SN
SCIENCE NEWS MAGAZINE
SOCIETY FOR SCIENCE & THE PUBLIC
MARCH 5, 2016

The Trouble With Vaping

Johnny Cash Tarantula

A Neutron Quartet

Neandertals' Genetic Legacy

Cosmic vibrations

SPECIAL REPORT

Finally, success in the hunt for gravitational waves

FREE Cultured Pearls
Limited to the first 1900 responders to this ad only!

CLIENTS LOVE STAUER JEWELRY...
"I couldn't believe it, but decided to call and I've not been disappointed since. I received the necklace and keep coming back for more."
— Amy, Fairmont, WV

How Do You Spell Pearl Necklace? F-R-E-E.

*Experience the luxury of Genuine Cultured Pearls...FREE!**

You read that right. If you'd like the Stauer genuine 26" cultured pearl necklace absolutely **FREE***, all you need to do is call us today. There is no catch. If you're wondering exactly how we can do this... read on.

This stunning, romantic necklace never goes out of style. In a world where some cultured pearl necklaces can cost thousands, shop around and I doubt that you will see any jewelry offer that even comes close.

Stauer has had a very good year and it's time for us to give back. That's why we're offering this stunning, 26" strand of genuine cultured white pearls for **FREE!** You pay only $24.95 for shipping & processing, our normal fee for a $295 necklace...and we'll even ***pay you back with a $25 Discount Certificate— that's our BETTER THAN FREE Shipping!***

"Each Mitsuko® cultured pearl is harvested, polished and strung by hand."
— James T. Fent, Stauer GIA Graduate Gemologist

Why would we do this? Our real goal is to build a long term client relationship with you. We are sure that most of you will become loyal Stauer clients in the years to come, but for now, while luxury prices soar, we will give you these classic pearls so you can treat yourself or someone you love without the outrageous price tag.

We did find a magnificent cache of cultured pearls at the best price that I have ever seen. Our pearl dealer was stuck. A large foreign luxury department store in financial trouble cancelled a massive order at the last minute, so instead, we grabbed all of those gorgeous pearls. He sold us an enormous cache of his roundest, whitest, most iridescent cultured 6 ½–7 ½ mm pearls for only pennies on the dollar.

But let me get to the point: his loss is your gain. Many of you may be wondering about your next gift for someone special. This year, we've really come to the rescue.

For the next few days, I'm not offering this cultured pearl necklace at $1,200. I'm not selling it for $300. That's because I don't want to SELL you these cultured pearls at all... I want to ***GIVE*** them to you for **FREE!**

It's okay to be skeptical. But the truth is that Stauer doesn't make money by selling one piece of jewelry to you on a single occasion. We do well by serving our long term clients. And as soon as you get a closer look at our exclusive selection including millions of carats of emeralds, rubies, sapphires, tanzanite and amethyst, you're not going to want to buy your jewelry anywhere else.

Too good to pass up. Too good to last long. Genuine cultured pearls are a luxurious statement. Stauer finds a deal this outrageous once every few years. We have sold over 200,000 strands of pearls in the last several years and this is our finest value ever**. There is only a limited quanity left in stock,** so when they're gone, they're GONE! Call to reserve your **FREE** ***Cultured Pearl Necklace*** today and experience a brilliant new definition of *price*-less luxury!

Mitsuko® Cultured Pearl Necklace (26" strand) ~~$295~~**

Your Cost With Offer Code*— FREE

***pay only shipping & processing of $24.95.**

You must use the offer code below to receive this special free necklace.

1-800-333-2045

Offer Code MFP357-03
Mention this code to receive free necklace.

BBB ACCREDITED BUSINESS **Rating of A+**

CONSUMER AFFAIRS ACCREDITED

Stauer® 14101 Southcross Drive W., Dept. MFP357-03, Burnsville, Minnesota 55337 www.stauer.com

* This offer is valid in the United States (and Puerto Rico) except in TX, FL, CO, OK, RI, NH, WV, OR, SC, VA and ID. These state residents will be charged one cent ($.01) + shipping & processing for the item. Void where prohibited or restricted by law. Offer subject to state and local regulations. Not valid with any other offers and only while supplies last. This offer is limited to one item per shipping address. ** *Free is only for customers using the offer code versus the price on Stauer.com without your offer code.*

Smart Luxuries—Surprising Prices™

VOL. 189 | NO. 5

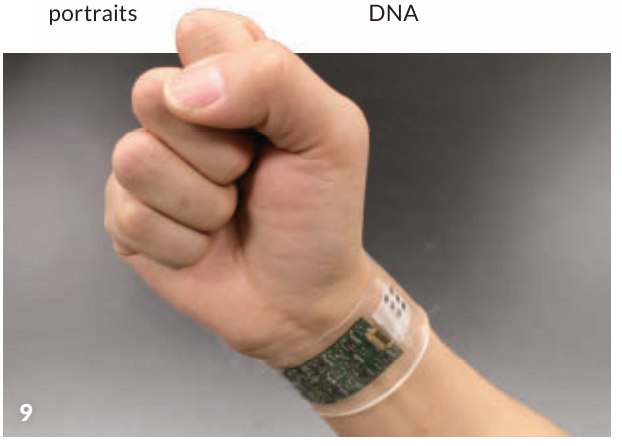
ScienceNews

Special Report

COSMIC VIBRATIONS

5

News



9

Departments

SOCIETY UPDATE
Science news for middle school students

COVER When two black holes collide (illustrated), resulting gravity waves can be picked up by Earth-based interferometers. *Nicolle Rager Fuller*

CLOCKWISE FROM TOP: SXS; C.A. HAMILTON (CC BY 4.0); W. GAO ET AL/NATURE 2016

Celebrating a new way to listen to the universe

"Up till now, we've been deaf to gravitational waves," said David Reitze. "But today, we are able to hear them."

It was one of many inspiring quotes from the news conference announcing the historic first direct detection of gravitational waves, the spacetime tremors forecast by Albert Einstein 100 years ago. Andrew Grant reported the announcement (Page 6), which described the cosmic shake-up of two black holes merging and, in the process, releasing a burst of energy in the form of gravitational waves. The waves began their journey about 1.3 billion years ago (give or take half a billion), unaware that we would be listening. Very, very carefully.

The listening device, twin observatories known as LIGO, had just been boosted to a new level of sensitivity, now able to notice such black hole collisions up to 5 billion light-years away. LIGO's interferometers can detect resulting spacetime ripples that kick laser waves out of alignment by less than the width of a proton — a tiny, next-to-nothing difference that can tell scientists if they have found their quarry (see Page 22).

On Page 24, science writer Marcia Bartusiak, the author of an award-winning book about the gravitational wave quest, provides historical context to the new finding. She tells why building LIGO was such a big risk for the National Science Foundation, making the detection a big win for the agency.

Physicists weren't actually surprised by the result. Many, like Kip Thorne, had invested decades of work on what they believed to be a sure thing. Einstein's theory had passed all previous tests, after all. And in 1993, Russell Hulse and Joseph Taylor Jr. won a Nobel Prize for finding indirect evidence of the waves in the orbital motion of a pulsar and its companion.

Surprise or not, the news is truly exciting for science. For one thing, LIGO was able to perform just as Thorne, Rainer Weiss of MIT and others had argued. Even more thrilling, scientists now will be able to use gravitational waves to study the universe, detecting previously invisible events (like two black holes colliding). And, tantalizingly, by listening to the cosmos through this new channel, Reitze said, "we will also hear things that we never expected." — *Eva Emerson, Editor in Chief*

EDITORIAL, ADVERTISING AND BUSINESS OFFICES
1719 N Street NW, Washington, DC 20036
Phone: (202) 785-2255
Alliance for Audited Media
Customer service: member@societyforscience.org
Editorial/letters: editors@sciencenews.org
Sponsor content: ads@societyforscience.org
Science News (ISSN 0036-8423) is published biweekly by Society for Science & the Public, 1719 N Street, NW, Washington, DC 20036.
Online and iPad access: Activate your subscribing member account, including digital access and the ability to opt out of print, at www.sciencenews.org/activate
Subscribe: Web www.sciencenews.org/join
For renewals, www.sciencenews.org/renew
Phone (800) 552-4412 in the U.S. or (570) 567-1191 outside of the U.S.
E-mail member@societyforscience.org
Mail *Science News*, PO Box 1205, Williamsport, PA 17703-1205
Subscribing memberships include 26 issues of *Science News* and are available for $50 for one year (international rate of $68 includes extra shipping charge). Single copies are $3.99 (plus $1.01 shipping and handling). Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.
Postmaster: Send address changes to *Science News*, PO Box 1205, Williamsport, PA 17703-1205. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided.

SANDY SCHAFFER

Affordable Hearing Aid Technology Only $299!

Learn about our great digital technology at an affordable price.

FREE 1 YEAR Supply Of Batteries*

A) Microphone
B) Volume Control Wheel
C) Program Button
D) Long Lasting Battery
E) Digital Signal Processor
F) Receiver (Speaker)
G) Sound Tube

More Technical Information At: www.AdvancedHearing.com/S63

The Revolutionary HCX!

- Digital sound processing chip provides **crystal clear sound and makes speech easier to understand** without feedback
- Multiple memory programs **adapt to most listening situations**
- Nearly invisible thin tube design
- Long lasting size 13 batteries and a **low battery warning**
- 10 bands of layered noise reduction helps to **emphasize voices while balancing out background noise**
- **100% Money Back Guarantee**

5 Star Reviews! ★★★★★

Wonderful Company! "I will definitely recommend your company to my patients." - **Dr. Arun P.**

They Are Fantastic! "I just received my HCX hearing aids and they are fantastic. Advanced Affordable is far superior and far more affordable!" - **Chuck D.**

Studies Show That Hearing Aids May Help Prevent Dementia.

A study by Dr. Frank Lin at John Hopkins University, found that adults with hearing loss are significantly more likely to develop dementia and at a faster rate. Fortunately, using hearing aids is an effective way to treat hearing loss and may help you maintain healthy mental activity.

Read More Information At:
www.AdvancedHearing.com/Dementia

Digital Hearing Aid Technology... For Only $299!

All hearing aids work the same way. The **microphone** picks up the sound and sends an electrical signal to the digital signal processor. The **digital signal processor** is the "brains" of the hearing aid. It takes the sound it receives and adjusts the sound to amplify important speech sounds as well as filtering out unwanted noise. (To ensure the best in quality, our digital processor is designed and manufactured right here in the **United States.**) Once the processor has amplified the sound, it is passed to the **receiver** (also known as the speaker) which emits a corrected and amplified sound through the **sound tube** into your ear.


The HCX™

Most importantly, your new HCX hearing aids work at a **fraction of the cost** of name-brand hearing aids. In addition to the technical components of the hearing aid, you also have a **volume control** that can be modified with a light touch of the finger. Your new hearing aids come with **3 different audio programs** that help you listen in different sound environments. You will love the Open-fit design, that is so light you probably won't even feel that you are wearing your hearing aids – you'll just be hearing clearly!

You can spend thousands for a high-end hearing aid or you can spend **just $299** for a hearing aid that just plain works **(only $279 each when you buy a pair)**. We are so sure you will love our product, that we offer a **100% Money Back Guarantee - Risk Free** if you are not satisfied for any reason. It's time to get great digital technology at an affordable price!

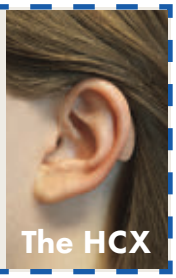
BUY A PAIR AND SAVE $40!

1-888-383-6730

Free 1 Year Supply Of Batteries!

*Use Coupon Code When You Order: **S63**

(Coupon Code & Price Valid For A Limited Time Only!)


The HCX

Advanced Affordable Hearing
Affordable Quality Since 1996!

A+ BBB ACCREDITED BUSINESS

100% MONEY BACK GUARANTEE

RISK FREE Trial

US Company Owned And Operated

FDA REGISTERED

Visit and Save: **www.AdvancedHearing.com/S63**

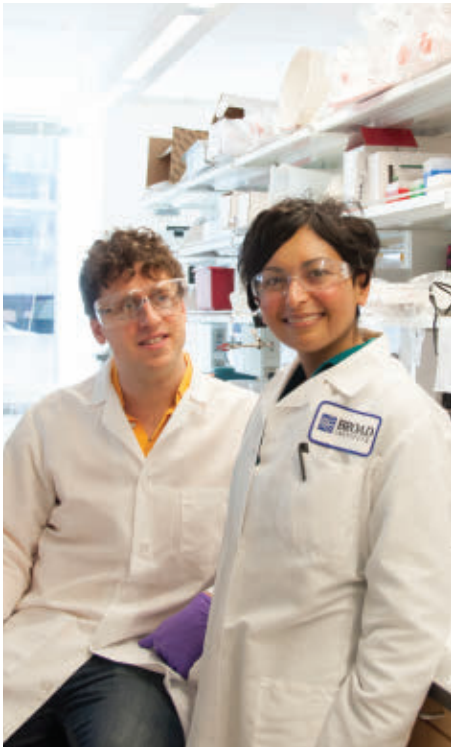
Excerpt from the March 5, 1966, issue of *Science News Letter*

50 YEARS AGO

Plutonium's 25th year

The 25th anniversary of the discovery of plutonium was celebrated in February.... Plutonium, a highly radioactive metallic element, is made by bombarding uranium with neutrons.... The nuclear energy released by the fissioning of one pound of plutonium is equal to the explosive effect of 20 million pounds of TNT.... Plutonium is now emerging as the nuclear energy source of the future. It was the first and is still the only radioisotope producing power in space and is in use now on four satellites.

UPDATE: Unlike Europe, the United States has been slow to use plutonium as a power source on the ground. But the element still drives NASA's long-distance missions, recently fueling the New Horizons probe on its trip to Pluto (the element's namesake). U.S. nuclear reactors could begin using plutonium to generate electricity if construction is completed on a South Carolina facility. The site will make nuclear fuel with small amounts of plutonium extracted from retired Cold War–era weapons.



Married couple Eric Minikel (left) and Sonia Vallabh (right) switched careers to investigate a deadly brain disease that Vallabh inherited from her mother.

THE SCIENCE LIFE

Prion disease is personal

Sonia Vallabh knows what will probably kill her.

In 2011, the Boston-area law school graduate learned she carries the same genetic mutation that caused her mother's death from a rare brain-wasting prion disease. Prions are twisted forms of normal brain proteins that clump together and destroy nerves. About 10 to 15 percent of prion diseases are caused by a mutation in the *PRNP* gene, leading to such deadly diseases as Creutzfeldt-Jakob disease, Gerstmann-Sträussler-Scheinker syndrome and fatal familial insomnia, the disease that killed Vallabh's mother.

Grief, shared with family and friends, came first. Eventually, Vallabh realized, "We can't get around this prognosis.... We've got to go through it." So began her and husband Eric Minikel's odyssey to learn about the disease that had turned their lives upside down.

A scientist friend came by with a

SCIENCE STATS

More than one way to quit tobacco

For people trying to stop smoking, the how might not really matter.

Six months after quitting, only about one in four people still abstained from smoking — regardless of whether they used a nicotine patch, twice daily varenicline (a pill that cuts cravings) or a combo nicotine lozenge and patch to quit, researchers report in the Jan. 26 *JAMA*.

The study's authors randomly split 1,086 cigarette smokers into three groups for 12 weeks of treatment. To confirm smoking status, the team relied on daily self-reported surveys and carbon monoxide testing six months and one year after treatment. Previous studies had suggested that varenicline and the combo therapy were better than the patch at helping people kick the habit.

Not so, the authors of the new research suggest: The three therapies were equally effective. The study is the first to compare all three head-to-head (to head). — *Meghan Rosen*

No big diff Fraction of study participants who abstained from smoking six months after quitting with the help of one of three methods:

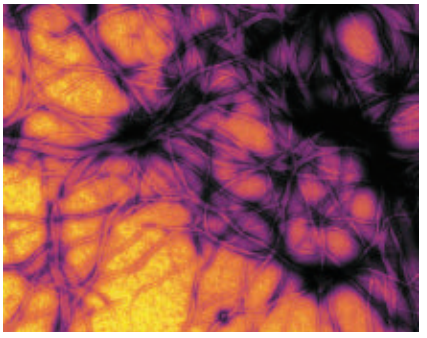
22.8 percent	23.6 percent	26.8 percent
nicotine patch	varenicline pill	nicotine patch and lozenge

FROM TOP: MARIA NEMCHUK, BROAD INST. COMMUNICATIONS; BULENT INCE/ISTOCKPHOTO

flash drive loaded with research papers about prion diseases. "We didn't have the vocabulary" to understand the information, Vallabh says. So she took a sabbatical from her job to take biology and chemistry classes. Minikel kept writing transportation software, but attended night classes with his wife.

Vallabh's first foray into brain research was as a technician in a lab studying Huntington's disease. During "science nights" at the couple's home, scientist pals team-taught biology and biochemistry. The couple took the biggest step when Minikel left his consulting job and both enrolled in graduate school to study prion diseases.

First, they had to learn whether Vallabh's mutation was really likely to cause disease. The couple worked with Harvard University geneticist Daniel MacArthur to examine genetic data from 16,025 people with prion diseases and 60,706 others who had the protein-coding parts of their genomes sequenced as part of the ExAC project, an effort to find disease-causing genetic



Prion proteins, some of which clump together or form fibrils, as in this *E. coli* bacteria, are often used to model how proteins misfold in some neurodegenerative disorders.

variants (*SN: 12/12/15, p. 8*). If mutations appear more often in people with the diseases than in the general population, the mutation is thought to be associated with the disease.

