SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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echoes in reverse

peanut-allergy prevention

polluting trees

crater viewed from space

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plasma power

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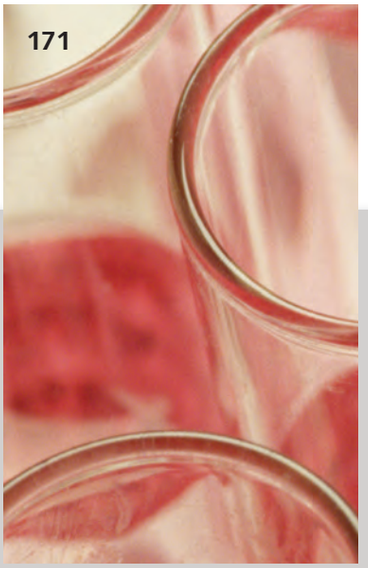

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Cover Scientists are screening for proteins in vials of plasma, the liquid portion of blood. Methods under development may turn up thousands of novel plasma proteins. Identifying such proteins could lead to new ways of predicting, diagnosing, or treating diseases. Page 171

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Tough Nut Is Cracked

Antibody treatment stifles peanut reactions

Researchers have successfully demonstrated the first preventive treatment against peanut allergy. The drug, which raises the threshold at which allergic people react to peanuts, could reach the market in 2 to 3 years, the scientists say.

In some ways, a peanut allergy is the worst kind, says Hugh A. Sampson of Mount Sinai School of Medicine in New York. Peanuts and peanut oil crop up in unlikely foods, such as egg rolls and chili, and can trigger severe reactions. Roughly 50 to 100 deaths every year in the United States can be traced to peanut allergies, Sampson says. What's more, while many children outgrow allergies to other foods, he says, "most people don't outgrow a peanut allergy."

Sampson and his colleagues enrolled 84 people who had a peanut allergy. The scientists gave the participants, ages 12 to 60, four injections over 4 months. One-fourth received inert shots; the others got various doses of an experimental antiallergy drug called TNX-901. Neither the researchers nor the volunteers knew which shots were placebos.

Two to 4 weeks after the last injection, the volunteers were brought into a clinic and, at 40-minute intervals, given capsules containing peanut flour. Each person received increasing doses of the flour until researchers diagnosed an allergic reaction.

The test showed that volunteers getting a placebo could withstand the equivalent of only half a peanut before reacting. People who received light doses of TNX-901 could handle slightly more. Study participants getting the highest doses of the drug withstood, on average, the equivalent of about nine peanuts before having a reaction, says study coauthor Donald Y.M. Leung of the National Jewish Medical and Research Center in Denver. Some managed the equivalent of 24 peanuts, he says. He and Sampson estimate that the average accidental exposure to peanuts is equal to one to two peanuts.

The study appears in the March 13 *New England Journal of Medicine*.

Allergic reactions occur when immune cells respond to a harmless substance by making a rogue version of an otherwise useful type of antibody called immunoglobulin E (IgE). When this wayward antibody binds to so-called mast cells in the skin, the lung, and mucus membranes, those cells produce rash-causing histamines and spur an influx of inflammatory proteins that causes swelling. Such an allergic reaction can bring on anaphylactic shock.

TNX-901 is a genetically engineered antibody that latches onto the rogue IgE antibodies and prevents them from binding to mast cells, Leung says. In the study, people getting TNX-901 showed a significant drop in IgE antibodies in their blood.

Noting that the study applies earlier research on hay fever and asthma to the realm of food allergies, Henry Metzger of the National Institute of Arthritis and Musculoskeletal and Skin Diseases in Bethesda, Md., calls the work an example of "beautiful translational research."

In the same journal issue carrying these findings, researchers in Britain report that baby lotion containing peanut oil may cause peanut allergy in some children (*see http://www.sciencenews.org/20030315/food.asp*). —N. SEPPA

Killer Crater

Shuttle-borne radar detects remnant of dino-killing impact

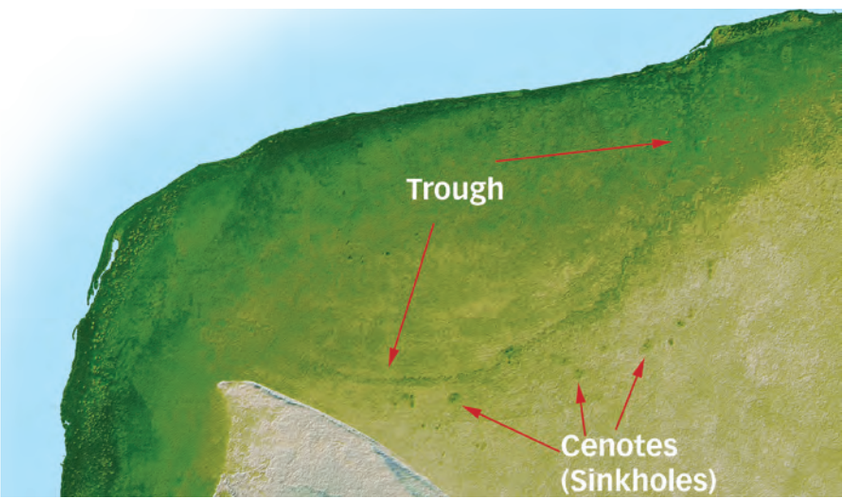
Newly released radar images gathered during a flight of the space shuttle Endeavour 3 years ago show what previous orbital photos haven't—the subtle topography related to the impact of an asteroid or comet that may have wiped out the dinosaurs 65 million years ago.

The original impact site lay beneath the waters of the ancient Caribbean. Sediments slowly filled in the 180-kilometer-wide crater, and subsequently, tectonic forces lifted part of the crater above sea level. Today, what's left of the Chicxulub crater, which is named for the fishing village near its center, straddles the northwest coast of Mexico's Yucatán peninsula.

Spaceborne instruments and earthbound geologists have detected gravitational and magnetic anomalies surrounding the ancient ground zero (*SN: 6/15/02, p. 378*). Until now, however, direct visual evidence of the killer crater hadn't shown up on images taken from space, says planetary scientist Michael Kobrick of NASA's Jet Propulsion Laboratory in Pasadena, Calif. Data garnered in February 2000 depict a 5-km-wide trough on the peninsula that roughly coincides with the crater's outer rim. That broad moat is typically no more than 5 m deep, a variation that's easy to miss across a large, forest-covered distance, says Kobrick.

Cenotes, or water-filled sinkholes, also dot the new radar map. These small, circular depressions form when large caverns in the limestone sediments at and around the crater's rim collapse.

The shuttle data that unveiled the extraterrestrial blemish on the Yucatán are just part of the nearly 1 trillion radar measurements made of Earth between latitudes of 60°N and 56°S. Those data points, spaced an average of 90 m apart, cover a swath that stretches from the latitude of Seward, Alaska, and St. Petersburg, Russia, to points just north of Antarctica. NASA previously released topographical data for the continental United States (*SN: 2/23/02, p. 126*) and will next publish detailed maps of South America.



NASA/JPL

BRINK OF EXTINCTION A high-resolution radar map of Mexico's northwestern Yucatán reveals the subtle trough just inside the rim of the Chicxulub crater.

Chicxulub's subtle trough had been noted by scientists surveying the area, but those measurements took years to acquire and were widely spaced, says Mark Pilkington, a geophysicist with Natural Resources Canada in Ottawa. The new high-resolution map undoubtedly improves on ones compiled from those sources, he notes. —S. PERKINS

Planet's Slim-Fast Plan

Extrasolar orb is too close for comfort

Planets beware! Get too close to your parent star and you will vaporize.

That's the message of a study that examines a planet residing within roasting distance of the star it orbits. The planet, dubbed HD209458b, circles a star at one-eighth the distance that Mercury orbits our sun. Observations suggest that the close-in planet, blasted by the star's heat and radiation and tugged by the star's gravity, can't hold on to all its material. Every second, the star is stripping at least 10,000 tons of hydrogen from the planet, according to Alfred Vidal-Madjar of the Astrophysics Institute of Paris and his colleagues, who report their study in the March 13 *Nature*.

