# SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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electrifying plastics

stone age DNA debate

journey to earth's center

how sea kids see

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# puzzling designs

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MAY 17, 2003 VOL. 163, NO. 20


## Features



## This Week





## Of Note



## Departments



**Cover** A new model of how large-scale polygonal patterns might have formed atop a glacier in Antarctica's Beacon Valley could explain similar configurations observed on Mars. (David R. Marchant) Page 314

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# Stone Age Genetics

## Ancient DNA enters humanity's heritage

**Genetic material that Italian researchers** extracted from the bones of European Stone Age *Homo sapiens*, sometimes called Cro-Magnons, bolsters the theory that people evolved independently of Neandertals, the team proposes.

Fossils of two anatomically modern *H. sapiens* found in a southern Italian cave yielded mitochondrial DNA, which is inherited from the mother, say Giorgio Bertorelle of the University of Ferrara in Italy and his colleagues. The DNA contains chemical sequences that resemble those of people today but differ substantially from those previously isolated from four Neandertal specimens, the scientists report.

One of the Italian Cro-Magnons dates to 25,000 years ago; the other, to 23,000 years ago. Neandertal fossils that have yielded mitochondrial DNA range from about 29,000 to 42,000 years old (*SN: 4/1/00, p. 213*).

"These results are at odds with the view [that] Neandertals were genetically related with the anatomically modern ancestors of current Europeans or contributed to the present-day human gene pool," Bertorelle's group concludes.

Contamination of ancient DNA can occur easily. However, the mitochondrial DNA obtained from the Cro-Magnon bones exhibits no trace of genetic material from other animals unearthed in the Italian cave or from people who have handled the bones, the scientists assert in an upcoming *Proceedings of the National Academy of Sciences*.

The researchers compared Cro-Magnon genetic sequences from an especially variable stretch of mitochondrial DNA with corresponding sequences from Neandertal fossils and from 80 people now living in Europe or western Asia.

Cro-Magnon sequences fall within a genetic category shared by people today but not by Neandertals, the scientists report. This result aligns with the theory that modern *H. sapiens* originated in Africa around 150,000 years ago and then replaced Neandertals in Europe rather than interbred with them, Bertorelle and his coworkers say.

Mark Stoneking of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, an advocate of this single-origin model of human evolution, nonetheless regards the new evidence with caution. He hasn't seen the report but worries that the Cro-Magnon DNA is contaminated. However, mitochondrial DNA analyses of living people align with the single-origin, or out-of-Africa, scenario, Stoneking says.

Adherents of the contrasting multiregional-origin theory of evolution view the Cro-Magnon findings even more skeptically. They argue that anatomically variable *H. sapiens* in Europe, Africa, and Asia interbred enough over the past 1 million years or more to evolve as a single species.

S. RICCI

**GENETIC FACE-OFF** **Mitochondrial DNA from this Cro-Magnon (left) and one other differs markedly from that of Neandertals (right).**

The reported genetic differences between Cro-Magnons and Neandertals may be consistent with interbreeding of small Neandertal and large *H. sapiens* populations, comments John H. Relethford of the State University of New York at Oneonta.

Moreover, if mitochondrial-DNA alterations spread quickly by providing survival advantages instead of gradually by chance, as is usually assumed (*SN: 2/6/99, p. 88*), then such evidence can't be used to reconstruct ancient human evolution, he notes.

Statistical analyses of worldwide living populations' nuclear DNA—the DNA that holds most of a person's genes—indicate that interbreeding of *H. sapiens* and other Stone Age Asian or European groups, if not Neandertals, contributed to modern humanity's evolution, remarks Alan R. Templeton of Washington University in St. Louis. —B. BOWER

# Going Down?

## Probe could ride to Earth's core in a mass of molten iron

**Blast a crack in Earth's crust, pour in a few** thousand tons of rock-busting molten iron, and then toss in a grapefruit-size instrument designed to ride the plunging elevator of liquid metal to the planet's core.

That scenario sounds like science fiction. Even its author, geophysicist David J. Stevenson of the California Institute of Technology in Pasadena, calls the proposal "highly speculative." However, in the May 15 *Nature*, he contends that such a mission to explore Earth's interior is technically feasible.

People have drilled into our planet's crust to investigate conditions there, but even the deepest borehole penetrates only about 10 kilometers, says Stevenson. Seismic analyses suggest that the continents, the thickest portions of Earth's outer layer, are between 200 and 250 km thick (*SN: 5/3/03, p. 285*). Below that hardened crust lies the viscous mantle, which surrounds a liquid outer core and a solid inner core that are both made predominantly of iron.

All that iron sank to Earth's core because it's so dense, and Stevenson's plan would exploit that property. If scientists pour molten iron into a narrow crack at least 300 meters deep, the pressure at the bottom of the fissure would be enough to fracture the rock there, Stephenson says. As the crack grows deeper, the molten iron would flow downward and maintain pressure at the crack tip. The self-propagating crack—which high pressure in deep rocks would seal after the iron passed by—would progress at about 5 m per second and reach Earth's outer core in about a week.

The energy required to blast the initial crack, which Stevenson estimates should also be at least 300 m long and about 10 centimeters wide, is equivalent to the explosive power of several million tons of TNT or a single modest hydrogen bomb. The molten iron needed to fill such a fissure—about 10,000 cubic meters—is the volume produced by all the world's foundries in an hour.

Getting the molten iron to Earth's core wouldn't be hard, says Norman H. Sleep, a geophysicist at Stanford University. Bigger challenges would arise in developing a suitable probe. Temperatures deep within Earth rise to 1,800°C, and pressures there are more than 1,000 times those found at the greatest ocean depths, he notes. In such conditions, most metals that probe-makers might use corrode in the presence of

liquid iron or dissolve into it, and the electronics inside the device probably wouldn't fare well, either.

"This idea is workable but needs to be thought out carefully to be sure the probe measures something that's useful," says Sleep.

For example, on its plunge through the mantle, the instrument could provide information about a portion of Earth's interior that has been inaccessible to direct observation. Raymond Jeanloz, a geophysicist at the University of California, Berkeley says that such a probe could provide detailed data about the density and composition of rocks, properties that drive the movement of materials within the mantle and of tectonic plates at the planet's surface. Using an automotive metaphor, he asks: "Wouldn't it be nice to lift up Earth's hood and see what's going on inside?" —S. PERKINS

# Columbia Disaster

## Working hypothesis: Wing hit by debris

**The independent board investigating the** breakup of the space shuttle Columbia last week presented its first detailed account of what might have caused the Feb. 1 disaster that killed all seven crew members.

After 3 months of reviewing abundant evidence, including shuttle debris, wind tunnel measurements, telemetry, and videos, the Columbia Accident Investigation Board offered a scenario: The tragedy began during liftoff on Jan. 16, when debris from an external fuel tank struck Columbia's left wing. The impact apparently punched a hole just below the wing's leading edge. During the shuttle's reentry 16 days later, this breach permitted superheated gases to penetrate the wing's wheel well. That, in turn, caused the wing to deform, leading to the catastrophic breakup of the vehicle.

That "working hypothesis," as board chairman retired Navy Admiral Harold Gehman Jr. called it during a May 6 press briefing in Houston, fits with speculation that emerged just days after the disaster (*SN: 2/8/03, p. 83*). However, the board stopped short of blaming the catastrophe on pieces of foam insulation that broke from the external tank.

**BIG GUN** Compressed-gas gun at Southwest Research Institute in San Antonio that's used to shoot chunks of shuttle foam at targets resembling shuttle coating.

"The board . . . is certainly suspicious that the foam had something to do with this" but is reserving judgment until further data are collected, Gehman told reporters. The group is still waiting for additional information, including results from tests at Southwest Research Institute in San Antonio. There, researchers are shooting chunks of shuttle foam out of a compressed-gas gun into panels of heat-resistant material known as reinforced carbon-carbon. These panels are similar to those that encased the shuttle's wings.

Ground-based video cameras recorded images of foam tumbling off one of Columbia's external fuel tanks and hitting the left wing just after liftoff. Foam has peeled off during other shuttle missions, and the board estimates that it occurs about once every 12 to 13 shuttle missions.

