SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

AUGUST 18, 2007 PAGES 97-112 VOL. 172, NO. 7

chirality, on the one hand …

beetle's novel color change

ms therapy passes first test

the power of paper

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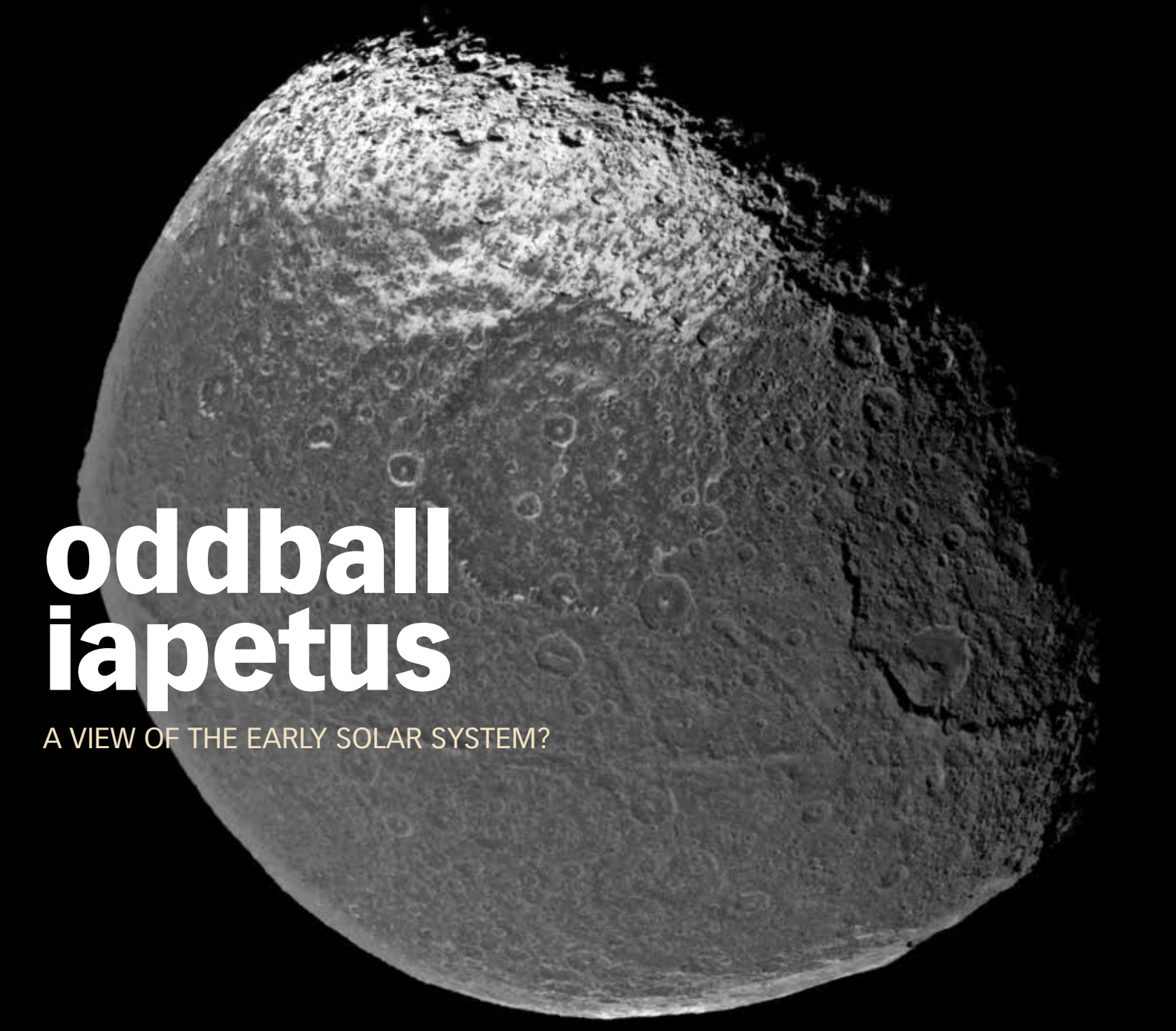

oddball iapetus

A VIEW OF THE EARLY SOLAR SYSTEM?

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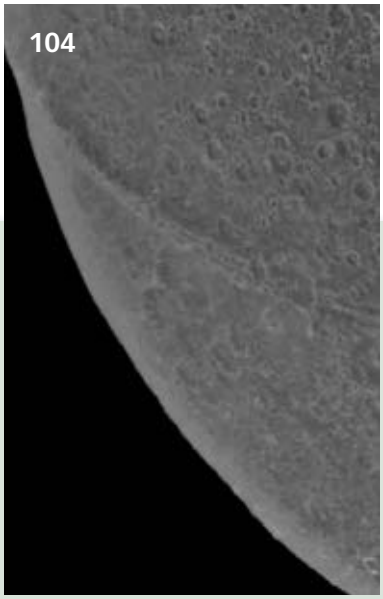

Features

This Week

THIS WEEK ONLINE
http://blog.sciencenews.org/

Food for Thought Coffee and tea appear to keep aging women sharp but men, not so much.

MathTrek A simple mathematical argument explains why children suddenly learn lots of new words.

Meetings

Of Note

Departments

Cover Saturn's strange moon Iapetus, imaged by the Cassini spacecraft late in 2004, has a ridge running along its equator. This feature and others of the walnut-shaped moon suggest that Iapetus has been frozen in time, giving astronomers a glimpse into the outer solar system's early development. (SSI, JPL/NASA) Page 104

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Mood Bugs

Beetle changes color in fluid fashion

Color-changing animals, such as chameleons and squid, typically alter their hues when nerve signals or hormones spur pigment cells in their skin to expand or shrink.

The Panamanian golden tortoise beetle, however, changes color dramatically from metallic gold to matte red by a very different method, researchers report. It uses its body fluid to structurally alter the reflectivity of its shell—a trick that could one day be built into devices that would optically signal the presence of a liquid.

This color-change method is "something very rare," says lead author Jean Pol Vigneron of the University of Numar in Belgium.

The 8-millimeter-long beetle, *Charidotella egregia*, sports a transparent shell made of the biopolymer chitin, which forms insect exoskeletons. The shell normally reflects a metallic-gold color, but that sheen fades to reveal a red pigment when the beetle is disturbed.

Using electron microscopy, Vigneron and his colleagues found that the shell has a three-tiered structure, with each tier consisting of a number of closely packed layers. Each of the tiers—the thickest is at the bottom, the thinnest at the top—reflects a particular wavelength of light, and those wavelengths combine to produce the gold coloration. Beneath the tiers is a layer of red pigment.

The researchers' high-resolution images also revealed randomly placed patches of nanosized grooves or channels in the layers that make up each tier. When the beetle's body fluid fills these channels, the layers become smooth. Only then do the tiers act as "perfect mirrors" that give the beetle its metallic sheen, Vigneron says.

Absence of fluid "destroys the optical properties" of the mirrors, Vigneron says, because the irregular surfaces don't reflect light cleanly. With no smoothing fluid, the tiers act not as mirrors but as windows to the red pigment below. Moreover, diffuse scattering of light by the shell takes away the beetle's metallic shine, giving it a matte appearance.

To confirm that liquid is crucial to the color change, the team deep-froze a beetle while it was colored gold. The dead, frozen beetle turned red. Shortly after the beetle was removed from the freezer, its color changed back to metallic gold. Later, when the dead beetle had dried out, it turned permanently red.

The findings appear in an upcoming *Physical Review E*.

"It's a new mechanism that hasn't been found in nature before," says Andrew Parker of the University of Oxford in England, who studies color changes in animals. Parker says that most animals control color at the cellular level, but that the beetle's ability to change color on a larger scale might have commercial potential.

"Nature never stops surprising us with elegant solutions to everyday problems," says Radislav Potyrailo, an analytical chemist at the GE Global Research Center in Niskayuna, N.Y. Engineers could learn a lot from biological mechanisms, he says. "There are quite a lot of solutions in nature that we admire and would like to mimic." —C. BARRY

M. GUERRA

COLOR ME BEETLE The 8-millimeter-long golden tortoise beetle uses shell structures, rather than pigmented cells, to dramatically change color. Main image and top inset show reflective-gold state, which progresses to matte red at bottom.

Calming Factor

DNA vaccine for MS passes initial test

An experimental vaccine for people who have multiple sclerosis has proved safe, clearing a necessary first hurdle toward regulatory approval. The results of this initial trial also suggest that the vaccine can indeed quell the self-destructive immune reaction that many scientists believe causes the disease.

