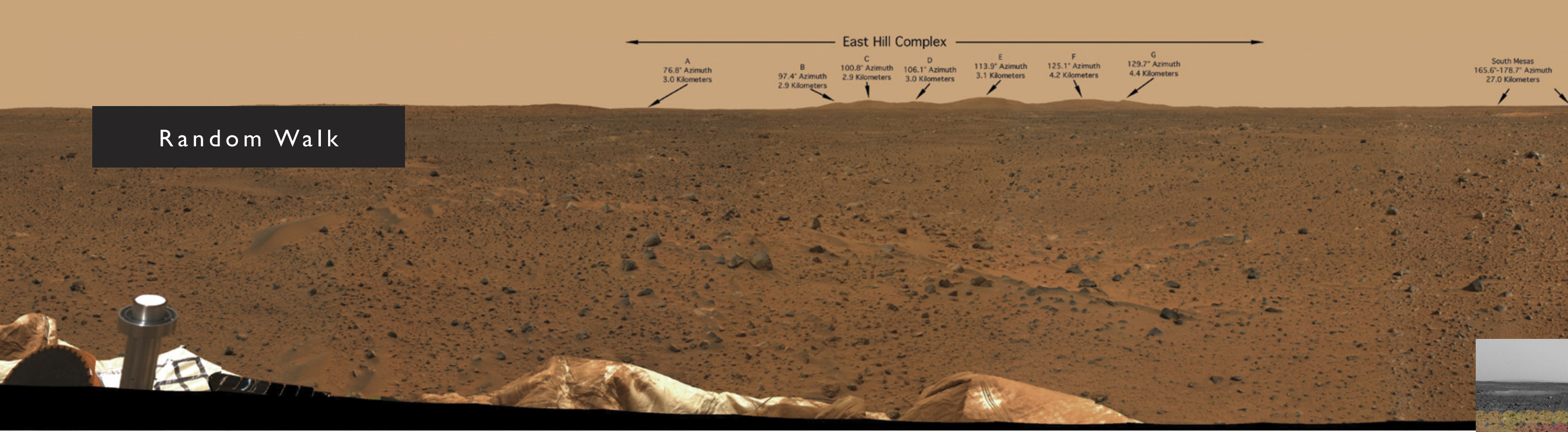
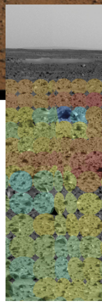




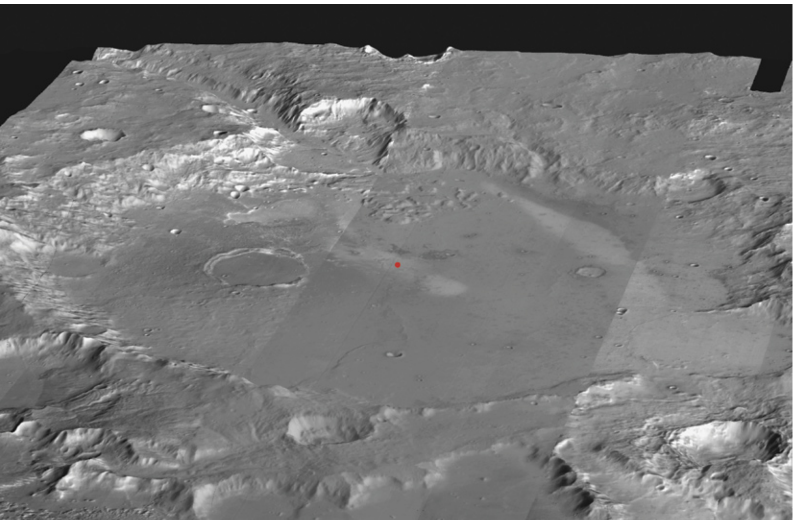
Above: This 360-degree panorama was taken before Spirit turned 115° clockwise to roll off the northwest ramp. The camera mast is also a periscope for the mini Thermal Emission Spectrometer (mini-TES), which sees infrared light; that is to say, heat. Warm, red regions like the shallow depression in the distance tend to be dusty, and perhaps treacherous. The infrared spectral data also help the geologists decide which rocks are worth visiting. In the inset, mini-TES data are superimposed on a corresponding panoramic camera image.

