



The canal would skirt the southern edge of Ometepe, an island formed by two volcanoes in Lake Nicaragua.

# Proposed Nicaragua Canal Cuts Deep Divide

→ A century ago, Panama beat out Nicaragua to snag one of the biggest engineering projects of the age: a U.S.-backed canal that would link the Atlantic and Pacific oceans, creating a shorter trade route between East and West. In 2014 — the 100th anniversary of the Panama Canal’s completion — Nicaragua made plans for its own interoceanic linkage, which would be triple the length of Panama’s. If completed, the project could break Panama’s long-standing monopoly on the shipping trade in the region — but at a severe ecological price.

The 175-mile-long canal, which was set to break ground in December, would cut a 1,700-foot-wide swath through two nature reserves, home to rare cloud forests and several endangered species of amphibians, birds and mammals. Designed to serve modern ships with larger hulls, the 90-foot-deep canal also would require dredging 65 miles across Lake Nicaragua, Central America’s largest lake and a key source of drinking water.

“In the scientific community, we’re quite worried,” says biologist Jorge Huete-Pérez of the Central American University in Managua. In February, after Nicaragua announced that it would fast-track legislation in support of the project, Huete-Pérez co-authored a letter in the journal *Nature*. He warned that the canal, proposed by the Hong Kong Nicaragua Development Group (HKND), would disturb almost 1 million acres of rainforest and wetlands, and he urged the government to commission an independent environmental analysis of the project.

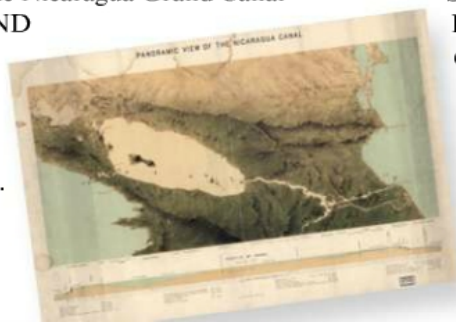
Instead, a spokesman for the Nicaragua Grand Canal Commission announced HKND would publish its own environmental assessment in



November. With the company scheduled to break ground just a month later, the document’s timing left little time for public review, critics protested.

HKND says it has hired environmental consultants to offset the canal’s impact by restoring nearby degraded areas. Huete-Pérez is not reassured. “The logic of causing damage in the protected areas . . . to later compensate with reforestation is totally mistaken and has been amply refuted by the international scientific community,” he says.

Even if the \$50 billion project overcomes environmental protests, it must still contend with the challenges of Nicaragua’s geology. The U.S. passed over Nicaragua when siting its 1914 canal because of its volcanic and seismic activity. Those geologic uncertainties remain a concern, says hydrologist Bob Stallard of the Smithsonian Tropical Research Institute in Panama City. And the new risk of climate change, which is fueling more intense hurricanes and severe droughts, could mean less than smooth sailing for ships navigating the waterway. — LUCAS LAURSEN