At that rate, the planet would have lost only 0.1 percent of its mass since its birth 5 billion years ago, and the orb would easily outlast its parent star. But the observations provide only a minimum rate of loss of hydrogen, the planet's most abundant element, so much more of the gas may be escaping. If so, the planet, which now weighs about 70 percent of Jupiter's mass and lies 150 light-years from Earth, may be slimming down rapidly.

The findings suggest that some other planets, residing even closer to a stellar furnace than HD209458b does, will simply evaporate. That could explain why among the roughly 100 extrasolar planets discovered to date, only 9 are so-called "hot Jupiters," orbiting their stars so closely that they complete one revolution in just a few days.

As with every other extrasolar planet known, astronomers discovered the extrahot HD209458b indirectly by the tug the body exerts on the star it orbits. But the unseen planet has a special property: Its orbit is aligned so that when the body passes between its star and Earth, it periodically blocks a small amount of the starlight.

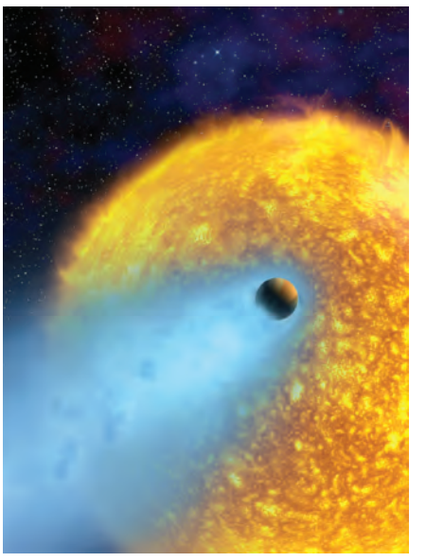
Each time the planet makes such a transit, some of the starlight must pass through the planet's atmosphere, which absorbs specific wavelengths of light according to the atmosphere's contents. Comparing the spectra of the star observed in and out of eclipse reveals the composition of the planet's atmosphere.

Two years ago, researchers used a spectrograph aboard the Hubble Space Telescope to detect trace amounts of sodium in the planet's atmosphere, the first time any constituent of an extrasolar planet was determined (*SN: 12/1/01, p. 340*).

Using the same spectrograph, another team, led by Vidal-Madjar, has now detected hydrogen. During three of the planet's transits, the team found that starlight was dimmed by 15 percent at an ultraviolet wavelength absorbed by hydrogen atoms. That's surprisingly large because the planet only blocks 1.5 percent of the star's area.

According to the team, the planet absorbs so much radiation because it has a bloated atmosphere that's more than twice as high as the radius of HD209458b. The planet's gravity can't hold all of the hydrogen atoms at the high altitudes. Succumbing to the heat and gravity of the star, some of the atoms escape into space. The gas expands and speeds away in a cometlike tail, the researchers speculate. The spectra confirm such a scenario, says Vidal-Madjar. His team now plans to look for heavier elements, such as carbon, oxygen, and nitrogen, leaving the planet's outer atmosphere.

"This data set is yet another milestone for an extrasolar planet, HD20948b, that can boast many," notes Adam S. Burrows of the University of Arizona in Tucson. "One hesitates to christen any astronomical object a Rosetta stone [for studying extrasolar planets], but in this case, one should not hesitate too long." —R. COWEN



EUROPEAN SPACE AGENCY

EATEN AWAY **Artist's depiction of a cometlike wind of hydrogen gas (blue) escaping from the outer atmosphere of the extrasolar planet HD209458b, which tightly orbits its parent star (yellow).**

Pressurized Pregnancies

Schizophrenia linked to fetal diuretic exposure

Pregnant women who take diuretic medication for high blood pressure during the third trimester substantially raise the chances that their unborn children will develop schizophrenia by age 35, according to a new study.

Schizophrenia affects 1 in 100 people. Its symptoms include hallucinations, delusions, apathy, and distorted emotional expression. Symptoms usually first appear in adolescence and young adulthood.

The new investigation is the first to link a specific treatment regimen for any medical condition during pregnancy to schizophrenia in offspring, say psychiatrist Holger J. Sørensen of the University of Copenhagen and his colleagues. However, the existence of this association doesn't demonstrate that third-trimester diuretic use directly causes schizophrenia, the researchers emphasize in the March *American Journal of Psychiatry*.

"There's been no prior suggestion of a link between diuretic use by hypertensive women during pregnancy and schizophrenia in their children," comments psychiatrist Daniel R. Weinberger of the National Institute of Mental Health in Bethesda, Md. "I'd be cautious about drawing conclusions from one study."

Still, the findings provide an intriguing clue in the search for factors that affect fetal-brain development and contribute to schizophrenia (*SN: 7/1/00, p. 6*), Sørensen's group contends. Other researchers have found that diuretic use after the first trimester of pregnancy lowers a woman's blood volume. If that effect occurs in the fetus as well, it could disrupt brain growth enough to lay the groundwork for schizophrenia, Sørensen and his coworkers theorize.

Their investigation focused on 7,866 people born in a Copenhagen hospital between 1959 and 1961. Prenatal medical information was matched with data from a registry that tracks all admissions to Danish psychiatric hospitals.

By 1994, 84 of the individuals had received a diagnosis of schizophrenia, according to a strict definition of the condition that's comparable to that now used in the United States.

Only the combination of a mother's hypertension during pregnancy and third-

trimester diuretic treatment showed a strong link to the subsequent development of schizophrenia in a child. This relationship held after the researchers statistically accounted for any past diagnoses of schizophrenia among mothers, family income, mothers' ages at the time of birth, and other prescription drugs used during pregnancy.

Preeclampsia—a dangerous condition that raises blood pressure in pregnant women (*SN: 3/8/03, p. 147*)—didn't contribute to the schizophrenia risk, the scientists say. Neither did the prescription of diuretics during the third trimester for medical conditions other than hypertension.

Maternal hypertension and diuretic use exhibited no link to later diagnoses of any other psychiatric disorder in offspring, the scientists add.

However, they can't rule out the possibility that pregnant women with particularly high blood pressures received more diuretic prescriptions than those with slightly elevated readings. In that case, severe maternal hypertension, not third-trimester diuretic use, may explain the association with schizophrenia in offspring, Sørensen cautions.

Most researchers now assume that many relatively common human genes interact with each other and with environmental forces, such as the ones uncovered in the new study, to prime a child's brain for schizophrenia, Weinberger says. —B. BOWER

Fish That Decorate

Females prefer nests with pizzazz

Biology has met home-decorating TV.

In spring, some male fish build nests of algae where females visit and occasionally deposit eggs. In the wild, a nest's murky mass looks to human eyes as if it would be perfect for camouflaging the eggs. Yet, when scientists offered some males bits of shiny foil, the fish went wild, taking home the bright strips and placing them around the entrance to the nests. Even though the strips hardly looked like camouflage, the fish were making a canny decorating choice, researchers report in the March *Behavioral Ecology and Sociobiology*. In tests, females preferred the gaudy nests.

It's the first modern, controlled test showing that nest decor matters when female fish pick their mates, says coauthor Sara Östlund-Nilsson of the University of Oslo in Norway.

Three-spined sticklebacks (*Gasterosteous aculeatus)* live in temperate waters worldwide and build nests with varied architecture. On the Swedish coast, Östlund-Nilsson and Mikael Holmlund

Science Flair

Top U.S. science and engineering students reap recognition, rewards

For young scientists, the spectacle was akin to the Academy Awards. To the whoops and cheers of formally attired admirers and beneath a cascade of confetti, 40 of the nation's brightest high school science seniors received credit for the years they devoted to original research. By the end of the gala, held March 11 at the Ronald Reagan Building in Washington, D.C., the finalists in this year's Intel Science Talent Search had collectively amassed more than $500,000 in scholarships.

"Many Intel STS finalists will go on to have distinguishing science careers, perhaps one day solving a fundamental scientific mystery or making a scientific breakthrough that helps improve people's lives," said Craig Barrett, the chief executive officer of Intel Corp., which sponsors the competition.

Science Service, the publisher of *Science News*, has run the venerated annual contest, previously funded by Westinghouse, since 1942.

This year's first prize, a $100,000 scholarship, went to Jamie Elyce Rubin, 16, of Canterbury School in Fort Myers, Fla. Rubin developed a technique that enabled her to describe two key enzymes of *Candida albicans*, the most common cause of yeast infections in people.

