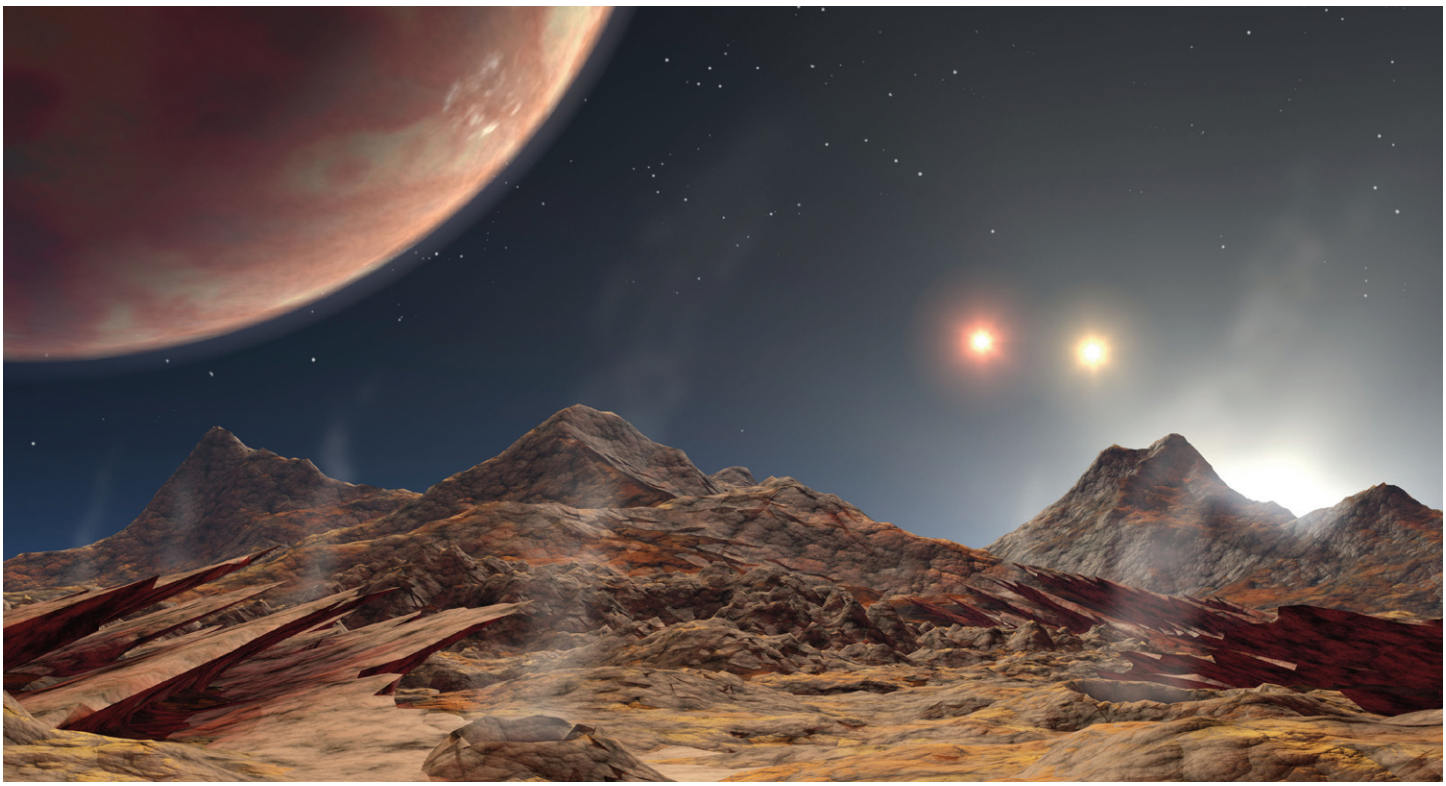


Our understanding of how planets form has been upended by postdoc Maciej Konacki, who's found a Jupiter-sized planet (in the upper left corner, shown here from the vantage point of a hypothetical moon) under three suns. The first planet ever discovered in a system where the companion star is neither distant nor small, it orbits the main star of a close triple, HD 188753, at about one-tenth the distance between our sun and Mercury. The secondary and tertiary stars form a tight binary of 1.63 solar masses, and orbit the 1.06 solar-mass primary about where Saturn does in our system. Since Konacki's planet should have formed somewhere around or beyond where our asteroid belt is—a zone that should have been swept clean by the double star—how it managed to coalesce is a mystery. But the fact that it did is good news for planet hunters, as binary and multiple stars outnumber single ones in our neighborhood by some 20 percent. Konacki calls this new class of planets Tatooines after Luke Skywalker's home world, which orbits a close binary. HD 188753 is about 149 light-years from Earth in the constellation Cygnus. Konacki used Caltech's 10-meter Keck I telescope, and the work appears in the July 14 issue of *Nature*.

PICTURE CREDITS: 2 – NASA/JPL-Caltech; 4-5 – NASA/JPL-Caltech / U. of Maryland

LIGO Rides Out Katrina

The Laser Interferometer Gravitational-Wave Observatory (LIGO) escaped serious hurricane damage to its Livingston, Louisiana installation (called LLO), some 50 miles west of the path of Katrina's eye. On August 30, Michael Zucker, head of the Livingston observatory (there is a twin facility in Hanford, Washington) reported via an e-mail from MIT, Caltech's partner on the project, that "site power is back on and the vacuum system is in good shape." However, "the internet connection was severed by falling trees, so there's no point trying to connect to LLO computers or sending e-mail to LLO personnel just yet. Nonessential personnel are asked to remain home; we will keep everyone posted as recovery progresses and will let you know as soon as operations resume." □—*DS*

Powering the Planet

With (pre-hurricane-Katrina) gasoline prices hovering at $3 per gallon, few Americans need convincing that another energy crisis is imminent. And this time it may be for keeps. Such people as Caltech Vice Provost David Goodstein argue that global oil production will peak in the next decade or so and then inexorably decline. There's talk of moving to a "hydrogen economy," but how to make the hydrogen? The best and cheapest methods currently available involve burning coal or natural gas, which means more greenhouse gases and more pollution; using natural gas would also merely replace our dependence on foreign oil with a dependence on foreign gas.