Several variants in the *PRNP* gene carry small risk, the couple and colleagues reported in the Jan. 20 *Science Translational Medicine*. Many people who carry those variants never develop prion diseases. Doctors could tell those patients that they have little to worry about. Four other variants, including the one Vallabh has, virtually guarantee the disease will develop.

After presenting preliminary results at a scientific conference, Minikel started losing sleep. What if they were wrong? So the two approached scientists at the genetic testing company 23andMe for help. The company provided anonymous genetic data from 531,575 customers. This larger analysis showed the results held.

Unfortunately, the findings don't change Vallabh's prognosis. But the couple is now working with chemical biologist Stuart Schreiber of the Broad Institute in Cambridge, Mass., to design drugs to treat prion diseases.

At age 31, Vallabh knows she doesn't have much time. Her disease strikes, on average, at age 49. When the pressure of an accelerated timeline gets hard, Vallabh reminds herself, "your clock was always ticking." At least now, she and Minikel may be able to find a way to buy time for her and others.

— Tina Hesman Saey

INTRODUCING

Meet the tarantula in black

Not far from the grounds of Folsom State Prison in California walks a male tarantula clad entirely in black.

When Chris Hamilton, an arachnologist then at Auburn University in Alabama, discovered the spider in data from a big tarantula survey, he noticed it came from the foothills of the Sierra Nevada.

Country music legend Johnny Cash and his "Folsom Prison Blues" immediately came to mind. So Hamilton, now at the University of Florida in Gainesville, named the species *Aphonopelma johnnycashi*. It's one of 14 new members of the *Aphonopelma* genus described by Hamilton and his colleagues February 4 in *ZooKeys*.

Aphonopelma tarantulas can be seen scampering into burrows in deserts, mountains and backyards in parts of North and Central America. Yet they are hard to distinguish based solely on their body features and appearance.

Over 10 years, the researchers collected and ran molecular and genetic tests on close to 1,800 male and female *Aphonopelma* tarantulas and their relatives. The researchers found that the *Aphonopelma* spiders could be classified into 29 species (14 of them new to scientists). "We knew that doing this was really going to be the only way to get the clear picture of the species boundaries of this group," Hamilton says.

Aphonopelma johnnycashi males are covered in black hairs and have been found in burrows near California's Folsom State Prison, giving scientists the idea for their name.

A. johnnycashi tarantulas had previously been lumped in with a similar species, but the two are actually distinct. The genomics work made the difference, Hamilton says.

Like the iconic man in black, *A. johnnycashi* has a fearsome exterior. But the spiders are relatively harmless to humans — hardly the type to bite a man in Reno just to watch him die. *— Helen Thompson*

FROM TOP: NIAID/FLICKR (CC BY 2.0); C.A. HAMILTON (CC BY 4.0)

ATOM & COSMOS

Physicists detect gravitational waves

LIGO experiment's discovery opens new window to the cosmos

BY ANDREW GRANT

WASHINGTON — Tremors in the cosmic fabric of space and time have finally been detected, opening a new avenue for exploring the universe.

The historic discovery of those tremors, known as gravitational waves, comes almost exactly a century after Albert Einstein first posited their existence. Researchers with the Advanced Laser Interferometer Gravitational-Wave Observatory, or Advanced LIGO, announced the seminal detection February 11 at a news conference and in a paper in *Physical Review Letters*. The gravitational swell originated more than 750 million light-years away, where the high-speed dance of two converging black holes shook the very foundation upon which planets, stars and galaxies reside.

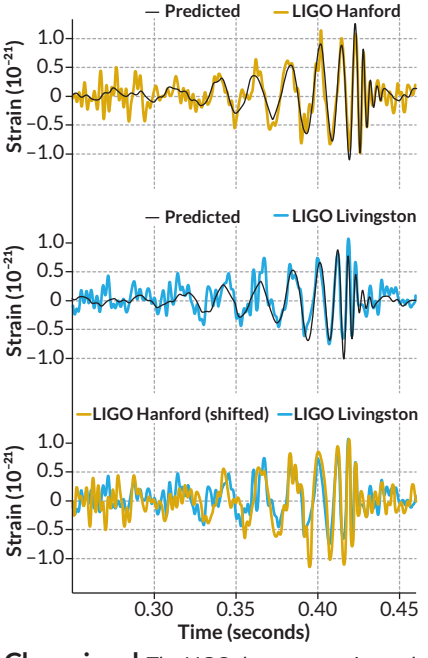
"It's the first time the universe has spoken to us through gravitational waves," LIGO laboratory executive director David Reitze said.

The discovery immediately becomes a likely candidate for a Nobel Prize, and not just because it ties a neat bow around decades of evidence supporting a major prediction of Einstein's 1915 general theory of relativity. "Gravitational waves allow us to look at the universe not just with light but with gravity," says astrophysicist Shane Larson of Northwestern University in Evanston, Ill. Gravitational waves can expose the gory details of black holes and other extreme phenomena that can't be obtained with traditional telescopes. With this discovery, the era of gravitational wave astronomy has begun.

The detection occurred September 14, 2015, four days before the official start of observations for the newly upgraded LIGO. Striking gold so quickly raises hopes for an impending flurry of sightings.

The fleeting burst of waves arrived on Earth long after two black holes, one about 36 times the mass of the sun and the other roughly 29, spiraled toward each other and coalesced. If Isaac Newton had been right about gravity, then the mass of the two black holes would have exerted an invisible force that pulled the objects together. But general relativity maintains that those black holes merged because their mass indented the fabric of space and time (*SN: 10/17/15, p. 16*). As the black holes drew near in a deepening pit of spacetime, they also churned up that fabric, emitting gravitational radiation (or gravity waves, as scientists often call them). Unlike more familiar kinds of waves, these gravitational ripples don't travel "through" space; they are vibrations of spacetime itself, propagating outward in all directions at the speed of light.

Nearly every instance of an object accelerating generates gravity waves — you produce feeble ones getting out of bed in the morning. Advanced LIGO is fine-tuned to home in on more detectable (and scientifically relevant) fare: waves emitted from regions where a lot of mass is packed into small spaces and moving very quickly. The colliding black holes certainly qualify. Their tremendous mass was packed into spheres about 150 kilometers in diameter. By the time the black holes experienced their final unifying plunge, they were circling each other at about half the speed of light. On September 14 at 4:50 a.m. Eastern time, the gravity waves emitted by the black holes during their last fractions of a second of independence encountered the two L-shaped LIGO detectors.



Clear signal The LIGO detectors registered nearly identical signals (top and middle) almost simultaneously as gravity waves from a black hole collision passed by the Earth. The signals closely match predictions.

LIGO

LIGO's detectors in Hanford, Wash., and Livingston, La., newly reactivated after five years of upgrades, each consist of a powerful laser that splits into two perpendicular, 4-kilometer-long beams (see Page 22). When the gravitational waters of spacetime are calm, the beams recombine at the junction and cancel each other out — the troughs of one beam's 1,064-nanometer waves of laser light completely negate the crests of the second beam's waves.

But the gravitational disturbance from the black hole pair distorted spacetime, slightly squeezing one arm of the detector while stretching the other (*SN: 1/8/00, p. 26*). When the beams recombined, the light no longer matched up perfectly. The detectors sensed that crest missed trough by the tiniest of distances, about a thousandth the diameter of a proton.

The LIGO facilities registered the signal just 7 milliseconds apart, indicating a light-speed pulse from deep space rather than a slower-moving vibration from an underground quake or a big rig rumbling along the highway. Physicists used the combined measurements to estimate a distance of 750 million to 1.8 billion light-years to the black holes, with 1.3 billion light-years as the best estimate. At least one more detector, preferably two, would have been needed to triangulate the precise location of the black holes in the sky.

While the black hole rendezvous was millions of years in the making, only the

final two-tenths of a second produced gravity waves with the requisite intensity and frequency for detection by Advanced LIGO. Those two-tenths of a second told quite a story. At first, the black holes were circling each other about 17 times a second; by the end, it was 75. The gravity wave frequency and intensity reached a peak, and then the black holes merged.

Combining the wave measurements with computer simulations, the scientists determined that a pair of 36- and 29-solar-mass black holes had become one 62-solar-mass beast. The missing mass had been transformed into energy and carried away as gravity waves. The power output during that mass-energy conversion was 50 times greater than that of all the stars in the universe combined.

The observed LIGO signal matches what physicists expected from a black hole merger almost perfectly. Ingrid Stairs, an astrophysicist at the University of British Columbia in Vancouver who was not involved with LIGO, says she and colleagues were "bowled over by how beautiful it was." Translated into sound, the signal resembled a rumbling followed by a chirp. "It stood out like a sore thumb," says Rainer Weiss, one of the primary architects of LIGO. The 83-year-old physicist had visited Livingston just days before and almost shut down the detector to fix some minor problems. Had he done so, "we would have missed it."

Despite the seeming no-doubt signal, LIGO researchers conducted a series of rigorous statistical tests. The signal survived. "I have great confidence in the team as a whole and everything they've done with the data," Stairs says.

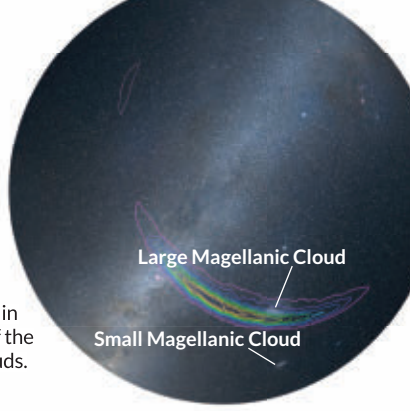
LIGO's announcement falls between two relevant centennials: Einstein's introduction of general relativity (November 1915) and his prediction of gravitational waves (June 1916, though he had to fix the math two years later). Russell Hulse and Joseph Taylor Jr. won the 1993 Nobel Prize in physics for deducing gravity wave emission based on the motion of a stellar corpse called a neutron star and a closely orbiting companion. Now Advanced LIGO has sealed the deal with the first direct measurement.

The observatory achieved what its predecessor, which ran from 2001 to 2010, could not because of an upgrade that enhanced sensitivity by at least a factor of three. Increased sensitivity translates to identifying more distant objects: If the search area of first-generation LIGO included all the space that could fit within a baseball, Advanced LIGO could spot everything inside a basketball. Advanced LIGO's range extends up to 5 billion light-years in all directions for merging objects about 100 times the mass of the sun, project leader David Shoemaker of MIT says. That extended reach, plus a boost in sensitivity at the wave frequencies associated with black holes, enabled the detection.

This ability to examine black holes and other influential dark objects without actually "seeing" them with light has scientists excited about the gravitational wave era. Black holes gobble up some matter and launch the rest away in powerful jets, scattering atoms within and between galaxies; pairs of neutron stars, also targets of Advanced LIGO, may ultimately trigger gamma-ray bursts, among the brightest and most energetic explosions known in the universe.

Yet while the influence of these cosmic troublemakers is sometimes visible with traditional telescopes, the objects themselves are not. Gravity waves offer a direct probe, and as a bonus they don't get impeded by gas, dust and other cosmic absorbers as light does. "It opens up a new window into astronomy that we never had," says John Mather, a Nobel-winning astrophysicist in attendance at the news conference. Before this discovery, scientists had never observed a pair of black holes orbiting each other. A big next step, scientists say, is to observe a nearby supernova or the collision of neutron stars via both gravity waves and light.

Gravitational wave astronomy has begun with the Advanced LIGO detection, but there's lots more to come. LIGO scientists still have three months of data to sort through from their first round of observing, and the analysis of the signal suggests similar events should occur multiple times a year. The researchers are further upgrading the detectors so that they can spot neutron star and black hole collisions even farther away. The observatory should be back up and running by late summer, says LIGO chief detector scientist Peter Fritschel.



Gravity waves from a black hole collision came from about 1.3 billion light-years away, probably in the direction of the Magellanic clouds.

Later this year, European partners of the LIGO collaboration plan to restart their revamped gravity wave observatory, Advanced VIRGO, near Pisa, Italy, providing a crucial third ultrasensitive detector for pinpointing gravity wave sources. Similar detectors are in the works for Japan and India.

LIGO was designed to spot waves in the sweet spot for converging black holes and neutron stars, with a frequency ranging from tens of hertz to several thousand. But just as scientists use radio and gamma-ray telescopes to probe different frequencies of light, physicists are building detectors sensitive to a range of gravity wave frequencies. The eLISA mission, consisting of three satellites, will hunt for waves with frequencies under 1 hertz when it launches in the 2030s. The satellite trio should be able to resolve black holes from the early universe and ones millions of times the mass of the sun.

The LIGO result is distinct from the 2014 claim of a gravity wave detection, since rescinded, by scientists with the BICEP2 telescope (*SN: 2/21/15, p. 13*). BICEP2 hunts for gravity waves with a much lower frequency, signaling reverberations from a split-second span just after the Big Bang called inflation, when space expanded very rapidly. Not detectable directly, these inflation-era gravity waves should be encoded in the universe's earliest light.

Scientists may well detect those flavors of gravity waves soon. But for now, they can bask in a discovery 100 years in the making. "This was truly a scientific moonshot," Reitze said. "We did it. We landed on the moon." ■

LIGO

GENES & CELLS

Antiaging treatment shows promise

Removing worn-out cells from body extends mouse life span

BY TINA HESMAN SAEY

Killing worn-out cells helps middle-aged mice live longer, healthier lives, a new study suggests.

Removing those worn-out, or "senescent," cells increased the median life span of mice 24 to 27 percent over that of mice in which senescent cells built up normally with age, Mayo Clinic researchers report in the Feb. 11 *Nature*. Clearing senescent cells also improved heart and kidney function.

If the results hold up in people, they could lead to an entirely new approach to treating aging, says gerontology and cancer researcher Norman Sharpless of the University of North Carolina School of Medicine in Chapel Hill. Most prospective antiaging treatments would require people to take a drug for decades. Periodically destroying senescent cells might temporarily turn back the clock and improve health for people who are already aging, he says. "If this paper is right, I believe it will be one of the most important aging papers ever."

Senescent cells have ceased to divide and no longer do their usual jobs. Instead, they hunker down and pump out inflammatory chemicals that may damage surrounding tissues and promote further aging. "They're zombie cells," says Steven Austad, a biogerontologist at the University of Alabama at Birmingham. "They've outlived their usefulness. They're bad."

Cancer biologist Jan van Deursen of the Mayo Clinic in Rochester, Minn., and colleagues devised the strategy for eliminating senescent cells by making the cells commit suicide. A protein called p16 builds up in senescent cells, the researchers had previously discovered. The team hooked up a gene for a protein that causes cells to kill themselves to a stretch of DNA that helps turn on p16 production, so that whenever p16 was made the suicide protein was also made.

> "If this paper is right, I believe it will be one of the most important aging papers ever."
>
> NORMAN SHARPLESS

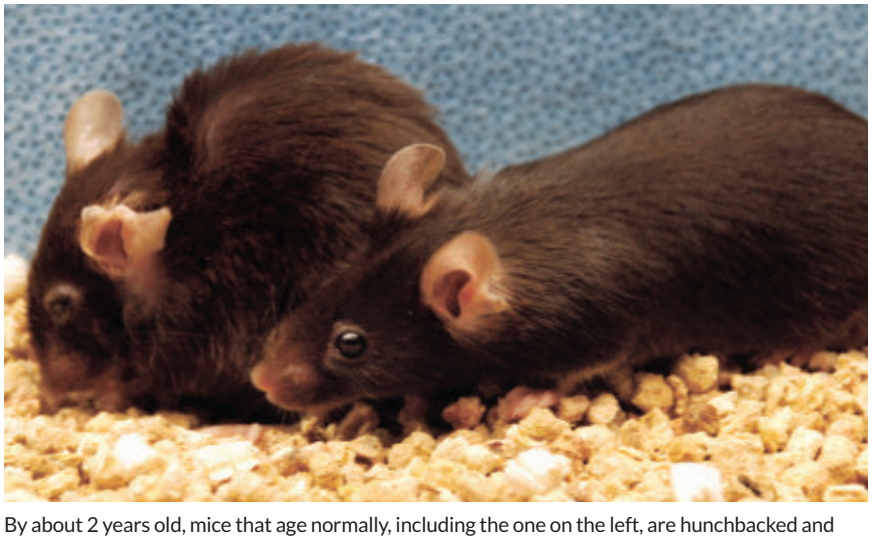
The suicide protein needs a chemical partner to actually kill cells, though. Once mice were a year old — 40 to 60 years old in human terms — the researchers started injecting the mice with the partner chemical. Mice got injections about every three days for at least six months. Mice that got the cell-suicide cocktail were then compared with genetically engineered mice that were injected with a placebo mix.

Age-related declines in the function of some organs — eyes, fat, heart and kidneys — were slowed in the mice that got the treatment. But senescent cells were easier to kill in some organs than in others. Senescent colon and liver cells weren't killed, for instance.

Genetic engineering and regular shots would not be feasible for people, but several companies are developing drugs that might clear the zombie cells from humans, says Austad. Some side effects that the mice experienced would be important to consider if those drugs are ever used in people. Senescent cells are needed for wound healing, previous work has shown, and mice that got the killing cocktail couldn't repair wounds as well as those that didn't get the treatment. Once treatment stopped, the mice were able to heal normally again. That result suggests that people undergoing senescent-cell therapy might need to stop temporarily to heal wounds from surgery or accidents.

Previously, the researchers had killed senescent cells in mice that had a genetic mutation that caused them to age prematurely (*SN: 12/3/11, p. 11*). Removing the worn-out cells helped the prematurely old mice live longer, but other researchers weren't convinced that those results applied to normal aging. "It's great when you find something that helps prevent premature aging, but there's always this nagging doubt," says Judith Campisi, a researcher at the Buck Institute for Research on Aging in Novato, Calif. It's gratifying that the treatment works to extend life and health in normally aging animals, she says.

