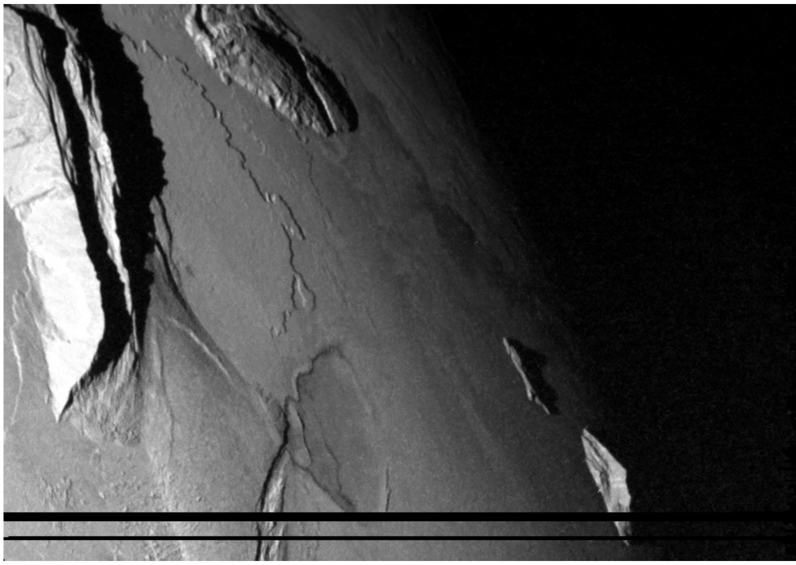
Image credits: NASA, JPL, University of Arizona, Arizona State University



Requiem for a Heavyweight

Image credits: NASA, JPL, University of Arizona, University of Colorado

Above: This close-up of Europa combines data from two flybys in 1998 and 1996. The reddish "freckles" and the shallow pits are each about 10 kilometers across. Taken together, they suggest that Europa's icy crust may be churning away like a lava lamp. The pits may mark where cold surficial ice is sinking, while the ruddy ice may be upwelling from the interior. If Europa really does have a liquid ocean beneath, samples from these colored spots could provide clues to its composition, and perhaps even signs of life.

Above, right: In this shot of Io from Galileo's February 2000 pass, the setting sun casts surface features into sharp relief. At left is Mongibello Mons, seven kilometers tall, or three-quarters the height of Everest. By contrast, the scarp emerging from Mongibello's shadow near the top of the image is a mere 250 meters high. Few of Io's mountains look like Earthly volcanoes, and are instead thought to be blocks of crust uplifted along thrust faults—picture the San Gabriel mountains behind Pasadena on an enormous scale. The rise beyond Mongibello appears to be an older, worn-down mountain.

Galileo's long journey is nearly over. Its tape recorder's final playback ended successfully on February 28, returning data from its closest-ever pass by Jupiter on November 5, when it flew by the moon Amalthea and through part of Jupiter's gossamer ring. But alas, in order to ensure that the high-priority magnetic-field and dust-particle data were returned successfully, no pictures were taken.

The maneuvering propellant is almost exhausted after 14 years in space, seven of them orbiting Jupiter. So before Galileo's handlers lose the ability to steer it, it was set on a course that will plunge it into the giant planet's crushing atmosphere on September 21. This was done to ensure that the moon Europa, whose icy crust may hide an ocean of liquid water that might conceivably harbor life, is not contaminated by some future collision with the spacecraft. (Galileo was not sterilized as rigorously as the Mars explorers are—who knew?)

Designed, built, and flown by JPL, which Caltech runs for NASA, and launched from the space shuttle *Atlantis* in October 1989, Galileo was to explore the Jovian system for two years. The mission was so successful it was extended three times, returning about 14,000 shots from the main camera plus a host of other data and making innumerable discoveries, many of which have been chronicled in past Random Walks.

Along the way, Galileo took punishment that makes what happened to Arnold Schwarzenegger in the first *Terminator* movie look pretty tame. From the stuck high-gain antenna to a balky tape recorder to cumulative radiation doses more than four times what it was designed to withstand, the doughty spacecraft and its indefatigable, ingenious controllers soldiered on.