"Clearly, one clean way to get hydrogen is by splitting water with sunlight," says Harry Gray, Caltech's Beckman Professor of Chemistry. Gray leads a group of Caltech and MIT chemists in a National Science Foundation-funded initiative, called "Powering the Planet," to pursue cheap, clean, and efficient ways to store solar energy. "Presently, this country spends more money in 10 minutes at the gas pump than it puts into a year of solar-energy research," says Nate Lewis (BS, MS '77), the Argyros Professor and professor of chemistry. "But the sun provides more energy to the planet in an hour than all the fossil energy consumed worldwide in a year."

But the sun sets every night, and energy demand continues day and night, summer and winter, rain or shine. And electricity can't really be stored in bulk—how many D batteries would it take to run the Empire State Building overnight?—while hydrogen can. Which gets us back to the question of how to make hydrogen.

Your junior-high chemistry lab broke water into hydrogen and oxygen by electrolysis, using a platinum catalyst. And platinum has been selling all year for more than $800 per ounce. So the Caltech group is starting by looking for a cheaper catalyst. In an upcoming article in *Chemical Communications*, Associate Professor of Chemistry Jonas Peters and his colleagues describe a cobalt catalyst. "This is a good first example for us," says Peters. "A key goal is to try to replace platinum, which is extremely expensive, with something like cobalt or, even better, iron or nickel. We have to find a way to make solar-derived fuel cheaply if we are to enable widespread use of solar energy as society's main power source."

The Caltech chemists also hope to fit out a local school to run entirely on solar energy. The initial conversion would likely be done with existing solar panels, but the idea is to use the school as a fairly large-scale testing facility. "We'd build it so that we could troubleshoot solar converters we're working on," explains Gray.

The ultimate goal is a "dream machine with no wires in it," Gray says. "We visualize a solar machine with boundary layers, where water comes in, hydrogen goes out one side, and oxygen goes out the other." Such a machine will require a number of breakthroughs, but as Lewis says, "If somebody doesn't figure this out, and fast, we're toast, both literally and practically, due to a growing dependence on foreign oil combined with the increasing projections of global warming."