Despite this early promise, the researchers caution that the findings are based on data gathered from a small group over a limited time.

The researchers used a technique called DNA vaccination, which introduces a gene into the body to elicit an immune response. But rather than rile the immune system against a foreign foe, the new multiple sclerosis (MS) vaccine seeks to induce immune tolerance of myelin basic protein, a component of myelin. A fatty material that protects nerves, myelin is degraded in MS, robbing patients of muscle control.

For the vaccine, researchers at Stanford University and Bayhill Therapeutics in Palo Alto, Calif., designed a DNA ring that encodes a slightly altered version of myelin basic protein. The changes replaced immune-stimulating parts of the protein with immune-suppressing ones.

Scientists gave 30 MS patients four injections over 9 weeks and then tracked their progress for a year. The study was made public this week and will appear in the October *Archives of Neurology*.

Periodic magnetic resonance imaging of the patients' brains showed that inflammation associated with the nerve damage of MS didn't worsen as a result of the vaccine.

Eight MS flare-ups, or relapses, occurred among the patients during the study, but seven of these struck patients who had finished receiving the vaccine, says study coauthor Amit Bar-Or, a neurologist and immunologist at McGill University in Montreal. These results allayed concerns that the vaccine might exacerbate MS.

Spinal fluid obtained from three patients before and after getting the vaccine showed a reduction in rogue antibodies that react against myelin. In addition, blood samples from five patients showed a decrease in immune T cells that react to myelin.

"This is an important development in the field of MS therapy," says immunologist Gérald J. Prud'homme of the University of Toronto, who wasn't part of the study team. "This is the first demonstration of a beneficial effect of DNA vaccination in a clinical trial of autoimmune disease."

The vaccine may inhibit myelin damage in several ways, Bar-Or says. For example, the vaccine's DNA apparently enters the nuclei of dendritic cells and other traffic cops that orchestrate immune reactions, he says. Because of the DNA's tweaked structure, the myelin basic protein that these cells then produce isn't seen as an enemy, and other immune cells decrease their responses against it.

This calming effect may extend to immune cells targeting central nervous system proteins besides myelin basic protein. However, more work needs to be done to confirm this, Bar-Or says.

Meanwhile, the findings have cleared the way for a larger trial designed to assess whether the therapeutic vaccine can limit the nerve damage that marks MS. In that study, researchers have already given 290 patients a longer course of the vaccine than the safety study entailed. The team expects to release the results of the current study within the next year. —N. SEPPA

A Moment in the Life of a Cell

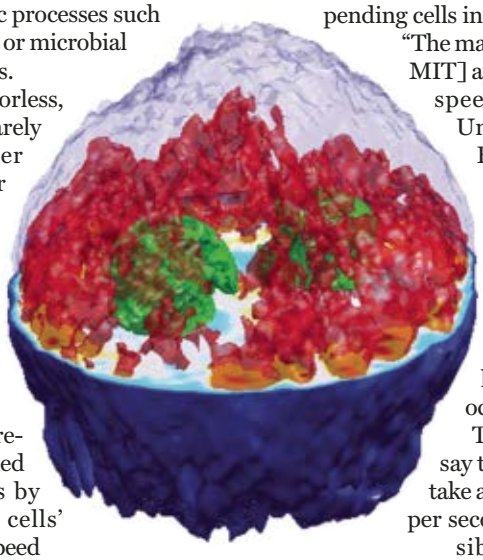
Microscopic scan images without intruding

A new imaging tool could enable researchers to get three-dimensional images of single living cells without resorting to the time-honored procedure of staining their inner structures with chemicals.

"We can image the cell as it is," says Wonshik Choi of the Massachusetts Institute of Technology (MIT). The new device could be retrofitted to existing microscopes and could track dynamic processes such as cell reproduction or microbial invasions, Choi adds.

Most cells are colorless, translucent, and barely visible even under a microscope. For more than a century, researchers have stained living cells with dyes to increase the contrast between parts such as the nucleus and the cytoplasm.

In recent years, researchers have learned to image live cells by mapping how the cells' materials slow the speed of light to different extents. Light's lower speed in water than in air is what makes a pencil look broken when it's dipped halfway into water.



INTIMATE VIEW Nucleoli in this cervical cancer cell appear green, indicating slower light propagation than in the cytoplasm, which appears red.

In the MIT device, a laser beam passes through a sample into a microscope and then on to a digital camera. The camera's detector records tiny shifts in the light waves with respect to a reference beam from the same laser. Those shifts indicate how the laser light slowed as it crossed different cell parts.

A system of tilting mirrors and lenses deflects the beam, allowing it to scan the sample across a 120-degree range of viewpoints. A computer algorithm—similar to the ones that produce computerized tomography scans from multiple X-ray views—then reconstructs a 3-D image of the sample. Differences in the speed of light as it passes through various parts of the cell can be displayed as different colors.

The researchers produced distinct images of nucleoli—structures contained in cellular nuclei—and the cytoplasm of cervical cancer cells, they report in an upcoming *Nature Methods*. The team also scanned and highlighted the internal structures of live microscopic roundworms.

The researchers estimate that their equipment can already resolve details as small as half a micron, and that they can probably bring the resolution down by two-thirds. Other imaging devices, such as electron microscopes, have much higher resolution, but they can't image living cells.

Last year, Christian Depeursinge and his colleagues at the École Polytechnique Fédérale in Lausanne, Switzerland, took similar 3-D scans of cells by rotating the sample while holding it inside a pipette. That 360-degree scan can yield a more detailed 3-D image than the MIT device provides, Depeursinge says. However, the Swiss team's technique required suspending cells in glycerin.

"The main advantage of [the MIT] approach seems to be speed," says Stanford University's Thomas Baer. That could enable researchers to image viruses, bacteria, or other microbes as they invade cells, and "lead to a better understanding of how these processes occur," Baer says.

The MIT researchers say that their device can take as many as 10 frames per second, making it possible to film such processes as they unfold—although real-time imaging is not yet possible, since computers take up to 30 minutes to process each frame. "One obvious thing" would be to make a movie of a cell as it divides, says MIT team leader Michael Feld. —D. CASTELVECCHI

Shocking Sheets

Power paper packs a punch

A new, ultrathin material made from cellulose, the main ingredient in paper, could power future electronic gadgets, medical implants, and even hybrid vehicles. Developed by researchers at Rensselaer Polytechnic Institute in Troy, N.Y., the material can be rolled into a tube, folded, and cut into different shapes with no effect on its function.

"This new, paperlike energy device could fundamentally change the way we power things," says Ning Pan, a materials scientist at the University of California, Davis.

Rensselaer biomaterials specialist Robert Linhardt and his students conceived the power paper while experimenting with cellulose membranes for kidney-dialysis machines. To strengthen the membranes, the researchers thought of mixing the cellulose with carbon nanotubes.

Working with Pulickel Ajayan, a carbon-nanotube researcher at Rensselaer, the Linhardt team dissolved cellulose in an ionic liquid—a liquid salt—and poured the solution over an array of vertically aligned carbon nanotubes on a silicon wafer. The

CHOI

researchers then washed away most of the ionic liquid and dried the material.

"When they peeled it off [the silicon], it was black on one side and white on the other," says Linhardt. Except for the black, "it looked like a regular piece of paper."

After enlisting Rensselaer electronics expert Omkaram Nalamasu, the team soon realized that this material could have an application altogether different from dialysis: energy storage.

Simply folding the paper in half with the black carbon-nanotube layer on the outside yielded a supercapacitor, a device that can provide quick bursts of energy. Coating the white side of the paper with a layer of lithium oxide produced a battery.

In the battery configuration, the paper's carbon-nanotube layer and the lithium oxide serve as positive and negative electrodes. The tiny amount of ionic liquid remaining in the paper functions as the electrolyte. Applying a voltage to the material charges the battery by causing the electrodes to pull apart the ions in the liquid. The cellulose acts as a separator, holding the charges apart.

BEND ME, SHAPE ME This flexible and lightweight material made of cellulose and carbon nanotubes can operate as a battery or another energy-storage device.

The difference in the supercapacitor scheme is that the two outside layers of carbon nanotubes serve as electrodes. Preliminary tests showed that the paperlike supercapacitors have the same energy-storage capacity as commercial devices do. The paper is "pretty fabulous," says Linhardt. "And it hasn't even been optimized yet."

