when the western United States is contending with massive fires and choking smoke. "There's so much science behind what people are experiencing in these devastating circumstances," Quill says.

These researchers also have interests that go beyond the lab bench. Fischer, for one, has built a network to mentor undergraduate women in the geosciences. The program reaches more than 300 women at institutions across the United States. She encourages her own mentees to go after big, bold questions. "It's OK to be wrong, and it's OK to take risks," she told staff writer Jonathan Lambert.

We hope you'll enjoy getting acquainted with these remarkable young scientists and following their exploits in the years to come. I expect big things from them. —*Nancy Shute, Editor in Chief*

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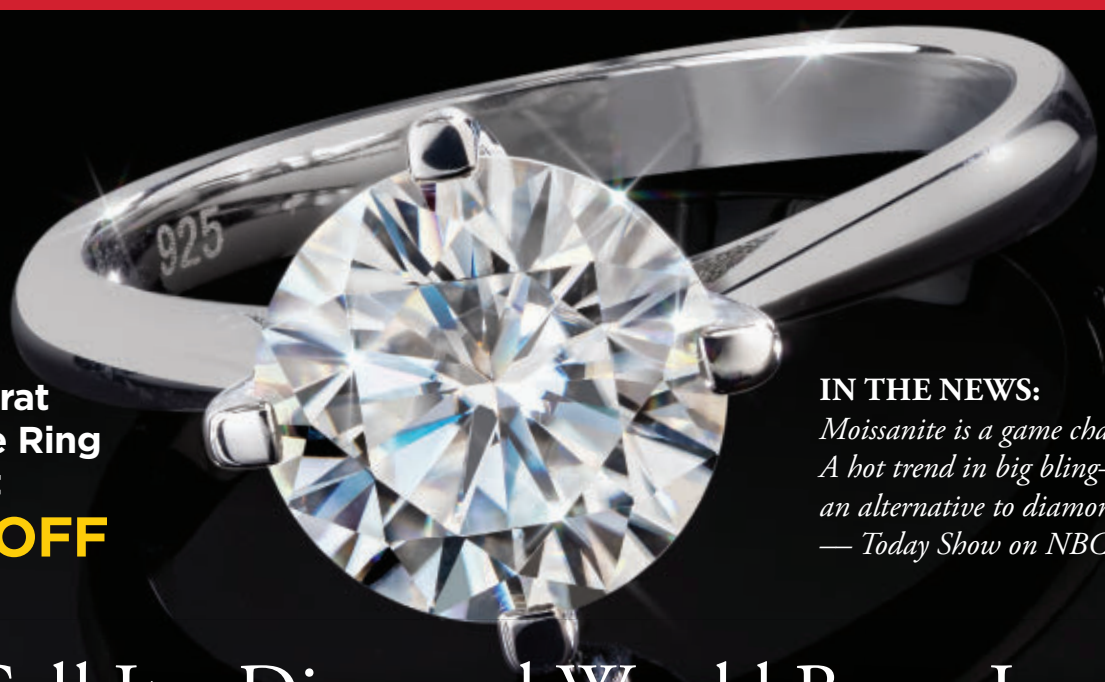

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IN THE NEWS:
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Excerpt from the October 10, 1970 issue of *Science News*

50 YEARS AGO

Warnings from the wells

Seismologists are studying ways to predict the occurrence of earthquakes.... One possibility ... is to monitor subterranean fluid pressures.... Fluctuations in the production rates of oil, gas and water wells are often associated with earthquakes, and sometimes precede them soon enough to provide some warning.

UPDATE: It's still not possible to predict when or where earthquakes will strike. But hazard models can estimate the likelihood that a quake will rock an area within a given time frame. Scientists now know that wastewater injection can trigger earthquakes, and account for those underground fluids in hazard models. When a quake does hit, modern early warning systems can help people brace for shaking. Those systems use readouts from seismic sensors to gauge when surrounding areas will start to tremble, offering seconds to minutes of advance notice. The first public system in the United States started sending alerts to Californians in 2019. A rollout to other quake-prone states has been delayed due to the coronavirus pandemic.

Parasitic *Langsdorffia hypogaea* plants (female, left; male, right) send up showy flowers but don't bother with greenery.

IT'S ALIVE

This plant hides creepy suckers under flashy flowers

Doorknobs in skirts. Microphones in tutus. There are lots of ways to describe *Langsdorffia* flowers, but parasitic-plant specialist Chris Thorogood says they "absolutely look to me like deep-sea creatures."

Whatever you compare them to, the flowers are intricate, screaming-red showpieces. That's the total opposite of the unshowy rest of the plant. It has no leaves, just grayish, ropelike tissue that probes through soil and ranks in looks somewhere between blah and dried-up dog droppings.

The mix of flashy sexual parts and supersimplified other structures makes sense for the plant kingdom's extreme parasites, including the four known *Langsdorffia* species. Why grow a lot of greenery to feed yourself when you can steal what you need?

"They're vampire plants," says Thorogood, of the University of Oxford Botanic Garden & Arboretum. *Langsdorffia*'s underground rope sucks all the nutrition the plant needs from the roots of other plants, such as figs and mimosas. The freeloaders "challenge our notion of what plants even do," he says.

Spotting such marvels requires finding the right wild spot. Neither Oxford nor any other botanical garden grows them, and underground plants get overlooked in the wild, Thorogood lamented in the May 2020 *Plants, People, Planet*. But coauthor Jean Carlos Santos has seen blooms.

The flowers of *L. hypogaea* pop out of the ground in Central and South America, including Brazil's savanna, the Cerrado. The flowers bloom during the dry season, erupting in loud reds from a thin carpet of dead, brown leaves.

Unlike many flowers that sport both male and female parts, an individual *L. hypogaea* plant is either all male or all female. Its knobby blooms burst from the soil as skirted masses of tiny same-sex nubbins. Males ooze nectar among the nubbins. Females release nectar from their skirt and the base of the bouquet. It's a banquet in a parched season. Ants, beetles, cockroaches and even birds such as white-naped jays gather to feast. Jays and maybe beetles do some pollination, says Santos, an ecologist at Federal University of Sergipe in São Cristóvão, Brazil. Many of the other guests are probably just freeloaders.

Below this parasitic plant's flowery veneer lurks ropy vampiric tissue that sucks on other species' roots.

Blooming is an extraordinary event, and shows that even for a stripped-down thief, elaborate floral sex is still worth the effort. Though, some observers have suggested, it may happen only once in each *Langsdorffia* lifetime. —*Susan Milius*

ALL: J.C. SANTOS

SCIENCE STATS

For young adults, risk of severe COVID-19 can't be dismissed

Portion of U.S. young adults hospitalized with COVID-19 who land in intensive care

Younger adults make up more than 20 percent of U.S. coronavirus cases. Now, a new study looks at how severe COVID-19 can be for those who are hospitalized.

Of roughly 3,200 people ages 18 to 34 who were admitted to 419 U.S. hospitals from April through June, 21 percent landed in intensive care, 10 percent ended up on ventilators and almost 3 percent died, researchers report September 9 in *JAMA Internal Medicine*. Underlying conditions like severe obesity or high blood pressure were linked to more serious illness or death. Younger adults who have multiple medical conditions can face similar risks of serious illness and death from COVID-19 as people ages 35 to 64 without those conditions.

Those numbers are "alarming figures given that COVID-19 outbreaks are rampant in many U.S. colleges," says epidemiologist Aubree Gordon of the University of Michigan in Ann Arbor. "Young people often shrug off their risk, citing their age." But they still are at risk of severe disease, she says. — *Erin Garcia de Jesus*

THE –EST

Hummingbird species is extremely chill

Atop the Andes Mountains of Peru, hummingbirds cool down at night, entering a state of suspended animation known as torpor. One species, the black metaltail (*Metallura phoebe*), chills to 3.26° Celsius, the lowest body temperature ever recorded in a bird or nonhibernating mammal, researchers report in the September *Biology Letters*.

"They're cold as a rock," says Blair Wolf, a physiological ecologist at the University of New Mexico in Albuquerque. "If you didn't know better, you'd think they were dead."

Black metaltail hummingbirds (one shown) can cool down to about 3° Celsius — the lowest body temperature ever recorded for a bird.

Torpor had been observed before in hummingbirds, but Wolf and his colleagues wanted a more detailed picture. They placed 26 individuals of six different species in cages overnight outside in the Peruvian Andes and inserted the equivalent of miniature rectal thermometers into the birds' cloacae. Perched and upright, the birds pointed their bills upward, fluffed their feathers and stopped moving. All of the species entered some kind of torpor, but the black metaltail cooled most, dropping from a daytime body temperature of about 40° C to just above freezing.

During the day, the hummingbirds' tiny-yet-mighty hearts can beat 1,200 times a minute. But during torpor, their heart rates plummet to as low as 40 beats a minute. Such a drop may allow the high-altitude birds to cut their energy use by about 95 percent, Wolf says. By not wasting energy trying to stay warm, the birds can thrive as high as 5,000 meters above sea level.

Around sunrise, the hummingbirds start revving up, warming about a degree a minute by vibrating their muscles. "You see the bird quivering there, then all the sudden its eyes pop open and it's ready to go," Wolf says. — *Jonathan Lambert*

Future travelers to the moon will need to manage abrasive, clingy lunar dust (illustrated).

FUTUROLOGY

Space explorers could beam dust off the moon

The NASA Artemis missions aim to send astronauts to the moon by 2024. But to succeed, they'll need to solve big problems caused by some tiny particles: dust.

Lunar motes are like "broken shards of glass," says physicist Mihály Horányi of the University of Colorado Boulder. This abrasive material can damage equipment and even harm astronauts' health if inhaled (*SN: 1/11/14, p. 6*). Making matters worse, moon dust has electric charge, so it sticks to everything.

Horányi and colleagues have developed a method for combating lunar dust's static cling that takes advantage of the dust's electric properties. Bombarding the particles with a low-energy electron beam causes negative charges to build up between particles. As a result, the particles repel each other and fly off surfaces, the researchers report in the December *Acta Astronautica*.

In lab tests, the electron beam left 15 to 25 percent of dust particles still clinging to surfaces. The researchers aim to improve the cleaning power. Horányi envisions this as one of multiple approaches that future space explorers will take to keep surfaces clean, in addition to other cleaning technologies, suit design and even lunar habitats with mudrooms. — *Jack J. Lee*

FROM TOP: NASA; GLENN BARTLEY/ALL CANADA PHOTOS/ALAMY STOCK PHOTO

ATOM & COSMOS

Possible sign of life is found on Venus

On Earth, the gas phosphine is made by microorganisms

BY LISA GROSSMAN

Venus' clouds appear to contain a gas that could be produced by microbes.

Chemical signs of the gas phosphine have been spotted in the planet's atmosphere, researchers report September 14 in *Nature Astronomy*. The clouds appear to contain about 20 parts per billion of the gas — enough that something must be actively producing it, the researchers say.

If the discovery holds up, and if no other explanations for the phosphine are found, then the planet next door could be the first to yield signs of extraterrestrial life — though those are very big ifs.

"We're not saying it's life," says Jane Greaves, an astronomer at Cardiff University in Wales. "We're saying it's a possible sign of life."

The atmosphere of Venus, shown here in a false-color image from Japan's Akatsuki spacecraft, appears to contain the gas phosphine, a potential indicator of life.

AKATSUKI PROJECT TEAM/ISAS/JAXA

Venus has roughly the same mass and size as Earth, so, from afar, Venus might look like a habitable world. But up close, the planet is a scorching hellscape with sulfuric acid rain and crushing atmospheric pressures. Yet, those conditions haven't stopped astrobiologists from speculating about where life could hang on, such as in the temperate cloud decks.

"Fifty kilometers above the surface of Venus, the conditions are what you would find if you walk out of your door right now," in terms of atmospheric pressure and temperature, says Sanjay Limaye, a planetary scientist at the University of Wisconsin–Madison who wasn't involved in the study. The chemistry is alien, but "that's a hospitable environment for life."

Previous work led by astrochemist Clara Sousa-Silva of MIT, a coauthor of the new study, suggested that phosphine is a promising biosignature, a chemical signature of life that could be detected in planets' atmospheres using telescopes.

On Earth, phosphine is associated with microbes or industrial activity. For most earthly life, phosphine is poisonous. "It interferes with oxygen metabolism in a variety of macabre ways," Sousa-Silva says. But for anaerobic life, which doesn't use oxygen, "phosphine is not so evil," she says. Anaerobic microbes living in such places as sewage, swamps and animal intestinal tracts are the only known life-forms that make the molecule.

The researchers hadn't expected to find signs of phosphine. Greaves led observations of Venus using the James Clerk Maxwell Telescope in Hawaii in June 2017, aiming to set a detectability benchmark for future studies seeking the gas in exoplanet atmospheres. She was startled to find hints of phosphine. When analyzing the data, "I thought, 'Oh, I must have done it wrong,'" she says.

The team checked again with a more powerful telescope, the Atacama Large Millimeter/submillimeter Array in Chile, in March 2019. The signature of phosphine, seen as a dip in the spectrum of light at a wavelength of about 1.12 millimeters, was still there. The gas absorbs light of that wavelength. Other molecules that absorb light near that wavelength couldn't explain the whole signal or seemed improbable, Greaves says. "One of those is a plastic," she says. "A floating plastic factory is a less plausible explanation than just saying there's phosphine."

Phosphine takes a fair bit of energy to create and is easily destroyed by sunlight or sulfuric acid, which is present in Venus' atmosphere. So if the gas was produced long ago, it shouldn't still be detectable.

Greaves, Sousa-Silva and colleagues considered every explanation they could think of apart from life: atmospheric chemistry; ground and subsurface chemistry; volcanoes outgassing phosphine; meteorites peppering the atmosphere with phosphine; lightning; solar wind; tectonic plates sliding against each other. Some of those processes could produce trace amounts of the gas, but orders of magnitude less than what was detected.

"We're at the end of our rope," Sousa-Silva says. "I'm curious what kind of exotic geochemistry [other scientists] will come up with to explain this abiotically."

The idea of searching for life on Venus "has been regarded as a pretty out-there concept," says Planetary Science Institute astrobiologist David Grinspoon, who is based in Washington, D.C. He has been publishing about the prospects for life on Venus since 1997. "So now I hear about this, and I'm delighted," he says. "Not because I want to declare victory and say this is definite evidence of life on Venus. It's not. But it's an intriguing signature that could be a sign of life on Venus. And it obligates us to go investigate further."

Several space agencies are considering missions that could fly to Venus in the next few decades. In the meantime, Greaves and colleagues want to confirm their detection in other wavelengths of light. Observations planned for the spring were put on hold by the coronavirus pandemic. Now, Venus is in a part of its orbit where the planet is not visible from Earth.

"Maybe when Venus comes around on the other side of the sun again," Greaves says, "things will be better for us here on Earth." ■

BODY & BRAIN

Treating the nose may stop COVID-19

Scientists test ways to hinder the coronavirus before it settles in

BY LAURA SANDERS

COVID-19 harms the lungs, heart and blood vessels. To curb this wide-ranging attack, scientists are focusing on another part of the body: the nose.

SARS-CoV-2, the coronavirus that causes COVID-19, gains its foothold by infecting certain nasal cells, studies suggest (*SN: 7/4/20 & 7/18/20, p. 9*). Slowing or stopping that invasion may ultimately be powerful enough to change the course of the pandemic, some scientists suspect.