We're Baaack. . .

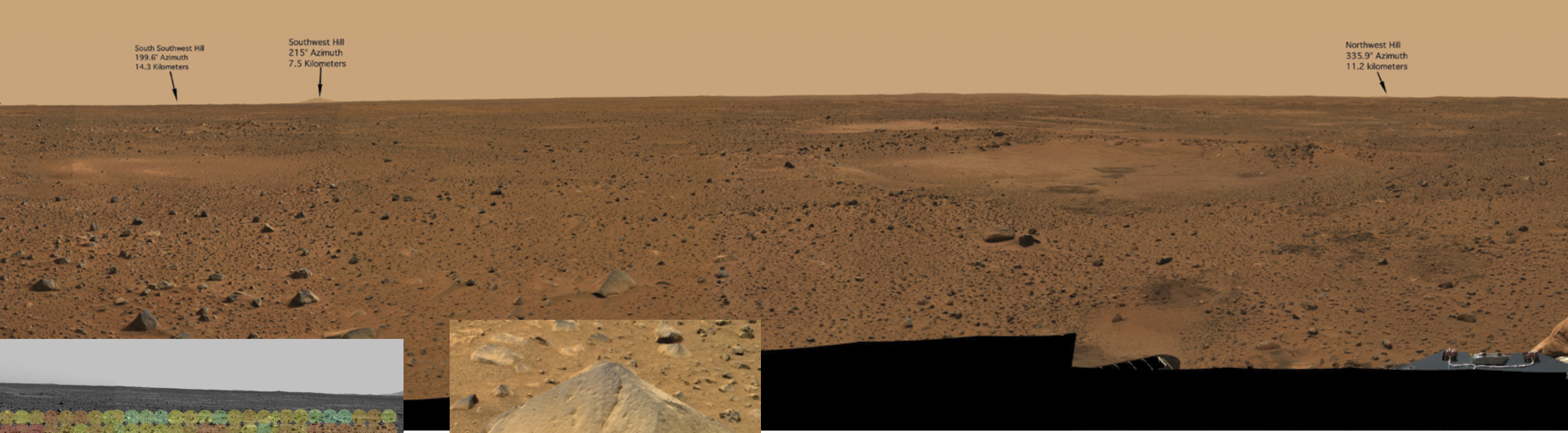
Above: NASA Administrator Sean O'Keefe pours champagne for, from left, Mars Exploration Rover Project Manager Pete Theisinger (BS '67), Deputy Project Manager Richard Cook, and Rover Entry, Descent, and Landing (EDL) Development Manager Rob Manning (BS '82) at the post-landing press conference on January 3.

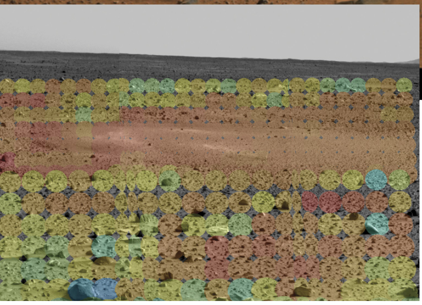
Unless you've been living under a rock yourself, you know that a JPL Mars rover named Spirit has rolled off its lander and is preparing to sample rocks. (Spirit's twin, Opportunity, was still en route as *E&S* went to press.) These robot geologists are the next best thing to being there. Each stands about five feet tall, so its panoramic camera gives us a human's-eye view of the landscape; its Swiss-Army-knife tool arm is about as long as a human's; and the arm's microscopic imager is the strength of a geologist's loupe, discriminating things as small as a grain of salt—all in hopes of positively identifying rocks that on Earth only form in the presence of water. It can turn in its own length, clear basketball-sized rocks, and traverse a 45° slope without tipping over. And it has to think for itself—since it takes about 10 minutes for a radio signal to reach Mars, you can't drive it with a joystick. You just give it marching orders.