As it will continue to do. The magnetometer will saturate about an hour and a half before impact, but the other fields and particles instruments will try to keep returning real-time data "right to the bitter end," says sequence integration engineer Bruce McLaughlin (BS '77), until Galileo passes out of sight behind Jupiter with seven minutes and ten seconds to go. "The remaining few minutes of the craft will be spent in darkness, and alone...." A moment of silence, if you please. □—*DS*

The Sporting News

You wouldn't expect it from balmy, palmy Caltech, but we have the Pacific Regional Collegiate Figure Skating champions right here on campus. Emily Schaller, Kelly Martin, Lara Pruitt, and Olga Kowalewsky edged out Stanford by two points to advance to the national championships in Denver.

The team is so new they don't even have a coach, but rely on one another instead. Schaller, a grad student in planetary science and a Vermont native, had seriously considered a skating career but decided at age 13 to forego the day-long practices and special schooling for "a normal life." Kowalewsky, an aeronautics grad student, was an accomplished skater during childhood who has only recently returned to the rink. And freshman Pruitt spent high school sewing costumes and teaching group lessons in exchange for ice time and coaching, eventually becoming a registered U.S. Figure Skating Association coach.

At the nationals, Caltech faced stiff competition from such cold-weather schools as Dartmouth (whose team Schaller helped found as an undergrad), the University of Delaware, Cornell, Miami University of Ohio, Michigan State, and Western Michigan. A team usually fields up to 20 skaters and the sum of their scores determines its standing, so each of the Caltech foursome had to enter as many events as she possibly could. Despite the odds, the squad placed sixth over all, with Martin tying for first in upper-division ice dancing, Schaller winning a lower-level ice dance, and Schaller and Martin finishing third in their short programs.

In other championship seasons, the Caltech chess team (founded last fall) won the U.S. Amateur Team West Chess Championship. Postdoc Wei Ji Ma, freshman Eugene Yanayt, junior Graham Free, and freshman Zhihao Liu thus became the first collegiate team to do so in recent history. Then freshman Patrick Hummel, Ma, grad student Sergiy Vasylkevych, Yanayt, Free, Liu, and frosh Stuart Ward and Clark Guo trounced That Other Institute of Technology, 5-3, over the Internet. And having won the west, the Techers faced favored University of Texas, Dallas for the national championship in an Internet showdown on March 17. Caltech bounced back from two early losses to a 2-2 tie and then tied the playoff, forcing a second playoff that turned into a nail-biter: with less than 30 seconds left on the clock and another tied score, Ma found the move that won the championship.

And finally, senior Nathan Paymer and freshmen Jacob Burnim and Adam D'Angelo were one of 70 teams (from an initial field of 3,850 worldwide) to advance to the finals of the Association for Computing Machinery's International Collegiate Programming Contest, held March 22–25 in Beverly Hills. Sponsored by IBM, the contest consisted of 10 real-world programming problems to be solved within five hours. Each team has only one computer to work with, and the team that solves the most problems in the fewest attempts in the least time is the winner. The Techers finished 13th overall, and were the top-placing team from North America. □

From left: Olga Kowalewsky (kneeling), Emily Schaller (behind her), Lara Pruitt, and Kelly Martin (kneeling).

Is Great-Grandma a Mutant?

"A very short one."

— Jeanne Louise Calment, of France, then the oldest known living person, when asked what sort of future she anticipated having. *Newsweek*, March 6, 1995.

Even though Mme. Calment died in 1997 at the age of 122, we envy her longevity. Better, perhaps, to envy her mother's lineage, suggest Caltech scientists. A study of unrelated people who have lived for a century or more found that they were five times more likely than the general population to have a certain mutation in their mitochondrial DNA (mtDNA). This mutation may provide an advantage by speeding mtDNA's replication, thereby increasing its amount or replacing that portion of it that has been battered by the ravages of aging. The study was conducted by postdocs Jin Zhang, Jordi Cayuela, and Yuichi Michikawa; Jennifer Fish, a research scientist; and Giuseppe Attardi, the Steele Professor of Molecular Biology; along with colleagues from the Universities of Bologna and Calabria in Italy, and the Italian National Research Center on Aging.