To prevent the virus from settling into prime nasal real estate, researchers are developing and testing a nasal spray that smothers and inactivates a key viral protein, disinfectants that are commonly used before sinus surgeries and even dilute baby shampoo misted up the nose.

The nose doesn't usually spark a lot of interest, says otolaryngologist Andrew Lane of Johns Hopkins University School of Medicine. "Now it's the center of people's attention."

To interrupt the infection in the nose, some scientists have turned to specialized immune proteins found in camels, llamas and alpacas. Called nanobodies, these proteins fight off invaders, but are smaller and perhaps hardier than their human antibody kin. In studies in lab dishes, biochemist Aashish Manglik and cell biologist Peter Walter, both of the University of California, San Francisco, and colleagues have shown that custom-designed nanobodies can smother the spike protein that the coronavirus can use to break into cells.

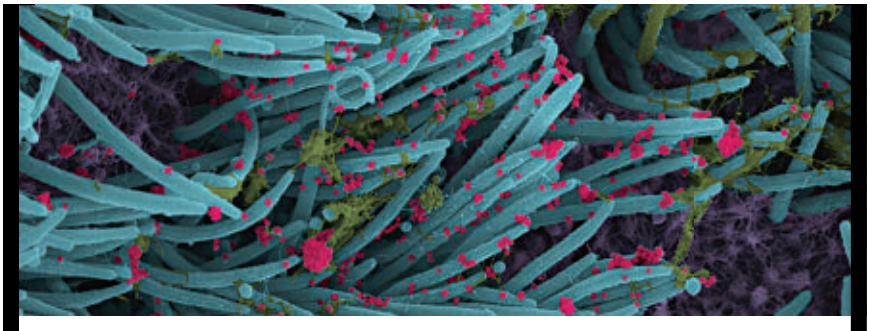
These preliminary results suggest that, once neutralized with nanobodies, the virus "cannot enter human cells," says Walter. "It cannot establish that beachfront in the nasal cavity." Nanobodies were stable when dried and aerosolized, suggesting that they could be made into a nasal spray. The results, which haven't been peer-reviewed, were posted August 17 at bioRxiv.org. The team hopes to begin tests in animals and eventually in humans. Walter and Manglik hold patents on the tested nanobodies.

A simpler approach would be to wash away or kill the virus. Some researchers are trying iodine, the basis of an antiseptic that can treat wounds and disinfect skin before surgery. In a June 10 review article in *Ear, Nose & Throat Journal*, researchers presented evidence that a dilute solution called povidone-iodine might safely eradicate the virus in the nasal cavity and throat. A clinical trial is now under way at the University of Kentucky with health care workers using povidone-iodine nasal sprays and gargling preventively before, during and after shifts.

Other researchers have their eyes on an even more low-tech solution: a mixture of soap and salt. Saline rinses can remove bacteria from the nasal cavity and ease symptoms of sinus infections and colds. A clinical trial that began May 1 is looking for effects of baby shampoo mixed with a salt solution on COVID-19 symptoms and the spread of the virus. The soapy solution might be able to wash viruses out of the nose or pop their protective outer layer and inactivate them, says nasal and sinus surgeon Justin Turner, one of the researchers running the trial at Vanderbilt University in Nashville.

During the trial, COVID-19 patients with mild to moderate symptoms either do nothing special to their nose or rinse it a couple times a day, either with saline or saline plus a small amount of baby shampoo. An early look at 45 of the trial's 100 patients shows that people who did the nose rinses, with saline or saline plus soap, got rid of their headaches and nasal congestion about a week earlier than people who didn't use rinses. Those results appear online September 11 in the *International Forum of Allergy & Rhinology*.

Nose rinses might "stir up the virus and facilitate its spread," Lane cautions. But the idea holds promise, he says. That study and others targeting the nose are gaining momentum. "Everybody is thinking the same way, and I think there's a lot of merit to it," Lane says. "Nip it in the bud, and stop it before it gets a hold." ■



EHRE LAB/UNC SCHOOL OF MEDICINE

GENES & CELLS

The coronavirus overwhelms lung cells

Closeup views of cells show just how prolifically SARS-CoV-2 can replicate once it infiltrates the respiratory tract. In lab dishes, researchers infected human lung cells with the coronavirus, waited 96 hours and then snapped scanning electron micrograph images. (The false-color image above shows virus particles, red, overwhelming a lung cell, purple. The cell's cilia are blue. Mucus is green.) Once infected, a cell produces "an astonishing number of viruses," says pediatric pulmonologist Camille Ehre of the University of North Carolina at Chapel Hill. In a dish of about 1 million cells, the viral load can skyrocket from about 1,000 infectious viruses to 10 million in just two days. Ehre describes these findings in the Sept. 3 *New England Journal of Medicine*. — *Jonathan Lambert*

Observations of galaxy clusters, including MACSJ1206.2-0847 (shown), reveal that some globs of dark matter are denser than thought.

ATOM & COSMOS

Dark matter stumps scientists again

Clumps of the invisible substance bend light more than expected

BY MARIA TEMMING

Dark matter just got even more puzzling.

This unidentified stuff, which makes up most of the mass in the cosmos, is invisible but detectable by the way it gravitationally tugs on objects like stars. Dark matter's gravity can also bend light traveling from distant galaxies to Earth — but now some of this mysterious substance appears to be bending light more than it's supposed to. A surprising number of clumps of dark matter in distant clusters of galaxies severely warp background light from other objects, researchers report in the Sept. 11 *Science*.

This finding suggests that these dark matter clumps, in which individual galaxies are embedded, are denser than expected. That could mean either the computer simulations of galaxy cluster behavior are wrong or cosmologists' understanding of dark matter is.

Very high concentrations of dark matter can act like a lens to bend light and drastically alter the appearance of background galaxies as seen from Earth, stretching them into arcs or splitting them into multiple images of the same object on the sky. "It's like a fun house mirror," says Priyamvada Natarajan, an astrophysicist at Yale University.

Judging by computer simulations of galaxy clusters, clumps of dark matter around individual galaxies that are dense enough to cause such dramatic gravitational lensing effects should be rare. Based on cluster simulations run by Natarajan and colleagues, "we would expect to see one [strong lensing] event in every 10 clusters or so," says study coauthor Massimo Meneghetti, an astrophysicist at the Astrophysics and Space Science Observatory of Bologna in Italy.

But telescope images told a different story. The researchers used observations from the Hubble Space Telescope and the Very Large Telescope in Chile to investigate 11 galaxy clusters from about 2.8 billion to 5.6 billion light-years away. The team identified 13 cases of severe gravitational lensing by dark matter clumps around individual galaxies. These data indicate there are more high-density dark matter clumps in real galaxy clusters than in simulated ones, Meneghetti says.

The simulations could be missing some physics that leads dark matter in

ATOM & COSMOS

Magnetars could solve dual mystery

Same source might produce fast radio bursts and neutrinos

BY LISA GROSSMAN

For over a decade, astronomers have pondered the origins of mysterious, brief blasts of radio waves known as fast radio bursts. Scientists have also wondered about high-energy neutrinos, ghostly particles from outside the Milky Way whose origins are also unknown.

A new theory suggests the two signals could come from a single source: highly active, magnetized neutron stars called magnetars. But catching a high-energy neutrino and an FRB from the same magnetar will be challenging because such neutrinos would be rare, says astrophysicist Brian Metzger of Columbia University. He and colleagues describe the idea in a study posted online September 1 at arXiv.org.

"This paper gives a possible link between what I think are two of the most exciting mysteries in astrophysics," says astrophysicist and neutrino researcher Justin Vandenbroucke of the University of Wisconsin–Madison.

Over 100 FRBs have been detected coming from outside the Milky Way — too far away to see what drives them. Dozens of explanations have been debated, including stellar collisions, black holes and rotating stellar corpses called pulsars. Recently, magnetars have emerged as a top contender. In April, astronomers detected the first FRB coming from within the Milky Way (*SN: 7/4/20 & 7/18/20, p. 12*), close enough to trace the FRB to a potential source, a magnetar.

There are several ways that magnetars could emit the bursts, Metzger says. The blasts could come from close to the neutron star's surface. Or they could come from shock waves produced after the magnetar burped out an energetic flare.

Only those shock waves would produce high-energy neutrinos and FRBs simultaneously, Metzger says. Here's how: Some magnetars emit flares repeatedly, enriching their surroundings with charged particles. Each flare would excavate some protons from the neutron star's surface. If the magnetar also has a halo of electrons, adding protons to the mix would set the stage for the dual cosmic phenomena.

As the next flare runs into the protons released by the previous flare, it would

HUBBLE/ESA AND NASA

galaxy clusters to glom tightly together, Natarajan says. "Or ... there's something fundamentally off about our assumptions about the nature of dark matter," like the notion that gravity is the only attractive force that dark matter feels.

Cosmologist Richard Ellis of University College London thinks the crux of the problem is more likely in the simulations. "A cluster of galaxies is a very dangerous place," he says. It's busy with galaxies whizzing past one another, colliding and getting torn up. "There's awful physics that goes into predicting how many of these little lensed things they should find," Ellis says, so "my suspicion is that there's something in the simulations ... that isn't quite right."

Observations with the upcoming Euclid space telescope, the Nancy Grace Roman Space Telescope and the Vera C. Rubin Observatory could help clear matters up, says astrophysicist Bhuvnesh Jain of the University of Pennsylvania. "These three telescopes are going to produce extremely large samples of galaxy clusters," he says. That may lead to a new understanding of the physics in these environments and help determine whether unrealistic simulations are to blame for this dark matter mystery. ■

accelerate protons and electrons in the same direction at the same speeds. This "ordered dance" of electrons could give rise to an FRB by converting the energy of the electrons' movement into radio waves, Metzger says. The protons would go through a chain reaction resulting in one high-energy neutrino per proton.

Metzger and colleagues calculated the energies of any neutrinos that would have been produced along with the FRB seen in April. Those energies matched those that could be detected by the IceCube neutrino observatory in Antarctica.

IceCube didn't detect any neutrinos from that magnetar, Vandenbroucke says. But that's not surprising. Because high-energy neutrinos produced along with an FRB should be rare, detecting any would probably require a particularly bright magnetar flare aimed directly at Earth. ■

ATOM & COSMOS

Weirdly warped disk circles star trio

Scientists offer competing explanations of the system's origins

BY LISA GROSSMAN

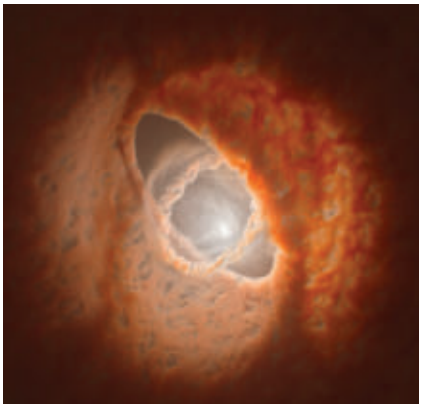
In one of the most complex cosmic dances yet spotted, three rings of gas and dust circle a trio of stars.

The star system GW Orionis, about 1,300 light-years from Earth in the constellation Orion, includes a pair of young stars locked in a do-si-do, with a third star making loops around both. Around all three stars is a broken-apart disk of dust and gas where planets could form. Unlike the flat disk that gave rise to the planets in our solar system, GW Orionis' disk has three loops, with a warped middle ring and an inner ring even more twisted and at a jaunty angle to the other two.

The weird geometry of this system, the first known of its kind, is reported in two recent studies by two groups of astronomers. The two teams have competing ideas for how the system formed.

In the Sept. 4 *Science*, Stefan Kraus of the University of Exeter in England and colleagues suggest that gravitational tugs and torques from the triple-star ballet tore apart and deformed the primordial disk. But in a May 20 study in the *Astrophysical Journal Letters*, Jiaqing Bi of the University of Victoria in Canada and colleagues blame a newborn planet.

"The question is how do you actually form such systems," says Giuseppe Lodato, a theoretical physicist at the University of Milan who was not on either team. "There could be different mechanisms that could do that."



The star system GW Orionis is surrounded by a complicated trio of rings (shown in this artist's illustration) that could form planets.

Scientists had seen tilted disks around binary star systems, but not systems of more than two stars. In binary systems, planets often go around their stars more like a jump rope than a Hula-Hoop, encircling the poles rather than the equator. That misalignment could originate with the disk in which the planets were born: If the disk was askew, the planets would be too.

Both Bi's team and Kraus' team looked at GW Orionis with the Atacama Large Millimeter/submillimeter Array in Chile. The observations revealed three distinct rings of dust and gas encircling the stars.

Kraus' group added observations from the European Southern Observatory's Very Large Telescope to show the shadow of the inner ring on the inside of the middle ring, which revealed that the middle one is warped, swooping up on one side and down on the other.

Both groups ran computer simulations of how the system formed. Bi's team says that a newly formed, not-yet-discovered planet cleared its orbit of gas and dust, splitting the inner ring off from the rest of the disk. Once the disk was split, the inner ring was free to swing around the stars, settling into its skewed alignment.

Kraus' team, however, says the chaotic gravity from the triple stars' orbital dance alone was enough to break up the disk. Each star tries to keep the disk aligned with itself, and the tug-of-war warped and sheared the disk, and twisted the inner ring even further.

The difference may lie in the assumptions the groups made about the disk's properties, says astrophysicist Nienke van der Marel, Bi's colleague at the University of Victoria. With current technology, there's no way to tell what the properties of GW Orionis' disk are really like. And neither group could explain what made the disk split into three. ■

L. CALÇADA/ESO, S. KRAUS *ET AL*, UNIV. OF EXETER

GENES & CELLS

Editing human embryos is not yet safe

Strict new guidelines lay out a path to modifying germline DNA

BY TINA HESMAN SAEY

Gene editing to make heritable changes in human DNA isn't yet safe and effective enough to make gene-edited babies, an international scientific commission says. But on September 3, the group released a road map for rolling out heritable gene editing should society decide that kind of DNA alteration is acceptable.

The International Commission on the Clinical Use of Human Germline Genome Editing formed after a Chinese scientist announced in 2018 that he had created gene-edited babies, sparking outrage. In the road map, the commission suggests strict scientific criteria that would need to be met before heritable gene editing could be tried clinically. If countries can't ensure those criteria are met, such editing shouldn't be approved, the group says.

Still, some critics charge that even presenting such criteria is premature: The science should wait until society decides whether to allow heritable gene editing.

Gene editing involves changing a DNA letter, or base, in a gene. One concern is that gene editors will make "off-target" changes elsewhere in DNA that may cause harm. Scientists need to develop better methods to determine that every cell in an embryo has the desired change — and only that change, the commission says.

"It's accurate and efficient enough to do in animals," but gene editing in human embryos requires much more precision, commission member Haoyi Wang, a stem cell biologist at the Chinese Academy of Sciences' Institute of Zoology in Beijing, said September 3 during a webinar.

Scientists are already testing gene-editing tools such as CRISPR/Cas9 to correct a few inherited disorders, such as sickle-cell anemia, in adults. Those edits can't be carried into future generations.

But altering DNA in the germ line — embryos, eggs, sperm or the cells that give rise to them — would create changes that could be passed on. Many people are concerned that rogue scientists wouldn't stop at editing out diseases and would create "designer babies" with enhanced intelligence or other desirable traits.

