

SCIENCE NEWS

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string theory knotted up
cassini's ring revelation
gene variant tied to autism
cloaking revealed

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starbursts

A GEOMETRIC EXPLOSION

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Cover An S-shaped sequence of ever-smaller triangles, the spidron underlies a host of novel structures, such as the starlike three-dimensional form shown here. (M. Pelletier, D. Erdélyi, and W. van Ballegooijen) **Page 266**

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Autism's DNA Trail

Gene variant tied to developmental disorder

Scientists have taken a promising step forward in untangling the genetic roots of autism. Inheritance of a common variant of a gene that influences immunity, gastrointestinal repair, and brain growth substantially raises the chances of developing autism, at least in families with more than one child diagnosed with the severe brain disorder, a study finds.

Children with autism show severe social difficulties, language problems, and repetitive behaviors. The gene, called *MET*, regulates production of a protein that influences cell proliferation in various parts of the body.

"This is a moderate-to-high-risk autism-vulnerability gene," reports developmental neurobiologist Pat Levitt of Vanderbilt University in Nashville.

Certain variants of the gene, which contain minor alterations in their genetic code, cause several cancers.

Levitt's group had explored how *MET* contributes to brain development. After learning that the gene lies on a stretch of chromosome 7 that other investigators had linked to autism, the group began its new study.

Consulting a large database, the researchers obtained genetic information from members of 204 families in which one or more children had autism. These children ranged from below average to average in intelligence.

The researchers then identified variants of *MET*. Study participants who carried two copies of a specific *MET* variant displayed autism substantially more often than the others did. Levitt's group later found the same association for children with autism in 539 additional families.

Further analyses indicated that the link between the *MET* variant and autism appeared primarily in families with two or more affected children, the researchers report online this week for an upcoming *Proceedings of the National Academy of Sciences*.

Laboratory tests showed that this *MET*

form lowers the gene's activity and reduces its production of proteins that bind to various tissues.

If confirmed by other groups, these results would explain controversial reports that people with autism often have immune and gastrointestinal problems, according to Levitt.

Roughly 47 percent of the population carries at least one copy of the autism-associated *MET* variant. The researchers have yet to learn how it operates in the minority of that group that develops autism, which affects about 1 in 500 individuals, Levitt notes. In some people, beginning before birth, *MET* might respond to unknown environmental influences or interact with other genes to derail brain formation, Levitt theorizes.

Other researchers had reported preliminary associations between DNA regions and autism. "This is the first time someone has identified a candidate gene for autism, replicated their finding, and demonstrated that gene's biological function," remarks geneticist Daniel H. Geschwind of the University of California, Los Angeles. *MET* may contribute to autism in diverse ways, he proposes.

However, *MET* could be just the tip of the genetic iceberg. "Autism will turn out to be many different disorders influenced by hundreds of genes," Geschwind predicts.

An effort is now under way, led by geneticist Anthony P. Monaco of the University of Oxford in England, to gather DNA from as many as 2,000 families with autistic children. When that database is completed in about a year, researchers will use it to confirm whether numerous candidate genes, including the *MET* variant, contribute to autism, Monaco says. —B. BOWER

Horns vs. Sperm

Male beetles on tight equipment budget

A group of dung beetle species that sprout horns like tiny elk, rhinos, or sci-fi invaders often face trade-offs between horn and testes sizes, say researchers.

Among the 2,000 species of *Onthophagus* dung beetles, males sport various styles of swooping prongs, with which they wrestle other males for access to females. "That's like producing another leg and wearing it around on your head for the rest of your life," says Douglas J. Emlen of the University of Montana in Missoula. His earlier experiments showed that as an individual

beetle develops horns, they steal resources from other organs, leading to smaller eyes, antennae, or wings.

To test for trade-offs between horns and testes, Emlen and Leigh W. Simmons of the University of Western Australia in Crawley

worked with immature *Onthophagus nigriventris* and cauterized cells that would have grown into horns. The prongless males grew testes that were about 30 percent larger than those of comparably sized, horned males, Simmons and Emlen report.

That finding, they note, fits with results from another research team, which stopped genital growth in an *Onthophagus* species. Unusually small males grew horns.

Sperm investment hasn't gotten its due respect, comments Scott Pitnick of Syracuse (N.Y.) University. He welcomes the beetle research as adding to the growing body of work demonstrating that "sperm production turns out not to be cheap, after all." Pitnick and his colleagues have reported that among species of small, insect-eating bats, investing in supersize testes tends to correspond to having smaller brains.

However, Simmons and Emlen didn't find such a straightforward pattern when

QUOTE

“This is a moderate-to-high-risk autism-vulnerability gene.”

PAT LEVITT,
Vanderbilt
University



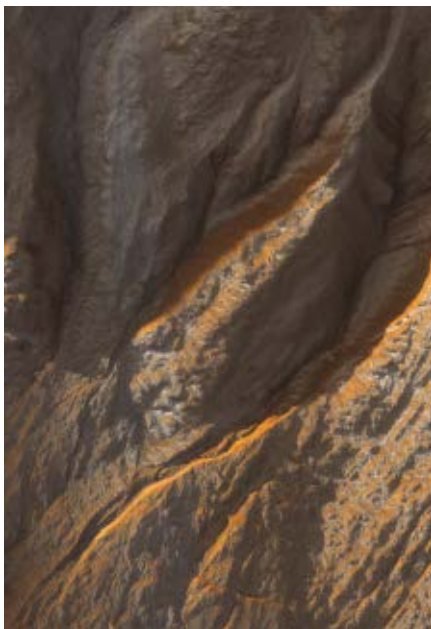
TOUGH GUYS *Onthophagus* dung beetles grow an extraordinary variety of horns.

they analyzed more than 20 species of *Onthophagus* beetles. Big horns didn't correspond to smaller testes, as would be expected if there were a simple constraint on growth.

Instead, some beetle species seem to protect their genital development. "Given enough [evolutionary] time, something will come up that's a way around a constraint," says Emlen.

The beetle species that broke the expected pattern had protected the development of their testes to an unusual degree. Emlen and Simmons report the findings online this week for an upcoming *Proceedings of the National Academy of Sciences*.

The relationships between horn and testes sizes “certainly suggest there’s something going on—it’s not random,” says Gerald Wilkinson of the National Science Foundation in Arlington, Va.



A sunrise view of Mars

Darkened gullies slice down the edge of a crater in one of the first high-resolution images sent by the Mars Reconnaissance Orbiter. The sharp edges of the channels suggest that they are no more than a few million years old. NASA scientists say that the braided gullies look as if sediment-rich streams had carved them, supporting the notion that water once flowed across much of the Red Planet. “This shows a soaking-wet Mars,” says Alfred McEwen of the University of Arizona in Tucson. The orange areas, enhanced for greater contrast, show clay-rich soil, which the scientists say could have formed only in the presence of water. The lightest areas in the picture are covered in carbon dioxide frost, which will burn off during the Martian day. —J. REHMEYER

The beauty of studying trade-offs between testes and horn sizes is that reproductive pressures drive them both, Wilkinson says. *Onthophagus* females mate with multiple males, so the competition favors males that deliver abundant sperm. Yet that delivery power doesn’t matter unless a male uses his horns to reach the female. —S. MILIUS

Back on the Table?

Element 118 is served up again

New research suggests that the periodic table may once again reach 118. A team of nuclear chemists from the United States and Russia has announced the brief appearance of the unnamed element, the heaviest to date.

A report of element 118 had made a splash before. In 1999, a group at Lawrence Berkeley (Calif.) National Laboratory claimed that it had created the element by bombarding lead with krypton ions (*SN*: 6/12/99, p. 372). But the researchers retracted the finding 2 years later (*SN*: 8/4/01, p. 68), after other labs couldn’t reproduce the results.

The new work synthesized element 118 from different materials—an isotope of californium and calcium ions. During each of two several-months-long experimental runs, the research team pummeled the californium with 10 million trillion calcium ions, says Mark A. Stoyer of Lawrence Livermore (Calif.) National Laboratory, which partnered with the Joint Institute for Nuclear Research in Dubna, Russia, for the project.

Three times—once in the first run in 2002 and twice in the second run in 2005—atoms of californium and calcium combined to form the new element, which contains 118 protons and 176 neutrons.

Each of the three atoms of element 118 remained on the scene for just under one-thousandth of a second. The element then decayed to element 116, then to element 114, and finally to element 112 before splitting in two, says Lawrence Livermore team member Dawn A. Shaughnessy.

At this point, the data “look good,” comments Kenneth E. Gregorich, a nuclear chemist at Lawrence Berkeley. “The decay properties that they are measuring are as expected,” he says. The results, published in the October *Physical Review C*, await independent confirmation.