The mitochondria are the "powerhouses" of the cell and have their own DNA, leading researchers to believe they were once independent organisms that were long ago assimilated. Mitochondrial DNA passes only from mother to offspring, and every human cell contains hundreds, or, more often, thousands of mtDNA molecules. It's known that mtDNA has a high mutation rate, and that such mutations can be harmful, beneficial, or neutral. In 1999, Attardi and colleagues found what Attardi described as a "clear trend" in the number of mtDNA mutations in individuals over the age of 65—in fact, in the skin cells the researchers examined, they found that up to 50 percent of the mtDNA molecules had been mutated. (See *E&S*, 1999, No. 4.) In another study two years ago, Attardi and colleagues found four centenarians who shared a genetic change in the so-called main control region of mtDNA. Because this region controls DNA replication, that observation raised the possibility that some mutations may extend life.

Now, by analyzing mtDNA isolated from a group of Italian centenarians, the researchers have found a common mutation in the same main control region. Looking at mtDNA in white blood cells of a group of 52 Italians between the ages of 99 and 106, they found that 17 percent had a specific mutation called the C150T transition. That frequency compares to only 3.4 percent of 117 people under the age of 99. To probe whether the mutation is inherited, the team studied skin cells collected from the same individuals between 9 and 19 years apart. In some, both samples showed that the mutation already existed, while in others, it either appeared or became more abundant during the intervening years. These results suggest that some people inherit the mutation from their mother, while others acquire it during their lifetime.

"We found the mutation shifts the site at which mtDNA starts to replicate, and perhaps that may accelerate its replication, possibly allowing the lucky individual to replace damaged molecules faster," Attardi says, adding that the study is the first to show a robust difference in an identified genetic marker between centenarians and younger folks. Their next goal, he says, is to find the exact physiological effect of this particular mutation.

The Italian contributors to the paper were Massimiliano Bonafe, Fabiola Olivieri, Giuseppe Passarino, Giovanna De Benedictis, and Claudio Franceschi. It appeared in the February 4 issue of the *Proceedings of the National Academy of Sciences*, and online at http://www.pnas.org. □—*MW*

Paged By a Gamma-Ray Burst

Scientists "arriving quickly on the scene" of an October 4 gamma-ray burst have seen, for the first time, that fresh energy continued to stoke its afterglow for more than half an hour after the initial explosion. The blast was first detected by NASA's High-Energy Transient Explorer (HETE) satellite, and follow-up observations were quickly undertaken by fast-thinking researchers around the globe, who report in the March 20 issue of *Nature*. The findings support the "collapsar" model of gamma-ray bursts, in which they are emitted after the core of a star 15 times more massive than the sun collapses into a black hole. "If a gamma-ray burst is the birth cry of a black hole, then the HETE satellite has just allowed us into the delivery room," said Derek Fox, a Caltech postdoc and lead author of the *Nature* paper. Fox discovered the afterglow using the Oschin 48-inch telescope located at Caltech's Palomar Observatory.

Gamma-ray bursts shine hundreds of times brighter than a supernova, or as bright as a million trillion suns. The mysterious bursts are common, yet random and fleeting. The gamma-ray portion of a burst typically lasts from a few milliseconds to a couple of minutes. An afterglow, caused by shock waves from the explosion sweeping up matter and compressing it until the heat makes it glow, can linger for much longer, releasing energy in X rays, visible light, and radio waves.

This gamma-ray burst, called GRB021004, appeared on October 4, 2002, at 8:06 a.m. EDT. Seconds after HETE detected the burst, its coordinates were downlinked to computers at NASA's Goddard Space Flight Center that generated an e-mail to a list of observatories around the world, including Palomar. Fox pinpointed the afterglow from images captured by the Oschin Telescope within minutes of the burst, and notified the astronomical community by e-mail. Then the race was on, as scientists in California, across the Pacific, Australia, Asia, and Europe employed more than 50 telescopes to zoom in on the afterglow before the approaching sunrise.

