It can't leap school buses the way Evel Knievel did in his prime, but an eight-wheeled prototype suspension system strutted its stuff by climbing over Brownie Troop 51 of Monrovia, California, during JPL's Kid's Day last summer.

How's My Driving? Call 1-800-NASA-JPL

The only likely disappointment is Sojourner's top speed—a blistering 16 inches per minute.

If everything goes according to plan, a six-wheeled all-terrain vehicle named Sojourner will start exploring the surface of Mars this summer. Brian Cooper, a member of the technical staff at Caltech's Jet Propulsion Laboratory, will be sitting in the driver's seat. Well, sort of. Sojourner is the size of a microwave oven, and Cooper will be sitting at a computer in his JPL office. Cooper has created the user interfaces for all the robotic vehicles leading up to Sojourner since 1985, and he drove them during testing, so he was the natural choice for this job.

Sojourner is any kid's Christmas wish. It's solar powered, so it never needs batteries (although it has some for nighttime operation). And it's a killer on the obstacle course. Each wheel has an independent motor in the hub, and any one wheel can lift the rover's full weight. The suspension system is flexible enough that a wheel can drive over things larger than its own diameter—Sojourner can even climb stairs! (Not that NASA expects to find any.) The only likely disappointment is Sojourner's top speed—a blistering 16 inches per minute. And speaking of toys, Cooper has the world's coolest sandbox, too—while the real Sojourner is en route to Mars, Cooper practices weekly with an identical copy, which he drives around in the Space Flight Operations Facility, in a large room that has been converted into a Mars-scape of sand and rocks. The other team members rearrange the rocks out of Cooper's view, and he then has to negotiate the terrain using the same data he'd get from Mars.

So here's the plan: JPL's Mars Pathfinder mission hits Mars at 10:00 a.m. Pasadena time on the Fourth of July, and "hits" is the operative word. Cushioned by its air bags and given some extra spring by the red planet's low atmospheric density, Pathfinder will make several multi-story bounces, perhaps rolling a kilometer or more before coming to rest. By 1:00 p.m., the air bags will have deflated, with three of the tetrahedral spacecraft's four faces then opening like a time-lapse movie of a rose blooming. The lander rights itself (the petals open with enough force that they can actually lever the lander out from between rocks, should it be unlucky enough to get wedged), and its stereo camera makes a sweep of its surroundings. At 6:25 and 6:30, two metal ramps unroll in opposite directions from one of the petals, like red carpets preceding the queen's entrance. The queen in this case is Sojourner, which spent the trip bolted to the petal. Meanwhile, back at the Lab, Cooper and the flight team will be studying the panorama to decide which ramp Sojourner should drive down. Sojourner will do so at 8:20 p.m., posing for a press photo at 9:30. Later, the rover will use its own stereo camera to see how the lander fared. These photos, and the other images the mission sends back, will be posted on the Web at http://mpfwww.jpl.nasa.gov as soon as they are processed.

Cooper will have a joystick and 3-D goggles, but that's where the similarity to an arcade game ends. For one thing, it will take 11 minutes for his radioed commands to reach Mars. So instead of steering in real time, Cooper will move a cursor the size and shape of the rover over

Below: The 60- by 120-mile oval in this Viking Orbiter photograph marks Pathfinder's planned landing site in the Ares Valles outwash plain. The mouth of Ares Valles is at the bottom right of the image, and north is toward the top.

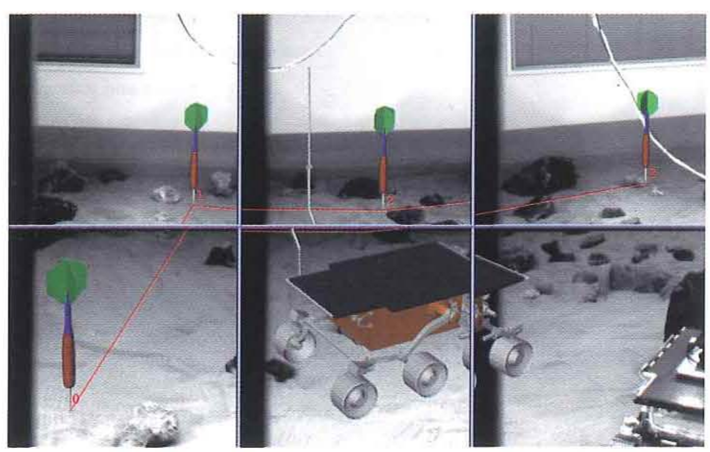
the 3-D landscape he sees. (This landscape is a mosaic of image pairs, corrected for camera distortions and perspective, from either the lander or the rover.) Starting from where Sojourner is in the picture, he clicks the cursor on an itinerary of points to be visited. Sojourner navigates to those "waypoints" on its own, using an onboard gyroscope to determine its heading and taking the average of the odometer readings from each wheel to calculate the distance traveled. "It's like a blind person with a cane," says Cooper. "It knows where it wants to go, and feels its way there." The cane is a set of laser beams that draw a five-by-five grid on the ground in front of the rover, starting at the front wheels and extending outward in a fan shape. Measuring how the grid points deviate from where they'd be if the ground were flat tells Sojourner the size of the rocks in its path. Onboard tiltmeters give warning of the potential for toppling over. If the hazard-avoidance software chickens out (it can be made more gutsy as Cooper gains confidence in the rover's abilities), Sojourner backs off and tries another route to the next waypoint. Sojourner prefers to drive in smooth arcs, like a car, but it can turn in its own length, like a tank, if it has to.