The "Powering the Planet" initiative is one of three new "chemical bonding centers" announced by the National Science Foundation on August 11. (The other two are at Columbia and UC Irvine.) The initiative has been funded at $1.5 million for three years, with the possibility of $2 to $3 million per year thereafter if the work appears promising. In addition to Gray, Lewis, and Peters, the initiative includes chemists Jay Winkler (PhD '84) and Bruce Brunschwig, both of Caltech's Beckman Institute, and MIT's Dan Nocera (PhD '84) and Kit Cummins.

The other authors of Peters' paper are Lewis, Brunschwig, postdoc Xile Hu, and undergrad Brandi Cossairt. □—*RT*

For the Record

The picture credits in the last issue of *Engineering & Science* accidentally omitted Shaun Healy, the cartographic deity of Geology and Planetary Sciences, who edited the fault map of Sumatra for us and helped prepare it for publication. Without his expert assistance, *E&S*'s first centerfold would not have been possible. □—*DS*

Can B Cells Be A Students?

Caltech president, Nobel laureate, and professor of biology David Baltimore and Pamela Bjorkman, the Delbrück Professor of Biology and an investigator with the Howard Hughes Medical Institute, have received a five-year, $14 million grant to try what Baltimore and postdoc Lili Yang (PhD '04) have dubbed "instructive immunotherapy." Proposed as an alternative to vaccines, the method would insert antibody-producing genes into the hematopoietic stem cells that live in our bone marrow. These cells produce billions of blood cells daily, including B cells. B cells, a type of white blood cell, develop into antibody-producing plasma cells, so programming them to recognize a disease that has defied vaccination—such as HIV, which Baltimore and Bjorkman will tackle as a test case—could confer lifelong immunity.

The grant, one of 43 totaling $437 million, was announced on June 27 by the Grand Challenges in Global Health initiative. The initiative, bankrolled chiefly by the Bill and Melinda Gates Foundation, funds the creation of "deliverable technologies"—effective, inexpensive to make, easy to distribute, and simple to use—for developing countries. □—*DS*

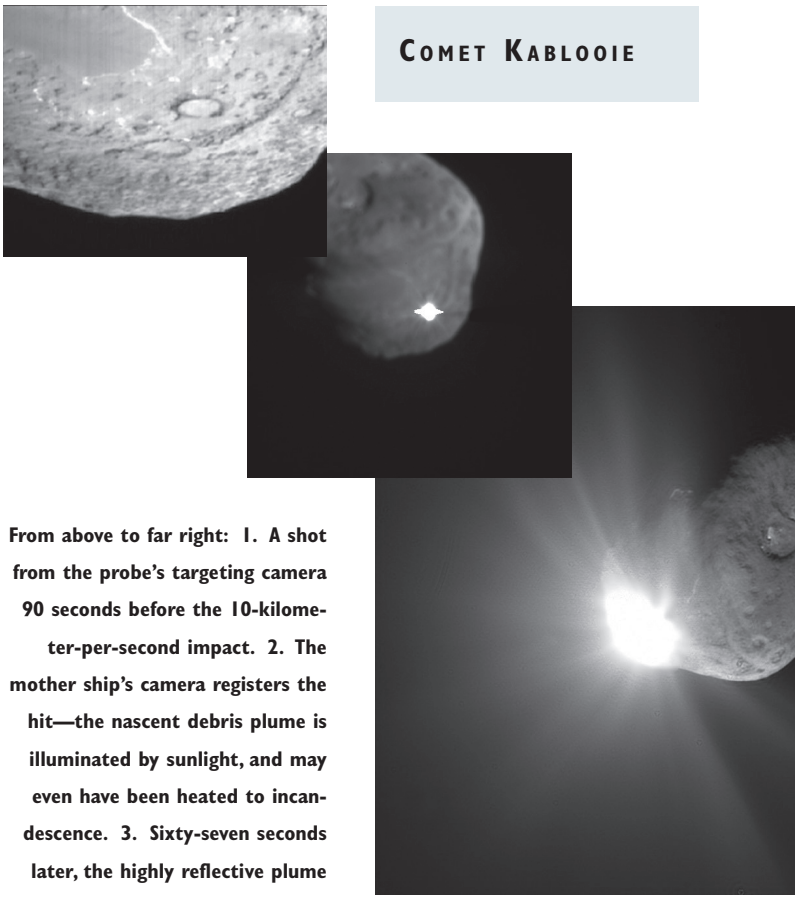
Ultrafast in 4-D

Nobel Laureate Ahmed Zewail, the Pauling Professor of Chemical Physics and professor of physics, has received an $18 million grant from the Gordon and Betty Moore Foundation to create the Ultrafast Science and Technology (UST) Center. The center will focus on a new scientific discipline that Zewail has dubbed "physical biology."