This amazing machine is only beginning to get to work, but here's the story so far. □—*DS*



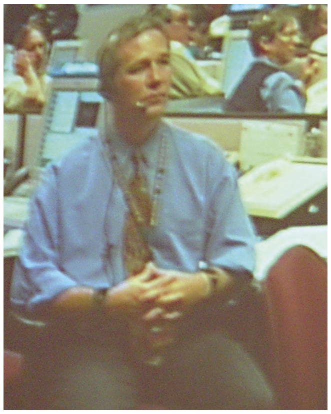
Left: Spirit (red dot) landed in Gusev Crater, which may once have held a lake slightly smaller than New Jersey. Ma'adim Vallis enters Gusev from the south (at top in this image) after running some 900 kilometers—about the distance from Baton Rouge to St. Louis—and appears to have been carved by flowing water about two billion years ago. (This Mars Odyssey daytime infrared image was draped over Mars Global Surveyor [MGS] topography.) Right: Spirit's planned itinerary includes a jaunt of some 250 meters to a 192-meter-diameter crater dubbed Sleepy Hollow by the jet-lagged mission team. With luck, clambering down into the crater's interior will give access to older subsurface rocks that may reveal a sedimentary history. Then we'll head for the (East) hills, two to three kilometers away. The long arrow points to Hill B—the black blob at the top (south) of this image, which is a composite of MGS photos and images from the lander's descent camera. The dark streaks are dust-devil trails.



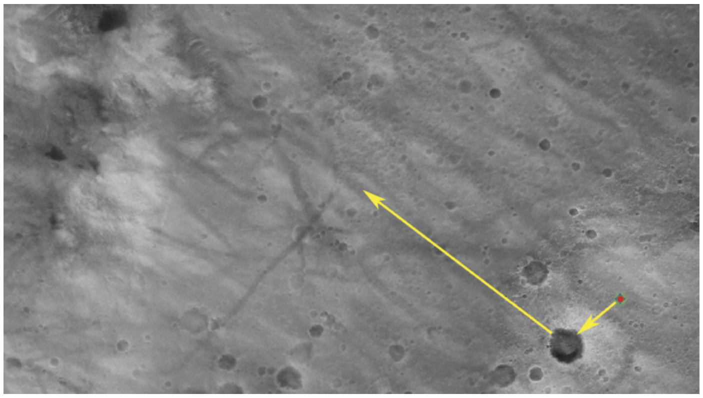


Left: Spirit's first target is Adirondack, a football-sized rock chosen for its flat, dust-free surface. (Adirondack can be seen in the panorama directly above the inset.) After exposing the rock's interior with an abrasion tool and determining its composition by both Mössbauer and alpha-particle X-ray spectrometry, Spirit will make its way by easy stages to Sleepy Hollow, the crater in the middle distance directly above. The patches of disturbed soil on Sleepy Hollow's floor may be bounce marks.

Left: Those patches may resolve a mystery—the top layer of soil scraped up by one deflating airbag crumpled up and peeled away almost as though it was wet sand overlaying dry, which it clearly is not. Spirit can't examine this area, called the Magic Carpet, for fear of getting fouled in the airbag, so perhaps the same soil-peeling process will be found to be at work where the airbags bounced.