While Columbia was still in flight, NASA officials consulted with the agency's own engineers and contractors and concluded that the impact didn't pose a danger to the shuttle crew. NASA decided not to arrange for satellite images of the shuttle to look for damage. However, e-mails made public in March reveal that some NASA scientists remained worried.

The board now recommends that such images be a standard requirement for each shuttle flight and that NASA should develop a more comprehensive inspection plan for all of the shuttle's reinforced carbon-carbon components.

Nongovernment members were placed on the board after Congress expressed concern that the investigation wouldn't be impartial. Earlier this week, the Orlando Sentinel reported that these recent additions had been placed on the NASA payroll so that the board would contain only federal employees and can legally keep secret closed-door testimony or transcripts of its deliberations.

Gehman has argued that such a policy encourages witnesses to speak more openly. But some observers say the secrecy undermines the board's credibility.

"Congress and the public are going to question the force and validity of their procedural recommendations without access to the evidence that led them to their conclusions," asserts John Pike, a space-policy analyst with GlobalSecurity.org in Alexandria, Va. —R. COWEN

# Gypsy Secret

## Children of sea see clearly underwater

**For hundreds of years, small nomadic tribes** called sea gypsies have lived among the islands of Southeast Asia, earning fame for their swimming and diving skills. Sea-gypsy children regularly collect food such as clams and sea cucumbers off the ocean floor. A research team studying one sea-gypsy tribe has now found that its children have better-than-normal underwater vision because their eyes adapt to the liquid environment.

While some animals such as frogs can see equally well on land and in water, the human eye has evolved to work best in air. Underwater, its focusing capability significantly deteriorates. That's why people typically need goggles to see clearly when diving.

Intrigued by tales from a colleague who had observed the food-collecting prowess of sea-gypsy children, vision researcher Anna Gislén of Lund University in Sweden decided to investigate how such kids can pick out small objects while diving without goggles. Since many sea-gypsy tribes live on boats in remote areas and dislike strangers, Gislén and her colleagues had to find a tribe willing to be studied. The researchers eventually worked with the Moken, a tribe living in the archipelago along the west coasts of Burma and Thailand.

Initially, the researchers compared the

COLUMBIA ACCIDENT INVESTIGATION BOARD

underwater vision of 6 Moken children with that of 28 European children visiting the region. In eye exams conducted in local waters, the sea-gypsy kids had superior resolving power and better perception of contrast, Gislén's team reports in the May 13 *Current Biology*.

Using an infrared video camera to film the eyes of both groups of children underwater, the investigators found that Moken kids constrict their pupils while European children don't. And the sea-gypsy children could also change their visual focus—in what researchers call accommodation—more than the European kids typically could.

"The small pupil and the accommodation both would serve to increase visual acuity," says David Guyton of Johns Hopkins Medical Institutions in Baltimore. Despite this improvement, the underwater vision of the sea-gypsy children is still impaired compared with their above-water eyesight, he adds.

Since sea-gypsy tribes have depended on the ocean for hundreds of years, it's possible that the Moken children have inherited genetic variations that enable them to see more clearly underwater, the researchers note. Or it may simply be that with regular diving, the eye learns to adapt to the underwater environment.

"My guess is that it's learning," says Gislén. She and her colleagues have preliminary evidence that with training, European children can develop better underwater vision in a few months. They still don't match the sea-gypsy children, who spend years diving for food, Gislén notes. —J. TRAVIS

# Melt-Resistant Metals

## Carbon coating keeps atoms in order

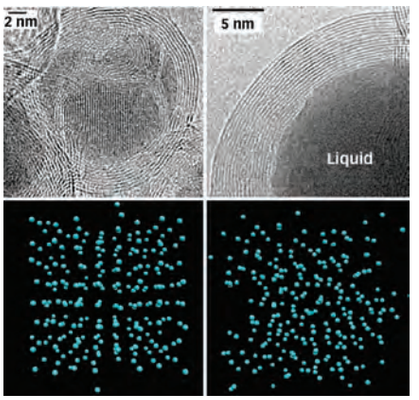
**Scientists have long known that impurities** and flaws in a metal's crystal structure can lower the material's melting point. In an unexpected twist, an international research team has dramatically boosted the melting points of metals by straightjacketing nanometer-scale crystals inside thin carbon shells.

The findings may lead to microcircuits, sensors, and polymers that can function at higher temperatures than current ones do, says team member Mauricio Terrones of the Instituto Potosino de Investigación Científica y Tecnológica in San Luis Potosí, Mexico. Terrones and his colleagues describe their results in the May 9 *Physical Review Letters*.

Ordinarily, metal nanoclusters containing only hundreds to thousands of atoms melt at temperatures much lower than the metals' larger-scale forms do. That relationship changed dramatically when Terrones and his colleagues enveloped tin or lead nanoclusters in graphitelike carbon layers a few atoms thick and then heated these assemblages while observing them with an electron microscope.

Although the scientists expected increases, they were startled by how high the metals' melting temperatures rose. For tin, the melting point leaped as high as 265°C above the bulk metal's melting threshold. Likewise, lead clusters melted only at temperatures more than 140°C above the melting point of bulk lead.

"The magnitude of the superheating is colossal," comments materials scientist




BANHART ET AL./PRL

**TAKING THE HEAT** **At 140°C above lead's normal melting point (top left), carbon-coated nanoclusters of the metal remain solid. At 270°C (top right) above the normal melting point, the nanoclusters have become liquid. Simulations (bottom) show corresponding crystal structures.**

Robert W. Cahn of the University of Cambridge in England. "Nothing like that has ever been seen before."

On a fundamental level, the researchers' observations may clarify what happens on the finest scale as a solid melts, Terrones says. For lead clusters, the researchers found that a characteristic magnitude of vibration presaged melting, no matter what the pressure and temperature. This new finding suggests that vibration threshold is a fundamental property of the metal, not just a product of experimental conditions.

In this case, Terrones suggests, the carbon sheaths suppressed the nanocrystals' vibrations compared with those in uncoated metal. Only at higher temperatures, therefore, did the vibrations reach the threshold for melting.

Some studies of crystals that had been essentially shrink-wrapped within ceramics and other materials have found more modest melting-point increases. These changes were attributed to restrictions in the motion of the crystals' surface atoms.

That's not enough to explain the huge melting-point boosts elicited by the carbon shells. In experiments and simulations, giant pressures—up to several thousand times atmospheric pressure—proved to be responsible, the scientists now report. The nanocapsules are "like pressure cookers," Terrones says.

That pressure effect may have practical implications in nanowires where the loss of even a few atoms can spell failure, comments David L. Carroll of Wake Forest University in Winston-Salem, N.C. For instance, the pressure exerted by a carbon coating on metallic nanowires in future ultrasmall circuits could keep atoms in place despite heat and current flow. —P. WEISS

# Bone Builder

## New drug could heal hard-to-mend fractures

**A synthetic compound can heal broken** bones that are so damaged they don't knit on their own, a study in rats and dogs shows. Encouraged by the findings, scientists are already testing the compound in people. If the experimental drug—so far, called only CP-533,536—passes safety and effectiveness trials, it could become an important treatment for the very worst of fractures.

The compound works by binding to a receptor molecule on the surface of bone-building cells. A natural compound called prostaglandin E2 normally attaches to this receptor, which sets off a flurry of bone-repair signals in the cell. When tested as a drug, however, prostaglandin E2 had dire side effects.

CP-533,536 appears to mimic the prostaglandin's bone-building benefits without its downside, says study coauthor David D. Thompson of Pfizer in Groton, Conn. He and his colleagues report their findings in an upcoming issue of the *Proceedings of the National Academy of Sciences*.

Prostaglandin E2 actually binds to several molecules on cell surfaces, some of which might account for its side effects, Thompson says. Previous studies suggested that one receptor is particularly instrumental to bone growth, so his team screened hundreds of compounds to find ones that would only latch onto that cell-surface molecule. They then modified one of the selected compounds to improve its binding. They named the result CP-533,536.

Next, the researchers injected CP-533,536 near fractures in some rats and gave other rats inert shots at their injury sites. Only the drug-treated rats showed significant gains in bone density.

The researchers then tested CP-533,536 on dogs, some with severe breaks that would be unlikely to heal on their own and

others with more modest fractures. Most of the dogs getting the drug healed fully within 24 weeks of surgery, regardless of the severity of the break. Dogs not getting CP-533,536 failed to heal at the worst breaks and mended the modest breaks more slowly than did treated dogs.