The U.S. and Russian team had previously discovered elements 113, 114, 115, and 116. None of its experiments has been confirmed by an outside laboratory, although recent research by a Swiss team working at the Russian facility provides evidence for 114, notes Gregorich.

Element 118 resides near the so-called island of stability (*SN*: 2/6/99, p. 85), a group of heavy elements that theoretical physicists predict will have “magic numbers” of protons and neutrons that make them highly stable.

Some physicists expect that these heavy elements, if they exist, will persist for “hours or days or even a year,” says Stoyer. “If you could find something that heavy and that long-lived, maybe you could find some more useful chemical properties,” he says. “That’s what excites people in this kind of work.”

The U.S. and Russian team will next try to synthesize element 120, Stoyer says. When researchers can no longer cram protons into a nucleus, “that will be the end of the periodic table,” he adds. —A. CUNNINGHAM

Quirky Cardiology

Crocs’ hearts may aid their digestion

The crocodile’s ability to direct oxygen-depleted blood to its stomach may be instrumental in digesting large, bony meals and recovering from hunting-induced accumulation of lactic acid, some researchers propose. But other scientists argue that the croc’s unique circulatory system is instead an adaptation for lengthy dives, during which the animal must hold its breath as it stalks and then drowns its prey.

The hearts of crocodilians, including crocodiles and alligators, have four compartments. Two chambers send oxygen-rich blood to most of the body, and two move deoxygenated blood toward the lungs to be replenished. Mammals and birds use that same basic hardware.

But unlike mammals and birds, crocodil-



HUNT AND SHUNT A research team proposes that alligators shunt deoxygenated blood to their stomachs to aid digestion of bones, such as the one seen in this X ray.

UNIV. ARIZONA, JPL/NASA; FARMER

ians have special cardiac valves that sometimes shunt blood between the oxygenated and deoxygenated parts of the system (SN: 8/26/00, p. 133). That functionality makes the croc's heart "the most elegant and sophisticated of all of the vertebrate hearts," says Gordon Grigg of the University of Queensland in Brisbane, Australia.

Researchers have known about shunting in crocs for decades, and some scientists, including Grigg, have suggested that it enables the animals to temporarily store oxygen-rich blood in the vessels of their lungs during long dives.

But Colleen G. Farmer of the University of Utah in Salt Lake City raises an alternative possibility: The crocodilian heart isn't designed for hunting but rather for what may come afterward. In experiments on captive alligators, she and her colleagues noticed that after the animals eat, they shunt large volumes of deoxygenated blood to their stomachs. This shunting, like digestion, persists for about 10 days, she says.

Deoxygenated blood returning from the body is rich in carbon dioxide, which is a building block of stomach acid.

To test whether the rerouted blood affects digestion, Farmer's team surgically inactivated the shunting mechanism in some alligators and performed an operation that left the mechanism intact in others.

The researchers fed the alligators meals of hamburger and an oxtail bone and then X rayed the animals four times over 9 days to monitor the pace of digestion. Alligators with intact circulatory systems digested the bone more rapidly than did animals that couldn't shunt blood, Farmer reported last week at an American Physiological Society meeting in Virginia Beach, Va.

The carbon dioxide-rich blood carries acid removed from muscle. During shunting, that acid is delivered to the stomach, where it's harmless or beneficial, Farmer theorizes. Lactic acid, a by-product of physical exertion, accumulates in the animals' muscles as they struggle to subdue prey.

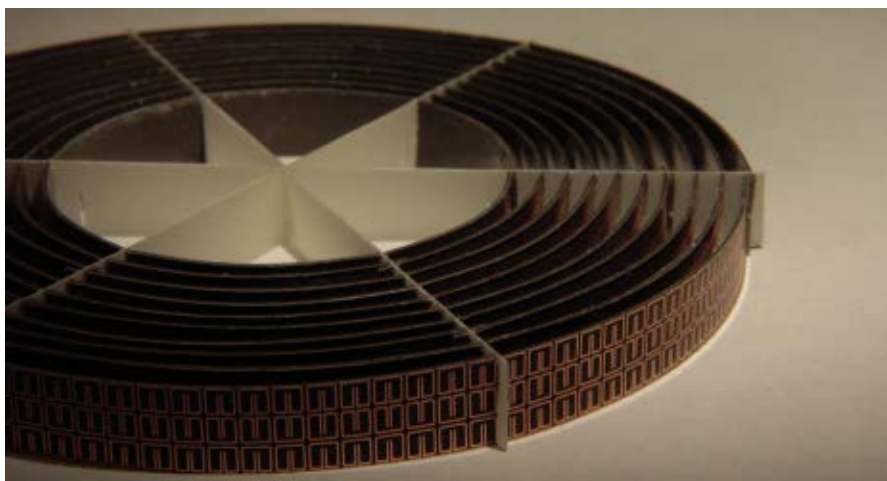
Shunting, Farmer suggests, "is an integrated way for them to meet two physiological needs: to recover from lactic acid buildup and to get ready for digesting a huge meal."

"I'm a bit skeptical," says Grigg. He suggests that the shunt-closing surgery might have impaired digestion by robbing the alligators' stomachs of blood flow. —B. HARDER

Vanishing Actor

Physicists unveil first invisibility cloak

It might not seem like much compared with Harry Potter's magic garment, but the first functional invisibility cloak has emerged from a North Carolina laboratory.



NOW YOU SEE IT Microwaves bent by the concentric walls of this 1-centimeter-tall invisibility device circumvent the center area and emerge on their original paths as if nothing had been in the way. The copper hoop that was cloaked in the tests isn't pictured.

The disk of concentric fiberglass-and-copper bands—about the size of a cocktail coaster—bends a narrow-frequency range of microwaves around a protected zone at its center. By then reorienting those electromagnetic rays so that they exit the disk on their original paths, as if undisturbed, the shield renders itself and whatever is in its protected zone almost invisible to a microwave detector downstream.

A team with members from Duke University in Durham, N.C., the Imperial College London, and the San Diego-based company SensorMetrix created the new device. Several of the scientists last spring proposed how to make such invisibility shields (SN: 7/15/06, p. 42).

In the latest experiments, the researchers placed a copper hoop in the path of microwaves and took readings with and without the novel cloak around the hoop. The measurements showed that the cloak eliminated nearly all the microwave disturbances that a naked hoop would cause.

The structure is "doing two things, not perfectly, [that] are the essence of cloaking" says Duke physicist David Schurig, who designed the device. "One is to reduce reflection, and the other is to reduce shadow." He and his colleagues describe the work in a report released Oct. 19 online by *Science*.

Physicist Oskar J. Painter of the California Institute of Technology in Pasadena calls the shield "a clear breakthrough that will have a ripple effect throughout the research-and-development community."

It's "a very big splash in the field," agrees mechanical engineer Xiang Zhang of the University of California, Berkeley. "Cloaking has been a dream for many years for many physicists and technologists."

Still, there was a noticeable shadow, notes theoretical physicist Costas M. Soukoulis of Iowa State University in Ames. "I was expecting the device to perform better," he says.

The new cloak's developers assembled the

cloak from 10 narrow bands of fiberglass on which they had imprinted thousands of copper loops. The researchers arrayed the bands in concentric circles. The bands belong to a new class of building blocks, called metamaterials, that go into devices that manipulate electromagnetic waves in ways that were never before possible (SN: 3/25/00, p. 198).

To reduce the challenge of making and testing its prototype, the team gave the device a low profile, virtually eliminating the third dimension. They then exposed it to a thin layer of microwaves.

The flat shield has shown that cloaking is possible, but the device is probably not of much practical value, Schurig notes. Three-dimensional cloaks promise to be much more useful—for instance, to potentially thwart military radar.

The first demonstration of 3-D cloaking in microwaves is still at least a year or two away, estimates Duke physicist and team leader David R. Smith.

To be practical against radar, cloaks will have to work across a broad range of microwave frequencies, comments theoretical physicist Nathan Myhrvold, the former chief scientist of Microsoft. Now heading Intellectual Ventures in Bellevue, Wash., he does research on metamaterials and has collaborated with the cloak's inventors.

Cloaking at visible-light frequencies isn't yet feasible, Smith notes. —P. WEISS

Assault on Andromeda

Nearby galaxy had recent collision

If the dinosaurs ever looked skyward, they might have been treated to a rare spectacle. About 210 million years ago, a small galaxy

plunged into Andromeda—the spiral galaxy closest to the Milky Way. Streamers of stars created by the collision would have been visible for million of years. Although the minor galaxy moved on, Andromeda still holds signs of the encounter. These include a newly discovered ring of glowing dust surrounding the inner part of the galaxy.

Astronomers had previously found other features that suggested a collision: an outer dust ring, some warping of Andromeda's spiral disk, and loops and ripples in the halo of gas and dust surrounding the galaxy. But the new inner ring clinches the notion that a satellite galaxy recently barreled through Andromeda, David Block of the University of the Witwatersrand in Johannesburg and his colleagues report in the Oct. 19 *Nature*.