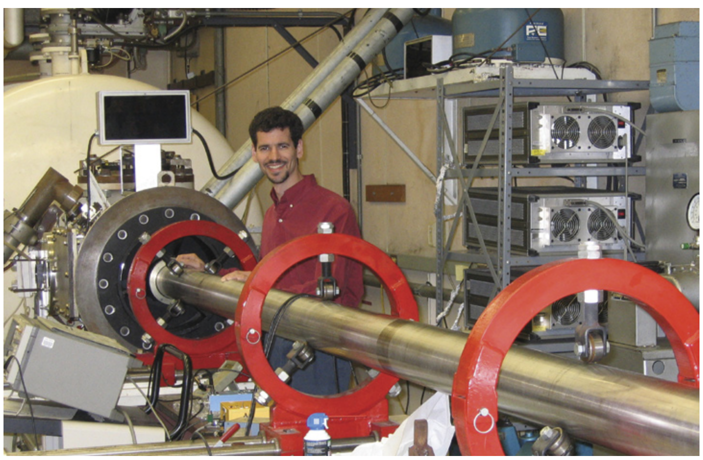
Above, left: Spirit Mission Chief Mark Adler (PhD '90) practices patience as Mission Control waits to hear if Spirit survived its landing. The rover should have bounced to a stop in five minutes or so, but there was no signal for nearly 10. Right: That's more like it! Adler and EDL Chief Engineer Wayne Lee celebrate as the first pictures begin to come down. Below, right: The rovers are solar powered, so team members must live and work on Mars time. Garo Anserlian, of Executive Jewelers in nearby Montrose, has modified several batches of 21-jewel timepieces by inserting precisely calibrated lead weights into their works to slow them to match the Martian day, which is about 39 minutes longer than an Earth day.



Right: It’s a bird! It’s a plane! It’s grad student Sean Humbert taking wing from a medieval siege engine known as a trebuchet (that’s French for “Really Big Catapult”) into the bracing waters of San Francisco Bay.

Between a Rock and a Hot Place

Earth’s core-mantle boundary is a place none of us will ever go, but Caltech researchers using a special high-velocity cannon have shown that there may be molten rock there, at a depth of about 1,800 miles. Further, it may have rested peacefully at the interface between the rocky mantle and the metallic core for eons.



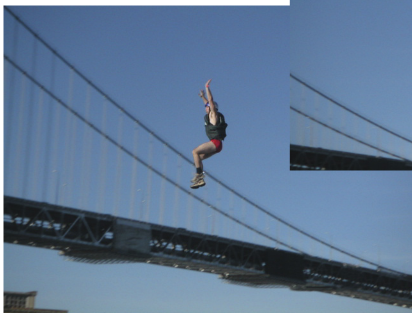
Paul Asimow operating the supergun.

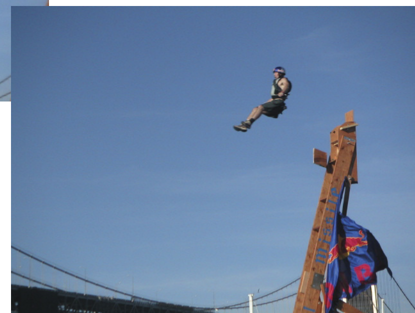
At the fall meeting of the American Geophysical Union, Professor of Geophysics Thomas Ahrens (MS ’58) reported new measurements of the density and temperature of magnesium silicate—the stuff found in Earth’s interior—when it is subjected to the conditions that exist at the planet’s core-mantle boundary. The team did their work in Caltech’s shock-wave laboratory, where an 80-foot light-gas gun is specially prepared to fire one-ounce tantalum-faced plastic bullets at mineral samples at speeds up to 220,000 feet per second—about a hundred times faster than a bullet fired from a conventional rifle. The resulting impact replicates the 1.35 million atmospheres of pressure and the 8,500 degrees Fahrenheit that exist at the core-mantle boundary.

The bullets were fired at natural semiprecious gem crystals of Sri Lankan enstatite—a form of magnesium silicate—as well as synthetic glass of the same composition. Upon compression, these materials transform to the 30-percent-denser structure called perovskite that dominates Earth’s lower mantle at depths from 415 miles to the core-mantle boundary.

Ahrens and Assistant Professor of Geology and Geochemistry Paul Asimow (MS ’93, PhD ’97), along with grad students Joseph Akins (MS ’99, PhD ’03) and Shengnian Luo (MS ’01, PhD ’03) demonstrated that the perovskite form of magnesium silicate melts at the pressure of the core-mantle boundary to produce a liquid whose density is greater than or equal to the mineral itself. This is highly unusual—most solids are denser than their melted form. Water is an exception, which is why lakes under the ice in Antarctica don’t freeze all the way down to the bottom. Similarly, this implies that a layer of partially molten mantle would be gravitationally stable at the core-mantle boundary over geologic timescales.