The rover and the lander talk to each other all the time, and once per Earth day (the Martian day is 41 minutes longer than a terrestrial day) the lander downlinks the accumulated conversations to Earth, along with all the images and data from the lander's other experiments. To ease the competition for transmission time, the images Cooper uses are compressed, but there's a fine line here. "On some tests, it was like we were looking through Vaseline-covered glass." Cooper and the science team study the images and negotiate where Sojourner should go next—the geologists decide which rocks to sample, and he tells them if Sojourner can get there. Once a consensus has been reached, Cooper assembles the command sequence, which gets uplinked back to the lander. He figures he'll be at it for 12 or more hours a day, at least to begin with; there's a backup driver, Jack Morrison, should Cooper get an inopportune flu bug. The primary mission only lasts a week, but with luck and TLC, Sojourner might keep going for months. Sojourner will stay within 10 meters of the lander to start with, but in a few days Cooper hopes to go out of its view—perhaps as far as 300 meters away—and rely on the rover's camera.

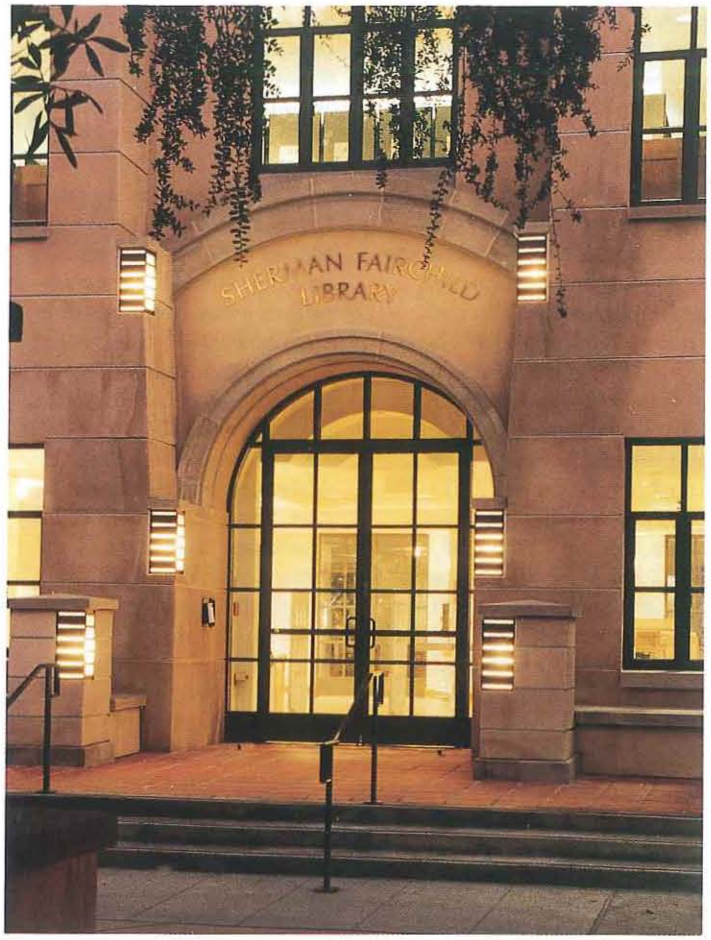
The point of all this wandering is to study the rocks and soil. Sojourner carries an Alpha Proton X-Ray Spectrometer (APXS), built by the Max Planck Institute in Mainz, Germany, and by the University of Chicago. To determine the surface's elemental composition, the APXS bombards a sample with alpha particles (helium nuclei) and measures the alpha particles, protons, and X rays that come back. The sensor head, which is about the size of a demitasse cup, is mounted on a flexible neck because the APXS has to remain pressed tightly against the sample for the up to 10 hours it takes to get a complete profile.