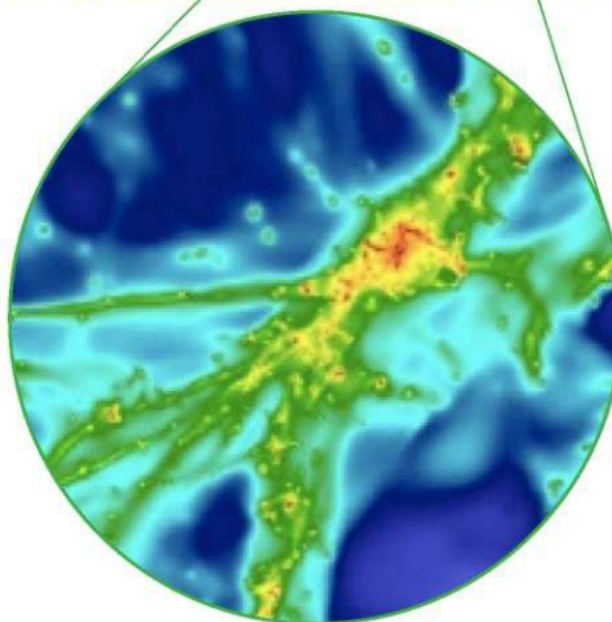
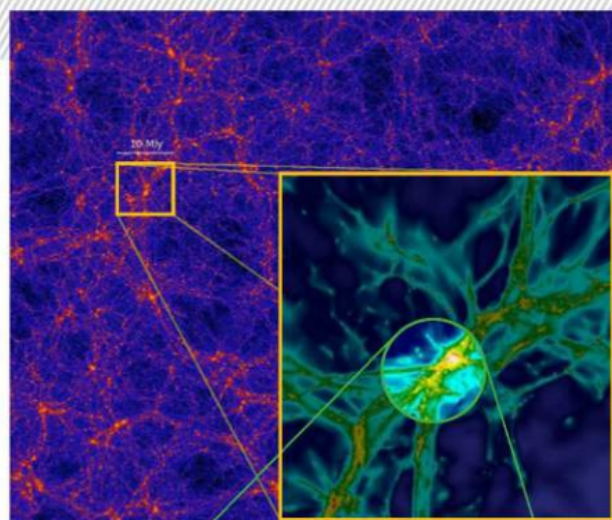


This 1870 map shows the route of an earlier Nicaragua Canal proposal.

FROM TOP: GUIZIOU FRANCK/HEMIS/CORBIS; ROEN KELLY/DISCOVER; BUYENLARGE/GETTY IMAGES

## Quasar Illuminates Cosmic Web

→ Observations suggest invisible dark matter spans the universe, underpinning its entire structure. The gravitationally sticky stuff catches galaxies and causes gases to adhere to filaments, which stretch between the star clusters in a giant cosmic web. Astronomers in California and Germany studying quasar UM287 spotted an enormous strand of nebulous gas illuminated by the quasar's light, like an attic window lighting up otherwise unseen cobwebs. At about 2 million light-years long, the gas is thought to give form to one of the filaments of this cosmic web, the first time scientists have seen it. In this simulation, which accompanied the January study, the brighter colors in the upper left image show higher concentrations of dark matter. The inset shows the quasar's spotlight on the cosmic web, with darker blue representing the lowest density of gas and red representing the highest density. —BILL ANDREWS



## HIV Resurfaces in 'Mississippi Baby'

→ It seemed too good to be true — and it was. A baby born in Mississippi in 2010 to an HIV-positive mom was able to fight off the virus without medication. She had been given a short course of intense anti-retroviral medication at birth, followed by 18 months of continuous



treatment. Then, for more than two years, she received no HIV medication. At age 3, when *Discover* featured the case in last year's Year in Science issue, the child remained infection-free. But doctors announced in July that the "Mississippi baby" showed detectable levels of the virus once again.

Doctors discovered the virus had returned when the child came in for routine blood work. Now the 4-year-old is back on anti-retroviral therapy. She is showing signs of improvement, says Hannah Gay, a physician treating the child at the University of Mississippi Medical Center. The girl's care team will watch for changes and plans to conduct more tests to find out why the virus suddenly reappeared. Meanwhile, a related federally funded trial, which aimed to replicate results in infected newborns, has been put on hold.