The work was motivated by the discovery of ultralow-seismic-velocity zones at the base of Earth’s mantle by Donald Helmberger, the Smits Family Professor of Geophysics and Planetary Science, and Edward Garnero (PhD ’94), now a professor at Arizona State University. Most prominent beneath the mid-Pacific region, these zones appear to be 1-to-30-mile-thick layers of rock at the base of the mantle that behave like molten material. Many researchers assumed that this partially molten zone might represent atypical mantle compositions, such as a concentration of iron-bearing silicates or oxides with a lower melting point than ordinary mantle—about 7,200°F at this pressure. The new results, however, indicate that no special composition is required. □—*RT*

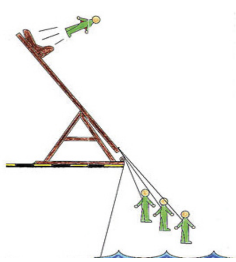




Not First Class, But Plenty of Leg Room

At the 2003 Red Bull Flügtag San Francisco, held in October, the kilt-clad team El Toro Guapo (“the handsome bull”) took first prize by adapting a trebuchet to lob a human into the bay rather than a rock over a castle wall. Sean Humbert (MS ’99), grad student in mechanical engineering, volunteered to be flung from the “Medieval Missile”—or perhaps he was the only one crazy enough to do it—and was launched into the air when Brent Hedgpeth, Brent Holloway, Ted Scheel, and Dave Campbell, harnessed to the other end of the throwing arm, jumped off the 30-foot-high pier. (A Flügtag is a tongue-in-cheek human-powered flight competition.)

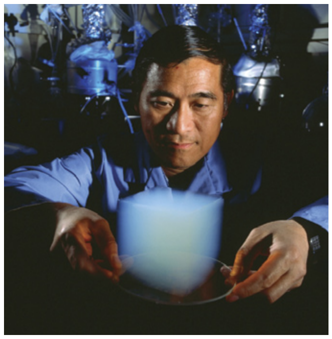
“The only preparation or training we were able to do was with a one-fifth scale model, from which we launched several weighted Barbie dolls to verify my computer simulation,” said Humbert. He was catapulted out of the specially designed wooden chair at a velocity of about 30 miles per hour, not knowing if what had worked for an overweight Barbie would also work for him. “The initial acceleration whipped my neck forward quite a bit,” he recalls, “but within a fraction of a second I was tossed out 50 feet above the water. Time seemed to stop and I couldn’t hear any sounds as I glided to a feet-first landing 61 feet from the end of the pier.” This is the second year in a row that El Toro Guapo has won the Frisco Flügtag, and Humbert is already working with aeronautics grad student James Faddy on the entry for 2004. And in case you were wondering what was under those kilts: their modesty was preserved by scarlet Speedos. ☐—*BE*