The molecular characteristics that Rubin detailed could serve as targets for drugs designed to attack the fungus without harming similar enzymes in human cells.

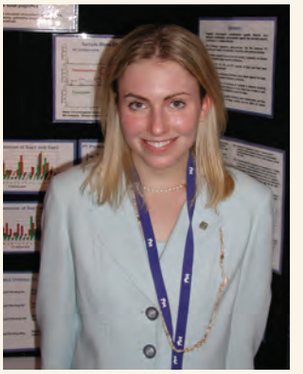
Tianhui "Michael" Li, 18, of Oregon Episcopal School in Portland captured second place—and a $75,000 scholarship. Li built, from materials that cost him about $100, a desktop device for studying the physics of nuclear fusion. His work with the device grew into a project with NASA in which Li measured electron densities in plasma.

Anatoly Preygel, 17, of Montgomery Blair High School in Maryland won third prize, a $50,000 scholarship, for his investigation into the mathematical properties of knots.

For placing fourth through sixth, Peter Michal Pawlowski, Naveen Neil Sinha, and Lester Wayne Mackey were awarded $25,000 each. Pawlowski, 17, of Troy High School in Fullerton, Calif., examined the chemistry of sulfur compounds suspended in air. Sinha, 18, of Los Alamos High School in New Mexico converted his bedroom into a laboratory—and moved into a guest bedroom—so that he could develop a technique for using sound waves to study bubbles and liquids. Mackey, 18, of Half Hollow Hills High School West in Dix Hills, N.Y., taught himself graph theory before proving that an existing mathematical conjecture applies to a previously unconsidered class of graphs.

Four additional winners received $20,000 apiece. Carolyn Morgan Tewksbury, 17, of Clinton Senior High School in New York used images of Venus to test a theory on the evolution of volcanic plateaus. Yi-Chen Zhang, 17, of Bronx High School of Science in New York studied how exposing cockroaches to common pesticides affects the insects' production of molecules that trigger people's allergies. Anna Gekker, 17, of Brooklyn Technical High School in New York analyzed psychosocial factors that influence how people recover in rehabilitation facilities. Emma Rose Schmidgall, 17, of Robbinsdale Cooper High School in New Hope, Minn., probed the crystal structure of a high-temperature superconductor. Among those 10 winners, half were women.

The remaining 30 finalists, who had risen to the top of the competition's 1,560 entrants this year, each received $5,000 toward educational costs. Intel presented all finalists with a high-performance computer.



S. NORCROSS

THE WINNER IS Jamie Elyce Rubin took top prize in the 2003 Intel Science Talent Search.

In the days leading up to the awards event, the finalists toured the national capital and presented their research to the competition's judges, other scientists, and curious and sometimes befuddled members of the public.

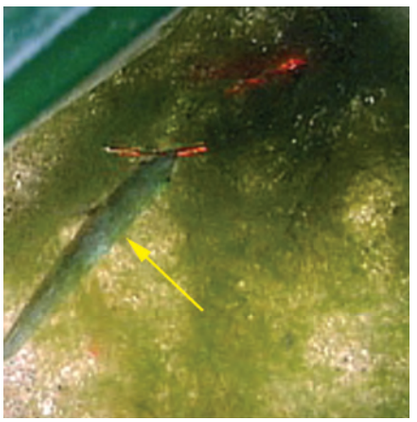
As the awards banquet concluded, the finalists let down their hair and accepted congratulations offered by teachers, parents, and fans. But the top winners were whisked away, bound for an early-morning television appearance in New York—and whatever prestigious discoveries their futures may bring. —B. HARDER

of Stockholm saw males tending nests of greenish algae that often had around the entrance several strands of red algae or of dead algae that had turned orange. The researchers had planned to study camouflage but became interested in learning why males incorporate bright accent colors if given the chance.

By cutting up the shiny foil from a Christmas candy, the researchers created 15-millimeter-long strips. When male sticklebacks in aquariums were ready to build nests, the researchers offered them foil in five colors as well as a choice of sequins.

The sequins weren't of much interest to the fish, but the nest builders added plenty of strips, especially red ones. The males themselves turn red in breeding season, so Östlund-Nilsson now wonders whether that color choice has special significance. She imagines the fish's message as: "I'm red, but my nest is even redder."

To set up a test of female response, the researchers replaced the decorators with other males and then compared foil-decorated and unadorned nests held at the time by males of similar size. When offered a choice, the females clearly preferred the nest bedecked with shiny strips.



PREFERRED PAD Stickleback females in the lab prefer algal nests with colorful foil strips (top). A male (bottom, arrow) brings home a red strip to brighten his prospects.

The finding makes an intriguing fit with an earlier study, says Felicity Huntingford of the University of Glasgow. She and Iain Barber of the University of Wales in Aberystwyth found that most desirable males, those with robust immune systems and high androgens, made the tidiest, most compact nests. This result suggested that nest architecture could tip off females to the appeal of the builder, but that study didn't test females' choice. "It's a nice precursor to the new study," says Huntingford.

The findings on shiny strips remind Huntingford of bowerbirds. Males display collected ornaments, such as colorful feathers and plastic objects, around twig structures. Females prefer males whose bowers have lots of decorator touches (*SN: 12/2/00, p. 362*). The female thereby chooses a top-quality male "who's good at getting and fighting for stuff," Huntingford says.

The Scandinavian test may have documented an underwater version of the bowerbird strategy, in which females go for the glitter to find the best guy. —S. MILIUS

Fallen Trees?

Scotch pines emit nitrogen oxides into the air

Even pristine forests can contribute to air pollution. In fact, researchers now say that northern pine forests exude a family of nitrogen oxides and do so in quantities that may rival those produced worldwide by industry and traffic.

Nitrogen oxides can react with hydrocarbons to yield nitric acid, a primary ingredient in acid rain. They can also help produce smog-causing ozone. Scientists generally peg automobiles as the prime source of nitrogen oxides. Trees, on the other hand, are usually credited with sopping up air pollutants.

Forests and industrial pollutants sometimes interact unpredictably, however. For example, researchers found that a hydrocarbon released by oak trees in the Sierra Nevada of California exacerbates ozone production from industrial nitrogen oxides (*SN: 6/1/02, p. 346*).

Now, forest ecologist Pertti Hari of the University of Helsinki and his colleagues add another layer of complexity to the relationship between trees and air pollution. The researchers suspected that pine trees growing in a southern Finland forest might use atmospheric nitrogen oxides as a source for nitrogen, an essential plant nutrient. To find out, they enclosed branches of forest *Pinus sylvestris*, or Scotch pine, in chambers that are transparent to ultraviolet (UV) light. Then they measured the change in air concentrations of nitrogen oxides.

TREE TWIST Some Scotch pines release a common, smog-causing pollutant.

In the March 13 *Nature*, the team reports that the branches emitted, rather than absorbed, the pollutants. Seconds after the researchers closed a chamber, concentrations of the gases doubled. When branches were shielded from the sun's UV light, they emitted less nitrogen oxides.

That might explain why earlier studies missed the nitrogen oxides that plants release, Hari says. Scientists often measure tree emissions under lab conditions that lack normal UV exposure or in chambers that block UV, he explains.

Arboreal emissions of nitrogen oxides are "evidently an important component of the nitrogen cycle," Hari says. Other evergreens—and perhaps even all plants—might also release the compounds under many natural conditions, he suspects.

Ambient concentrations of the air pollutants may be a deciding factor, Hari says. In the forests of Finland, air concentrations of nitrogen oxides can fall below 1 part per billion. That's less than one-fiftieth of the U.S. air-quality standard for the chemicals. Plants living in such clean air may release nitrogen oxides, while the same plants living in polluted air might absorb the chemicals, Hari suggests.