Pathfinder's landing site (19.5°N, 32.8°W) was chosen because it's a geologic souvenir store. Eons ago, a wall of water hundreds of feet high and 10–15 miles across tore through the Martian highlands and ridged plains, gouging out a 700-mile-long arroyo named Ares Valles. Although nobody knows for sure, the water is believed to have come from the sudden, catastrophic melting of roughly enough ice to cover California's Central Valley one mile deep from Bakersfield to Redding. The water, and the collection of rocks from all the terrain it had scoured clean, eventually spilled out into the lowlands of Chryse Planitia. And it's there, in the floodplain of Ares Valles, that Sojourner can sample rocks from thousands of square miles of Mars without straying far from the lander. Of course, the geologists won't know where any one rock came from, but they can get a lot of information about the region's overall mineralogy.

Oh, and by the way, 1-800-NASA-JPL rings at a paging service; don't call that number. Sojourner is unlisted. □—*DS*



Right: A view of the Mars Room as Cooper sees it. The colored rover in the center of this mosaic of six images from the lander's camera is the cursor that Cooper manipulates to drive the real rover, a corner of which can be seen in the lower right frame. The darts mark the waypoints the rover will visit. Superimposing the cursor exactly on the real rover's image tells the computer where the rover is and which way it's facing. The computer then tells the rover the distance and heading to each waypoint.



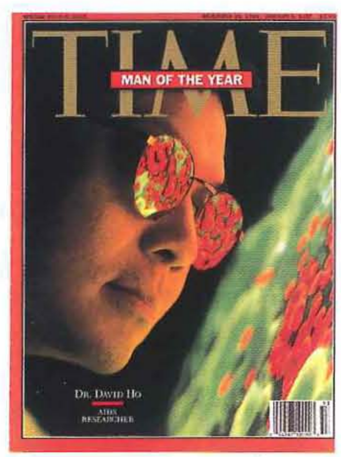
The Sherman Fairchild Library of Engineering and Applied Science, featuring the latest in "technological information delivery," opened for business January 2. Made possible by a $9.6 million grant from the Sherman Fairchild Foundation, the new library arose on the site of the old steam plant, between Thomas and Spalding Laboratories. Besides providing a central home for the collections from the department libraries in aeronautics, applied physics, electrical engineering, chemical engineering, computer science, engineering, earthquake engineering, and environmental engineering, the building is computerized, wired, and networked up to its gutters. But it's also user-friendly, with comfortable furniture and cozy reading spaces (yes, there are still books and journals).

MAN OF THE YEAR

AIDS researcher David D. Ho '74, was named *Time* magazine's Man of the Year for 1996 because his (and others') work brought real hope this past year that AIDS can be beaten. The tide against AIDS has turned, and those who accomplished this feat, *Time* claims, history will anoint as true heroes of the age.

Time devotes 16 pages of its December 30, 1996, issue to Ho, his career, and the assault on AIDS. After graduating from Caltech in biology (not physics, as the magazine states) Ho went on to Harvard Medical School and, as a virologist, began work on AIDS immediately after the disease was discovered in 1981. According to *Time*, he was among those who, from the very beginning, suspected that a virus was the cause. While most researchers concentrated on the later stages of the disease, Ho's most important insights came from his focus on the early stages of infection with HIV, characterized by a long period after initial infection during which, it had been presumed, the virus was dormant. Ho showed that HIV is extremely active during this symptomless period, replicating itself billions of times over and causing the immune system to wear itself out in a counterattack.

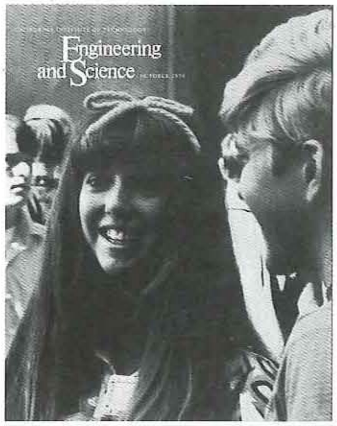
New therapies with combinations of drugs including protease inhibitors have shown promise for holding AIDS in check in its later stages, although not for curing it. Ho, who has been director of the Aaron Diamond AIDS Research Center in New York since 1991, used these drug combinations to treat 24 subjects in the very early stages of HIV infection, theorizing, according to the *Time* article, that if the virus could be knocked out at this point, it could be completely eradicated and the immune system would still be healthy enough to rebound. He announced at the 11th International Conference on AIDS in Vancouver last summer that none of his subjects showed a trace of the virus in their blood after a year of treatment, although this does not necessarily assure that the virus has been eradicated in their bodies. Remnants of the virus could still be hiding, infection may recur if treatment is stopped, and the drugs are very expensive. "But the worst fear—the one that seeded a decade with despair, the foreboding sense that the AIDS virus might be invincible—has finally been subdued," says *Time*.