Campisi also studies the effect of senescent cells on aging, but doesn't think the cells are entirely to blame for the ills of old age. "We don't believe senescence is the only thing that drives aging," she says. "If this were the magic bullet, Jan's mice would live forever, but they don't." ■



By about 2 years old, mice that age normally, including the one on the left, are hunchbacked and nearly blind. A treatment that removes decrepit "senescent" cells makes mice of the same age, such as the one on the right, healthier: They look and act younger and typically live a few months longer.

MAYO CLINIC

MATH & TECHNOLOGY

Health tracker sweats out the details

Wearable electronic device analyzes chemicals in perspiration

BY MEGHAN ROSEN

Fitness trackers just got an upgrade.

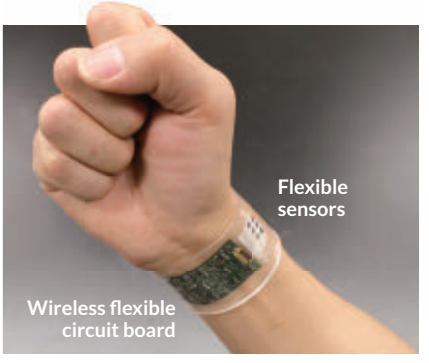
A new electronic health-monitoring device can sense a person's temperature, analyze chemicals in a drop of sweat and send the data wirelessly to a smartphone app — all in a package about the size of a few postage stamps.

The gadget could help athletes instantly gauge their hydration level, or give scientists an easy and noninvasive way to collect data for medical studies.

Sweat sensors aren't new, but the device is another level of sophistication, says materials scientist John Rogers of the University of Illinois at Urbana-Champaign.

Previous sensors have typically detected only a single chemical. The new sensor can measure four — glucose, lactate, sodium and potassium — in real time, Ali Javey and colleagues report in the Jan. 28 *Nature*.

Traditional electronics rely on "brains" made of tiny circuits laid out on silicon chips. But the chips are "too small and rigid," says Javey, an electrical engineer at the University of California, Berkeley. They're great for data processing — not for making sensors that hug the skin.



A new health device combines flexible sensors and an electronic circuit board to analyze sweat.

So scientists typically use flexible electronics for sensing and let traditional electronics do the "thinking," connecting the two via long wires, says Dae-Hyeong Kim, a bioengineer at Seoul National University in South Korea. Javey's team merged the two technologies together into a single, wireless device. "This level of integration is amazing," Kim says.

The device was tested in and out of the lab. In one test, 12 volunteers wore the device tucked into a headband while running outdoors. Six drank water every five minutes; the others didn't drink at all. After about an hour and a half, the sensor picked up a sign of dehydration in the nondrinkers: an uptick in sodium levels.

By tweaking the device, Javey says, researchers could one day use it to diagnose lead poisoning without drawing blood, or even to detect molecules in sweat that may be linked to depression. ■

BODY & BRAIN

Mice offer clues to concussion risk

Brain needs time to recover between hits, study suggests

BY LAURA SANDERS

The brain can bounce back after a single head hit, but multiple hits in quick succession don't give the brain time to recover, a new study suggests. Although the finding comes from mice, it may help scientists better understand the damage caused by repetitive impacts such as those sustained in soccer, football and other contact sports.

The results, published online February 4 in the *American Journal of Pathology*, hint that a mild head hit isn't always cause for alarm. "There are things to be afraid of after a concussion," says Mark Burns of Georgetown University Medical Center in Washington, D.C. "But not every concussion is going to cause long-term damage."

Burns and colleagues subjected some anesthetized mice to a single mild head hit. The relatively weak hit slowed the mice's return to consciousness, but didn't cause major trauma. The impact was designed to mimic a mild traumatic brain injury, or concussion, in a person.

Tests a day after the impact showed that about 13 percent of dendritic spines, docking sites that help connect brain cells, had vanished in a particular part of the brain. Three days after the injury, the number of docking sites rebounded, even surpassing the original number.

This fluctuating number of dendritic spines may help the brain recover, Burns says. "The cells weren't dying," he says. "They were responding to the injury."

The team expected to see even more dendritic spines vanish with recurring hits. But that's not what happened. Mice subjected to 30 mild hits over six weeks didn't show a dip in spines followed by a resurgence. When the hits kept coming, the dendritic spine count stopped fluctuating.

When mice were given a week off between injuries, their brains once again showed signs of dendritic spine loss and recovery, suggesting that time between injuries resets the brain in a way that lets it handle another hit.

Pediatrician Danny Thomas of Children's Hospital of Wisconsin in Milwaukee says that the results highlight the dangers of reinjury. "This says when people have a concussion, they shouldn't expose themselves to another head injury," he says. "That's the worst thing they can do."

Brain damage from mild hits in quick succession lingered. A year after the injuries, the researchers found inflammation in the white matter of the mice's brains, which carries signals from one brain area to another. What's more, these animals had trouble balancing on a rotating rod and showed signs of anxiety.

Though preliminary, the results "add another small piece to the ever-growing puzzle of what's happening after repetitive traumatic brain injury," says neuroscientist Ramesh Raghupathi of Drexel University College of Medicine in Philadelphia. ■

W. GAO ET AL/NATURE 2016

GENES & CELLS

Male mice made sans Y chromosomes

Scientists engineer female embryos to develop as opposite sex

BY TINA HESMAN SAEY

Researchers have created male mice with no trace of a Y chromosome, supposedly the defining hallmark of being male.

Reproductive biologist Monika Ward of the University of Hawaii in Honolulu and colleagues started with mice that have only one X chromosome (and no second sex chromosome). Normally, those animals would develop as females. But when the researchers manipulated genes found on the X and on another chromosome, the mice became males that could produce immature sperm. Those engineered males fathered offspring with reproductive assistance from the researchers, who injected the sperm into eggs, Ward and colleagues report in the Jan. 29 *Science*.

The experiments show that there are multiple ways to make males, says Richard Behringer, a developmental geneticist at MD Anderson Cancer Center in Houston. "They've done it without any Y chromosome gene information."

At first glance, the experiments would seem to suggest Y chromosomes aren't necessary for reproduction, which hints that evolution may eventually show Y's the door. "To me, it is a paradigm of the decline and fall of the Y chromosome," says reproductive biologist Jennifer Marshall Graves of La Trobe University in Melbourne, Australia.

But Ward and others say the Y isn't going anywhere. Because the Y-less males needed help to reproduce, "clearly we need the Y chromosome for full natural male reproduction," says reproductive biologist Mary Ann Handel of Jackson Laboratory in Bar Harbor, Maine.

Ward and colleagues had previously shown that two Y chromosome genes — *Sry* and *Eif2s3y* — are crucial for male mouse development. *Sry* is a master gene that turns on male developmental programming in early embryos. It turns on a gene called *Sox9*, which then sets off a biochemical chain reaction that leads to male development.

But in the new experiments, the researchers turned on *Sox9* through other means. Activating *Sox9* in a genetically female embryo causes it to develop as a male, Ward and colleagues found. But those males didn't make sperm.

To produce sperm, mice need the *Eif2s3y* gene, the researchers had previously discovered. In the new experiments, the mice lacked the gene because they didn't have Y chromosomes. So the team substituted a similar gene from the X chromosome called *Eif2s3x*. Only one copy of the Y version is needed to make immature, tailless sperm, but it takes at least five copies of the X version to do so. "This indicates that the Y chromosome gene is the strong one," Ward says.

The research suggests that the Y chromosome has optimized production from genes that are necessary for making males. Making just the right dose of male development factors is how the Y protects itself from evolutionary erasure, Ward says. "Our work does not support that the Y chromosome will disappear."

Graves disagrees. The work is "a lovely example of how you can lose even a really important gene," she says. At least two species of rodents have already jettisoned their Y chromosomes entirely.

Primates, including humans, don't have *Eif2s3y* genes on their Y chromosomes. No one knows whether *Eif2s3y*'s function in primates was taken over by other genes on the Y, its X counterpart or genes elsewhere in the genome. The new work may help explain how primates get along without the gene, Graves suggests, and may "give us useful information about what happens at the end of the life of the Y chromosome." ■

MATTER & ENERGY

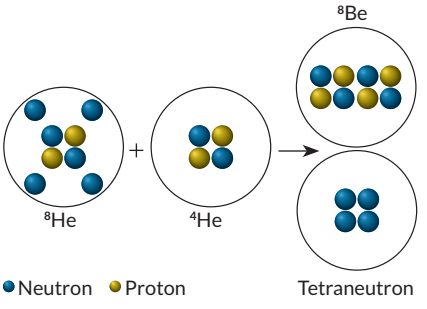
Four-neutron nucleus detected

Tetraneutron's possible existence defies expectations

BY ANDREW GRANT

The suspected discovery of an atomic nucleus with four neutrons but no protons has physicists scratching their heads. If confirmed, this "tetraneutron" would be the first example of an uncharged nucleus, something that many theorists say should not exist. "It would be something of a sensation," says Peter Schuck, a nuclear theorist at CNRS in France who was not involved in the work. Details on the tetraneutron appear in the Feb. 5 *Physical Review Letters*.

Researchers spotted the signature of tetraneutrons at RIKEN in Japan after firing neutron-rich helium nuclei (two protons, six neutrons) at a liquid composed of the most common form of helium (two protons, two neutrons). Occasionally, the reaction produced beryllium nuclei with four protons and four neutrons, leaving four neutrons missing in action. The scientists couldn't see this other product directly, but its properties fit the description of a clumped neutron quartet. The four-neutron nuclei lasted about a billionth of a trillionth of a second before decaying into other particles.



Four of a kind Collisions of helium nuclei produced beryllium nuclei and perhaps nuclei with just four neutrons. SOURCE: APS

Physicists will need more detections before agreeing that tetraneutrons exist, though Schuck says this study offers better evidence than several past claims. Theorists would probably have to propose some kind of interneutron force to explain the exotic nuclei, he says. ■

J. HIRSHFELD

EARTH & ENVIRONMENT

Indian Ocean phytoplankton in danger

Photosynthetic microbes are vanishing as sea surface warms

BY THOMAS SUMNER

A rapid loss of phytoplankton threatens to turn the western Indian Ocean into an "ecological desert," a new study warns. The research reveals that phytoplankton populations in the region fell an alarming 30 percent over the last 16 years.

A decline in ocean mixing due to warming surface waters is to blame, researchers propose online January 19 in *Geophysical Research Letters*. The mixing ferries nutrients from the ocean's dark depths up into the sunlit layers that the phytoplankton inhabit.

The loss of these photosynthesizers, which form the foundation of the ocean food web, may undermine the region's ecosystem, says study coauthor Raghu Murtugudde, an oceanographer at the University of Maryland in College Park.

The phytoplankton decline may be partially responsible for a 50 to 90 percent drop in tuna catch rates over the last half-century in the Indian Ocean, he says. "This is a wake-up call to look if similar things are happening elsewhere."

In the 20th century, surface temperatures in the Indian Ocean rose about 50 percent more than the global average. Previous investigations suggested that phytoplankton populations increased in response to this warming. But those studies looked at only a few years of data.

Roxy Mathew Koll, a climate scientist at the Indian Institute of Tropical Meteorology, Murtugudde and colleagues tracked the phytoplankton from space. When the sea surface is filled with phytoplankton, the water takes on a lighter, greener tinge. As the population thins, the water turns darker and bluer.

Analyzing satellite images collected over the last 16 years, the team found a 30 percent drop in the abundance of green-tinted microbes per cubic meter of water. Combining that data with historical environmental data and computer simulations, the team reconstructed the ups and downs of phytoplankton over the last six decades. That work suggests that populations in the western Indian Ocean have declined 20 percent relative to 1950.

Warming caused the long-term drop in phytoplankton, the simulations revealed. Phytoplankton rely on nitrates, produced by bacteria that dwell about 100 to 500 meters deep, that are churned upward. Warmer water is less dense and stays near the surface. As the surface becomes warmer relative to the deeper ocean, the two layers become harder to mix and nutrients become scarcer in the top layer.

Upcoming ship-based studies should verify the new results, says Michael McPhaden, a physical oceanographer at the National Oceanic and Atmospheric Administration in Seattle. ■

HUMANS & SOCIETY

Babylonians used fancy geometry

Ancients had remarkably modern way to track Jupiter

BY BRUCE BOWER

Ancient Babylonians charted Jupiter's heavenly motion in a surprisingly modern, mathematically abstract way — a feat that until now was thought to have originated among European scholars who lived roughly 1,400 years later.

Analyses of cuneiform writing on four largely intact clay tablets show that innovative geometric calculations enabled ancient astronomers to track the giant planet's movement across the sky, Mathieu Ossendrijver reports in the Jan. 29 *Science*.

Researchers did not document exactly where these and thousands of other clay tablets were uncovered in 19th century excavations in Iraq. But most scholars today think that the tablets from those digs that contain astronomical tables and calculations were found in Babylon, the ancient capital of Babylonia, says Ossendrijver, a historian of ancient science at Humboldt University of Berlin. Based on previous age estimates for other Babylonian tablets dealing with mathematical astronomy, the geometry-bearing tablets were probably written between 2,366 and 2,066 years ago, he says.

"Babylonians applied geometric methods that had been used for 1,000 years to develop a very modern way of studying motion," Ossendrijver says.

The new findings show that Babylonians made a mental leap from describing planetary motion in concrete, arithmetic terms to representing those movements in an abstract, geometric space, says University of Chicago historian of ancient science John Wee.

About 450 tablets recovered at Babylonian sites contain calculations about planets and the moon, mostly based on addition and other arithmetic operations, or instructions for carrying out those calculations.

This cuneiform tablet provided the key to understanding how ancient Babylonians used abstract geometric spaces to calculate planetary motion.

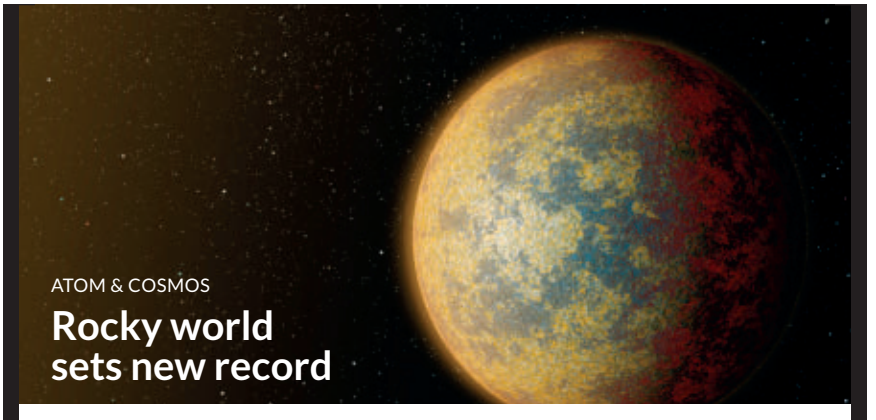
Four small tablets housed at the British Museum in London preserve portions of a different, poorly understood astronomical calculation system. Researchers call these calculations trapezoid procedures, because of references to four-sided shapes with two parallel sides of differing lengths.

Ossendrijver deciphered those tablets with the aid of a fifth Babylonian tablet held by the British Museum that he identified as containing nearly complete instructions for carrying out trapezoid procedures. While studying photographs of the museum's tablets in January 2015, Ossendrijver noticed mentions of Jupiter and trapezoid procedures on that crucial piece of impressed clay.

Armed with this Babylonian "Rosetta stone," Ossendrijver determined that Babylonians used trapezoid-shaped graphs to determine Jupiter's movements. Those ancients calculated how the planet's velocity changed from day to day and the distance Jupiter covered over two consecutive 60-day intervals. Babylonians also divided trapezoidal graphs into two smaller trapezoids of equal area to determine the time when Jupiter traveled half the distance it would eventually cover over 60 days.

English and French scholars in the 14th century developed similar methods for tracking planets' movements in an abstract, geometric space. But Babylonians pioneered those calculations, Ossendrijver says.

Geometry, defined broadly as any mathematical procedure concerning shapes, sizes, lines and angles, was widely used in the ancient world by the time of Babylonian astronomy, Wee says. Ancient Greek astronomers used geometry, although not the trapezoidal procedures developed by Babylonians, to study planetary motion. ■



ATOM & COSMOS

Rocky world sets new record

When it comes to big balls of rock, exoplanet BD+20594b might have all other known worlds beat. At roughly half the diameter of Neptune, BD+20594b is 100 percent rock, researchers suggest online January 28 at arXiv.org. The planet seems to defy recent calculations that indicate a planet this large should be gassy (*SN: 8/22/15, p. 32*).

Discovered with the Kepler space telescope last year, BD+20594b sits about 500 light-years away in the constellation Taurus. The planet is about 16 times as massive as Earth. And at just a little over twice as wide, the planet has a density of about 8 grams per cubic centimeter, astrophysicist Néstor Espinoza of the Pontifical Catholic University of Chile in Santiago and colleagues report. Earth's density, by comparison, is 5.5 g/cm^3.

— Christopher Crockett

FROM TOP: M. OSSENDRIJVER/*SCIENCE* 2016; JPL-CALTECH/NASA

LIFE & EVOLUTION

Deer have their own malaria

Long-overlooked parasite found in some U.S. states

BY SUSAN MILIUS

The white-tailed deer, maybe the best-studied wild animal in North America, carries a malaria parasite that science has overlooked for decades.

The malaria parasite in deer is a different species from the ones that cause disease in humans. It's unlikely to switch to people, says Ellen Martinsen of the Smithsonian Conservation Biology Institute in Washington, D.C. And how the parasite affects deer isn't yet clear.