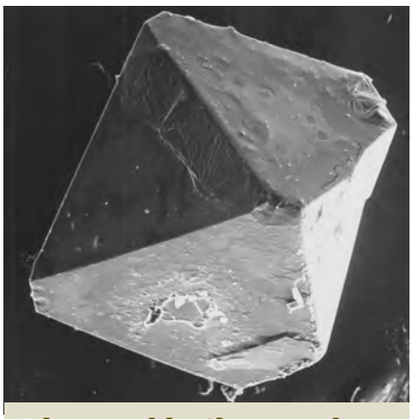
None of the dogs given CP-533,536 exhibited the harsh diarrhea, lethargy, or kidney and heart damage seen in past animal tests of prostaglandin E2.

Because of these side effects, "nobody has ever developed clinical utility for prostaglandin E2 itself," says Lawrence G. Raisz of the University of Connecticut in Farmington. "This compound [CP-533,536] could be a much better way of doing this."

Of the 6.2 million fractures diagnosed in the United States each year, up to 10 percent don't heal properly, says Thomas A. Einhorn of Boston University School of Medicine. Many of these are the result of violent accidents, but some simply occur in parts of the body, such as the shinbone, that have poor circulation. If CP-533,536 tests well in people, it might facilitate healing in such cases and eliminate the need for some bone grafts, he says.

As such, it would join another line of pharmaceuticals approved for fractures in the past few years (*SN: 6/3/00, p. 357*). Those so-called bone morphogenic proteins also heal severely damaged bones, but they don't work on all patients.

It may also be possible, Einhorn says, to develop an oral treatment using CP-533,536. —N. SEPPA



## Diamond in the rough

**It takes a scanning tunneling microscope to view this crystal made of billions of $10^{-21}$-carat diamondlike molecules. These newly discovered, naturally occurring molecules are called cyclohexamantane. For decades, researchers have synthesized so-called diamondoids with simpler molecular structures and have even used one of these, adamantane, to make medicines. Simple diamondoids are also found in petroleum, where they can form well-clogging sediments. While studying this problem several years ago, Jeremy E.P. Dahl, a geologist at Stanford University and ChevronTexaco in Richmond, Calif., and his colleagues speculated that oil might contain more-complex diamondoids. They were right. They recently found several complex diamondoids in oil, and in the May 9 *Angewandte Chemie International Edition*, they describe the isolation and characterization of cyclohexamantane.** —J. GORMAN

# Troubling Treat

## Guam mystery disease from bat entrée?

**A famous unsolved medical puzzle of last** century—why a neurological disease spiked on Guam—may hinge on the local tradition of serving boiled bat.

After World War II, doctors noticed that the Chamorro people of Guam experienced 100 times as high an incidence of diseases resembling amyotrophic lateral sclerosis than people in the continental United States do. Last year, scientists proposed that when large local bats called flying foxes (*Pteropus mariannus*) dine on seeds of the cycad plant, they accumulate high concentrations of neurotoxins, which transfer to people who eat the bats. Now, ethnobotanist Paul Alan Cox of the National Tropical Botanical Garden in Kalaheo, Hawaii, and his colleagues report that the rise and fall of the disease tracks an increase and then decrease in human consumption of local bats.

In the Guam disease, people typically lose muscle strength and control and then waste away. Studies of these cases might reveal a chemical trigger for certain neurological conditions, comments Peter Spencer at Oregon Health Sciences University in Portland.

Cox adds a new reason to study the Guam cases: Animals that haven't traditionally played a large role in human diets now show up in markets around the world in great abundance. "We're worried," says Cox.

Early investigators of the Guam disease ruled out genetic explanations and found links to traditional lifestyles. The Chamorro people make tortillas of flour from seeds of cycads, which carry potent chemicals such as the neurotoxin BMAA.

**BAT DINER** Flying fox feeds at a cycad.

DAHL ET AL./ ANGEW. CHEM. INT. ED.; M. TUTTLE, BAT CONSERVATION INTERNATIONAL/WWW.BATCON.ORG

However, researchers found that cooks soak the seeds in a way that leaches out much of the neurotoxins.

In a fresh approach, Cox and New York neurologist Oliver Sacks sketched out the basics of the bat hypothesis in the March 26, 2002 *Neurology*. Cox and other colleagues more recently correlated hunting and trade of bats with the disease's incidence, they report in the June *Conservation Biology*.

The Chamorro people have a long tradition of serving flying foxes as delicacies, says coauthor Sandra Banack of California State University at Fullerton. The bats, complete with fur, eyeballs, and viscera, are usually eaten in coconut milk. Traditionally, hunters snag the bats with thorny vines, not an easy feat. During the past century, though, increased military presence on the island made guns more widely available and bat hunting more efficient. As a cash economy emerged, the bat market boomed. Hunters sold the flying foxes for up to $30 apiece.

Eventually, the relentless hunting and the ravages of the introduced brown tree snake drove the bats on Guam near extinction. People then relied on imported bats. Banack reports that bats on other islands don't eat cycads as much, and thus wouldn't accumulate as much of the neurotoxins as the Guam bats do. Cox says that he and his colleagues are now measuring high concentrations of cycad compounds in Guam bat tissue.

Whether the cycad's active component comes from bats or tortillas, "it's the structure of the chemical that's important," says Spencer. Because he's failed to produce the full, progressive disease in monkeys by dosing them with BMAA, he's now pursuing cycasin, another cycad compound.

The flying fox is "a potentially interesting additional source of cycad exposure," says Spencer. —S. MILIUS

# PLASTIC ELECTRIC

## Lining up the future of conducting polymers

BY JESSICA GORMAN

For the last century, technology has blossomed in an age of plastics. We drive cars with plastic parts, we wear eyeglasses with plastic lenses, and we sip mineral water from plastic bottles. Plastic cell phones connect us to family and friends, and plastic keys typed these very words. Plastics may now be entering additional avenues of technological greatness based on one of their newer properties—electrical conductance.

First discovered in the 1970s, conducting polymers have made it into a few small-scale commercial applications, such as antistatic coatings on photographic film and light emitting diodes in a display of maintenance information on an electric razor.

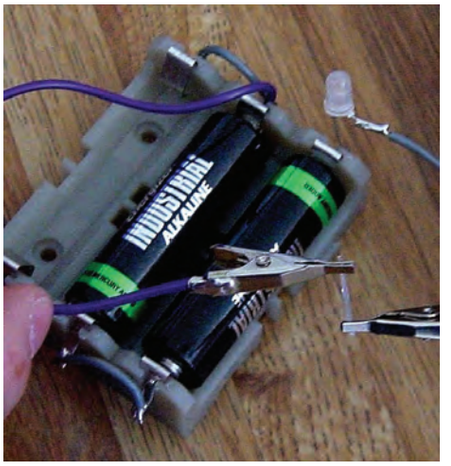
Now, however, a range of development efforts aims to put conducting polymers to use in products as diverse as paper-thin televisions and sensors for chemical-weapons detectors. Meanwhile, polymer scientists are doing fundamental research, seeking ever more conductive plastic materials.

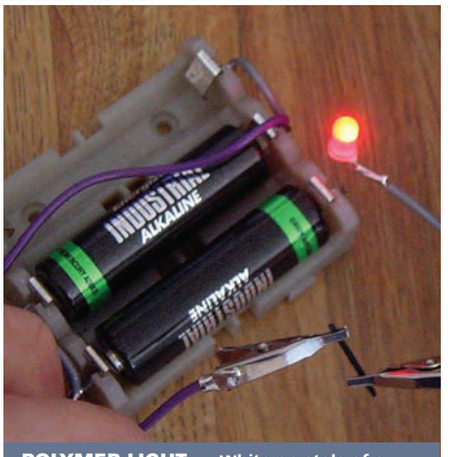
One major thrust of this work is to figure out how to make existing conducting plastics more orderly on the molecular level. Disorder limits the polymers' conductivity and can hinder their performance in electronic devices. In two recent reports centered on the leading conducting polymer, researchers describe progress in the quest for more order.

