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SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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dairy, weight-loss debate
easter islanders' arrival
vaccines for ear infections

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star birth illustrated

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This Week

Of Note

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Cover Roughly 100,000 years from now, a budding star-formation region known as W3 might become as bright as the Orion nebula is today. This artist's illustration depicts W3 as it might look in that future era. (D. Aguilar/Harvard-Smithsonian) Page 154

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Magnetic Memory

New model forecasts solar storms

Even at its quietest, the sun about once a week belches out a billion-ton cloud of charged particles and magnetic fields. When those eruptions are directed toward Earth, they can irradiate astronauts, disable satellites, and knock out power grids on the planet.

This week, scientists announced that they have developed a new computer model for forecasting the frequency and strength of these solar storms, which tend to follow an 11-year cycle. The sun is currently near the low point of its activity. The model predicts that solar activity won't begin rising until late 2008—as much as a year later than the sun's standard cycle would forecast. Furthermore, the next entire cycle of solar activity will be 30 to 50 percent stronger than the current one, according to the new model.

Mausumi Dikpati of the National Center for Atmospheric Research in Boulder, Colo., and her team reported the findings during a March 6 briefing and describe their work in the March *Geophysical Research Letters*.

Each solar cycle is heralded by the emergence of dark regions, called sunspots, at the sun's midlatitudes. In the sunspots, magnetic fields concentrate and unleash enormous amounts of energy. Changes in the structure of the sun's magnetic fields cause storm activity to wax and wane.

The new model relies on observations of the movement of electrically charged gas, or plasma, as it flows across the sun's visible surface and deep within the roiling interior. Tracking the movement of plasma is pivotal for understanding the solar temperament because the charged gas carries parcels of the sun's magnetic field. As the plasma moves, magnetic fields imprinted on it dissipate and reconcentrate, setting the stage for the next solar cycle.

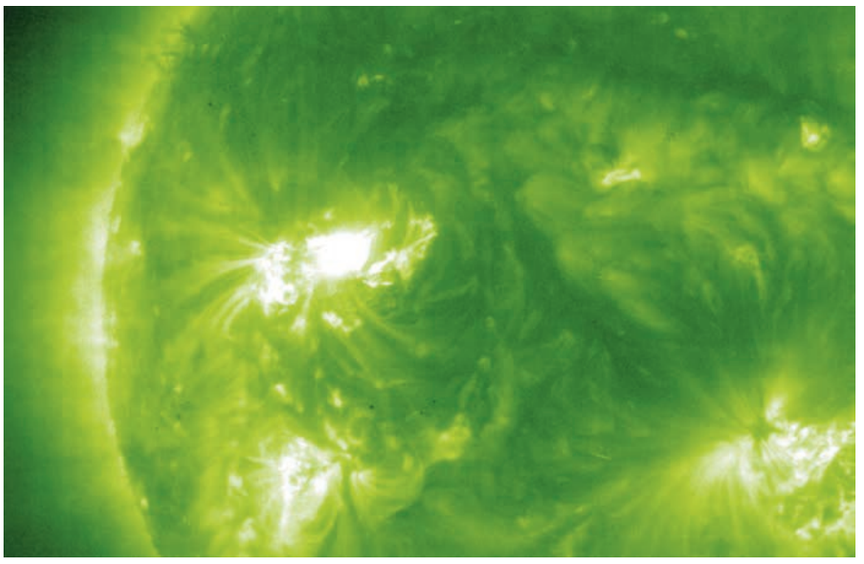
The plasma exhibits two types of flow. One type acts like a conveyor belt moving plasma—and the magnetic field that it carries—from the equator to the poles, then into the interior of the sun, and finally back to the equatorial surface. While beneath the surface, the remnant magnetic fields gather strength, become buoyant, and eventually tear through the solar surface to generate new sunspots.

The second type of plasma flow also intensifies the remnant magnetic fields. Because the sun's surface rotates faster at the equator than it does at the poles, the magnetic fields stretch and twist.

Observations from the Solar and Heliospheric Observatory, a NASA–European Space Agency mission, indicate that four solar cycles contribute to the sun's magnetic field configuration at any time, Dikpati says. "The next solar cycle depends on characteristics from as far back as 40 years previously—the sun has a magnetic memory," she notes.

According to Dikpati's team, the conveyor-belt-like motion has slowed over the past few decades, indicating that the next solar cycle will be delayed. But some other models forecast that the next solar cycle will come a year sooner than average. Predictions also vary about the next cycle's intensity.

"What's exciting is that the next cycle is only a few years away," says solar physicist Leif Svalgaard of the software company Easy Tool Kit in Houston. "We'll know soon which model is pointing us in the right direction, and that will be a real breakthrough." —R. COWEN



SOHO, ESA, NASA

STORMY WEATHER **This large, active region on the sun is more than 20 times as large as Earth. A new model predicts that the next period of intense solar activity won't begin until late 2008, about a year later than the standard, 11-year cycle would forecast.**

Got Data?

Consuming calcium, dairy doesn't keep off weight

Dairy products and other calcium-contain- ing foods and supplements don't prevent weight gain, according to a 12-year study of thousands of middle-aged men. But some scientists maintain that the finding has no bearing on the dairy industry's claim that dairy consumption promotes weight loss in people who cut back on calories.

Controversy about calcium's role in weight management has grown since a study in 2000 suggested that it facilitates weight loss (*SN: 4/29/00, p. 277*). Obesity researcher Michael B. Zemel of the University of Tennessee in Knoxville, who led that dairy-industry–funded study, has since reported that other constituents of dairy products augment calcium's fat-shedding effect.

Last year, the Physicians Committee for Responsible Medicine, a nonprofit group in Washington, D.C., sued several food companies and dairy-industry groups over advertisements claiming that dairy products aid weight loss. The group's president, Neal D. Barnard, says that the results of most of the relevant studies conflict with the findings of Zemel and other industry-funded researchers. The lawsuit is pending.

In the newly reported, federally funded test, epidemiologist Swapnil N. Rajpathak of the Albert Einstein College of Medicine in New York City and his colleagues at Harvard University tracked more than 19,000 men, age 40 and older, from 1986 until 1998. Every 4 years, each volunteer completed a questionnaire about his body weight and dietary habits. The average weight gain during the study was nearly 3 kilograms.

In an initial analysis of the data, men with the highest calcium intake experienced a lower-than-average weight increase of about 2.5 kg, Rajpathak and his colleagues report in the March *American Journal of Clinical Nutrition*. However, many of those

men exercised more or consumed fewer calories than other volunteers did.

Among men who exercised similar amounts and had similar caloric intakes, the researchers found no association between weight gain and calcium or dairy intake. In fact, Rajpathak says, men with the largest increase in high-fat dairy intake over the 12 years gained slightly more weight than the men who decreased their high-fat dairy intake did.

The new finding "confirms that the weight of the evidence is against dairy products having any weight-loss effects at all," says Barnard.

But Madelyn H. Fernstrom, director of the Weight Management Center at the University of Pittsburgh Medical Center, says that the study doesn't address whether, "if you cut back your calories and replace some of your remaining calories with dairy, you will lose weight at a faster rate ... than if you're simply cutting back your calories."

In a previous dairy-industry–supported study, Robert P. Heaney of Creighton University in Omaha, Neb., says that he found that "there is a calcium effect, but it's a small effect." He says that questionnaires provide only rough estimates of dietary intake, leading to uncertainty that may have masked a small, beneficial effect of calcium intake in the new study. —B. HARDER

Polynesian Latecomers

Easter Islanders took fast track to culture

Massive stone statues of humanlike figures on Easter Island in the South Pacific stand mute sentry over the remains of a now-defunct society thought by many researchers to have originated as early as A.D. 400.

However, new radiocarbon dates from Easter Island tell a different story. The first Polynesians arrived there around A.D. 1200, rapidly launching construction projects and carving imposing statues that they lugged all over the island, two anthropologists report in an upcoming *Science*. Cultural growth fostered tree loss and soil erosion that continued after European contact 500 years later, they say.

Terry L. Hunt of the University of Hawaii-Manoa in Honolulu and Carl P. Lipo of California State University in Long Beach obtained radiocarbon dates for burned wood from various soil layers at an Easter Island site containing animal bones and other remains left by former inhabitants. Hunt and Lipo excavated the deposit, which lies in the island's only sand dune, during 2004 and 2005.

STONE COLD Figures carved in rock stare impassively from their perches on Easter Island, which may have been settled as late as A.D. 1200.

Hunt and Lipo disagree with the notion, advanced by Jared Diamond of the University of California, Los Angeles in his book *Collapse* (2005, Viking Penguin, New York), that population growth and environmental destruction at first fueled Easter Islanders' cultural achievements but caused social chaos by the time of European contact.

"We see the grand scale of cultural investment on [Easter Island] as the cause of their salvation, not of their demise," Hunt says. The island culture's downfall came from European-based disease and slave trading, in his view.