A report in 1967 based on one deer in Texas had claimed that the parasite existed, and a 1980 paper had named it *Plasmodium odocoilei*. But no one had reported it again until Martinsen and colleagues accidentally rediscovered it.

Their find dashes the current belief that no mammals other than people carry their own native forms of malaria in the Western Hemisphere, Martinsen and colleagues say February 5 in *Science Advances*. The work also challenges the conventional wisdom that no members of the deer family anywhere have their own malaria parasites.

"I feel a bit discombobulated by the paper," says Penn State evolutionary parasitologist Andrew Read. At some locations, the parasite was found in 25 percent of sampled white-tailed deer (*Odocoileus virginianus*). "How could anybody have missed malaria at these levels?" he says. The parasite has so far appeared at low concentrations in deer blood, and Read wonders what other forms of malaria have been overlooked.

The old report of a deer parasite had been "really just a mystery," Martinsen says. It came from a leading malaria parasite expert and so was difficult to dismiss lightly. But Martinsen wasn't even thinking about it when she and Robert Fleischer were using genetic methods to survey for bird malaria parasites in mosquitoes at the Smithsonian's National Zoo in Washington, D.C. A peculiar sample of malaria-parasite DNA turned up in a mosquito that had bitten a white-tailed deer (a conclusion gleaned from other DNA in blood the mosquito had fed on). Then smears of deer blood checked under a light microscope revealed actual parasites in the forms they take while reproducing in mammalian hosts.

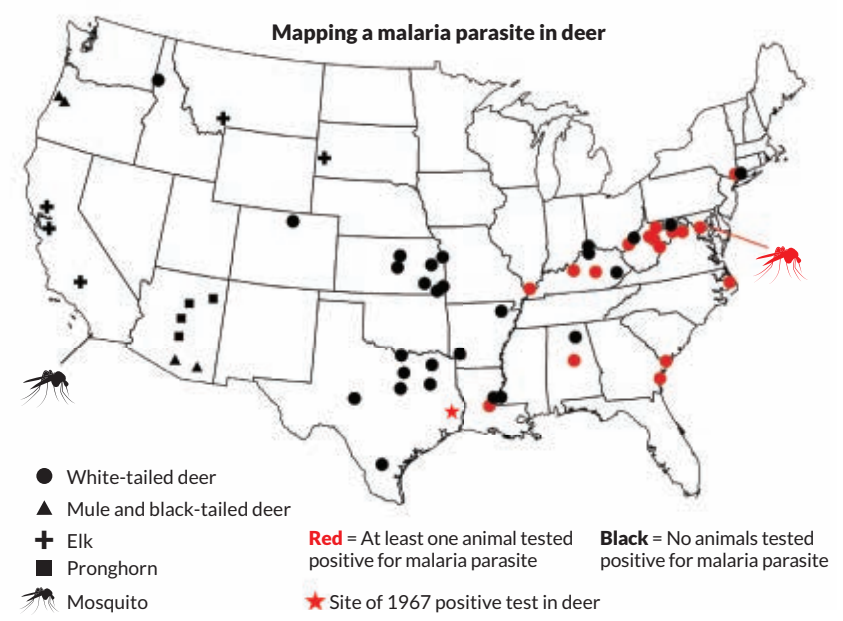
So far, based on sampling from across the country, the parasite appears to be a phenomenon of white-tailed deer mainly in the southeastern United States, with some reports from as far north as Westchester County, N.Y. The parasite didn't show up in genetic tests of blood samples from elk, pronghorn, mule deer, black-tailed deer or even in all of the samples from white-tailed deer. Nor did it show up in mosquitoes tested from San Diego County in California.

Now what's needed is large-scale sampling, says Juliane Schaer of the Max Planck Institute for Infection Biology in Berlin. "There is always the chance that other deer, or other mammals, have malaria parasites that just haven't been detected yet."

The mosquito *Anopheles punctipennis*, which could spread human malaria should those parasites return to North America, could be spreading the deer disease, Martinsen suggests. DNA indicates that the deer parasites, sucked up during a blood meal, can at least make it from this mosquito's gut to its salivary glands, where the parasites might dribble into the next deer that the mosquito bites.

What effects that bite has on the deer could have been overlooked, too, says Steve Demarais of the Mississippi State University Deer Lab. Studies of sage grouse in Wyoming, for example, found little visible difference in males infected with malaria, he says. But the infected birds didn't spend time on the breeding grounds as regularly or mate as early or as frequently as uninfected birds did. At first glance, "impacts are not always obvious," he says, yet behavioral differences matter to an animal's breeding success.

More information on deer malaria is already on the way. Diana Outlaw, also of Mississippi State, says she and colleagues have independently rediscovered malaria parasites in white-tailed deer. The researchers have submitted a paper to a journal and are continuing to check the 30,000 mosquitoes they've collected for signs of the parasite and of the animals the mosquitoes have bitten. ■



Sampling sites Researchers have found a malaria parasite in populations of white-tailed deer, mainly across the southeastern United States, as well as in mosquitoes in the Washington, D.C., area. Deer and some related species in other parts of the country tested negative.

E.S. MARTINSEN ET AL/SCIENCE ADVANCES 2016

LIFE & EVOLUTION

Biologists fight to save salamanders

Fears of new disease prompt import ban in United States

BY SUSAN MILIUS

Biologists hope a new import ban — and help from citizen scientists — will protect North America's extraordinary diversity of salamanders, like this *Ensatina* salamander, from the deadly *Bsal* fungus, which has already hit some European species.

North America, a Garden of Eden for salamanders, faces a dire threat from a recently discovered fungal disease. But biologists say that lessons learned from the last worldwide wave of amphibian die-offs are helping to rush a new animal import ban and other measures into effect that might slow the spread of the deadly disease.

Fears of widespread die-offs come from the 2013 discovery in northern Europe of a previously unrecognized *Batrachochytrium* fungus nicknamed *Bsal* (*SN: 10/5/13, p. 18*). This fungus has already ravaged populations of salamanders in the Netherlands by eating away their skin. There's no known way to rid most wild populations of the disease. But the good news is that there's no sign — yet — that *Bsal* has reached North America, Karen Lips of the University of Maryland in College Park reported February 12.

Lips is one of several biologists who has had the rare horror of witnessing a previous wave of lethal fungus, called *Bd*, sweep through new territory and kill amphibians by the thousands. She and colleagues pleaded for a faster, more informed attempt at defense this time.

What biologists call the most important defense has just been put in place: an interim measure from the U.S. Fish and Wildlife Service that, as of January 28, bans the import of 201 salamander species to the United States. Even moving those species across state lines is no longer permitted. This pet-trade measure matters, the speakers explained, because international shipping of *Bsal*-infected animals apparently carried the fungus from its longtime home in Asia to Europe, where such species as fire salamanders had no resistance to the fungus (*SN: 11/29/14, p. 6*).

With a *Bsal* threat looming in the United States, Joe Mendelson, a herpetologist at Zoo Atlanta, urged anyone who notices a dead salamander to report it via the new online Amphibian Disease Portal. One lesson from the last die-offs was how difficult it is for scientists to observe catastrophes as they happen. Infections burned through remote sites in months, with scavenging animals quickly cleaning up carcasses. To catch the earliest signs of any *Bsal* outbreaks, "we want to see dead salamanders," Mendelson said. "Well, we don't *want* to...."

If the *Bsal* pathogen slips into North America, such widespread species as the Eastern newt could prove disastrously susceptible, said Ana Longo of the University of Maryland and the Smithsonian Conservation Biology Institute. North America has the greatest diversity of

BODY & BRAIN

Early signing benefits deaf kids later on

Exposure to sign language from birth may enhance mental skills

BY LAURA SANDERS

Deaf children who learn to sign early may boost their brainpower in ways unrelated to language.

"Most deaf children are born to hearing families, and most hearing parents do not sign with their newborn deaf children," clinical neuropsychologist Peter Hauser, who is deaf, explained February 12. "The deaf children, as a consequence, have very limited exposure to sign language," signed Hauser, of the Rochester Institute of Technology in New York.

That paucity of input derails not only normal language development, but other aspects of mental performance, too, Hauser's new research suggests. He and colleagues studied executive function — high-level mental effort that involves controlling attention, impulses and emotions — by having 115 deaf children draw lines connecting circles with sequential numbers. The kids had to alternate colors of circles, a tricky task because it required resisting the urge to connect circles of the same color.

Compared with children exposed to signing from birth, children who didn't learn to sign until around age 3 took about 17 seconds longer to connect the dots, Hauser reported. What's more, the late signers don't seem to ever catch up. In similar tests of 40 adults, native signers beat the times of late signers by 23 seconds.

This result "shows that it's something that's still there in adulthood," says psychologist and language expert Jenny Singleton of Georgia Tech in Atlanta.

Earlier work by Singleton examined

GREG SCHECHTER/FLICKR (CC BY 2.0)

salamander species in the world, with close to 200 of the known 700 or so species. The Appalachians and the West Coast are especially rich in species, and the threat of disease savaging them has amphibian researchers "all very worried," said Patricia Burrowes of the University of Puerto Rico in San Juan.

Burrowes' research on the disease ecology of *Bd*, the first fungus discovered to kill adult amphibians, has helped demonstrate just how difficult managing, or even predicting, outcomes of disease invasion can be. The other animals sharing the habitat, the microbes that teem on animal skin and the details of local climate all make a difference. Burrowes' current project shows that even small patches of sunlight beaming through gaps in the canopy of a tropical forest might, in theory, create refuges where the *Bd* fungus would not grow well on a basking animal.

The biggest lesson that scientists learned from the previous invasion is that one fungus disease can quickly crash local populations of a lot of species, says Vance Vredenburg of San Francisco State University. He was working at a remote lake in California over a decade ago when mountain yellow-legged frogs that had looked fine one day were floating belly up by the hundreds the next day. "We just couldn't believe what was happening." ■

classrooms of deaf children, some exposed to signing from birth and some who learned to sign later. The late signers required more guidance to follow signed conversations, the study showed.

"We now have a preponderance of evidence to suggest that if these children have not acquired language early, there can be lifelong impacts," she says.

That means that families of deaf children who receive cochlear implants shouldn't necessarily abandon attempts to sign, she says. If a child doesn't succeed with the implant, then signing would still ensure that the child has a language to use. ■

FRED HUTCH NEWS SERVICE

GENES & CELLS

Memory cells enhance cancer therapy

Strategy of engineering subset of immune cells shows promise

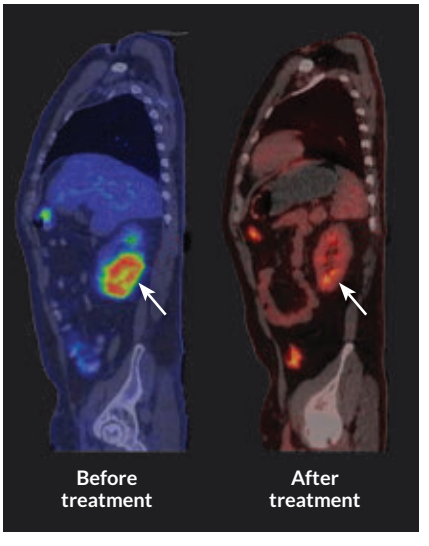
BY TINA HESMAN SAEY

Stem cells with memory may improve a powerful new type of cancer therapy.

Recently, scientists have engineered cells from a patient's own immune system to fight blood cancers. The treatment, called CAR–T cell therapy, may work even better if doctors limit the transplant to a subset of immune stem cells known as memory T cells, researchers reported February 14.

A single engineered memory T cell was enough to replenish the infection-fighting ability of mice lacking T cells, said Dirk Busch, an immunologist at the Technical University of Munich. That finding indicates that very low numbers of the cells in the body could be enough to protect human patients from maladies ranging from infections to cancer.

In preliminary clinical trials, CAR–T cell therapy using the memory T cells eliminated cancer in 27 of 29 patients with acute lymphoblastic leukemia, or ALL, for whom other treatments had failed. Stanley Riddell, an immunotherapy researcher at the Fred Hutchinson Cancer Research Center in Seattle, reported the finding. Memory CAR–T cell therapy also melted away tumors in six of seven patients in whom cancer had spread from the bone marrow to other parts of the body. And 10 of 11 patients who had previously undergone CAR–T cell therapy with a mixed bag of engineered T cells were in remission after being treated with just the engineered memory cells, Riddell reported.



A new type of immune therapy that uses genetically engineered cells, called CAR T cells, melted away a lymphoma tumor in a patient's kidney. These PET scans show the tumor before CAR–T cell therapy (left) and two months after treatment (right). Chemotherapy had previously failed to shrink the tumor.

Only a few hundred to a few thousand of the memory cells were needed to shrink a patient's tumor, he said. The low doses also lessened side effects of the therapy.

CAR T cells are genetically engineered versions of immune cells called T cells. T cells prowl the body and identify invaders, such as bacteria, viruses, parasites and other foreign cells. For decades, researchers have been trying to boost cancer patients' immune systems to kill cancer cells (*SN: 6/14/14, p. 22*). Recently, scientists created CAR T cells, or "chimeric antigen receptor" T cells, that make proteins that allow the cells to track down and kill particular types of cells. Researchers removed T cells from ALL patients and genetically engineered the cells to hunt and destroy cells that make a protein called CD19. Such cells include antibody-producing B cells, which overgrow in most patients with ALL and some other types of lymphoma or leukemia.

Gene-edited CAR T cells were recently used to treat a baby with leukemia (*SN: 12/12/15, p. 7*).

Engineered memory T cells can persist and propagate in patients for at least 14 years, Chiara Bonini of the San Raffaele Scientific Institute in Milan, Italy, reported. Such cells may "act as a living drug that can persist and respond in a patient in case the tumor comes back," she said. ■

BODY & BRAIN

E-cigarettes linked to new health risks

Vaping may affect immune system, heart, sperm and behavior

BY JANET RALOFF

Many people have turned to electronic cigarettes in hopes of avoiding the heart and cancer risks associated with smoking conventional tobacco products. But vaping increasingly appears far from benign, a trio of toxicologists reported February 11 and 12.

If used as a means to totally wean people off of tobacco products, then e-cigarettes might have value, conceded Ilona Jaspers of the University of North Carolina at Chapel Hill. But she's not sure. Unpublished data that she and the others presented link e-cigarette products to a host of new risks. So vaping may not eliminate risks associated with conventional smoking as some have thought, Jaspers maintained, "and may actually be introducing new ones."

Vaping may not eliminate risks associated with conventional smoking.

Her group examined scraped cells from the noses of otherwise healthy people who had a history of smoking, vaping or doing neither. The researchers then measured in these cells the activity levels of 594 genes associated with the body's ability to fight infections. Among smokers, the activity of 53 genes was substantially diminished, compared with people who neither smoked nor vaped. Among vapers, those same 53 genes showed significantly diminished activity as did 305 others, Jaspers reported.

The normal role of these genes suggests that the lung and nasal tissue of smokers — and especially vapers — "may be more susceptible to any kind of infection," Jaspers said.

To test that possibility, Jaspers' team collected immune cells from healthy human volunteers, then exposed those cells to flavored liquids used in e-cigarettes. Tested cells included blood neutrophils and lung macrophages, both normally tasked with gobbling up and killing bacteria. Some of the liquids proved disturbingly effective at suppressing the ability of those immune cells to do their job, Jaspers reported.

One compound with a particularly suppressive effect was the cinnamon-flavored cinnamaldehyde. Jaspers said she was surprised to find cinnamaldehyde in some of the noncinnamon-flavored liquids, including a cola one.

Judy Zelikoff of the New York University Langone Medical Center in Tuxedo also looked at genes affected by e-cigarette vapors. Her group exposed mice developing in the womb, and for a month after birth, to vapors at concentrations calculated to be comparable to what a vaping pregnant woman might encounter. Then Zelikoff tracked the activity of genes in the mice's frontal cortex, a brain region associated with planning and integrating the senses to understand the environment.

Whether the e-cigarette vapors contained nicotine made a big difference.

Males exposed to nicotine-laced vapors showed no gene-activity changes. Among females, vapors laced with nicotine appeared to alter the activity levels of 148 genes in the brain's frontal cortex. But among mice exposed to nicotine-free vapors, a whopping 830 or more genes in the frontal cortex showed altered activity — either much higher or lower than in unexposed mice. Both males and females were about equally affected.

Zelikoff said that she was so surprised by the exaggerated effect of the nicotine-free vapors that her team repeated the experiment two more times.

Zelikoff's group then teamed up with researchers at the University of Rochester in New York to investigate whether the gene-activity changes alter behavior. Mice in both the nicotine and no-nicotine groups showed behavioral changes. When adult mice that had been exposed to nicotine-free vapors in the womb moved, they tended to do so at almost twice the pace as unexposed mice. Mice moved faster still if they had been exposed to nicotine. Both groups of mice also jumped more. And mice exposed to vapors also stood on their hind legs more than those that had not been exposed.

All of these "are behaviors that are reflective of increased, or hyper, activity," Zelikoff reported, "and possibly agitation." Her group is now exploring possible effects on memory and mental disorders.

Her group also uncovered reproductive problems in young adult male mice exposed to e-cigarette vapors in the womb. Their sperm concentrations were roughly half the value as those in unexposed mice. And their share of motile sperm was only a fifth as high as in unexposed males.

Exposing mice to e-cigarette vapors also increased plaque buildup in the arteries, a sign of emerging atherosclerosis, reported Daniel Conklin of the University of Louisville in Kentucky. Cigarette smoke did too. In both cases, he noted, toxic aldehydes, such as acrolein, formaldehyde and acetaldehyde, appear to be contributors. As such, he concluded, e-cigarette vapors "could adversely impact the cardiovascular health of users."