**PLASTICS THAT CONDUCT** Before the 1970s, plastics' closest association with electricity was as the insulation around electrical wires. The discovery of conducting polymers has been regarded as so important that it was recognized with the 2000 Nobel Prize in Chemistry (*SN: 10/14/00, p. 247*). Three researchers who had worked together at the University of Pennsylvania—Alan Heeger of the University of California, Santa Barbara, Alan MacDiarmid of the University of Pennsylvania, and Hideki Shirakawa of the University of Tsukuba in Japan—shared that award.

A theme in the development of conducting polymers has been chemists' ingeniously capitalizing on mistakes. Both luck and insight played roles in the discovery of the first conducting polymer, a form of the material called polyacetylene. As its name implies, this polymer molecule is built from smaller molecules of acetylene, the substance that burns in welders' torches.

While trying to make ordinary polyacetylene, a researcher visiting Shirakawa's laboratory in Japan accidentally added 1,000 times the usual amount of polymerization catalyst to a vessel containing acetylene. Instead of yielding what looked like a typical plastic, the reaction produced a shiny, metallic-looking material. Working on a hunch they had developed from experiments on inorganic materials that conduct electricity, the three future Nobel laureates added small amounts of bromine or iodine gas to remove some electrons from the plastic. Called doping, this process afforded the strange polyacetylene's remaining electrons enough freedom to move rapidly up and down the polymer's molecular chains.




**POLYMER LIGHT —** White crystals of a thiophene monomer don't conduct electricity (top). After heat polymerizes the material, it turns black and conducts electricity well enough to turn on a lightbulb (bottom).

But polyacetylene has one important flaw: It decomposes quickly in air. Researchers, however, soon formulated other electrically conductive plastics. One of the best studied, most stable, and most commercially important of these is a class of polymers called polythiophenes, whose members are made up of repeating units called thiophenes. It's "the conducting polymer of choice," says materials scientist George Malliaras of Cornell University.

However, while polythiophenes have many superior properties, researchers can't easily align the molecules within a sample, which limits current flow.

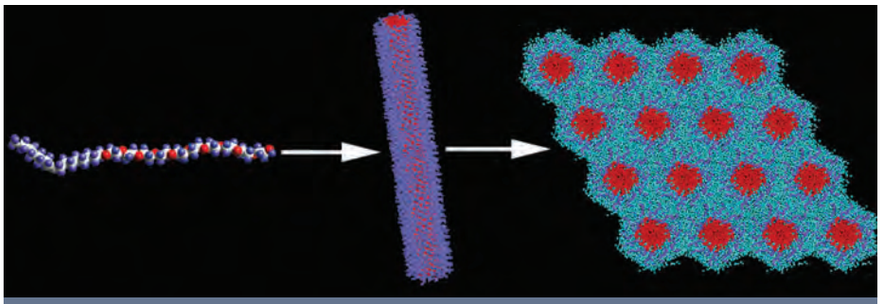
"The properties of the materials are definitely limited by disorder," says Heeger, who in 1990 cofounded the company UNIAX, which was purchased by DuPont in 2000, to commercialize conducting polymers.

**ORDERLY POLYMERS** A different type of accident contributed to the discovery of a way to make a well-ordered, conducting polythiophene. In May 2000, Hong Meng, a student working in chemist Fred Wudl's laboratory at the University of California, Los Angeles, made a sample of a thiophene monomer known as 2,5-dibromo-3,4-ethylenedioxythiophene and sealed it in a jar. In March 2002, when Meng retrieved the jar, he discovered that the white crystalline powder he'd prepared now looked like shiny, black crystals. Because Wudl's

MENG

lab studies conducting polymers, it has a rule that any metallic-appearing material that a researcher makes or finds must be tested for electrical conductivity.

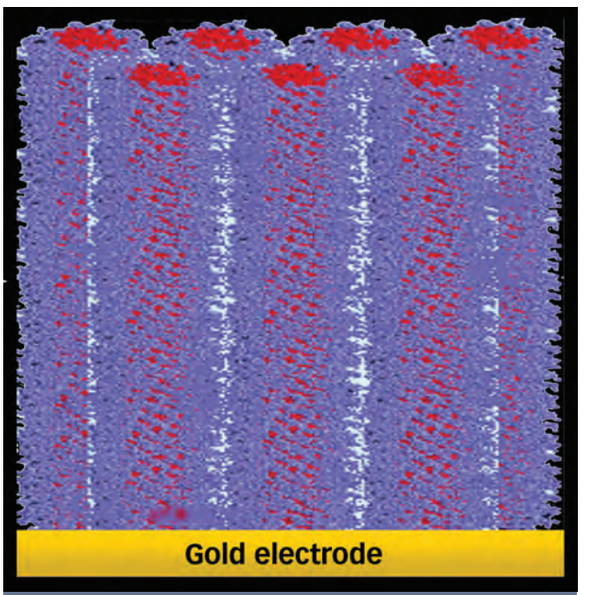
As it turned out, the Wudl team discovered that Meng's material—a polymer that formed in the jar when the stored monomers linked up—conducted electricity better than commercially available versions of the same polythiophene.



**TEMPLATE ASSEMBLY —** Liquid crystals assemble in water to form a honeycomb pattern. Monomers become confined and oriented in the hydrophobic cores (red), where they polymerize.

The transformation of monomer powder into a solid polymer material had not been seen before in a polythiophene, says Wudl. He suspected that this so-called solid-state transformation might have created a polymer in a highly ordered, defect-free, crystalline form—locking in the regimented orientation of the original monomer components. This kind of organization doesn't appear in polythiophenes created via the standard procedure of mixing catalysts and other additives with monomers in solution.

What had caused the transformation in the storage jar? Was it light? Heat? In laboratory experiments, Meng, Wudl, and their coworker Dmitrii Perepichka found that they could polymerize the monomer in a solid-state reaction simply by heating it. And the reaction didn't need to take 2 years. It could be achieved in just a day, or even several hours, by heating the material to 60°C or 80°C, respectively, the researchers reported in the Feb. 10 *Angewandte Chemie International Edition*. That's well below the monomer's melting temperature of 96°C.




**POLYMER PRODUCTION —** Illustration shows a side view of a liquid-crystalline template that has assembled into a honeycomb pattern on a piece of gold. Researchers use an electric field to polymerize monomers inside the liquid crystals' cores (red).

To conduct electricity, a polymer needs to be doped so that electrons can move freely. As it happened, Meng's 2-year reaction on the UCLA shelf had itself taken care of this doping. Each monomer contained two bromine atoms, and during the material's polymerization, some carbon-bromine bonds broke. This liberated bromine gas had doped the polymer, the researchers found.

In subsequent experiments, the team added steps that remove the bromine dopant and replace it with iodine. This increases the polymer's conductivity.

While this conducting plastic looks crystalline to the naked eye, experiments revealed that it's not really crystalline nor as highly ordered as solid-state reactions might be able to produce, says Wudl. Now, he says, his lab and others will try to use the solid-state synthesis to create even more highly ordered polythiophenes.

If a solid-state reaction can produce crystals of polythiophenes, Malliaras comments, researchers will have the opportunity to examine them in ways that will provide a better fundamental understanding of the materials. "If you can enhance the properties of the conducting polymer, you might be able to enhance the properties of the devices" that you make of it, he says.

**POLYMER TEMPLATES** With an approach that seems the opposite of accidental discovery, Samuel Stupp's lab at Northwestern University in Evanston, Ill., is also searching for better conducting polythiophenes. Stupp and James Hulvat, also at Northwestern, have created a novel template for organizing thiophene monomers into more highly aligned arrangements. Made of liquid crystal, this template holds the monomers in place while they polymerize.

Liquid crystals are fluid materials that nonetheless contain particles arranged in a very uniform structure. The liquid crystals chosen by Stupp and Hulvat are gels made of tiny cylinders, just 3 nanometers wide, that in water assemble into a honeycomb pattern. The inside of the cylinders are water-avoiding, as are monomers of 3,4-ethylenedioxythiophene. When the researchers mixed the gel and the monomers, the monomers sequestered themselves within the dry interiors of the cylinders. Hulvat and Stupp then used an electric field to polymerize the molecules inside the cylinders.