The ring “revolutionizes the history of the Andromeda galaxy,” asserts Block. Although now rare, such galactic encounters were common in the cosmos billions of years ago and stimulated galaxy growth. Andromeda provides “an absolutely unique vantage point for studying head-on collisions, right on our doorstep,” Block adds.

Block's team used NASA's infrared Spitzer Space Telescope to examine the inner part of the Andromeda galaxy, which lies just 2.5 million light-years from Earth and is visible to the naked eye. The new inner ring, composed of fine dust particles, shows up at some infrared wavelengths, but in visible light, the bright stars at the galaxy's core hide it.

The ring is about 4,900 light-years long and 3,300 light-years wide. Both the inner and outer rings are expanding like ripples in a pond. Such ripples appear whenever a small galaxy collides nearly head-on with a larger one, says Block.

The new alternative model to account for Andromeda's overall disheveled appearance holds that a rotating bar of gas and dust at the galaxy's center has disturbed the galaxy's

structure. Block's team reports that the radius of the inner ring is offset from Andromeda's bright center by roughly 1,600 light-years, or about 40 percent of the ring's average radius. In contrast, the outer ring's diameter is offset by just 10 percent. These offsets can't be explained by the rotating-bar theory.

Team members Frederic Bournaud and Françoise Combes of the Observatory of Paris say that they have identified the alleged hit-and-run galaxy. The astronomers' computer simulation reveals that a collision between Andromeda and its companion dwarf galaxy M32 reproduces the rings.

“The new inner ring adds evidence of a recent encounter, specifically a rare, head-on, bull's-eye collision, and [the researchers] add M32 to the top of the list of candidate culprits,” comments Kirk Borne of the QSS Group at NASA's Goddard Space Flight Center in Greenbelt, Md.

Andromeda's future holds even more violence. Several billion years from now, scientists predict, the galaxy and the Milky Way will collide to become a single, giant, elliptical galaxy. —R. COWEN

Prep Work

Bird-flu vaccine might work better with primer

Avian-influenza virus is evolving, so no one can predict the exact genetic makeup of a killer bird-flu strain that would spread from person to person and cause a pandemic. So, if such a strain arose, manufacturers would be hard-pressed to rapidly make enough effective vaccine.

Scientists are looking for ways to stretch the amount of vaccine that would be available. One team now reports that priming people against bird flu with an existing, if not perfectly specific, vaccine might render a specially tailored one more potent during a pandemic.

Currently, three strains of the bird-flu virus, called H5N1, are known to infect people. Nega Ali Goji, a physician at the University of Rochester School of Medicine and Dentistry, and his colleagues identified 37 people who 8 years ago had received two doses of an experimental vaccine against one H5N1 strain of bird flu. That strain from Hong Kong was the first to jump the species barrier from birds to people.

In their study, Goji and his colleagues administered a recently developed bird-flu vaccine that targets an H5N1 strain identified in Vietnam in 2004. Each of the 37 volunteers from the earlier study received a single injection into muscle, as did 103 people who hadn't been previously vaccinated against bird flu.

Four weeks after the injection, the people primed with the earlier vaccine had made, on average, more than four times as many antibodies against the virus as the people in the other group had, says Goji, who presented the findings last week in Toronto at a meeting of the Infectious Diseases Society of America.

“If this is confirmed in larger studies, a prepandemic-vaccination program could be considered,” Goji says.

“This was definitely a very positive finding,” says Kathleen M. Neuzil, an infectious-disease physician at the University of Washington in Seattle. But she cautions that the single dose of new vaccine given to people in this study was quite large.

The finding suggests that with pre-vaccination, a smaller dose of an emergency vaccine might be sufficient, says physician and study coauthor John Treanor, also of the University of Rochester.

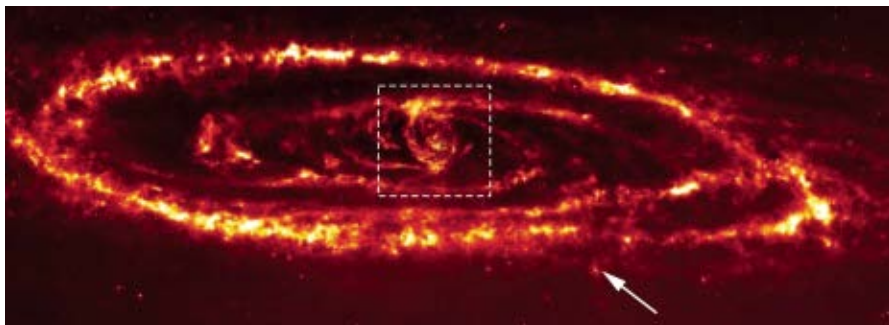
At the same meeting, physician Shital M. Patel of Baylor College of Medicine in Houston and her colleagues reported on another approach to economizing on bird-flu vaccine. They gave the new vaccine in three small doses, spread over several months, to 77 volunteers. Some doses were 1/30th the size of the shots that Goji and Treanor used. The vaccine was injected just under the skin, which can boost effectiveness (*SN: 11/13/04, p. 307*). Nonetheless, the low doses failed to consistently produce a robust immune response.

Meanwhile, other data show that the spread of bird flu among people could be catastrophic. Between December 2003 and September 2006, the World Health Organization confirmed 247 cases of bird flu in people. Jeffrey S. Markowitz of Health Data Analytics in Princeton Junction, N.J., reported at the Toronto meeting that 58 percent of those people died, compared with a fatality rate of 2.5 percent during the flu pandemic of 1918. —N. SEPPA

STATS

58%

Mortality rate among people contracting bird flu



NEIGHBORHOOD VIOLENCE A newfound dust ring (inside white box) at the core of the Andromeda galaxy and the previously known outer dust ring suggest that the small galaxy M32 (arrow) barreled through Andromeda 210 million years ago.

RING SHOTS

Cassini spies new bands, other features, around Saturn

BY RON COWEN

Add another glimmer of glamour to the icy jewels that adorn the outer solar system's largest planet. On Sept. 15, the Cassini spacecraft spied two new rings around Saturn. The craft had an unusual viewpoint. It was in Saturn's shadow on the opposite side of the planet from the sun. For 11 hours, as the sun lit the rings from behind, Cassini recorded the vast system of ice particles that stretches across a region of space greater than the distance between the Earth and its moon.

The brilliant back lighting provided a rare opportunity for Cassini to see microscopic ring particles that are usually too faint to be recorded.

"It's like the sun coming directly through a really dusty windshield," explains Cassini scientist Linda Spilker of NASA's Jet Propulsion Laboratory in Pasadena, Calif. Just as the dust particles on a windshield are brightened by illumination, so, too, are ice particles in the rings. In August 2005, Cassini had viewed the rings under the same conditions, but for only about 2.5 hours, notes Cassini scientist Matt Hedman of Cornell University. The September session is the longest such observation that the craft will make during its mission.

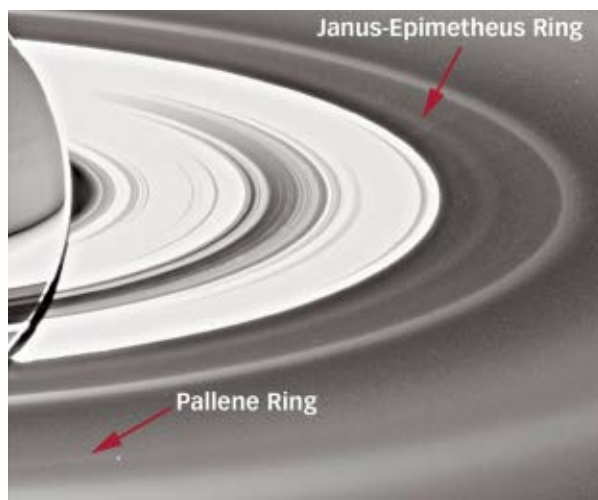
"It's very exciting to see the rings in a way that no one has ever seen them before," says Spilker.

MOONMADE The billions of ice particles that make up Saturn's rings circle the planet like cars on racetracks. The particles' gyrations sculpt waves, wakes, and other structures (*SN: 11/19/05, p. 328*). The rings that Cassini sighted in September are the first discovered in more than 25 years. The brighter of the two rings is 5,000 kilometers wide and lies between Saturn's main rings and the faint, outer G ring. That new ring's location coincides

with the orbits of Janus and Epimetheus, two tiny moons of Saturn. The fainter new ring is about half as wide and overlies the orbit of another tiny moon, Pallene, that lies between the two outermost rings.

Saturn's moons are bombarded by comets or micro-meteoroids. Those collisions knock off ice particles and send them into orbit about Saturn, forming rings.