A late arrival for Easter Islanders fits with an earlier theory that Polynesians spread quickly from one Pacific island to the next because of rapid population growth and intensive exploitation of island resources, Hunt says.

In the isolated, harsh locale, Easter Islanders focused on activities such as building monuments and carving statues rather than on raising large, unsupportable families, Hunt and Lipo propose. In habitats with unpredictable resources, many animal species show a preference for non-reproductive activities, they note.

Hunt and Lipo's revised dating of Easter Island's settlement makes "much better sense of other archaeological evidence," remarks archaeologist Paul Rainbird of the University of Wales, Lampeter. For example, colonization at A.D. 1200 allows for the sweet potato to have been cultivated in central and eastern Polynesia for at least 200 years before its transport to Easter Island as the main plant crop.

However, Hunt and Lipo's evidence doesn't represent an "ironclad" case for a late settlement, contends anthropologist Patrick V. Kirch of the University of California, Berkeley. He notes that previous radiocarbon analyses of the same site, directed by David W. Steadman of the University of Florida in Gainesville, suggested that people reached Easter Island perhaps by A.D. 900.

Recent work on the Mangareva Islands, the probable source of the first Easter Island colonists, suggests that the islands were settled between A.D. 900 and A.D. 1000, Kirch adds. Easter Island could have been colonized around the same time, in his view. —B. BOWER

Meddling with Metal

Novel nanocontrol yields chromium rival

A legal battle launched in 1993 over toxic chromium metal became the basis for the movie *Erin Brockovich*, which featured superstar Julia Roberts. Now, materials scientists have quietly taken aim at one common use of that harmful substance by creating a nontoxic alloy with the potential to replace a coating containing chromium.

Costarring in these laboratory developments is a new method for making alloys. With it, scientists can dictate the sizes of nanoscale crystals in an alloy's structure—

HUNT

and therefore the alloy's properties—by manipulating its atomic composition. Christopher A. Schuh of the Massachusetts Institute of Technology (MIT) and his colleagues have applied the method to alloys composed mainly of nickel.

The scientists set out to create nontoxic coatings as hard and corrosion resistant as the chromium layer applied to steel. The so-called hexavalent form of chromium—used in those coatings and also in paints and dyes—poses a cancer risk to more than a half-million U.S. workers.

The Occupational Safety and Health Administration on Feb. 28 slashed the permissible concentration of hexavalent chromium in workplace air by a factor of 10.

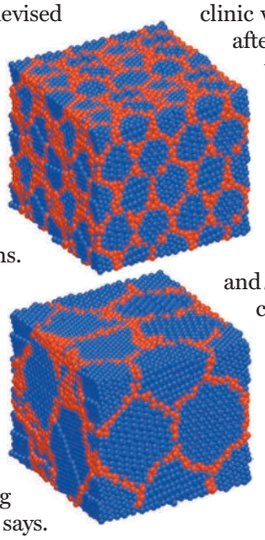
To make their nontoxic coatings sturdy, Schuh and his coworkers applied a well-known strategy: creating nanoscale crystalline grains in the materials. To do this, other researchers have rolled and pounded metals to reduce grain size (*SN: 8/24/02, p. 117*) or heated nanocrystalline powders to weld together smaller structures. Neither of these methods gives precise size control, Schuh says.

In a new twist, his team devised an electroplating method that finely tunes the mixture of nickel and tungsten atoms as it coats, for example, steel or copper. Tungsten atoms are bigger than nickel ones, so they don't fit comfortably into nickel's crystal lattice, Schuh explains. Grains of tungsten-poor alloy become cemented together by tungsten-rich material to form a brick-and-mortar structure.

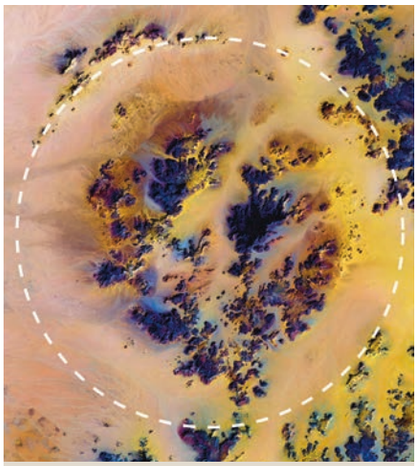
Upping the alloy's overall fraction of tungsten forces the brick size to shrink to provide additional room for the big atoms in the mortar, Schuh says. Varying the tungsten fraction from 10.7 percent to 14.5 percent to 17.5 percent yielded grains of 20 nanometers, 10 nm, and 3 nm, respectively, Schuh and Andrew J. Detor, also at MIT, report in an upcoming *Materials Research Society Proceedings*.

Tests of the 10-nm alloy as a coating for steel have shown it to be as hard as chromium and more resistant to marine corrosion, Schuh says.

That could be good news for coating gun bores and other military items, says materials scientist Deepak Kapoor of the U.S. Army's Picatinny Arsenal in New Jersey. He adds that he's even more impressed with the way in which the new coating was created. "Schuh can predict and then, basically at will, produce an average grain size.... That's the beauty of this," he says. —P. WEISS



AGAINST THE GRAIN
Computer simulations show how extra tungsten in a nickel-tungsten alloy (top) would lead to crystal grains (blue chunks) 2 nanometers across, whereas less tungsten (bottom) would yield 4-nm grains.



LANDSAT; SCHUH

Crater in the sand

Researchers analyzing satellite images of the Sahara have discovered the region's largest impact crater, a 31-kilometer-wide feature located in remote southwestern Egypt. The crater's heavily eroded rim (marked by the white dashes) rises about 230 meters above the surrounding terrain, says Eman Ghoneim, a physical geographer at Boston University. The age of the crater is unknown, but the feature must be younger than 100 million years, the age of the underlying sandstone, Ghoneim and her colleague Farouk El-Baz announced last week. The ancient impact, probably caused by an asteroid about 1 km across, might be responsible for the formation of Libyan desert glass. Those mysterious chunks of fused silica, first noted by explorers in the 1930s, are found scattered across a 50-by-130-km region near the crater. —S. PERKINS

Ear Protection

Combo vaccine prevents some infections

A vaccine that triggers immunity against two common bacteria can prevent many ear infections in babies, a European team of researchers reports.

Middle ear infections send roughly 20 million U.S. children, most of them infants, to the doctor every year. Recurrent infections sometimes lead to partial hearing loss and can require surgical implantation of tubes to improve fluid drainage.

In their test, the scientists enrolled about 4,900 healthy infants visiting 50 clinics across the Czech Republic and Slovakia. The team randomly assigned half the babies to get the new vaccine, called Streptorix, in four doses, starting around 3 months of age and ending by 15 months. As a control group, the other babies got shots that protect against hepatitis A but not ear infections.

The researchers recorded the children's clinic visits until age 2. In the period after the third vaccine dose, 499 of the controls were diagnosed with ear infections, compared with only 333 of those getting the new vaccine, the researchers report in the March 4 *Lancet*.

This is the first vaccine to combine parts of two bacteria called *Haemophilus influenzae* and *Streptococcus pneumoniae*, says coauthor Roman Prymula, an epidemiologist at the University of Defence in Hradec Králové in the Czech Republic. Between them, the two microbes cause roughly two-thirds of middle ear infections.

A vaccine approved by the Food and Drug Administration in 2000 has already shown some effectiveness in averting ear infections. Marketed as Prevnar by Wyeth Pharmaceuticals in Collegeville, Pa., it had been designed to stop pneumonia, meningitis, and blood infections. The vaccine is made up of a nontoxic diphtheria protein attached to sugar molecules from seven strains of *S. pneumoniae*. A study by Finnish researchers subsequently found that babies getting the vaccine had fewer than half as many ear infections caused by those *S. pneumoniae* strains as did babies getting a control vaccine.

The newer vaccine broadens coverage by coupling sugar molecules from 11 *S. pneumoniae* strains to a protein taken from *H. influenzae*. It protected against infections caused by *Streptococcus* or by *Haemophilus*.

In babies, the immune system doesn't always identify bacterial sugar molecules as foreign, says Cynthia Whitney, an epidemiologist at the Centers for Disease Control and Prevention in Atlanta. Combining them with the protein "allows the immune system to recognize the vaccine," she says.

Although the new vaccine's immune coverage isn't complete, "it gives those of us who've spent most of our careers interested in the treatment and prevention of ear infections a lot of optimism," says Stephen I. Pelton, a pediatrician at Boston University Medical Center.

The long-term effectiveness of the vaccine hasn't yet been tested, but it may not matter. "If you can get a vaccine that works for the first 3 years of life, that would have a major impact," he says.

Prymula expects GlaxoSmithKline of Rixensart, Belgium, which makes the new vaccine, to seek regulatory approval for it in 2007. —N. SEPPA

Fit Moms, Brainier Babies

Exercising mothers provide neurological benefits

Offspring of mice that jogged each day during pregnancy may have an advantage over pups of sedentary moms, according to a new study. In a part of the brain that contributes to learning and memory, the exercisers' pups have more cells than those of sedentary mice do.