Neal Benowitz of the University of California, San Francisco notes that "we're really at the beginning of understanding the toxicity of emerging products." There is a lot of complexity to understanding what goes into the vapors and the tissues that may be at risk. Certainly, he says, there has been a general perception that vaping is safer than smoking (*SN:7/11/15, p. 18*). "The challenge to science," he says, will be to tease out: "Is this really true?" For now, he says, "we really don't know."

Perhaps it's true, Zelikoff said. "But I'm a firm believer in the precautionary principle." If she were pregnant, she said, "I would look at these animal data with a great deal of respect." ■

MEETING NOTES

Tiny brains made in lab dishes

Tiny orbs of brain cells swirling in lab dishes may offer a better way to study the complexities of the human brain. Toxicologist Thomas Hartung of Johns Hopkins University described these minibrains, grown from stem cells derived from people's skin cells, on February 12.

Previous minibrain systems have had complex neural structures and elaborate development (*SN: 9/21/13, p. 5*). But the new bare-bones models, made of nerve cells and support cells in a sphere about the size of a fly eye, offer a standardized system that can reliably test the effects of a wide range of drugs.

Hartung and colleagues are creating a company to make minibrains available to researchers who could use them to study autism, Alzheimer's disease and other disorders. The minibrains would cost about as much as a lab rat. — *Laura Sanders*

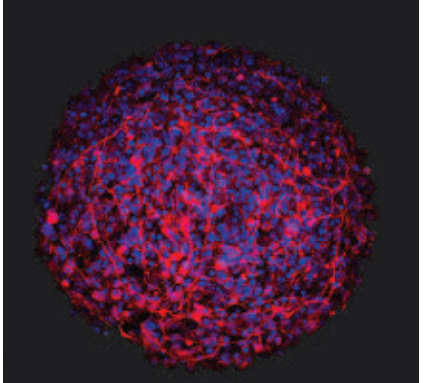
Planets may emerge from stellar duo gathering icy dust

A pair of stars is setting up an icy planetary construction zone, new data suggest. Carbon monoxide gas is freezing onto tiny dust grains orbiting the stellar duo. The particles might eventually give rise to comets or even a new planet.

A belt of gas and dust encircles the binary star HD 142527, about 450 light-years away in the constellation Lupus. Observations with the Atacama Large Millimeter/submillimeter Array in Chile reveal a region of the belt where there is little carbon monoxide compared with dust. The gas is probably condensing onto dust grains and building a reservoir of ice-encrusted particles, astrophysicist Andrea Isella reported February 13.

"It's the perfect recipe if you want to form planets or planetesimals," said Isella, of Rice University in Houston. "Icy grains collide and stick together well."

Gravitational interactions between the binary star and the belt gather dust grains in this zone, providing surfaces on which the gas can condense. Without knowing the mass of the corralled dust, Isella can't say if a family of comets or a full-fledged planet will form. — *Christopher Crockett*



In this lab-made minibrain, nerve cells (red) knit themselves together and send messages. Cell nuclei are shown in blue.

New clues illuminate mysteries of ancient Egyptian portraits

Scientists are getting a clearer picture of how ancient Egyptians painted lifelike portraits that were buried with the subjects' mummified remains. The paintings departed from Egyptians' previous, simpler artworks and were among the first examples of modern Western portraits, archaeologist and materials scientist Marc Walton reported February 14. The "mummy portraits" date to around 2,000 years ago, when the Roman Empire controlled Egypt.

Three such portraits, found more than a century ago at a site called Tebtunis, were created by the same artist, said Walton, of Northwestern University in Evanston, Ill. Separate computerized analyses of colors and shapes in the stylistically similar paintings revealed that brushstrokes of the same width were used to apply the same pigment mixes to different parts of each portrait.

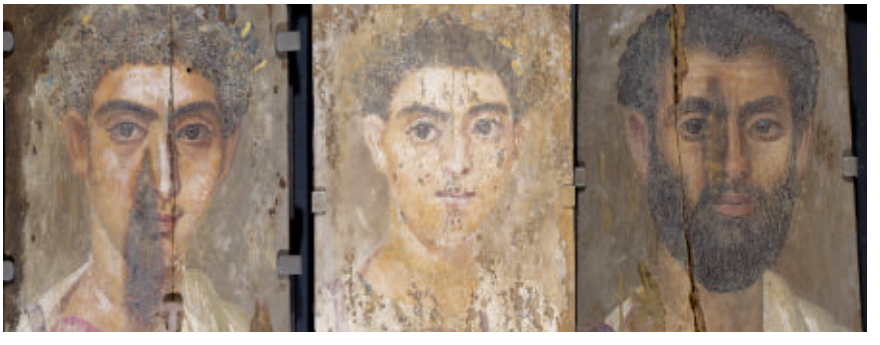
Many pigments in the portraits probably came from Greece, Walton said. Ancient Greeks' naturalistic painting style influenced the Egyptians' switch to portrait painting, he suggested. But the paintings also suggest even more distant contacts: Walton's team traced red lead used in Egyptian pigments to Spain and wood on which the portraits were painted to Central Europe. — *Bruce Bower*

New app puts an earthquake detector in your pocket

If you need to detect earthquakes, there's an app for that. Seismologists have harnessed the motion-sensing accelerometers built into smartphones to detect tremors. The app, called MyShake, could eventually provide early warning of approaching quakes in regions lacking sophisticated seismometer networks, Richard Allen of the University of California, Berkeley said February 11.

MyShake monitors a smartphone's movements. The software differentiates between everyday motion, such as a phone jostling in a pocket, and vibrations caused by a quake. The system also monitors whether smartphones running the app in the same area report a quake (*SN: 4/19/14, p. 16*). One day, the system could send earthquake alerts to users' phones, Allen said.

The researchers tested the app by placing smartphones on vibrating tables that mimic real temblors. MyShake can accurately record earthquakes of magnitude 5 or above within 10 kilometers of the epicenter, the researchers report February 12 in *Science Advances*. Had MyShake been deployed before the April 2015 Nepal earthquake, the system could have provided about 20 seconds of warning before the tremors struck Kathmandu, where most fatalities occurred (*SN: 5/16/15, p. 12*), the researchers estimate. — *Thomas Sumner*



Digital analyses of Egyptian portraits dating to about 2,000 years ago indicate that the same person created all three paintings and that many of their pigments probably came from Greece.

FROM TOP: JHU CENTER FOR ALTERNATIVES TO ANIMAL TESTING; PHOEBE A. HEARST MUSEUM OF ANTHROPOLOGY/UCB

GENES & CELLS

Neandertal DNA poses health risks

Genes inherited through ancient interbreeding tied to disease

BY TINA HESMAN SAEY

Finding Neandertal ancestors in the human family tree was shocking enough when researchers announced it in 2010. Now, the implications for modern-day people carrying surviving Neandertal DNA may prove just as stunning.

Today, Europeans and Asians carry, on average, between 1.5 and 4 percent Neandertal DNA. A flurry of new studies suggest that the genetic hand-me-downs may once have helped human newcomers adjust to their new homes. But these genetic bits and pieces may no longer be helpful, and may even raise the risk of depression, heart disease, some skin conditions, allergies and other maladies.

"There was, and still is, a lingering cost of having this admixture," says John Capra, an evolutionary geneticist at Vanderbilt University in Nashville.

Capra and colleagues examined DNA and electronic health records from more than 28,000 people of European descent to determine whether genes from extinct hominid ancestors are associated with diseases. Genetic variants inherited from Neandertals are associated with a slightly increased risk of depression and heart attack, as well as corns, callouses and other skin disorders, the researchers reported February 11 at the American Association for the Advancement of Science's annual meeting in Washington, D.C., and in the Feb. 12 *Science*.

Modern people have inherited some genetic variants from Neandertals (one reconstructed here) that may affect health.

H. NEUMANN/NEANDERTHAL MUSEUM

For instance, Neandertal variants account for about 1 percent of the genetic risk of getting depression. However, some bits of Neandertal DNA actually seem to protect against depression, study coauthor Corinne Simonti, also of Vanderbilt, said after a news briefing at the AAAS meeting. So a person's risk of depression may depend, in part, on which bits of Neandertal DNA were inherited.

Other researchers caution that Capra's group hasn't demonstrated that the Neandertal variants are the genetic changes responsible for the disease. They may be innocent bystanders implicated just by their proximity to variants that are really causing problems. And, says evolutionary geneticist Rasmus Nielsen of the University of California, Berkeley, "because we're talking about genetic variation here, the effect is not in one direction — so the study doesn't show that you're more (or less) likely to become ill because of Neandertal DNA."

20 percent
Fraction of the Neandertal genome still around today

Neandertal variants usually don't fall within genes, instead affecting DNA that influences where, when and how strongly genes are activated, Capra said at the news briefing. The Neandertal variants most strongly associated with depression were located near circadian clock genes, which synchronize the body's rhythms with the sun, the researchers found. Other variants appear to affect activity of genes involved in bladder pain and incontinence and a gene that predisposes people to nicotine addiction. Knowing which Neandertal variants a person has inherited might help doctors better predict disease risk, Capra says.

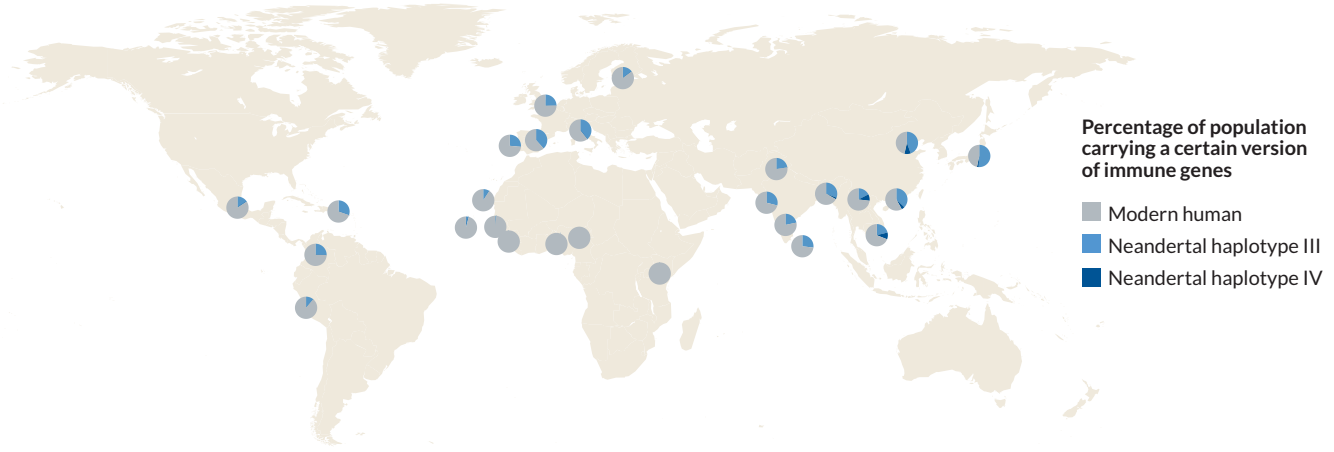
If Neandertal DNA is harmful, why is it still around? It may not always have been a deficit, Capra says. His group found that Neandertal DNA is associated with a disorder in which the blood clots too much. That's been linked to increased activity of a gene called *SELP*. Inheriting the Neandertal gene may have been helpful in the Stone Age when closing a wound quickly was a major concern, Capra says. "It's certainly possible that some of these Neandertal contributions were beneficial 40,000 years ago, but are not now."

No one knows exactly when human-Neandertal interbreeding occurred or how much went on. Estimates range from about 60,000 years ago or earlier until shortly before Neandertals disappeared about 30,000 years ago (*SN: 6/13/15, p. 11*). Some studies have concluded that Asians' ancestors mixed with Neandertals more than once, leaving Asians with more Neandertal DNA than Europeans (*SN Online: 2/12/15*). In addition, Asians inherited a small amount of DNA from another extinct group of human relatives called Denisovans.

That genetic legacy was not passed along wholesale like a precious Ming vase. Instead, DNA was shuffled during reproduction. Families bequeathed different bits of DNA to their heirs, as if each child inherited different shards of a shattered vase. If everyone's Neandertal genetic keepsakes were glued back together, there would be enough pieces to reconstruct 20 percent or more of a Neandertal's genome.

"In a way, Neandertals survived in us," says Fernando Racimo, a population geneticist at the University of California, Berkeley. "You could say that they're not really completely extinct."

Some parts of the human genome don't contain any Neandertal DNA at all, while other parts may be 60 percent or more Neandertal (*SN: 3/8/14, p. 12*). Scientists have debated whether that means that evolution has favored some Neandertal genes because they benefit humans or that evolution has been slowly weeding out Neandertal DNA, and some genes have risen to prominence by chance.



Inheriting immunity Present-day people participating in the 1000 Genomes project inherited one of three versions, or haplotypes, of immunity genes. Neandertals passed haplotype III to all non-African groups examined. Some Asians also inherited Neandertal haplotype IV. Those versions of the immunity genes may have helped human ancestors fend off new pathogens after they left Africa, but now contribute to allergies.

Early on, natural selection may have played a numbers game in determining which genes would stay or go. In independent studies published online last fall at bioRxiv.org, two groups of researchers argued that dwindling Neandertal populations had built up weakly harmful mutations. Because Neandertal populations were small and inbred, natural selection couldn't efficiently clear out the mutations. Computer simulations suggest that all of those small genetic disadvantages would have added up to make the average Neandertal at least 40 percent less evolutionarily fit than the average early modern human fresh from Africa. Nielsen and evolutionary geneticist Kelley Harris of Stanford University reported that finding October 31.

When humans and Neandertals interbred, the humans' larger population size allowed evolution to weed out the slightly bad variants, a group of researchers from the University of California, Davis reported November 21. Both groups agree that the burden of extra Neandertal mutations would have been a drag on early human–Neandertal hybrids. Europeans and Asians are still shouldering that mutational load today. Non-Africans are about 0.5 percent less evolutionarily fit than their African counterparts thanks to Neandertal DNA, Harris and Nielsen say.

But a wealth of genetic data indicate that at least some genes inherited from humans' extinct cousins were evolutionary windfalls. For instance, a gene Tibetans inherited from Denisovans allowed them to adapt to high altitudes (*SN: 8/9/14, p. 8*).

Some of the most Neandertal-rich regions of the modern human genome are those that contain immune system genes. There's a good reason for that, says Lluis Quintana-Murci, a population geneticist at the Pasteur Institute in Paris.

Genes involved in the body's first line of defense against pathogens are under strong evolutionary pressure not to change, Quintana-Murci and colleagues report in the Jan. 7 *American Journal of Human Genetics*. Some of the genes under the strongest pressure are Toll-like receptor genes *TLR1*, *TLR6* and *TLR10*. Mutations in those genes, which help detect pathogens and coordinate inflammatory responses, could lead to severe, life-threatening diseases, he says.

But there's a conundrum: In modern humans, these genes would have had to change to deal with new pathogens that humans encountered outside of Africa. It would have taken humans thousands of years to build up the right mutations. Interbreeding with Neandertals may have provided a shortcut to immunity without risking life-threatening mutations, Quintana-Murci surmises. Neandertals had been living with European pathogens for hundreds of thousands of years. The hominids gradually accumulated helpful tweaks that warded off the pathogens but didn't overreact and produce strong inflammation that could kill an infected person, he says. Those *TLR* genes were some of those most often inherited from Neandertals, the researchers found.

Computational biologist Janet Kelso of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and colleagues examined the same *TLR* genes. They report, also in the Jan. 7 *American Journal of Human Genetics*, that humans inherited at least three versions from extinct ancestors.

One Neandertal version of those genes, called core haplotype III, was found in all the non-African populations the researchers examined. It was also found in two people from northwest Gambia, but not in other Africans. A second Neandertal version, core haplotype IV, was also found in Asians. That result supports earlier work suggesting that Asians' ancestors interbred more than once with Neandertals. A Denisovan version of the genes, core haplotype VII, was found in two Southeast Asians.

Kelso's group took a closer look at what the ancient genes do for present-day people. The Neandertal versions don't change the *TLR* genes themselves, but change the genes' activity. The *TLR* genes are more active in people with Neandertal core haplotype III. Those people are less likely to get infected with the ulcer-causing *Helicobacter pylori* bacterium. But the advantage comes with a cost: These people are more prone to allergies.

"We can't really blame Neandertals for all the diseases we have," Capra said, but, on the whole, the ancient DNA probably isn't doing modern people much good. ■

M. DANNEMANN, A.M. ANDRÉS AND J. KELSO/*AMERICAN JOURNAL OF HUMAN GENETICS* 2016

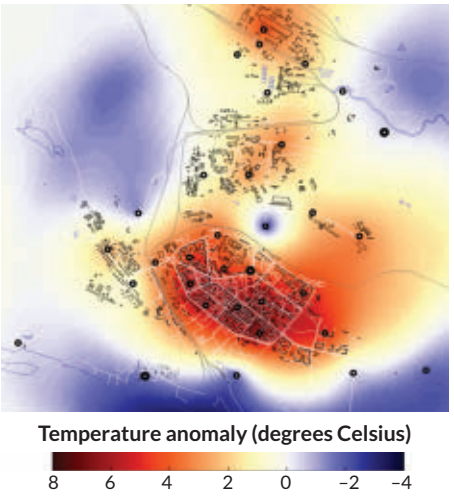
EARTH & ENVIRONMENT

Urban heat islands exist in the Arctic

TROMSØ, NORWAY — A novel form of the "urban heat island" effect might be important in the far north, where warming is faster than in the rest of the globe, a study of five Arctic cities finds.

Sunlight heats dense building materials. Later, buildings can release some solar energy. This helps explain why urban centers around the world tend to be warmer than nearby rural areas.