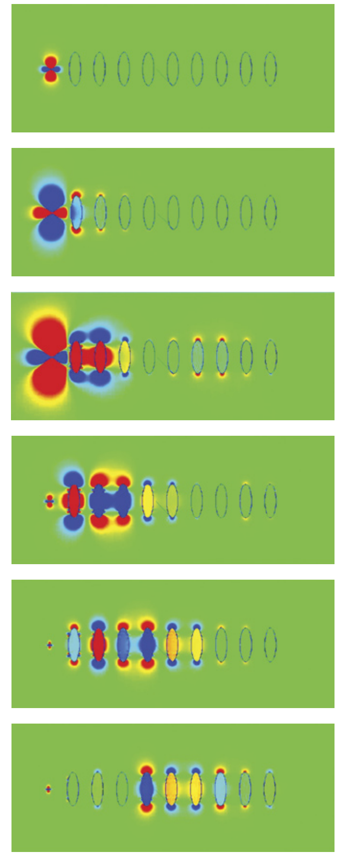
At about the same time, the afterglow was detected by the Automated Response Telescope (ART), a 20-centimeter instrument located in a Tokyo suburb and operated by the Japanese research institute RIKEN. ART started observing the region a mere 193 seconds after the burst, but it took a few days for these essential observations to be properly analyzed and distributed.

The combined observations revealed "flickers" that hinted that energy was still being injected into the afterglow well after the burst occurred. According to Shrinivas Kulkarni, the MacArthur Professor of Astronomy and Planetary Science and a co-author of the *Nature* paper, this power must have been provided by whatever object produced the gamma-ray burst itself. "This ongoing energy shows that the explosion is not a simple, one-time event, but that the central source lives for a longer time. This is bringing us closer to

Diffraction Unlimited

Four hundred years ago, a scientist could peer into one of those newfangled optical microscopes and see microorganisms, but nothing much smaller. Nowadays, a scientist can look in the latest generation of lens-based optical microscopes and also see, well, microorganisms, but nothing much smaller. The limiting factor has always been diffraction, a fundamental property of the wave nature of light, which fuzzes out images of objects much smaller than the wavelength of the light that illuminates them. Diffraction also hampers the ability to make and use optical devices that are less than a wavelength in size. Now Harry Atwater, the Hughes Professor and professor of applied physics and materials science, and his associates have created the world's smallest "light pipe"—a chain of several dozen submicroscopic metal slivers along which light "hops" in defiance of the diffraction limit.

Called a plasmon waveguide, the device consists of a glass slide with a thin metal coating on its surface. The metal was etched away to form a series of nanoparticles, each about 30 nanometers (30 billionths of a meter) in width, 30 nanometers in height, and 90 nanometers in length, lying parallel to one another like railroad ties. The space between the ties is so tiny that light energy moves from one to the next with very little radiated loss. The nanoparticles themselves are some 20 to 30 times smaller than the wavelength of visible light, so the energy moves between them by a

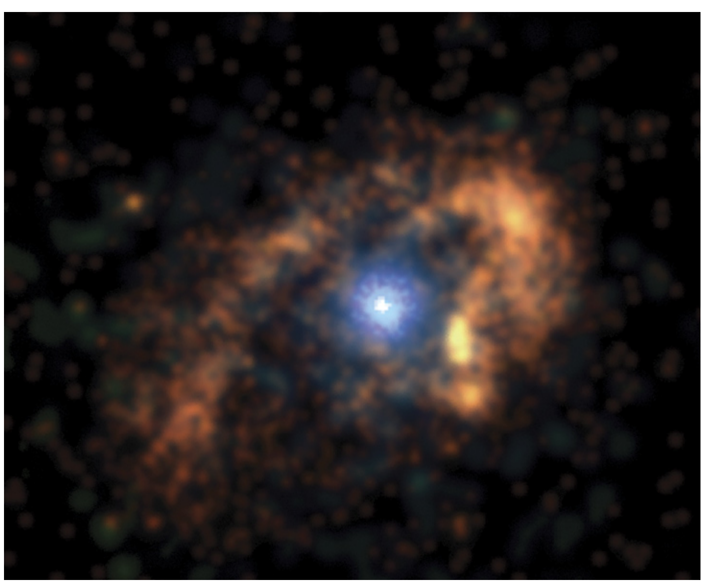


Above: These frames from an animation of a plasmon propagating between nanoparticles don't do justice to the truly trippy movies available at http://daedalus.caltech.edu/research/nanophotonics.html. Check 'em out!

a full understanding of these remarkable cosmic flashes." Added Fox, "We used to be impressed by the energy release in gamma-rays alone. These explosions appear to be more energetic than meets the eye."