Because life processes are so complex, understanding them completely requires that *all* the atoms in a biological structure be observed over time as they go about their business. The UST Center will develop the science and technology for imaging biological and molecular structures in space and time using diffraction, spectroscopy, and microscopy in order to address the fundamental physics of molecular and biological behavior at varying levels, from the atom to the cell.

"All existing methods have focused on either the spatial *or* the temporal resolution," said Zewail, "but in complex systems, including biological systems, the combined resolutions are essential for a unified picture. The UST Center will be a nucleus for interactions between faculty and research assistants from the different disciplines of physics, chemistry, and biology. As unique techniques of "seeing" are developed by Zewail and colleagues, said Tom Tombrello, Kenan Professor and chair of the Division of Physics, Mathematics and Astronomy, "We shall soon be in a position to see the molecules of life in action." □—*RT*

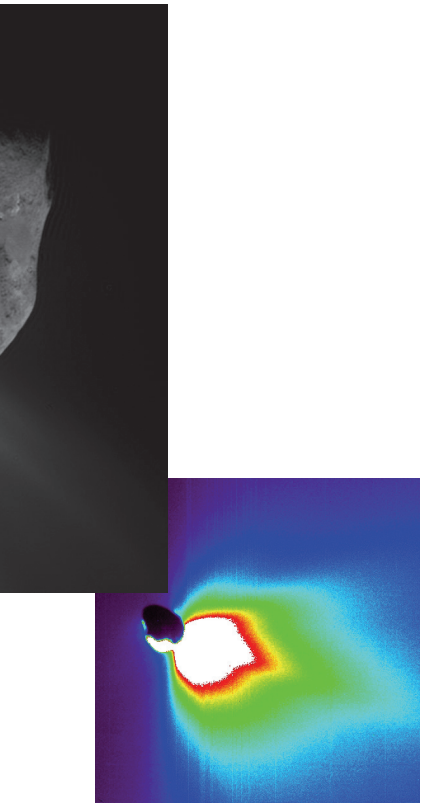
Comet Kablooie



From above to far right: 1. A shot from the probe's targeting camera 90 seconds before the 10-kilometer-per-second impact. 2. The mother ship's camera registers the hit—the nascent debris plume is illuminated by sunlight, and may even have been heated to incandescence. 3. Sixty-seven seconds later, the highly reflective plume has lit up the whole soot-black nucleus, which is some six kilometers across. 4. A backward glance about 50 minutes later shows the growing plume's brightness in false color; the crater, estimated to be 100 to 300 meters in diameter, is on the comet's far side.

Deep Impact, the spacecraft emphatically *not* named after the comet-crash movie, crashed into its comet for real at 10:52 p.m. PDT on July 3. The preholiday fireworks display astonished scientists by being easily visible to the naked eye here on Earth. The plume was bigger and much more reflective than expected, indicating that the comet is covered with a thick layer of very fine dust—"more like talcum powder than beach sand," says Principal Investigator Michael A'Hearn of the University of Maryland, College Park, "and definitely not an ice cube." No large chunks of debris were seen, meaning that the comet probably does not have an icy crust.

The 372-kilogram, copper-clad (to prevent spectral contamination; copper is not found in comets), washing-machine-sized impactor had been released from its mother



ship at 11:07 p.m. PDT July 2, and then steered itself independently into Comet Tempel 1's path, correcting its course three times in the process. The mother ship's sensors saw water, carbon dioxide, and unidentified hydrocarbons in the plume.

A whole fleet of spacecraft and innumerable telescopes have also been watching the show. The first slew of papers will be published in a September issue of *Science*.