The commission proposes restricting germline editing to serious diseases caused by specific versions of single genes that are virtually guaranteed to cause the disease if inherited. Such disorders include Duchenne muscular dystrophy and cystic fibrosis, which cause people to die young or have serious medical issues.

"It's accurate and efficient enough to do in animals," but gene editing in human embryos requires much more precision.

HAOYI WANG

The commission also specifies that before germline editing is considered, there should be no other way to ensure that a couple can produce embryos without the harmful genetic variants. That would winnow the eligible list down to couples who meet one of two criteria: Both parents have two copies of recessive disease-causing variants. Or, one parent has two copies of mutations that cause a dominant genetic disorder, such as Huntington's disease, which results from one copy of a faulty gene.

Perhaps 20 couples around the world would meet these strict criteria, commission member Michèle Ramsay, a human geneticist at the University of the Witwatersrand in Johannesburg, said September 3 during a news briefing.

So the commission also decided that some families with less serious disorders, but who have little chance of producing embryos without disease-causing variants, might also be eligible. One example is familial hypercholesterolemia, a form of high cholesterol that can lead to early heart disease and death. Gene editing might be an option when 25 percent or fewer of a couple's embryos would be free of the disease-causing mutation.

Even then, such couples must already have attempted in vitro fertilization with a technique called preimplantation genetic testing to screen out embryos that carry the faulty gene. "We're not thinking there are going to be a lot of people" who are qualified to take part in the initial research, Ramsay said. But if the technology is both safe and effective in those few families, such editing might then be considered for other conditions.

The commission recommends more research on using stem cells to make eggs and sperm in lab dishes, which could then be used to create embryos that don't carry genetic diseases. Such research has been done in mice (*SN: 6/24/17, p. 13*), said commission member and human geneticist Richard Lifton of the Rockefeller University in New York City.

The report also suggests establishing an international scientific advisory panel to evaluate the state of germline editing and consult on applications to do such editing. An organization similar to the World Anti-Doping Agency, which oversees the use of performance-enhancing drugs in sports, might be set up to keep an eye out for unauthorized gene editing, Lifton said.

Setting up global governance to prevent scientists from going rogue may not be as effective as a clear moratorium or ban, says Katie Hasson, program director for genetic justice at the nonprofit Center for Genetics and Society, based in Berkeley, Calif. Hasson also argues that hashing out how to do germline editing before society has indicated its desire to do so is backward. "The question has been and still is whether we want to move forward with editing the genes and traits of future generations," she says. "To skip ahead to how ... seems like getting ahead of things a bit."

Over 40 countries have laws prohibiting germline editing, and a moratorium and other laws might effectively stop the technology from moving forward, she says. "There's no reason [germline editing] should be inevitable. Laying out this path in advance makes it seem more inevitable and pushes us toward that conclusion." ■

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BODY & BRAIN

COVID-19 may harm athletes' hearts

A small study of college players found indicators of inflammation

BY AIMEE CUNNINGHAM

Amid growing concerns that a bout of COVID-19 might damage the heart, a small study is reporting signs of an inflammatory heart condition in college athletes who had the infection.

Over two dozen male and female competitive athletes underwent magnetic resonance imaging of their hearts in the weeks to months after a positive test for SARS-CoV-2, the virus that causes COVID-19. The images indicated swelling in the heart muscle and possible injury to cells in four of the athletes, or 15 percent, researchers report online September 11 in *JAMA Cardiology*. That could mean the athletes had myocarditis, an inflammation of the heart muscle usually caused by viral infections.

Heart images of eight additional athletes showed signs of possible injury to cells without evidence of swelling. It's more difficult to interpret whether these changes in the heart tissue could be due to the coronavirus infection, says cardiologist Saurabh Rajpal of the Ohio State University Wexner Medical Center in Columbus. One limitation of the research is the lack of images of the athletes' hearts before the illness for comparison, Rajpal and his colleagues say.

None of the 26 athletes in the study — who play football, soccer, basketball, lacrosse or run track — were hospitalized due to COVID-19. Twelve of the 26, including two of the four with signs of inflamed hearts, reported mild symptoms during the infection, such as fever, sore throat, muscle aches and difficulty breathing.

It will take more research to confirm the study's findings and understand what they mean for these young hearts. For now, the results suggest that the heart may be at risk of injury. After having COVID-19 — even with mild or no symptoms — young people need to pay attention to how they feel when they return to exercise, Rajpal says. If they have symptoms like chest pain, shortness of breath or an abnormal heartbeat, he says, they should see a doctor.

It's been apparent since early in the pandemic that COVID-19 can be worse in patients who already have heart problems (*SN: 4/11/20, p. 7*). More recently, studies have reported on what the infection might do to the heart. For example, researchers assessed 100 German adults who had recovered from COVID-19, one-third of whom needed to be hospitalized. Cardiac MRIs revealed signs of inflammation in 60 of the patients post-infection.

Those signals of heart inflammation could mean that the patients had developed myocarditis, which is estimated to occur in about 22 out of 100,000 people annually around the world. Patients with myocarditis can experience chest pain, shortness of breath, fatigue or a rapid or irregular heartbeat. The heart can recover from myocarditis, but in rare cases, the condition can lead to heart failure.

For athletes diagnosed with myocarditis, the recommendation is to stop participating in sports for three to six months to give the heart time to heal, as evidence from lab animals suggests that vigorous exercise when the heart is still inflamed worsens the injury. With a break from sports, young athletes can expect to recover. But the condition is taken seriously: A 2015 study estimated that 10 percent of sudden cardiac deaths in NCAA athletes were due to myocarditis. When the Big Ten Conference, for example, announced in August that it was postponing the start of its fall sports season, one of the reported reasons was concern about COVID-19–related myocarditis.

The new study "is really a step in the right direction," says Meagan Wasfy, a sports cardiologist at Massachusetts General Hospital. "We need more data like this." But it's hard to draw firm conclusions, she says. Cardiac MRIs are usually used to confirm a diagnosis of myocarditis in combination with other clinical signs, she says, including symptoms, abnormal findings in an electrocardiogram and blood test results that show signals of inflammation and a high level of a protein called troponin I that indicates stress on the heart.

While some colleges went ahead with fall sports (a September game shown above), others have postponed their seasons because of COVID-19. A small study indicates myocarditis might be a concern for college athletes.

In the study, while some athletes had signs of possible myocarditis in imaging, their troponin I levels were normal, and their electrocardiograms didn't look unusual. Wasfy sees a few possible explanations. Had the athletes been tested when they were first infected, those other clinical signs might have shown up. Perhaps the other indications had returned to normal by the time the cardiac MRI and other tests were performed. In that case, the MRI is a "ghost" of that prior inflammation and stress, she says.

Another possibility is that the virus affects the heart muscle in a way that cardiologists aren't accustomed to, absent some of the usual signs of inflammation and stress. Without those indicators of myocarditis, it's hard to say if the heart had this condition, she says.

Some might argue that the imaging signs could be chalked up to differences between the hearts of competitive athletes and those of the more sedentary. Wasfy thinks that's less likely, but cardiologists "certainly have a lot of work to do to define what the prevalence of these [imaging] findings is at baseline" in healthy athletes.

To expand on the study, Rajpal and colleagues plan to take heart scans of more athletes, repeat cardiac MRIs in the athletes already imaged and scan athletes who did not have COVID-19 to compare their images with those who have had it. ■

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HUMANS & SOCIETY

Drones find signs of an ancient city

Kansas site holds clues to a big Native American settlement

BY BRUCE BOWER

Remote-sensing devices on drones identified an earthwork (arrow) beneath this Kansas pasture. The site may have been part of one of the largest Native American settlements north of Mexico.

Specially equipped drones flying over a Kansas cattle ranch have detected the buried remnants of a horseshoe-shaped ditch made more than 400 years ago by ancestors of today's Wichita and Affiliated Tribes, scientists say.

The find adds to suspicions that the Kansas site was part of a sprawling population center that Spanish explorers dubbed the Great Settlement in 1601, archaeologist Jesse Casana of Dartmouth College and his colleagues report online August 24 in *American Antiquity*.

Called Etzanoa by a captive the Spanish took from the Great Settlement, it could turn out to be one of the largest Native American settlements ever established north of Mexico, if confirmed by further work. The largest currently known is the Cahokia site in Illinois where as many as 20,000 people lived from 1050 to 1150.

Ancestral Wichita communities in Kansas and northern Oklahoma that built earthworks date to between about 1425 and 1650 — a time frame during which South America's Inca civilization rose and fell. In the 1800s, European settlers drove ancestral Wichita people from their native lands, leading to the destruction of villages and communal traditions.

The newly discovered earthwork, a 2-meter-wide ditch that forms a semicircle about 50 meters across, is similar to circular earthworks known as council circles. Five council circles have been found among 22 ancestral Wichita sites excavated along an eight-kilometer stretch of the Little Arkansas and Smoky Hill rivers, about 230 kilometers north of the newly surveyed site.

"We apparently have located the sixth council circle and the only one that has not been disturbed," says anthropological archaeologist Donald Blakeslee of Wichita State University. Farming and construction projects have damaged or covered many ancestral Wichita sites.

Drone surveys "can truly transform our ability to locate sites and map important features where huge areas have been plowed, and surface traces of houses and ditches are often close to invisible," says archaeologist Douglas Bamforth of the University of Colorado Boulder.

It's unclear how ancestral Wichita people used council circles. Researchers have suggested that these structures were places for ritual ceremonies, houses of social elites or protection from attackers.

Based on previous discoveries of items made of obsidian, seashells and other exotic materials at council circles, the structures must have hosted rituals of some kind, says archaeologist Susan Vehik of the University of Oklahoma in Norman. Drone imagery alone can't establish whether rituals occurred at the buried earthwork or if, perhaps, noncombatants hid behind walls along its borders when the site was attacked.

Blakeslee was inspired by publications by an archaeologist who excavated at the same bluff site over 60 years ago and suspected it had been a central part of Etzanoa. Since then, Blakeslee's work along the Walnut River has filled in gaps between ancestral Wichita sites. Etzanoa was likely a single, spread-out community, he contends. Upstream from Etzanoa sites, excavations have uncovered remnants of a separate Wichita town that ran for about three kilometers, he says.

From 2015 to 2019, Blakeslee directed an excavation at the House family cattle ranch in southeastern Kansas that uncovered ancestral Wichita objects such as stone tools and cooking utensils as well as 17th century Spanish items, including a horseshoe nail and bullets. These finds supported Spanish documents and maps of Etzanoa that resulted from the 1601 expedition to Wichita territory.

Blakeslee's artifact discoveries led to the new drone survey. Casana directed aerial sweeps over grazing land at the cattle ranch, where ancient structures had likely suffered minimal damage. Drone-mounted equipment measured heat and radiation differences in the ground to detect buried structures.

The underground earthwork is near the ranch's highest point. Other circular earthworks of the ancestral Wichita and neighboring groups in the southern Great Plains were also built at elevated spots, Casana's team says.

Drone imagery also picked up signs of two pits, one at or near each end of the semicircular structure. The earthwork's makers may have removed soil from the pits to construct mounds inside the borders, as has been observed at excavated council circles in the region. Erosion may have partly worn away what was originally a circular structure, the team says.

Blakeslee plans to explore more of the site's underground features with additional remote-sensing techniques to ensure digging can precisely target the earthwork and any surrounding remains. That will also up the likelihood of uncovering material suitable for radiocarbon dating to reveal the earthwork's age. ■

J. CASANA

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LIFE & EVOLUTION

Giant sperm go back 100 million years

Fossilized crustacean holds what may be the oldest known sperm

BY CURTIS SEGARRA

Ostracods look like seeds with legs. But some species of these tiny crustaceans have an outsize claim to fame: giant sperm. The longest ostracod sperm can stretch 1.18 centimeters, over three times the length of an adult.

An ostracod fossil reveals megasperm date back to at least about 100 million years ago, researchers report in the Sept. 30 *Proceedings of the Royal Society B*. Sperm found inside a female are among the oldest, if not the oldest, fossilized sperm ever found.

Using micro-CT scans, Dave Horne, a micropaleontologist at Queen Mary University of London, and colleagues peered inside several ancient ostracods preserved in amber from Myanmar. The layout of internal sex organs resembled that of their modern counterparts. In one female, the team found giant sperm packed inside her seminal receptacles.

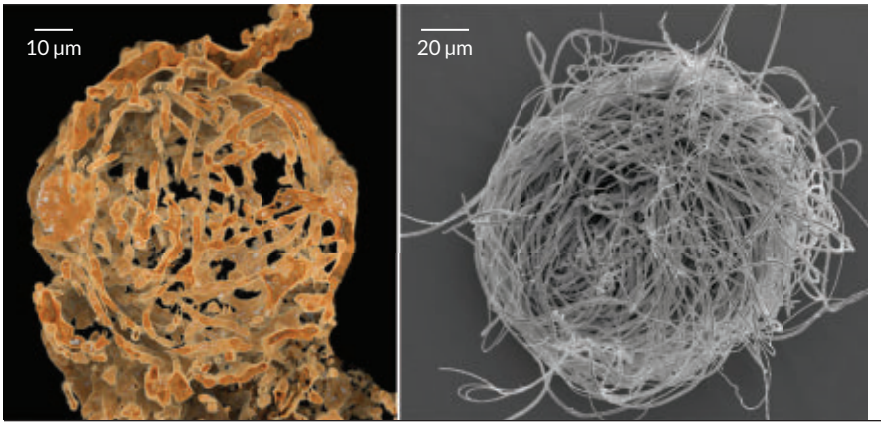
Ostracods aren't the only animals with giant sperm. Some fruit flies, for example, also rely on megasperm. In ostracods, giant sperm perhaps evolved as a result of "competition between sperms of two or more males trying to fertilize the eggs of the same female," Horne says. The sperm must make a long, winding journey from the vagina to the eggs, and shorter sperm may not make it, adds coauthor Renate Matzke-Karasz, a geobiologist at Ludwig-Maximilians-Universität in Munich.

The new find rivals the age of reported sperm found in ancient crickets. But Horne and colleagues argue the cricket fossil could hold the tube used to transfer sperm rather than sperm itself. So the ostracod sperm, they argue, is "the oldest unequivocal fossil animal sperm."

"I have looked at a lot of ostracod spermatozoa over the years, and there is no question; these are preserved spermatozoa," says Robin Smith, a zoologist at Lake Biwa Museum in Shiga Prefecture, Japan, who was not involved in the study. The evidence of ancient cricket sperm is less clear, he says.

George Poinar, a paleontologist at Oregon State University in Corvallis who described the ancient cricket, stands by his conclusion. Still, he says, the new find shows that certain features — like giant sperm — have stood the test of time. ■

Based on micro-CT scans, scientists reconstructed the jumble of sperm (left) found in an ancient female ostracod. The sperm resemble modern ostracod sperm (right, shown in a micrograph).



BOTH: R. MATZKE-KARASZ

LIFE & EVOLUTION

How a moth can outsmart smog

In tests, a pollinator learned to like ozone-altered floral scents

BY CARMEN DRAHL

Pollution can play havoc with pollinators' favorite flower smells. But one kind of moth can learn how to take to an unfamiliar new scent like, well, a moth to a flame.