Over the past few years, studies have suggested that exercise provides a host of neurological benefits (*SN: 2/25/06, p. 122*). However, scientists typically performed these studies on adult animals, notes neuroscientist Gerd Kempermann of the Max Delbrück Center for Molecular Medicine in Berlin. He says that he wondered, "If exercise has this neurological effect during adulthood and in old age, what about the other extreme of life, during the earliest development?"

To explore how a mother's exercise affects very young brains, Kempermann and his colleagues devised a simple experiment. A day after laboratory mice had mated, the researchers put the pregnant animals into standard, individual cages with or without a running wheel.

Kempermann's team compared the brains of the offspring during gestation and after birth. The scientists focused on a particular region called the dentate gyrus, which earlier studies had suggested plays a role in consolidating memories.

Animals with and without access to the running wheel all seemed to progress normally through their pregnancies. However, the researchers began noticing distinct differences in the embryos at 15 days of gestation, a time when brain cells are rapidly dividing. Compared with the dentate gyri in the sedentary animals' embryos, those in the runners' embryos had about 20 percent fewer cells.

Despite this initially slow development, the brains of the runners' offspring seemed to rebound rapidly in the weeks after birth. When the runners' pups were 6 weeks old, their dentate gyri had about 40 percent more cells than those of the inactive animals' offspring did. The researchers report these findings in the March 7 *Proceedings of the National Academy of Sciences*.

Although previous studies had highlighted several different proteins as contributing to exercise's neurological benefits in adults, Kempermann says that the effect in embryos probably doesn't result from a simple transfer of these proteins across the placenta. That scenario can't explain why development in the dentate gyrus was delayed, then bounced back.

In future studies, Kempermann and his team plan to look for the underlying mechanism. They are also curious whether the extra cells in the dentate gyrus have any effect on learning and memory.

Says Henriette van Praag, a neuroscientist at the Salk Institute in San Diego, "It would be interesting to find out how these animals behave over the long term, whether [exercise] could give them a better start in life."

Only after analyzing the results of such research might scientists recommend heavy exercise during pregnancy, notes Fernando Gómez-Pinilla, who studies exercise's neurological effects at the University of California, Los Angeles. "We cannot say that this has a beneficial effect for the brain," he cautions. —C. BROWNLEE

Vesuvius' Shadow

A major volcanic blast could threaten Naples

When Italy's Mount Vesuvius begins to rumble again, nearby Naples may be in danger, a new study shows. In 4,000-year-old ash beds buried under the city, researchers have uncovered the first geologic evidence that the volcano's power could extend so far—and they warn that the city's hazard planners should take heed.

The 25,000-year-old volcano has had eight major explosive eruptions in recorded history, including the blast in A.D. 79 that buried Pompeii in ash, says volcanologist Michael Sheridan of the State University of New York at Buffalo. Violent explosions of ash and gases have been interspersed with dozens of less dramatic lava flows.

The most powerful eruption recorded occurred around 1780 B.C., sending billowing clouds of ash far to the northwest. Sheridan and his colleagues at the Vesuvius Observatory in Naples and the Università degli Studi di Napoli Federico II speculated that Naples, 15 kilometers from Mount Vesuvius, might have been in the path of that blast. The researchers dug under the city's paved streets to search for evidence of the eruption.

They found signs of a "prehistoric catastrophe" both in the city and in neighboring villages, Sheridan says. Within Naples' current metropolitan area, the researchers uncovered 3-meter-thick ash deposits from the eruption. They probably resulted from settling clouds of dry ash followed by denser lahars, deadly flows of water-saturated ash and rock, Sheridan adds.

Another startling find was the discovery of thousands of preserved footprints pressed into ash beds and lahar deposits. The tracks, found in villages just outside Naples, indicate a hurried exodus to the northwest that lasted throughout several stages of the eruption, the researchers report in an upcoming *Proceedings of the National Academy of Sciences*.

FLEEING FEET Footprints, preserved in ash deposits, tell of a mass exodus during an eruption at Mount Vesuvius 3,780 years ago.

PNAS

The sleeping volcano is under close watch by researchers, and there are no signs that it's stirring. But scientists are hotly debating how to interpret any future indications of renewed activity. Currently, hazard planners in Naples are preparing for eruptions similar to a relatively minor one that occurred in 1631, Sheridan says.

The new evidence suggests that the planners need to increase their expectations of a rare worst-case eruption, he adds. A Naples-burying eruption "could happen," he says. "It's happened in the past."

The paper is "a strong example" of how scientists can combine geologic and historical studies of eruptions to envision the ways in which volcanoes might affect societies, says volcanologist Greg Valentine of Los Alamos (N.M.) National Laboratory. Such studies are essential to prepare for future volcanic catastrophes, he adds.

"They will occur," Valentine says. "It's just a matter of where and when." —C. GRAMLING

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A705

ALL SQUARE

A surprising, far-reaching overhaul for theories about quadratic expressions

BY IVARS PETERSON

Start with the square numbers 1, 4, 9, 16, 25, 36, and so on. Pick any other number and you can express it as a sum of squares. For example, $10 = 1 + 1 + 4 + 4$ and $30 = 1 + 4 + 9 + 16$. In 1770, French mathematician Joseph-Louis Lagrange proved that every positive integer is either a square itself or the sum of two, three, or four squares. No more than four squares, $x^2 + y^2 + z^2 + t^2$, are ever needed to express any number, no matter how large.

Given Lagrange's result, number theorists asked whether there are other such expressions, called quadratic forms, that also represent all positive integers. In 1916, Indian mathematician Srinivasa Ramanujan uncovered 53 such expressions. He showed, for instance, that every number could be written as a square plus twice a square plus three times a square plus five times a square.

Ramanujan's discovery led mathematicians to tackle the general question: How can you predict when a quadratic form represents all positive integers?

Now, Manjul Bhargava of Princeton University and Jonathan P. Hanke of Duke University in Durham, N.C., have demonstrated that this question has a simple, surprising answer. Bhargava described the findings—a set of theorems—at the International Conference on Number Theory and Mathematical Physics, held last December at SASTRA University in Kumbakonam, India.

The work has turned up "many amazing results," says Ken Ono of the University of Wisconsin–Madison. "They are the ultimate theorems in the theory of representations of integers as sums of squares."

Universal Expressions: Looking for squares

Early last century, Srinivasa Ramanujan found 53 universal quadratics of the form $ax^2 + by^2 + cz^2 + dt^2$, where a, b, c, and d are integers. This list provides the values of a, b, c, and d for each of these forms. For example, $1x^2 + 2y^2 + 3z^2 + 5t^2$ yields all positive integers for suitable choices of x, y, z, and t.

[1, 1, 1, 2]	[1, 1, 1, 3]	[1, 1, 1, 4]	[1, 1, 1, 5]	[1, 1, 1, 6]
[1, 1, 1, 7]	[1, 1, 2, 2]	[1, 1, 2, 3]	[1, 1, 2, 4]	[1, 1, 2, 5]
[1, 1, 2, 6]	[1, 1, 2, 7]	[1, 1, 2, 8]	[1, 1, 2, 9]	[1, 1, 2, 10]
[1, 1, 2, 11]	[1, 1, 2, 12]	[1, 1, 2, 13]	[1, 1, 2, 14]	[1, 1, 3, 3]
[1, 1, 3, 4]	[1, 1, 3, 5]	[1, 1, 3, 6]	[1, 2, 2, 2]	[1, 2, 2, 3]
[1, 2, 2, 4]	[1, 2, 2, 5]	[1, 2, 2, 6]	[1, 2, 2, 7]	[1, 2, 3, 3]
[1, 2, 3, 4]	[1, 2, 3, 5]	[1, 2, 3, 6]	[1, 2, 3, 7]	[1, 2, 3, 8]
[1, 2, 3, 9]	[1, 2, 3, 10]	[1, 2, 4, 4]	[1, 2, 4, 5]	[1, 2, 4, 6]
[1, 2, 4, 7]	[1, 2, 4, 8]	[1, 2, 4, 9]	[1, 2, 4, 10]	[1, 2, 4, 11]
[1, 2, 4, 12]	[1, 2, 4, 13]	[1, 2, 4, 14]	[1, 2, 5, 6]	[1, 2, 5, 7]
[1, 2, 5, 8]	[1, 2, 5, 9]	[1, 2, 5, 10]		

COMPOSITION LAWS Bhargava has had a strong interest in math since childhood (*see box p. 153*). His mathematical research dating back to his graduate school years at Princeton contributed to the recent findings.

In his 2001 Ph.D. thesis, Bhargava proved several important theorems in a branch of number theory that grew out of work done by German mathematician Karl Friedrich Gauss in 1801. It focused on the polynomial expressions called quadratic forms, such as $ax^2 + bxy + cy^2$, in which each term has a variable with an exponent of 2 or is the product of two variables.

Gauss had developed a method for combining two quadratic equations ($ax^2 + bxy + cy^2 = 0$) in a way that differs from normal addition. Such a method is known as a composition law. Gauss' composition law offered a new way of thinking about relationships among numbers and led to the development of the mathematical field now known as algebraic number theory.