The University of Maryland is in charge of the overall mission science; the spacecraft is being flown and managed by JPL, and was built by Ball Aerospace & Technologies Corp. in Boulder, Colorado. □—*DS*

The Dean, Remembered

Saul Bellow died on April 5 at age 89. This photo was taken 25 years earlier, during his stay at Caltech.

In January 1980 my husband, Dan Kevles, then Caltech's Executive Officer for the Humanities, was asked by Roger Noll, the Chair of the Humanities and Social Sciences Division, to arrange "something" for the spouse of a Sherman Fairchild Fellow in Mathematics. Alexandra Ionescu Tulcea was about to arrive from Northwestern University with her husband, a recent Nobel laureate in literature. Could Dan work out a plan with Saul Bellow?

So it came to pass that Dan met Saul and took him for a drive in our 1967 Jaguar sedan, a car that was even then almost a classic. Though dilapidated, at least it ran, which the '56 Jaguar drophead convertible Dan was restoring in our garage did not.

Dan and Saul agreed that Saul would offer a series of seminars with these ground rules—no assignments, no agenda, just literary discussions for the Caltech community. These would meet Wednesday afternoons and Dan would escort him to the auditorium of the new Beckman Laboratory, across from Baxter Hall, where Dan had his office, and where an office was assigned to Saul.

The term "seminar" suggests an intimate and informal discussion, but these meetings were neither. Saul Bellow's fame then was akin to Richard Feynman's after the *Challenger* hearings, so it was not surprising that the auditorium was filled from the first meeting to the last. Postwar readers loved the American voice of his novels *The Adventures of Augie March* and *Henderson The Rain King*; and *Humboldt's Gift* had won a Pulitzer Prize in 1976, the year of his Nobel.

Wednesdays that spring I attended his seminars. The regulars, besides me and Dan, included faculty, students, and some of Caltech's contingent of writers. Saul always took questions, some of which must have taxed his patience. I remember him responding to "Just how do you start writing every day?" by explaining that first he checked his typewriter to see that all the letters of the alphabet were still there. On a more serious note, he told us that he reread all of Shakespeare every year or two.

When not lecturing or working on his next book, Saul seems to have wandered around the campus talking and listening to scientists, who might have sounded different to him from his humanist colleagues on the Committee on Social Thought at the University of Chicago. At Caltech he got to know at least one of our most idiosyncratic scientific characters, apparently providing himself with background for his work-in-progress. He even took time to offer valuable advice to me about my as-yet-unfinished historical novel.

As the Bellows' stay drew to a close, I decided to have a dinner party to thank him for his help and to meet Alexandra. Besides us, the guest list included astronomer Marshall Cohen and his wife, Shirley, who then taught mathematics at John Muir High School in Pasadena, and philosophy professor Will Jones and his wife, Molly Mason Jones, a child psychologist then at Pomona College. Fifteen minutes before the guests were expected, the first course caught fire at almost the exact moment that the doorbell rang. The Bellows were early. I can still hear Dan telling me, "These are your guests, go take care of them. I'll put out the fire."

The near-disaster notwithstanding, the rest of the evening must have been successful, because no one wanted to break up the party. Marshall suggested that the group should reconvene during the week for a visit to

Palomar. We jumped at the idea, and Marshall promised to see about making arrangements at the telescope and to try to get an Institute car.

For the trip to the observatory, six of us (the Joneses did not come) met again at my home in southwest Pasadena, and piled into the limo in mid-afternoon. The plan was to stop en route for a picnic supper and arrive at the observatory as it grew dark. As the weather wavered between drizzle and overcast, we decided against the picnic but did stop to stretch our legs at the Pala Mission, a regular stop on the way up the mountain.

It was raining when we reached the observatory, and Marshall explained that they would not open the dome unless the rain stopped. Disappointed, we found an office inside where we ate our "picnic." Then we scattered to explore the cavernous space beneath the dome. But soon, to my surprise, I heard a grinding noise and looked up to see the dome parting. As I stared, it opened with deliberate speed and the stars—seemingly closer than they would have appeared were I standing outside in the woods—glowed in the clear sky. We were all excited by our change of fortune and sought each other to share the moment.