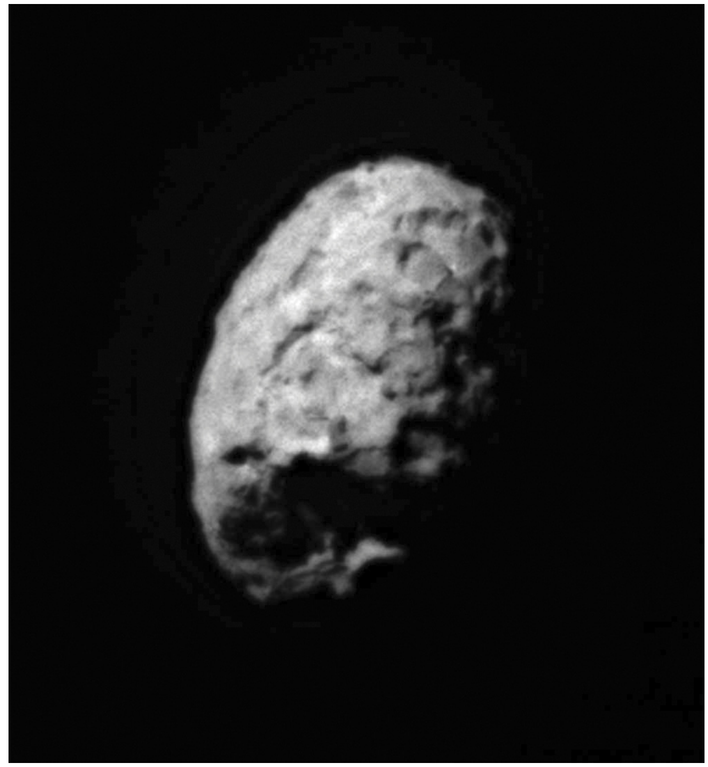
Caltech Wins Olympic Gold—in Physics

Three incoming freshmen were medalists at the 34th International Physics Olympiad, held in Taipei, Taiwan in August. The annual event is the world’s major physics competition for secondary-school pupils, and students from 54 countries participated. Axline scholar Pavel Batrachenko, who is originally from Moscow, had the highest overall score, 42.30 points, and won a gold medal; Axline and Lingle Scholar Emily Russell, from Yorktown Heights, New York, and Yernur Rysmagambetov, originally from Kazakhstan, each took silver. Russell was also named Best Female Participant. Russell and Batrachenko are majoring in physics, and Rysmagambetov is majoring in computer science. ☐

Right: In October, William and Delores Bing played for the Los Angeles Master Chorale’s first concert in its stunning new home, the Frank Gehry–designed Walt Disney Concert Hall. William Bing is director of bands at Caltech and a lecturer in concert band and jazz band, and Delores directs the chamber music program.



Far right: An image of comet Wild 2 (pronounced Vilt-2, with a Swiss accent) taken by JPL's Stardust spacecraft on January 2 shows the pockmarked, roughly spherical nucleus, with one hemisphere in sunlight, the other in shadow, similar to a view of the quarter-moon from Earth. The craft got to within 240 kilometers of the comet, protected from the sandblasting stream of cometary particles by laminated shields of five sheets of carbon filament and ceramic cloths. Stardust captured some of the particles in aerogel, the silicon-based porous material developed at JPL that's so light, it's almost not there (shown above with Peter Tsou, Stardust's deputy principal investigator), and will drop them off in Utah on January 15, 2006—the first comet samples in the history of space exploration, and the first time any material has been deliberately brought back from deep space. Tom Duxbury, Stardust's project manager, remarked that it couldn't have gone better in a fairy tale. And co-investigator Ray Newburn (BS '54, MS '55) added, "These images are better than we had hoped for in our wildest dreams. They will help us better understand the mechanisms that drive conditions on comets."



Spring Watson Lectures Set

John Schwarz, the Harold Brown Professor of Theoretical Physics, kicks off the spring Watson lecture series on February 11 with a talk titled "String Theory: Past, Present, and Future," followed on March 3 by Professor of History Robert Rosenstone with "Inventing Historical Truth on the Silver Screen." On March 31, Richard Murray (BS '85), professor of mechanical engineering and chair of the Division of Engineering and Applied Science, will present "Team Caltech: Racing to Win the DARPA Grand Challenge," and Charles Elachi (MS '69, PhD '71), director of the Jet Propulsion Laboratory and professor of electrical engineering and planetary science, will share with us the "Challenges and Excitement of Space Exploration" on April 28. All Watson lectures are at 8:00 p.m. in Beckman Auditorium; no tickets or reservations are required. The lectures also become available online at Caltech's Streaming Theater, http://today.caltech.edu/theater/, about a week after the event.