—LACY SCHLEY

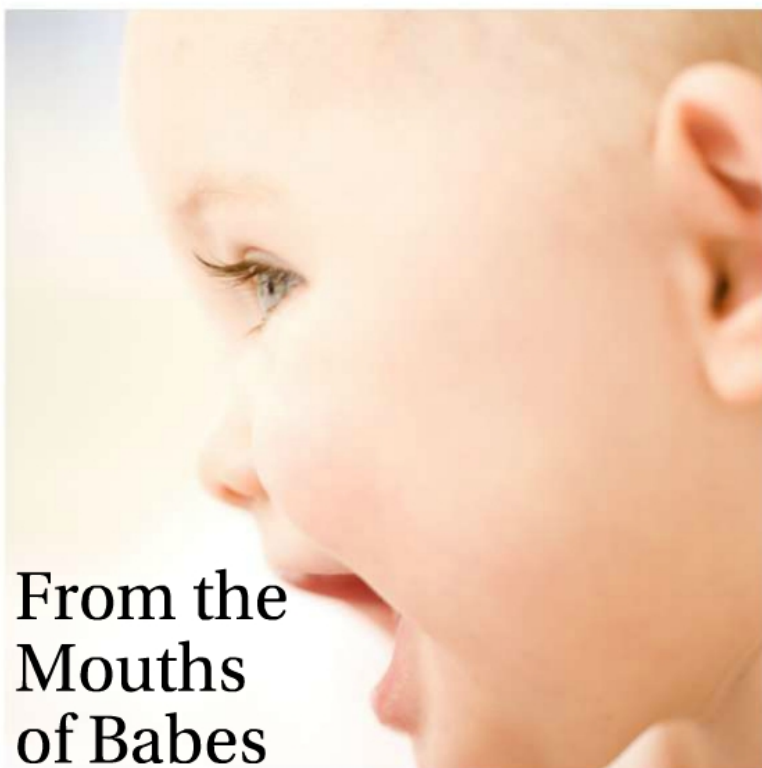
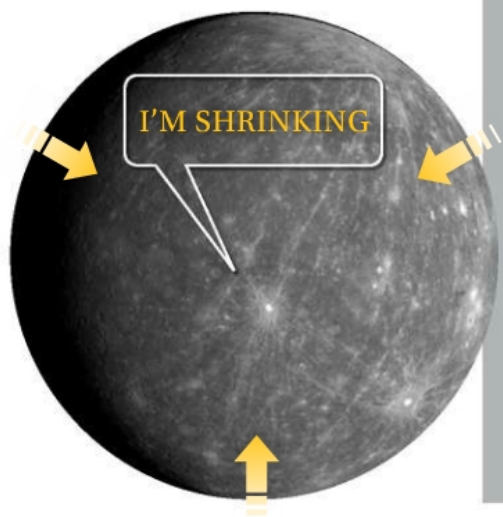
Physician Hannah Gay will help oversee the 4-year-old girl's treatment at the University of Mississippi Medical Center.

## The Smallest Planet Gets Smaller

→ Scientists know from watching its surface activity that Mercury has shrunk over its 4.5 billion-year history. For decades, though, the question has been by how much. Observations from 1970s-era data suggested a shrinkage of 1 to 2 kilometers in radius throughout Mercury's history, while newer thermal models showed a more significant change over that time, about 5 to 10 kilometers.

Enter NASA's MESSENGER spacecraft, which produced a comprehensive survey of the smallest planet's surface features. The Carnegie Institution's Paul Byrne and his team used this planet-wide coverage to determine in March that Mercury's radius has shrunk between 4 and 7 kilometers over the past 4.5 billion years. "We were looking at this independently," says Byrne, "but it happened to be that the value we got is pretty much what the models had been saying all along."

Knowing the thermal models are spot-on is good news for planetary scientists working to understand Mercury's remaining secrets. "Now that we can show that the models are more robust than we had thought," Byrne says, "we can start looking at what the models are telling us about the interior of the planet, which we can't otherwise get." — KARRI FERRON



## From the Mouths of Babes

→ How does a babbling baby become a talking tyke? In June, researchers found part of the answer. Toward the end of the first year of life, they discovered, two brain areas begin coordinating to help babies figure out speech.

Until 6 or 7 months of age, babies can easily distinguish vowels and consonants from all languages. But by about 11 or 12 months, they've homed in on their native language — the one they've heard most — and started ignoring foreign sounds. Baby's first word follows soon after.

To learn how this transition into speech occurs in the brain, the University of Washington's Patricia Kuhl played babies in both age ranges separate recordings of their native tongue and a foreign one while measuring their brain activity.

When 7-month-olds heard either language, they showed similar activity levels in both the auditory system, which perceives sounds, and the motor system, which is involved in mimicking sounds. But 11- and 12-month-olds showed more activity in their auditory systems when they heard their native language. When they heard foreign words, on the other hand, it was their motor systems that lit up on the brain scan, indicating they had to work harder to imitate them.