By combining the paper battery and supercapacitor, the researchers made a hybrid device that uses the battery to charge the supercapacitor. Such a setup could be especially useful in hybrid vehicles, which require an efficient means of storing and releasing energy on demand, says Linhardt.

"This is a very significant step toward developing a hybrid battery-supercapacitor structure," says Gehan Amaratunga, an electrical engineer at the University of Cambridge in England.

The researchers found that their supercapacitors worked well when a bodily fluid—such as blood or sweat—was used in place of the ionic liquid as the electrolyte. This opens up the possibility of using the material to power medical implants such as pacemakers and drug-delivery chips. Linhardt and his colleagues describe their material in an upcoming *Proceedings of the National Academy of Sciences*. —A. GOHO

V. PUSHPARAJ/RPI; E. ORTLUND/UNIV. NORTH CAROLINA

Protein Lineages

Randomness was crucial to ancient genetic changes

After resurrecting a protein from an animal species that lived about 470 million years ago, a team of scientists has now partly reconstructed the protein's evolutionary history.

The rare glimpse into a protein's past reveals how a sequence of mutations caused the ancestral molecule to acquire a function possessed by modern forms of the protein, which is present in people and other vertebrates.

The research addresses a long-standing debate among biologists: If the evolutionary clock were turned back and allowed to run again, would the pressures of natural selection steer an organism to the same outcome, or would chance mutations produce a different result?

"What we observed suggests that there's a significant degree of contingency and randomness in evolution," says research team leader Joseph W. Thornton of the University of Oregon in Eugene.

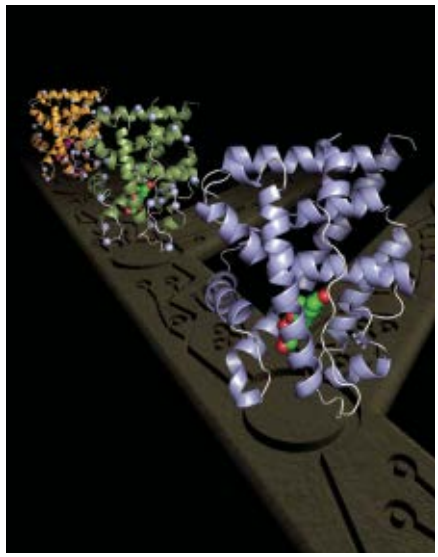
In previous work, Thornton's team inferred the ancient protein's genetic code by comparing many species' genes for glucocorticoid receptors, which are the modern descendants of the protein. If a portion of the gene is identical in several species, chances are that those species all inherited that portion from a common ancestor. This kind of analysis enabled Thornton and his colleagues to reconstruct the ancestral gene with about 99 percent confidence.

In the current study, the team synthesized the ancient gene and inserted it into cells grown in the lab. The cells translated the gene into its protein, whose three-dimensional structure the researchers then determined. They also inferred the genetic code of descendants of the protein dated to roughly 440 million and 420 million years ago and estimated their 3-D structures. The scientists found that sometime during that 20-million-year time span, the protein developed the ability to bind exclusively to cortisol, a stress hormone.

By looking at how the protein's 3-D structure changed during that time, the team identified three crucial mutations that appeared to be responsible for the protein's ability to bind cortisol. But when the researchers applied those mutations to the 440-million-year-old version, structural weaknesses within the protein interfered with the mutations' effects, and the protein couldn't bind cortisol at all.

The scientists then found additional mutations that had no effect on the protein's function but that buttressed the protein's weak spots. Applying these functionally neutral mutations, as well as the key mutations, produced a protein that, unlike its older version, bound only cortisol. The team's findings appear online and in an upcoming *Science*.

Thornton and his colleagues reasoned that the neutral mutations must have occurred first, paving the way for the function-causing mutations. But because natural selection can act only on changes that make a functional difference, the earlier, enabling mutations were essentially invisible to its steering influence.



BACK TO THE FUTURE Inferred structures of a protein as it existed about 470 million, 440 million, and 420 million years ago (front to back) reveal the protein's evolution.

A different set of random, neutral mutations might have buttressed the protein in ways that would have facilitated a different key mutation. This would have led to an alternate "evolutionary road not taken," Thornton speculates.

If neutral, enabling mutations prove to be common in protein evolution, "that's pretty groundbreaking," comments Christopher C. Dascher of the Mount Sinai School of Medicine in New York. —P. BARRY

Depression Defense

Sick elderly get mood aid from home treatment

Brief instructional sessions delivered by a nurse or psychologist show promise as a way to prevent depression in elderly peo-

ple with serious health problems, at least in the short run.

As the U.S. population ages, such treatment—which focuses on finding ways for people to continue daily activities and achieve goals despite physical ailments—will attract increasing interest, say psychiatrist Barry W. Rovner of Jefferson Hospital for Neuroscience in Philadelphia and his colleagues.

Rovner's group studied 206 patients, all in their 70s or 80s, with preexisting macular degeneration in one eye and newly diagnosed macular degeneration in the other eye, an indicator of impending blindness.

Macular degeneration, characterized by deterioration of part of the retina, affects nearly 10 million people. It's the most common cause of legal blindness in the United States.

In a prior study, Rovner and his coworkers found that almost 30 percent of patients with macular degeneration in one eye became depressed soon after their other eye became affected.

In the new investigation, participants randomly received either sessions known as problem-solving treatment or standard follow-up medical care. In the former plan, a nurse or a psychologist visited volunteers' homes six times over 8 weeks to tailor an approach for patients to cope with blindness.

Two months after the study began, 12 percent of patients receiving problem-solving treatment were depressed, compared with 23 percent of those getting standard care. Markedly fewer patients in the problem-solving group than in the standard-care group had given up activities that they valued, such as visiting friends. The preservation of key daily activities may protect elderly medical patients against depression, the researchers propose.

However, by 6 months after the study had started, the emotional benefits of problem-solving treatment over standard care had narrowed. At that point, depression afflicted 21 percent of the problem-solving group and 27 percent of the standard-care group. Patients who had completed problem-solving treatment still pursued valued activities more often than standard-care recipients did.

Frequent contact with experimenters and an expectation of receiving problem-solving treatment after the clinical trial ended kept the depression rate artificially low in standard-care patients, the scientists suggest in the August *Archives of General Psychiatry*.

They call for further trials of problem-solving treatment that target medical patients in the early stages of depression and that include more than six sessions. Future trials might include counseling focused on emotional support in order to examine how the relationship of caregiver to patient influences depression.

Prior studies of depression prevention in elderly patients have primarily explored the use of antidepressant medication to protect against mood disorders following strokes and other illnesses.

Rovner's study "breaks new ground" because physically ill people probably prefer to learn coping skills at home than to take antidepressants when they still feel fine, write psychiatrist Charles F. Reynolds III of the University of Pittsburgh School of Medicine and his coworkers in a comment published with the new report. —B. BOWER

Road Bumps

Why dirt roads develop a washboard surface

Driving on a dirt road can rattle the bones. Every foot or so, a ridge of dirt up to several inches high lies in wait to jolt passing cars and trucks and their hapless occupants. In many places, road crews battle this "washboard" effect by frequently scraping the roads with bulldozers. But as soon as more vehicles pass, the ridges, phoenixlike, return.

Now, a team of physicists has explained why a washboard forms, and their research has a dispiriting message for road crews: Scrape often, or give up. Washboard is inevitable.

Most previous theories of washboard formation involved relatively complex dynamics. Some focused on the bounce of a vehicle's suspension and tires. Others suggested that differences in compaction between the bottoms and tops of bumps were essential. Still other theories invoked the tendency of dirt to segregate according to grain size. Many an engineer has tried to design washboard-resistant road surfaces, but the ridges keep rising.

Stephen W. Morris of the University of Toronto and his colleagues Nicolas Taberlet and Jim N. McElwaine of the University of Cambridge in England aimed to find the simplest possible explanation for the phenomenon. They built a circular turntable that they could cover with dirt or sand, and positioned a hard rubber wheel above it.

After smoothing the dirt, they turned the table at varying speeds, allowing the wheel to run over the surface. Then they watched the washboard form.

The researchers varied the experiment in every way they could think of. They compacted the dirt. They used sand grains of varying sizes and mixtures, and they even tried substituting rice. They used wheels of different sizes and weights as well as a flat plow-wheel that didn't spin. Some of the variations changed the pattern, spreading the ripples or packing them closer together, but the ripples always formed.