In his graduate work, Bhargava discovered 13 composition laws and developed a mathematical framework for explaining them.

"Bhargava's work is marked by extreme ingenuity and depth," says Krishnaswami Alladi of the University of Florida in Gainesville. Bhargava's unexpected discovery of new composition laws created an exciting line of research on a topic that had seen little activity since the time of Gauss.

For these novel and elegant formulations, Bhargava earned not only his doctorate but also a prestigious fellowship at the Clay Mathematics Institute in Cambridge, Mass. In 2003, at age 28, he joined the Princeton faculty as a full professor, one of the youngest scholars ever to achieve this rank.

MAGIC 15 In the meantime, Bhargava had become intrigued by the question of which quadratic forms represent all positive integers. Mathematicians call such expressions universal quadratic forms.

Early last century, Ramanujan focused on quadratic expressions of the form $ax^2 + by^2 + cz^2 + dt^2$, where a, b, c, and d are integers. He found the 53 universal quadratics in that group. For example, varying the values of x, y, z, and t in the quadratic form $x^2 + 2y^2 + 5z^2 + 10t^2$ can generate all positive integers. To get 14, set $x = 1$, $y = 2$, $z = 1$, $t = 0$; to get 32, set $x = 0$, $y = 1$, $z = 2$, and $t = 1$.

Mathematicians wanted to know how many more universal quadratics exist. They therefore needed a simple test to determine whether a given form represents all positive integers.

In 1993, John H. Conway of Princeton and his student William Schneeberger announced a startling result that applies to a subset of quadratic forms, those that can be defined by a specific type of matrix. To decide whether a form within that group is universal, they needed only to check whether it can represent each of nine integers: 1, 2, 3, 5, 6, 7, 10, 14, and 15. If it does, then that par-

ticular quadratic form represents all the positive integers.

This result came to be known as the "15 theorem." It serves as a filter, separating a certain group of quadratic forms into universal and nonuniversal expressions.

The universal quadratics previously recognized by Lagrange and Ramanujan belong to the matrix-defined subset considered by Conway and Schneeberger. So, the 15 theorem also provides a rapid proof of Lagrange's four-square theorem.

Conway and Schneeberger never published their lengthy and intricate proof of the 15 theorem. They proceeded, however, to try to extend it to a much wider group of quadratic forms, described as integer valued. This group includes expressions such as $3x^2 + xy + 5y^2 + 6z^2 + t^2$.

After performing additional calculations, Conway and Schneeberger conjectured that testing the numbers from 1 to 290 would suffice to tell whether a particular form is universal.

TEMPTING THEOREMS In the late 1990s at Princeton, Conway happened to describe the 15 theorem to Bhargava. "I was totally amazed: first, that something so incredible could be true and, second, that there was no [published] proof," Bhargava says. "I immediately dropped everything else I was doing ... and started thinking about the problem and its suspected generalization."

Bhargava began by devising a new proof for the 15 theorem. Recasting the problem in a geometric context, he came up with a line of reasoning that was much simpler and shorter than the proof originally developed by Conway and Schneeberger. With a simplified calculation, he found that, altogether, there are 204 universal, matrix-defined quadratic forms.

Mathematicians previously thought that the tally had been completed in 1948, when Margaret F. Willerding in her doctoral research at St. Louis University painstakingly worked out 178 universal matrix-defined quadratic forms. Bhargava's new enumeration, taking advantage of the shortcut provided by the 15 theorem, shows that Willerding missed 36 universal forms, listed one universal form twice, and included nine forms that are, in fact, not universal.

After his work on the 15 theorem, Bhargava went on to prove what he called the 33 theorem. It asserts that a matrix-defined quadratic form represents all odd numbers if it works for 1, 3, 5, 7, 11, 15, and 33.

"This result required the use of some very clever and subtle arithmetic arguments," Conway says.

Bhargava also discovered a way to check whether a quadratic form represents all prime numbers, that is, numbers evenly divisible only by themselves and 1. One needs only to check the primes up to 73, he reported.

TOUGH NUT To crack the much tougher 290 conjecture, Bhargava began collaborating with Hanke. "We were both interested in questions about quadratic forms, though from different perspectives," Hanke says. Hanke, for instance, was adept at using computers to examine quadratic forms.

"There are not too many number theorists who use computers to assist them in proving theorems, though there are more every day," Hanke says. "While a computer does not even come close to replacing a mathematician, it can be very useful in handling big tasks which you understand very well."

Hanke has explored the connection between quadratic forms and mathematical structures called modular forms and written software to enable others to do so.

29-STEP SHORTCUT **If an integer-valued quadratic form represents each of 1, 2, 3, 5, 6, 7, 10, 13, 14, 15, 17, 19, 21, 22, 23, 26, 29, 30, 31, 34, 35, 37, 42, 58, 93, 110, 145, 203, and 290, then it represents all positive integers. Using these numbers, you can show, for example, that the quadratic $3x^2 + xy + 5y^2 + 6z^2 + t^2$ is universal.**

D. APPLEWHITE/PRINCETON UNIV.

Number Theory and Musical Flow

Portrait of a young mathematician

PATTERNS — Bhargava playing the tabla.

Manjul Bhargava says that music and math "stimulate the creative spirit in very similar ways." Now a mathematician at Princeton University, Bhargava has been fascinated by the properties and relationships of numbers since his childhood. His mother, a mathematics professor, encouraged his early interest in numbers, and he enjoyed reading books on recreational math. By ninth grade, Bhargava had completed all his Long Island, N.Y., high school's math and computer courses.

As a child, Bhargava had a variety of other interests. He biked, played tennis, and flew kites. He also learned to play the sitar, guitar, and violin, and his mother introduced him to the tabla, a pair of small Indian drums, and to classical Indian music.

During his teen years, Bhargava studied the tabla in India, and he continued to play while pursuing mathematics as an undergraduate at Harvard University. An accomplished musician, he gave public tabla performances in the Boston area.

Both number theory and tabla playing may be viewed as the study of patterns, Bhargava says. "The goal of every number theorist and every tabla player," he explains, "is to combine these patterns, carefully and creatively, so that they flow as a sequence of ideas, tell a story, and form a complete and beautiful piece." —I.P.

"The ability for people to use computers to help them experiment with ideas, find patterns, and even occasionally prove theorems should have a very positive role in the development of mathematics in the future," Hanke contends.

After several years of effort, Bhargava and Hanke succeeded in proving the 290 theorem. Their direct, elegant solution to the problem answered a fundamental question about quadratic forms.

First, they found that a check of whether each of a certain set of 29 integers, each less than or equal to 290, reveals whether all integers can be represented by a given quadratic form. Bhargava and Hanke then used that finding to enumerate the complete list of universal, four-variable, integer-valued quadratic forms, which they determined includes 6,436 quadratics.

"The problem of finding and understanding universal forms with integer coefficients has now been completely solved," Hanke says.

However, "there is always room to play," he adds. "Some of the most fruitful ideas in mathematics arise by revisiting questions that have been answered, but seeing them from a new perspective."

Alladi notes, "In establishing this result, [Bhargava and Hanke] used a variety of techniques and results due to Ramanujan." Last December, Bhargava was one of two recipients of the SASTRA Ramanujan Prize, awarded annually to young mathematicians for outstanding contributions in areas influenced by Ramanujan.

In his address accepting the award, Bhargava noted that Ramanujan would have been pleased not only with the complete resolution of the problem of universal quadratic forms but also with the methods employed in the proofs.

Ono agrees. "It's beautiful mathematics," he says. ■

PEELING BACK ORION'S LAYERS

Astronomers unveil a portrait of star formation

BY RON COWEN

Somewhere in the universe, in the dim recesses of a vast cloud of gas and dust, wisps of material are slowly coalescing onto a clump that has been growing for hundreds of thousands of years. Squeezed by gravity, hydrogen atoms deep within the clump suddenly fuse, igniting a fiery glow. A star is born.

Over billions of years, star birth has illuminated countless galaxies and enriched the universe with the elements necessary for life. In the Milky Way, the energy shooting out of young stars pummels surrounding space, creating a tapestry of pillars, arcs, loops, and ripples. Yet for all the drama, scientists' understanding of star formation remains sketchy. Thick cocoons of gas and dust hide most of the action.

That's why astronomers have for decades been drawn to the Milky Way's Orion nebula. This young, star-forming region provides a remarkably clear window on star making. Intense radiation and fierce winds from a quartet of young, massive stars at Orion's center have blasted away much of the dusty material.

What's more, at just 1,500 light-years from Earth, Orion is the closest stellar maternity ward where massive stars have cleared the view.

Twelve years ago, soon after astronauts installed corrective optics on the flawed Hubble Space Telescope, the observatory's Wide Field and Planetary Camera took the first high-resolution images of Orion. It focused on the region's core (*SN: 6/18/94, p. 391*), which includes the massive-star quartet, called the Trapezium. Researchers were surprised to learn that many stars at the core, including some of the Trapezium, had the potential to make planets.