This procedure resulted in the formation of polythiophene molecules, all lined up in the same direction. After the scientists washed away the liquid crystal, they were left with a polymer film that retained the nanoscale and microscale structure of the liquid-crystal cylinders, says Stupp.

Hulvat and Stupp described these results in the Feb. 17 *Angewandte Chemie International Edition*. In further experiments, preliminary tests of conductivity supported the researchers' expectations. The more regularly oriented polymer structure conducted electricity better than less regularly structured versions of the same polymer.

Moreover, light-emitting diodes containing the highly aligned material performed better than light-emitting diodes using the disordered material, says Stupp.

Using liquid crystals as a template is clever and promising, says Heeger. After all, "we cannot reach in there and pull on each molecule and align each one separately," he says.

Hulvat and Stupp say that by using different liquid-crystal templates, they expect to achieve a wide variety of molecular orientations. No single orientation will be the best choice for every application.

As scientists wield ever more refined control over the structures of conducting polymers, these materials may extend the Plastics Age into the indefinite future. ■

HULVAT

# PATTERNS FROM NOWHERE

## Natural forces bring order to untouched ground

BY SID PERKINS

In remote regions of the Arctic, Antarctica, and the Australian outback, an explorer can trek across bleak, uninhabited landscapes only to suddenly stumble upon ground decorated with weird patterns. These lonely sites feature ankle-high and meter-wide donuts of gravel; mazes, stripes, and polygonal networks of pebbles, sand, or ice; and sometimes ice crevasses in perfect geometric patterns. The enigmatic configurations, seemingly created without human influence, call to mind the mysterious phenomenon of crop circles, except that the puzzling structures are made of rocks or ice instead of trampled corn or wheat.

Scientists studying so-called patterned grounds have developed geological models for how some of these varied landforms have arisen from the influence of only soil, water, and sunlight. Although such simulations do a good job of reproducing Earth's variety of patterned ground, one of them may also go much farther: It could explain the hundreds of patterned regions that spacecraft have spied on the surface of Mars.

**CRUNCHY DONUTS —** These raised rings of stones on Kvadehuksletta, an island off the western coast of Norway, probably were formed by repeated cycles of freezing and thawing of the stone-littered ground. Rings are about 2 meters across.

KESSLER

### SORTING IT OUT

Water expands about 10 percent when it freezes, which explains why ice floats and why cans of soda explode in the freezer. It also suggests how water can be so destructive. When its molecules begin assembling into ice's open, crystalline structure, their expansion can transform small cracks in the highway into monster potholes.

That expansive force also plays a prominent role in the geological processes that probably account for much of the world's patterned ground, says Mark A. Kessler, a geologist at the University of California, Santa Cruz. One phenomenon, called frost heave, is the expansion that occurs when wet, fine-grained soils freeze. If rocks are scattered throughout such soils, repeated episodes of freezing and thawing brings the stones to the surface because damp soil particles gradually flow around and settle under the stones.

Another phenomenon of freezing soil moves pebbles around once they're at or near the surface, Kessler contends. For one thing, because soil holds water but stone doesn't, stone-poor areas have more water and expand more than stone-rich areas do. Also, the boundary between the freezing soil above and the wet soil below moves down from the surface more quickly in stone-rich areas. Lateral forces stemming from both these actions tend to push stones toward each other.

Once frost heave has thus corralled the stones into clusters, it squeezes those clusters into piles or mounded stripes, says Kessler. Over time, the repeated freeze-thaw cycles sculpt the rock groups and smooth out any irregularities—odd-shaped piles eventually become round in top view, and linear formations take on a uniform width and height. If frost heave ends up stacking rocks too steeply, miniavalanches change the formations accordingly.

While at the University of California, San Diego, Kessler and his colleague Bradley T. Werner developed a computer model that simulates the interactions among the three processes: the lateral sorting of rocks into groups, further squeezing of those groups, and gravity-induced miniavalanches. By adjusting certain parameters in the model, Kessler and Werner reproduced the full range of stone patterns that make up what scientists call sorted patterned ground. They describe their results in the Jan. 17 *Science*.

When only a few stones—about 100 per square meter—were scattered across the pair's cybertundra, frost heave shaped them into small heaps. If large quantities of the centimeter-size stones were available—up to 1,400 stones per square meter—the model produced donutlike circles. An intermediate supply of rocks typically produced networks of polygons or labyrinthine mazes of connected stripes. Other factors in the model also affected the shapes created by frost heave. For instance, formations on sloping ground tended to stretch into oblong shapes with the longest dimension pointing downhill.

Before Kessler and Werner's model, scientists had struggled for almost a century to identify the geological processes responsible for sorted patterned ground, says Daniel H. Mann of the University of Alaska in Fairbanks. Through the years, lab and field

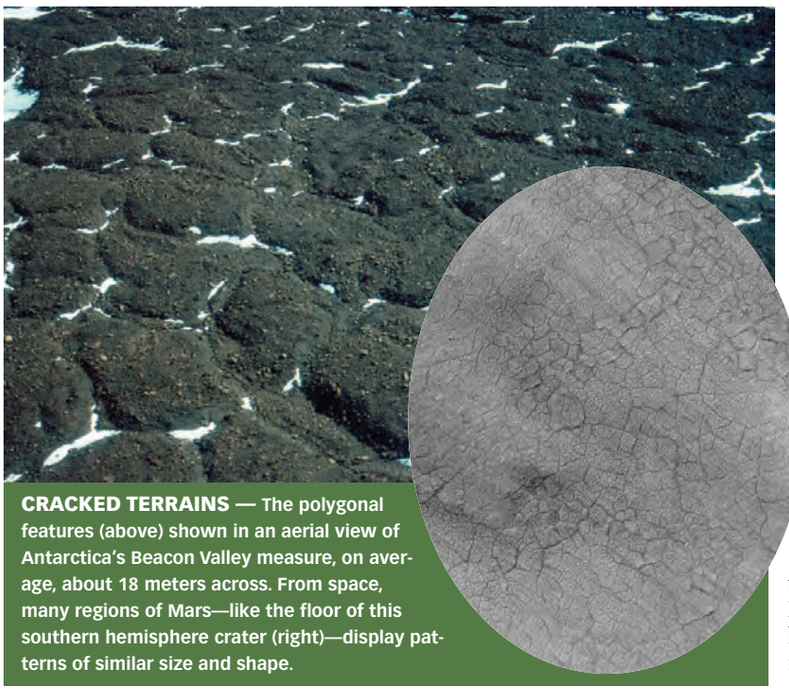
experiments confirmed some notions, but none of the purported mechanisms could generate the full variety of patterns seen in nature.

One problem, says Mann, was that scientists were trying to model the physical interactions affecting individual grains of silt, sand, and pebbles. Another hurdle was a lack of computer power required to simulate and track the three-dimensional movements of thousands of rocks through hundreds of freeze-thaw cycles. "There's nothing in the physics of a shovelful of stony mud that can predict the emergence of an intricate pattern of rock formations that can cover many square meters," Mann notes.

Kessler and Werner's computer model often needed several hundred freeze-thaw cycles for sorted patterned ground to develop from an initial random scattering of stones. In high-latitude regions, where the ground may thaw only a few times each year, sorted patterned ground may take centuries to arise, according to the model. At sites where freeze-thaw cycles occur frequently, stone formations may form in just a few years.

Some such fast-forming patterns grace terrain once covered by glaciers near Jotunheimen, Norway. Lichens on some of the rocks left behind by the melting ice streams indicate that the glaciers began retreating in about 1750. That's around the end of an extended cool spell that scientists call the Little Ice Age, says Jason Haugland, a geologist at the University of Colorado in Boulder.

The freshest areas of sorted patterned ground, those closest to the edge of the retreating glacier, have formed in just the past 10 years or so and are still active, says Haugland. Zones of stone patterns farther from the ice margin have become stabilized by vegetation that's taken hold along the polygons' stony borders. Haugland described his findings in March at the annual meeting of the Association of American Geographers in New Orleans.



**CRACKED TERRAINS —** The polygonal features (above) shown in an aerial view of Antarctica's Beacon Valley measure, on average, about 18 meters across. From space, many regions of Mars—like the floor of this southern hemisphere crater (right)—display patterns of similar size and shape.