Aromas help pollinators locate plants. Air pollutants scramble those fragrances, throwing off the tracking abilities of such beneficial insects as honeybees. But new lab tests demonstrate that one pollinator, the tobacco hawkmoth (*Manduca sexta*), can learn that a pollution-altered scent comes from the jasmine tobacco flower (*Nicotiana alata*) the insect likes.

That ability may imply that the moth can find food and pollinate plants despite pollution, researchers report September 2 in the *Journal of Chemical Ecology*.

"This study is a clarion call to other scientists" to examine how different pollinators might adapt to human-driven changes to their environment, says chemical ecologist Shannon Olsson of the Tata Institute of Fundamental Research in Bangalore, India.

Chemical ecologist Markus Knaden and colleagues focused on ozone, the main ingredient in smog. Ozone reacts with aroma molecules, changing their chemical structure and thus fragrance. In Knaden's lab at the Max Planck Institute for Chemical Ecology in Jena, Germany, his team blew an ozone-altered jasmine tobacco scent from a tube into a refrigerator-sized plexiglass tunnel, with a moth at the far end. Usually, when smelling unaltered fragrance, a moth flies upwind and probes the tube as it would a blossom. But the insects weren't attracted to an aroma exposed to ozone levels typical of some hot, sunny days.

In addition to scent, hawkmoths track flowers visually, so the team used a fake flower, plus sugar water, to train the moths to like the pollution-altered scent. After training, the moths were attracted to the new smell when sent into the tunnel, even when neither the sugar water nor the visual cue was present.

Although the moths learned the new scent in the lab, Knaden isn't sure how often that occurs in the wild. ■

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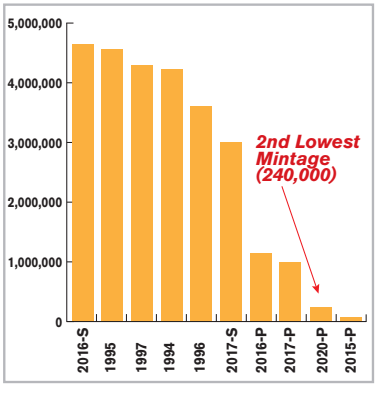

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EARTH & ENVIRONMENT

Primordial carbon formed rare gems

Diamonds from the very deep reveal carbon cycle's limits

BY CAROLYN GRAMLING

Most diamonds are made of carbon recycled over and over again between Earth's surface and crust. But diamonds with the deepest origins — such as the famed Hope Diamond — are made of carbon from a separate source: a newfound, ancient reservoir hidden in the lower mantle, scientists report in the Sept. 10 *Nature*.

Chemical clues within these superdeep diamonds suggest there's a limit to how deep Earth's carbon cycle goes. Understanding how and where carbon moves in and out of the planet's interior can help scientists understand changes to the climate over eons, the researchers say.

Diamonds form at different depths before making their way toward the surface. "Most of the diamonds people are familiar with are from the upper 250 kilometers of the planet," says geochemist Margo Regier of the University of Alberta in Edmonton, Canada. Rare "superdeep" diamonds come from at least 250 kilometers underground.

Rarest of all are diamonds that form as far as 700 kilometers down. Because of their origins, these diamonds are scientifically priceless, offering a rare window into the lower mantle.

The source of the carbon in these deep diamonds has been a mystery. Scientists have wondered whether the carbon came from the subduction of Earth's tectonic plates. As one plate slides beneath another and sinks into the mantle, it transports carbon from the surface to the interior. Some of the carbon eventually returns to the surface, via erupting volcanoes or as diamonds, while some gets sequestered in the deep crust or upper mantle. Carbon sequestration by subduction may have played a key role in creating space for oxygen to accumulate in Earth's atmosphere, paving the way for the first big surge of oxygen into the atmosphere, during the Great Oxidation Event, by 2.3 billion years ago.

Diamonds and their inclusions — slivers of rock that become embedded in the crystal structures as the diamonds form — provide clues to the environments in which they formed. So Regier and colleagues examined diamonds that originated in the crust, upper mantle or lower mantle, hunting for the chemical traces of subducted crust.

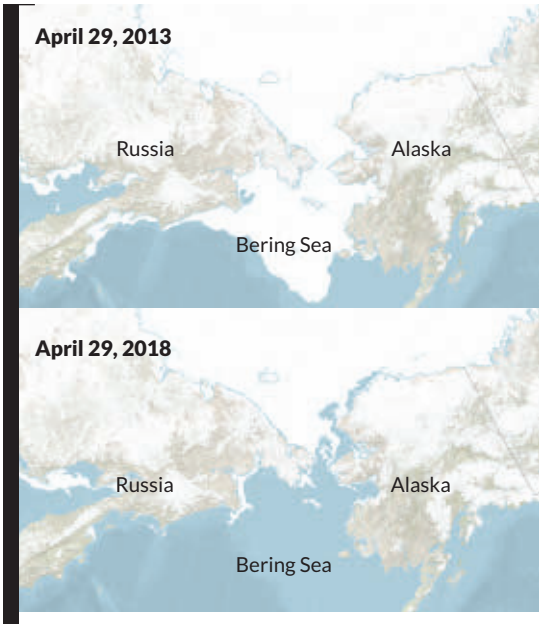
The relative amounts of different isotopes — different forms of an element — indicated the chemical makeup of the magma in which the diamonds crystallized. For example, diamonds from the crust and upper mantle had inclusions enriched in oxygen-18 — suggesting that the gemstones crystallized out of magma formed from subducted oceanic crust.

"All the isotopes tell the same story in a different way," Regier says. "They're all saying that subducting slabs are able to transport carbon and similar elements to a similar depth in the mantle. But at around 500 to 600 kilometers deep, most of that carbon is lost through magma" that rises back to the surface, she says.

The chemical makeup of diamonds from deeper than 660 kilometers was markedly different from that of the shallower diamonds. Those "form in a different way, from carbon already stored within the mantle," Regier says. "The very deepest samples must have been [made of] primordial carbon that never escaped from the planet."

The finding also suggests a limit to how deeply carbon from the surface can be buried. That calls into question, Regier says, whether subduction was able to bury carbon deeply and for long enough to be a driving force behind the Great Oxidation Event.

But subducting slabs don't need to carry carbon all the way to the lower mantle to sequester it, or to have a profound impact on Earth's climate, says Megan Duncan, a petrologist at Virginia Tech in Blacksburg. "The carbon doesn't need to make it that far down," Duncan says. "It just needs to be removed from the surface to have that oxygen-rise effect." ■



JOSHUA STEVENS/NASA EARTH OBSERVATORY

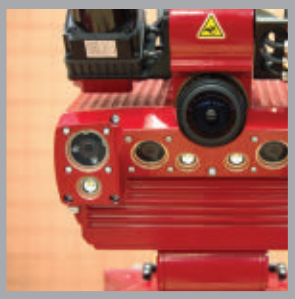
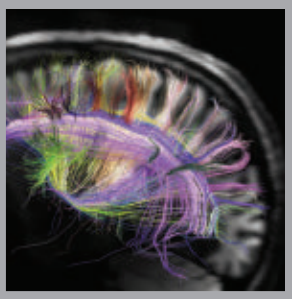
EARTH & ENVIRONMENT

Bering Sea winter ice shrinks to record low

In 2018, sea ice in the Bering Sea, on the southern margin of the Arctic Ocean, dwindled to its smallest winter expanse in 5,500 years (extent is shown above in white compared with 2013 levels), data show. Just as with shrinking summer sea ice, recent winter ice losses in the region are linked to climate change, researchers suggest in the Sept. 2 *Science Advances*.

The team collected cores of peat from a Bering Sea island. The peat holds chemical evidence of the region's climate history that, along with satellite data and a computer simulation, allowed the team to trace winter sea ice over 5,500 years.

In preindustrial times, the ice was gradually decreasing, largely due to changes in sunlight related to changes in Earth's orbit. But with the Industrial Revolution's onset, greater losses corresponded with rising carbon dioxide levels. How exactly rising CO_2 relates to winter sea ice — through greenhouse gas warming or effects on atmospheric circulation patterns — is less clear. But the study suggests that winter ice losses lag behind CO_2 changes by decades or even a century, which means by 2100, the Bering Sea could be ice-free. — *Carolyn Gramling*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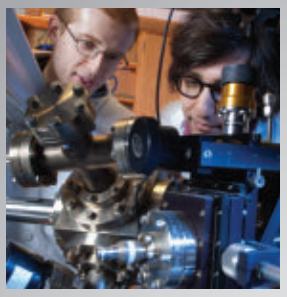

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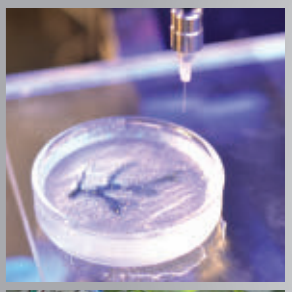



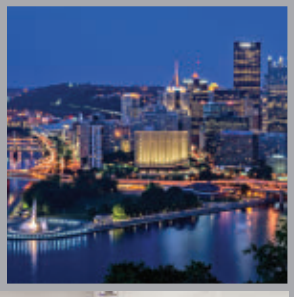





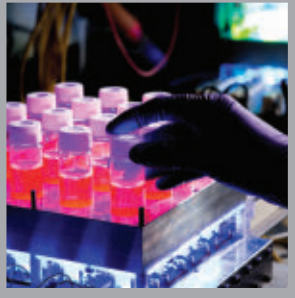
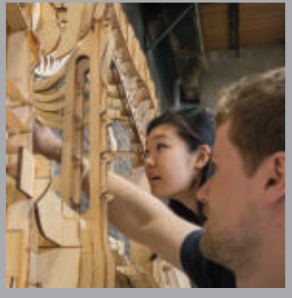

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LIFE & EVOLUTION

Sea butterflies' shells determine how the marine snails swim

Sea butterflies flit through the ocean on gossamer wings, each species with a style of its own.

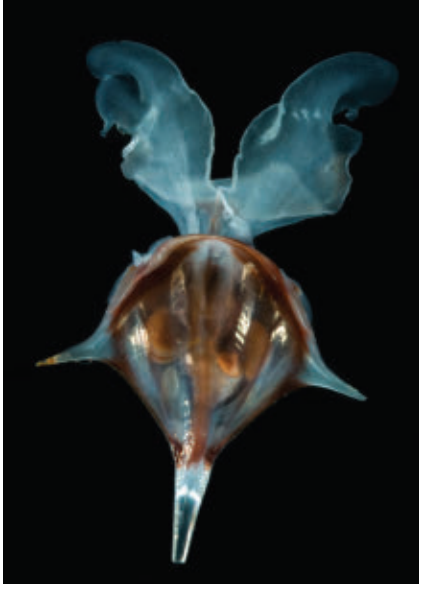
These tiny marine snails migrate up to surface waters at night to feed and sink to deeper waters during the day to hide from predators. But exactly how the animals move through the water has been a mystery.

New video reveals that species swim and sink at different angles and speeds, depending on the sizes and shapes of their shells, researchers report online September 7 in *Frontiers in Marine Science*. The finding could inspire new designs for underwater robots.

Researchers filmed seven species of sea butterfly, collected off Bermuda, in an aquarium. Two tiny species had coiled shells about 1 millimeter across; four midsize species had long, conical or urn-shaped shells about 7 to 11 millimeters wide; and one species had a flat shell up to 14 millimeters across.

All of the sea butterflies propelled themselves along zigzagging paths as they flapped their wings. Those wingbeats caused bodies of the species with tiny, coiled shells and midsize, long shells to rock back and forth as the animals swam.

Snails with coiled or elongated shells tended to swim straight up and to sink straight down whenever they stopped flapping, their shells hanging like pendulums beneath their wings. But the large species with a wide, flat shell climbed at a shallower angle and drifted sideways as it sank, potentially due to lift generated by the shell. — *Maria Temming*



Different species of marine snails known as sea butterflies (one shown) have distinct styles of swimming as they migrate up and down the water column each day.

BODY & BRAIN

U.S. blood donations reveal COVID-19 infection trends

To better understand how widely the coronavirus has spread in the United States, some researchers have turned to an unusual data source: blood donations.

Many blood collection centers have been offering to test donated blood for antibodies to SARS-CoV-2, which indicate a past infection with the virus that causes COVID-19. Of the nearly 1 million blood donations to the American Red Cross from June 15 to August 23 that were tested, only 1.82 percent of the samples had the antibodies. That finding hints that many Americans have yet to be infected, researchers report online September 14 in *JAMA*.

Blood donations aren't a random sample of the population, but the data can give an idea of how much of a population has been exposed to the virus, a concept known as seroprevalence, and how susceptible different populations remain to continuing outbreaks, though scientists are still unsure how much protection antibodies provide against reinfection.

Seroprevalence varied by region. By August 23, the South had a seroprevalence of about 2.9 percent, higher than the Midwest (about 2.7 percent), West (about 2.4 percent) and Northeast (about 2.1 percent). — *Jonathan Lambert*

MATH & TECHNOLOGY

Game Boy look-alike runs on solar panels and button smashes

For a Game Boy doppelgänger, "batteries not included" is a perk, not a problem.

The prototype handheld game console harvests enough energy from sunlight and key-smashing to run games like *Tetris*.

Such a battery-free setup, presented September 15 at the virtual UbiComp conference, could one day help curb electronic waste from mobile devices.

The heart of the Game Boy look-alike is a small, low-power microcontroller. Solar panels on the front of the device collect energy from sunlight. And each button contains a small magnet that, when pressed down or released, moves through a wire coil underneath the button. That change in the magnetic field around the coil generates an electric current that also can be used to power the device.

In well-lit environments, the battery-free console can collect enough power to sustain about 10 seconds of play before the system dies for a second and reboots. The console's memory allows games to resume play at the exact same spot after a power interruption. The researchers who developed the device are exploring other means of harvesting energy on the go, including through shaking, heat or friction. — *Maria Temming*

LIFE & EVOLUTION

Stray molar is the oldest known fossil from an ancient gibbon

A roughly 13-million-year-old molar is the oldest known fossil of an ancestor of small-bodied apes called gibbons.

The fossil, which was eroding out of previously dated sediment at a site in northern India called Ramnagar, belongs to a new genus and species, named *Kapi ramnagarensis*, researchers report in the Sept. 9 *Proceedings of the Royal Society B*.

Until now, the oldest remains of an ancient gibbon species consisted of a small number of teeth found in China, dating from around 9 million to 7 million years ago. Genetic studies of living primates suggest that gibbon ancestors emerged by at least 20 million years ago in Africa.

K. ramnagarensis comes from deposits that previously yielded fossils of an orangutan ancestor, suggesting that both apes reached South Asia from Africa around the same time. "We're catching a window into that event" as small-bodied gibbons and large-bodied orangutans headed to their recent and current home ranges in East and Southeast Asia, says Christopher Gilbert, a paleontologist at Hunter College at the City University of New York. — *Bruce Bower*

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THE SN 10 SCIENTISTS TO WATCH

Chasing helpful solutions and a sense of wonder

In the midst of a pandemic that has brought so much worry and loss, it's natural to want to help — to do some small part to solve a problem, to counter pain, or to, importantly, remind others that there is beauty and wonder in the world. Scientists have long been doing just that. Many are chasing answers to the myriad challenges that people face every day, and revealing the rewards in the pursuit of knowledge itself. It's in that spirit that we present this year's SN 10: Scientists to Watch.