"We decided that our Russian Arctic cities should also show this phenomenon," says Mikhail Varentsov, a climatologist at Lomonosov Moscow State University. But indoor heating — not the sun — would be the major heat source, at least in winter, when the sun shines little if at all. To test that idea, Varentsov and colleagues set up weather stations in the five largest cities north of the Arctic Circle to collect data for about a week during the polar night (with 24 hours of darkness).



Heat up Even during the polar night, the center of Apatity, Russia, is warmer (red) than the city's outskirts. The town provides an example of the urban heat island effect in the Arctic.

Apatity, with a population of about 57,000, showed the strongest effect. Its city center was up to 10 degrees Celsius warmer than outlying areas. Murmansk, with over 300,000 residents, showed a smaller difference of about 3 degrees Celsius. Varentsov shared the findings January 28 at the Arctic Frontiers conference. — *Janet Raloff*

BODY & BRAIN

Cancer drug's effect against Alzheimer's debated

A preliminary report from scientists at the biotech company Amgen questions a cancer drug's ability to fight Alzheimer's disease. In tests described February 4 in *F1000Research*, bexarotene, a lymphoma drug, didn't reduce levels of the Alzheimer's-related amyloid-beta protein.

In work described in *Science* in 2012 (*SN: 3/10/12, p. 5*), neuroscientist Gary Landreth of Case Western Reserve University in Cleveland and colleagues showed that bexarotene clears A-beta from the brains of mice, reducing both the sticky plaques and smaller forms of the protein that circulate in the brain. The mice also showed signs of improved learning and memory. A year after that work appeared, four reports, also in *Science*, disputed some of those findings.

In tests on rats, Amgen scientists found that bexarotene did not drop levels of plaques or smaller forms of A-beta. The new study didn't describe behavioral tests. Landreth points out that Amgen's study, and previous experiments that failed to find a benefit, used a formulation of the drug that wouldn't persist at high enough levels in the brain to be useful.

"The controversy with the preclinical data is going to go away in the face of solid clinical trials," Landreth says. A small clinical trial published online January 29 in *Alzheimer's Research & Therapy* found that bexarotene reduced A-beta in the brains of people, but only in people without a particular version of the *ApoE* gene, a known risk factor for Alzheimer's.

Larger trials would be more informative, says Landreth, who stands by his group's findings. "When we published our *Science* paper, it took us five years and we did the best science we could," he says. "I am convinced that we are right." — *Laura Sanders*

MATH & TECHNOLOGY

Machine triumphs in strategy game

In a victory that rivals the computer Deep Blue's 1997 win over chess champion Garry Kasparov, a computer has now bested a professional human player in the classic strategy game Go.

The computer program, called AlphaGo, trounced Fan Hui, the reigning European Go champion, 5 games to 0, researchers report in the Jan. 28 *Nature*.

Go, a game that originated in China more than 2,500 years ago, is much more complicated than chess, with an order of magnitude more possible opening moves, study coauthor Demis Hassabis of Google DeepMind said at a news conference. Many researchers thought a computer wouldn't be able to beat a top human player for another five or 10 years, he said.

AlphaGo learned to play Go from experience. But the program needed much more practice than humans do to become an expert, Hassabis said: millions of games, rather than thousands.

In March, the program will put its skills to the ultimate test in a match against South Korean Lee Sedol, considered the world's best Go player. — *Meghan Rosen*

GENES & CELLS

DNA may determine if you're an early bird or night owl

Being a morning person could be in your genes.

Certain genetic variations occur more frequently in people who self-identify as having an early-to-bed, early-to-rise lifestyle, a study of DNA from about 89,000 people has found.

Researchers found 15 different spots in the genetic script that were likely to vary between morning people and evening people. Seven of these genetic swaps occurred near genes involved in regulating a person's daily cycles, or circadian rhythm.

Morning people, who were more likely to be female, were less likely than night people to have insomnia or sleep apnea. But such conditions didn't appear to be directly controlled by any of the genetic tweaks found in the study, published February 2 in *Nature Communications*. — *Sarah Schwartz*

M. VARENTSOV *ET AL*/LOMONOSOV MOSCOW STATE UNIV., RUSSIAN ACADEMY OF SCIENCES AND WORLD METEOROLOGICAL ORG.

Three outstanding optical instruments from Jomira. Our exclusive imports, our exclusive prices*

***But be sure to read this entire ad for our "Special Deal!"**

The spy glass that made naval history…

ADMIRAL FARRAGUT'S TELESCOPE

(with table top tripod) from us only $69.95
(Why pay more?) *

• The optics of Admiral Farragut's Telescope are 25x30. This means that you get 25x magnification and the great light-gathering capacity of a 30mm objective lens. The scope is fully chromed (over brass) for extra beauty, protection and durability. Admiral Farragut's Telescope comes with a vinyl belt-looped carry case and a table-top tripod for extended observations.

When Admiral Farragut ("Damn the torpedoes; full speed ahead!") fought his legendary naval battles he used a telescope just like this to monitor the movements of the enemies' fleets. This beautiful optical instrument, a faithful replica of the famous original (except that Admiral Farragut's was made of brass – ours is fully chromed over its pure brass body), is about 5" long in its collapsed position and 13" when extended to full operating length.

Enlargement is 25x, which means that it brings everything 25-times closer, and in needle-sharp focus, than if viewed with the unaided eye. Compare that to binoculars, which usually give you not more than 6x or perhaps 8x magnification. ADMIRAL FARRAGUT'S TELESCOPE comes with a belt-loop vinyl carrying case. There is also a table-top tripod for extended observations. This beautiful instrument is something you always wanted but thought you couldn't afford. It is a small luxury that you will really enjoy and that will give you wonderful service for many years. It is now available from us at a most affordable price.

The only universal optical instrument…

PANSCOPE

(the complete optical system) from us only $59.95 (Why pay more?) *

• PANSCOPE is beautifully gift-boxed, comes with its neatly fitted leather case and with a plastic "tripod" for extended observations at 15x and 30x.

This is a little optical marvel. PANSCOPE (only 2" long) contains a complete optical system in its tiny body. You may use it as a 3x telescope or as a unique 3x telescope-loupe. In its magnifying mode, it delivers magnifiers and loupes at 5x, 10x, and 15x enlargement. And to top it all, it also functions as a 30x microscope of laboratory quality.

A special stand for long-term observation for 15x and 30x microscope is included

This marvelous little instrument, developed in Wetzlar (Germany), home of famous Leica cameras, is the product of one of Asia's finest makers. Its coated optics are of superb quality, delivering the image with brilliant luminosity, in needle-sharp focus, with absolute clarity and with full chromatic correction. PANSCOPE is the indispensable first choice of scientists and professionals and of just about everybody who wants and needs to see the infinite detail in life that is not readily available to the unaided eye.

Hold the whole world in your hand with…

Jomirascope

8 x 20 monocular from us only $59.95 (Why pay more?) *

• The optics of jomirascope are 8x20 – 8x magnification with 20 mm objective lens. it comes in a neat zippered carrying case. The objective lens can be used as an 8x magnifier. A 25x microscope attachment ($29.95, 3 for $59.90) is also available.

Jomirascope is so small that it fits unobtrusively in a man's coat pocket or a lady's purse. Yet it packs a tremendous wallop in its tiny body. Its 8 x 20 fully prismatic and hard-coated optics give you 8x magnification, with a remarkable field of 366 ft. at 1,000 yds. Its 20 mm objective lens affords unusual light gathering even at dusk or dawn. What was that rustling in the bushes? With jomirascope you'll discover that it was an ivory-billed woodpecker. Do you wish to explore every feature on the moon, or (with some luck) discern the rings of Saturn? jomirascope will be your instrument of choice. Much smaller than even "pocket" binoculars and with greater magnification than most, jomirascope should be your constant companion, for enjoyment and exploration. You can use the objective lens of the jomirascope as an excellent 8x magnifier. And do consider the 25x microscope attachment of laboratory quality, which makes jomirascope a complete optical system.

jomira

330 SW 43rd St., Ste K333, Renton, WA 98057

*** And here is our "special deal": You may buy any three of these outstanding optical instruments (mixed or matched) for the price of two, only $119.90 — even the somewhat more expensive Telescope. (Note: Three Telescopes are $139.90)**

You may order by toll-free phone, by mail, and pay by check or AMEX/Visa/MasterCard. Please give order code shown. Add $6.95 for ship./ins. for one and $9.90 for three instruments - except one Adm. Farragut's Telescope is $9.90 and any three instruments containing Adm. Farragut's Telescope $12.95 - and sales tax for WA delivery. You have 30-day refund and one-year warranty. We do not refund postage. For customer service or wholesale information, please call (425) 264-6393.

We ship the same day we receive your order. Please give order code Z015!

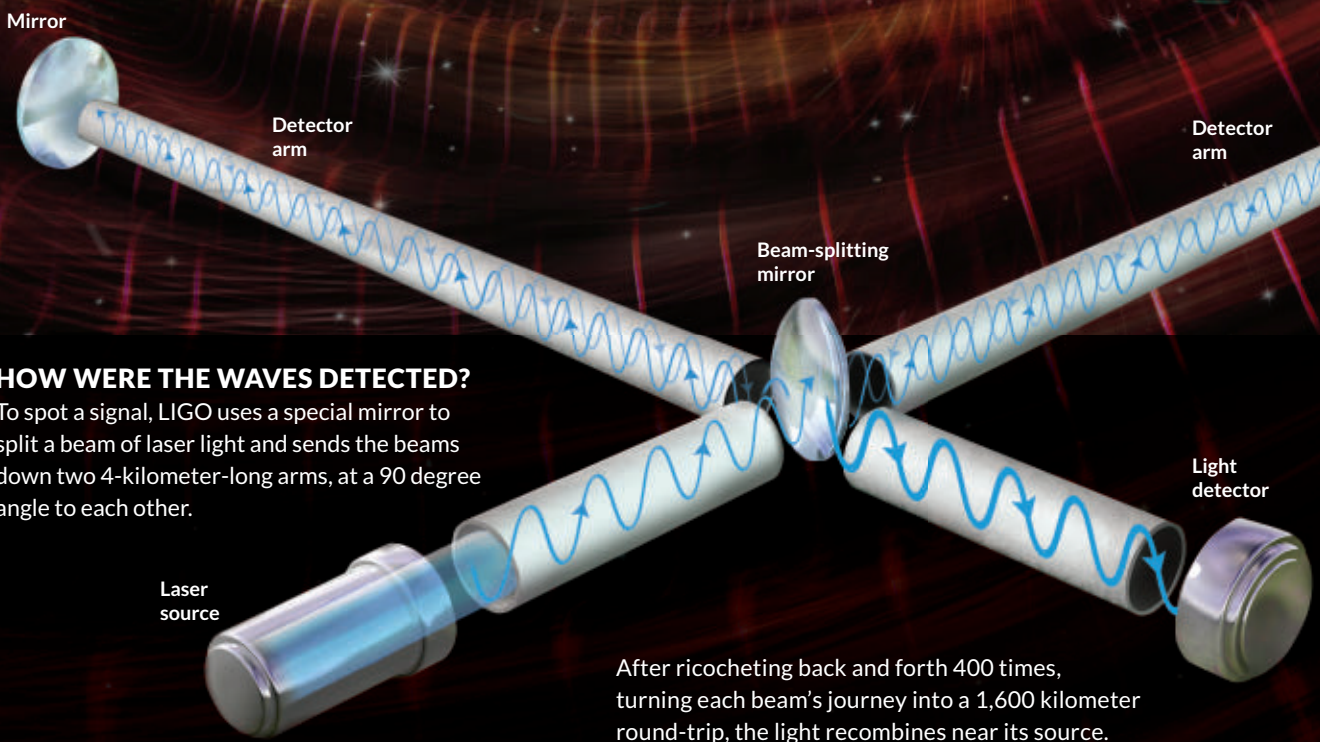
Order by toll-free phone: 1-800/600-2777
Visit our website at www.jomira.com

Cosmic shake-up

A century after Albert Einstein rewrote our understanding of space and time, physicists have confirmed one of the most elusive predictions of his general theory of relativity. In another galaxy, a billion or so light-years away, two black holes collided, shaking the fabric of spacetime. Here on Earth, two giant detectors on opposite sides of the United States quivered as gravitational waves washed over them. After decades trying to directly detect the waves, the recently upgraded Laser Interferometer Gravitational-Wave Observatory, now known as Advanced LIGO, appears to have succeeded, ushering in a new era of astronomy (see Page 6). — *Christopher Crockett*

WHAT ARE GRAVITATIONAL WAVES?

Colossal cosmic collisions and stellar explosions can rattle spacetime itself. General relativity predicts that ripples in the fabric of spacetime radiate energy away from such catastrophes. The ripples are subtle; by the time they reach Earth, some compress spacetime by as little as one ten-thousandth the width of a proton.



HOW WERE THE WAVES DETECTED?

To spot a signal, LIGO uses a special mirror to split a beam of laser light and sends the beams down two 4-kilometer-long arms, at a 90 degree angle to each other.

After ricocheting back and forth 400 times, turning each beam's journey into a 1,600 kilometer round-trip, the light recombines near its source.

NICOLLE RAGER FULLER

WHERE WERE THE WAVES DETECTED?

LIGO has one detector in Louisiana and another in Washington to ensure the wave is not a local phenomenon and to help identify its source.

WHAT ABOUT OTHER SOURCES?

By studying computer simulations of astrophysical phenomena, scientists can figure out what type of signals to expect from various gravitational wave sources.

Spinning neutron stars

A single spinning neutron star, the core left behind after a massive star explodes, can whip up spacetime at frequencies similar to those produced by colliding black holes.

Supernovas

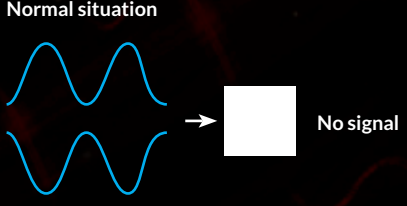
Powerful explosions known as supernovas, triggered when a massive star dies, can shake up space and blast the cosmos with a burst of high-frequency gravitational waves.

Supermassive black hole pairs

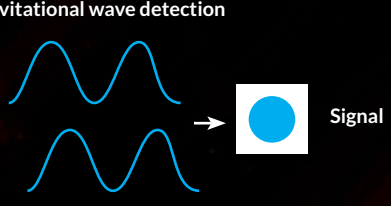
Pairs of gargantuan black holes, more than a million times as massive as the sun and larger than the ones Advanced LIGO detected, radiate long, undulating waves. Though Advanced LIGO can't detect waves at this frequency, scientists might spot them by looking for subtle variations in the steady beats of pulsars.

Big Bang

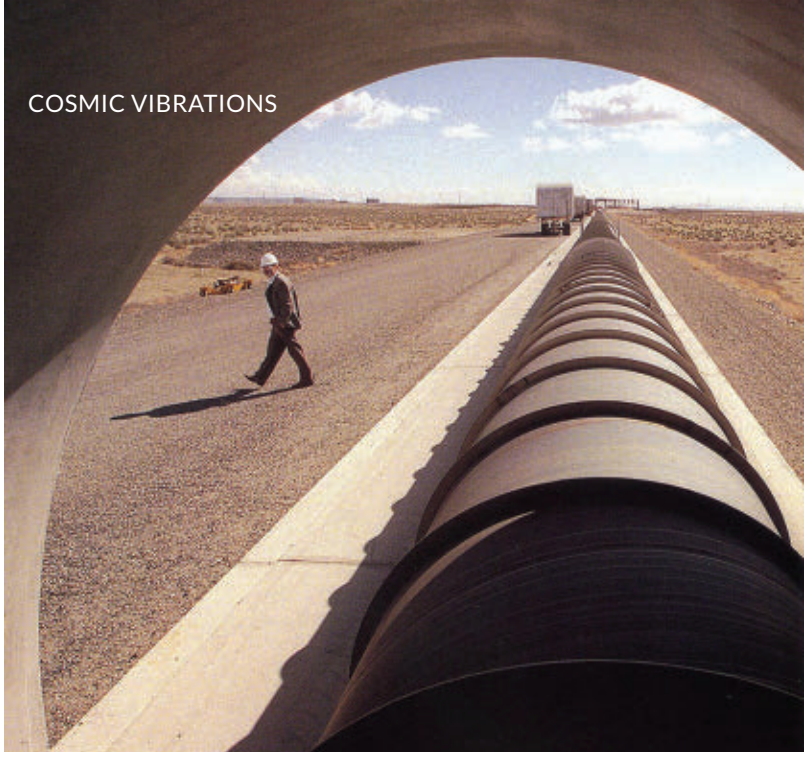
The Big Bang might have triggered universe-sized gravitational waves 13.8 billion years ago. These waves would have left an imprint on the first light released into the cosmos 380,000 years later, and could be seen today in the cosmic microwave background.



The experiment is designed so that, in normal conditions, the light waves cancel one another out when they recombine, sending no light signal to the nearby detector.



But a gravitational wave stretches one tube while squeezing the other, altering the distance the two beams travel relative to each other. Because of this difference in distance, the recombining waves are no longer perfectly aligned and therefore don't cancel out. The detector picks up a faint glow, signaling a passing wave.



Listening for GRAVITY WAVES

The long road to detecting rumbles in the fabric of spacetime

By Marcia Bartusiak

Two stainless steel tubes, 4 kilometers long, house laser beams and mirrors to detect waves from space at a LIGO site in Hanford, Wash.

BENJAMIN BENSCHNEIDER/*THE SEATTLE TIMES*

The January e-mail from Syracuse University physicist Peter Saulson caught me off guard. It probably shouldn't have, since I had been anticipating the news for 16 years, ever since I wrote *Einstein's Unfinished Symphony*. The book chronicled the astrophysical community's most cutting-edge start-up: gravity wave astronomy.