Now, a newer and sharper camera on Hubble, the Advanced Camera for Surveys, has recorded the full Orion nebula in detail at wavelengths ranging from the near-infrared to the ultraviolet. The new portrait, a mosaic of 520 razor-sharp Hubble images supplemented by ground-based observations, includes some 3,000 stars packed into a region 13 light-years across. The picture covers 10 times the area of Orion originally imaged by Hubble. About half the stars have never been seen before in visible light, from which astronomers can directly measure illumination from a star's surface.

The stars span an unusually wide range of sizes, from a few times Jupiter's mass to 40 times as heavy as the sun. Seeing stars of all sizes so close together provides an extraordinary opportunity to study star formation in all its variety, says Massimo Robberto of the Space Telescope Science Institute in Baltimore. He and his colleagues unveiled the mosaic in January at a meeting of the American Astronomical Society in Washington, D.C.

The portrait also reveals how shock waves, in response to ionizing radiation and winds from the quartet in Orion, sculpt surrounding space into pillars and other shapes. Massive stars not only have a strong influence on their surroundings but also are considered the first type of stars that formed in the universe.

"This is a treasure trove," comments astronomer Stephen Strom, director of the National Optical Astronomy Observatories in Tucson.

STAR-BIRTH SPOTLIGHT — Glow from the Trapezium, Orion's four heftiest stars, which appear at center of image.

ROBBERTO AND THE HST ORION TREASURY PROJECT TEAM, NASA, ESA

ORION'S BULLIES Astronomers are just beginning to sift through the wealth of data in the new Orion portrait. A main goal, says Robberto, is to measure the masses and ages of all the stars in the nebula. That will enable astronomers to map the lifetime of stars, determine how rapidly they're evolving, and learn whether the 3,000 stars formed episodically or in a single burst. Charting the history of Orion stars might serve as a blueprint for star formation in others parts of the Milky Way and perhaps other galaxies.

Determining a star's mass and age requires an accurate measurement of its brightness, and in that endeavor the sharpness of the Hubble images is invaluable, notes Robberto. Each star appears as a pinpoint rather than a blob. Researchers can distinguish the light emitted by an individual star from the glow of surrounding gas that's being heated and sculpted by that star, he says.

The accumulating data indicate that stars in the nebula formed all at once, in a baby boom only about a million years ago, says team member Lynne Hillenbrand of the California Institute of Technology in Pasadena. Astronomers had previously proposed that star birth in Orion was a more sluggish process, spread out over several million years. That scenario was based on less-accurate estimates of stellar brightness in the nebula, Hillenbrand explains.

Another team member, Bob O'Dell of Vanderbilt University in

Nashville, led the first Hubble effort to image Orion in 1994. He's now examining the effect that massive stars at Orion's core, including the Trapezium, have had on stars at the cloud's outskirts. These massive stars, the bullies of Orion, produce winds of charged particles a million times as dense as and more energetic than those streaming from the sun.

Images taken at specific wavelengths have enabled astronomers to distinguish the stars from the glow of shock waves generated when strong stellar winds slam into surrounding space. The shock waves erode surrounding gas clouds, and some of the waves may compress free-floating clouds, triggering them to collapse and make new stars.

Hundreds of shock waves travel within Orion. Near the center of the nebula, the shocks race at several hundred kilometers per second, while those in the outer nebula move at only about one-tenth that speed, O'Dell says.

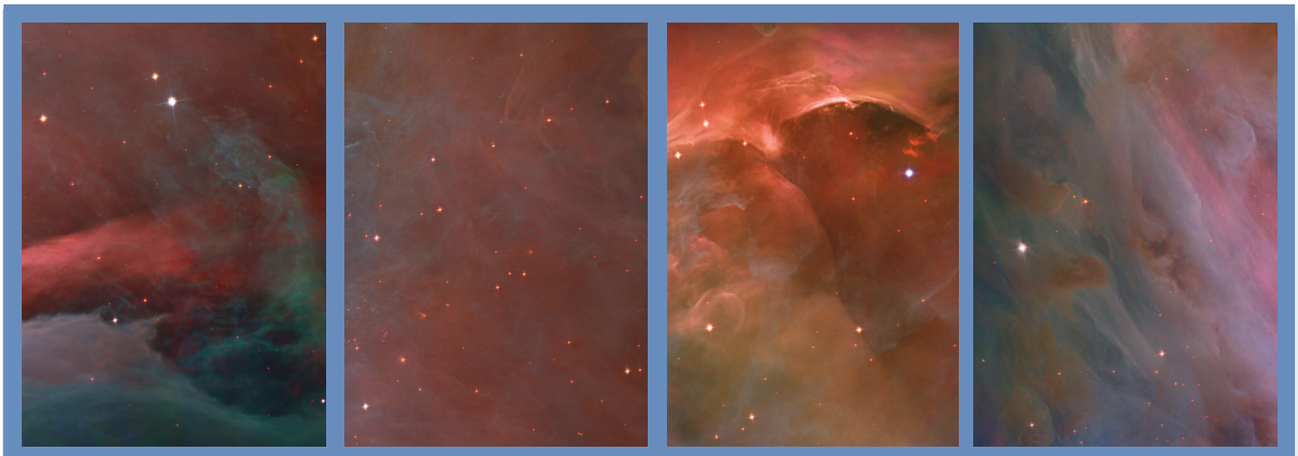
Using the shapes and speed of these disturbances to indicate the waves' direction, O'Dell finds that a series of shock waves in the outer part of Orion "trace right back into the middle" of the nebula, about 6 light-years away, he told *Science News*.

A few of these low-mass pairs might be so small—less than 13 times the mass of Jupiter—that they wouldn't even qualify as brown dwarfs. Instead, they would be considered giant planets unattached to a parent star. Astronomers have spied such free floaters in other parts of the galaxy.

Free-floating planets in the high-resolution Orion portrait could shed light on their origins, Robberto says. In the standard planet-formation theory, planets arise exclusively when gas and dust coalesce within disks encircling young stars. In this scenario, free-floating planets once orbited a star but got kicked out of its system, perhaps by the tug of another star.

But a new hypothesis holds that some free floaters never had a parent star. Instead, they arose directly from a star-making cloud of dust and gas.

If mass measurements confirm that some of the red-dot pairs are made up of planets, the standard theory can be put to the test. Robberto and his colleagues plan to determine the velocity of the planets to discern whether they've all received a kick. If they haven't, the researchers say, some of the planets must have come directly from the same clouds that make stars.



ORION CLOSE-UP — Four detailed views of the Orion star-forming region. Left image: Dark-red column shows the edge of the cavity carved by the ultraviolet light emitted by the Trapezium. Second image: Faint red stars are brown dwarfs, objects too lightweight to burn as stars. This portrait for the first time shows brown dwarfs in Orion in visible light. Third image: Glowing region reveals arc and bubbles formed when stellar winds emanating from the Trapezium stars collide with interstellar material. Right image: Dense, dark pillars of dust and gas—the homes of embryonic stars—are being eroded by intense ultraviolet light from the Trapezium stars.

ROBBERTO AND THE HST ORION TREASURY PROJECT TEAM, NASA, ESA

The team focused on shocks emanating from two of the star-forming centers in Orion. One region, known as BN-KL, lies about half a light-year behind the Trapezium, as viewed from Earth; the other, Orion South, resides just a few hundredths of a light-year behind the Trapezium.

By tracing the most distant visible shock waves emanating from these regions, O'Dell's team finds that winds and jets from BN-KL have been pummeling their surroundings for 900 to 1,100 years, while those from Orion South have been blowing for 200 to 1,500 years. These are short periods compared with the million years required for star birth, notes O'Dell. So, winds and jets from newborns appear to blow only intermittently.

Older shock waves may exist but not show up because they've moved well beyond the star-forming clusters, where they set the gas aglow, and into more-tenuous parts of the nebula.

PLANETS IN THE MAKING While O'Dell and his colleagues look at Orion as a whole, other astronomers are zooming in on specific regions within the nursery. Several faint red dots identified by Robberto and his team indicate pairs of objects known as brown dwarfs, which glow brightest at near-infrared wavelengths.

Brown dwarfs form as stars do, from the collapse of clouds of gas and dust, but unlike stars, they're not massive enough to sustain nuclear fusion at their cores.

Astronomers are using other information from the Hubble images to explore the planet-making potential of Orion's stars. The researchers are examining the stars surrounded by planet-making disks of gas and dust to predict which will form massive, Jupiterlike planets and which will create smaller, Earth-mass objects. Our solar system might be unusual in having both a Jupiter and smaller planets.

Hubble's measurements of ultraviolet light (UV) take center stage in the analysis of planet formation, says Strom. UV is produced when material from a disk slams into a star's surface at speeds of several hundred kilometers per second. Those collisions produce hot spots with temperatures about 10,000 kelvins, almost twice that of the surface of a sunlike star.