For the sixth consecutive year, *Science News* is featuring 10 early- and mid-career scientists who are pushing the boundaries of scientific inquiry. Some of the researchers are asking questions with huge societal importance: How do we prevent teen suicide? What are the ingredients in wildfire smoke that are damaging to health? Is there a better way to monitor earthquakes to save lives? What about finding new ways to diagnose and treat diseases?

Others are trying to grasp how weird and wonderful the natural world is — from exploring how many supermassive black holes are out there in space to understanding the minuscule genetic details that drive evolution. For instance, SaraH Zanders, one of this year's SN 10, is unveiling the drama that unfolds when life divvies up its genetic material.

A couple of the scientists on this year's list have also taken steps to support people from groups that are underrepresented in the sciences. These researchers see how science benefits when people from diverse backgrounds contribute to the pursuit of answers.

All of this year's honorees are age 40 and under, and all were nominated by Nobel laureates, recently elected members of the U.S. National Academy of Sciences or previous SN 10 scientists. The world feels very different than it did at the start of 2020, when we first put out our call for SN 10 nominations, but the passion these scientists have for their work endures. The curiosity, creativity and drive of this crew offers hope that we can overcome some of our biggest challenges.

Though it often takes time, out of crisis comes action. Also out of crisis comes a renewed appreciation for small pleasures that give life meaning. These researchers find joy in the search for scientific answers. Here's how Zanders describes what motivates her work: "It's just I like to solve puzzles." — *Elizabeth Quill*

Black hole hunter seeks a cosmic census

Tonima Tasnim Ananna, 29
ASTROPHYSICIST

Affiliation: Dartmouth College

Hometown: Dhaka, Bangladesh

Favorite black hole: Cygnus X-1

Standout research

Tonima Tasnim Ananna is bringing the heaviest black holes out of hiding. She has drawn the most complete picture yet of black holes across the universe — where they are, how they grow and how they affect their environments. And she did it with the help of artificial intelligence.

As far as astronomers can tell, nearly every galaxy stows a black hole at its center, weighing millions or billions of times the mass of the sun. Though these supermassive black holes can heat surrounding material until it glows brighter than all the galaxy's stars combined, the light can be concealed by gas and dust. High-energy X-rays cut through that dusty veil. So for her Ph.D., completed in 2019, Ananna gathered surveys from four X-ray telescopes, more datasets than any previous study had used. Her goal was to create a model of how black holes grow and change across cosmic history. "It was supposed to be a short paper," Ananna says. But models that explained one or a few of the datasets didn't work for the full sample. "It stumped us for some time."

To break the gridlock, she developed a neural network, a type of artificial intelligence, to find a description of the black hole population that explained what all the observatories saw. "She just went off and taught herself machine learning," says Meg Urry, an astrophysicist at Yale University and Ananna's Ph.D. adviser. "She doesn't say, 'Oh, I can't do this.' She just figures out a way to learn it and do it." One early result suggests that there are many more active black holes out there than previously realized.

Big goal

Galaxies live and die by their black holes. "When a black hole puts out energy into the galaxy, it can cause stars to form," Ananna says. "Or it could blow gas away," shutting down star formation and stunting the galaxy's growth (*SN: 4/25/20, p. 9*). So understanding black holes is key to understanding how cosmic structures — from galaxy clusters down to planets and perhaps even life — came to be. Ananna's model is built on data describing black holes at different cosmic distances. Because looking far in space is like looking back in time, the model shows how black holes change over time. It could also help figure out how efficiently black holes eat, which may help explain how some got so big so fast.

Inspiration

When Ananna was a 5-year-old in Dhaka, Bangladesh, her mother told her about the Pathfinder spacecraft landing on Mars. Her mother was a homemaker, she says, but was curious about science and encouraged Ananna's curiosity, too. "That's when I realized there were other worlds," she says. "That's when I wanted to study astronomy." There were not a lot of opportunities to study space in Bangladesh, so she came to the United States for undergrad, attending Bryn Mawr College in Pennsylvania. She chose an all-women's school not known for a lot of drinking to reassure her parents that she was not "going abroad to party." Although Ananna intended to keep her head down and study, the social opportunities surprised her. "The women at Bryn Mawr were fiercely feminist, articulate, opinionated and independent," she says. "It really helped me grow a lot." Internships at NASA and CERN, the European particle physics laboratory near Geneva, and a year at Cambridge University, boosted her confidence. (She did go to some parties — "no alcohol for me, though.")

Now, Ananna is giving back. She cofounded Wi-STEM (pronounced "wisdom"), a mentorship network for girls and young women interested in science. She and four other Bangladeshi scientists who studied in the United States mentor a group of 20 female high school and college students in Bangladesh, helping them find paths to pursue science. — *Lisa Grossman*

ELI BURAKIAN/DARTMOUTH COLLEGE

Regeneration through an engineer's eyes

Bo Wang, 39
BIOENGINEER

Affiliation: Stanford University

Hometown: Nanjing, China

Favorite organism: Planarian

Inspiration

Planarians are the most charismatic of all flatworms, Bo Wang says. "They have this childish cuteness that people just love." But the adorable facade isn't what drew Wang to study the deceptively simple worms, which resemble little arrows with eyes. It was planarians' superpower: regeneration. Slice a planarian into pieces and, within a week or two, each chunk will grow into a new flatworm — head and all. Studying the cells that drive this process could offer lessons for turning on regeneration in human tissues to treat various diseases, regrow limbs and grow organs for next-generation transplants.

Bold idea

Wang uses statistical physics to figure out how planarians regenerate entire organs cell by cell. Newly formed brain cells, for instance, must physically position themselves to avoid turning into "amorphous aggregates," Wang says. His interest in how things fit together began in graduate school at the University of Illinois at Urbana-Champaign. There, Wang trained as a physicist and worked on self-assembling materials. Wang now works to uncover the physical rules that living cells follow. "I'm fascinated by how molecules arrange themselves seemingly randomly, but there are still statistical rules that those molecules will follow," he says.

> "I'm fascinated by how molecules arrange themselves seemingly randomly, but there are still statistical rules that those molecules will follow."
> **BO WANG**

His physics-based approach is raising new questions and unveiling biological processes that would be hard for biologists to come by using traditional methods alone, says regeneration biologist Alejandro Sánchez Alvarado of the Stowers Institute for Medical Research in Kansas City, Mo. Wang is "a new breed" of flatworm biologist, Sánchez Alvarado says. "He is occupying a very unique niche in the community of developmental biology."

Standout research

Wang and colleagues recently found that nerve cells, or neurons, in regenerating planarian brains form a predictable pattern dictated by the types of cells in their midst. Planarian brains are akin to cities made up of neighborhoods of neurons. Within each neighborhood, no two neurons that do the same job will live next to each other; those cells repulse each other but stay close enough to communicate, the researchers reported in the May *Nature Physics*. Because of this behavior, increasing the types of neurons in a neighborhood limits the ways cells can pack together. The team dubbed this packing process "chromatic jamming," after a famous mathematical puzzle called the four-color problem.

The finding is surprising and challenges "what we think we understand about organogenesis and about organization of cells within an organ," says Sánchez Alvarado. Chromatic jamming appears to be key to how the planarian brain comes together, guiding single cells into neighborhoods that are a driving force in organ development, he says. If similar physical rules apply to human cells, that could help scientists sketch blueprints for engineering and growing artificial organs. — *Cassie Martin*

STANFORD MEDICINE

Challenging ideas about youth suicide

Anna Mueller, 40
SOCIOLOGIST

Affiliation:
Indiana University

Hometown:
Houston, Texas

Favorite fieldwork:
Observing rituals

SARAH DIEFENDORF

Standout research

Between 2000 and 2015, at a high school of about 2,000 students in the town of Poplar Grove (a pseudonym), 16 former and current students died by suicide; three other similar-aged individuals in the community, mostly at private schools, also took their own lives. A clinician who had grown up in the town reached out to Anna Mueller for help breaking the cruel cycle. Before that e-mail in fall 2013, Mueller was using big data to understand why teen and young adult suicide rates in the United States were spiking.

Scholars theorized that suicidal people attracted other suicidal people. But Mueller's work undercut that idea. In 2015 in the *Journal of Health and Social Behavior*, for instance, she reported that merely having a suicidal friend did not increase a teen's suicide risk. A teen's risk only went up with awareness that a teenage friend had made a suicide attempt. "Knowledge of the attempt matters to transforming ... risk," Mueller says. She carried an understanding of that contagion effect to Poplar Grove, where she worked with sociologist Seth Abrutyn of the University of British Columbia in Vancouver, the half of the duo who is more focused on the theoretical.

The team conducted 110 interviews and focus group meetings, lasting up to four hours, with residents of Poplar Grove plus individuals outside the community. The research revealed that teens felt an intense pressure to achieve in their affluent, mostly white town, where everybody seemed to know everyone else. While teens and young adults in a first wave of suicides might have had mental health problems, peers and community members often attributed those deaths to the town's pressure cooker environment. That narrative, however incomplete, became embedded over time, making even youth who weren't previously suicidal see suicide as an option, Mueller says.

The team was among the first to start chipping away at the reasons for rising suicide rates in high schoolers, says Bernice Pescosolido, a sociologist at Indiana University in Bloomington who helped bring Mueller to the school's sociology department. "What Anna and Seth have really been able to show is how imitation works and what the contagion effect looks like on the ground."

Big goal

Mueller's long-term goal is to create a sort of litmus test that identifies schools that could be at risk of a suicide cluster. That way, school and community leaders can intervene before the first suicide and its resulting firestorm. Since fall 2018, she has been studying districts in Colorado that are larger and more diverse than Poplar Grove. Early work shows that there's often a trade-off between academic or athletic excellence and a supportive environment.

Top tool

In anticipation of her work in Poplar Grove, Mueller knew she needed a more boots-on-the-ground approach than her big data training allowed. So she trained in qualitative methods, including how to design a study, interview techniques and the detailed data analysis required for this research tactic.

Mueller also sees the value in observing interactions, a common sociological approach. This spring, with the pandemic in full swing, she spent a lot of time on her home computer watching socially distant graduation ceremonies in Colorado schools. She found that a school's culture showed in the details, such as whether valedictorians addressed hot-button issues, such as the Black Lives Matter movement, in their speeches. "Of all of my moments in the field, rituals are the ones that tug at my own heartstrings because I'm watching kids graduate and that's just inherently beautiful, but it also is a very powerful data moment," she says. — *Sujata Gupta*

The National Suicide Prevention Lifeline can be reached at 1-800-273-TALK (8255).

Pioneer pairs light with gravity waves

Alessandra Corsi, 40
ASTROPHYSICIST

Affiliation: Texas Tech University

Hometown: Rome, Italy

Favorite telescope: Very Large Array, New Mexico

Standout research

On September 3, 2017, Alessandra Corsi finally saw what she had been waiting for since mid-August: a small dot in her telescope images that was the radio afterglow of a neutron star collision. That stellar clash, discovered by the Advanced Laser Interferometer Gravitational-Wave Observatory team, including Corsi, was the first direct sighting of a neutron star collision (*SN: 11/11/17, p. 6*). The event, dubbed GW170817, was also the first of any kind seen in both gravitational waves and light waves.

Telescopes around the world spotted all kinds of light from the crash site, but one particular kind, the radio waves, took their sweet time showing up. Corsi had been waiting since August 17, when the gravitational waves were spotted. "Longest two weeks of my life," Corsi says. The radio waves were key to understanding a superfast particle jet launched by the colliding stars.

Early on, the jet appeared to have been smothered by a plume of debris from the collision. But follow-up radio observations made by Corsi's team and others confirmed that the jet had punched through the wreckage (*SN: 3/30/19, p. 7*). This jet was the first of its kind to be seen from the side, allowing Corsi and colleagues to probe its structure. The jet almost certainly would have gone unnoticed if the gravitational waves hadn't clued astronomers in.

Big goal

Corsi is a pioneer in the emerging field of multimessenger astronomy, which pairs observations of light waves with spacetime ripples, or gravitational waves. The pairing is like having eyes and ears on the cosmos, Corsi says. "You cannot learn all that you could with only one of the two." In the case of GW170817, gravitational waves revealed how the neutron stars danced around each other as they spiraled toward collision, and light waves unveiled the type of material left in the aftermath (*SN: 11/23/19, p. 8*). Using this multimessenger approach could also give astronomers a more complete picture of other cataclysms, such as smashups between neutron stars and black holes, and the explosive deaths of massive stars. Such spectacular events "reveal some of the most fundamental physics in our universe," Corsi says.

Corsi is well-versed in light and gravitational waves, says Wen-fai Fong, an astrophysicist at Northwestern University in Evanston, Ill. "That makes her extremely versatile in terms of the types of multimessenger science she can study."

What's next

Corsi has now built a computational tool to scan data for gravitational waves stirred up by whatever is left behind in a neutron star merger. The tool is based on a paper she published in 2009 — years before the first gravitational wave detection (*SN: 3/5/16, p. 6*). The paper described the gravitational wave pattern that would signal the presence of one possible remnant: a rapidly spinning, elongated neutron star. Alternatively, a neutron star smashup could leave behind a black hole. Knowing which "tells us a lot about how matter behaves at densities way higher than we could ever explore in a lab," Corsi says.

Inspiration

Corsi taught herself to play the piano in high school, and now enjoys playing both classical music and tunes from favorite childhood movies, like *Beauty and the Beast*. The audio frequencies of piano notes are similar to the frequencies of spacetime tremors picked up by researchers. If gravitational wave signals were converted into sound, they would create their own kind of music. "That's the thing I like to think of when I'm playing," she says. — *Maria Temming*

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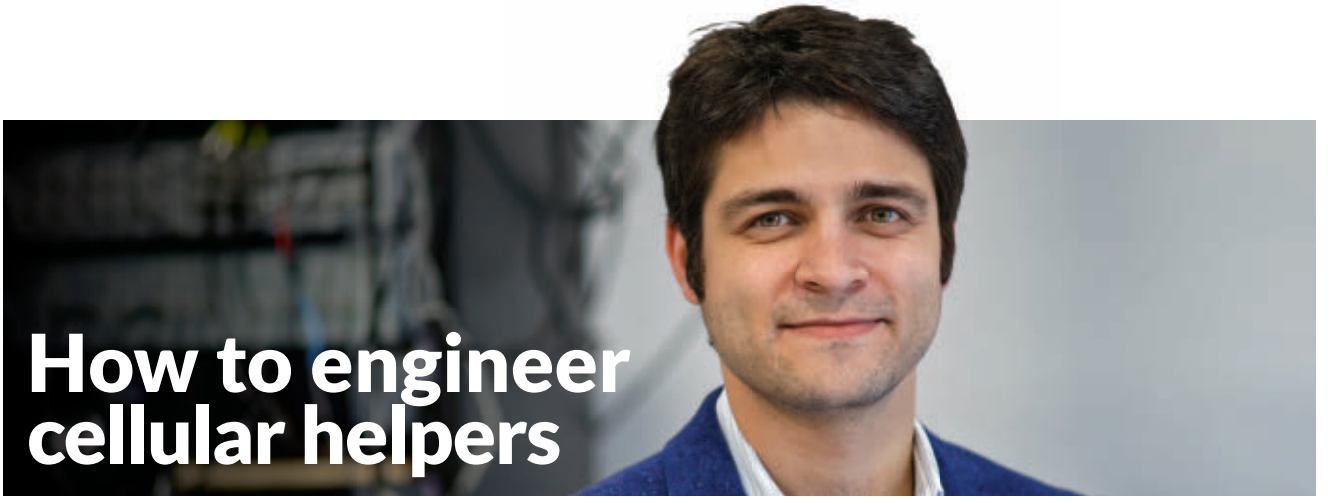


How to engineer cellular helpers

Mikhail Shapiro, 39
BIOCHEMICAL ENGINEER

Affiliation: Caltech

Hometown: Kolomna, Russia

Favorite protein: He can't pick just one

"There is not a protein that I learn about that I don't think about ways to misuse it."
MIKHAIL SHAPIRO

Bold idea

Mikhail Shapiro believes that in the future, "we're going to have smart biological devices that are roaming our bodies, diagnosing and treating disease" — something akin to the submarine in the 1966 classic sci-fi film *Fantastic Voyage*. As the shrunken sub entered and repaired the body of a sick scientist, commanders on the outside helped control it. "Similarly, we're going to want to talk to the cells that we are going to send into the body to treat cancer, or inflammation, or neurological diseases," Shapiro says.