"The study makes clear that vegetation may indeed be a significant source for nitrogen oxides," says forest biologist Russell K. Monson of the University of Colorado at Boulder. As the thinning ozone layer allows more UV light to reach Earth's surface, plants' contribution to nitrogen oxides and smog might even increase, he adds. —K. MORGAN

ÖSTLUND-NILSSON AND HOLMLUND; B. COOK/MICHIGAN STATE UNIV., WWW.FORESTRYIMAGES.ORG

ON THE REBOUND

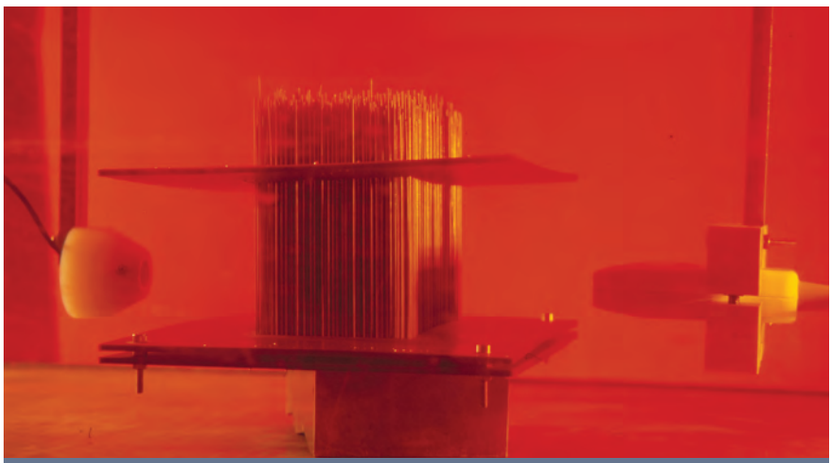
Reversed echoes may fight disease and foster communication

BY PETER WEISS

Imagine descending into an Alice-in-Wonderland canyon where the echo that returns when you shout "hello" sounds like "olleh." No such sound-reversal canyons exist in nature. However, physicists in Europe and the United States have recently been creating environments in the laboratory and underwater that exhibit reversed echoing. Instead of actual walls, from which only run-of-the-mill echoes would reflect, the researchers direct their sounds to computerized microphone-loudspeaker units that return them in a time-reversed order—the last sound component to arrive is the first to be sent back.

Such setups refocus sound with remarkable precision. When a person sings out "hello" in such an environment, the sound not only comes back reversed but it also beams specifically to the vocalist's head—and nowhere else.

These traits make time-reversed acoustics, as this technology is known, promising for a wide range of uses, including shattering kidney stones, tracking submarines, and broadcasting different translations of a speaker to listeners sitting side by side.



STEELY LENS — In laboratory experiments, a thicket of steel rods can serve as a sound-scattering environment. A time-reversal mirror (right) focuses echoes back to their ultrasonic source (left) more precisely when the rods are present.

MIRROR, MIRROR Acoustics specialists build a time-reversal mirror using an array of piezoelectric transducers. Those devices can act both as microphones, which convert sounds' pressure fluctuations into electric signals, and as loudspeakers, which convert electric signals into vibrations that people hear as sounds.

Time-reversing sound requires yet more from these transducers—they also must be able to capture, process, and store sounds. Some of the gridlike arrays used for medical applications are the size of dinner plates; some underwater versions can be taller than a 20-story building.

When an acoustic mirror picks up a sound pulse and its reverberations, each transducer converts vibrations into electric signals and loads them into its memory in time-reversed order. To create the echo, all the transducers reissue signals as sounds aimed back in the direction from which they came.

That's akin to undoing the wave action that follows when you drop a pebble into a pond. It's as if "the ripples in the pond collapse back onto the pebble," says David M. Pepper of HRL Laboratories in Malibu, Calif., who has studied similar refocusing behavior in light.

Many environments bend and bounce signals around so much that they become severely distorted. The acoustic signals arriving at the array of transducers carry all the modifications they underwent on their way from the sound's source, but those modifications are undone as the signals travel back to the source.

That's an attractive feature of the time-reversal technique, its developers say. Other signal-conditioning techniques also can diminish distortion, but these require complex computations that time-reversal methods can forego.

In fact, an environment with many sound-bending and sound-reflecting obstacles actually improves a time-reversal mirror's projection of sounds back to a specific location. The more reflecting surfaces there are in the environment, the wider the spatial spread of the components of sound the mirror gathers. And that provides the mirror with more precise guidance for targeting the echo.

"The best application is usually where the medium is really ugly and inhomogeneous," says time-reversal pioneer Mathias Fink of the University of Denis Diderot in Paris, France.

Fink and some other scientists also expect that the same techniques may work in the electromagnetic realm, perhaps increasing the signal-carrying capability of wireless communication systems (*see box, page 169*).

SEARCH AND DESTROY For many years, scientists have been investigating the use of inaudible, high-intensity ultrasound for incision-free surgery (*SN: 10/14/00, p. 12*), but the hodgepodge of tissues in the human body distorts acoustic signals, making it difficult to precisely aim the acoustic energy.

That's where time-reversal mirrors can come in. For more than a decade, Fink's group has been developing versions of ultrasonic devices, known as lithotripters, for destroying mineral stones that can form in the kidney and gall bladder. First, the lithotripter's

VO TRUNG DUNG

time-reversal mirror broadcasts unfocused sound into an organ to create reflections that reveal a stone's location. Then, the device sends a time-reversed form of the reflections, but greatly amplified, to shatter the target.

Even if a stone is moving during the procedure, the time-reversed system works so rapidly that the target is still within the focal spot when the echoed signal returns. Then the next broad signal determines the target's location anew, since many shots are usually needed to destroy a stone.

By the early 1990s, Fink's group and an industrial partner had developed a lithotripter with a time reversal mirror composed of 128 transducers. In clinical trials, the device proved it could track kidney stones, even as the patients breathed and fidgeted. However, the project folded because the instrument was too expensive for commercialization.

Fink's team didn't give up. In the past few years, the group has come up with a way to simplify the device and is working with another company on a 16-transducer mirror.

Emad S. Ebbini and his colleagues at the University of Minnesota in Minneapolis are also showing how such mirrors might be applied in medicine. They are investigating time-reversed ultrasound for two procedures: knocking out heart tissue that misfires electrically and destroying tumors. The group is creating a system that uses ultrasound signals to both generate images of the affected region and to burn away the troublesome tissue.

Among human tissues, the skull may create the greatest distortions of sound waves. Fink and his colleagues are developing time-reversal mirrors that would beam tissue-killing ultrasound into brain tumors. However, they have to introduce mathematical methods to alter features of the sound signals to counteract the effect of the skull. The researchers describe some of their work on brain-tumor instruments in the January *Journal of the Acoustical Society of America*.

While medical applications of time-reversal mirrors remain on the horizon, an instrument that finds defects in titanium aircraft engine parts will probably be in operation sooner, perhaps within 2 years, Fink says. Time reversal can aid engine makers by pinpointing flaws within the irregular microstructure of titanium that other scanning methods miss. Fink's lab has been collaborating with the French aerospace giant Snecma, headquartered in Paris, to develop a detector.

BENEATH THE WAVES Another acoustically noisy environment where time-reversal methods are drawing attention is the ocean. In coastal waters, sounds ping-pong between the sea floor and surface, creating echoes that foil undersea communications and interfere with acoustic detection of submarines and mines, says William A. Kuperman of Scripps Institution of Oceanography in La Jolla, Calif.

Kuperman became interested in time-reversed acoustics in the mid-1990s while working on a Navy-funded ocean-modeling project. His challenge was to devise computer models of ocean acoustics that would make it possible to take signals received at underwater listening posts and trace them back to their sources—for instance, enemy submarines. The advantage of doing it all on computers, he notes, is that no sonar pings are generated, so there would be nothing to tip off a target that it's being stalked.

When Kuperman learned about Fink's work in which read signals were driven back to their sources, the Scripps researcher began similar experiments on a much grander scale.

Over the past 8 years, Kuperman and William S. Hodgkiss of Scripps, Tuncay Akal of the NATO SACLANT Undersea Research Center in La Spezia, Italy, and their colleagues have conducted various tests in the Mediterranean Sea using transducer arrays some 80 meters long. Such arrays are fine for research, but they would have to be shrunk down dramatically to be of wider practical use, Kuperman notes.

Beyond Sound

Frequency boost may push echo technique into cell-phone realm

Now that time-reversal mirrors are proving themselves in acoustics applications, researchers aim to usher the technology into the electromagnetic realm of telecommunications. In the past few years, engineers have recognized that high-rise clutter in cities and other complicated environments where radio signals bounce around a lot—long considered a curse—actually increase the capacity of wireless information channels for cell phones and other devices (*SN: 1/20/01, p. 37*). By reflecting off many obstacles, a signal takes multiple pathways, thereby increasing the effective number of communications channels.