Later radio observations at the Very Large Array in New Mexico, Caltech's Owens Valley Radio Observatory, the IRAM millimeter telescope in France, and elsewhere lend further support to the idea that the explosions continued increasing in energy. "Whatever monster created this burst just refused to die quietly," said co-author Dale Frail, a staff astronomer at the Very Large Array.

In 2001, a team of JPL astronomers led by Steven Pravdo refurbished and fully automated the Oschin Telescope, adding the Near Earth Asteroid Tracking (NEAT) camera. Although intended to hunt for asteroids that might one day hit Earth, the robotic system has helped to identify fully 25 percent of the gamma-ray burst afterglows discovered worldwide since the fall of 2001, when Fox wrote some software for the telescope. □—*RT*



Left: Eta Carinae shines five million times brighter than the sun, and is boiling matter off its surface at a prodigious rate—the feather boa in this X-ray image is about two light years across and is made of gas heated to about 3,000,000°C—causing some astronomers to think it could go supernova any day now. Since it's 7,000 light years from Earth, we needn't worry about the sunburn, but it would be an awesome spectacle.

process known as dipole-dipole coupling, which propagates considerably more slowly than does light in a vacuum. And dipole-dipole coupling is omnidirectional, so light in the waveguide can negotiate 90° turns with ease.

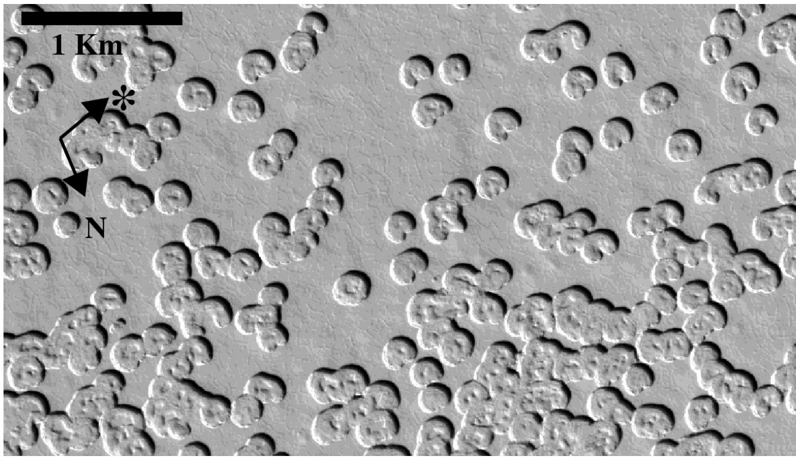
Because the era of nanoscale devices is rapidly approaching, Atwater says, the future bodes well for extremely tiny optical devices that, in theory, would be able to connect to molecules and someday even to individual atoms. Individual transistors on a microchip are already too small to be seen in a conventional optical microscope, so plasmon waveguides could be used as optical interconnects. And metal nanoparticles are known to interact with biomolecules, so a virus or even a single molecule of nerve gas could conceivably be detected.

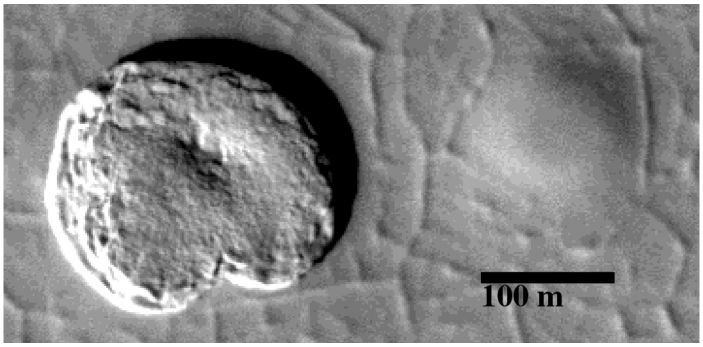
A description of the device will appear in the April 2003 issue of *Nature Materials*. Besides Atwater, the other Caltech authors are postdocs Stefan Maier (MS '00, PhD '03), who was responsible for the working device, and Pieter Kik. Other authors were Sheffer Meltzer, Elad Harel, Bruce Koel, and Ari Requicha, all from the University of Southern California. The waveguides were fabricated at JPL's electron-beam lithography facility with the help of JPL employees Richard Muller, Paul Maker, and Pierre Echternach. The work was sponsored by the Air Force Office of Scientific Research, with additional support by grants from the National Science Foundation and Caltech's Center for Science and Engineering of Materials. □—*RT*