The UV intensity from such hot spots reflects how rapidly material is crashing onto the surface of the young star, says Strom. Calculations suggest that those stars with the densest disks produce the brightest ultraviolet emissions. High-density disks are the ones most likely to pack together lots of material rapidly into large, Jupiter-size planets, says Strom. If even a single planet several times heavier than Jupiter forms and migrates inward, its gravity could kick a lower-mass planet out of the system.

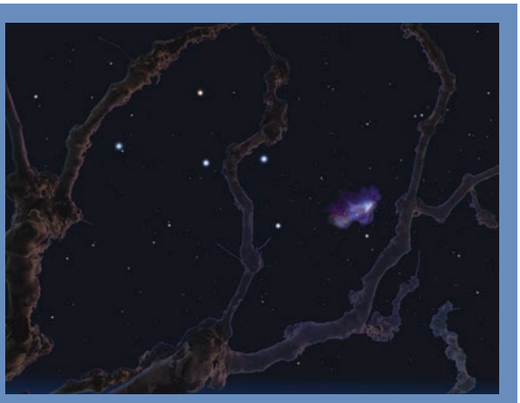
Earth-size planets, therefore, probably reside only in low-density disks, which produce only dim UV, Strom notes.

OLDER OR YOUNGER At roughly 1 million years of age, the Orion nebula is a relatively immature star-forming region. While its most massive stars have emerged from their dusty cocoons, many of its lower-mass stars have not yet done so. Robberto and his colleagues have now proposed using Hubble to examine a star-forming region that's 10 times as old as Orion. They say that comparing an older region with Orion will enable astronomers to trace the process of star birth and planet formation in more detail and over a longer time.

The proposed observation would pose a challenge to Hubble because the orbiting telescope has an extremely narrow field of view. The persistent winds and radiation from massive stars cause the stars of older nurseries to disperse, so a full picture would have to cover a vast area. To take a picture as sharp and complete as the Orion portrait, the observatory would have to spend at least 100 times as much time—its most precious commodity in its last few years of operation—as it required to depict Orion.

Other astronomers have the opposite quest: to compare Orion with a much younger nebula. Researchers announced at the January astronomy meeting that they had identified what may be a future Orion, a gas cloud that has only begun to shine in the constellation Cassiopeia. Shrouds of dust now hide most of the visible light from the nebula, called W3, but the cloud could become the "grand nebula in Cassiopeia," says Tom Megeath of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass.

He and his colleagues speculate that in 100,000 years or so, W3 will be as bright as the Orion nebula is now. Indeed, W3 could come into full bloom just as the Orion nebula begins to fade, says Megeath. The researchers base their findings on infrared and radio wave observations of a clump of budding stars in W3. The team made these long-wavelength images with Hubble's infrared camera and the Very Large Array radio telescope near Socorro, N.M.



UP AND COMING — Roughly 100,000 years from now, a budding star formation region, W3, may become as bright as the Orion nebula is today. This artist's illustration depicts W3 as it may look in that future era.

The long wavelengths penetrate the star-forming clump's thick layers of gas and dust better than visible light does. Astronomers had previously speculated that the cloud contains a single pair of new stars. But Megeath's team found that it actually holds four or five young, massive stars—like the ones in Orion's Trapezium but at a much earlier stage of development.

Over the next 100,000 years, says Megeath, these stars may transform W3 in the same way in which the Trapezium stars have altered Orion. Their harsh ultraviolet light and winds will eat away at their dusty surroundings, carving a hole through which visible light can shine.

The notion that W3 could be the next Orion is intriguing, says Hillenbrand, but she cautions that Megeath's team has examined only the most-massive stars in the region. The researchers can't be certain whether W3, like Orion, also contains a plethora of lower-mass stars.

Still, such an up-and-coming place, along with the more established Orion, could become "favorite targets for professional astronomers trying to solve the riddle of massive-star formation," says Megeath. ■

D.A. AGUILAR/HARVARD-SMITHSONIAN

OF NOTE

BIOMEDICINE

Indigestion drug makes headway

Functional dyspepsia is the diagnosis that doctors often assign to people with chronic indigestion who don't have a stomach ulcer or clear signs of acid-reflux disease. These people have a sense of fullness even though they haven't eaten much, and they have bloating, nausea, and stomach pain that can resemble heartburn. The cause of functional dyspepsia is unclear, and standard medications offer little help.

Researchers report in the Feb. 23 *New England Journal of Medicine* that a drug called itopride relieves symptoms of functional dyspepsia significantly better than a placebo does.

Physician Gerald Holtmann of the Royal Adelaide Hospital in Australia and his colleagues randomly assigned 554 volunteers with functional dyspepsia to receive one of three dosages of itopride or a similar-looking inert pill.

After 8 weeks, 60 percent of the people getting itopride and 41 percent of those on the placebo reported improvement in their symptoms.

Itopride binds to a protein called the D2 dopamine receptor on cell surfaces. The authors note that stimulation of this receptor enhances the release of the hormone prolactin, and, in their test, prolactin concentrations rose in people getting itopride but not the placebo recipients. Earlier work suggested that prolactin speeds the flow of food through the stomach, possibly relieving functional dyspepsia. —N.S.

PLANETARY SCIENCE

Pluto's posse

Images taken by the Hubble Space Telescope on Feb. 15 have confirmed that Pluto has two small, previously unknown moons. First detected by Hubble last year (*SN: 11/5/05, p. 291*), each moon is only about 50 kilometers across, less than one-hundredth the size of Pluto's giant moon Charon.

One of the bodies lies about 48,000 km from Pluto and the other lies 64,000 km away. In contrast, Charon orbits 19,000 km away from the planet. The February observations rule out the possibility that other similarly small satellites orbit closer to Pluto than either of the new moons do.

The two moons lie in the same plane as Charon and move in synchrony with it. Those properties suggest that the tiny moons were born in the same giant collision that astronomers say spawned Charon. In this model, Charon arose when an object about the size of Pluto struck the planet 4 billion years ago. A large chunk of debris coalesced to form Charon, while smaller bits merged to form the two tiny moons, argue Alan Stern of the Southwest Research Institute in Boulder, Colo., and his colleagues in the Feb. 23 *Nature*. The researchers, who discovered the small moons, also note that the impact could have created an as-yet-unseen dust ring around Pluto.

The findings suggest that the handful of other denizens of the outer solar system known to have partners about as big as Charon (*SN: 1/14/06, p. 26*) may also harbor tinier moons and rings, the team says.

The latest Hubble observations, taken March 2, show that the trio of Pluto's moons have similar color, another clue that they have a common origin, Stern says. —R.C.

STERN, H. WEAVER, ET AL./ NASA

THREE'S COMPANY
Pluto and its two small, outlying moons, along with giant moon Charon.

BIOMEDICINE

A link between emotional stress and heart attacks

The biological events linking emotional stress and heart attack are poorly understood. Researchers now find that in some people with heart disease, a stressful event precipitates changes in blood components and flow that may trigger a heart attack.

Scientists identified 34 men who had recovered from heart attacks that occurred an average of 15 months earlier. Fourteen had experienced emotional stress, such as arguments with neighbors or sadness about a sick or deceased relative, less than 2 hours before their heart attacks, says Andrew Steptoe, a psychologist at University College London. The other 20 men reported no such stress just before their heart attacks.

Each participant voluntarily completed a series of mentally challenging tests designed to rev up stress. After the tests, the men who had had a stressful event before their heart attacks took longer to stabilize their systolic blood pressures—the high number of the two readings—and heart rate than did the other men, Steptoe and his colleagues report in an upcoming *Proceedings of the National Academy of Sciences*.

Blood samples drawn immediately after the tests showed that accumulations of platelets bound to immune cells had roughly doubled in the men who had had a stressful event before their heart attacks. The blood reading was unchanged in the other men. High accumulations of platelets can trigger a heart attack in people who have coronary artery disease.

While clinicians can't counsel at-risk patients to avoid emotional upset, Steptoe says, "we can help them cope with problems like uncontrollable anger." —N.S.

BIOCHEMISTRY

Spore-detecting diving board

Researchers have demonstrated a new way to detect bacteria. The approach could lead to faster and more reliable detection of virulent microbes in the environment.

Most detection systems capture microbes by using an antibody to bind to a region on a pathogen's surface, says Philip S. Low of Purdue University in West Lafayette, Ind. But these regions aren't usually important to the pathogen's survival, so they often mutate, he says. This renders the detection system ineffective.

Low's group instead designed a protein fragment to recognize a region on a microbe's surface that doesn't typically change. In a pathogen, he says, such a site can't be mutated without the microbe losing virulence. So, there's a much lower chance that alterations in the targeted region will defeat the test, says Low.

The team paints the protein fragment, or peptide, onto a silicon chip frayed at one end into rectangles 500 micrometers (μm) long, 100 μm wide, and 1 μm thick. When these miniature diving boards capture spores, their surface tension changes, causing a deflection that can be measured with a laser, explains Low.