In a new experiment using ultrasound in water to model an electromagnetic environment, Mathias Fink of the University of Denis Diderot in Paris and his team have demonstrated that time-reversal arrays simultaneously can send different data streams through a cluttered environment to multiple receivers. The transmission was successful even when the receivers were in a tightly spaced cluster, as cell-phone users might be in a train car. The team reported its results in the Jan. 10 *Physical Review Letters*.

The findings suggest that time-reversal techniques could be better at increasing signaling capacity than the methods devised so far by wireless specialists, says Fink. A time-reversal approach could also bring other benefits to wireless communications, predicts Jean-Pierre Fouque of North Carolina State University in Raleigh. He has developed mathematical descriptions for the temporal focusing of time-reversed signals.

The tendency of those signals to target specific receivers would make such communications more secure than conventional cell-phone links, Fouque suggests. Also, because time-reversed echoes aren't broadcast in all directions like ordinary wireless messages, communications systems using them would be more energy efficient.

"Time reversal has the potential to change a lot of things in communications," comments theorist George C. Papanicolaou of Stanford University.

However, the oscillations of typical wireless signals are thousands of times faster than those of the ultrasound transmissions in Fink's laboratory. Moreover, as Papanicolaou and his colleagues have demonstrated, time-reversed signals require transducers that operate across an extraordinarily wide band of frequencies.

Because of such technical challenges, upgrading time reversal to the wireless realm seems far-fetched, some telecommunications specialists say. Equipment that can precisely handle such a broad frequency range is extremely expensive to build, notes Aris L. Moustakas of Bell Labs' Lucent Technologies in Murray Hill, N.J.

As another practical concern, the cost of rights to use such a large chunk of the electromagnetic spectrum for a wireless system would be high. "It's a neat idea, but I don't know how important it will be in the telecommunications industry soon or ever," Moustakas comments.

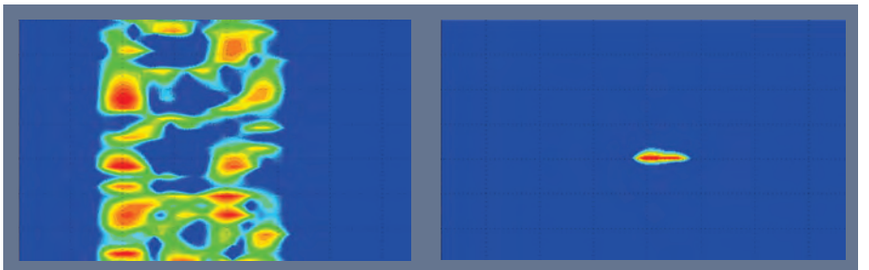
Fink's group is forging ahead nonetheless. It has built a one-transducer time-reversal mirror that Fink says is intended for microwaves at the cell-phone frequency of 2 billion cycles per second (gigaherz). In the coming months, Fink's team expects to test whether the device performs well enough to make a significant difference in wireless networks. —P.W.

The test results have been "spectacular," Kuperman says. "Time reversal is undoing the complexity of the ocean." From a distance of 10 kilometers, for example, the team refocused a sound pulse into a spot only a few meters in depth.

Now that Kuperman and his colleagues have established how well ocean-based time reversal can work, they're investigating how to exploit time-reversed acoustics for detecting submarines and mines, developing a better understanding of the ocean environment, and communicating between undersea vehicles.

One of the nifty features of this communication scheme is that the information is covert, Kuperman says. "Off the focus, you get [only] rumbling."

The researchers have scheduled their next round of undersea experiments for the end of this month.



RETURN TO SENDER — A single-tone pulse emitted in the ocean by a point source spreads out in time (horizontal axis) and depth (vertical axis) before reaching an 80-meter-tall time-reversal mirror 9 kilometers away (left). Bounced back to the source by the mirror, the 19-millisecond-long, smeared sound pulse reassembles as a tightly focused, 12-msec.-long, time-reversed replica (right) of the original pulse. Color indicates increasing sound intensity from blue to red. Time axis is magnified approximately twofold on left.

STILL AUDITIONING As a step toward more household possibilities, Fink and his colleagues have assembled a time-reversal mirror made of conventional audio equipment that actually does change people's "hellos" into "ollehs."

Getting more practical, scientists are considering such uses as auditorium systems that could simultaneously transmit completely different sound streams to people sitting right next to each other. This concept could be applied, for example, at the United Nations, where speeches must be simultaneously translated into many languages for different listeners. Instead of donning headphones, however, the UN delegates would simply hear the appropriate translation where they sit.

Similarly, family members traveling in a car might simultaneously listen to different radio stations.

Until recently, however, no one has actually determined what audio applications of time-reversal techniques are possible under everyday circumstances. In a new experiment, Fink and his collaborators Sylvain Yon and Mickael Tanter set up an audio time-reversal mirror in their busy laboratory. Researchers had been concerned that sound absorption by people moving around might undermine the system. In this month's *Journal of the Acoustical Society of America*, the researchers report that the time-reversal setup outperformed a standard sound-focusing method and was scarcely perturbed by the room's occupants.

As researchers push time-reversal techniques toward implementation in hospitals, oceans, and homes, their results are likely to have plenty of unexpected reverberations. ■

H. SONG/SCRIPPS

BLOOD WORK

Scientists seek to identify all the proteins in plasma

BY JOHN TRAVIS

In his 1998 book *Blood: An Epic History of Medicine and Commerce*, author Douglas Starr traced the rise of blood as a commercially exploited tissue. In the preface, he compared blood to oil and suggested that the former is more valuable. At the time of the book, a barrel of crude oil sold for about $13, whereas Starr estimated that the same quantity of whole blood would fetch $20,000—and more than $67,000 if it were processed. "Just like the oil industry, the blood trade involves collecting a liquid resource, breaking it into components and selling the product globally," he wrote.

Consider the intense demand for plasma, the clear liquid portion of blood that contains therapeutic molecules such as clotting factors and albumin, a protein regularly used to treat shock and other conditions. The companies selling these natural compounds process more than 22 million liters of plasma each year, according to the Plasma Protein Therapeutics Association in Annapolis, Md.

The annual worldwide revenue from plasma-derived therapeutic products is around $5 billion, according to one estimate cited in Starr's book.

Plasma proteins also provide a wealth of diagnostic tools. For instance, physicians look at high blood concentrations of a protein called prostate-specific antigen as an indication of prostate cancer. And people view their blood concentrations of HDL and LDL, two cholesterol-carrying proteins, as signs of the health of their heart.

Still, there may be a lot more value hidden within plasma. To date, scientists have identified only several hundred of the estimated thousands of proteins typically coursing through a person's bloodstream.

Between 1977 and 2001, scientists screening human plasma for new proteins added only about 20 proteins to the tally, says N. Leigh Anderson, who founded the Plasma Proteome Institute, a nonprofit research organization in Washington, D.C. "That's just astoundingly, amazingly bad," he says.

Indeed, Anderson and other scientists suggest that human plasma contains some of every protein produced by the human body, perhaps hundreds of thousands of different molecules. Identifying this repertoire of plasma proteins could offer new ways to detect—or even treat and prevent—many diseases.

"It's a very broad and bold opportunity," says Gilbert Omenn of the University of Michigan in Ann Arbor, who leads an international consortium of scientists seeking to characterize plasma proteins.

The search for plasma proteins is speeding up. Last December, a team at Pacific Northwest National Laboratory in Richland, Wash., reported that it had identified almost 500 proteins in a sample of human plasma. That nearly doubles the number previously known, says team leader Joel G. Pounds.

"We're right at the cusp of a huge revolution in the field," says Anderson.

TOO MUCH OF A GOOD THING Spin a vial of blood in a centrifuge, and the red and white blood cells, as well as the disklike platelets responsible for normal clotting, sink to the bottom. A clear liquid remains above them. That fluid, the plasma, consists of water with salts, hormones, enzymes, antibodies, and other proteins dissolved in it.

Over the past few decades, Anderson and other scientists have largely used a process called gel electrophoresis to identify plasma proteins. In this approach, investigators put plasma at one end of a slab of gel and run an electric current through it. Migrating with the current through the gel at speeds based on their molecular weight and electric charge, plasma proteins separate from each other. The researchers then extract purified proteins from the gel.