The team reports its findings in the Aug. 10 *Physical Review Letters*.

D. MAYS

TROUBLED TRAVEL **Vehicles passing constantly over dirt roads create an irksome washboard surface, seen here on a road in Australia.**

The researchers found one, and only one, solution: Slow down. A lot. "The critical velocity below which [the surface] would remain flat is about 5 miles per hour," Taberlet says.

The researchers then created a computer simulation to model the movements of individual grains of sand so that they could see precisely how the ripples formed.

Any bed of dirt or sand, even a very smooth one, has minuscule irregularities that slightly jog a rolling wheel. Each time the wheel hits a bump, the computer simulation showed, it pushes the dirt forward a bit, enlarging the irregularity. Then, as the wheel passes over the top of the bump, the force of its descent pushes dirt forward into the next bump. Repeat these actions a hundred or more times and the familiar pattern of ridges appears.

Douglas Kurtze of Saint Joseph's University in Philadelphia says that this is the first time anyone has studied washboard formation using a controlled experiment. Although it won't eliminate washboards, it lets scientists "get down to the essentials of what the mechanism is," says Kurtze. —J. REHMEYER

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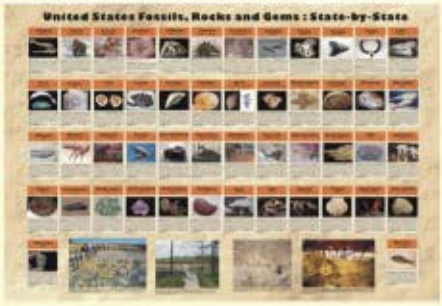

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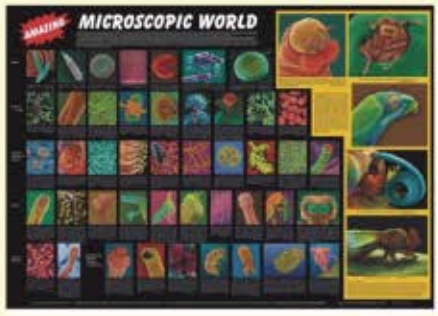

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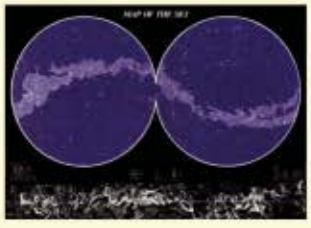

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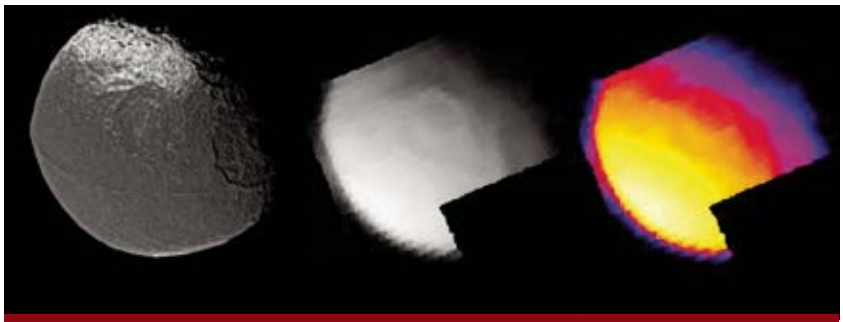
IDIOSYNCRATIC IAPETUS

Saturnian moon puts a time stamp on the outer solar system

BY RON COWEN

Iapetus, the third-largest and second-farthest-out of Saturn's satellites, is the weirdest moon in the solar system. One half of it is as bright as snow, the other as black as charcoal. Neither spherical nor ellipsoidal, as most moons are, Iapetus looks like a walnut, with a bulging waistline and squashed poles. Accentuating its nutty appearance is a narrow, 20-kilometer-high ridge that girdles most of the moon's equator, like the brim of a hat. No other moon in the solar system has such a ridge.

Now astronomers think that they may have cracked the mystery of this walnut moon. Iapetus' odd shape and isolated location, they say, suggest that its evolution came to an abrupt halt just a few hundred million years after it came into being. If that's so, Iapetus may serve as a well-preserved relic from the early days of the solar system, not long after the planets were born.



INFRARED IAPETUS — Temperature map of Iapetus, both color coded and in a gray scale image. The latter is equivalent to what the eye would see if it were sensitive to radiation at an infrared wavelength of 15 micrometers. Red indicates the warmest temperature, blue the coldest. The highest temperature, 130 kelvins at noon at the equator, occurs within the dark material that covers most of this view of the moon and which may be the warmest place in the Saturnian system.

Flash-frozen as it appeared several billion years ago, this distant moon "may be the Rosetta stone of the outer solar system," says Dennis Matson of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif.

MISSHAPEN MOON Matson, Julie Castillo-Rogez of JPL, and their colleagues were prompted to develop a new model for the formation of Iapetus after studying images from the Cassini spacecraft, which flew past the moon in 2005. Those images revealed Iapetus' bulging waistline and equatorial ridge—a chain of mountains that wraps at least halfway around the moon's 2,600-km-long midsection.

The odd features surprised planetary scientists. A rapidly rotating moon or planet with a sufficiently pliant crust can develop a bulge because centrifugal forces push material out around the equator and flatten the object at its poles. Astronomers have known for more than 2 decades, however, that Iapetus rotates extremely slowly, taking 79 Earth days to complete a single revolution.

To develop the bulge seen today, Iapetus in its youth must have spun much faster, initially rotating about once every 10 hours and then decreasing to a 16-hour period, Matson's team calculates. But for Iapetus to have preserved that shape to this day, the moon's rotation must have drastically slowed and its crust must have cooled and thickened within 100 million to 900 million years after the satellite's birth. Those two processes, moreover, would have had to proceed in a precisely choreographed dance, in which timing was everything, says Matson. Only in that way could the moon have preserved its youthful, bulging figure, the researchers assert in an upcoming *Icarus*.

"Iapetus literally stopped in its tracks," says Castillo-Rogez.

The ridge, which may encircle the entire moon, provides additional evidence that Iapetus froze in place relatively soon after it coalesced, says Matson. The chain of mountains is peppered with craters, indicating that it's an ancient structure that has endured bombardment by space debris for several billion years. To preserve a structure this large and long, Iapetus' once-pliable crust must have solidified quickly. Otherwise, the ridge would have slumped away long ago, like a scoop of ice cream melting on a warm day.

The second part of the Iapetus storyline focuses on the forces that conspired to slow the moon's rotation. Iapetus experiences tides, induced by the difference in Saturn's gravitational tug on the moon's near and far sides. Tidal stresses would have acted as a brake on the moon's spin, just as the tides raised by Earth have slowed its moon's rotation.

But the colder and more rigid a body is, the weaker those tidal forces are. To slow Iapetus to its present spin rate, Saturn's tidal forces must have acted when the moon's interior was nearly warm enough to melt water ice.

"The shape corresponds to that of a fluid body spinning every 16 hours, so something must have heated its interior" even while its surface became rigid, notes planetary scientist Joseph Burns of Cornell University.

HOT TIMES What could have heated Iapetus? Whatever provided the extra warmth had to have done so only briefly. Otherwise, the moon's equatorial bulge would have continued to diminish, rather than to have been frozen in place. "We searched and searched" for just the right mechanism, says Matson.