Despite myriad observations of Saturn's majestic rings since the time of Galileo, no one knows how long rings survive or how often they're replenished by the planet's small moons, notes planetary scientist Josh Colwell of the University of Colorado in Boulder.



REVELATIONS — Two newly discovered, diffuse Saturn rings (arrows in top image) coincide with the orbits of small moons. The brighter of the two rings overlies the orbits of Janus and Epimetheus, while the other ring overlies the orbit of Pallene. Panoramic portrait (bottom) combines 165 images taken on Sept. 15, when Cassini was behind Saturn, which sheltered the craft from the sun's blinding glare, thereby permitting a unique view.

DYNAMIC BANDS Other images taken during the Sept. 15 event reveal the ephemeral nature of the rings. Thousands of narrow bands of icy particles, collectively called ringlets, appear within gaps in each of the rings. Cassini's September images confirmed two ringlets first spied earlier in the craft's mission.

These ringlets showed up in the Cassini Division, a large gap between Saturn's third and fourth main rings. The ringlets must have formed recently—they weren't seen when the Voyager craft passed by 25 years ago, notes Cassini scientist Joe Burns of Cornell University. Indeed, the color and brightness of one of the ringlets suggest that it's composed of fresh ice, Burns adds.

Cassini also uncovered evidence that a comet or an asteroid recently collided with Saturn's innermost, D ring. The craft found what appears to be a series of bright ringlets spaced 30 km apart in the outer part of the ring. In 1995, the Hubble Space Telescope recorded similar features spaced about twice as far apart. Furthermore, Cassini images show that the D ring has corrugations, as a tin roof does.

These features are best explained by a collision that knocked the ring about a kilometer out of the plane in which the main rings orbit Saturn, Burns notes.

"Saturn's rings are dynamic and have changed before our eyes," he says. ■

FIT TO BE TIED

Impatience with string theory boils over

BY PETER WEISS

Jazz musician Ken Hatfield entitled his compact disc released in June *String Theory*. A quilt-maker, Denyse Schmidt, offers quilts with the same title in two color schemes. Elizabeth Dewberry's novel *His Lovely Wife* (2006, Harcourt), about a woman married to a Nobel laureate physicist, "uses string theory to weave together two women's lives," the publisher's note says. The abstruse theory asserting that infinitesimal strings of energy make up the most fundamental constituents of the universe is flourishing as an icon of scientific brilliance.

Much of the theory's mainstream popularity stems from glowing presentations of it that have been aimed at general audiences: For instance, Columbia University string theorist Brian R. Greene's *The Elegant Universe* (1999, W.W. Norton) and his 2003 television special based on the book. Last month, however, two new general-audience books came out—one by a mathematician with a Ph.D. degree in theoretical particle physics and the other by a physicist who sometimes works in string theory—that cast string theory in a dramatically unflattering light.

The books—*Not Even Wrong* (2006, Basic Books) by mathematician Peter Woit of Columbia University and *The Trouble with Physics* (2006, Houghton Mifflin) by theoretical physicist Lee Smolin of the Perimeter Institute for Theoretical Physics in Waterloo, Ontario—assail string theory as sketchy, ambiguous, and untestable.

"Any further progress toward understanding the most fundamental constituents of the universe will require physicists to abandon the now ossified ideology" of string theory, writes Woit.

The two authors also charge that string theory practitioners stifle rival theoretical approaches to fundamental physics while ignoring increasingly obvious weaknesses of their own theorizing. "The ethics of science have been to some degree corrupted" by both string theorists and their academic institutions, Smolin claims.

Defending their enterprise and themselves, string theorists excuse their model's shortcomings as typical for a work in progress. Not only has the field made important strides, they say, but also its ranks have swelled because of those successes.

WORLDS APART In string theory, the universe is at once wildly different than scientists have so far thought it to be and potentially more thoroughly explained than it is by conventional theory.

In string theory's universe, space-time includes six or seven dimensions beyond the familiar three of space and one of time. In many versions of string theory, strings of energy coexist with extended objects called branes—short for membranes—that can also exist in many-dimensional forms. In numerous iterations of the theory, extra dimensions curl up tightly upon themselves and therefore aren't observed (*SN*: 2/19/00, p. 122).

Although the string universe includes the pointlike, elementary particles of conventional physics, such as quarks and electrons, those are just vibrations of the more-fundamental strings. In string theory, there are also many yet-to-be-discovered particles that are partners to those already known. The hypothesis of partner particles arises from a concept called supersymmetry, so researchers also refer to string theory as superstring theory.

By going out on a limb with extra dimensions and extra particles, string theorists get glimpses of possible answers to major questions that conventional theory has left unanswered. For example: Are the four basic forces of nature—the electromagnetic force, the weak force that controls nuclear decays, the strong force that holds atomic nuclei together, and gravity—variations of a single, more fundamental force? Many physicists suspect that they are, but today's prevailing theory of particle physics has revealed intimate connections only between the electromagnetic and weak forces.

Yet in string theory, simple behaviors of strings—for instance, how they vibrate and whether they break or form loops—generate not only all four forces but also all the elementary particles.

For that reason and others, many researchers see string theory as a potential theory of everything—a unified, mathematical framework that accounts for all forces and particles and resolves other dilemmas about the nature of space and time.

The enthusiasts have conjectured that there is a deeper version of the theory, dubbed M theory, that they simply haven't found yet.

"It's a little funny for Woit and Smolin to be making a judgment about how we should be carrying on our research."

— ANDREW STROMINGER,
HARVARD UNIVERSITY

HYPOTHETICAL Despite the nearly 40-year-old theory's apparent promise, string theory remains just an outline, say the new books.

Over the years, string researchers have devised explicit equations for only a few parts of the theory, and they have solved them under extraordinarily limited circumstances, Woit and Smolin both argue. And even when string theorists have done so, the answers they've gotten are often found to disagree with facts or accepted physical laws. For instance, to be compatible with Einstein's general theory of relativity, early string theory equations required a 26-dimensional universe and a highly unlikely particle, called a tachyon, that travels faster than the speed of light.

The theory is so underdeveloped that it's "not even wrong," says Woit, borrowing the phrase from the acerbic Austrian theorist Wolfgang Pauli, a pioneer of quantum mechanics.

Because the theory is so sketchy, it's unable to generate specific predictions, the critics say. The only predictions that string theory has come up with simply duplicate those made by better-established theories.

Smolin identifies string theory's dearth of predictions as "the

crux" of what's amiss with the field. For a theory to be tested and accepted, he writes, "it must make a new prediction—different from those made by previous theories—for an experiment not yet done."

For both Smolin and Woit, the most glaring evidence that string theory is incapable of making testable predictions emerged in 2003 in an analysis that has convinced most researchers that 10^{500} , or even more, versions of string theory are possible.

Some string researchers regard this plethora of theories as a hint that multiple universes exist and that a unique version of string theory plays out in each of them. Theorists refer to this array of possible universes, called vacuum states, as the landscape.

"The possible existence of, say, 10^{500} consistent different vacuum states for superstring theory probably destroys the hope of using the theory to predict anything," writes Woit.

Proponents of string theory readily admit in books, articles, and interviews with *Science News* that the theory remains rudimentary and devoid of predictions. However, the potentially extraordinary payoff—a theory of everything—makes the task of fleshing out the theory unusually deserving of patience and perseverance, supporters say. Moreover, they argue that they have been making progress.

String researcher Barton Zwiebach of the Massachusetts Institute of Technology points out, for instance, that string theorists have devised a theoretical model of black holes that seems to resolve a fundamental puzzle about those objects. Physicists hadn't figured out how a black hole—a uniform, ultradense ball of matter—could have any substructure. Yet thermodynamics suggests that black holes aren't homogeneous.

"In string theory, the black hole can be seen as built from strings and branes," says Zwiebach. "It's a spectacular insight."

Even the landscape of possible universes, although it has alarmed some leaders of string physics, might be good thing, argues Leonard Susskind of Stanford University, one of string theory's founders. Although he declined to be interviewed for this article, he has written extensively about the landscape in scientific papers, on Web sites, and in a general-audience book published last December, entitled *The Cosmic Landscape: String Theory and the Illusion of Intelligent Design* (2005, Little, Brown and Co.).

Thanks to the landscape's many versions of string theory, he says, at least some of them are compatible with recent astronomical observations indicating that the universe's expansion is accelerating because of an unknown called dark energy (SN: 1/21/06, p. 35).

Defenders of string theory also say that experiments will soon probe some elements of their proposals—most notably, extra dimensions—even though decisive tests aren't yet possible. String theorist Joseph G. Polchinski of the University of California, Santa Barbara notes that in the next couple of years, the Large Hadron Collider, near Geneva, Switzerland, will start operating. With this most powerful particle collider ever built, physicists will look for evidence of energy escaping into hidden dimensions or other clues of such extra realms, says Polchinski.