> "The circulatory system is like the canals of Venice. It transports all the good things, and it also transports a lot of junk."
>
> —N. LEIGH ANDERSON

In a review of plasma-protein research published in the November 2002 *Molecular and Cellular Proteomics*, Anderson and his father, Norman G. Anderson, estimate that about 290 plasma proteins have been identified in this way. They argue that gel electrophoresis used by itself will find few additional blood proteins.

There's no doubt that many more proteins lurk in serum, say the researchers. Blood comes into contact with almost all tissues in the body, and damaged or dying cells regularly dump their contents into the bloodstream. An important example is the protein creatine-kinase MB, which some dying heart cells release. Physicians use the protein's presence in plasma to diagnose heart attacks, and its concentration reflects the amount of heart tissue that has been damaged.

Plasma "is a great place to look for proteins that leak out of tissues," says N. Leigh Anderson. "The circulatory system is like the canals of Venice. It transports all the good things, and it also transports a lot of junk."

But it's not easy to see many of the good things or the junk in plasma because they're often obscured by a few overwhelmingly abundant proteins. The most plentiful is albumin, which transports several other proteins and maintains blood pressure.

By itself, albumin makes up about 60 percent of the serum-protein content, says Pounds. The 10 most abundant proteins—which include antibodies, the iron transporter called transferrin, and fibrinogen—account for more than 90 percent of all

plasma protein. Many other proteins are present at extremely low relative concentrations. For example, albumin's concentration is 5 to 10 billion times that of the immune system signal interleukin-6.

ALL BROKE UP Researchers are sorting out the best way to search for additional plasma proteins. Some add enzymes to their plasma samples to prevent the natural breakdown of proteins, yet others argue that these enzymes may hinder discovery. Investigators are also divided on whether to remove the albumin before they analyze a sample. That strategy might aid identification of low-abundance proteins, but it runs the risk of accidentally discarding plasma proteins that adhere to the abundant molecule. "Albumin is a sticky protein," notes Pounds.

Therefore, in their recent analysis, he and his colleagues didn't remove albumin from plasma samples. They did, however, seek to simplify their analysis by stripping the plasma of clotting factors. This creates a liquid commonly known as blood serum.

Also, by running the liquid over beads coated with a molecule that binds antibodies, they removed most of these immune proteins. They then added the enzyme trypsin to carve up the remaining proteins into small, but still recognizable fragments, or peptides.

The scientists next used a series of chromatography techniques that disperse peptides in a liquid or gas environment rather than on slabs of gel. This process separates albumin-derived peptides from those generated by other proteins, says Pounds.

Finally, the scientists injected each group of peptides into a tandem mass spectrometer, a device that weighs each peptide and then shatters it into its component amino acids and weighs each of them. From that information, the researchers deduced the amino acid sequence of each peptide and then identified the blood proteins that it came from.

When Pounds' team applied this complex procedure to a few drops of plasma from a healthy woman, it identified 490 proteins, including some low-abundance ones such as human growth hormone and prostate-specific antigen. In their analysis, reported in the December 2002 *Molecular and Cellular Proteomics*, Pounds and his colleagues describe finding most, but not all, of the previously documented plasma proteins.

One protein that was missing was C-reactive protein, whose elevated presence in the blood may serve as a predictor of heart attacks (*SN: 12/7/02, p. 364*). The plasma donor's heart may have been so healthy that she had little C-reactive protein in her blood, or some facet of the group's approach may have obscured the protein's detection. For example, some peptides aren't easily broken apart in a mass spectrometer.

Two proteins that typically function in the retina were unexpectedly found in the plasma. The woman might have some retinal damage that caused the proteins to leak into her bloodstream, speculates Pounds. Another explanation is that these proteins function in other tissues where scientists haven't yet detected them.

PLASMA PORTRAIT Pounds says that his group's work is just a first step toward compiling the master list of proteins in plasma. Members of the international Plasma Proteome Project are testing many other analytical strategies using chromatography and mass spectrometry, notes Omenn. "The whole idea is to have a global effort that characterizes the advantages and limitations of various technologies," he says.

N. Leigh Anderson predicts that the number of known plasma proteins will double by the end of this year.

Once a low-abundance plasma protein is identified, it's still a formidable challenge to develop an inexpensive and effective assay to detect it or measure its concentration. Such assays are needed if the protein is ever to be used to diagnose or predict a disease.

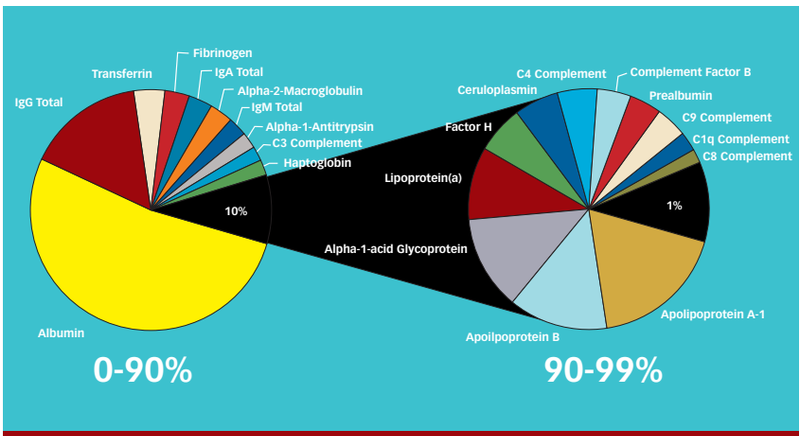
"Only a handful of proteins are currently used in routine clinical diagnosis, and the rate of introduction of new protein tests approved by the [Food and Drug Administration] has paradoxically declined over the last decade to less than one new protein diagnostic marker per year," N. Leigh Anderson and Norman G. Anderson note in their review.

STATS

$5 billion

Annual revenue from plasma-derived therapeutic products worldwide

A promising advance on the horizon may speed development of such tests. Several companies are rushing to create simple devices that can detect hundreds if not thousands of proteins at a time. Similar in concept to the so-called DNA chips that were invented and quickly marketed about a decade ago (*SN: 3/8/97, p. 144*), these protein chips are wafers dotted with microscopic pools of molecules such as antibodies. As DNA chips enable scientists to monitor the activity of thousands of genes, protein chips could show the presence of thousands of proteins in a single blood test. When a liquid such as plasma is run over a protein chip, the antibodies bind their target protein, revealing its presence.



MOLECULAR MIX — Relative abundance of the proteins that make up 99 percent of the protein mass in blood plasma. The final 1 percent represents thousands of proteins.

With such chips, suggests Pounds, researchers will devise better diagnostic assays for cancer. Whereas a single marker, such as prostate-specific antigen, may mislead a physician, simultaneous readings of multiple plasma proteins should be more definitive.

This wealth of new plasma-protein information could pose a challenge, however. "Physicians are not accustomed to looking at 10 different proteins in a certain pattern as an indication of disease," notes N. Leigh Anderson.

Ultimately, through the analysis of proteins in plasma, researchers may capture a "molecular image" of a person's normal physiology or of a disease state, says Pounds. They will also be able to study how a person's diet, genetic background, lifestyle, and environment influence the contents of plasma, he adds.

"If we have all this information, we'll probably be in a much better position to identify and design new drugs," says Pounds. "We think there are thousands of proteins in plasma, and there's a lot of opportunity here to improve human health." ■

PLASMA PROTEIN INSTITUTE

OF NOTE

ANTHROPOLOGY

Ancient people get dated Down Under

Estimates of ages for two human skeletons excavated at Lake Mungo in southeastern Australia have ranged from 60,000 to 20,000 years old. Results of new dating analyses, confirmed at four laboratories, split that difference. The Lake Mungo individuals were buried roughly 40,000 years ago, according to James M. Bowler of the University of Melbourne and his colleagues.

The new evidence also indicates that people first settled the Lake Mungo area between 50,000 and 46,000 years ago, soon after the arrivals of humans in northern and western Australia, Bowler's group reports in the Feb. 20 *Nature*. Soil investigations conducted by the same researchers suggest that the water level in the lake fluctuated sharply from 50,000 to 40,000 years ago. The area then succumbed to drought for the next 10,000 years, forcing prehistoric people to adapt to a parched locale.