In an upcoming *Journal of the American Chemical Society*, Low's group reports results for a chip frayed into eight sections—four coated with a binding peptide and four with a nonbinding peptide. The binding

OF NOTE

peptide captured more spores of *Bacillus subtilis*, the nonvirulent form of the bacterium that causes anthrax. The researchers confirmed the spores' presence with microscopy.

The group is now testing a peptide specific for the anthrax pathogen *Bacillus anthracis*. —A.C.

BIOLOGY

Thymus twice as nice for mice

Researchers have long assumed that a mouse has only a single thymus. This organ, located directly over the heart, generates immune system components called T cells that protect the body from many pathogens. However, new research has turned up a second thymus, located in the neck.

While generating mutant mice for an unrelated study, Hans-Reimer Rodewald of the University of Ulm in Germany and his colleagues noticed that some of the altered animals had no thymus. However, the mice could still produce T cells, a job that only the thymus performs.

Searching for the T cells' source, Rodewald's team examined the animals' entire bodies. Eventually, they focused on an organ in the neck that looked like a lymph node. Unlike other lymph nodes, this organ showed activity in several genes previously known to function only in the thymus.

When the researchers transplanted these mysterious organs into other mice that had no evidence of thymus function, the animals began producing working T cells. The team reports these findings in an upcoming *Science*.

Rodewald notes that the findings could lead scientists to rethink previous experiments in which researchers removed thymuses from lab mice to stop them from making T cells. "We're not saying that those experiments don't hold up, but that you have to take this extra little thymus into consideration," he says. —C.B.

CHEMISTRY

Fragment foils Alzheimer's protein

Chemists have synthesized a protein fragment that, in test-tube studies, disrupts the formation of the fiber networks suspected to be a cause of Alzheimer's disease.

In the brains of Alzheimer's patients, a protein called beta-amyloid assembles into fibers, which clump together to create networks of fibers called plaques. In the first step toward this fiber formation, the string-like proteins bind along their sub-nanometer lengths, says Robert P. Hammer of Louisiana State University in Baton Rouge. The resulting sheets of protein organize into micrometer-scale fibers.

Hammer's team focused on a set of five amino acids in the middle of the beta-amyloid, which has a total length of 40 amino acids. The scientists synthesized a protein fragment, or peptide, that mimicked this set, but they tweaked certain chemical groups that normally enable beta-amyloid proteins to bind. The idea was to create a peptide that would "interrupt or change the assembly of beta-amyloid protein," says Hammer.

The researchers compared a sample of only beta-amyloid protein with a mixture of beta-amyloid protein and the peptide at equal concentrations. The samples were kept at room temperature for 4 ½ months. Transmission-electron-microscopy images revealed fibrous structures in the pure beta-amyloid sample, but the sample containing the peptide showed no fibers, the team reports in an upcoming *Journal of the American Chemical Society*. —A.C.

NEUROSCIENCE

Low-protein diet boosts treatment

In patients with Parkinson's disease, the brain's dopamine-secreting neurons inexorably die off. The most common treatment to combat the tremors, slowness, and rigidity in these patients is a dopamine precursor called levodopa. But the drug's effects can decrease over time, causing a person to cycle between "on" periods of low symptoms and "off" periods of high, often-debilitating, symptoms.

A research team in Italy reports that lowering the protein content in a patient's diet can improve levodopa therapy and reduce off periods.

Researchers know that protein affects the movement of levodopa into the brain: Too little protein results in too much medication too fast, causing involuntary, jerking muscle movements. Too much protein results in too little levodopa acting against tremors and other Parkinson's symptoms.

Ioannis Ugo Isaias of the Institut Clinici di Perfezionamento in Milan and his colleagues compared the effects of a low-animal-protein diet and a more typical, balanced diet in 18 Parkinson's patients. The volunteers followed one diet for 2 months and then the other diet for 2 months. During both phases of the study, patients recorded the lengths of their on and off periods as well as the dosages of levodopa required to quell their symptoms.

While eating the low-protein diet, all 18 patients recorded fewer off periods and averaged about 100 fewer minutes of off time per day than while on the balanced diet. Twelve patients reported no change in levodopa dosage while on the low-protein diet, but six patients required an average of 9 percent less levodopa in their midday dose while eating less protein. The researchers reported their findings on Feb. 23 at the World Parkinson Congress in Washington, D.C.

Though "more studies are needed" to confirm the value of eating less protein, the results suggest that "instead of [just looking for] new drugs, we can use the ones we have more effectively," says Isaias. —C.G.

BIOMEDICINE

Genes for macular degeneration

Variations in two genes could account for three-quarters of all cases of age-related macular degeneration, a new study reports.

The disease is the leading cause of blindness in people over 60 and affects more than 50 million people worldwide. It occurs when light-sensing cells malfunction in a part of the retina called the macula and block the central field of vision.

Last year, a team led by Columbia University researcher Rando Allikmets reported that certain forms of a gene for a protein called factor H can increase a person's risk of age-related macular degeneration. Other versions of this gene seem to protect a person from the disease. Factor H shuts off inflammation throughout the body once an infection is eliminated and the immune reaction is no longer needed.

However, of the 1,300 elderly people examined in that study, 29 percent had a risky version of the factor H gene but didn't have macular degeneration. That led Allikmets' team to suspect that other genes affecting the inflammation response that factor H regulates also play a part in the disease.

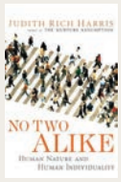
After reexamining blood and tissue samples from the previous study, the researchers honed in on a gene for a protein called factor B, which turns on the same pathway that factor H shuts off. Like the factor H gene, the factor B gene appears to have some variants that increase the risk of macular degeneration and others that provide a protective effect. About 74 percent of the study subjects with the disease had risky gene variants for factor H, factor B, or both, the researchers report in an upcoming *Nature Genetics*. —C.B.

Books

A selection of new and notable books of scientific interest

NO TWO ALIKE: Human Nature and Human Individuality

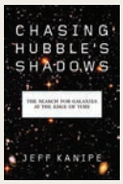
JUDITH RICH HARRIS



Most people believe that they're the product of both their genes and their environments, or nature and nurture. Why, then, do conjoined identical twins, who have the same genes and the same environment, develop different personalities, hopes, and ambitions? What is really at the root of human individuality? Harris, an independent investigator, seeks answers beyond the nature-nurture debate, which she views as insufficient for explaining the development of personality. She first dispels many of the myths that surround human development, including, for instance, the idea that birth order has an effect on personality. She asserts that many of the current theories of development give too little weight to the influence of genes and heredity on behavior and that they don't correctly incorporate the effect of the environment. She cites classic psychology experiments with monkeys as well as cutting-edge research with DNA as evidence that there is more to the puzzle of human individuality than an interaction between genes and environment. Harris' view is that three systems—relationship, socialization, and status—interact to develop personality. These systems have evolved in people to prepare us for life outside our homes, as members of a society. Readers interested in evolutionary psychology and human development will find a lot to ponder here. ***Norton, 2006, 352 p., hardcover, $26.95.***

CHASING HUBBLE'S SHADOWS: The Search for Galaxies at the Edge of Time

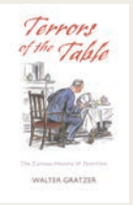
JEFF KANIPE



Part history, part detective story, and even part travelogue, this is astronomy journalist Kanipe's attempt to explain cosmology to the average reader. First, the definition: Cosmology is the branch of astronomy that studies the origin, evolution, and structure of the universe. The author recounts the field's history, presents interviews with astronomers, and takes readers on a trip to the 10-meter Keck telescopes atop Hawaii's Mauna Kea. The largest part of the book, however, is devoted to explaining the early life of the universe. After the Big Bang, the universe had a dark age dominated by light-blocking hydrogen gas. As the gas began to coalesce, new stars burned off the hydrogen fog. After this process, the now-transparent universe evolved galaxies, including our own solar system. With the author's obvious enjoyment of the subject matter and his ability to explain difficult concepts, this book will be both instructive and enjoyable for anyone with an interest in the night skies. ***Hill and Wang, 2006, 224 p., color photos, hardcover, $24.00.***

TERRORS OF THE TABLE: The Curious History of Nutrition

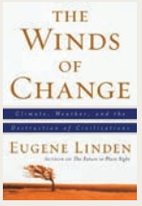
WALTER GRATZER



Before the early 17th century, little scientific attention was given to what we put in our mouths, beyond basic admonitions against overindulgence and obesity. Biophysicist Gratzer unfolds the history of nutrition science as it advanced, illuminating how food is processed in the body and what nutrients are essential to health. Initial nutritional theories followed misguided ideas about bodily humors. Then, in the 18th century, Antoine Lavoisier defined basal metabolic rate. In 1822, physician William Beaumont studied the workings of the stomach through a bullet hole in a wounded soldier. Louis Pasteur's 1860 demonstration that spoilage is caused by microorganisms also contributed to scientists' understanding of digestion. Gratzer examines food preservation through canning, pickling, and refrigeration; the recognition of the importance of vitamins; and the emergence of various dietary fads that promise eternal youth and health. The author ends this history with an early review of nutrition in the new millennium, with its focus on good and bad cholesterol, the backlash against carbohydrates, and the uphill fight against obesity in many populations. ***Oxford, 2005, 288 p., b&w plates, hardcover, $30.00.***