According to Kuhl, these brain patterns show that once babies reach their first birthday, they not only pay closer attention to native words, they also prepare to start uttering them. At that age, the auditory system and motor system work together to set the stage for speech, Kuhl says.

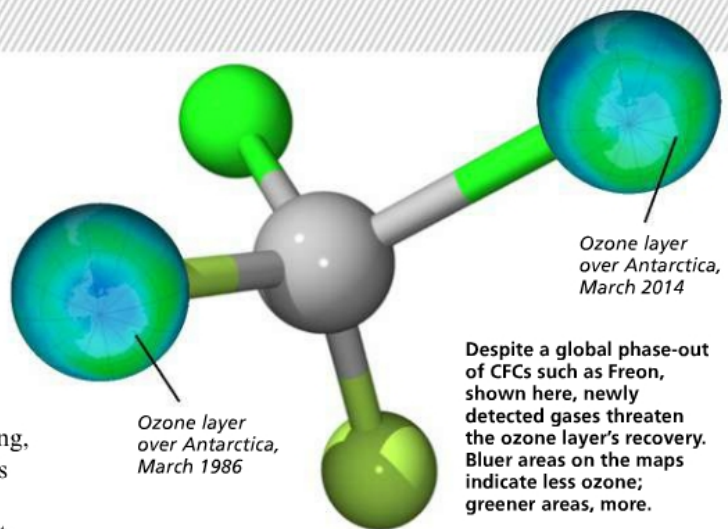
Baby talk is an important part of that process, she adds. "The idea that a young child at 12 months can hear you say something and then know what to do to replicate that signal with their own mouths is remarkable," Kuhl says. — LACY SCHLEY

## 7 New Gases Deal Damage to Ozone Layer

→ The recovery of Earth's protective ozone layer has been hailed as an environmental success story. But the celebration may have been premature: Last spring, scientists discovered new ozone-destroying gases in the atmosphere.

The U.N.'s 1987 Montreal Protocol phased out almost all of the offending gases, and the ozone hole began to shrink. But in March, researchers with England's University of East Anglia reported finding four new ozone-depleting compounds in the atmosphere — three chlorofluorocarbons (CFCs) and one hydrochlorofluorocarbon (HCFC) — amounting to about 81,000 tons. In June, they found three more — two CFCs and one HCFC — bringing the total to seven.

And more could be discovered, says Johannes



Despite a global phase-out of CFCs such as Freon, shown here, newly detected gases threaten the ozone layer's recovery. Bluer areas on the maps indicate less ozone; greener areas, more.

Laube, a co-author of the studies. "It could reverse the recovery trend," he says.

The emissions may have come from the production of insecticides, refrigerants or solvents, he says, either under the treaty's exemptions or through illegal use.

Overall levels of ozone-harming gases are still lower than before the ban, but since some disintegrate slowly, they'll continue destroying ozone for decades to come, Laube says. — JENNIFER DRAPER

### 2014 World Debut: New Species Series



**Kamikaze Coitus**

### 2014 World Debut: New Species Series

#### *Antechinus arktos*

**Type of animal:** Mouse-like marsupial

**Description:** Fur ranging from grayish-brown at head to orange-brown at rump; yellow markings around eyes; distinctive black tail

**Home:** Southeast Queensland, Australia

**Fun fact:** Finding a new mammal species is rare; finding one that kills itself through ardent and repeated sexual encounters is even more rare. *A. arktos* follows the mating patterns of others in its genus, copulating for up to 14 hours at a time and with multiple partners in order to ensure the survival of its lineage. Yet these fervent sexual escapades take their toll: Males' stress hormone levels increase dramatically during the weeks-long mating season, eventually causing their bodies to shut down completely. What a way to go. — BRENDA POPPY