Dating of the Lake Mungo finds hinged on a technique for measuring radiation emanating from quartz grains in various levels of the archaeological deposits. Radiation accumulates at a known rate in buried minerals. —B.B.

NEUROSCIENCE

Brain training aids kids with dyslexia

A reading-improvement course for children with dyslexia appears to go to their heads. After completing the course, 20 grade-schoolers diagnosed with this reading disorder not only improved their speech and reading skills, but showed signs of increased activity in key brain areas as they read, according to a study in the Mar. 4 *Proceedings of the National Academy of Sciences*.

The children with dyslexia and another 12 kids with no reading problems, all ages 8 to 12, performed daily tasks on a computer for nearly 1 month.

The children were asked to match speech sounds to written consonants and vowels, and they practiced related skills. Before and after the course, the researchers used a functional-magnetic-resonance-imaging scanner to measure blood-flow changes throughout each child's brain that were uniquely linked to the identification of rhyming letters. This task taps into the ability to decode sounds associated with different letters, a crucial element of reading.

After training, only children with dyslexia exhibited substantial gains in reading and speech comprehension as well as blood-flow surges—a sign of increased cell activity—in several brain areas previously implicated in reading, report Elise Temple of Cornell University and her coworkers. The same children displayed elevated brain activity in attention and memory areas that probably contributed to their reading improvement, the researchers say.

It will take more research to determine how long the course's effects on brain function last. Moreover, Temple acknowledges, it's not known whether or to what extent other literacy programs influence the brains of kids with dyslexia. Two of Temple's colleagues designed the training program and have a financial interest in it. —B.B.

PHYSICS

New approach smooths wrinkle analysis

From furrowed brows to mountain-forming ripples in Earth's crust, wrinkles are ubiquitous. To better understand these widespread phenomena (*SN: 6/15/96, p. 376*), scientists would like to predict certain topographical properties of wrinkles, such as the heights of their folds and how close together those folds lie.

RUMPLED DOG SKIN A new theory predicts how materials, like the skin of this shar-pei, crumple up.

A simple new theory does just that. In the Feb. 21 *Physical Review Letters*, Enrique Cerda of the University of Santiago in Chile and Lakshminarayanan Mahadevan of the University of Cambridge in England mathematically analyze wrinkles. They report a straightforward relationship between elasticities of materials and the topographies of the wrinkles that form in them.

In their report, Cerda and Mahadevan focus on membranes, such as the skins of apples and people, in which a thin, pliant layer overlies thicker, stiffer tissue. Because the thin surface tends to bow smoothly when compressed whereas the stiffer substrate prefers to crinkle, the wrinkle pattern comes out somewhere in between, the scientists say.

That analysis seems to work—at least for some examples. The scientists accurately predicted creases spaced like barcode lines in a drying apple's skin. Moreover, the analysis correctly predicted the wider spacings that occurred in pinched human skin. In both cases, the researchers note, the heights of the folds were roughly equal to their spacings. The new wrinkle-prediction technique could be useful for studying the mechanics of skin and cell motility, the researchers say. —P.W.

IMMUNOLOGY

Protective virus ties up HIV docking sites

In 2001, two groups of scientists reported that people with HIV are much less likely to die from AIDS if they're concurrently infected with a harmless virus called GBV-C (*SN: 10/6/01, p. 216*). One of the research groups has now uncovered a mechanism by which this protection might be conferred.

GBV-C, originally misnamed hepatitis G, occupies molecular receptors on the surface of CD4 T cells, the immune cells typically hijacked by HIV, the scientists report. These receptor molecules, called CCR5 and CXCR4, are also ports for HIV. Tests in laboratory dishes show that once occupied by the GBV-C virus, the receptors can't take on the more dangerous HIV.

"GBV-C decreases the number of [available] receptors on the surface of a cell, and that limits the amount of HIV getting into cells," says Jack T. Stapleton of the University of Iowa in Iowa City. This binding thwarts HIV from replicating within and killing these immune cells.

The test-tube findings might explain why co-infection with GBV-C inhibits HIV from disabling the immune system in HIV-positive people, Stapleton suggests. He presented the findings at the 10th Conference on Retroviruses and Opportunistic Infections in Boston last month. —N.S.

ZOOLOGY

Vampire bats don't learn from bad lunch

A vampire bat may be the first mammal ever to flunk the ultimate taste test, researchers say.

Mammals that eat something with a novel flavor and then get sick are known to

OF NOTE

avoid that flavor after just one experience, says John M. Ratcliffe of the University of Toronto. While other bats in a recent test did just that, the common vampire bat came back for more.

Ratcliffe and his colleagues tested an insect-eating species, the big brown bat; the Antillean fruit-eating bat; the Jamaican fruit bat; and the common vampire bat of the New World. Groups of the first three bats were given food flavored with cinnamon, a spice that these Western Hemisphere animals wouldn't have encountered. The vampires ate cow blood dosed with citric acid, a flavor that earlier tests showed vampires reliably detect.

After each group of bats ate, the researchers gave the animals an injection that made them vomit. To see if delay affected the lesson, the researchers injected some bats immediately and others after an hour. Regardless of the delay, when next offered cinnamon-flavored food, the fruit and insect eaters barely nibbled their meal.

The injection made the vampire bats sick, too. Yet they showed no significant aversion to another meal of flavored blood, the researchers report in the February *Animal Behaviour*.

Vampire bats eat only blood and therefore probably don't encounter toxins in their food, say Ratcliffe and his colleagues. They speculate that the vampire bat may have lost a specialized adaptation for learning a quick lesson from a lousy meal. —S.M.

BIOMEDICINE

Abortion-cancer link is rejected

A report stemming from a workshop sponsored by the National Cancer Institute (NCI) in Bethesda, Md., concludes that abortions don't increase a woman's risk of developing breast cancer. This controversial issue was reviewed in late February during a meeting of clinicians, epidemiologists, and basic scientists who study how early reproductive events influence breast cancer risk. There's a large body of evidence, for example, that young women have a reduced breast cancer risk if they've had a baby.

The workshop was organized after members of Congress last summer inquired into the validity of an NCI fact sheet stating that abortions don't increase a woman's breast cancer risk. Several studies have suggested such a connection, but subsequent larger studies have not (*SN: 1/11/97, p. 20*). NCI responded to the inquiry by withdrawing its fact sheet and convening the meeting.

Workshop participants reviewed published research and, in a closed-door session, listened to presentations on unpublished data from additional studies. "There is strong evidence that there is no association between induced abortions and breast cancer risk," says Daniel Medina of Baylor College of Medicine in Houston, who summarized the workshop's conclusions.

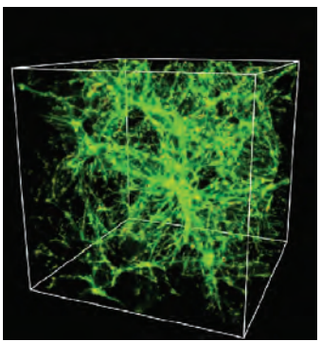
The investigators also agreed that there's compelling evidence that full-term pregnancies do have a protective effect in young women and called for more research in that area. The workshop findings have been presented to NCI, which will consider rereleasing the fact sheet. —J.T.

ASTRONOMY

Ordinary matter: Lost and found

Never mind about dark matter. Forget dark energy. Astronomers aren't even sure of the whereabouts of most of the cosmos' ordinary material: protons, neutrons, and electrons. New findings add to the evidence that two-thirds of this matter resides not in galaxies but in warm gas clouds that surround them.

Ordinary matter has posed a puzzle for many years. Observations of the early universe indicate that ordinary matter should account for 4 percent of all mass and energy, with dark matter and dark energy making up the rest. Yet astronomers looking for normal matter in galaxies have found only about one-third of this amount.



HIDDEN MATTER Simulation shows that most of the ordinary matter (green) in the cosmos today consists of gas glowing at invisible X-ray and ultraviolet wavelengths.

Simulations have suggested that the missing matter lies within gas clouds that are hard to find because they shine faintly and only at ultraviolet and X-ray wavelengths (*SN: 6/20/98, p. 390*). That's why several teams have looked for these clouds not via the light they emit, but by the light they absorb (*SN: 8/10/02, p. 83*). In the Feb. 13 *Nature*, researchers describe the latest effort, using the Far Ultraviolet Explorer Satellite. By recording the spectra of several distant quasars whose light pierces the Milky Way, the spacecraft revealed some 50 ultraviolet-absorbing gas clouds around our galaxy.