The researchers propose that the geologically brief infusion of heat came from the rocks that formed Iapetus. In particular, the team suggests that the energy released by the radioactive decay of two short-lived radioisotopes—aluminum-26 and, to a lesser extent, iron-60—within those rocks kept the moon warm for some hun-

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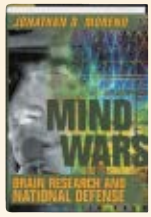

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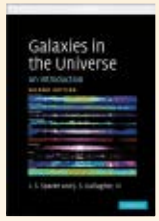

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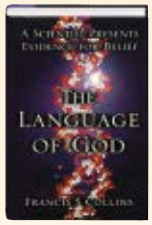

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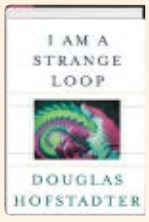

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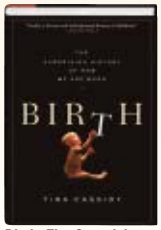

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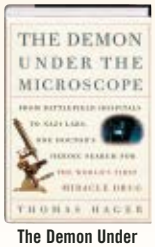

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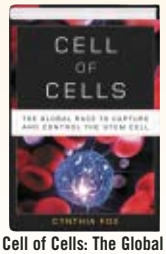

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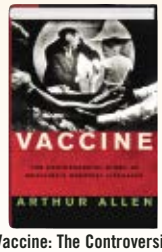

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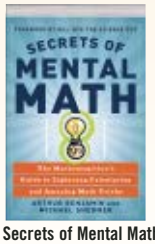

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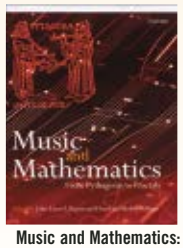

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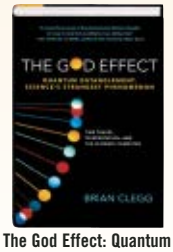

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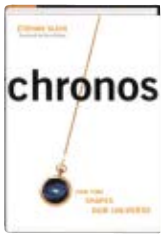

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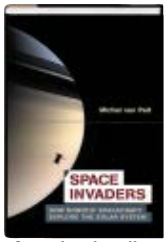

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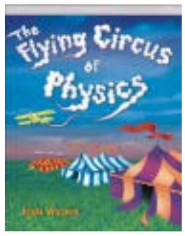

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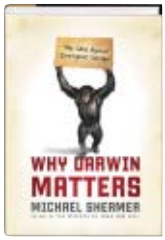

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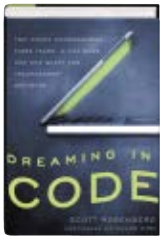

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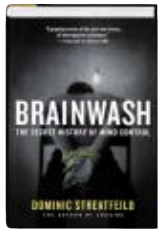

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dreds of thousands of years. Then the radioactivity petered out, the heat from the rocks declined, and the moon froze, preserving its immature figure.

Because these isotopes decay at known rates, the planetary scientists can calculate when Iapetus formed. For the decay of aluminum-26 to have kept the moon's surface pliable enough to allow tidal slowing of its rotation, the moon must have coalesced between 2.5 million and 5 million years after the solar system's first objects—its most primitive asteroids—started forming.

If the theory proves correct, it would be the first time that scientists could compare the early chronology of an object in the outer solar system with that of a body in the inner solar system, where asteroids were born.

"This model is pretty improbable since it requires quite special timings [for the formation of the moon and other events], but Iapetus itself is pretty improbable," says Burns. "If the authors are correct, we've learned a lot about conditions in the early years in Saturn's neighborhood."

The odd moon is "a remarkably primordial body," says William McKinnon of Washington University in St. Louis. "We could be looking at the [formation] epoch when we look at its surface. Most satellites have been so heavily bombarded since the very earliest times that some of the moons have even broken up or reassembled." But in part because Iapetus formed far from Saturn, and so hasn't been heavily pummeled, its surface appearance seems to have been preserved, McKinnon says.

DARK SIDE — Composite portrait of Iapetus, combining near-infrared, visible light, and ultraviolet images, shows the northern part of the dark Cassini Regio region and the transition to a brighter surface at high northern latitudes. This image doesn't show Iapetus' north pole or the moon's bright hemisphere.

ALL IN THE TIMING Saturn and its moons formed simultaneously, theorists argue, because all these objects coalesced from the same region within a cloud of gas, dust, and ice that swaddled the young sun. Likewise, most theorists believe that although Jupiter arose from a part of that cloud far closer to the infant sun than did Saturn, the two planets came into existence at about the same time. Dating Iapetus' beginnings therefore pegs Jupiter's formation to 2.5 million to 5 million years after the birth of the solar system.

That time frame is consistent with the formation of Jupiter's large outer moon, Callisto, says McKinnon. Callisto consists of a well-mixed amalgam of ice and rock. The relatively uniform composition implies that the moon didn't experience heating severe enough to have melted the ice, which would have allowed water to collect and refreeze into a distinct layer above the rock. That means Callisto could not have coalesced until 2 million years after the formation of the solar system, the time it took for temperatures to fall to freezing at Jupiter's location.

A decade ago, the leading model of planet formation would have had a hard time making a large planet in 5 million years or less, notes theorist Jack Lissauer of NASA's Ames Research Center in Mountain View, Calif. In that model, known as core accretion, Saturn and Jupiter began as solid, rocky objects with about 10 times Earth's mass. Those objects would have coalesced from particles in the disk that swirled around the young sun. Only later did those cores capture enough gas to create the giant planets seen today.

Researchers initially proposed that planet formation in the core-accretion model could take about 10 million years. But faced with a multitude of data indicating that the protoplanetary disks that surround young stars last only a few million years, the scientists have now fine-tuned the model to make Saturn and Jupiter faster.

A newer, competing model, in which these gas giants form all at once from the sudden fragmentation of the protoplanetary disk, could make these behemoths even quicker, notes Alan Boss of the Carnegie Institution of Washington (D.C.), who developed this model. However, with core-accretion theorists inching closer to accepting a more-rapid time frame for planet formation, "I expect that the core-accretion folks would not be terribly concerned" with Iapetus' apparently quick creation, he says.

RIDGE RIDDLE It's still unclear how Iapetus' ridge was created. Although Matson, Castillo-Rogez, and their colleagues didn't develop their model to explain the ridge, their theory provides a possible solution. As the moon's rotation slowed, the centrifugal force pushing material outward at the equator diminished and the still-warm interior of Iapetus took on a more spherical shape. But the surface material, which had already frozen, couldn't adjust. Instead, the crust cracked and piled up, forming the ridge.

"The spherical shape has less area than the [bulge]," says Matson. "The extra yardage has to go somewhere," namely, sticking out on the surface.

Last year, in *Geophysical Research Letters*, Wing-Huen Ip of the National Central University in Chun Li, Taiwan, outlined an alternative model. He suggested that the equatorial ridge was created when icy rings that may have initially surrounded Iapetus collapsed onto the moon.

The rings could have arisen in either of two ways, Ip says. Because of its mass, Iapetus wields substantial gravitational influence on its surroundings. As it began to coalesce from ice and dust, Iapetus might have formed its own system of rings from surrounding material that didn't become part of the moon itself.

Alternatively, says Ip, rings could have arisen after a massive asteroid or other body struck a still-forming Iapetus, knocking off debris that temporarily lined up in a circle around the moon. He adds that a separate satellite, which has since escaped, may have accompanied the temporary ring. In a similar manner, researchers have proposed that Earth's moon formed when a Mars-size projectile struck the young Earth.

Regardless of how the rings formed, they would have orbited Iapetus' equator. And if they fell back onto the moon, they would naturally have fallen along that line.

Competing ridge theories may be put to the test next September, when the Cassini mission is scheduled to fly within 1,000 km of Iapetus. So far, the craft has imaged only about half of Iapetus, and researchers are uncertain whether the ridge there goes much beyond what's been photographed so far. If Ip is correct, the ridge ought to wrap around the moon's entire equator, since his model predicts a uniform ring all the way around, notes McKinnon. Debris from the ring would have fallen all along the planet's midsection, he adds. A ridge that doesn't follow the equator exactly might favor Matson's model instead, McKinnon says.

Whatever the solution of the ridge puzzle, observations of this strange satellite may prove a gold mine for planetary scientists. "The weirdness of Iapetus could be giving us a view into the distant past, just like the Rosetta stone did," Burns says. ■

SPACE SCIENCE INSTITUTE, JPL/NASA

ALIEN PIZZA, ANYONE?

Biochemistry may have taken a different turn on other worlds

BY DAVIDE CASTELVECCHI

Everything was ready for the celebratory feast. Weeks earlier, the alien fleet had entered Earth's orbit and made radio contact, and now the visitors would receive their official welcome. Dozens of heads of state would greet humanity's guests during an official dinner at the White House.

The aliens looked remarkably similar to us—apart from their green scales, that is. Moreover, the chemistry of their bodies and of ours was also very similar, scientists from the two worlds had concluded. Sure, the alien cells produced molecules not found in human biochemistry, but the building blocks of those molecules were essentially the same carbon-based amino acids and sugars as the ones in our bodies.

But on the eve of the great meeting, the science adviser to the President burst into the Oval Office. "The dinner must be called off, or the aliens might die!" the adviser told the startled President. "We forgot to check their chirality!"

That's a word that few politicians—indeed, few people outside science—will know. But chirality, or handedness, is an essential characteristic of the molecules of life. Most naturally occurring organic molecules are chiral, meaning that they are distinct from their mirror images in the same way that our right and left hands differ.