Shapiro and his colleagues are working on building, watching and controlling such cellular submarines in the real world. Such a deep view inside the body might offer clues to basic science questions, such as how communities of gut bacteria grow, how immune cells migrate through the body or how brains are built cell by cell.

Despite his futuristic visions, Shapiro is often drawn to the past. "I like science history a lot," he says. Right now, he's in the middle of rereading the Pulitzer Prize–winning *The Making of the Atomic Bomb*. Just before that, he read a biography of Marie Curie.

Standout research

"There is not a protein that I learn about that I don't think about ways to misuse it," Shapiro says. But he's especially fond of the proteins that build the outer shell of gas vesicles in certain kinds of bacteria. These microscopic air bags "have so many uses that were totally unanticipated," Shapiro says.

In addition to letting bacteria sink or float, these bubbles provide a communication system, Shapiro and colleagues have found. Over the last several years, they have coaxed both bacterial cells and human cells to make gas vesicles and have placed such cells within mice. Because the air-filled pockets reflect sound, the engineered cells can be tracked from outside a mouse's body. Using patterns of sound waves, the researchers can also drive bacterial cells around in lab dishes.

In another nod to *Fantastic Voyage*, scientists can weaponize these cellular submarines. "We've essentially turned cells into suicide agents triggered by ultrasound," Shapiro says. This explosion could release chemicals into the surroundings and destroy nearby cells. This sort of targeted detonation could be damaging to tumors, for instance. "Complete warfare is possible," he says.

By seeing the potential in these esoteric gas vesicles, Shapiro was "ahead of his time and hugely innovative," says molecular imaging scientist Jason Lewis of Memorial Sloan Kettering Cancer Center in New York City. "I think we've only scratched the surface of what his work will do in terms of a greater impact."

Motivation

"Frustration," Shapiro says, is what made him switch to engineering after studying neuroscience as an undergraduate at Brown University in Providence, R.I. He realized that existing tools for studying processes inside the brain fell short. "And I didn't see enough people making better tools."

But he didn't stop at developing new neuroscience technologies. "Oddly enough, once I got into the engineering part of things, I got so fascinated with weird proteins, and magnetic fields, and sound waves, and all the more physics-y side of things," Shapiro says. "That's become as much, if not more, of my passion as the original neuroscience."

In his Twitter bio, Shapiro describes his expertise as succinctly as possible: "Bio-Acousto-Magneto-Neuro-Chemical Engineer at Caltech." — *Laura Sanders*

CALTECH

Quake expert co-opts underground cables

Zhongwen Zhan, 33
SEISMOLOGIST

Affiliation: Caltech

Hometown: Jinzhai County, China

Favorite hobby: Carpentry

Big goal

As the Rose Parade wound through Pasadena, Calif., on January 1, 2020, Zhongwen Zhan listened to the underground echoes of the marching bands and dancers. With a sensitive technology known as distributed acoustic sensing, or DAS, Zhan tracked the parade's progress. He even identified the most ground-shaking band (the Southern University and A&M College's Human Jukebox).

The study was a small but elegant proof of concept, revealing how DAS is capable of mapping out and distinguishing among small seismic sources that span just a few meters: zigzagging motorcycles, the heavy press of floats on the road, the steady pace of a marching band. But Zhan seeks to use the technology for bigger scientific questions, including developing early warning systems for earthquakes, studying the forces that control the slow slide of glaciers and exploring seismic signals on other worlds.

Zhan has a "crystal-clear vision" of DAS' scientific possibilities, says Nate Lindsey, a geophysicist at Stanford University who is also part of the small community of researchers exploring the uses of DAS. "When you get such a cool new tool, you like to just apply it to everything," he adds. But Zhan's expertise is "very deep, and it goes into many different areas. He knows what's important."

So far, Zhan and others have used the technology to study aftershocks following the 2019 Ridgecrest earthquakes in Southern California, to demonstrate that interactions between ocean waves produce tiny quakes beneath the North Sea, and to examine the structure of glaciers.

Top tool

DAS piggybacks off the millions of fiber-optic cables that run beneath the ground, ferrying data for internet service, phones and televisions (*SN: 7/21/18, p. 8*). Not all of the glass cables are in use all of the time, and these strands of "dark fiber" can be temporarily repurposed as seismic sensors. When light pulses are fired into the ends, defects in the glass reflect the light back to its source. As vibrations within the Earth shift and stretch the fibers, a pulse's travel time also shifts.

Over the last few years, scientists have begun testing these dark fibers as inexpensive, dense seismic arrays — which researchers call DAS — to help monitor earthquakes and create fine-scale images of the subsurface. In these cases, Zhan notes, DAS is a useful supplement to existing seismographs. But the potential is far greater. Whole networks could be deployed in places currently difficult or impossible to monitor — at the ocean bottom, atop Antarctic glaciers, on other planets. "Seismology is a very observation-based field, so a seismic network is a fundamental tool," he says.

Inspiration

"I've been interested in science since I was young, but wasn't sure what kind of science I wanted to do," Zhan says. In China, students usually have to decide on a field before they go to college. But at age 15, Zhan was admitted to a special class for younger kids within the University of Science and Technology of China in Hefei. The program allowed him to try out different research fields. A nature lover, Zhan gravitated toward the earth sciences. "Environmental science, chemistry, atmospheric science — I tried all of them."

Then, in late 2004, a magnitude 9.1 earthquake ruptured the seafloor under the Indian Ocean, spawning deadly tsunamis (*SN: 1/8/05, p. 19*). After hearing from a researcher studying the quake, Zhan knew he wanted to study seismology. "I was amazed by how seismologists can study very remote things by monitoring vibrations in the Earth," Zhan says. The data are just "complicated wiggles," but so much info can be extracted. "And when we do it fast, it can provide a lot of benefit to society." — *Carolyn Gramling*

CALTECH

What's in smoky air?

Emily Fischer, 39
ATMOSPHERIC CHEMIST

Affiliation: Colorado State University

Hometown: Richmond, R.I.

Favorite outdoor activities: Cross-country skiing and gardening

"You can't choose not to breathe, right? You have to have clean air for everyone."
EMILY FISCHER

BILL COTTON/COLORADO STATE UNIV.

Motivation

Emily Fischer has always cared about air pollution. "It's innate.... It's a calling," she says. Exposure to air pollution raises your risk for many common ailments, such as cardiovascular disease, asthma, diabetes and obesity. But unlike some other risk factors, "you can't choose not to breathe, right? You have to have clean air for everyone." In her youth, she organized rallies to clean up the cigarette smoke–filled air of her Rhode Island high school. That interest led Fischer to study atmospheric chemistry and motivates her current work as a self-described air pollution detective. Air pollution may conjure images of thick black plumes billowing from smokestacks, but Fischer says most of it is invisible and poorly understood. She combines analytical chemistry with high-flying techniques to understand where air pollution comes from and how it changes as it moves.

Bold idea

Wildfire smoke like that filling the skies in the American West this season is a major, but still mysterious, source of air pollution. Thousands of different solids, liquids and gases swirl together to form wildfire smoke, and its chemical composition changes over time. This dynamic mixture is tricky to measure, since each of its many components requires highly specialized equipment and expertise to assess. The equipment also has to be airborne, typically lofted into the air via planes or balloons. "There has been beautiful work on wildfire smoke," Fischer says, "but in most studies, we just have not had all the measurements needed to really interpret things."

To get a fuller view, she dreamed big: "Why not try to measure everything, and measure it systematically?" She pulled together a diverse team of 10 lead researchers, plus graduate students and postdocs, to pull off the most comprehensive analysis of wildfire smoke ever attempted, a project dubbed WE-CAN. During the summer of 2018, Fischer led over a dozen six-hour flights over the West, chasing wildfire smoke plumes and systematically measuring the air in and around the plumes with nearly 30 different instruments crammed into the cargo hold of a C-130 plane.

"[WE-CAN] is a big collaboration," says Ronald Cohen, an atmospheric chemist at the University of California, Berkeley. He says success stemmed in large part from the team that came together.

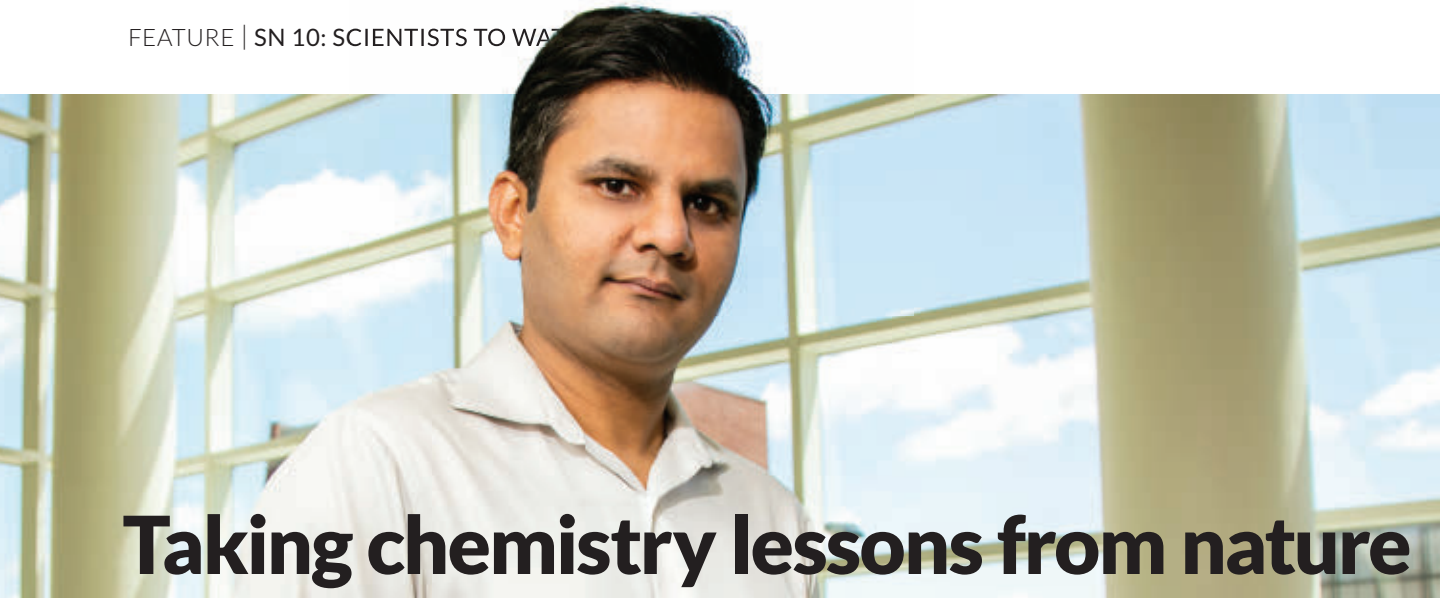
"Making an environment for successful collaboration is really satisfying to me," Fischer says.

While the researchers are still analyzing the data, the project is already revealing some secrets. Formaldehyde and hydrogen cyanide — linked to cancer and other health problems — are abundant in wildfire smoke, for example. Recent wildfires show how important it is to understand the role of climate change in fires, Fischer says, and "who is most vulnerable in our society, and how we can best prepare and protect those communities."

Big goal

Fischer is deeply committed to bringing more undergraduate women, especially women of color, into the geosciences. And she's using science to figure out how. She brought a team of social scientists and geoscientists together to study how different interventions can help. For every female role model a student has, her probability of continuing on in her geosciences major roughly doubles, the team found. Having someone to look up to who looks like them is key to building a sense of belonging and identity as a scientist, Fischer says. To help build that network, she started PROGRESS, a workshop and mentorship program to support undergraduate women in the geosciences. The program now reaches over 300 women across the United States.

For her own mentees, Fischer tries to instill a willingness to go after big, bold questions. "The easy things are done," she says. Pushing forward means chasing research projects that might lead nowhere, or might crack open a new field of research. "It's OK to be wrong, and it's OK to take risks." — *Jonathan Lambert*



Taking chemistry lessons from nature

Prashant Jain, 38
PHYSICAL CHEMIST

Affiliation: University of Illinois at Urbana-Champaign

Hometown: Mumbai, India

Favorite element: Gold

Big goal

Prashant Jain explores how light interacts with matter — such as how plants use sunlight to photosynthesize — and applies that knowledge to new problems. He recently took lessons from nature to convert carbon dioxide into other useful molecules. In a paper last year in *Nature Communications*, Jain and Sungju Yu, also at Illinois at the time, reported using gold nanoparticles as a catalyst to drive chemical reactions between carbon dioxide and water.

When light hit the nanoparticles, it set off a series of reactions that converted carbon dioxide into hydrocarbon fuels such as methane and propane. In essence, the process not only sucked carbon dioxide — a greenhouse gas — out of the air, but it also made that carbon into fuel. No wonder the oil giant Shell is funding Jain's work. The whole process isn't very efficient, so Jain is working to improve how much carbon dioxide gets used and how much fuel gets produced. But along the way he hopes to learn more about how nature uses energy to make matter — and to inspire his lab to create more sustainable and renewable energy technologies.

In another example of using chemistry to push toward future tech, Jain and colleagues shined light on gold and platinum nanoparticles and triggered reactions that liberated hydrogen from ammonia molecules. Hydrogen is important in many industries — fuel cells for zero-carbon vehicles use it, for example — but it can be dangerous to transport because it's flammable. Jain's discovery, reported online in July in *Angewandte Chemie*, could allow workers to transport ammonia instead, which is safer, and then free the hydrogen once it has arrived where it's needed.

Superpower

Jain has a remarkable ability and optimism to see unsuccessful laboratory experiments as successful steps toward understanding the natural world, says Karthish Manthiram, a chemical engineer at MIT. As a first-year graduate student at the University of California, Berkeley, Manthiram remembers being frustrated that his experiments weren't turning out as expected. But Jain, a postdoctoral fellow in the same lab, stepped in to help and recast the problematic results. "He's always viewed what others see as failure as moments of clarity that build up to moments when things make more sense," Manthiram says. "For me that was an important lesson in how to be a scientist."