"Then we could say, 'Look, there they are,'" he says.

STRINGLED Scientists typically abandon theories that remain inaccessible to experiment for as long as string theory has, Woit and Smolin argue. So, they ask, what keeps string theory afloat?

"What we are dealing with is a sociological phenomenon," answers Smolin. Both he and Woit attribute string theory's popularity and longevity to social and financial pressures—an excess of

theoretical-physics graduates and stagnant research funding, for example—and a culture of arrogance, closed mindedness, and self-promotion among entrenched string theorists. Many researchers in the string field hotly contest that analysis.

Back in the mid-1980s, Woit and Smolin each watched from the margins as string theory's popularity surged. Woit, age 48, tells *Science News* that as a theoretical-physics postdoc, he felt his field turn inhospitable because he preferred to delve deeper into standard theory rather than to pursue string theory.

Now an untenured mathematician, Woit teaches courses and administers the computer system for Columbia University's math department.

Smolin, 51, has worked on string theory at times, but he has played a prominent role in developing rival theories.

Even though string theory hasn't panned out, Woit and Smolin claim, its senior practitioners cling to increasingly far-fetched dreams and use their influence to gather the lion's share of resources. Smolin devotes most of a chapter of his book to enumerating "seven unusual aspects of the string theory community" that have enabled its members to create their self-perpetuating enterprise. Among those aspects are overweening self-confidence, intellectual conformity, clannishness, and disregard for the ideas of outsiders. Smolin has even invoked a sociological theory that originated in the 1970s, called groupthink, to explain what has happened.

String proponents bristle at that characterization, suggesting that maybe the critics themselves are being arrogant. "It's a little funny for Woit and Smolin to be making a judgment about how we should be carrying on our research," says string theorist Andrew Strominger of Harvard University.

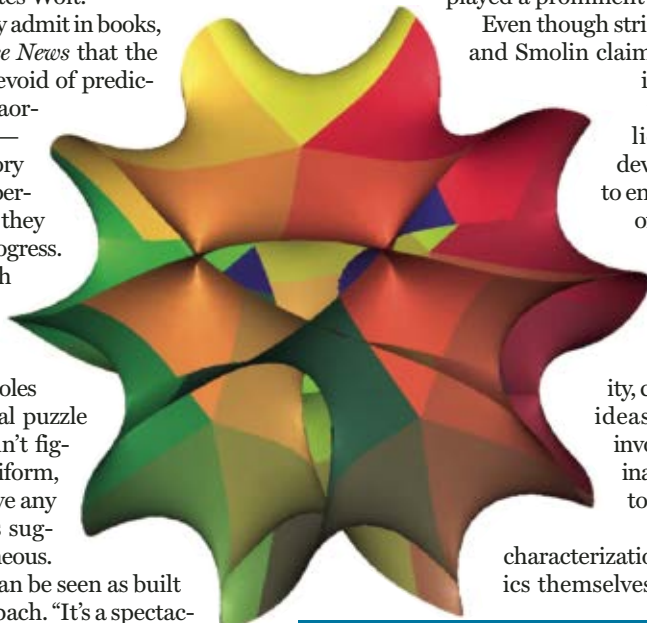
Strominger also disputes that jobs and perks, rather than string theory's scientific merits,

attract young researchers. Strong string-theorist groups have arisen not because they've been buoyed by the physics establishment, he says, but because young physicists have found string theory to be the best way to answer some of the most puzzling questions that they encounter. "It was really a kind of grassroots thing," Strominger told *Science News*.

Woit's and Smolin's books have generated plenty of buzz in the media, earning reviews and mentions in such publications as the *Wall Street Journal*, the *New York Times*, *USA Today*, and *Time*. The books are also part of a broader debate taking place on the Web, where Woit has maintained a blog since 2004 (www.math.columbia.edu/~woit/wordpress/).

The backlash against string theory might hurt its public image. Fewer musicians, artists, novelists, and other nonscientists may want to associate their creations and products with the theory. Woit hopes the criticisms are heard. "If the public gets interested in this and causes the physics community to have a debate about the whole subject, so much the better," he says.

Even some leading string theorists say they'd welcome an image shift, but for a different reason. "I've felt for a long time that the general public's impression of what string theory had accomplished and how much of it was correct was too positive," Strominger says. Maybe if the public comes to expect less of string theory, he adds, they'll ultimately appreciate it more. ■



INNER SPACE — String theory's extra dimensions could curl up into invisibly small versions of six-dimensional Calabi-Yau spaces, such as this one shown in cross section. Colors code for various mathematical relationships.

SWIRLING SEAS, CRYSTAL BALLS

Spirals of triangles crinkle into intricate structures

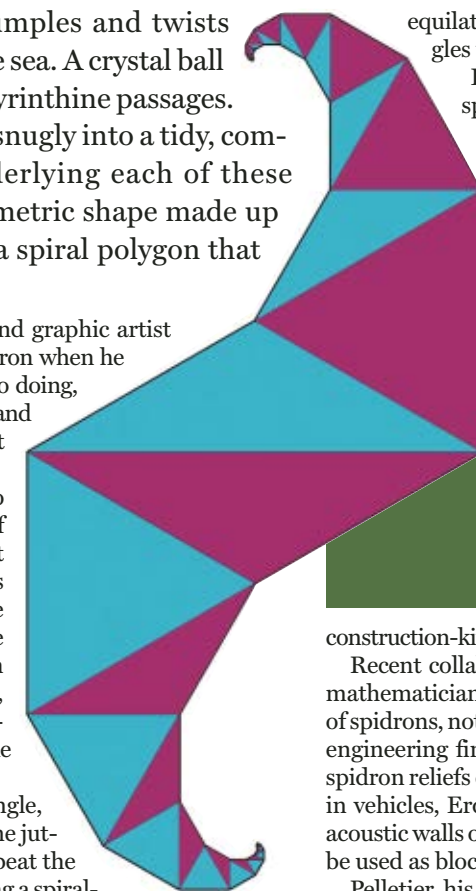
BY IVARS PETERSON

A field of triangles crumples and twists into a wavy crystalline sea. A crystal ball sprouts spiraling, labyrinthine passages. Faceted bricks stack snugly into a tidy, compact structure. Underlying each of these objects is a remarkable geometric shape made up of a sequence of triangles—a spiral polygon that resembles a seahorse's tail.

Hungarian industrial designer and graphic artist Dániel Erdély called the form a spidron when he discovered it in the early 1970s. In so doing, he evoked the figure's two spiral arms and the polygonal structures that can result when spidrons are joined.

A standard spidron consists of two alternating, adjoining sequences of equilateral and isosceles triangles. Start with an equilateral triangle. Draw lines from the three corners of the triangle to a spot at its center, creating three identical isosceles triangles, each with angles of 30° , 120° , and 30° . Then, draw a reflection of one of these isosceles triangles so that it projects from the side of the original triangle.

Next, make a new equilateral triangle, using one of the two short sides of the jutting isosceles triangle as a base. Repeat the procedure again and again, producing a spiraling sequence of ever-smaller triangles. Erase the original equilateral triangle, and join two of these structures along the long side of the largest isosceles triangle to create the s-shape of a spidron.



equilateral triangle. In other words, all the smaller triangles would fit together to fill the larger one.

Far more startling, however, is what happens when spidrons, laid down like tiles on a flat surface, are creased in just the right way and the flat, tiled structure is forced to fold accordion-style. The transformation from two to three dimensions creates mountain and valley folds that steepen. Each section of the pattern rotates as the configuration tightens. At its limit, it's a wavy, three-dimensional surface made up of triangles at a few set angles to each other.

TWO ARMS, TWO ARMS —
The spiral arms of a spidron consist of alternating sequences of equilateral and isosceles triangles.

Sets of these creased and folded spidrons can themselves be assembled into a wide variety of intricate forms that resemble exotic crystal geodes.

"There's a massive potential for sculpture here," says artist Marc Pelletier, co-founder of the geometric-

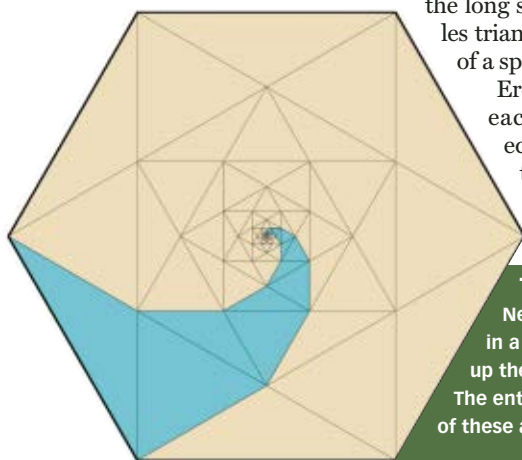
construction-kit company Zometool in Denver. "It's really beautiful."