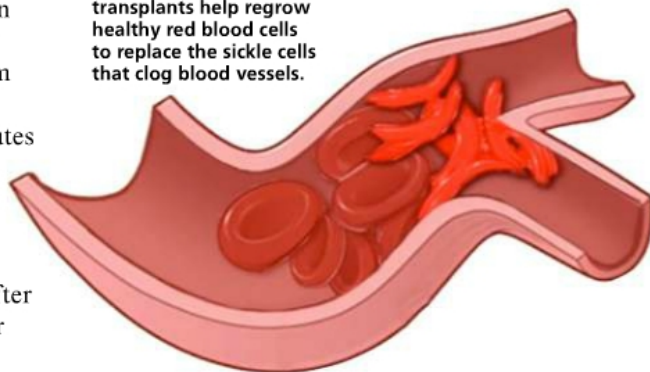
# Sickle Cell Anemia Patients Get a Partial Reprieve

➔ In sickle cell anemia, a single genetic mutation leads to abnormal, crescent-shaped red blood cells that clot in tiny blood vessels throughout the body, causing severe pain and eventual organ damage. The most common treatment is almost as debilitating: high-dose radiation therapy to remove the bone marrow that produces the abnormal cells, then a full bone-marrow transplant and a daily regimen of immunosuppressant drugs to keep the body from rejecting the transplanted marrow.

But in July, John Tisdale of the National Institutes of Health and his team reported that 26 of 30 adult sickle cell patients recovered after a far less grueling treatment: low-dose radiation, a partial bone-marrow transplant and an antibody to prevent immune attacks on the new marrow. After a few patients serendipitously stopped taking their

meds, they remained healthy. The researchers then replicated those results in 15 patients. If larger studies pan out, adult patients will be one step closer to living a pain- and drug-free life. —LACY SCHLEY

**Partial bone-marrow transplants help regrow healthy red blood cells to replace the sickle cells that clog blood vessels.**





## Plotting the Pattern of Emotion

→ Rock legend Tom Petty famously crooned that we just don't know how it feels to be him. Well, he might be wrong.

In June, neuroscientist Adam Anderson's team at Cornell University demonstrated that, though our feelings may seem unique, our brains process them using a similar pattern of brain cell, or neuron, activation — meaning we feel feelings the same way. To find that pattern, researchers monitored 16 participants' brain activity while presenting them with images and tastes; subjects then rated their

feelings about each.

The team saw that when participants reported similar feelings, their brain cells fired in a similar sequence. Specifically, when more neurons fired in one direction along the sequence, participants reported positive feelings; when more neurons fired in the other direction, they reported negative feelings. Looking at a beautiful sunset or sipping a favorite cocktail, for example, evoked the same firing in the “positive” direction in each person.

This pattern of activity runs through vision- and taste-

processing brain regions, indicating our subjective feelings are actually intertwined with perception. That is, our sensations are preloaded with emotions. According to Anderson, that upends the traditional belief that the brain perceives feelings first and then processes them in its emotional centers. Instead, seeing and feeling both happen at the same time.

Experts hope next to understand how this sequence differs in individuals with mental disorders, potentially leading to better treatment. — CARL ENGELKING



## Insect Lends Us Its Ears

Imagine a world where a fly on the wall could help Grandpa Joe and James Bond. In July, researchers announced that one fly's hypersensitive ears had inspired a cutting-edge hearing device.

*Ormia ochracea*, a parasitic fly species, needs extremely accurate directional hearing to target its prey: crickets. But the fly's ears are just half a millimeter apart — too close together to pinpoint a chirping cricket, which emits sound waves on a much larger scale, without some extra help. So *O. ochracea* relies on a seesaw-shaped mechanism to amplify the difference between what each ear hears.

Researchers re-created the fly's unique mechanism by constructing a 2-millimeter rectangular silicon device with a fulcrumlike pivot supporting a tiny beam, similar to a seesaw. Pressure from sound waves flexes and rotates the beam to create an electric signal that's processed to determine sound direction — the same way *O. ochracea* does.

"We believe the optimized version will perform better than any commercially available microphones using the same spacing," says study author Michael Kuntzman, who conducted the research at the University of Texas at Austin.