Twenty-five Years of Women at Caltech—But Who's Counting?

A few end-of-year events casually marked the 25th anniversary of the admission of female undergraduates to Caltech: some concerts alluded to the date, a Women's Club luncheon celebrated it. Not exactly hoopla. But then, 1996 was not exactly the 25th anniversary; it was probably the 26th, depending on how you count.

Certainly people at Caltech can do the math. Maybe the anniversary just slipped by before anyone noticed because it's now so hard to imagine Caltech without women. But the change to coeducation was neither an easy battle nor a sure thing. At a Women's Club luncheon in November 1996, Professor of Biology, Emeritus, Ray Owen (without whose crusading efforts we might be celebrating the 10th year, or the first) described the chronology. Owen began lobbying for the admission of women as early as 1962, citing the pervasive social changes of the time; by 1967 he was calling the exclusion of women from undergraduate work at Caltech "an intolerable anachronism." And in November 1967 the Faculty Board minutes record that "Professor Owen moved . . . that the Faculty Board recommend to the Faculty that the Faculty recommend to the Administration and the Board of Trustees that the Institute proceed with all deliberate speed to the admission of women to undergraduate work at Caltech" — academic bureaucracy's version of a call for revolution.



Woman of the Year
***E&S*, October 1970**

By 1967 [Owen] was calling the exclusion of women from undergraduate work at Caltech "an intolerable anachronism."

Evidently the Board of Trustees was persuaded but cautious, because in November 1968 it passed a resolution approving "in principle" the admission of women both as entering freshmen and as upperclass transfers. Caltech's first truly coeducational class entered two years later, in 1970, and included 29 first-year women and two sophomore transfers. (The present freshman class includes 67 women). A few more women came as upperclass transfers in 1972, so 1973 marked the first graduation of women from Caltech, and 1974 the graduation of women who had entered as freshmen.

And how did that pioneering class of women fare? Surprisingly well, if the several alumnae who spoke to the Women's Club are a representative sample. Attorney Debbie Dison Hall remembers being greeted by a homemade banner strung from Millikan Library reading "Welcome Co-Techs," which she thought more clever than malicious. Otherwise, she says, she was not treated any differently than the male students, was not subjected to different pressures, and was made to feel "welcomed, successful, and valued." Kim Fisher Thomas, an environmental economist at Whittier College, says she passed her whole first year (she entered in 1971) with a knot in her stomach, but that can probably be said of many Caltech freshman.

The speakers emphasized, however, that they had been a diverse group whose experiences differed. One alumna—not at the luncheon—has another freshman-year memory: a professor privately advising her to drop his class, because she wasn't going to be up to it.

For those committed to celebrating 25 years of women at Caltech, several authentic milestones loom on the horizon: 1998, the 25th anniversary of the first female undergraduates to graduate; and 1999, the actual 25th anniversary of the graduation of the first genuine class of women at Caltech. Mark your calendars. □—*RR*

More Things To Worry About

A popular treatment for kidney stones may not be as safe as has been thought. The procedure, called extracorporeal shockwave lithotripsy by the doctors and plain old lithotripsy by the rest of us, uses tightly focused shock waves to pulverize the stones (which really *are* rocks—they're mineral deposits, usually calcium oxalate) while they're still inside the kidney. The procedure is quick, doesn't involve surgery, and can be done even in a mobile clinic. But there can be short-term side effects: internal bleeding, blood in the urine, and bruises where the shock wave enters and exits the body. This would seem to indicate tissue damage and possible long-term effects, so Bradford Sturtevant (MS '56, PhD '60), Liepmann Professor of Aeronautics, and grad student Danny Howard (MS '91, PhD '96) decided to find out what was going on. They used a laboratory lithotripter, as the stone-crushing machine is called, built by Dr. Bruce Hartenbaum of H-Tech Laboratories in Santa Monica, California.