Saulson's message meant that Einstein's symphony is no longer "unfinished." A gravitational wave (gravity wave in common parlance), the historic prediction arising from Einstein's equations of general relativity, had never been detected directly. But now, thanks to two colliding black holes, that unfinished task was finally completed, after decades of blood, sweat and immeasurable frustrations. It took that long to get a gravity wave detector working. More than that, the discovery's announcement (see Page 6) was made almost exactly 100 years after Einstein wrote his first paper on gravity waves. "As if those black holes were waiting for that moment," Saulson says.

In papers published in the *Proceedings of the Royal Prussian Academy of Sciences* in 1916 and 1918, Einstein reasoned that just as electromagnetic radiation, such as radio waves, is generated when electric charges travel up and down an antenna, waves of gravitational radiation (what he called *gravitationswellen*) must also be produced when masses move about.

But these waves do not travel through space the way light does; they are literally quakes in spacetime's very framework. Detectable rumbles emanate from the most violent events the universe has to offer — such as the ferocious encounter of two massive black holes (recorded by two gravity wave observatories) merging in a fateful embrace about 1.3 billion years ago. Alternately stretching and squeezing space, the wave right at the clash of the black holes would have stretched a 6-foot man to 12 feet and within a millisecond, squeezed him to 3 feet, before stretching him out once again.

Einstein never imagined such outrageous sources for his waves. Given the relatively quiet nature of the universe assumed in the 1910s, he was picturing waves rippling outward as two stars simply orbited one another. And he and others knew that those spacetime ripples would be feeble, certainly too weak to bother looking for them. Others wondered if his *gravitationswellen* didn't exist at all and were rather just imaginary artifacts of the relativistic mathematics. General relativists argued back and forth over this issue for many years.

Hope and disappointment

But the stalemate shifted in the late 1950s, when a young University of Maryland physicist named Joseph Weber decided to build a gravity wave detector to settle the question. Experimental relativity was undergoing a renaissance at this time, and Weber had been encouraged by Princeton physicist John Archibald Wheeler, then the dean of American general relativity, to hunt for an actual wave.

For his design, Weber surrounded a solid,

water heater–sized cylinder of aluminum — a bar — with sensors, figuring that a passing wave would cause the bar to resonate like a bell. The sensors would convert the oscillations into electrical signals registered on a paper chart recorder. Two detectors separated by hundreds of miles, he reasoned, were needed to rule out local noises. In 1969, Weber grandly proclaimed at a relativity conference in Cincinnati that he had simultaneously recorded a signal on two bars, one on the Maryland campus, the other at Argonne National Laboratory near Chicago. Conferees greeted his announcement with applause (*SN: 6/21/69, p. 593*). The popular press heralded his find as the most important event in physics in half a century. "Many laymen will be startled, no doubt," reported the *New York Times*. A year later, Weber declared that the signal was emanating from the center of the Milky Way galaxy, possibly from a supernova going off or maybe from pulsars, the rapidly spinning neutron stars that had been recently discovered.

Soon other physics groups built their own detectors. They detected no waves whatsoever. Yet they didn't give up. By the 1980s, teams in various countries had constructed even bigger bar detectors to increase sensitivity. They adjusted the designs, encasing detectors in supercooled fluids to reduce thermal noise. But, again, no signals were recorded. While Weber is still credited with jump-starting the field, the lack of verification damaged his reputation, although he insisted until his death in 2000 that his detectors were recording waves. Today, physicists put the claim down to noise and believe Weber didn't fully understand the natural noises emanating within his bars.

But while the bar technology was maturing, a new gravity wave–detecting strategy surfaced — a method known as laser interferometry. Two researchers in the Soviet Union, Mikhail Gertsenshtein and V.I. Pustovoit, first published the idea in 1962, but no one outside their country became aware of it. Weber, too, briefly thought of the technique but never published. In 1966, Rainer Weiss at MIT also came up with the scheme independently — and in an offbeat way.

Bouncing lasers

Asked to teach a course on general relativity, Weiss, who worked on gravity as an experimentalist, not a theorist, scrambled. "I couldn't admit that I didn't know it. I was just one exercise ahead of my students," he said in 1999. Arriving at the topic of gravity waves, and wanting to understand them from a more hands-on perspective, he came up with a homework assignment. Imagine, he told his students, three masses suspended above the ground, their orientation forming an L shape. How would the distances between those masses change as a gravity wave passed by? He knew that a gravity wave compresses space in one direction (say, north-south), while expanding it in the other (east-west). A millisecond later, as the wave passes by, the effect reverses. By the time Weiss worked out the solution for himself, he knew that he had a darn good experiment in mind. Continually bounce laser beams between the masses, have the beams eventually recombine (optically "interfere" with one another) to measure the gravity wave shifts, and you have a detector! And it had one great advantage over the bars. Whereas bars could be tuned to only one frequency, laser interferometers could register a wider range of frequencies, increasing the chances of detecting a source.

By 1972, Weiss had written a landmark report for MIT's Research Laboratory of Electronics identifying all the fundamental sources of noise that could mask a signal in such a setup. The paper is still consulted today by gravity wave researchers. From that point on, Weiss devoted a large part of his career to getting a laser interferometer constructed and to finding the means to reduce those noises. There was extra incentive to do so: In 1974 radio astronomers Joseph Taylor and Russell Hulse, then at the University of Massachusetts Amherst, found a neutron star orbiting a dense companion, the two drawing closer and closer by about a few meters each year — just the change in distance physicists expect if the binary pair is losing orbital energy as gravity waves. Though the proof was indirect (and the waves themselves too weak to measure), it greatly encouraged the gravity wave astronomy community that sources would be available.

By the 1980s, Weiss joined forces with Caltech theorist Kip Thorne, the world's top expert on the physics of gravity waves, and Scottish experimentalist Ronald Drever, also at Caltech, to leapfrog the small, laboratory prototypes being built and erect two sizable

The 100-year wait Physicists' efforts to detect gravity waves paid off one century after Einstein predicted the waves existed.

1915 Einstein presents his general theory of relativity

1916 Einstein writes papers in the *Proceedings of the Royal Prussian Academy of Sciences* describing the possibility of gravity waves

Late 1950s Joseph Weber begins work on a gravity wave detector

1966 Rainer Weiss at MIT conceives laser interferometry method to detect gravity waves

1969 Weber (pictured in *Science News*) announces detection of a gravity wave (it was never confirmed)

1974 Joseph Taylor and Russell Hulse find a binary pulsar system later shown to be losing energy consistent with the emission of gravity waves

1992 National Science Foundation selects sites in Washington and Louisiana for the Laser Interferometer Gravitational-Wave Observatory, or LIGO

1994 Construction begins at the two LIGO sites

2001 LIGO begins operating

2008 Construction begins on Advanced LIGO

2010 LIGO ends operations; Advanced LIGO installation begins

September 2015 Advanced LIGO begins observations and detects a wave

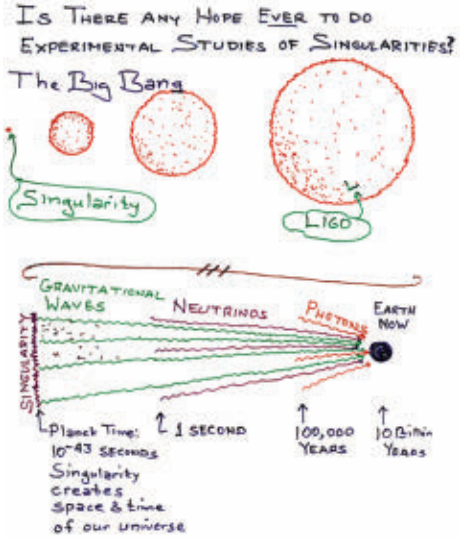
FROM TOP: SCIENCE NEWS ARCHIVES; LIGO; LIGO; NICOLLE RAGER FULLER

detectors with lengthy arms instead. A nearly simultaneous reception at a pair of detectors set far apart geographically would verify a wave passed through at the speed of light. Increasing the laser light's path in the arms would magnify the detector's sensitivity. Astrophysical sources, such as supernovas exploding or black holes colliding, generate ripples in spacetime that would be deadly near the event, but by the time those waves reach Earth, they would wiggle the interferometer masses less than the width of a proton. Kilometers-long arms would be needed to measure such subtle movements.

A feasibility study for this daring proposal (later dubbed the Laser Interferometer Gravitational-Wave Observatory) was completed in 1983. The report ultimately convinced the National Science Foundation (in particular NSF administrators Marcel Bardon and Richard Isaacson) to take a chance on going big. But so high was LIGO's estimated construction cost (it rose to nearly $300 million) that it was the first time that the NSF had to go to Congress to get approval for a project. When astronomers and physicists heard about the proposal, a few became very vocal, angered that the NSF was proposing to use precious funds on a gamble rather than a proven technology. As a result, the LIGO proposal went through innumerable ups and downs and was almost canceled more than once (*SN: 6/26/93, p. 408; SN: 1/8/00, p. 26*).

A crucial turning point occurred in 1992 when Caltech physicist Rochus Vogt, then the LIGO director, wrangled a meeting with Louisiana Sen. J. Bennett Johnston, who later

Kip Thorne (above) drew this sketch of gravity waves being emitted from the Big Bang for a 1999 lecture.



Joseph Weber, in 1969, working on his gravity wave detector at the University of Maryland in College Park.

became an ardent supporter of the project. Vogt originally had only 20 minutes, but his tales of cosmology so captivated Johnston that the senator canceled his next three appointments. For several hours, the two huddled over the senator's coffee table, while Vogt drew pictures of curved spacetime. Once again, Einstein's name worked magic. Congress eventually authorized funds to build two detectors, each with 4-kilometer-long arms: one situated in Livingston, La., the other 1,900 miles to the northwest in Hanford, Wash.

Ground was broken for those first-generation detectors in 1994. Both were up and running by 2001. Primarily a test bed to try out the novel technologies needed to find a gravity wave, the first LIGO wasn't expected to register any waves. But it still did its job. What LIGO collaborators learned from each detector's performance went into the design of innovative instrumentation, which was gradually installed over the last five years. This upgrade, called Advanced LIGO, led to an increased sensitivity that, bingo, found a gravity wave as soon as it began operation last fall.

Instruments around the globe are already joining LIGO's quest. A LIGO-like detector known as VIRGO, run by a European collaboration, has been operating on the vast alluvial plain outside Pisa, Italy, since 2007. (VIRGO was offline for instrumentation improvements when Advanced LIGO registered its first gravity wave.) A smaller interferometer named GEO600, with 600-meter-long arms, operates in Germany. Other detectors are under construction in Japan and planned for India.

But laser interferometers on Earth are limited in the frequencies they can register (roughly 10 to several thousand hertz), much the way an optical telescope cannot see radio waves or X-rays. To expand that range so gravity wave events from a variety of sources can be detected, gravity wave astronomers are

FROM TOP: SPECIAL COLLECTIONS/UNIV. OF MARYLAND LIBRARIES; CALTECH; K. THORNE/CALTECH

pursuing other methods as well. One clever scheme is based on well-studied astronomical objects — pulsars, the most exquisite timepieces in the universe due to the unvarying rhythm of beeps emitted by the rapidly spinning neutron stars (*SN: 10/17/15, p. 24*). By closely monitoring the pulses arriving from an array of particularly fast pulsars situated around the sky, astronomers are on the lookout for slight changes in the pulsing due to an extremely low-frequency gravity wave (10^{-9} to 10^{-6} hertz) passing between the pulsar and the earthbound detector. Supermassive black hole binaries would emit these tremendously long waves as they slowly orbit in the centers of merging galaxies. And ultimately, researchers hope to send laser interferometers into space. The European Space Agency is working on a proposal called the Evolved Laser Interferometer Space Antenna (*SN Online: 12/3/15*), which would enable the detection of weaker gravity waves.

A new astronomy

What the world is witnessing is the birth of a new astronomy. Detecting the ripples of those two black holes, uniting in the distant universe, is like Galileo's first peek at the heavens through a telescope in 1609. Galileo discovered moons orbiting Jupiter and jagged mountains and craters on the moon, amazing wonders to 17th century eyes. Now, gravity wave astronomy is poised to offer its own radically new visions.

Electromagnetic waves, be they visible light, radio, infrared or X-rays, are released by individual atoms and electrons. Such radiation reveals a celestial object's physical condition — how hot it is, how old it is, what it looks like and what it is made of. Gravity waves convey much different information. They will tell about the overall motions of massive objects, indicating how they move, twirl and collide throughout the universe, especially for objects that are too small to be seen directly, such as neutron stars and stellar black holes.

"We've now embarked on an era of exploring phenomena in the universe that are made from warped spacetime," Thorne says. "I like to call it the warped side of the universe." In due course, this new method of observing may be able to record the remnant rumble of the first nanosecond of creation, by gathering the residual gravity waves emitted by the awesome spacetime jolt of the Big Bang itself.

After more than four long and turbulent decades, Weiss has at last seen his experimental dream come true. Did he ever despair? "No," he says without hesitation today. "The reason you don't worry about the end result is this: The problems were interesting, you enjoyed the people you were working with, and it was fun to do!" Ever the experimentalist, Weiss, now 83, continues to travel to observatories, roll up his sleeves and check out the equipment.

He worked on the initial idea in the 1970s with just a few colleagues and students; today, more than 1,000 people are involved — LIGO/VIRGO collaborators at universities and institutes around the world advancing both the theory and the technology.

At the dedication of LIGO's Louisiana observatory in 1999, Rita Colwell, then director of the NSF, noted that those gathered were "breaking a bottle of champagne over the figurative bow of a modern-day galleon — a gravity wave observatory that may ultimately take us farther back in time than we've ever been." With their first signal, a crescendo that when converted to audio starts as a deep bass and heads toward middle C, LIGO scientists are beginning their journey, now able to listen for the myriad events that await detection.

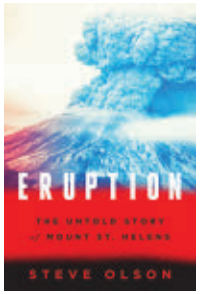
With that in mind, I take back what I said at the opening to this essay. Einstein's symphony will never be finished. ■

Marcia Bartusiak is a professor of science writing at MIT and the author of six books on astrophysics and the history of astronomy.

Global gravity wave detectors

A global quest
Gravity wave detectors are operating in the United States, Germany and Italy, with two more in the works in India and Japan. Researchers expect an expanded network to improve detection confidence and source localization accuracy.

M. TELFER



Eruption
Steve Olson
W.W. NORTON & CO., $27.95

BOOKSHELF

Mount St. Helens' rumblings fueled regional tensions

Early in the spring of 1980, immense and inexorable forces were roiling the Pacific Northwest. Oh, and one of the region's most active volcanoes was getting ready to blow its top.

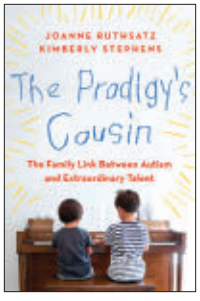
In *Eruption*, science writer Steve Olson goes well beyond recounting Mount St. Helens' geologic awakening, deadly explosion and aftermath. This fascinating book also chronicles the economic and cultural tensions gripping this part of the nation in the run-up to the May 18, 1980, catastrophe.

The eruption itself — which was more powerful than the 1906 San Francisco earthquake or even a small atomic bomb — removed about 400 meters of formerly tranquil mountaintop.

Earthquakes that rocked the peak in the weeks before the eruption exacerbated long-simmering tensions between environmentalists and the logging companies that wanted to extract as much timber as possible before the wood was lost to an eruption. The tremors also created short-term friction between the scientists and authorities who sought to protect the public from an impending, though fundamentally unpredictable, disaster and the locals and tourists who wanted to get to their homes and prime fishing spots near the volcano. Proposals to expand the restricted zones around Mount St. Helens were sitting on the governor's desk awaiting signature when the peak finally blew.

But the book's most gripping parts are the accounts of those who survived the eruption and the stories of those who were smothered by ash, crushed by falling trees or swept away by one of the largest landslides humans have ever seen. Fifty-seven people died during the eruption, a toll that would have been much higher had the blast not occurred on a Sunday, when logging crews had the day off.

In retrospect, Olson contends, it is clear that people had been allowed to get too close to a dangerous volcano. Scientists had been concerned about the kilometer-wide bulge that had grown on the north slopes of Mount St. Helens in the weeks before it erupted. Geologists had previously theorized — but had never before seen — a lateral blast of the scope seen when the peak blew out ash from its side. The oddly hummocky terrain left in the eruption's wake (*SN: 4/24/10, p. 18*) enabled scientists to recognize that similar eruptions have happened at other peaks worldwide — just one of the scientific legacies of Mount St. Helens. — *Sid Perkins*



The Prodigy's Cousin
Joanne Ruthsatz and Kimberly Stephens
CURRENT, $28

BOOKSHELF

Probing links between genius and autism

In 1998, Joanne Ruthsatz traveled to Louisiana to meet a 6-year-old musical genius. Ruthsatz, a graduate student at the time, hoped to evaluate the boy as part of her work "unearthing the inner workings of the prodigy mind." While taking a break from testing her subject, Ruthsatz met the boy's cousin — a nonverbal teenager with autism. She suddenly wondered: Could there be a link between one boy's talent and his relative's autism?

In *The Prodigy's Cousin*, Ruthsatz and her daughter, journalist and sociologist Kimberly Stephens, explore the scientific and anecdotal evidence that may help answer this question. The book centers on the stories of young savants that Ruthsatz, now a psychologist at Ohio State University, has encountered in her own work. The authors draw on the children's stories to explore the idea that certain similarities — for example, extraordinary memory and atypical empathy — link prodigy and autism.