The device could help the elderly hear all the gossip at a dinner party or, with the funding the project got from the U.S. military, let spies hear secrets that could save lives. Kuntzman said the next step is to design a device that's durable enough for the rigors of everyday use. — CARL ENGELKING

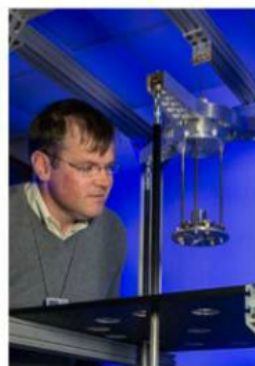
## Tinkering With the Cosmos's Constants

Underlying the universe is a variety of physical constants, values not based on anything — they just are. This year, experiments refined two of them.

By measuring the relationships between electric current, voltage and the pull of gravity, scientists can determine a number of fundamental values, including Planck's constant. That's an integral value used in quantum mechanics that describes the relationship between energy and frequency. In January, physicists at the National Institute of Standards and Technology found a more precise value for Planck's constant — one that differs from the old one by just 22 parts in a billion.

Scientists also updated the gravitational constant, which governs how strongly massive objects attract each other. A team of scientists in Italy used a new experimental setup, measuring the gravitational pull between a cloud of cooled rubidium atoms and tungsten weights. (The new value differs from the old by less than a tenth of a percent.)

These new values won't change how we see the universe, but they may make our understanding more precise, and eventually that much deeper. — SARAH KOLLMORGEN



Physicist Stephan Schlamminger tests one of the instruments behind the new Planck value.

## The Changed Constants

### Planck's Constant

Old Value

$6.626\ 069\ 57 \times 10^{-34}$  Joules\*second

New Value

$6.626\ 069\ 79 \times 10^{-34}$  Js

### Gravitational Constant

Old Value

$6.673\ 84 \times 10^{-11}$  cubic meters by kilogram by seconds squared

New Value

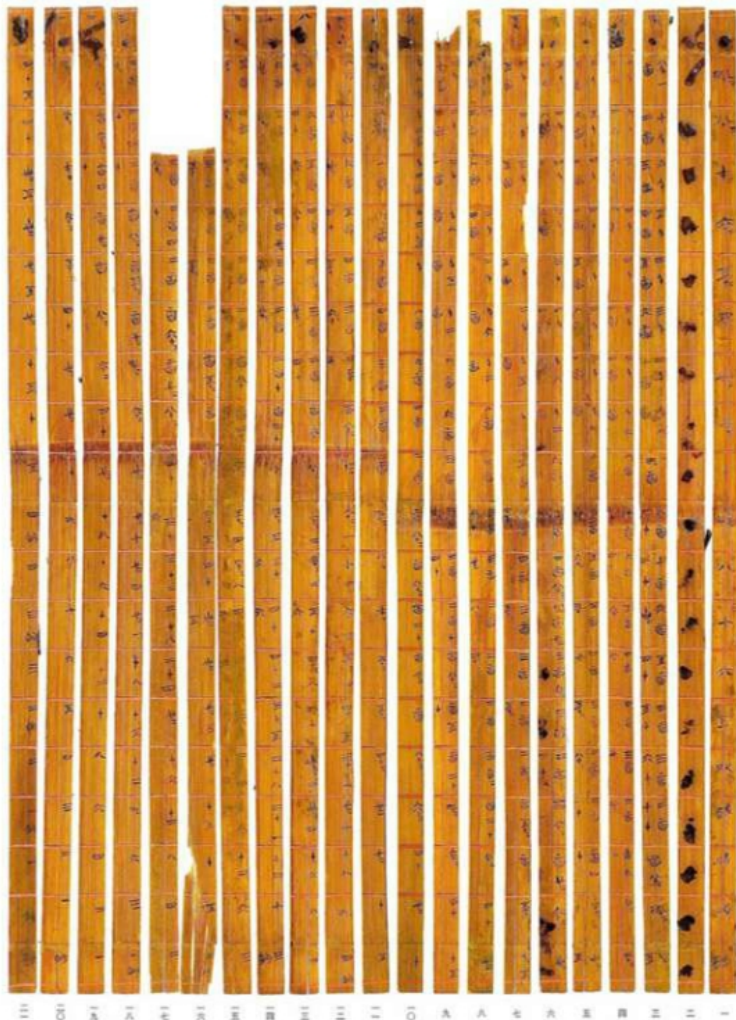
$6.671\ 91 \times 10^{-11}$  m<sup>3</sup> kg<sup>-1</sup> s<sup>-2</sup>