**CRACKING UP** Although rocks are necessary to produce sorted patterned ground, other types of designs can form in stonefree soils. Certain types of soil shrink significantly when they undergo big changes in temperature or when they lose moisture. That's what happens on a small scale when the wet clays and silts along the shore of an evaporating lake desiccate and break into polygonal blocks a few centimeters across and separated by wide cracks.

The same process happens on a large scale during dry winters in soils that overlie permafrost, such as some in Alaska and Canada's Northwest Territories. When spring rains return or the annual thaw occurs, water runs into the fissures between polygonal soil clumps that can measure tens of meters on a side. The water freezes when it comes into contact with the permafrost at the bottom of the fissure. Eventually, a wedge of ice grows in the gap. Some of these wedges reach Earth's surface and the cracks become semi-permanent features in the terrain.

A similar process created patterned ground long ago in the western portions of New South Wales, Australia. Fine-grained, windblown soils that accumulated there in the past 1.8 million years are rich in a clay that shrinks and swells as it loses and absorbs moisture. In this region, windblown sand, dust, and other material fills the crevasses that form when soils dry and shrink, leaving an indelible pattern.

Yet farther south, Beacon Valley, one of the dry valleys of Antarctica, sports an unusual ground pattern—this one, over ice. Across a broad area of the valley floor, a 25-to-80-cm-thick layer of rocky rubble lies atop an ancient glacier. Polygonal areas ranging from 9 m to 35 m on a side are surrounded by rocky troughs as much as 3 m deep and 6 m wide, says David R. Marchant, a geologist at Boston University.

Beacon Valley's climate is harsh. The area gets less than 10 millimeters of precipitation per year. And, based on temperatures measured at nearby Lake Vanda, scientists estimate that Beacon Valley's average annual temperature is –34°C. Even at the height of summer, when there's 24-hour-a-day sunlight, soil temperatures in the valley probably rise only to a point just below freezing, says Marchant. That means the patterned valley floor probably wasn't formed by repeated freeze-thaw cycles. In the June 2002 *Geology*, Marchant and his colleagues, who have dug more than 100 trenches across the patterned ground's troughs, presented a model that describes how the Beacon Valley polygons might have formed.

Even though the rubble layer tends to insulate the underlying glacier, temperatures along the ice's upper surface vary significantly between summer and winter, Marchant notes. That variation, especially the sudden chill during the onset of winter, can cause cracks to form in the glacial ice. As the cracks widen, sand, grit, and small rocks from the overlying rubble trickle down into the fractures. Because cold, dry air can then reach the glacier by seeping through newly opened spaces between larger, undisturbed stones, the rubble directly over cracks loses its insulating value.

Although temperatures along the cracks may never rise above freezing, the ice begins to sublimate, or move directly from solid form to a vapor. That makes the cracks grow wider and deeper, permitting larger stones to pour in. In a process that continues in the valley today, cracks become rock-lined troughs and form a network of furrows that surround stable, rubble-capped polygons.

Once the troughs become deep enough to collect blowing snow, they typically stop growing. That's because even the small amount of snow available can fill the air gaps between the large stones lining the trough and restore some measure of insulation, preventing the sublimation of ice from the glacier. Deep, rock-filled troughs that have collected snow are still distinguishable from the stable, flat-topped polygonal blocks.

MARCHANT; NASA/JPL/MALIN SPACE SCIENCE SYSTEMS

Several lines of evidence support the model, says Marchant. First, the team's excavations have provided a look at the complete life cycle of a typical trough. One feature of mature troughs is a fresh layer of ice that forms when snow that had collected there evaporates in the summer, is pulled down through the air gaps between the stones, and then solidifies atop the ancient glacial ice. The ratio of oxygen isotopes in the fresh ice is different from that in the glacier's ice, a sign that the ice layer condensed from vapor in the trough and wasn't originally glacier ice.

The concentration of radioactive helium-3 isotopes in the rocks exposed by a small landslide in one trough suggests that the slump occurred about 1.2 million years ago. Those isotopes are generated when the stones, open to the elements, are struck by cosmic rays. Similar chemical analyses indicate that some of the ice polygons are up to 4 million years old.

But those studies may not have found the oldest troughs and polygons, says Marchant. Analyses of volcanic ash in the rubble atop the glacial ice show the material is at least 8.1 million years old.

The great age of the ice is exciting for a number of reasons. Most importantly, says Marchant, the glacier beneath the rubble has to be older than the rubble atop it. Samples of gases trapped in layers of precipitation that fell 3 million to 4 million years ago, if they still exist and can be recovered from the glacier, could give scientists insight into what Earth's atmosphere was like at a time when the planet's climate was around 3°C warmer than it is today.

This new, thawfree explanation of patterned ground in the cold, dry conditions of Antarctica may also apply to similar polygonal patterns on Mars.

Probes taking images from Martian orbit have spied at least 600 different sites at which polygons measure between 30 m and 200 m on a side, says Rachel L. Klima, a geologist at the University of Illinois at Chicago. So far, more than 80 percent of the total area of patterned ground discovered on Mars is in regions where the Odyssey probe measured large amounts of hydrogen buried just beneath the Martian surface at southern latitudes (*SN: 6/8/02, p. 355*). Scientists studying those data suggest that the hydrogen is associated with frozen water deposits.

That strongly suggests that these areas of patterned ground have a glacial origin, says Klima.

The new, thawfree explanation of patterned ground may apply to similar polygonal patterns on Mars.

However, most of the polygonal patterns found in Mars' northern hemisphere occurs in Utopia Planitia, a region in which Odyssey didn't find large amounts of subsurface hydrogen. Nevertheless, Klima believes that the Antarctic-style cracking of a buried glacier probably formed the polygonal features there, too.

Other possible causes of the formations, including the desiccation of soils or the cooling of lava, don't fit the observations, Klima notes. It's possible, she says, that subsurface ice in the area formed patterns and then sublimated long ago. Astronomers estimate that the terrain there is 3.5 billion years old.

The apparent lack of subsurface water at Utopia Planitia doesn't disturb James W. Head, a planetary geologist at Brown University in Providence, R.I. Odyssey can detect only hydrogen that's within 1.5 m or so of the surface. That's only a little thicker than the rubble covering the Beacon Valley glacier in Antarctica, Head points out. So even at Utopia Planitia, hidden ice could still be patterning the Martian landscape. ■

# OF NOTE

ASTRONOMY

## Supernovas, gamma-ray bursts: Two of a kind?

Astronomers have discovered direct evidence that gamma-ray bursts, the most energetic events in the universe, are linked to supernovas, the explosive death of massive stars.

On March 29, NASA's High-Energy Transient Explorer satellite detected one of the closest gamma-ray bursts on record. For half a minute, the burst outshone the gamma rays from all the rest of the universe.

Observations of the burst's afterglow began a half-day later. In early April, astronomers saw signs of a supernova explosion superimposed on the afterglow. Those signs included an upswing in the fading light's intensity as well as the presence of heavy elements, such as iron, that can be forged only in supernovas.

Astronomers have for several years suspected a link between gamma-ray bursts, theorized to be the birth cries of black holes, and supernovas, whose aftermaths can leave behind either a neutron star or a black hole (*SN: 7/10/99, p. 28*).

"This is the first direct, spectroscopic confirmation that a subset of . . . gamma-ray bursts originate from supernovas," Tom Matheson of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., and his colleagues assert in an April 9 circular of the International Astronomical Union. —R.C.

PALEOBIOLOGY

## Ancient wood points to arctic greenhouse

Chemical analyses of wood that grew in an ancient arctic forest suggest that the air there once was about twice as humid as it is now.

About 45 million years ago, forests of redwoods grew on what is now Axel Heiberg Island, a Maryland-size landmass off the northern coast of Canada. At some sites, wood from those trees is exquisitely preserved, apparently changed only by desiccation and slight compression by surrounding sediments. "It's like driftwood," says A. Hope Jahren, a geochemist at Johns Hopkins University in Baltimore.

By analyzing the ratios of oxygen isotopes and hydrogen isotopes in the wood's cellulose, Jahren and Leonel S.L. Sternberg of the University of Miami could estimate how humid the ancient forest was. On average, they report in the May *Geology*, the forest's atmosphere held about twice the water vapor found in the region today. The extra humidity would have provided a vital greenhouse effect, trapping outbound heat radiating from the ground during winter periods marked by 24-hour-a-day darkness.