Swiss Cheese and Cold Drinks

For future Martian astronauts, finding a plentiful water supply may be as simple as grabbing an ice pick and getting to work. Caltech planetary scientists think that Mars's polar residual caps are made almost entirely of water ice—with just a smattering of frozen carbon dioxide, or "dry ice," at the surface. Reporting in the February 14 issue of *Science*, Professor of Planetary Science Andrew Ingersoll and grad student Shane Byrne (MS '01) present evidence that the decades-old model of the polar caps being made of dry ice is in error. The model dates back to 1966, when the first Mars spacecraft determined that the Martian atmosphere was largely carbon dioxide. Later observations by the Viking spacecraft showed that the north polar cap consisted of water ice underneath a dry-ice covering, but experts continued to believe that the south polar cap was made of dry ice.

However, high-resolution images from the Mars Global Surveyor show that most of the south polar residual cap resembles Swiss cheese—pocked with flat-floored, circular pits some eight meters deep and 200 to 1,000 meters in diameter that grow outward (but not downward) by about one to three meters per year. And infrared





Right: Earth's moon may be made of green cheese, but parts of Mars's south polar cap look more like a slice of Swiss. In the upper image, N stands for north and * indicates the direction to the sun. The fact that all the "holes" are roughly the same size indicates they all started growing at roughly the same time. The lower image of a typical hole shows its flat floor, steep walls with hints of collapse debris, and a prominent cusp on the north, or less lit, rim—a strong hint that sunlight is at the root of the hole's formation. The adjoining shallow depression may be a hole in the making.

Image credits: NASA, JPL, Malin Space Science Systems measurements from the newly arrived Mars Odyssey show that the pit floors heat up during the Martian summer. Water ice, which is well below its freezing point, would be expected to get warmer as the summer progresses. But dry ice freezes at a lower temperature and in summer reaches the point at which it sublimes, or turns straight into a gas. It then remains at the sublimation temperature until it's all gone. So Byrne (the lead author) and Ingersoll concluded that the pitted layer is dry ice, but that the floor material, which makes up the bulk of the polar cap, is water ice. Thus the south polar cap is actually similar to its northern counterpart, which Viking data showed loses its one-meter covering of dry ice each summer, exposing the water ice underneath. But the south pole's eight-meter dry-ice cover is too thick to disappear entirely.

Although we may not be obliged to haul our own water to the Red Planet, the news is paradoxically bad for the visionary plans often voiced for "terraforming" Mars in the distant future, Ingersoll says. "Mars has all these flood and river channels, so one theory is that the planet was once warm and wet." Injecting a large amount of carbon dioxide into the atmosphere would create a "greenhouse effect," capturing enough solar energy for liquid water to exist. "If you wanted to make Mars warm and wet again, you'd need carbon dioxide, but there isn't nearly enough if the polar caps are made of water."

The new findings also pose the question of how Mars could have been warm and wet to begin with. People had assumed that there was once enough carbon dioxide in the atmosphere to keep the planet warm, but now there's simply not enough carbon dioxide at the poles for this to clearly have been the case. "There could be other explanations," Byrne says. "It could be that Mars was a cold, wet planet." Water could have flowed underneath an insulating layer of ice to form the channels and other erosion features we see today. Then, perhaps, the ice sublimed away, to be eventually redeposited at the poles.

And planetary scientists have assumed that Earth, Venus, and Mars are similar in their total carbon dioxide content, with Earth having most of its carbon dioxide locked up in marine carbonates and Venus's carbon dioxide causing a runaway greenhouse effect. But eight meters' worth of polar ice amounts to only a small fraction of the carbon dioxide found on Earth and Venus. So finding Mars's missing carbon dioxide, or accounting for its absence, will now be a major goal. □—*RT*

A Mars Orbiter Camera image (top) and a THEMIS temperature map of the same area. The difference between blue and red is about 10°C or 20°F, a significant spread, and the warmer areas correspond to the pit floors. But if all the visible surfaces were dry ice, the temperatures would be uniform.