In the lab, chemical reactions that synthesize amino acids and sugars create the right- and left-handed versions of the molecules in equal amounts. Life on Earth, however, uses one version almost exclusively, preferring what are conventionally called right-handed sugars and left-handed amino acids. A molecular preference for only one handedness is what chemists call homochirality.

In principle, organisms could exist that use both kinds of molecules or that exclusively adopt the opposite forms from those used in life on Earth. This is what troubled the scientists in the alien state dinner scenario: Just as our bodies can't absorb organic matter of the wrong handedness, so too the aliens might find our food equally indigestible—and perhaps even toxic.

Most scientists believe that Earth life's choice of chemical handedness was purely random. "The most plausible idea is that it was an accident," says biochemist David Deamer of the University of California, Santa Cruz. It's possible, then, that the chemistry of some alien forms of carbon-based life—assuming such things exist—may well have the opposite chirality to ours. We might find alien pizza even harder to digest than deep-dish.

On the other hand, a few scientists say that something more fundamental might be going on. They argue that throughout the universe, nature might consistently choose one handedness over the other. That intrinsic preference, these scientists suggest, might originate from the influence of the weak nuclear force, the only fundamental force of nature that can tell left from right. In recent years, a number of experiments have provided tentative—if controversial—support for this proposal.

Whatever its origin, most scientists agree that homochirality must have begun with a tiny excess of one handedness in the chemistry of the primordial broth. Recently, chemists have discovered a mechanism that might explain how that slight imbalance could have developed into a complete predominance of one handedness, with the virtual absence of the other. Homochirality itself may not be so surprising after all—although knowing which of the two possibilities occurs on any given planet remains a toss-up.

CHANCE AND NECESSITY There is some reason to believe that nature favors homochirality: It takes extra metabolic energy to keep molecules of different handednesses separate, says Jack Szostak, a biochemist at Harvard University. "There is a selective pressure to have a system that is basically homochiral," he says.

> "There is a selective pressure to have a system that is basically homochiral."
>
> — JACK SZOSTAK, HARVARD UNIVERSITY

However, the laws of physics provide little reason to think that the original choice of biochemical chirality could have been anything other than random. Chemistry is ruled by electromagnetic forces—which determine how atoms, molecules, and electrons interact—and electromagnetism doesn't distinguish between left and right. For that reason, a reaction between, say, two left-handed molecules should proceed at exactly the same rate as the same reaction between the right-handed equivalents of those molecules.

Then how did our world end up with homochiral biochemistry?

Scientists have proposed various mechanisms that might have generated a small initial excess of one handedness over the other (*SN 5/5/01, p. 276; 9/6/03, p. 157*). For example, right- and left-handed molecules respond differently to circularly polarized light, whose waves move in a corkscrew fashion that can have either a right- or a left-handed twist. If the organic matter that seeded life on Earth formed in space, as some scientists have suggested, astrophysical sources might have zapped it with circularly polarized light, perhaps selectively destroying molecules with a particular handedness.

Organic matter found in some meteorites indeed shows a slight excess of left-handed amino acids. In this scenario, if such a meteorite had been hit by corkscrew waves with the opposite twist, life on Earth could have ended up with the opposite chirality.

If, by contrast, nature shows a consistent preference for one handedness over the other, that bias must exist somewhere in the laws of physics. Like electromagnetism, neither gravity nor the strong nuclear interaction cares about chirality. The exception is the fourth fundamental force, the weak nuclear force, which can tell left from

right. But this asymmetry mostly shows up in certain kinds of nuclear decay, offering little opportunity for any influence on life.

Through the quantum property known as spin, however, the weak interaction also exerts a small effect on the way atomic nuclei interact with electrons. As it moves about within an atom, an electron can occasionally—by the rules of quantum physics—fly through the nucleus. When that happens, nuclear particles influence the electron via the weak interaction in a way that depends on the orientation of the electron's spin relative to its motion. "It's as if the sun's gravity had a force that depended on the direction of the Earth's axis of rotation," says Norval Fortson, a physicist at the University of Washington in Seattle.

In the 1960s, scientists realized that this effect, called parity violation, could induce a tiny energy difference between the corresponding electron states in left-handed and right-handed molecules. That difference could mean, for example, that breaking up a left-handed amino acid might take slightly more energy than breaking up its mirror-image counterpart. If left-handed amino acids were stabler, they could have slowly become more abundant.

Whether these effects could have any practical consequences remains questionable. "As far as I know, they've never been measured in the lab, even with very delicate experiments under highly controlled circumstances," says physicist Frank Wilczek of the Massachusetts Institute of Technology. If they exist, energy differences between electron states in left- and right- handed molecules are expected to be many orders of magnitude smaller than the energies involved in chemical reactions. "Any energy difference is going to drown in the noise of any chemical process," says Donna Blackmond, a chemist at Imperial College London.

Even so, chemist Dilip Kondepudi of Wake Forest University in Winston-Salem, N.C., says that a small effect pushing consistently in one direction—such as slightly favoring left-handed amino acids—could win over a noisy background in the long run. Kondepudi and his collaborator George Nelson, now at the National Cancer Institute in Bethesda, Md., theoretically calculated this "noise-averaging" effect in 1985.

SINISTER EVIDENCE Over the years, several groups of researchers have claimed to have observed intrinsic chiral preferences in biological molecules. Most scientists have judged these experiments as inconclusive at best, however.

Although he calls himself a skeptic, Deamer says that some of these effects seem too interesting to ignore. When Deamer was visiting the Weizmann Institute in Rehovot, Israel, in the late 1990s, Meir Shinitzky, a chemist there, showed him some surprising findings. Shinitzky had noticed that an amino acid called tyrosine had two different crystallization rates in its left- and right-handed forms. Deamer reproduced the same results at his lab, trying to rule out any contamination problems. "No matter how hard we tried, we still saw a difference," he says. Deamer, Shinitzky, and their collaborators published their results in 2002.

If, in some primordial pond, a right-handed amino acid crystallized faster, it would have left behind a solution enriched with the left-handed version. That could have got biochemistry started on the road to homochirality, Deamer explains.

WHICH WAY IS RIGHT? — Francis Crick (pointing) and James Watson discovered that DNA winds like a right-handed screw. If life exists on other worlds, some of its molecules might be mirror-image equivalents of those on Earth, giving alien DNA a left-handed twist, as in the mirror image (right) of the original photo.

Moreover, he and Shinitzky suggested that parity violation could be behind the asymmetry that they discovered. They speculated that parity-violating energy differences would endow left- and right-handed amino acids with slightly different magnetic properties that would make them interact differently with water molecules. As a result, water molecules that form a layer around dissolved amino acids might bind a little more strongly to the left-handed version, so it would crystallize more slowly than the right-handed version. "A lot of the energy that goes into making a crystal comes from breaking this layer," Deamer says.

Critics pointed out that undetectably small impurities in the samples easily could have produced a spurious effect, because crystallization is so sensitive to details of the steps that get it started. But Deamer and Shinitzky say that when they repeated their experiment in heavy water—water made with deuterium, the isotope of hydrogen that has a neutron in its nucleus—the effect virtually disappeared. Molecules of heavy water have weaker magnetic interactions than molecules of ordinary water do.

In 2005, Shinitzky and his collaborators made another surprising observation. They took spiral-shaped molecular chains of the amino acid glutamate, which spontaneously unwind as the solution in which they're dissolved becomes less acidic. The researchers found that left- and right-handed versions of glutamate unwound at different acidities. That difference largely went

away, however, when the experiment was repeated in a heavy-water solution. His team published these results in the December 2005 *Physical Chemistry Chemical Physics*.

Robert Hazen of the Carnegie Institution of Washington (D.C.) maintains that it's hard to rule out contamination as the explanation for such findings. "It's almost impossible to find a chirally neutral environment on Earth because life's chiral excesses infect everything," he says.

And even if the experimental results are true, says Martin Quack, a physical chemist at the Swiss Federal Institute of Technology (ETH) in Zurich, the researchers have demonstrated no credible link with the weak nuclear force.

More recently, a team at DESY, a particle accelerator lab in Hamburg, Germany, studied synthetic left-handed versions of RNA in addition to the natural right-handed forms. By shining ultraviolet radiation on RNA suspended in water, the team measured the energy that it takes to excite some of the electrons in the molecules. The scientists found that handedness mattered.

"There is a difference on the order of one part in one thousand" between the two forms, which is likely to make the left-handed form less stable, says team member Michael Rübhausen, a physicist at the University of Hamburg. That difference was many orders of magnitude larger than the expected effects of parity violation.