Recent collaborations between Erdély and several artists and mathematicians have vastly increased the potential applications of spidrons, not only for creating intriguing art objects but also for engineering finely adjustable dynamic structures. For example, spidron reliefs could be used as shock absorbers or crumple zones in vehicles, Erdély says. Spidron surfaces could serve as flexible acoustic walls or solar panels. Spidron-based structures could also be used as blocks for builders—or construction toys.

Pelletier, his colleague Amina Buhler Allen, and math enthusiast Walt van Ballegooijen of the Netherlands have been working with Erdély for the past year, coming up with many new spidron-based designs. They presented their work in August in London at Bridges, a conference on mathematical connections among math, music, and art.

HEXAGONAL TWIST Erdély started his spidron tinkering while working in a Budapest printing house, where he noticed networks of lines and hexagons on rolls of paper prepared for printing. Subsequent doodling beginning with a hexagon led him to an intriguing pattern. He had connected every second vertex of the hexagon with a straight line, thus creating a six-pointed star. Inside the star was a smaller hexagon. He again connected every second vertex and continued the process until the figure in the center was too small to distinguish. The resulting inscribed pattern consisted of just two types of triangles—equilateral and isosceles—that got smaller as they neared the hexagon's center.

From his doodling, Erdély found that a hexagon contains six



TO THE CORE —
Nested triangles inscribed in a regular hexagon make up the spiral arm of a spidron. The entire hexagon contains six of these arms.

Erdély observed that within each arm, the area of any equilateral triangle equals the sum of the areas of all the triangles with areas smaller than the given

identical copies of a spiral sequence of triangles—a shape that he later called a spidron arm. His subsequent insight was to start with an array of inscribed hexagons drawn on a sheet of paper and laid as if they were bathroom tiles. By creasing the pattern in the right combination of mountains and valleys at the lines within each spidron arm and leaving a small hole at the center of each hexagon to allow movement, he crinkled the whole array into a dramatic three-dimensional relief.

In Erdély's words, the folding pattern "mobilizes" the hexagonal array, permitting a flat surface to take on a range of three-dimensional forms. The surface area of the hexagon remains unchanged, and the constituent triangles neither bend nor distort.

In 1979, Erdély presented this swirling, moveable relief to his teacher, Ernő Rubik at the Hungarian University of Applied Art. According to Erdély, Rubik—known for the invention of Rubik's cube—said that he'd never seen anything like it. That interest encouraged Erdély to continue experimenting with spidron structures.

Colored spidrons in various configurations make interesting tiling patterns on flat surfaces. Moreover, spidron patterns can be not only crinkled into reliefs but also assembled into novel three-dimensional crystal-like forms with spiral, polygonal faces.

But it wasn't until after Erdély met Romanian crystal physicist Cristiana Grigorescu, that news of his discovery began to spread. Encouraged by Grigorescu, Erdély described

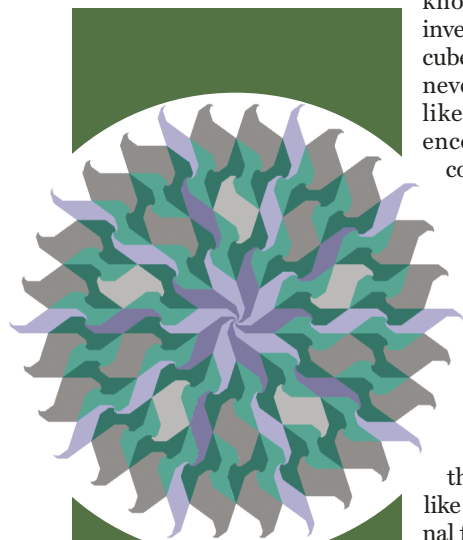
spidrons in 1998 in Jerusalem at the 12th International Conference on Crystal Growth.

Five years later, mathematician Lajos Szilassi of the University of Szeged in Hungary provided the first mathematical description of Erdély's spidron system and precisely defined its movements.

Subsequent collaborations with several artists, particularly Rinus Roelofs of the Netherlands, have vastly increased the realm of spidron structures and opened many new design possibilities. For example, Paul Gailiunas, an artist in Newcastle, England, encouraged Erdély to look for additional spidron-based polyhedral forms that can pack together to fill space.

The suggestion was fruitful. "[Erdély] has worked with many other people to create a wide variety of forms that I find visually and intellectually interesting," Gailiunas says.

Gailiunas also urged Erdély to consider the possibility that



DESIGN OPTIONS — An example of a tiling for a flat surface made up of various arrangements of spidrons.



SPIDRON CELEBRATION — This elaborate polyhedral structure is made up of 120 spidrons.

spidrons might be constructed from parts of polygons other than hexagons. Now, the spidron originally discovered by Erdély is known to be one of a family of such figures.

"Since they found how to make spidrons based on other polygons, many more three-dimensional structures have become possible, and there is a lot still to explore," Gailiunas says.

Pelletier is excited by the possibilities of what he describes as the "expanding spidron universe." For example, he, van Ballegooijen, Buhler Allen, and Erdély have this year come up with various novel types of tilings, reliefs, and space-filling units, including ones that don't have regularly repeating patterns. They've



CATCH A WAVE — A surface made of spidrons can crinkle along its triangular boundaries into a relief that's reminiscent of a turbulent sea, as shown in this computer rendering.

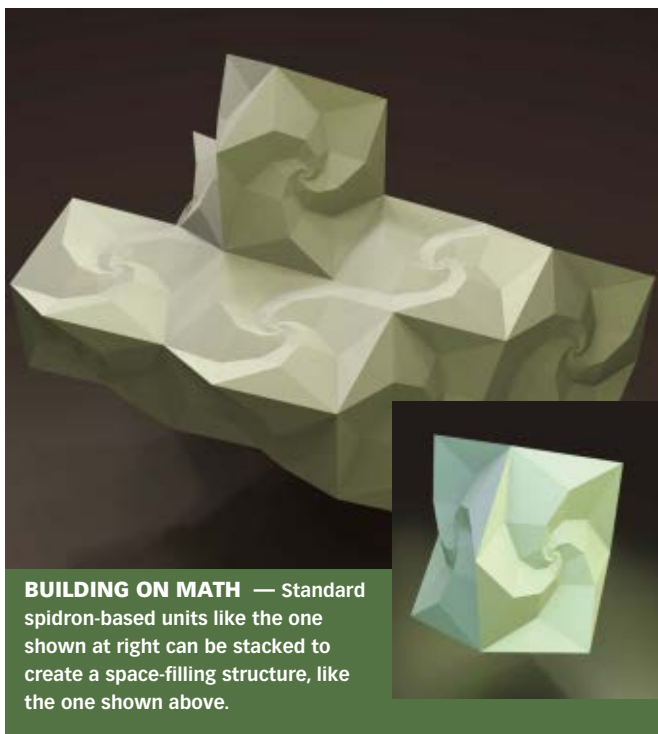


BY ANY OTHER NAME — This spidrohedron sculpture in a park near Leeuwarden in the Netherlands was assembled from 240 equilateral and 240 isosceles triangles. The object is a closed polyhedron made of 24 spidrons. Such spidrohedra can be stacked, each one with eight neighbors, to fill space.

also used spidrons to construct many innovative three-dimensional forms—rings, nests, linkages, labyrinths, polyhedrons, and more. “We’ve increased what you can do with these things by an order of magnitude in just a few months,” Pelletier says.

Because spidrons are hinged, movable structures, they’re especially intriguing to artists and engineers, Gailiunas says. Many of the three-dimensional structures built from spidrons share this property.

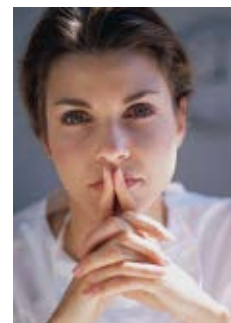
“Modern computing techniques make it relatively easy to generate high-quality images and animations,” Gailiunas says. Erdélyi and his collaborators have generated “some really impressive material,” he adds. “And I’m sure there’s a lot more to come.” ■



BUILDING ON MATH — Standard spidron-based units like the one shown at right can be stacked to create a space-filling structure, like the one shown above.

ERDÉLYI, J. SÁGI; ROELOFS

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ASTRONOMY

Record-breaking galaxy

Looking ever deeper into space and farther back in time, astronomers have found a galaxy more distant than any other known in the universe. Using the large Subaru telescope atop Hawaii's Mauna Kea, researchers recorded a galaxy as it appeared just 780 million years after the Big Bang. The universe is now 13.7 billion years old.