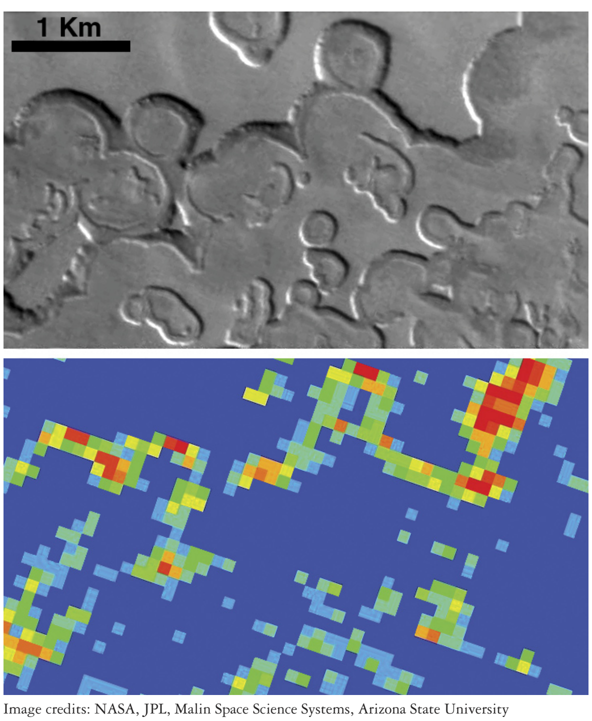


Image credits: NASA, JPL, Malin Space Science Systems, Arizona State University

S. Low Networks for FAST Data Rates

Caltech computer scientists have developed an Internet data-transfer protocol fast enough to download a full-length DVD movie in less than five seconds. Called FAST, for Fast Active queue management Scalable Transmission control protocol, it achieved a speed of 8,609 megabits per second in the presence of background traffic by using 10 simultaneous data flows. The FAST protocol was developed in Caltech's Networking Lab, led by Steven Low, associate professor of computer science and electrical engineering, and is based on theoretical work done in collaboration with Caltech's John Doyle, a professor of control and dynamical systems, electrical engineering, and bioengineering; and Fernando Paganini, an associate professor of electrical engineering at UCLA.

The experiment was performed last November during the Supercomputing Conference in Baltimore, by a team from Caltech and the Stanford Linear Accelerator Center, in partnership with the European Organization for Nuclear Research (CERN), DataTAG, StarLight, TeraGrid, Cisco, and Level(3). Commercial, off-the-shelf hardware and applications were used, as were standard Internet packet sizes. The key was modifying a ubiquitous piece of software called Transmission Control Protocol, or TCP, on the computer sending the data.

TCP, which manages traffic flow on the Internet and attempts to minimize congestion, was designed in 1988 when the 'Net could barely carry a single uncompressed telephone call. TCP cannot be scaled to meet anticipated needs, and interim remedies such as using nonstandard packet sizes or aggressive algorithms (which can monopolize network resources to the detriment of other users) have proven ineffective, or are difficult to deploy.

With Internet speeds doubling roughly annually, the performances demonstrated by this collaboration are likely to become commonly available in the next few years. □—*RT*

New Science or Old Math?

Stephen Wolfram (PhD '80), a 1981 MacArthur Foundation "genius" and the creator of the technical-computing software system *Mathematica*, spoke to a packed Beckman Auditorium on Saturday, February 1, about his book *A New Kind of Science*. He then engaged in an occasionally spirited discussion with a panel of cordial yet skeptical Caltech faculty members, after which he took questions from the floor.

According to Wolfram, his book represents 20 years of study and experiment, with about a decade of that going into the actual writing. Beginning with the discovery that computer programs carrying out simple rules over and over and over again—"cellular automata," which have been known since the 1950s—could produce extremely complex behavior, he came to the conclusion that the iteration of simple rules can describe the workings of the natural world more successfully than can the often complex mathematical equations used by science up until now. He illustrated his thesis with numerous computer-generated images of complex patterns produced by simple rules, which he compared to similar patterns from nature: the forms of snowflakes, the markings on seashells, the veining of leaves, and even the evolution of the universe. He averred that much of nature represents the same level of computational complexity as do human beings, though the human race remains unique through its own history of effort and development.