But Saul was not there—he was sitting in the gondola that was rising slowly above us along the inner surface of the dome, heading towards the prime-focus cage at the top. He had "seized the day" (although it was night) the instant he learned that the dome would open. Later, on the ride down the mountain, he was silent—struck mute by the experience, perhaps, or fixing the impression in his mind. I wouldn't know until later, in 1982, after he published his ninth novel, *The Dean's December*.

Although the first page carries the usual disclaimer about the book's fictional nature, it was obvious to me that Bellow had drawn on some of the people, places, and situations he had encountered that spring in Southern California. Though it takes place in Bucharest and Chicago, *The Dean's December* is in a number of ways a Caltech novel.

The protagonist is a journalist (not a novelist), the Dean of a Chicago university. He is married to a Romanian astronomer (not a mathematician). No mirror of the Bellows, but a good facsimile. As I turned the pages I encountered Clair Patterson, Caltech's great geochemist, in the character of Beech, a scientist obsessed, as Patterson was, with waking up Congress and the citizenry to the dangers of lead—from automobile emissions and paint—to the vulnerable brains of children. As Saul has Beech say: "Millions of tons of intractable lead residues [are] poisoning the children of the poor. . . . It's the growing children who assimilate the lead fastest. The calcium takes it up. And if you watch the behavior of those kids with a clinical eye, you see the classic symptoms of chronic lead insult. . . . Crime and social disorganization in inner city populations can all be traced to the effects of lead. It comes down to the nerves, to brain damage."

Bellow hadn't made any effort to mask Patterson. He even credits Beech, like Patterson, with having used radioactivity to "measure the age of the planet." I wasn't surprised that Bellow was impressed by Patterson's theories. His proselytizing helped to create the Clean Air Act of 1970 and ultimately brought about the removal of lead from gasoline. Bellow's Dean is not convinced, but he listens, as Bellow clearly did.

In the character Varennes, the public defender, I recognized some qualities of my husband, Dan: "healthy, a normal person, with a preference for decent liberal thought . . . his hobby was fixing up classic cars." I recalled how Saul had shuddered every time he entered our quasi-wreck.

On the last pages of the book, I found myself, once again, on the road to Palomar. This time I was with the Dean and his wife, Minna, who had arranged time on the two-hundred–inch. On the drive they stopped at the mission and looked at some handicrafts. This time there was no doubt that the dome would open; Saul had given them beautiful weather—and why not? This was his world.

The Dean ascends with Minna and a resident astronomer in a small elevator that swings in a curve as it moves upward. "If you came for a look at astral space it was appropriate that you should have a taste of the cold *out there*, its power to cancel everything merely human . . . Segments of the curved surface opened quickly and let in the sky—first a clear piercing slice. All at once there was only the lift, moving along the arch. The interior was abolished altogether—no interior—nothing but the open, freezing heavens. If this present motion were to go on, you would travel straight out. You would go up into the stars."

In this description I found the clue to why Saul had been so quiet on our real ride home. He wasn't simply fixing the experience in his memory, he was still in the grip of his ascent. In fact, *The Dean's December* ends with the following words:

"The young man pressed the switch for the descent. 'Never saw the sky like this, did you?'

'No. I was told how cold it would be. It *is* damn cold.'

'Does that really get you, do you really mind it all that much?'

They were traveling slowly in the hooked path of their beam towards the big circle of the floor.

'The cold? Yes. But I almost think I mind coming down more.'"

It is hard to imagine that Bellow ever would have written that passage had he not visited Caltech and Palomar. □—*BK*

Saul . . . was sitting in the gondola that was rising slowly above us along the inner surface of the dome, heading towards the prime-focus cage at the top. He had "seized the day" (although it was night) the instant he learned that the dome would open. Later, on the ride down the mountain, he was silent—struck mute by the experience, perhaps, or fixing the impression in his mind.

Bettyann Holtzmann Kevles is the author of Almost Heaven: Women on the Frontier of Space *and* Naked to the Bone: Medical Imaging in the Twentieth Century*, as well as other books. Her husband, Daniel J. Kevles, the Koepfli Professor of the Humanities, Emeritus, taught at Caltech from 1964 to 2001.*

Fish Heads, Fish Heads Eat Them Up, Yum!