For their study, Masanori Iye of the National Astronomical Observatory of Japan in Tokyo and his colleagues used a filter that selects near-infrared light corresponding to radiation

emitted by hydrogen atoms in distant galaxies. The distant galaxies emit this light at ultraviolet wavelengths, but the expansion of the universe shifts that radiation into longer, infrared wavelengths that Subaru can detect.

The team found 41,533 candidate galaxies and then used a spectrograph to confirm that one faint galaxy, now dubbed IOK-1, is extraordinarily remote, 12.88 billion light-years from Earth. That's 60 million light-years farther away than the previous galactic distance holder, which astronomers had also found with Subaru. The team reported its findings in the Sept. 14 *Nature*. —R. C.

BIOMEDICINE

Do acid blockers let microbes reach the colon?

Suppressing stomach acid while taking antibiotics may allow antibiotic-resistant bacteria to colonize the intestines, a study shows.

Researchers had previously linked

stomach-acid suppression to pneumonia (*SN: 10/30/04, p. 277*). To test the effect of acid-suppressing drugs on bacteria passing through the stomach to the intestines, researchers gave mice two kinds of live, resistant bacteria via a feeding tube over 3 days. The animals then received an acid-suppressing drug, the antibiotic clindamycin, or both. The acid blocker was a proton-pump inhibitor called pantoprazole.

The bacteria colonized the intestines of the mice receiving both the acid blocker and the antibiotic more than three times as often as they did the intestines of mice receiving the antibiotic alone, says Curtis J. Donskey, an infectious-disease physician at the Louis Stokes Cleveland Veterans Affairs Medical Center in Ohio. He presented the findings at the 46th Interscience Conference on Antimicrobial Agents and Chemotherapy in San Francisco last month.

Both factors—acid suppression and an antibiotic—were needed to make the intestines a welcoming home to the resistant microbes. By reducing acid concentrations in the animals' stomachs, pantoprazole provided "free passage through the stomach" for the microbes, Donskey says. In the intestines, the antibiotic suppressed natural, protective microbes, while the invading drug-resistant bacteria thrived, he says. —N.S.

INFECTIOUS DISEASES

Antiviral drug may limit herpes spread

In people who have had at least one outbreak of blistering from genital herpes, the drug famciclovir sharply reduces virus shedding from the external portions of the genitalia, a new study finds. Such shedding can spread the virus between people.

Despite the apparent risk of herpes spreading during an outbreak, most new cases of genital herpes are caused by sexual contact with an infected person without visible blisters, says Peter Leone, a physician at the University of North Carolina School of Medicine in Chapel Hill. Because such silent transmission "is what drives the epidemic," he says, inhibiting shedding could prove valuable.

Famciclovir (Famvir) is a daily antiviral pill prescribed to limit herpes outbreaks. To test whether it can also stop viral shedding, researchers identified 129 men and women with genital herpes and randomly assigned half to take famciclovir and half to get an inert pill. After 42 days, the regimens were reversed. Participants and researchers didn't know which pill a volunteer was getting.

Every day throughout the study, each participant collected swabs of his or her genital area.

Although previous tests had shown that all the participants carried the genital herpes virus, some had never had an outbreak. Analysis of the swabs revealed that those asymptomatic people were as likely to shed the virus when they were getting the drug as when they received the placebo.

In contrast, famciclovir showed an effect in participants with histories of genital herpes outbreaks. This group was only about one-fourth as likely to shed virus while getting the drug as they were while getting the placebo, says Leone, who presented the findings last month at the 46th Interscience Conference on Antimicrobial Agents and Chemotherapy in San Francisco. —N.S.

BEHAVIOR

Prepared brains achieve insight

Sudden verbal insights arise from distinct brain operations that focus attention and facilitate access to word knowledge, a new investigation suggests.

A team led by John Kounios of Drexel University in Philadelphia used electric sensors on people's scalps and functional magnetic resonance imaging to track brain activity in 44 volunteers. The researchers took measurements in the seconds while each participant contemplated solutions to word problems. For each problem, volunteers viewed three words—say, *pine*, *crab*, and *sauce*—and tried to think of another word—such as *apple*—that could be combined with each of them to form larger words.

Participants solved nearly half of such problems correctly. During the experiment, they reported when solutions came to them in sudden, "Aha!" flashes or as a result of slow deliberations.

Brain measurements indicated that sudden, insightful solutions followed activity in areas toward the front of the brain that suppress unwanted thoughts and generate word associations. In con-



SO FAR AWAY The most remote galaxy known (red) lies 12.88 billion light-years from Earth. Image depicts radiation emitted by hydrogen atoms.

trast, deliberative solutions followed activity in regions at the back of the brain that increase a person's visual attention. In the October *Psychological Science*, the researchers speculate that the increase in visual attention reflects focus on an external problem. —B.B.

EVOLUTION

Tropical diversity came with time

Species in the richly diverse tropics don't evolve any faster than do species in temperate zones, researchers report.

Rather, the tropics accumulated its astounding abundance of species largely because life has thrived there so long.

Why the low latitudes teem, flutter, buzz, and slither with so much more diversity than the temperate zones do is a long-standing question. Biologists have proposed a rich abundance of hypotheses, notes John Wiens of the State University of New York at Stony Brook. In the

1990s, several researchers devised versions of what Wiens calls the tropical-conservation hypothesis. It argues that many of the tropics' species-rich lineages originated there and were slow in colonizing the temperate zones that have killer winters. Thus, life in the tropics has had longer to diversify.

Wiens and his colleagues tested the idea in tree frogs. Working with a researcher at San Diego State University, the Stony Brook team constructed and analyzed a family tree of 124 species of tree frogs.

The analysis roots the tree in tropical South America. The researchers found that the longer a lineage lived in any region, the more likely it was to have diversified into lots of species. They also report that tropical lineages didn't branch any faster than the temperate ones. The team's findings appear in the November *American Naturalist*. —S.M.

BIOLOGY

Cloning is most efficient using non-stem cells

Fully matured cells can be used to clone animals; in fact, using such cells for this purpose may be more efficient than using stem cells, scientists report.

Since Dolly the cloned sheep was born in 1996, some scientists have speculated that the donor cells used to create her and other cloned animals were rare adult stem cells—immature cells that have the potential to create a multitude of other cell types.

To examine how a cell's maturity affects its usefulness for cloning, Xiangzhong (Jerry) Yang of the University of Connecticut in Storrs and his colleagues worked with three types of blood cells from a mouse: stem cells that produce all types of blood cells, more-mature cells that can make only a few blood cell types, and fully mature white blood cells called granulocytes that can no longer divide. All the cells were harvested on the same day.

Yang's team isolated the cells' nuclei and injected them into mouse eggs whose own nuclei had been removed. The researchers got a surprising result: About 35 percent of the fully mature cells produced embryos, whereas only 11 percent of the intermediate and 8 percent of the stem cells did.

Yang and his colleagues report in *Nature Genetics*, as published online Oct. 1, that the finding could eventually streamline therapeutic cloning. In that procedure, researchers make cloned embryos and then harvest stem cells from them for growing specific tissues. —C.B.

MEETINGS

American Physiological Society
Virginia Beach, Va.
October 8 – 11

ECOTOXICOLOGY

Waters near croplands impair frogs' immunity

Pesticide-containing waters leave frogs more susceptible to fungal infections than pristine environments do, new field data suggest.

Tyrone Hayes and his collaborators at the University of California, Berkeley located tadpoles of *Rana aurora*, a protected frog species, at three sites in California. One site was upstream of any farm and had a comfortable water depth for tadpoles, about 2 feet. Another site, also upstream of agriculture, was so shallow that some frogs were exposed to air, causing some dryness-related distress. The third site was in Salinas Valley, a major area for lettuce and spinach cultivation. Waters there, about 2 feet deep, contain various pesticides that drain from the croplands.

The researchers confined some tadpoles in cages at each site and gave the animals injections of either an inert solution or a dose of bread yeast, a frog pathogen.

Tadpoles exposed to 0.125 or 0.2 gram of yeast per milliliter were assured of survival only if they lived in the deep, pristine site. At the shallower site, those doses killed 20 percent and 80 percent of the animals, respectively. Those numbers demonstrate that dryness-induced stress can compromise frogs' immunity, says Hayes.

In Salinas Valley, all tadpoles exposed to the yeast either died or became comatose, Hayes reported. He concludes that the pesticides compromised the animals' immunity even more than dry conditions did. —B.H.

DEVELOPMENT

Air's oxygen content constrains insect growth

The size to which insects grow is limited by how much oxygen they can route to tissues in their legs, new airway measurements suggest.

The researcher knew that some insects grow particularly large when reared in high-oxygen laboratories and that massive insects that lived during the prehistoric Paleozoic period vanished.

Researchers have long suspected that the big bugs of the Paleozoic period could grow large because each milliliter of atmosphere then carried nearly twice as much oxygen as it does today (*SN*: 12/17/05, p. 395).