The panel comprised Christoph Adami, faculty associate in computation and neural systems and director of the Digital Life Laboratory at Caltech, as well as principal scientist in JPL's quantum technologies group; John Preskill, the MacArthur Professor of Theoretical Physics and director of the Institute for Quantum Information; David Stevenson, the Van Osdol Professor of Planetary Science; and Steven Koonin (BS '72), Caltech's provost and a professor of theoretical physics, who moderated. Much of the discussion revolved around whether or not Wolfram's work is genuinely science. Preskill, for instance, while granting that *A New Kind of Science* works well as science writing, was less sure of its usefulness for scientists, and Stevenson pointed out that one of the rules of "old" science is the production of testable predictions, of which he found in Wolfram's book "not one." Wolfram demurred, maintaining that his book is concerned with basic issues, not specific applications, and that his ideas are closer to those of mathematics and the biological sciences than to physics. In response to a question by Koonin, he suggested that his concepts would no more be proved right in a laboratory than would those of calculus. Preskill, while accepting that one of the many models computers could generate might fit reality, wondered whether that offers anything in the way of genuine explanatory power. Wolfram felt that it does, and that his concepts' potential to describe the natural world would allow one to generate testable predictions.

The most spirited exchange may have been with Adami, who stated that what biologists mean by complexity is very different from how Wolfram was using the term. Biologists deal with *functional* complexity: in cell division, metabolic processes, and other biological systems that have accumulated over billions of years of ensuring the survival of organisms in their environments. For such systems, he maintained, there is no single underlying rule that creates a pattern. Wolfram replied that it's dangerous to quote "what biologists think," since biology represents a wide spectrum of views.

Stevenson noted that, while Feynman diagrams—invented by the late Caltech professor of theoretical physics and Nobel laureate Richard Feynman as a way to visualize the interactions of atomic particles, and which a number of Wolfram's patterns rather resembled—improved physics computations, they didn't really change the underlying science, and wondered how Wolfram's approach was any different. While conceding that his ideas could be construed as a computational method if one wished, Wolfram insisted that they are more useful than traditional methods. When Preskill questioned how far scientists could actually get with them, saying that there was little in the chapter on physics that he could, as he put it, "get my hands on," Wolfram made the point that no one was going to know how his models would pan out until they had panned out.

Koonin wrapped up the discussion with a spot-on imitation of John McLaughlin of TV's *McLaughlin Group*, asking—"Yes or no!"—whether *A New Kind of Science* would be seen 20 years hence as a paradigm shift, that is, an event that transforms the way scientists view the world. None of the panelists thought so, and Koonin expressed the hope that they might be wrong, while Wolfram joked that he'd heard pretty much what he would expect to hear from scientists on the verge of such a shift. □—*MF*

It's already been a banner year for distinguished authors on campus. The man who brought us *Prey*, *Jurassic Park*, *The Andromeda Strain*, and the Emmy-winning medical drama *ER*, Michael Crichton, gave the annual Michelin Lecture on January 17. "Do Aliens Cause Global Warming?" looked at scientists who publish results of dubious rigor in order to support political agendas.

On March 17, Oliver Sacks, the neurologist whose research inspired him to write *Awakenings,* which later became a movie starring Robin Williams and Robert DeNiro; and *The Man Who Mistook His Wife for a Hat*, a classic compendium of clinical stories; spoke on "Creativity and the Brain."

And physicist-cum-science-writer-and-novelist Alan Lightman (MS '73, PhD '74), author of *Ancient Light* and *Einstein's Dreams*, participated in several public events during his tenure as writer in residence, sponsored by Caltech's Words Matter project. □

Crichton lingered for quite a while afterward to give autographs and chat with fans.

Below: A flying tortoise? No, it's a 25,000-pound magnet being lowered into position in the Broad Center's basement, where the Magnetic Resonance Imaging lab will probe the neurological bases of activities such as reading, as well as such staples of great literature as jealousy, greed, and altruism. Volunteers will be needed, and you might even get a picture of your brain as a souvenir if you do.

Above: This origami frog, cast in bronze, adorns a drinking fountain in Santa Monica on the corner of Second Avenue and Santa Monica Boulevard. Four native critters designed by Robert Lang (BS '82, PhD '86), author or co-author of seven books on origami, were commissioned for the Third Street Promenade. But as Kermit might have said, "It's not easy being public art." The sea urchin and the garibaldi (a kind of fish) were removed by the city as being too pointy, and the dragonfly was stolen.