## The Bamboo Calculator

→ By cleaning away mold from a set of 21 ancient bamboo strips, researchers have revealed a mathematical surprise: the world's oldest decimal multiplication table. Unlike the times tables that Western schoolchildren memorize, the bamboo table even multiplies fractions.

The bamboo strips are part of a roughly 2,500-strip collection that dates to 300 B.C., before China was unified. In January 2014, historians and paleogeographers at China's Tsinghua University announced that the calligraphy on them forms a matrix with rows and columns of numbers from  $\frac{1}{2}$  to 90 that, like modern multiplication tables, yield a mathematical product where they intersect.

Bureaucrats and businessmen would have used the table to quickly tally payrolls or taxes. No other ancient civilization multiplied numbers in this way, says paleogeographer Wen Xing of Dartmouth College: "It is an amazing discovery." —CONNOR WALTERS



The Tsinghua table places factors across the top row and down the far right column. From left to right, or from bottom to top, respectively, the values are  $\frac{1}{2}$ , 1, 2 ... 9, then 10, 20 ... 90. The rest of the table shows the products of these factors.

## Massive Viking Fortress Is First Found in 60 Years

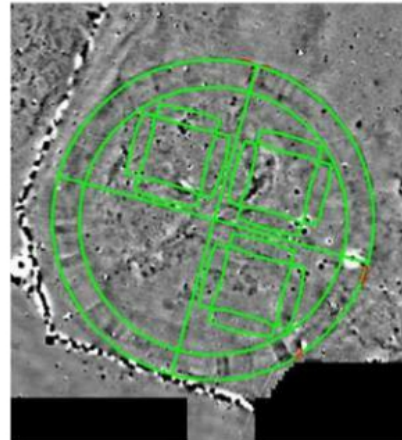
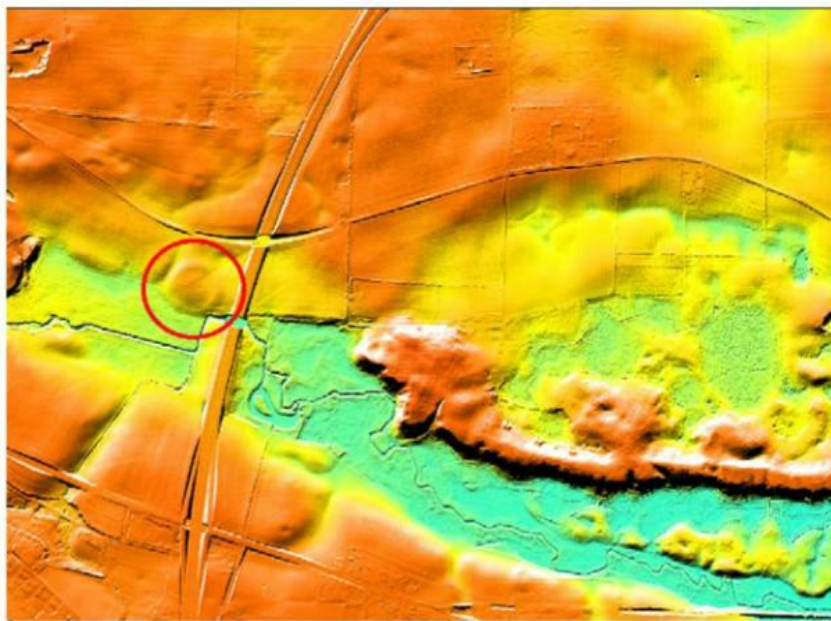
→ For centuries, a ripple of land in a farmer's field about 35 miles southwest of Copenhagen, Denmark, attracted little attention.