THE WINDS OF CHANGE: Climate, Weather, and the Destruction of Civilizations

EUGENE LINDEN



Anthropologists and historians who piece together the how and why of the ascent and collapse of civilizations, Linden writes, often overlook one major factor: climate. The recent devastation of New Orleans by Hurricane Katrina brings to light the power of climatic events to alter the course of history. The author, an environmental journalist, outlines how the young science of analyzing ice cores enables scientists to determine climate trends going back 110,000 years. Those data and analyses of historical weather records are reshaping scientists' ideas about the interplay between people and their environment. For example, 4,200 years ago, people of the Akkadian civilization in the Fertile Crescent were abruptly driven from their homes by drought and famine that would last some 300 years. A mysterious event in A.D. 536—perhaps a comet or asteroid impact—darkened the sky for more than a year. The sudden climate change, producing drought in Mesoamerica and famines in Asia, pushed waves of migration and plague across Europe and the Middle East. Linden describes the evidence for these and earlier climate scenarios. It includes the analysis of lakebed sediments to indicate how temperatures changed around the globe. He also looks at the role played by modern society in recent climate changes, such as the growing strength of El Niños in the Pacific. The author offers a bleak outlook for humanity if steps aren't taken to stop global warming. ***Simon & Schuster, 2006, 320 p., hardcover, $26.00.***

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LETTERS

Seasonal effect?

Might your article, "Bright Lights, Big Cancer" (*SN: 1/7/06, p. 8*), on breast cancer have missed something? If the daily light-dark cycle affects melatonin, is there a seasonal change in cancer rates in the Northern (and Southern) Hemispheres? If so or not, that might give a clue to any latency period.

ALAN MACGREGOR, SALMON ARM, B.C.

Bad fit?

The picture of the new cochlear implant ("Hearing implant knows where it goes," *SN: 1/14/06, p. 29*) shows a square piece that is to be implanted deeply into the inner ear. "Square peg in a round hole" was my response. Why doesn't the probe have a more rounded shape?

YVONNE LYERLA, SONOMA, CALIF.

Only the slender shaft attached to the square piece goes into the inner ear. —P. WEISS

All together

I experienced something very interesting after Sept. 11, 2001 ("Masters of Disaster: Survey taps resilience of post-9/11 New York," *SN: 1/14/06, p. 19*). Rather than post-traumatic stress disorder, there seemed to be a togetherness exhibited. I found people to be more courteous, thoughtful, compassionate, and polite in general. I'm sure that people can say they experienced this same type of oneness in past experiences.

J. DAWSON, FOLSOM, CALIF.

Correlation, not cause

The conclusion drawn by pediatrician Julie C. Lumeng in "Fattening fears" (*SN: 1/14/06, p. 30*) is that parents' safety concerns lead to kids being cooped up indoors where the opportunity for exercise is limited and food is easily accessible. While the study apparently shows a correlation between parental fears and overweight children, correlation does not equal causation.

I would hazard a guess that parents who live in neighborhoods that create fear live there because they can't afford to live anywhere else. Such families may not be able to afford nutritious food, may lack the education to understand the benefit of a balanced diet, or may be working single parents and simply unable to manage their children's eating habits.

SKIP SIMONDS, SAUGUS, CALIF.

In this study, fear of crime correlated with weight, even taking into account family income. — J. RALOFF

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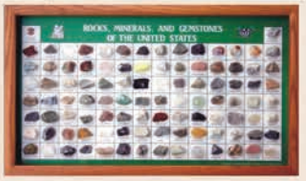
Rocks, Minerals and Gemstones



Rocks, Minerals and Gemstones of the U.S. 100 piece set, size: 20"L X 12"W X 1"D, Oak casing. Great for classrooms, collectors or young scientists. No glass covering necessary. Suitable for wall hanging. Order #JPT-1888, Cost: $85.00 *Meteorite included!*

Oviraptor in Egg Replica
Authentic, hand-painted replica of the first carnivorous dinosaur embryo ever found. It was discovered in 1994, in Mongolia. The replica is the actual size and is constructed of durable polyvinyl. NEW! Comes with educational tag. Size: 5"L X 3" H, Order: #JPT-ovegg, Cost $12.95; #JPT-ovishell, replica with small real, generic dino egg shell, with info. Cost $19.95

Sumerian Medical Tablet

Sumerian Medical Tablet - Reproduction of the earliest known prescription written in cuneiform. A detailed booklet comes with the tablet and gives a translation and history. The original was found a Nippur (c. 2100 B.C.). Size: 6" X 3" X about 3/4" thick. Comes with an adjustable walnut wood easel stand. Order # JPT-sumer, Cost: $69.95

Mayan Altar Leg Bookend

This is an exceptionally impressive reproduction inspired by a limestone carving from Piedras Negras, Guatemala, 790 A.D. This reproduction of the west leg of Altar 4 is one of four with symbols of rain and clouds. This leg probably represents one of the four "chacs," the serpent spirits that bring rains and wind from the four directions. The modern Maya still offer food and drink to the four "chacs" at planting time. Comes with information. Order #JPTmayan12, Cost: $69.95, #JPT-mayan 2, Two for $130

Description: Weight: 8 lbs. Size: 5 1/2"W X 4 1/4"D X 8 1/4"H

Dino Panorama Floor Puzzle - 70 piece - NEW!
Puzzle size: 39"W X 14"H
#JPT-dinofloor, Cost: $16.95
Advanced Dino Panorama Puzzle - 1,000 piece - Puzzle size: 37"W X 13"H #JPT-1000 Cost $19.95,
Both puzzles are based on the deluxe poster shown above, right.

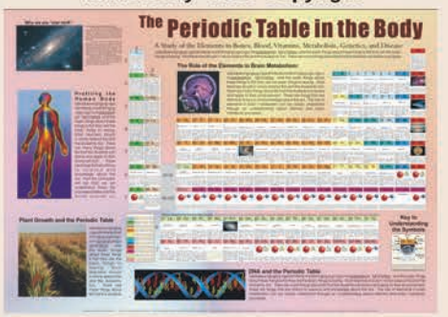
Nautilus Shell - Tri-cut

Beautiful natural nautilus shell from the Phillippines. One of natures best examples of the Fibonacci sequence! Comes with information about the shell and Fibonacci sequence Tri-cut. Size: 5-6", Order#JPT-naut14, Cost $28.95; Pearlized,6-7" JPT-pearlized, cost: $32.95

Deluxe Dinosaur Panorama Poster

The Deluxe Dinosaur Panorama poster - A colossal wall poster that embodies the elegance and power of dinosaurs. Painted by Haruo Takino. Size: 64.375"L X 22.75"H and comes laminated. Order #JPT-dinopan cost: $38.00

The Periodic Table NEW! in the Body - 2006 Copyright



The Periodic Table in the Body - poster discusses each of the elements on the Periodic Table in relation to how the body uses them. It helps us understand how the elements are used by bones, blood, metabolism, genetics, and disease. Also, there are five sections to this periodic table poster. One section examines why we are indeed "star stuff" and our chemical ties to the universe; others profile the chemical makeup of the human body, plant growth, DNA, and the role of the elements in brain metabolism. Full color, laminated, 28"W X 38"H poster, Copyright 2006....#JPT-4191.... Cost $28.95

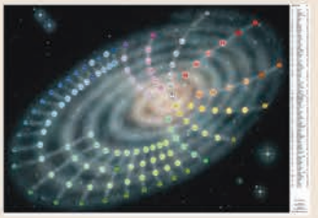
Periodic Table in Earth & Sky

Truly becoming a CLASSIC! A colorful poster presentation of the elements in our Universe. Featuring 117 razor-sharp color photos and graphics, this tour-de-force of the elements shows samples of minerals and crystals containing the element in question. Printed on heavyweight stock UV protective coating.
38.5"W x 27"H
#JPT-7200 Laminated version: $28.95

Attractive Ammonite Pendant(above) wrapped in 14K gold. These are the best quality in the world, and are from Madagascar. The ammonite comes in an attractive jewelry box with information and with authenticity. There will be some variation in color and pattern, as each is different but of the same quality. Size: 1 1/2" W x 2 1/4" L, Order: #JPT-1719 $120

CALL TOLL FREE!
Free Genome poster with orders over $45!

Chemical Galaxy: *A New Vision of the Periodic Table of the Elements*



Chemical Galaxy poster is a new creation in the world of periodic table charts. Developed by Philip Stewart, Oxford University, this table was created in a spiral design. It uses a starry pathway to link the elements and to express the astronomical reach of chemistry. Copyright 2006, Size: 26"H X 38"W Laminated, info sheet provided. Order#JPT-2221, Cost $28.95

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