Ruthsatz and Stephens survey the history of autism and prodigy, occasionally mulling over the notes of geneticists, neuroscientists and autism researchers such as Hans Asperger. However provocative, the data linking the two conditions are sparse, muddled or baffling. For instance, preliminary data suggesting a genetic link between prodigy and autism need to be replicated, the authors say. However, if these tantalizing hints hold up, they argue, studies of child prodigies could help shed light on autism and provide a potential Rosetta stone for a baffling, diverse disorder that is difficult to define and treat.

Yet more than diagnoses or data, *The Prodigy's Cousin* is about people. There's Jourdan, who displayed perfect pitch before his second birthday and interned at Cold Spring Harbor Laboratory by age 9. Another prodigy, Autumn, taught herself to paint before first grade and gave her first solo art exhibition at 10. And Jacob participated in an astronomy lecture at age 3 — the same year he was diagnosed with autism — and enrolled as an official college student at 11.

Whether or not their lives inform new clinical understandings, the stories of these extraordinary young achievers, growing up with unique gifts and challenges, deliver a fascinating look at the humanity behind the world of brilliant, unusual minds. — *Sarah Schwartz*

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

Science News for Students

***Science News for Students* (sciencenewsforstudents.org)** is an award-winning, free, online magazine that reports daily on research and new developments across the science disciplines to inquiring minds of every age—from middle school on up.

Olive oil untangles plastic

Chefs often add olive oil to spaghetti. Now a study finds that olive oil and other vegetable oils can also help make one type of fiber—essentially plastic spaghetti—super-strong. Researchers stumbled onto using the oils on plastic while trying to develop a better type of wax for skis. And those oils can not only keep those fibers from getting tangled, but are also safer and better for the environment than the solvents normally used for this purpose. The new oil-treated fibers could find a use in products such as bulletproof fabrics or ropes that anchor offshore oil rigs. — *Kathiann Kowalski*

Read more: **student.societyforscience.org/oil-plastic**

The truth about zits

Rumors abound about what causes or prevents acne. Some people blame outbreaks on diets rich in dairy products or on sloppy personal hygiene. The truth is more complicated. Teens could cut out all milk and cheese and wash their faces twice a day, yet still break out. Bacteria play a major role in pimply breakouts. And here's the big irony: The same bacteria species that can trigger outbreaks can also, in some circumstances, quash them. Some researchers are now looking at one day treating acne by applying those *Propionibacterium acnes* germs. — *Kathryn Hulick*

Read more: **student.societyforscience.org/zits**

An alarm system for Earth crashers

The term "killer asteroid" might bring to mind the kind of massive space rock that wiped out the dinosaurs millions of years ago. Yet an asteroid just 45 meters (50 yards) wide could destroy a city. (Chelyabinsk asteroid trail pictured, left.) Fortunately, the first in a new two-telescope system in Hawaii has just begun scanning the skies for such "city-killers." And what it finds might give people a life-saving warning of their approach. "I've been quite surprised at how much the other surveys were missing," says Ari Heinze of the University of Hawaii. The new system has already spotted space rocks that had until now slipped through the cracks. — *Ilima Loomis*

Read more: **student.societyforscience.org/asteroid-alarm**

JANUARY 9, 2016

SOCIAL MEDIA

Penguin face

The photo that accompanied a story about why gentoo penguins don't freeze (*SN: 1/9/16, p. 5*) got nearly as much social media attention as the story itself. Researchers found that tiny grooves and an oily sheath force water out of the feathers, but it was the eye-to-eye look at the penguin that delighted some readers — and frightened others.

It actually looks a bit like thunderbird 2
@StephenLJeffery

Looks like a USAF C5 Galaxy transporter design.
@nthnycwn

Yes but as slippery as he is, he looks mad! Id stand a safe distance!
@StacyPegram

Join the conversation

E-MAIL editors@sciencenews.org

MAIL Attn: Feedback
1719 N St., NW
Washington, DC 20036

Connect with us

Spiders sing the blues

Tarantulas evolved a blue hue at least eight times, but scientists aren't yet sure what purpose the coloration serves, ***Susan Milius*** *wrote in "Tarantula blue is no accident"* (SN: 1/9/16, p. 4)*. In the article, spider researcher* ***Bor-Kai Hsiung*** *wonders if, for example, the blue might scare away predators or attract insects.* More than one reader wanted to know whether tarantulas are diurnal, a clue that might help researchers narrow in on the significance of the coloration. In a paper reporting their findings, **Hsiung** and his colleagues wrote that tarantulas are "largely nocturnal ambush predators that reside in burrows," further deepening the puzzle of how color could be helpful, says **Milius**.

Ann Ony Mus compared the puzzle of tarantula blue to the more famous conundrum of whether scorpions get any benefit from glowing under ultraviolet light. That trait, though widespread among scorpions, is often dismissed as having no function of its own, but instead being a side effect of some other trait. There is, as she said, "No apparent advantage to it that we can discern at this time."

Hsiung and colleagues argue against dismissing tarantula blue as a useless side effect. A satisfying dismissal, they say, would have to explain how the different structures in hairs in different tarantula species, which appear to have independent origins, converged on rather similar shades of blue.

Energetic tricks

Physicists at Harvard have measured quantum entanglement among several atoms, not just two. As part of the experiment, the researchers cooled the atoms to nearly absolute zero. "As the atoms jumped around, they interacted and established a state of entanglement," wrote ***Andrew Grant*** *in "Multiparticle entanglement quantified"* (SN: 1/9/16, p. 9)*.*
Jack LaValley wondered how atoms cooled so close to absolute zero could jump. "An observation of atoms jumping around at that temperature threatens my basic understanding of the behavior of matter in the absence of heat," **LaValley** wrote.

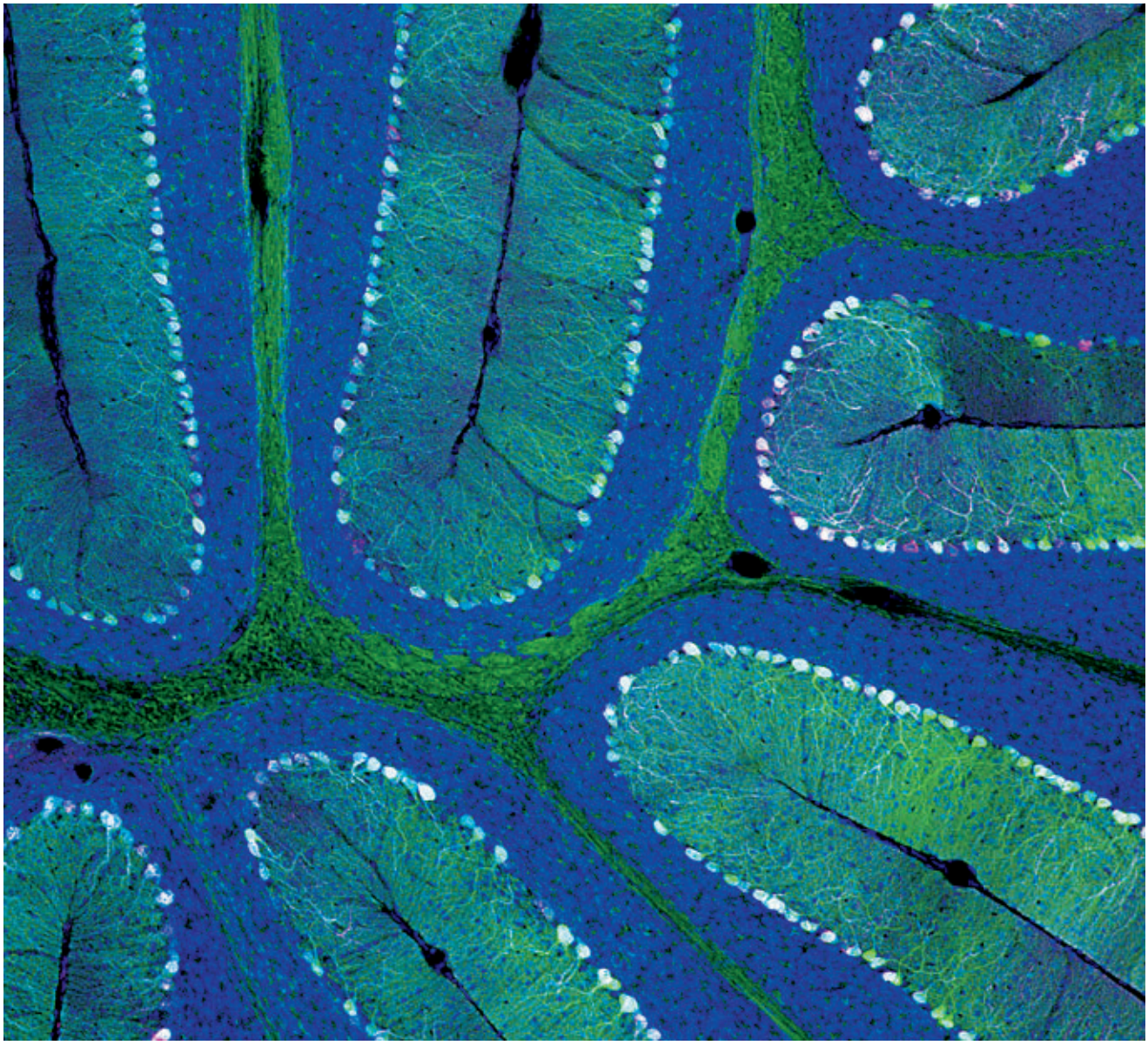
Atoms have their ways, says **Grant**. Even when cooled to fractions of a kelvin, atoms still have some energy of motion. They can also employ the trick of quantum tunneling. The optical cage in the experiment presented a barrier, requiring atoms to spend a certain amount of energy to hop over into a neighboring compartment. But occasionally the atoms crossed through the barrier, essentially burrowing through, without paying the full energetic price. This doesn't happen in everyday life (wouldn't it be great if we could pass through walls rather than climbing over them?), but quantum physics permits it.

Poetry of devastation

Scientists are studying the science behind avalanches in an effort to better understand their immense power and perhaps predict them, ***Alexandra Witze*** *wrote in the cover story "White out"* (SN: 1/9/16, p. 16)*.* Readers agreed that this is important work. **John Turner** wrote that it would also be "fascinating to compare avalanches on Earth's ice and snow fields to avalanches on icy moons and dwarf planets." But perhaps the most poetic commentary came from Twitter user **@topherutech**, who shared this bit of "modern haiku":
snow heavy,
gravity sucks,
avalanche.

Correction

In Alan Boyle's recent story on nuclear fusion approaches by private-sector start-ups (*SN: 2/6/16, p. 18*), some points about Tri Alpha Energy's approach were incorrect. Rather than a type of magnetic hybrid fusion, Tri Alpha considers its approach a form of magnetic confinement fusion. The company expects to reach temperatures that are a few times higher, not 10 times higher, than previous efforts. It expects to take the first steps toward commercialization in a decade, rather than having a complete product on the market.

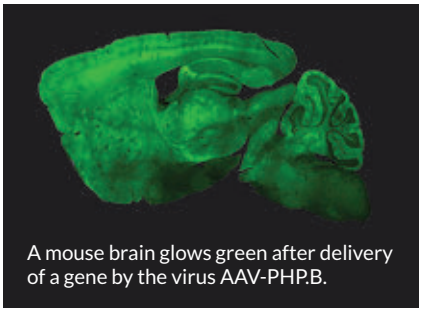


Sneaky virus delivers the goods to brain cells

In a multivirus competition, a newcomer came out on top for its ability to transport genetic cargo to a mouse's brain cells. The engineered virus AAV-PHP.B was best at delivering a gene that instructed Purkinje cells, the dots in the micrograph above, to take on a whitish glow. Unaffected surrounding cells in the mouse cerebellum look blue. Cargo carried by viruses like AAV-PHP.B could one day replace faulty genes in the brains of people.

AAV-PHP.B beat out other viruses including a similar one called AAV9, which is already used to get genes into the brains of mice. Genes delivered by AAV-PHP.B also showed up in the spinal cord, retina and elsewhere in the body, Benjamin Deverman of Caltech and colleagues report in the February *Nature Biotechnology*.

Similar competitions could uncover viruses with the ability to deliver genes to specific types of cells, the researchers write. Selective viruses that can also get into the brain would enable deeper studies of the brain and might improve gene therapy techniques in people. — *Laura Sanders*



A mouse brain glows green after delivery of a gene by the virus AAV-PHP.B.

BOTH: B. DEVERMAN AND THE GRADINARU LABORATORY/CALTECH

Introducing ***The new and revolutionary*** **Jacuzzi® Hydrotherapy Shower.**

AGING = PAIN

For many, arthritis and spinal disc degeneration are the most common source of pain, along with hips, knees, shoulders and the neck. In designing the Jacuzzi Hydrotherapy Shower, we worked with expert physicians to maximize its pain relieving therapy by utilizing the correct level of water pressure to provide gentle yet effective hydrotherapy.

JACUZZI® SHOWER = RELIEF

Four Jacuzzi® ShowerPro™ Jets focus on the neck, back, hips, knees and may help ease the pain and discomfort of:

- Arthritis
- Circulation Issues
- Aches and pains
- Neuropathy
- Sciatica
- Inflammation

The Jacuzzi® Hydrotherapy Shower provides a lifetime of comfort and relief… safely and affordably.

As we age, the occasional aches and pains of everyday life become less and less occasional. Most of us are bothered by sore muscles, creaky joints and general fatigue as we go through the day- and it's made worse by everything from exertion and stress to arthritis and a number of other ailments. Sure, there are pills and creams that claim to provide comfort, but there is only one 100% natural way to feel better… hydrotherapy. Now, the world leader in hydrotherapy has invented the only shower that features Jacuzzi® Jets. It's called the Jacuzzi® Hydrotherapy Shower, and it can truly change your life.

For over 50 years, the Jacuzzi® Design Engineers have worked to bring the powerful benefits of soothing hydrotherapy into millions of homes. Now, they've created a system that can fit in the space of your existing bathtub or shower and give you a lifetime of enjoyment, comfort and pain-relief. They've thought of everything. From the high-gloss acrylic surface, slip-resistant flooring, a hand-held shower wand, a comfortable and adjustable seat, to strategically-placed grab bars and lots of storage, this shower has it all.

Why wait to experience the Jacuzzi® Hydrotherapy Shower? Call now… it's the first step in getting relief from those aches and pains.

Call toll free now to get your FREE special report "Tips on Living to be 100"

Mention promotional code 102552.

1-888-804-7179

Jacuzzi.

82028

The incredible *Five-Star Opal Anniversary Ring* fulfills one of our long-held commitments, and celebrates yours.

1.5 total carats of genuine Ethiopian opal for under $100! PLUS, FREE matching earrings!

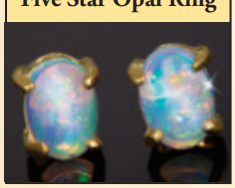
Add Some Wow to Your Vows

Put a rainbow on her finger with the opal that's taking the jewelry industry by storm.

Long ago, we made a vow: We would not produce a five-opal anniversary ring until two very specific conditions were met. First, the opals had to be of superior quality, with the joyous iridescence to delight all who saw the precious stone's colors dance in the light. Second, the price had to be right, so that we could provide the value Stauer clients expect from us. So when The New York Times style section called Ethiopian opal the "undisputed winner" of the 2014 Gem Show, we decided to pounce. The result is the astoundingly beautiful ***Five-Star Opal Anniversary Ring***.

All five of these exotic beauties possess the radiant rainbow of color we've been looking for. Arranged in a sterling silver setting finished in lustrous gold, this ring is a beautiful tribute to your lasting love.

EXCLUSIVE FREE
Five Star Opal Stud Earrings
-a $199 value-
with purchase of Five Star Opal Ring



So how about our price promise? We met that too. We want you to know there is absolutely no reason to overpay for luxury gemstones. The big name jewelers have been deceiving the public long enough, charging as much as $16,000 for an Ethiopian opal ring. We won't trump up the price to make you think it's luxurious. This ring is just as luxurious (if not more) than the big designer name rings, AND it's yours for **under $100**. I think it's safe to say we more than met our price promise. We exceeded it... by about 16,000%!

"Opal's spectacular play-of-color can display all the colors of the rainbow."
— Gemological Institute of America

"The play of color in opals is so gorgeous they sometimes don't even seem real and yet they are." — from 2015 Couture Show

Your satisfaction is 100% guaranteed. Slip this rainbow on her finger. If she's not absolutely delighted simply send it back within 60 days for a complete refund of the sale price. The stud earrings are yours to keep. See if your jewelry store can match that!

The *Five-Star Opal Ring* is one of Stauer's fastest sellers. Supplies are limited. We can't seem to keep this ring in stock. Don't miss this rare opportunity. **Plus, call today and receive the matching opal stud earrings FREE!** You'll want to catch this radiant rainbow before it's gone!

Five-Star Opal Anniversary Ring ~~$399~~*
Offer Code Price *Only* **$99** + **S&P** *Save $300!*
***Plus,* FREE opal stud earrings,** a $199 value
You must use the insider offer code to get our special sale price.

1-800-333-2045

Your Insider Offer Code: OAR102-01
Please use this code when you order to receive your discount.

Stauer®
14101 Southcross Drive W., Dept. OAR102-01,
Burnsville, Minnesota 55337 **www.stauer.com**

BBB ACCREDITED BUSINESS **Rating of A+**

CONSUMER AFFAIRS ACCREDITED

** Special price only for customers using the offer code versus the price on Stauer.com without your offer code.*

1.5 ctw Ethiopian opal • Gold-finished .925 sterling silver setting • Whole ring sizes 5–10

Smart Luxuries—Surprising Prices™