Inspiration

Growing up in a family that worked mostly in business and finance, Jain fell in love with science as a preteen — inspired in part by watching the movie *Jurassic Park* and its fictional depiction of what might be possible through understanding the molecular world. Soon he spotted a physics textbook for sale from a street vendor and bought it. "I tried to read the book, nothing much made sense," he says. "I wanted to be the one to figure out all these mysteries of nature." He majored in chemical engineering in college (inspired in part by a magazine published by the chemical company DuPont), switching to physical chemistry when he moved to the United States to get a Ph.D.

Promoted this year to full professor, Jain has never stopped pushing to acquire new knowledge; last spring, he enrolled in an online MIT course on quantum information science. "I am myself still a student," he says. —*Alexandra Witze*

L. BRIAN STAUFFER/UI NEWS BUREAU

P. SHANAHAN

The inner lives of protons and neutrons

Phiala Shanahan, 29
THEORETICAL PHYSICIST

Affiliation:
MIT

Hometown:
Adelaide, Australia

Favorite subatomic particle:
The gluon

Big goal

When Phiala Shanahan was a graduate student, she was shocked to learn that experiments disagreed on the size of the proton. "Protons and neutrons are the key building blocks of 99 percent of the visible matter in the universe," she says. "And we know, in some sense, surprisingly little about their internal structure." That ignorance inspires her studies. She aims to calculate the characteristics of protons and neutrons based on fundamental physics. That includes not just their size, but also their mass and the nature of their components — how, for example, the quarks and gluons that make them up are sprinkled around inside. Such calculations can help scientists put the standard model, the theory that governs elementary particles and their interactions, to the test.

Standout research

Shanahan is known for her prowess calculating the influence of gluons, particles that carry the strong force, which binds the proton together. For example, when gluons' contributions are included, the proton is squeezed to a pressure greater than estimated to exist within incredibly dense neutron stars, she and a coauthor reported in *Physical Review Letters* in 2019. "It's a very remarkable calculation," says physicist Volker Burkert of the Thomas Jefferson National Accelerator Facility in Newport News, Va. "That's very fundamental, and it's the first time it has been done." Because they have no electric charge, gluons tend to elude experimental measurements, and that has left the particles neglected in theoretical calculations as well. Shanahan's gluon results should be testable at a new particle collider, the Electron-Ion Collider, planned to be built at Brookhaven National Lab in Upton, N.Y. (*SN: 4/29/17, p. 22*).

> "If there's something I don't understand, I'm extremely stubborn when it comes to figuring out the answer."
> PHIALA SHANAHAN

Superpower

Persistence. "I hate not knowing something," she says. "So if there's something I don't understand, I'm extremely stubborn when it comes to figuring out the answer."

Top tool

A technique called lattice QCD is the foundation for Shanahan's work. It's named for quantum chromodynamics, the piece of the standard model that describes the behavior of quarks and gluons. QCD should allow scientists to predict the properties of protons and neutrons from the bottom up, but it's incredibly complex, making full calculations impossible to perform even on the best available supercomputers. Lattice QCD is a shortcut. It breaks up space and time into a grid on which particles reside, simplifying calculations. Shanahan is leading efforts to use machine learning to rev up lattice QCD calculations — putting her persistence to good use. "We don't have to rely on computers getting better. We can have smarter algorithms for exploiting those computers," she says. She hopes to speed up calculations enough that she can go beyond protons and neutrons, working her way up to the properties of atomic nuclei. — *Emily Conover*

Cheaters can't evade this genetic sleuth

SaraH Zanders, 38
GENETICIST

Affiliation: Stowers Institute for Medical Research

Hometown: Glenwood, Iowa

Favorite organism: Fission yeast

Backstory

An invitation to work in the lab of her genetics professor Robert Malone at the University of Iowa in Iowa City set SaraH Zanders on the path to becoming a scientist. "It was a turning point in my life," Zanders says. Before that, she didn't really know how she would put her biology degree to use, or what it meant to be a scientist. In Malone's lab, she fell in love with meiosis, the process by which organisms divvy up genetic information to pass on to future generations. The first step is julienning the genome and swapping pieces of chromosomes. "That just seems like such a bad idea to basically shred your [DNA] in the process of getting it from one generation to the next," she says. She started studying the proteins involved in making the cuts. "It was like I was born to do that. I never would have known without that push."

A different kind of push led Zanders to spell her first name with a capital H: An elementary school teacher kept leaving the letter off. Zanders has capitalized it for emphasis ever since. "If I write it without the big H, it doesn't look like my name anymore," she says. "It feels like somebody else."

Standout research

Meiosis is full of conflict. For her postdoctoral work, Zanders focused on a particular type of dustup caused by some selfish genes — genes that propagate themselves even if it hurts the host. As the monk Gregor Mendel laid out in his study of pea plants, a particular version of a gene typically has a 50-50 chance of being passed on to the next generation. But the selfish genes Zanders was studying, a type called meiotic drivers because they propel themselves during meiosis, manage to get themselves inherited far more often. "These kinds of systems do a complete end run around Mendel's laws," says Daniel Barbash, an evolutionary geneticist at Cornell University.

In *Schizosaccharomyces pombe*, also called fission yeast, Zanders discovered, a family of selfish genes makes moves that would be right at home in a *Game of Thrones* story line. Zanders and colleagues were the first to work out the molecular tricks that these genes use to skirt Mendel's laws, reporting the findings in *eLife* in 2017. The genes, known as *wtf* genes, produce both a poison and an antidote. All of the spores — the yeast's gametes — get the poison, but only those that inherit certain gene versions also get an antidote. Spores that don't get the antidote die, ensuring that only offspring with specific *wtf* gene versions survive to pass on their genes. For the fission yeast, such predatory tactics can have big consequences, even driving two nearly identical strains toward becoming different species. In humans and other animals, genetic conflicts may lead to infertility.

"This extremely important family of meiotic cheaters has been just sitting in plain sight waiting for somebody who had the right kind of lens and the care ... to discover them," says Harmit Malik, an evolutionary geneticist at the Fred Hutchinson Cancer Research Center in Seattle and Zanders' postdoctoral mentor. Before she began her work, virtually nothing was known about meiotic drivers in yeast. Now the *wtf* genes are among the best known meiotic drivers studied in any lab organism. Some selfish genes in worms also use the poison-antidote trick to beat the competition (*SN: 6/24/17, p. 10*). Meiotic drivers in fruit flies, mice — and maybe humans — win genetic conflicts by other means (*SN: 11/11/17, p. 16*; *SN: 3/19/16, p. 12*).

Motivation

Zanders is now on the lookout for other genetic fights in yeast. Understanding such conflicts more generally may help answer big questions in evolution, as well as shedding light on human infertility. As for what motivates her, "It's just I like to solve puzzles," Zanders laughs. "I wish it was a deep desire to help people, but it's definitely not that." — *Tina Hesman Saey*

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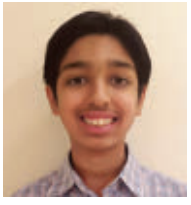

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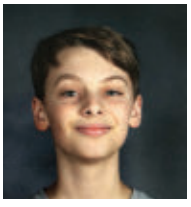

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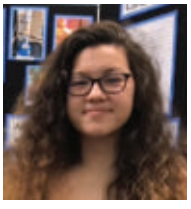

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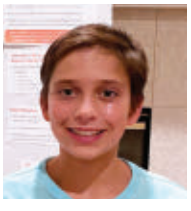

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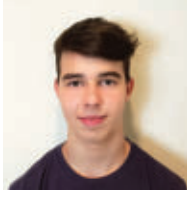

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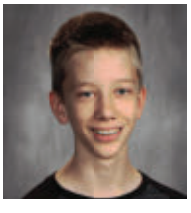

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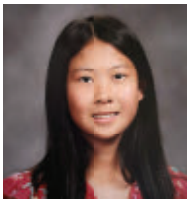

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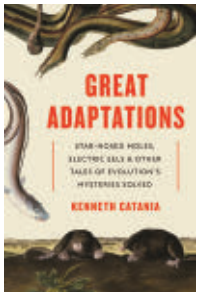

Great Adaptations
Kenneth Catania
PRINCETON UNIV., $27.95

BOOKSHELF

Adventures in analyzing amazing animal abilities

Neurobiologist Kenneth Catania's passion for scrutinizing odd animal adaptations all started with a creature with a 22-point star on its face.

Catania first saw a star-nosed mole (*Condylura cristata*) in a children's book. Later as a 10-year-old, he found a dead one near a stream close to his home in Columbia, Md. From then on, he kept his eyes peeled for more. He had to wait until he was in college, when he landed a research position that required him to trap star-nosed moles in Pennsylvania's wetlands. At the time, no one knew what that unique nose was good for, and he wanted to figure it out.

In *Great Adaptations*, Catania describes his pursuit of the mystery behind the mole's wiggly star-shaped appendage (it helps the subterranean animal sense prey without using sight) as well as a slew of other animal tricks. The account of his adventures as a biological sleuth provides a detailed look at curiosities such as how "hangry" water shrews execute the fastest documented predatory attack by a mammal and how cockroaches resist becoming zombies during parasitoid wasp attacks (*SN: 11/24/18, p. 9*).

"It's part of human nature to be intrigued by mysteries, but the mystery only gets us to the door," he writes. "You never know what you might find on the other side."

In search of answers, Catania has set up some odd, but amusing, experiments. To film wasps attacking cockroaches, he built a set fit for a horror flick, by filling a tiny kitchen with warning signs and a plastic human skull for the wasp to store its zombified victim in. Keeping with the horror theme, he also stripped the paint off decorative severed zombie arms and offered the plastic limbs to electric eels (*Electrophorus electricus*) to show that the animals leap out of the water as an attack strategy.

Each chapter follows a logical flow as Catania describes his discoveries, from what first piqued his interest in an animal to his ultimate findings. Science, however, is rarely as straightforward as he makes it seem. Catania's scientific detective work didn't always go off without a hitch, but, he notes, including all the failures would have meant a much longer book. Even so, the book alludes to some ideas that didn't pan out. "The animals are always able to do something unexpected and more interesting than I'd imagined," he writes.

For instance, the notion that a tentacled snake (*Erpeton tentaculatum*) might use the short appendages close to its mouth to lure in nearby fish, just like snapping turtles do with their tongues, turned out to be wrong. Instead, the tentacles help a snake sense a fish's position in the water and know when to attack. What's more, the snakes have hacked their prey's natural escape reflexes. In a fatal mistake, fish flee in the wrong direction — straight toward a snake's mouth — when duped by a twitch of the snake's neck right before the predator strikes.

Catania's lighthearted yet informative narrative presents science in a way that's easy for anyone with a basic knowledge of biology to understand. But even the most seasoned expert will likely learn new details, the type that never make it into a scientific paper. For a particularly daring experiment, in which Catania offered his own arm for an electric eel's shock to measure the shock's electricity, Catania admits that he certainly couldn't subject another animal or a student volunteer to the unpleasant jolt (*SN: 10/14/17, p. 4*). His own arm was the "obvious solution."

In page after page, Catania's enthusiasm and awe for the animals shine through. When he discovered tentacled snakes are born knowing how to strike at prey rather than learning through failure, Catania recalls that he couldn't "find enough superlatives to sum up these results." He also describes a fight between a parasitoid wasp and a cockroach as an "insect rodeo." The wasp attacks a cockroach's head in an attempt to lay an egg, but in defense the roach "bucks, jumps, and flails with all its might."

Some of that enthusiasm will likely rub off on readers and spark a sense of wonder. *Great Adaptations* packs in plenty of astounding details about some remarkable creatures. As Catania puts it: "I've stopped assuming I know the limits of animal abilities." — *Erin Garcia de Jesus*

The pointy snout of the star-nosed mole helps the animal sense its environment while underground. In a new book, neurobiologist Kenneth Catania explains how he helped solve the mysteries of this and other unusual animal adaptations.

BLICKWINKEL/ALAMY STOCK PHOTO

FILM

Mathematicians unite an unlikely pair of films

There's no one way to be a mathematical genius.

Shakuntala Devi had little formal education. Maryam Mirzakhani attended graduate school at Harvard University. Two films chronicle how each woman became famous for her own variety of mathematical prowess.

The two women's skills took vastly different forms: Devi was known for her blazingly fast mental arithmetic, while Mirzakhani made strides in the mathematics of surfaces, becoming the first woman to win one of the highest honors bestowed on mathematicians, the Fields Medal.

The contrast between the two women is echoed in the divergent styles of the two films: One is a Bollywood biopic heavy on emotional drama, and the other is a documentary replete with mathematical lingo.

Born in India in 1929, Devi grew up in an impoverished family. As recounted in the Hindi-language film *Shakuntala Devi*, available with subtitles on Amazon Prime, she could make complex mental calculations at a rapid-fire pace, even as a small child. Devi became a performer, touring internationally and stunning observers with her feats, which outpaced computers in the 1970s and '80s.

While fun, the movie features bouts of cheesy dialog that may be off-putting to some viewers. But others will enjoy the scenes that re-create some of Devi's most famous achievements, such as taking the 23rd root of a 201-digit number in under a minute, and multiplying two 13-digit numbers in less than 30 seconds. Careful viewers might be able to glean a few number facts from the film, but the movie focuses on Devi's fraught relationships — particularly with her daughter — rather than on the details of mental math algorithms.

Secrets of the Surface, available on the online video platform Vimeo, recounts Mirzakhani's life via interviews with her friends, teachers and colleagues. Although Mirzakhani preferred reading to mathematics at first, her mathematical talent soon became apparent. As a high school student in Iran in the 1990s, she twice won gold medals in the International Mathematical Olympiad. But aside from the youthful mathematical interests Devi and Mirzakhani shared, the two women's backgrounds couldn't be more different. Mirzakhani attended a high school for gifted girls and studied mathematics at Sharif University of Technology in Tehran before heading to Harvard and eventually a professorship at Stanford University.

Mirzakhani's work focused on the geometry of surfaces, such as doughnuts with multiple holes. Her work has connections to other fields such as string theory, the mathematics-intensive branch of physics that attempts to describe the universe as composed of tiny, vibrating strings. The film includes beautifully clear descriptions and visualizations — for example, lines winding around a doughnut shape illustrate Mirzakhani's study of the number of closed loops that can form on various curved surfaces. These visual aids elucidate the complicated mathematical concepts underlying Mirzakhani's work, for which she won the Fields Medal in 2014. Three years after receiving that honor, Mirzakhani died of cancer at just 40 years old. In the film, interviews with students at her former high school reveal what an inspirational figure she still is. "I think she's raised the bar for girls, but beside that, she has opened up a new way," says student Dorsa Majdi.