Unlike vertebrates, which move oxygen within the body by way of their bloodstreams, insects move air through their bodies via an internal network of hollow channels called trachea. To probe the relationship between body size and trachea volume, researchers compared related species of beetles that ranged from 3 millimeters to 3.5 centimeters in length.

The investigators, led by physiologist Jon Harrison of Arizona State University in Tempe, found that larger insects devote more of their interior space to trachea. At the point where each leg joins the body, the diameter of the trachea was so wide in the largest beetles that little space remained for other tissues, Harrison says.

Insects "hyperinvest in their respiratory system as they get bigger," he says. —B.H.

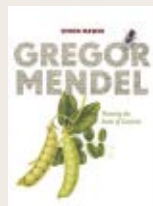
Books

A selection of new and notable books of scientific interest

GREGOR MENDEL: Planting the Seeds of Genetics

SIMON MAWER

Though most biology students know Gregor Mendel as the father of genetics, they know little about the man himself. According to lore, he was simply a monk who worked with peas and discovered how traits such as flower color were inherited through generations. Mawer, a novelist and biologist, fills in the gaps in this story with a detailed biography of this influential scientist, whose work was ignored during his lifetime. Mawer outlines Mendel's hybridization experiments, in which he painstakingly bred seven types of garden peas to determine which characteristics were inherited. It wasn't until 30 years after he completed work that the significance of Mendel's discoveries was rediscovered and appreciated. His legacy is modern genetics research, leading to the discovery of chromosomes and DNA and the sequencing of genomes. **Abrams, 2006, 176 p., color photos, hardcover, \$29.95.**



CREATURES OF ACCIDENT: The Rise of the Animal Kingdom

WALLACE ARTHUR

Proponents of intelligent design argue that life is too complex to have arisen by chance and that it must have come about at the hands of a creator. But Arthur, a professor of zoology, explains how complex organisms could indeed have evolved as composites of many genetic accidents. His book outlines the various ways in which life on Earth developed. Historically, Arthur notes, evolution has been envisioned primarily along either an x-axis or a y-axis. The x-axis acknowledges the great diversity of organisms, and the y-axis notes organisms' increasing complexity. The author argues that the evolutionary process lies along a diagonal between these two views. In a non-technical narrative, Arthur analyzes how organisms change. Finally, he speculates about the nature of extraterrestrial life and ponders the relationship between belief in evolution and belief in God. **Hill and Wang, 2006, 255 p., hardcover, \$25.00.**



THE ARTIST AND THE MATHEMATICIAN: The Story of Nicolas Bourbaki, the Genius Mathematician Who Never Existed

AMIR D. ACZEL

In the early part of the past century, influential French mathematicians such as Alexandre Grothendieck, André Weil, Henri Cartan, and others were all influenced by the work of a man known as Nicolas Bourbaki. But Bourbaki never existed. What began as a prank devised to trick first-year mathematics students at the École Normale Supérieure in

Paris in 1923 became a secret society of mathematicians, with rotating members, who collectively became known as Nicolas Bourbaki, complete with an invented family and background. The group's work under its pseudonym went on to profoundly influence 20th-century mathematics, including the new math movement that revolutionized school instruction in the 1950s. Bourbaki's influence went beyond math and introduced the notions of structural-

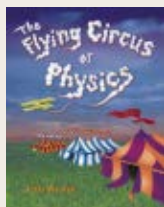


ism to philosophy, psychology, economics, and, indirectly, anthropology. That influence waned in the 1970s, but Bourbaki's legend lives on. **Thunder's Mouth Press, 2006, 239 p., b&w images, hardcover, \$23.95.**

THE FLYING CIRCUS OF PHYSICS: 2nd Edition

JEARL WALKER

Burdened by tedious equations and difficult terminology, many a student has wondered what physics has to do with real life. This question inspired

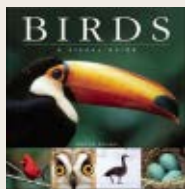


Walker, an unusual physicist who lists an Emmy among his awards, to write this book about how physics is at work all around us. He explains how physical principles apply to things as varied as smoke rings, popcorn, and pearls. For example, physics explains that a smoke ring is simply a ring vortex. These and more than 700 other examples of physics in action detail the concepts of motion, fluids, sound, thermal processes, electricity, magnetism, optics, and vision in a jargon- and mathematics-free way. Walker even answers such nagging questions as whether it's best to lie down, stand still, or jump in a free-falling elevator. **Wiley, 2007, 331 p., b&w illus, paperback, \$24.95.**

BIRDS: A Visual Guide

JOANNA BURGER

This latest addition to Firefly's Visual Guide series explores the extraordinary diversity of birds. These animals have uniquely fascinated us because of their flying and their often-dazzling plumage. With the aid of rich, full-color photos, Burger, a professor of biology at Rutgers University, takes a close look at how birds have evolved, at their unique physiology, and at their behavioral, mating, and nesting habits. Far from being "bird brained," Burger writes, birds exhibit a high degree of intelligence in their behavior, including tool usage and the learning of songs. Also, birds have adapted to life in diverse habitats. The book also provides in-depth information about specific birds detailing several species in each category—their size, identifying characteristics, and locations around the world. Burger also details how people have affected birds both positively and negatively. A fact file provides more information on bird classification, the 20 critically endangered birds, bird-watching ethics, and tips for attracting birds, as well as a table of bird sizes. **Firefly, 2006, 304 p., color photos, hardcover, \$29.95.**



LETTERS

Fish story?

To argue that the concentrations reported in "Macho Moms: Perchlorate pollutant masculinizes fish" (*SN: 8/12/06, p. 99*) are environmentally relevant is misleading. Those concentrations are usually in groundwater, not surface waters. I've been involved in the environmental field for almost 20 years and have yet to hear of any fish being caught in groundwater.

JOHN HARRIS, SACRAMENTO, CALIF.

Study coauthor Frank von Hippel notes that much of the nation's water supply comes from groundwater and says that "groundwater flows just like surface water and, in many places, becomes surface water." —J. RALOFF

Poor Pluto

I was sorry to learn Pluto did not qualify as a planet ("New Solar System? Twelve planets and counting," *SN: 8/19/06, p. 115*, and "Doggone! Pluto gets a planetary demotion," *SN: 9/2/06, p. 149*). Pluto has a diameter comparable with the Earth's moon. The size of our moon relative to Earth might cause any observer to consider Earth and its moon as double planets. Pluto and Charon could have equal status.

DENNIS RICH, LAS VEGAS, NEV.

Strictly speaking, the original five "wandering stars" (in the Copernican sense) are the only sun-orbiting bodies that can rightly be called planets. In changing the definition of *planet*, the International Astronomical Union is messing with something much bigger than it is. Think of all the dictionaries, encyclopedias, textbooks, and Web sites that will need revision as a result of IAU's action.

VIRGIL H. SOULE, FREDERICK, MD.

The detection of bodies orbiting other stars suggests that the criteria we use to apply the word *planet* is a matter of broad significance. The criteria accepted by IAU seem to work for our solar system but don't seem general enough to allow classification of all bodies we may detect.

CHARLES STEWART, CORAL GABLES, FLA.

Astronomers have duly decided that Pluto and others should be called "dwarf planets," but the greater problem is with the term for subordinate satellites. Galileo referred to Jupiter's subordinates as "moons." That is really wrong. There is one Moon. We need a term, such as *subsat*, for subordinate satellites.

HARRY POTTOL, SUNNYVALE, CALIF.

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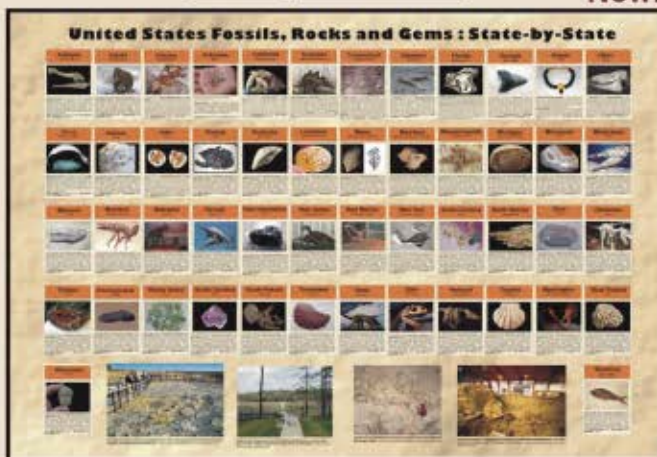
The Volcano



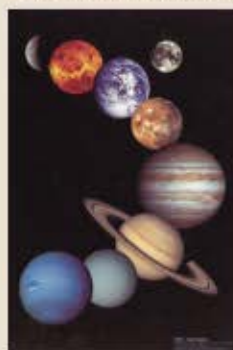
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