Sturtevant and Howard suspected that the shock waves weren't so tightly focused after all. The speed of sound in blood is about 5 percent higher than in tissue, and the kidneys, which filter the blood, are filled with blood vessels. Some simple calculations showed that the portion of a shock wave passing through a blood vessel can get far enough ahead of the rest of the wave to distort the overall wavefront. As the wave travels through the maze of blood vessels en route to convergence on the kidney stone, the wavefront can get hopelessly folded. The pulse's energy can blur, forming microscopic regions of intense shear that can tear the surrounding tissue and cause additional damage with each pulse.

The first set of experiments established a baseline by finding out what a properly focused pulse looks like. By using a pressure sensor immersed in four test fluids (water, ethylene glycol, glycerin, and castor oil), it was established that a pulse generated at the focal point a transient pressure of nearly 4,000 pounds per square inch—a single, crisp peak.

In the second round of tests, hollow glass beads averaging 65 microns (0.00004 inches) in diameter were added as stand-ins for blood vessels. (Blood vessel diameters in the kidney range from 20 to 200 microns.) The beads did, in fact, scatter and weaken the pulse. And the more beads that were added—the denser the blood-vessel network, in other words—the smaller and more broken up the pulse became. At spacings comparable to the average density of blood vessels in the kidney, the pulse's peak was a hundred-fold less intense, and the pressure trace looked like a seismogram.

The third set used tissue samples from a local supermarket. Howard made a sandwich, layering skin (one millimeter thick); muscle—that is, steak (19 mm); fat (10 mm); and kidney (30 mm) between the shock source and the pressure sensor. Again, the peak dispersed and lost most of its punch.

To assess the potential for collateral damage, Howard repeated the bead and tissue tests, replacing the pressure sensor with a nitrocellulose membrane about 10 microns thick. This membrane, which represented cell walls in the vicinity of the kidney stone, emerged looking like it had been hit by buckshot. Small holes and tears could appear after as few as 20 pulses; after 100 shots there generally wasn't much left. Since several thousand pulses are generally administered in a lithotripsy treatment, this is clearly cause for concern. "When these machines were originally approved," says Sturtevant, "basically none of the right questions were asked." Sturtevant is now collaborating with Dr. James Lingeman, of Methodist Hospital in Indianapolis, and Dr. Andrew Evan, a professor of anatomy at Indiana University, in an attempt to learn what the right questions are.
□—*DS*

"A Conversation with Walter Cronkite" launched the Lee DuBridge Distinguished Lecture Series last November. Playing to a capacity crowd in Beckman Auditorium, the veteran newscaster recounted stories of presidents he has known (from Hoover onward) and events he had witnessed in his career—most of the major ones of this century since World War II. Jess Marlow, news anchor of KNBC, was the other half of the conversation, keeping Cronkite supplied with questions. Caltech honored Cronkite with an asteroid named for him, discovered by Eleanor Helin (see below) in 1990. The asteroid, 6318 Cronkite, has a "high profile and slightly eccentric orbit" and only a very slight chance of a collision with Earth some 10 to 30 million years hence.

Still More Things to Worry About

Yet another kind of stone that can cause you grief is the Aten class of asteroids, one of several classes of asteroids whose orbits bring them very close to Earth. JPL astronomer Eleanor Helin discovered the first Aten back in 1976, and she and colleagues Steven Pravdo, Kenneth Lawrence, and David Rabinowitz of JPL's NEAT (Near-Earth Asteroid Tracking) program have just located the 24th one. This new find, provisionally named 1977AC11, is about 1,000 feet in diameter, so it's really going to hurt when it hits us. *If* it hits us, that is—it missed Earth by 10 million miles on January 23rd (Pasadena time), and in its current orbit doesn't get any closer to Earth than about one million miles, which is four times farther away from us than the moon is. Also, its orbital plane is skewed 31 degrees from ours, so it gets far fewer chances at us than an asteroid with a nearly coplanar orbit would. But its orbit is gradually evolving, Helin says. "These guys are always being nudged around over the eons. This one is unusual in that its orbit crosses both Earth's and Venus's. They each give it a little kick every time it gets close to them." So over the next several million years, who knows?

In the meantime, Helin has no plans to name 1977AC11 for a prominent journalist.
□—*DS*

Decompression Chili Heats up Students

Wan, staring, night-dwelling, they stagger forth from whatever dark place they've nested. It's the smell that draws them, that and the warm red liquid. They need it to replenish vital energy, to rebuild neural circuits, to go on. They need it badly. And they need a lot of it. About 3,000 bowls, in fact.