Hamburg chemist Christian Betzel, a coauthor of the study, says that he can't explain the phenomenon, but adds that "it would be interesting to see if it happens in heavy water." The results are due to appear in the journal *RNA*.

NATURE'S DEXTERITY However homochirality arises, a tiny seed of chiral asymmetry in the first molecules of life represents only a fraction of what it would take to bring about fully homochiral biochemistry, in which molecules of one handedness dominate the scene, while the other handedness has all but disappeared. Recent studies suggest how that result could come about.

Kenso Soai of the Tokyo University of Science and his collaborators first demonstrated experimentally in the mid-1990s that some molecules can catalyze the synthesis of copies of themselves. That process can amplify any small initial imbalance in chirality and lead to the complete dominance of one handedness over the other.

Just how this molecule was able to multiply at the expense of its oppositely handed counterpart remained unclear until 2001, when Imperial College's Blackmond and her collaborators discovered a possible mechanism underlying Soai's reaction. The idea is to have a molecule that tends to bind to itself in pairs and that catalyzes production of new copies of itself only when in pairs of the same handedness. Suppose an initial mixture contains slightly unequal numbers of the two types—say, 102 of type A and 100 of type B. If all pairings are equally probable, the mixture will typically form into 50 AB pairs, 26 AA pairs, and 25 BB pairs.

> "Life's chiral excesses infect everything."
>
> — ROBERT HAZEN, CARNEGIE INSTITUTION OF WASHINGTON

Only AA pairs and BB pairs can reproduce, so to speak, yielding more A and B molecules, respectively. Because the AA:BB ratio is 26:25—which is larger than 102:100—the proportion of A molecules in the mix will be slightly greater after reproduction and will further increase at each generation. "Once the reaction takes off, it will never look back," Blackmond says.

A mechanism such as this could explain how homochiral biochemistry, favored for reasons of metabolic efficiency, might actually come about. But whether life has the same handedness throughout the universe, or leans randomly to the left or right every time that life springs up, is a question that can be resolved only through a deeper understanding of the laws of nature. Or by eating a lot of alien pizza. ■

MEETINGS

Animal Behavior Society
Burlington, Vermont
July 21 – 25

PARTNERING

Badly matched birds make troubled parents

The troubles of parents who don't communicate well take a toll on their offspring—even among cockatiels.

That's the conclusion of work by Rebecca Fox, now of the University of Nevada in Reno.

She let captive cockatiels choose mates and gauged how well matched each pair was, according to a "personality" test of cockatiel traits. Some birds seemed compatible, and others ended up very dissimilar. Nine of the pairs laid eggs and raised young, and Fox reported that the better-matched pairs tended to fledge more chicks.

Fox analyzed how the parents managed a basic task: switching places at the nest. Sometimes the process went awry, with both parents leaving the nest. In one case, both parents stayed away for 4 hours.

The more-compatible pairs failed at changing the guard 15 percent of the time. The less-compatible pairs' failure rate was 80 percent.

Biologists tend to emphasize the qualities of an individual animal in producing offspring, says Fox. She urges more attention to how well a pair functions as a unit. —S.M.

COMMUNICATION

What's so great about 'chuck'?

A little "chuck" sound that a kind of male frog can add to his call proves attractive to friends and foes alike. Now, researchers suggest an explanation for the sound's wide appeal.

Small, dark túngara frogs, found in Mexico and northern South America, have become a classic animal for studies of communication. Males gather in pools and call, and females follow the sounds to find mates.

Unfortunately for the male frogs, their calls also reveal their locations to predators. The frog-eating bats *Trachops cirrhosus* swoop out of the night sky and grab calling males. Mosquitolike flies in the genus *Corethrella* will land on the back of a vocalizing frog, stroll to his nose, and take a meal from blood vessels in his nostrils.

Earlier work had established that bats, as well as female frogs, prefer a whining call followed by some chuck noises instead of a plain whine. It now turns out that flies also prefer the whine-chucks, says Ximena Bernal of the University of Texas at Austin.

Coincidence? Maybe not, says Bernal. She and her colleagues have been investigating whether chucks might indicate something about males that all three groups would benefit from knowing.

To see whether frequent chuckers might be high-quality males, for both mating and eating, the researchers measured frogs and recorded their calls. They found no correlation between frog physique and tendency to chuck.

Bernal and her colleagues found, however, that frogs are more likely to chuck as males crowd together. Detecting the presence of a bigger cluster of possible mates or meals could benefit all the searchers, the researchers suggest. —S.M.

OF NOTE

ENVIRONMENT

How reading may protect the brain

Workers at lead-smelting plants can suffer substantial neural damage from exposure to the toxic heavy metal. Workers who read well, however, experience comparatively less mental impairment, a new study finds.

It's not that the better readers were smarter, but that they have more "cognitive reserve," explains study leader Margit L. Bleecker, a neurologist at the Center for Occupational and Environmental Neurology in Baltimore. She says that people typically gain cognitive reserve—better or more resilient neural connections in the brain—through reading, puzzle solving, and other mentally challenging activities.

Her team recruited 112 men at a lead smelter to participate in a battery of neural assessments. After measuring the men's reading abilities—a rough gauge of cognitive reserve—the researchers split the volunteers into two groups of equal size, consisting of high or low scorers. In other respects—age, number of years worked, educational background—the two groups were similar. Most important, participants in each group exhibited the same range of blood-lead concentrations.

In the July 31 *Neurology*, the researchers report that in each group, men with higher blood-lead values scored more poorly on tests of hand-eye coordination. That's typical of lead poisoning. However, men in the better-reading group performed 2.5 times as well on tests of memory, attention, and concentration—tasks not necessarily related to reading.

The brain is like a muscle, Bleecker concludes: Exercising it strengthens it and makes it better able to counter the ravages of disease and poisoning. —J.R.

TECHNOLOGY

Uncharted atomic landscapes

Electron microscopes can now not only image single atoms but also map the locations of different chemical elements in a sample.

A scanning-transmission electron microscope (STEM) operates by sending an atom-thin beam of electrons through a sample. Those electrons lose energy as they kick up the energy of some of the sample's electrons. The energy losses depend on the characteristic energies of electron states in an atom. Exploiting that fact, scientists have in recent years learned to identify which elements the beam has encountered.

So far, however, researchers haven't been able to determine the locations of those elements on the two-dimensional image that the microscope produces. That's because the STEM detector varies somewhat in sensitivity across its area, and because it's hard to keep a sample still.

Michel Bosman, then of the University of Sydney in Australia, and his collaborators scanned a crystalline material at the SuperSTEM facility in Daresbury, England. They then slightly shifted the sample and scanned it again. Comparing data from different scans greatly reduced uncertainties due to motion of the sample and to nonuniform detector sensitivity, Bosman says. The researchers describe their results in an upcoming *Physical Review Letters*.

"These are unquestionably the best two-dimensional compositional maps so far obtained," says Steve Pennycook, of the Oak Ridge (Tenn.) National Laboratory.

"It's exciting to be able to do chemical analysis at the atomic level," Bosman says. The technique could prove useful in the development of new materials, he adds. For example, the way small amounts of elements are scattered in a material can dramatically affect an alloy's toughness or a semiconductor's reaction to changes in a voltage. —D.C.

BIOMEDICINE

Anti-inflammatory prevents pancreatic cancer in mice

An inflammation-fighting drug limits premalignant lesions in mice prone to getting pancreatic cancer. The new finding suggests that this drug or related ones might prevent pancreatic cancer in people who face an elevated risk of developing it. Risk factors include smoking or having a relative with the disease.

Pancreatic-cancer cells often harbor a mutation in a gene called *Kras*. In mice genetically engineered to carry this mutation in their pancreas tissues, the pancreatic ducts develop precancerous lesions and, by age 12 to 15 months, cancer.

Past research had implicated the inflammation-causing enzyme cyclooxygenase-2 (COX-2) in a chain of biological events leading to abnormal cell growth and cancer in other organs (*SN: 4/10/04, p. 230; 8/18/01, p. 109*).

To test whether thwarting COX-2 would have an effect on mice predisposed to pancreatic cancer, the researchers fed chow containing a COX-2 inhibitor called nimesulide to mice harboring the *Kras* mutation. A group of similar mice received chow without the COX-2 inhibitor.