Isotope ratios in a carbonate mineral infiltrating other wood samples suggest the region's average annual temperature 45 million years ago was about 13°C, says Jahren.

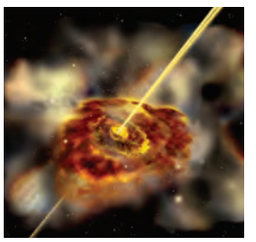
Overall, these environmental conditions match the springtime climate in today's coastal forests of Oregon. —S.P.

ASTRONOMY

## A black hole that goes the distance

The mass of the most distant black hole known has been measured, and it's a behemoth. The black hole lies some 13 billion light-years away and weighs the equivalent of 3 billion suns, researchers report in the April 10 *Astrophysical Journal Letters*.

To weigh the hole, astronomers examined light from the most remote quasar ever detected. According to theory, quasars are powered by supermassive black holes. Specifically, a quasar's brilliant light would come from the radiation released when material falls onto a rotating disk of gas surrounding a black hole.



**COSMIC FLASHLIGHT** Artist's drawing of a quasar powered by a hidden black hole.

A. SIMONNET/SONOMA UNIV.

Using the United Kingdom Infrared Telescope atop Hawaii's Mauna Kea, researchers took a spectrum of the quasar light and identified radiation emitted by magnesium ions in the black hole's swirling disk. Each type of ion emits light at a specific wavelength, which under tamer conditions would show up as a narrow line in the quasar's spectrum. But the velocity of the rotating disk broadens each line of emitted radiation. The more massive the black hole, the higher the disk's velocity and the greater the broadening.

By measuring the width of the magnesium-ion emission line, Chris Willott of the Herzberg Institute of Astrophysics in Victoria, Canada, and his colleagues deduced the disk's velocity, enabling them to calculate the black hole's mass.

The finding indicates that heavyweight black holes existed 13 billion years ago, when the universe was a mere babe. Using the same technique, the team hopes to determine the mass of supermassive black holes over a range of cosmic times. Because of close connections between supermassive black holes and the cores of the galaxies in which the holes reside, measurements of these masses may reveal new details about how galaxies evolve. —R.C.

FOOD AND NUTRITION

## Fecal glow could improve meat safety

Workers who process animal carcasses might soon use a laser scanner to identify contaminated meat. Researchers at the Department of Agriculture and Iowa State University in Ames have devised a technology that exploits the unique fluorescent properties of digested plant matter in feces. Under the laser, the surface of a carcass lights up if it's tainted with feces, which can carry dangerous bacteria.

Currently, each meat inspector in a packing plant visually examines hundreds of carcasses per hour. Contaminated sections are cut away and discarded. However, visual inspection can't always distinguish harmless blemishes from spots of fecal matter.

To assist inspectors, Jacob W. Petrich of Iowa State and his colleagues built a device that shines blue or green laser light at a spot on a carcass and measures how much light comes back at various wavelengths.

In experiments using a handheld prototype, Petrich and his colleagues found the digestion products of chlorophyll, a plant component, fluoresce at about 670 nanometers (nm), which is visible as red light. Feces, which contain these products, and meat contaminated with even trace amounts of feces also emit 670-nm light under the laser, but uncontaminated cattle carcasses don't fluoresce at that wavelength, the researchers report in an upcoming *Journal of Agriculture and Food Chemistry*.

The researchers have patented their technology and licensed it to a Florida-based firm, which plans to market devices large enough to scan an entire carcass as it moves down a processing line, Petrich says. —B.H.

# OF NOTE

SCIENCE AND SOCIETY

## Sea burial for Canada's cod fisheries

The Canadian government has declared an end to cod fishing in nearly all of the country's Atlantic waters.

The ban, announced April 24 by Fisheries and Oceans Canada, the equivalent of the U.S. Fish and Wildlife Service, effectively eliminates the remnants of an industry that has been in crisis for years. It halts cod fishing in the Gulf of St. Lawrence and the once-bountiful waters off Newfoundland, where mariners have harvested cod for more than 500 years.

Overfishing and environmental changes caused cod stocks to tumble in recent decades. In an effort to help the fish recover, Canada sharply curtailed annual catches in 1992, but that measure failed to stop the cod's decline.

Fisheries and Oceans Canada says some financial assistance will be available to the estimated 3,300 cod industry workers affected by the ban. About 40,000 workers lost jobs when the 1992 restrictions set in.

Last fall, European officials rejected a proposed cod-fishing ban in the North Sea, where fish stocks have also crashed. —B.H.

IMMUNOLOGY

## Boosting the TB vaccine

The best available vaccine against tuberculosis isn't foolproof. The so-called bacille Calmette-Guérin (BCG) vaccine is a live but disabled form of the tuberculosis bacterium itself, *Mycobacterium tuberculosis*. Unfortunately, the vaccine doesn't carry enough bacterial proteins to prime the immune systems of all recipients for challenges by the real pathogen. The BCG vaccine leaves a fourth of vaccinated children unprotected and protects even fewer adults.

Stewart T. Cole of the Pasteur Institute in Paris and his colleagues report restoring to the vaccine several *M. tuberculosis* genes that have been absent. The product elicits a more potent immune response in mice and guinea pigs than does the standard BCG, the researchers report in the May *Nature Medicine*.

Cole's team noted that people with TB make extra immune cells of the type called T cells. These bonus cells recognize the protein encoded by the gene dubbed *ESAT-6*, which is knocked out in the process of making BCG. However, the researchers found that restoring the gene for that protein alone wasn't enough to strengthen T cell response against TB. Only by also restoring several bacterial genes that seem to work with *ESAT-6* did the researchers boost immune responses.

"The aim of 'classical' vaccines is to mimic natural infections as closely as possible without causing disease," says Douglas B. Young of the Imperial College London in the same journal. The modifications to BGC seem to accomplish that, he says.

The advent of antibiotics in the 20th century slashed TB rates in developed countries until the disease began a comeback in the 1980s (*SN: 10/21/00, p. 270*). Worldwide, nearly 3 million people die of TB each year. —N.S.

CHEMISTRY

## Drug smugglers leave cellular tracks

Getting drug molecules to targets within cells is a challenge, especially when the therapeutic molecules aren't soluble or stable, or when they can be toxic to cells. To circumvent these problems, scientists are designing protective nanoscale carriers that might someday shuttle medicine to exactly where it's needed.

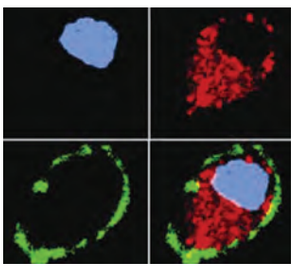
In the April 25 *Science*, Dusica Maysinger and her colleagues at McGill University in Montreal describe their new particles, or micelles, and how they behave inside rat and mouse cells.

The team made micelles from polymer molecules that have a water-attracting end and a water-avoiding end. Each polymer strand also bears a fluorescent marker. In water, the molecules spontaneously assemble into spheres just 20 to 45 nanometers wide, with their water-averse ends on the inside. Drugs that are relatively insoluble in water, including some anticancer agents, sequester themselves inside the water-averse interiors of the nanoscale micelles.

Maysinger and her colleagues applied drug-filled micelles to cells growing in lab dishes. The researchers report that the particles entered the cells and congregated in organelles such as the cell-powering mitochondria and the protein-processing Golgi apparatus. In doing so, the micelles ferried more drug molecules into each cell than would make it there on their own.

The spheres didn't penetrate the cells' nuclei. This is good, says Maysinger, since the team wanted the micelles to avoid interfering with the genetic material in the nucleus.

Maysinger says the findings are just a first step. The researchers now plan to add attachments to the micelles to make them seek out specific cellular targets where a ferried drug might prove most therapeutic. —J.G.



**MICELLES IN CELLS** Drug-carrying micelles (red) enter a cell but don't go into the nucleus (blue). The cellular membrane is green.

MATERIALS SCIENCE

## Zeolites get an organic makeover

The labyrinth of pores that characterize a family of inorganic crystals known as zeolites gives the crystals catalytic and adsorbent powers. The crystals, which occur in natural and synthetic forms, are used in refining petroleum, removing water from organic solvents, and a host of other laboratory and industrial processes (*SN: 10/5/02, p. 213*).