The Caltech Y's Decompression Chili has been a custom—"permanent if sporadic," says Sue Borrego, executive director of the Y—since the 1970s. But in the past few years it's become a regular part of undergraduates' Decompression, an event designed to lighten those hellish weekends before fall, winter, and spring finals. (Decompression was December 7–8 last term.) When Borrego became director of the Y several years ago and heard about the chili, she asked innocently, "Who cooks it?" "You do," she was told. So she became a chef on an industrial scale.

She has a lot of help: three to five undergraduates each time, and sometimes alumni. (In December, Greg Steiert '96, nostalgic for all-nighters, came down from his job at Intel in Oregon to sauté and stir). And they have it down to a science, she claims; she procures the vanful of ingredients for both beef and vegetarian batches at her local supermarket—look for pre-chopped onions, she's learned; much easier on the eyes—then the whole crew mixes up the concoction (see recipe below) in the kitchen of Chandler Dining Hall, and doles out steaming bowls on the sidewalk between Chandler and Winnett Student Center.

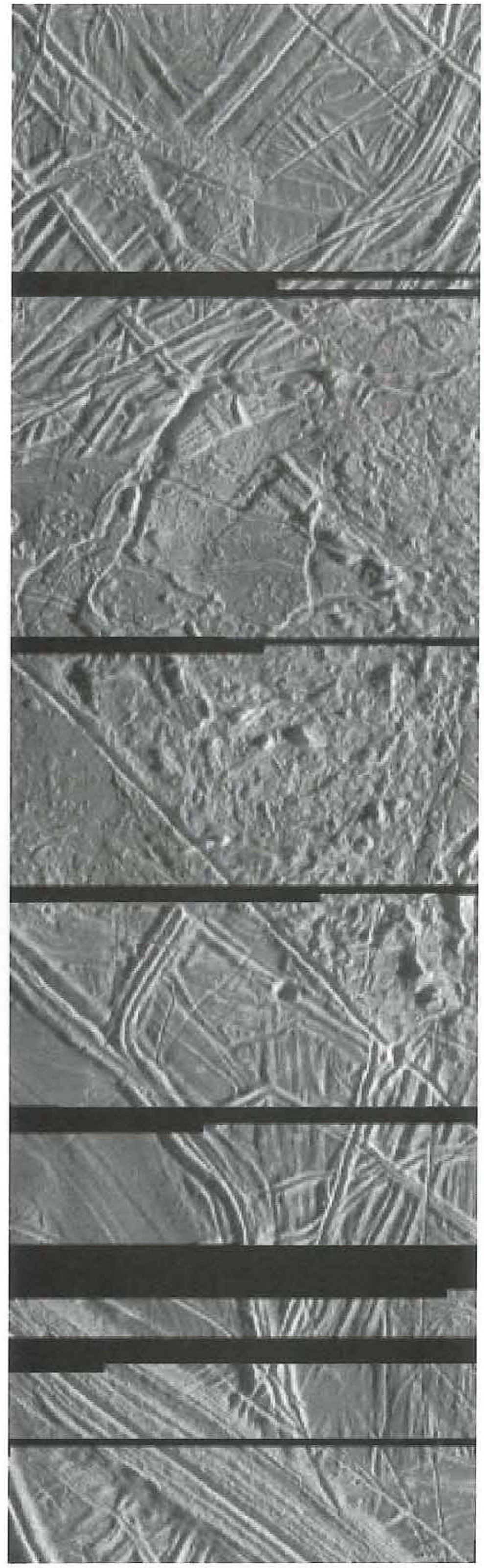
The final, and most crucial, step of the process is the addition of spices, and here, Borrego admits, she was a failure: her chili was too bland. The students mutinied, dumping in three times more chili powder. "I'm from the Midwest," she says apologetically, "where ketchup is a spice." □—*RR*