At 10 months, none of the ducts in mice treated with nimesulide had developed dangerous precancerous lesions, whereas 10 percent of the pancreatic ducts in mice not getting the drug had such lesions, the scientists report in the Aug. 1 *Cancer Research*.

"This shows that COX-2 is a very important molecule in the progression of pancreatic cancer, and inhibiting it can delay or prevent cancer," says Guido Eibl, a surgeon at the University of California, Los Angeles.

However, COX-2 inhibitors have been linked to a heightened risk of heart problems (*SN: 10/30/04, p. 286*). If they prove too chancy to give to people as a cancer preventive, Eibl says, scientists can test other drugs that affect the events that lead to abnormal growth and cancer. —N.S.

PLANETARY SCIENCE

Geyser gawker: Plans for a closer look at Enceladus

Saturn's moon Enceladus has been in the spotlight ever since the Cassini spacecraft discovered geysers jetting plumes of water vapor from its south pole (*SN: 6/2/07, p. 350*). The presence of water, along with organic compounds found on the moon's surface, are two tantalizing indications that some kind of primitive life may have existed or might still reside on or within this highly reflective moon.

Now planetary scientists are planning to take the closest look yet at the geysers. NASA announced Aug. 1 that it will adjust the orbit of Cassini, originally scheduled to fly past Enceladus next March at a stately distance of about 1,000 kilometers, so that the craft will swoop through plumes 30 to 100 km above the moon's surface.

To protect sensitive detectors on the robotic craft, engineers may command some of the devices to face away from the venting material, says NASA Associate Administrator for Science Alan Stern. During the March 2008 flyby, Cassini's radar may also get its first look at Enceladus' tiger stripes, the linear cracks from which the plumes emanate. —R.C.

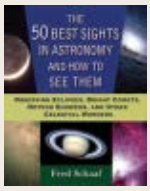
Books

A selection of new and notable books of scientific interest

THE 50 BEST SIGHTS IN ASTRONOMY AND HOW TO SEE THEM: Observing Eclipses, Bright Comets, Meteor Showers, and Other Celestial Wonders

FRED SCHAAF

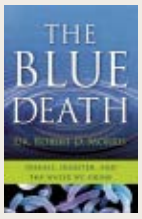
On the basis of a lifetime of space observations, Schaaf, an astronomer and a writer for *Sky & Telescope* magazine, selects 50 of the most interesting objects in the sky. All the features he chooses can be seen by the amateur astronomer, and some, such as a total eclipse of the moon, can be viewed with the naked eye. Others, such as Jupiter and its moons, require binoculars or a telescope. Among the sights included in Schaaf's "must-see" list are Orion and other constellations, the Milky Way, and star clusters. For each sight, Schaaf provides information on basic features, the optimal times to observe, and other viewing tips, such as how to cope with light pollution. ***Wiley, 2007, 280 p., b&w and color plates, paperback, $19.95.***



THE BLUE DEATH: Disease, Disaster, and the Water We Drink

ROBERT D. MORRIS

Many people in the United States take clean drinking water for granted. Such complacency, Morris argues, could mean trouble down the road, as the water supply is threatened by ever-evolving microbes, bioterrorism, and environmental toxins. Waterborne illness still occurs, and drinking water may sicken millions of people every year in the United States. Morris, an environmental epidemiologist, looks at the history of waterborne disease, including the cholera outbreaks in London that led to John Snow's discovery of the disease's source in drinking water and the typhoid outbreaks of 19th-century Chicago. He describes early engineering efforts to guarantee clean water, including expensive and treacherous dam construction as well as environmental regulations. Morris contends that despite such efforts, the U.S. water system remains at risk from pollution, leaking water mains, and resistant microbes. Finally, Morris offers suggestions for ensuring a safe water supply, including using more-advanced water-treatment technology and making filters an integral part of the water-supply system. ***HarperCollins, 2007, 310 p., hardcover, $24.95.***



LIVES OF THE PLANETS: A Natural History of the Solar System

RICHARD CORFIELD

Within the past 20 years, astronomical exploration has vastly increased the understanding of Earth's planetary neighbors. In an effort to capture and distill this new knowledge, Corfield tours the solar system planet by planet, explaining what is known about these foreign worlds—from the solar observations of Stonehenge's creators to present-day robotic missions. He details the major contributors to planetary science and the satellite missions sent to planets such as Mercury, Venus, and Mars. These missions have helped dispel ancient myths about the planets and have revealed new information about the existence of subterranean water and atmospheric conditions as well as about the planets' surface features. Corfield concludes by outlining efforts to explore the very edges of the solar system and the ongoing search for other planets within and beyond it. ***Basic Books, 2007, 268 p., color plates, hardcover, $27.50.***

A MEASURE OF ALL THINGS: The Story of Man and Measurement

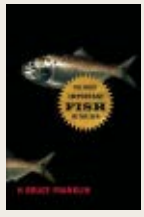
IAN WHITELAW

Inches and centimeters are common units of measurement. But does anyone know what a sydharb is? Or a perch or lustrum, for that matter? Who created these terms, and what do they measure? Whitelaw chronicles the history of measurement and describes how it has enriched people's understanding of their world. Much of modern measurement got its start in Mesopotamia, where the need for standard measurement was first recognized. Whitelaw recounts the development of the imperial system of Great Britain and describes how the newly formed United States colonies abandoned that system for their own. He summarizes common units of measurement such as length, weight, area, volume, mass, temperature, speed, and time. Along the way, he provides interesting notes about everyday units of measurement, such as ring sizes and alcohol content, as well as lesser-known units, such as those that measure fly-fishing weights and the distance between railroad tracks. ***St. Martin's, 2007, 160 p., b&w illus., hardcover, $17.95.***

THE MOST IMPORTANT FISH IN THE SEA

H. BRUCE FRANKLIN

Franklin recounts how the menhaden, a fish that most people today have never heard of, helped shape the natural history of the United States. Native Americans and early settlers buried the small and unappetizing fish with seeds to encourage crop growth. Following the Civil War, manufacturers extracted oil from the fish and used it in fertilizer. Later, as the health benefits of omega proteins became apparent, the demand for these fish rose precipitously. Overfishing of menhaden eventually had a negative impact on the ecosystems of the U.S.–Atlantic and Gulf coasts. The numbers of larger fish species, which relied on menhaden for food, dwindled. And in the absence of menhaden, algal growth threatened to choke the other organisms living in the coastal waters. Franklin reveals how an unlikely alliance between recreational anglers and environmentalists helped save the menhaden populations of the Eastern seaboard. ***Island Press, 2007, 264 p., b&w photos & illus., hardcover, $25.00.***



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LETTERS

Exhaustive analysis

I would debate the "1,000 watts or more" value attributed to typical adults during strenuous exercise ("Powering the Revolution: Tiny gadgets pick up energy for free," *SN: 6/2/07, p. 344*). Hiking up steep slopes, I rarely exceed 250 W myself, and typical hikers are going much slower. The 1,000-watt figure can only apply to elite athletes during brief periods of peak exertion.

DAVID B. THOMAS, KENAI, ALASKA

Seeking the hole truth

Rather than concluding that the object that hit Canada 12,900 years ago was a comet, I wonder whether there might not be an alternate reason that geologists haven't discovered a large hole ("Ice Age Ends Smashingly: Did a comet blow up over eastern Canada?" *SN: 6/2/07, p. 339*). If a meteor hit a kilometer-thick glacier, would it have left a crater in the rock underneath the ice?

PETER SHOR, WELLESLEY, MASS.

Scientists "haven't discovered a large, smoking hole" left by the event. Have they considered that James Bay and Hudson Bay look remarkably like what you'd expect an impact crater to look like?

WM. CARTER ELLIOTT, RESEDA, CALIF.

Now I am inclined to believe that this comet explosion had more to do with the demise of the Pleistocene mammoths, bears, camels, and other animals than superefficient hunting by Clovis hunters did. I have always had doubts that the Clovis hunters wiped out the large animals.

MICHAEL F. CROWE, AURORA, COLO.

Previous expeditions to the area around Hudson and James Bays haven't found incontrovertible signs of an extraterrestrial impact, such as shocked grains of quartz or cone-shaped zones of shattered bedrock, says Allen West of Geoscience Consulting in Dewey, Ariz. However, he notes, the thick ice sheet overlying the area at the time might have softened the blow from space somewhat, eliminating or minimizing such evidence. On the topic of extinctions, the impact had only a regional impact and didn't wipe out mammoths living in what are now Mexico and Siberia. —S. PERKINS

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