Can't stomach Elvis's fried peanut butter 'n 'nanner sandwiches? It could all be in your head—it appears that it may be possible to dislike a food without even being able to recognize its taste, as two different regions of the brain seem to be responsible for the two processes. In the June issue of *Nature Neuroscience*, Caltech professor of psychology and neuroscience Ralph Adolphs and his colleagues at the University of Iowa report on a patient who is unable to name even familiar foods by taste or by smell, and shows remarkably little preference in his choice of food and drink.

The 72-year-old man, known as "B," had had a brain infection that destroyed his amygdala, hippocampus, the nearby temporal cortices, and the insula, and damaged several other structures. As a result, he has a memory span of about 40 seconds, somewhat similar to that of the protagonist in the film *Memento*. B is also unable to recognize familiar people and many objects, although his vision and his use of language are unaffected.

B, several other subjects with brain damage, and several normal subjects were all offered salty and sweet drinks. Everyone drank the sweet drinks and said they enjoyed them, and all—with the notable exception of B—said they found the saline drink disgusting. B drank the saline solution with a pleased expression, saying it "tasted like pop." However, when he was asked to sip both a salty and a sweet drink and to continue drinking the one he preferred, he chose the sweet one.

It appears that B, like most people, has some fundamental preference for sweet drinks over salty ones even if he is unaware of the identity of either, but that he can only exercise this preference when he can compare them within the 40-second span of his memory. In other words, the sensation of taste and the innate preference are separate processes whose divorce is revealed by B's memory loss.

Of course "our likes and dislikes in taste stem from both innate and cultural causes," Adolphs remarks. "You may like sushi or bitter melon or certain smelly cheeses, whereas other people turn away from these foods in distaste."

The paper's coauthors are Daniel Tranel, Michael Koenigs, and Antonio R. Damasio, all of the University of Iowa's Department of Neurology and Neuroscience. □—*RT*

All It Needs Is a Divining Rod

JPL's Mars Reconnaissance Orbiter lifted off from Cape Canaveral at 4:43 a.m. Friday, August 12, after two postponements, and is slated to arrive at the Red Planet on March 10, 2006. Six months of aerobraking will follow—to an orbit 20 percent tighter than those of our current eyes there—before the spacecraft gets down to the business of following the water. The orbiter carries three cameras, including the largest telescopic camera to ever orbit another planet, capable of seeing dishwasher-sized rocks; a visible/infrared imaging spectrometer that can identify minerals, particularly those revealing a sodden past, in swatches the size of the grassy portion of a softball infield; an atmospheric profiler; and a ground-penetrating radar from the Italian Space Agency that can look up to a kilometer deep for large deposits of frozen or liquid water.

In order to keep up with this flood of information, the orbiter's communications systems can transmit 10 times as much data per minute as any previous Mars mission. This will come in handy when the orbiter begins additional duty as a relay station for the Phoenix lander, set to touch down in the north polar region in May 2008, and the Mars Science Laboratory rover, arriving in October 2010. The Mars Reconnaissance Orbiter was built by Lockheed Martin Space Systems of Denver, Colorado. □—*DS*

Xena, Warrior Planet

Associate Professor of Planetary Astronomy Michael Brown and colleagues have discovered a planet larger than Pluto in the outlying regions of the solar system. The planet is a typical member of the Kuiper belt, but its sheer size means that it can only be classified as a planet, Brown says. Currently about 97 times Earth's distance from the sun, it becomes the farthest-known object in the solar system, and the third brightest of the Kuiper-belt objects. "It is visible in the early-morning sky, in the constellation Cetus," says Brown, who made the discovery with colleagues Chad Trujillo, of the Gemini Observatory, and David Rabinowitz, of Yale University, on January 8.

Brown and Trujillo first photographed the new planet with the 48-inch Samuel Oschin Telescope at Palomar Observatory on October 31, 2003. However, the object was so far away that its motion was not detected until the data was reanalyzed last January. The planet's size is inferred from its brightness, and "if it reflected 100 percent of the light reaching it, it would be as big as Pluto," says Brown. This is unlikely, however, so he estimates that it's probably one and a half times Pluto's size.

A name has been proposed to the International Astronomical Union, but pending approval Brown *et. al.* have been calling their find Xena, in a nod to the Planet X beloved by science-fiction writers. □—*RT*