Decompression Chili

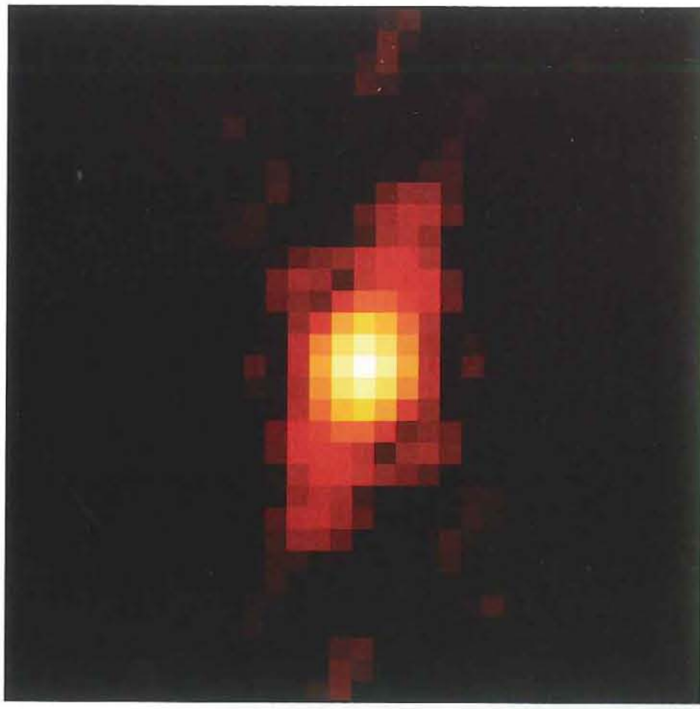
Sauté:
- 90 lbs ground beef (substitute carrots, broccoli, mushrooms, other vegetables in season for meatless recipe)
- 30 lbs onions, chopped
- 20 lbs (one case, or 25 bunches) celery, chopped

Simmer with:
- 24 32-oz cans each tomatoes, beans
- 60 oz chili powder (to taste)

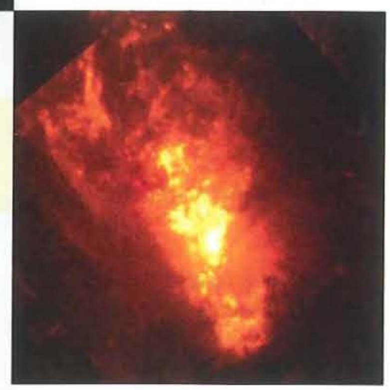
Yield: about 3,000 bowls



Not the tracks left over from a dirt-bike convention (or a lost robotic vehicle), these complex faults and ridges were created by tectonic processes in Europa's surface. Jupiter's icy moon was captured in this very high-resolution mosaic image made during Galileo's first close pass (2,119 miles) by Europa in December, during the spacecraft's fourth orbit around Jupiter. The resolution of the mosaic (the section shown here spans about 10 miles by 30 miles) is 50 times better than the best Voyager images and 500 times better than Voyager pictures of Europa. The sun is illuminating the surface from the right.



The new infrared image of the nucleus of NGC 1068 (far left), made at a wavelength of 2.2 microns, shows the same level of detail as the Hubble Space Telescope image (at ultraviolet and visible wavelengths) of a much wider view of the galaxy's nuclear region (below). Weinberger's image is 160 light-years on a side and sits just at the bottom apex of the central bright cone in the HST picture, which spans 1,200 light-years by 1,700 light-years. The two pictures are oriented in the same direction here, but the close-up infrared image shows an elongated structure, probably made of stars, which does not point in the same direction as the cone in the larger-scale picture. A distribution of stars like this could help force gas into the black hole at the center. In both pictures, the colors from red to white represent increasing brightness.



Close-up View of a Galactic Nucleus

The most detailed infrared image of the environment of an active black hole has emerged from work at the 10-meter W. M. Keck Telescope on Mauna Kea, Hawaii. Grad student Alycia Weinberger and her collaborators have used the computer-intensive technique of speckle imaging at the Keck to image the nucleus of NGC 1068 and have uncovered a new structure in this nearby active galaxy. The galaxy, found in the constellation Cetus at a distance of about 50 million light-years, reveals a a bright active nucleus at infrared wavelengths. This nucleus has long been thought to harbor a black hole as its central engine and, because it is bright and nearby, has been intensely studied by astrophysicists.

Made at a wavelength of 2.2 microns, Weinberger's near-infrared image has the capability to reveal structures which are only 12 light-years across. This is an extremely small distance by galactic standards, as small as about three times the distance between the sun and its nearest stellar neighbors. Although taken from a ground-based observatory, this image has resolution as fine as the Hubble Space Telescope achieves in the visual part of the spectrum. The space telescope does not currently have an infrared camera, but is scheduled to receive one as *E&S* goes to press. The elongated feature discovered by the Caltech group has not been seen in Hubble's optical images.

There are two very interesting aspects of this image. First, the image does not show a circular distribution of light, but rather an elongated one, and second, the axis of the emission points in a direction different from that of previously observed visual emission. The near-infrared light used to make this picture typically traces the distribution of hot dust and cool stars.