"We knew there was something out there, but we thought it was Iron Age, 800 years before the Vikings, so nobody was interested in it," says Nanna Holm, curator of the Danish Castle Center.

But Holm became curious about the site in rural Vallø when she came across new, more precise topography maps, which the Danish government created in 2009 and issued in 2012. She noticed that the







A 2009 map (left), made by using lasers to measure subtle differences in elevation, reveals the circular shape of the fort (circled in red). In 2013, researchers created a finer-scale map of the site (above) and overlaid it with the floor plan of another Viking-era fortress that had already been excavated (in green) to compare scale.

new maps, created to identify areas at increased risk for flooding due to climate change, put subtle landscape variations into sharper focus.

What she saw — confirmed during a partial excavation last summer — was the outline of a massive Viking-era fortress. Measuring 475 feet in diameter, the fortress is perfectly circular, with four gates aligned to the four compass points — a uniquely Viking-age Danish style called Trelleborg. It's the first new Viking fortress discovered in more than 60 years.

In September, researchers dated the fortress to the 10th century, likely during the reign of Harald Bluetooth, the first king of a united Denmark. Details of that unification remain murky.

“New technologies mean new possibilities to answer old questions,” says Holm. “Something happened during Harald’s reign that created Denmark. We don’t know how the state was created, but this fortress may help us answer that.” — GEMMA TARLACH

Although the fortress at Vallo has not been fully excavated, data suggest it is the Trelleborg style, named after a Viking-age fortification near Slagelse, Denmark (right).



Nanna Holm (above), curator of the Danish Castle Center, identified the charred remains of wooden posts and postholes during a partial excavation of the Vallo fortress last summer. The artifacts were dated to the 10th century, about the time Denmark became unified.



CLOCKWISE FROM TOP: LEFT: DANISH CASTLE CENTER/ARRHUS UNIVERSITY (2); OPHOTOS/ALAMY LIVE NEWS; THUE C. LEBRANDT/CREATIVE COMMONS

## Want a Better Brain? Sleep on It

→ Brain scientists know sleep improves memory, but why and how has been a tough nut to crack. Some evidence suggested brain cells form new connections during sleep; other evidence suggested sleep pares away existing connections.

Neurobiologist Wen-Biao Gan of New York University's School of Medicine and his team saw solid proof of the former. They taught mice a physical task and then watched their brains as the animals slept



— and saw neurons forming new connections.

To observe the changes, the team used genetically altered mice that produced a fluorescent protein gene that made certain neurons visible. The

mice were divided into two groups: one that slept after learning a physical task and one that didn't. When Gan imaged their brains, he found mice that had slept developed more dendrites — the tiny filaments that allow neurons to communicate — than did sleep-deprived mice.

These observations, announced in June, demonstrate that deep, non-dreaming sleep helps create new brain-cell connections, at least, Gan says, when learning physical tasks.

—KAT MCGOWAN

## Otherworldly Spring Found in High Arctic

→ For years, gullies on the surface of Mars have perplexed Red Planet specialists: How could such a frigid, desert-like environment have supported water?

Clues to this conundrum might lie in the Canadian High Arctic. In June, scientists announced they had found the world's northernmost perennial spring, whose head, channel and fan are similar to those on Mars.

"It's almost uncanny in resemblance," says Benoit Beauchamp, a geoscience professor at the University of Calgary, who discovered the spring with a colleague.

The Ice River spring, as researchers have dubbed it, intrigues scientists for more than its Martian connection. The spring's source remains a mystery. Since it's in a polar desert where the average temperature is minus 3.46 degrees Fahrenheit (minus 19.7 degrees Celsius), precipitation can't explain the cascade, gushing through the Arctic permafrost at nearly 137 gallons per second.

The next time the Canadian team treks back to the river, they'll be scanning the landscape for other bubblers. "Finding another spring like this would be a tremendous discovery," Beauchamp says.

—SARAH KOLLMORGEN



The gully formed by the Ice River spring, the northernmost bubbler ever found, bears a remarkable resemblance to this channel on Mars (inset).