Devi likewise inspired schoolchildren, promoting math as fun and unintimidating and authoring books about numbers. Watching the two films, I couldn't help but wonder how Devi's life might have been different had she been privileged with the type of schooling Mirzakhani received. In the biopic's depiction, Devi seems to yearn for such an opportunity. She is portrayed staring longingly at children attending a school at which she is paid to perform, but which she can't afford to attend. — *Emily Conover*

Shakuntala Devi
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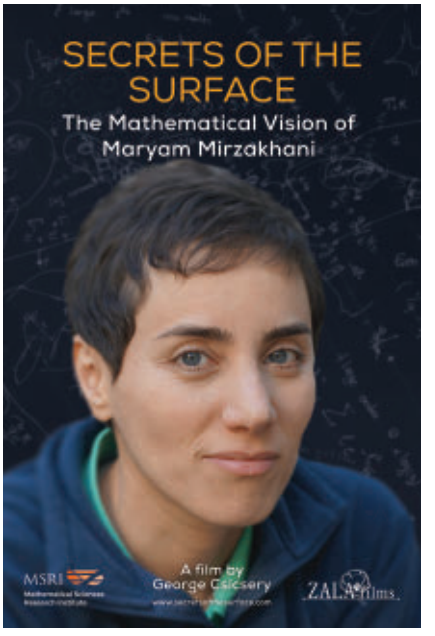


Secrets of the Surface
NOW STREAMING
ZALA FILMS

CONVERSATIONS WITH MAYA

WEI-HWA HUANG
Professional puzzler and game designer

Maya Ajmera, President & CEO of Society for Science & the Public and Publisher of *Science News*, chatted with Wei-Hwa Huang, an alumnus of the Science Talent Search, former Google engineer and world-renowned creator of puzzles and games. We are thrilled to share an edited summary of their conversation.

You are an alum of the 1993 Science Talent Search with a project entitled "The Peg Solitaire Army." Are there any particular moments that stand out for you from that week?
We got to meet President Bill Clinton. All the finalists had the opportunity to get in line, shake his hand and have a small photo op. If I remember correctly, I did not actually shake his hand, because I was trying to stand out. But not in the way you think. I had just read in a magazine that Bill Clinton was a big fan of crossword puzzles, and I had just written my first crossword puzzle. It wasn't a very good crossword puzzle in retrospect, but it was a perfectly fine one. So I said, "Mr. President, I heard you really liked crossword puzzles. I wrote one, and I'd like to see if you would enjoy this." And during the photo op, he's talking with me with a big smile, holding my crossword puzzle. About two months later, I got a letter from the White House with a completed crossword puzzle that was signed by him.

When did you figure out that you were going to have a career as a professional puzzler? How did that happen?
It wasn't really a "figure it out" thing, as much as a "this was something I was always interested in and wanted to create puzzles." So, it started out as a hobby. When I eventually left my actual job as a software engineer at Google, and decided not to work full-time, I turned to making puzzles and games. I'm fortunate that I did very well at Google and could take that route.

Your team, Left Out, won the 2019 MIT Mystery Hunt, a contest you have participated in since 2006. What was the 54-hour-long event like?
The Mystery Hunt is probably the largest puzzle hunt, or at least, it's one of the most prestigious and hardest ones. It started at MIT in the 1980s and continues to grow larger each year. Originally, it was just for MIT students, but as those students graduated and moved on, they continued to play in the event.

So as winners of the hunt, your team came up with the 2020 theme Penny Park. Can you explain this theme?
Every year, the winning team gets the honor—or the onus—of designing next year's hunt. The hunt, which took place in early 2020, has now evolved to the point where it is beyond just puzzles. The hunt includes non-puzzle challenges, often a scavenger hunt. It's much better if you have a framing story for the event. So our team, Left Out, developed a theme about a dilapidated theme park, with teams vying to fix the theme park.

As a puzzler, you're exposed to lots of different cultures. Can you share one of the favorite places you've visited?
I was on the American World Puzzle team for several years and on the American Sudoku team for several years, which exposed me to a lot of different cultures. The World Sudoku Championship and the World Puzzle Championship are held in a different country every year. I've been to probably about 20 or 30 different countries throughout.

I recall one time when we were in the Croatian city of Dubrovnik, staying in a beautiful hotel with a view of the Adriatic. You could look out your big hotel room window and the Adriatic waves would just be lapping on.

One day, we saw thunderstorms in the far distance and it was just beautiful.

You've worked with Will Shortz, the well-known *New York Times* crossword puzzle editor. I'd love to hear more about the experience.

I would say that certainly, being able to write a puzzle for the *New York Times* is considered one of the most prestigious things in the puzzle world.

How many times have you had a crossword puzzle published in the *New York Times*?

This is a strange question to answer. The part that actually has the prestige is the crossword puzzle. I've only written one crossword puzzle for Will, and he accepted it. So the minus is that I've only done it once; the plus is I have a 100 percent acceptance rate.

My puzzle expertise tends more to be in logic and numbers and less so in crosswords. A few years ago, the *New York Times Magazine* redesigned the puzzle section and wanted to include a full page with lots of other small puzzles. Will wanted a number logic puzzle, and the page was designed so that every issue of the magazine has a number logic puzzle in the upper right corner of that page. I wrote that puzzle for about two years, starting with the launch of the redesigned page until my children were born.

What other puzzles are you working on currently?

I work with a company called ThinkFun that makes a lot of little mechanical puzzle toys. Their most famous one is a game called Rush Hour, which involves pushing cars back and forth along a grid. I've been working with them for nearly 10 years, developing some challenges for certain products, such as Laser Maze and Gravity Maze.

What books are you reading right now? And what books did you read when you were young?

When I was young, I read a lot of science fiction. I was a really big fan of Isaac Asimov. And certainly, I've always amassed a growing collection of puzzle books. It's not reading in the same sense as a novel. But honestly, these days, almost all of my reading is done online, and I often end up reading news. There are certain political blogs I like following, such as electoral-vote.com.

And in terms of being a political junkie, I read vox.com. I also read fivethirtyeight.com, which does a lot of statistical analysis and works to be objective. They very rarely give opinions, instead stating, "Here's what the numbers actually say." I really respect that aspect of their reporting.

But in terms of physical books, I have a lot of comic books and graphic novels.

A young Wei-Hwa Huang is shown with former U.S. Representative Roscoe Bartlett.

What advice do you have for young people just starting college or their professional careers?

A good decision doesn't always lead to a good outcome. To give a little bit more exposition to that, it's that because of the vagaries of luck or opportunity or situation, sometimes you can make the choice that is the best option, in terms of the information you have, but the outcome doesn't always turn out the way you think it should.

At that point, you should still keep that faith that you actually made the correct decision, even though the results didn't turn out the way you were hoping they would be.

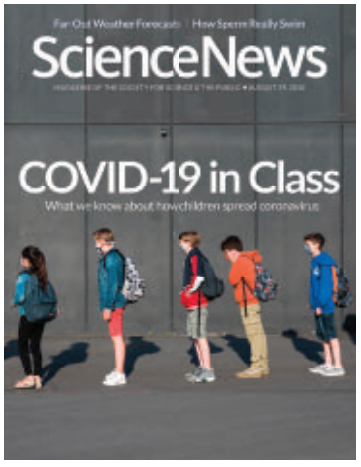
My last question to you is that there are so many challenges in the world today. What keeps you up at night?

It's strange for a puzzle person to say this, and most people don't expect it, but I am not a good problem-solver. There is a large distinction between a puzzle and a problem, a distinction that has become more and more clear to me over the years. A puzzle is a fun diversion, where somebody knows what the correct answer is and they set up a trail or path for you to find that solution.

Whereas a problem is something where nobody knows for sure what the right solution is. We can do our best to get there and maybe in some fields, like mathematics or physics, the solution actually exists and when you get it, you'd know that you are right. But there are also problems like economic inequality or pandemics, where we will have solutions that are better and better at solving a problem, but we won't necessarily know when we have the perfect solution.

As a person who wants to help the world to solve problems, but only does puzzles, all I can do is use some of my resources to support and help the people out there who are solving problems. Supporting and enabling people who solve the world's problems can be just as important as solving the problems yourself.

It's why helping the disadvantaged, the needy and the unfortunate is important, but shouldn't come from a position of what people "deserve"; it's because you don't know if the next person you help will end up being an important future problem-solver, to curing the pandemic or fixing global warming. I really fear that too many people focus on compensating for the wrongs of the past, when instead they should be looking at the wrongs of the past as a cautionary tale to avoid doing bad things in the future.



AUGUST 29, 2020

SOCIAL MEDIA

Beetlemania

A water beetle eaten by a pond frog (one shown below) scurried through the frog's digestive tract and emerged out the backside unscathed, **Jonathan Lambert** reported in "Eaten beetle exits the other end alive" (*SN: 8/29/20, p. 18*). The story amazed readers on Twitter. **@JoePoutous** likened the beetle's journey to the tunnel of terror scene in the 1971 film *Willy Wonka & the Chocolate Factory*. **@Rogie_The_Medic** suggested a new name for the insect: fecal walking beetle.

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Faraway view

*Astronomers snapped the first photo of a solar system with a sunlike star and two exoplanets, **Lisa Grossman** reported in "A weird solar system cousin makes its photographic debut"* (SN: 8/29/20, p. 5). "At the scale of the picture, both planets — massive as they are — should appear as point sources, so I assume their spherical appearance is due to the light collection method for this direct imaging," reader **Jean Asselin** wrote.

Asselin is correct that the system is so far away that scientists cannot physically resolve any of the planets, says **Alexander Bohn**, an astronomer at Leiden University in the Netherlands. Both of the planets have no spatial size as seen from Earth. "That both have a physical diameter in the image is just caused by the optical response of an imaging device to a point source," **Bohn** says. "If you image the night sky with your smartphone camera, the stars also have a finite size of pixels in your image, even though they are point sources for both you and your smartphone."

Webicillin?

*Some spider webs are coated in neurotoxins that may paralyze prey, **Christie Wilcox** reported in "Orb weavers may spin poisonous webs"* (SN: 8/29/20, p. 18). The story reminded reader **Renata Riegler** of a bit of medical folklore: Spider webs were said to be used to dress wounds. "The paralyzing or antimicrobial properties ... could have helped the healing," **Riegler** wrote.

Spider webs may have been used for centuries to dress wounds. The practice even is mentioned in Shakespeare's *A Midsummer Night's Dream*: "I shall desire you of more acquaintance, good Master Cobweb: If I cut my finger, I shall make bold of you." Spider silk is coated with chemicals that might promote blood clotting, prevent infection and speed healing, though scientific evidence for these properties is sparse, says associate editor **Cassie Martin**. Today, engineers are investigating spider silk as a drug delivery method and as scaffolding for tissue repair, she says.

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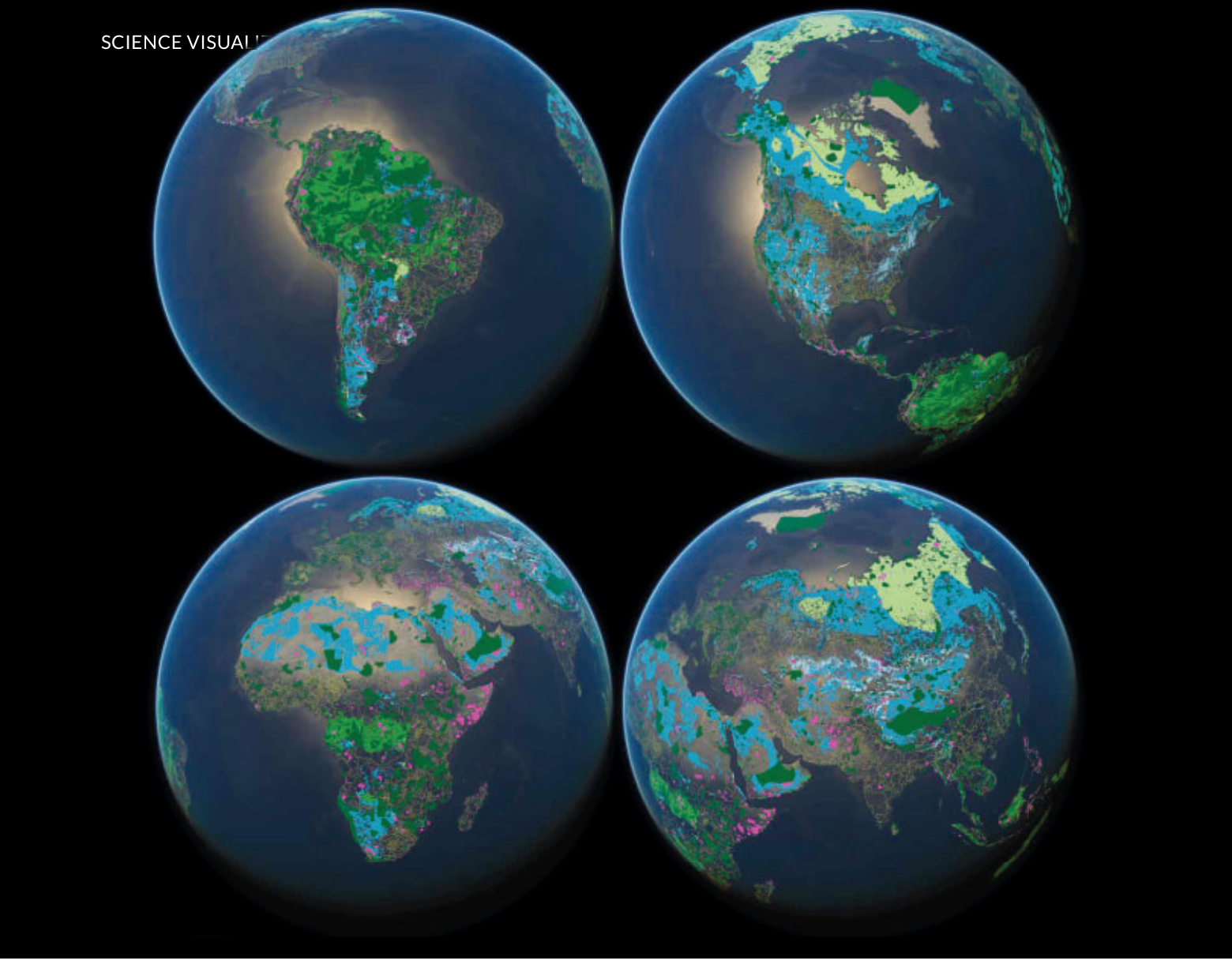

Mapping Earth's 'Global Safety Net'

Earth faces two interrelated crises: accelerating loss of biodiversity and climate change. Both are worsened by human development of natural lands that would otherwise allow species to flourish and would store atmosphere-warming carbon, helping to stabilize the climate.

Nations can help avert those twin crises by preserving the roughly 50 percent of land that remains relatively undeveloped, a new study argues. In the Sept. 2 *Science Advances*, researchers dub that proposed conserved area Earth's "Global Safety Net" and map out regions (shown above) that would meet crucial conservation and climate goals.

Eric Dinerstein, a conservation biologist at RESOLVE, a nonprofit based in Washington, D.C., and colleagues began by mapping out existing protected areas, which cover about 15 percent of land. The team then sequentially added slices of largely undeveloped land needed to meet different goals. Preserving rare species not already protected would require 2.3 percent more land, the team found. To conserve additional areas with exceptional species diversity, an extra 6 percent needs protecting.

An additional 6.3 percent of land would be needed for "rare phenomena," to preserve unique areas that support large mammals, like the Pantanal region in South America, where jaguars roam. And 16 percent more land would be needed to preserve remaining intact habitats that provide potential refuges for wildlife. Finally, the analysis shows where an additional 4.7 percent of land, including some northeastern U.S. forests, could be set aside as key carbon-storage areas. — *Jonathan Lambert*

- Current protected areas (15.1% of Earth's land area)

Proposed additional areas needed for:

- Rare species (2.3%)
- Exceptional species diversity (6%)
- Rare phenomena (6.3%)
- Habitat intactness (16%)
- Climate stabilization (4.7%)

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