In NGC 1068, however, it is very unlikely that there could be dust 100 light-years from the central black hole that would be hot enough to produce the observed emission. Rather, Weinberger says, it is likely that the observed extended near-infrared light is from stars. Furthermore, since it points in a different direction, this newly resolved infrared emission is likely to come from a source entirely different from that of the visual emission.

It has long been proposed that elongated, noncircular distributions of stars in the shape of a "bar" are a way of funneling material to an active nucleus. As gas moves in a noncircular distribution of stars, such as what may be seen in Weinberger's image, it is forced into orbits likely to take it near the central black hole. This provides a continuous mechanism for "feeding" the central engine.

"The significance of this research is that it finds a brand-new feature in this galaxy," Weinberger says. "And even more, this new feature may provide observational evidence for a theoretically predicted means of channeling material to the black hole on very small scales." The image is by no means detailed enough to show the in-fall of the matter itself, Weinberger stresses. For this, one would need a resolution of less than a light-year, and there is currently no way to make such finely detailed pictures.

Nonetheless, the quality of this image is unparalleled because it relies on the unique resolving power of Caltech's 10-meter Keck Telescope and the technique of speckle interferometry to remove the distorting effects of Earth's atmosphere. With this technique, a series of very rapid exposures are made of the object, freezing the atmospheric distortions that cause stars to twinkle. Then the distortions are removed in computer post-processing. As the largest infrared telescope in the world, the Keck Telescope provides the best obtainable resolution.

Weinberger is currently completing work on her doctorate. She will continue doing observations to support this research, a part of her thesis. "It will be exciting to look at NGC 1068 with similar resolution in other infrared wavelengths," she says. "The more information we have across the spectrum the more we'll understand about the nature of this extended emission."

Also collaborating in this research are her thesis supervisor, Gerry Neugebauer, and Keith Matthews, both of the Caltech physics department. □—*RT*

A Brief History of Nakedness

It's not every day that a theoretical physicist pays off a bet on nakedness, but Stephen Hawking did so February 5. Hawking, the Lucasian Professor of Mathematics at Cambridge University, had been at Caltech for the previous six weeks as a Sherman Fairchild Distinguished Scholar. He conceded, just before leaving for home in England, a 1991 bet he had made with Kip Thorne and John Preskill that a phenomenon known as the naked singularity is possible.

Thorne and Preskill, both professors of theoretical physics at Caltech, think that naked singularities are allowed by nature. Hawking does not, but conceded the bet "on a technicality," he said.

In accepting Hawking's payoff, Preskill said that "We're much more tolerant of nakedness" than the British physicist.

"It comes from living in Southern California," Thorne added.

Hawking paid off the bet by presenting his two American colleagues with adequate raiments to shield their nakedness from the vulgar view. Specifically, the goods consisted of two T-shirts, which the bettors would only say were inscribed with "an appropriate message" from Hawking.

From left, John Preskill and Kip Thorne assist Stephen Hawking in sealing with his thumbprint a new bet on whether general conditions for the creation of a naked singularity will be found.

The big breakthrough came when another physicist named Matthew Choptuik (now at the University of Texas at Austin) developed a supercomputer simulation showing how a naked singularity could occur. To back up a bit, a singularity is a place where matter or light crashes in by force of its own weight to form a region of exceedingly high density.

No one disputes that singularities can exist, but Hawking believes that a singularity can occur only inside a black hole, where it cannot be seen. According to Thorne and Preskill, there should be situations in which singularities could exist outside of black holes and therefore be observed.

Hawking has always rejected the idea of the naked singularity, but admits that Choptuik's computer simulation shows how one could conceivably exist. There's virtually no possibility that Choptuik's naked singularity would ever arise in a real universe, however.

"Basically, it could exist only in a computer," Preskill said. "But it's the sort of event that would be allowed to happen, and that's what the bet was all about."

For his part, Hawking said that he's still a betting man when it comes to theoretical physics, even though he is now 0-2. In fact, a new bet is already on (see above).

"I'm going to win this time, but I don't know when," he said. □—*RT*

Political Scientists Ranked Sixth

Even with only nine faculty members, Caltech's political science group ranks sixth (after adjusting for size) in the nation, according to a report issued in December by *Political Science and Politics*. The top 10 with numbers of faculty are:

1. Rochester Institute of Technology (18)
2. Stanford (28)
3. Harvard (48)
4. Yale (29)
5. University of Michigan (44)
6. Caltech (9)
7. UC Berkeley (41)
8. University of Iowa (22)
9. University of Indiana (27)
10. University of Minnesota (30)