"This warm fog may hold as much as two-thirds of the normal matter within the neighborhood of the Milky Way," says study coauthor Fabrizio Nicastro of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. If this is true elsewhere, it could explain the cosmic shortfall.

Nicastro adds that mapping ordinary matter will reveal the location of dark matter. This invisible material is believed to be the stuff that coalesced first in the universe, which triggered ordinary matter to clump into galaxies. —R.C.

PHYSICS

Bunches of atoms madly morph

Minuscule clusters of atoms don't hold their shapes as well as hold-in-your-hand solids do. Understanding such instability is a growing priority as circuits, machines, and other structures shrink to atomic scales (*SN: 2/15/03, p. 110*).

Now, using ultrafast lasers, physicists at the University of Virginia in Charlottesville have observed that clusters randomly morph between different arrangements, or isomers, many times within a nanosecond.

In the Feb. 14 *Physical Review Letters*, Andrew J. Dally and Louis A. Bloomfield report rapid cycling among three isomers—a cube, a ladder, and a ring—by seven-atom clusters of cesium iodide salt.

To focus on suspected shape-shifting by clusters, the Charlottesville team repeatedly condensed cesium iodide vapor in cooler helium gas to form a stream containing hundreds of clusters.

The researchers then zapped the cluster stream with a laser pulse strong enough to shatter only the cubic clusters and waited up to a nanosecond for subsequent shape changes to take place among the remaining isomers. Then the scientists measured the proportions of all three isomers in the stream to see whether some of the other isomers changed into cubic ones.

By overlaying thousands of such measurements, Dally and Bloomfield say they have demonstrated that shape changes indeed take place and that those transformations recur at extremely brief intervals of tens to hundreds of trillionths of a second.

Shiv N. Khanna of Virginia Commonwealth University in Richmond calls the new results "a very important contribution." Besides verifying theoretical predictions, he says, the findings may also help researchers figure out how to select and stabilize isomers with desirable traits for use as nanometer-scale building blocks for novel structures. —P.W.

R. CEN AND J. OSTRIKER

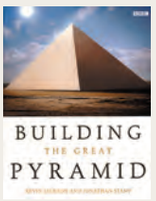
Books

A selection of new and notable books of scientific interest

BUILDING THE GREAT PYRAMID

KEVIN JACKSON AND JONATHAN STAMP

Nearly 4,500 years since it was erected, the Great Pyramid of Khufu is the last standing monument that



was once counted as one of the Seven Wonders of the World. For many years, its origins were speculative. It was almost inconceivable to think that people could place 2.3 million blocks that each weighed nearly 2.5 tons into a structure that stands some 500 feet. This companion book to a Discovery Channel television series reveals how the stones were cut, moved, and set into place, as well as something of the people who put them there. The book's images bring this process to life. ***Firefly, 2003, 191 p., color photos/illus., paperback, $19.95.***

THE FIREFLY DICTIONARY OF PLANT NAMES: Common and Botanical

HAROLD BAGUST

Arranged according to 14 plant groups—including aquatics, bulbs, herbs, house and garden plants, trees, bushes, shrubs, and wildflowers—this dictionary lists more than 30,000 plants alphabetically by their common names and notes the botanical designation for each. The volume then turns around and lists the plants by botanical names, with common names duly noted. Readers will find that one common name may refer to a number of plant varieties. For instance, *Anagallis arvensis* is known as scarlet pimpernel, shepherd's barometer, and poor man's weatherglass. The book's compact design makes it a handy travel companion. ***Firefly, 2003, 440 p., flexibind, $24.95.***

HACKING MATTER: Levitating Chairs, Quantum Mirages, and the Infinite Weirdness of Programmable Atoms

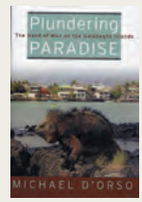
WIL MCCARTHY

Imagine that with a flick of a switch, a wall becomes a window, a soft cushion becomes hard, or your sweater changes color. Imagine making such changes in almost any type of material on a whim. Today, scientists are developing quantum dots—microscopic devices capable of acting like programmable atoms—to try make that possible. Theoretically, quantum dots can be configured to replicate the properties of any known atom and can then be changed—as fast as an electronic signal can travel—to have the properties of a different atom. McCarthy details the physics behind quantum dots and surveys their myriad potential applications that could change life in the 22nd century. ***Basic, 2003, 222 p., b&w illus., hardcover, $26.00.***

PLUNDERING PARADISE: The Hand of Man on the Galápagos Islands

MICHAEL D'ORSO

For many people, the Galápagos Islands conjure up images of a pristine natural habitat that is home to some of the world's most exotic plant and animal life and largely devoid of people. D'Orso believed this until he traveled there. What he discovered is not quite the Eden that Charles Darwin encountered nearly 2 centuries ago. After the Galápagos National Park was created in 1959, the few hundred people living in the Galápagos were allowed to remain on 3 percent of the islands' landmass. In recent years, this population has swelled into thousands of individuals who earn only meager livings by selling the rare commodities of their land. The burgeoning ecotourism business comes at a price to the environment. D'Orso charts the human history of the islands by telling it through the eyes of some of its most lively characters. ***HarpC, 2002, 345 p., b&w photos/illus., hardcover, $24.95.***



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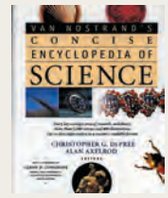

THE WORLD OF CAFFEINE: The Science and Culture of the World's Most Popular Drug

BENNETT ALAN WEINBERG AND BONNIE K. BEALER

Considering that 85 percent of Americans use caffeine on a daily basis, its prevalence in society is overwhelming—but hardly new. Weinberg and Bealer tell how cave dwellers may have chewed seeds and bark to experience the effects of caffeine. The authors then continue their story of how the drug permeated cultures throughout history, leading to the modern abundance of gourmet coffee shops, among other effects. They also consider the physiological effect of caffeine and reveal, for example, how the drug affects brain function and how chemicals in chocolate augment the effects of its relatively small amounts of caffeine. Originally published in hardcover in 2001. ***Routledge, 2002, 394 p., b&w photos/illus., paperback, $17.95.***

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LETTERS

Camel comment

Thank you for the article about the wild Bactrian camel ("Camelid Comeback," *SN: 1/11/03, p. 26*). However, one false impression needs correction. The Wild Camel Protection Foundation (WCPF) is not planning a program of captive wild camel embryo transfer in order to release the offspring into the wild. The program's immediate aim is to increase the number of captive wild stock and to preserve the unique genetic makeup of the wild strain of the Bactrian camel.

JOHN HARE, WCPF, KENT, ENGLAND

On target?

Sorry to be paranoid, but if the technology exists to make scratches on bullets that are exact duplicates for use in testing ("A Shot in the Light," *SN: 1/11/03, p. 23*), does not the ability also exist to produce a bullet supposedly from a shooting victim that's an exact match to one fired from your gun?

HAROLD REED, MILLEDGEVILLE, GA.

Fingerprints and DNA are useful in solving crimes because they are both unique and permanent. The "fingerprints" that a gun puts on the cartridge case and bullet may be unique, but they are not permanent. Spending 2 minutes at the chamber and muzzle with a small file will completely change the "fingerprint" of the case and the bullet.

FRED JEFFERS, ESCONDIDO, CALIF.

Well-grounded fear

"Unfounded Fear: Scared to fly after 9/11? Don't reach for the car keys" (*SN: 1/11/03, p. 20*) tells us there are 65 times fewer deaths per mile traveled in flying commercial aircraft than in driving. Fear of being killed in traveling is, I submit, based not on safety per mile traveled but on safety per trip taken. Further, fear of flying is based on the manner of death. If cars, before they were about to have a fatal crash, shot up 3 miles into the sky and dropped to Earth, they would be far less popular.

H. CHARLES ROMESBURG, LOGAN, UTAH

Correction *"Columbia Disaster: Why did the space shuttle burn up?"* (SN: 2/8/03, p. 83) *gave the wrong name, Hamilton, for a commenter in the story. Jeffrey A. Hoffman of the Massachusetts Institute of Technology said that age wasn't necessarily a factor in the shuttle's failure.*

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