Now, scientists in Japan have incorporated organic chemical groups into zeolites' frameworks. Zeolites typically contain silicon and aluminum, with oxygen linking the elements together. Organic parts could enable zeolites to remove organic substances from water or catalyze different reactions than purely inorganic zeolites do, comments Christopher W. Jones of the Georgia Institute of Technology in Atlanta, who has tried to make organic zeolites.

In the April 18 *Science*, the Japanese researchers describe how they replaced a conventional starting material, called tetraethyl orthosilicate, with a substance equally hard to say: bis(triethoxysilyl) methane. This change resulted in the replacement of many oxygen atoms with methylene groups, each of which contains a carbon atom and two hydrogen atoms. These organic groups enabled the new zeolites to adsorb some organic molecules, but the zeolites didn't catalyze any new reactions.

"Introduction of methylene groups is just a first step," says coauthor Takashi Tatsumi of Yokohama National University. The scientists now plan to introduce catalytically active organic groups into their zeolites.

In the past, attempts at creating useful organic zeolites have hit snags, says Jones. For example, the organic groups in his zeolites stuck out of the framework and blocked its pores. The Japanese team has succeeded in incorporating the organic groups right into the zeolite framework. —J.G.

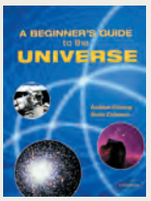
# Books

A selection of new and notable books of scientific interest

### A BEGINNER'S GUIDE TO THE UNIVERSE

**ANDREW CONWAY AND ROSIE COLEMAN**

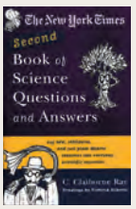
An astronomer and an elementary school teacher team up to introduce youngsters to the marvels of space. A general introduction to the nature and components of the universe leads to an in-depth overview of our solar system, planet by planet. Other sections examine moons, asteroids, meteoroids, and comets. A question-and-answer section at the book's end addresses, for example, How long can a person stay in space? How big is a crater on the moon? What goes on in a black hole? Recommended for ages 7 to 14. ***CUP, 2003, 147 p., color photos/illus, hardcover, $25.00.***




### THE NEW YORK TIMES SECOND BOOK OF SCIENCE QUESTIONS AND ANSWERS: 225 New, Intriguing, and Just Plain Bizarre Inquiries into Everyday Scientific Mysteries

**C. CLAIBORNE RAY**

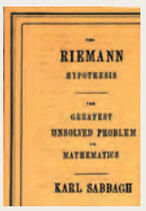
What makes the holes in Swiss cheese? Why do we have earwax? What would happen to you if you fell into a black hole? These are the questions that vex readers of The New York Times and are fielded each week by Ray. Here she pulls together another 225 such queries, the answers to which provide healthy doses of scientific fact, background information, and entertainment. ***Anchor Bks, 2003, 228 p., b&w illus., paperback, $13.00.***




### THE RIEMANN HYPOTHESIS: The Greatest Unsolved Problem in Mathematics

**KARL SABBAGH**

For nearly 150 years, mathematicians have puzzled over Bernard Riemann's hypothesis that there is a discernable pattern to the appearance of prime numbers in the infinite string of whole numbers. Some of the greatest minds have tried unsuccessfully to prove the notion, including the now-famous and beautiful one of John Nash. Currently, the Clay Institute promises to award $1 million to the individual who can solve the hypothesis. Sabbagh profiles some of the individuals who find this challenge so enticing that they've devoted their lives to its pursuit. In the process, he coaxes the reader to understand that the appeal of the problem is in its pursuit, rather than its ramifications for pure mathematics. This is an engaging look at the human side of mathematics, as well as an accessible introduction to a mind-boggling problem. ***FSG, 2003, 340 p., hardcover, $25.00.***




### SLEEP AND REST IN ANIMALS

**CORINE LACRAMPE**

Snails do it during the day. Budgies do it at night. Crocodiles do it with their mouths open. Cranes do it standing on one leg. Parrotfish do it do it in natural sleeping bags. Of course, these are all methods that animals use for sleeping, resting, and hibernating—methods that vary widely across the animal kingdom. This wide-ranging survey of such habits reveals that many are strange and unusual yet are a critical part of each species' survival. For instance, some birds sleep while flying and some fish rest while swimming. This book addresses each major classification of the animal kingdom, from insects to fish to mammals. Stunning color photographs accompany explanations of why animals need to sleep and otherwise rest. Recommended for age 12 and up. ***Firefly, 2003, 109 p., color photos/illus., flexibind, $24.95.***

### STIFF: The Curious Lives of Human Cadavers

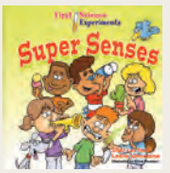
**MARY ROACH**

It's common knowledge that medical students routinely use corpses to further their studies, but as Roach discovered, cadavers benefit the living in myriad other ways. With a solid dose of wit yet reverence for her topic, Roach uncovers a dozen or so other uses for dead bodies in scientific and other pursuits. For instance, human corpses have been used since the 1960s as crash test dummies to check various restraints and airbag devices in cars. At the body farm, as it's called, of the University of Tennessee, cadavers are put out in the sun, under water, in concrete, or any number of other places killers might leave victims so scientists can study human decomposition and techniques for solving crimes. Roach investigates grave robbing—a pursuit that supplied corpses to anatomy schools in London in the 1850s. Her firsthand accounts of places and people make this a captivating look at life after death. ***Norton, 2003, 303 p., hardcover, $23.95.***


### SUPER SENSES
**SHAR LEVINE AND LESLIE JOHNSTONE**

### WONDERFUL WEATHER
**SHAR LEVINE AND LESLIE JOHNSTONE**

Clear explanations of basic scientific principles and simple experiments will satisfy young readers of both these books. With the help of an adult, youngsters perform activities from *Super Senses* that explain why people need glasses, have two ears, and taste flavors differently when they have a cold. In *Wonderful Weather*, projects address why the sky is blue, what hail is, and what makes a tornado twist. Only common household items are needed for each experiment. Recommended for ages 5 to 8. ***Both books Sterling, 2003, 48 p., color illus., hardcover, $12.95 each.***





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# LETTERS

## Got it backwards

I object to the glib use of the phrase "time reversal" in "On the Rebound" (*SN: 3/15/03, p. 168*). Time is a sequential history of events and is not reversible. What the researchers are accomplishing is a clever resequencing of events, roughly analogous to playing a strip of movie film backwards, an event that I'm sure you will agree occurs in quite normal time. The mirror analogy in the article is much more valid.

**FRANK MOFFETT MOSIER,** FRESNO, CALIF.

## Come out fighting

*Tyrannosaurus rex*'s environment may have provided sufficient carrion for the giant to survive as a scavenger ("Was *T. rex* just a big freeloader?" *SN: 3/22/03, p. 190*), and studies of its ratio of leg-muscle mass to body mass suggest that it wasn't speedy enough to be an efficient predator. But this may be only how it ended its life. It didn't hatch from the egg as a lumbering giant but, probably, as a very swift and agile killer of anything smaller. The youthful, medium-size *T. rex* may have been the fastest and most fearsome Cretaceous predator. Only in the end would the beasts be sluggish but domineering scavengers.

**STEVE PALMER,** PLAINFIELD, N.J.

## Shell game

I feel compelled to respond to "At a Snail's Place: Rock climbing cuts mollusk diversity" (*SN: 4/12/03, p. 228*). No one can enter and leave the wilderness without a trace, whether on foot, bike, horse, all-terrain vehicle (ATV), skis, snowmobile, or snowshoes. However, rock climbing is among the least invasive outdoor activities. Apparently, someone with a personal vendetta against rock climbers discovered that a snail population in one location might be affected by climbers. Is there anyone available to consider the effect of a single, noisy, smoke-spewing, oil-dripping ATV on a forest road?

**SARI BENMEIR,** DURANGO, COLO.

Your article seems myopic. This is like doing a study to find that there are fewer species living on trails than untouched land. The benefits of the sport of climbing to the environment are much more important than this finding. Every climber is an environmentalist and open-space advocate.

**ALEXANDER ROSE,** SAN FRANCISCO, CALIF.

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