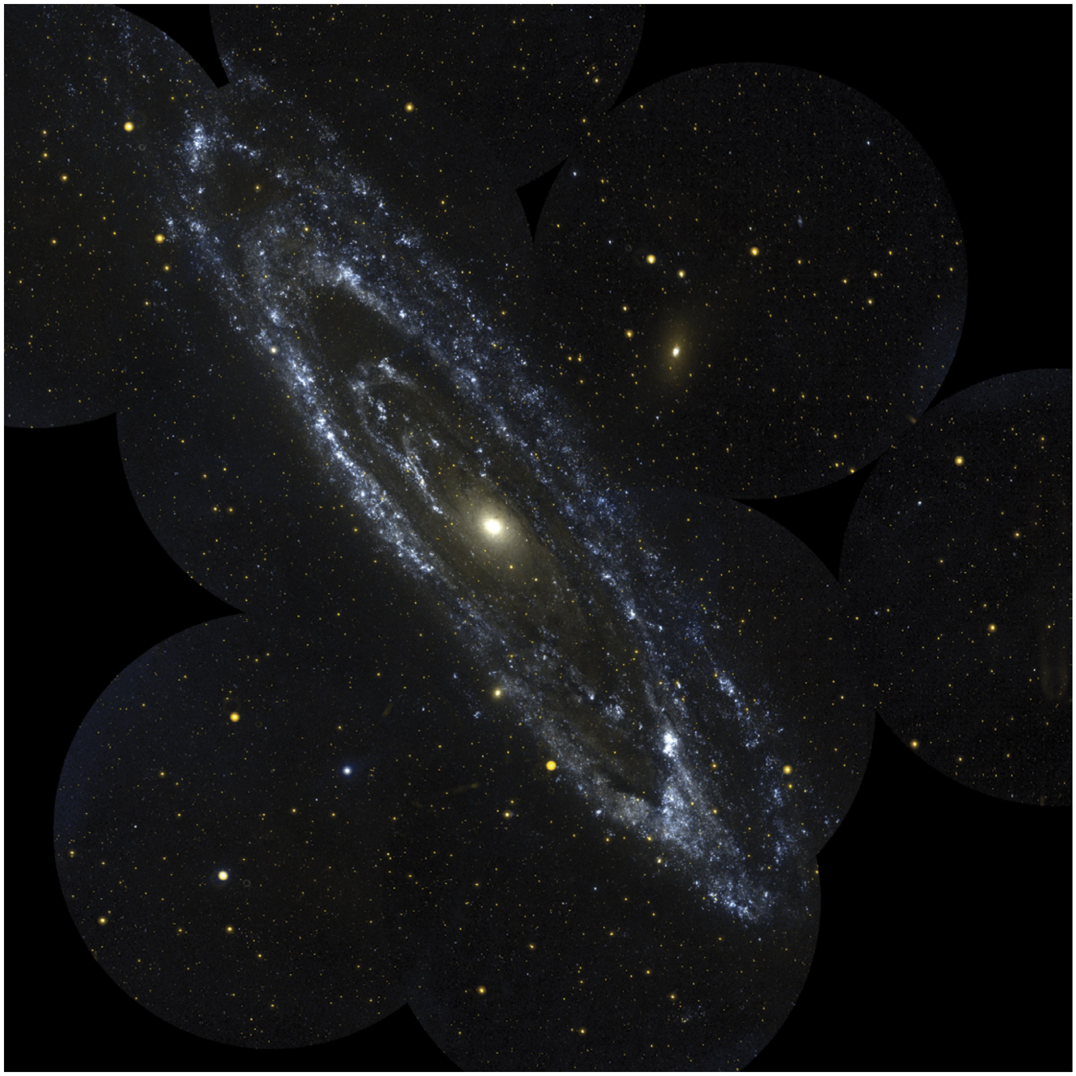
The Stems of Brain Cancer?

Caltech biologists, in collaboration with UCLA's Jonsson Cancer Center, have discovered that brain tumors may be derived from the cells that form the nervous system. These cells, called neural stem cells, may help researchers understand how this cancer begins.

The study, published in the *Proceedings of the National Academy of Sciences*, suggests that pediatric brain tumors develop from cells that have many of the same characteristics as neural stem cells. However, these cells also have an abnormal ability to grow and change.

"We want to understand the transformation process from a normal stem cell to a cancer cell," said Houman Hemmati, the paper's lead author and an MD/PhD student in the UCLA-Caltech Medical Scientist Training Program. "Recent work has shown that some cancers can arise from abnormal cells that are like stem cells, in that they self-renew while at the same time producing the different kinds of cells that make up a tumor. This is a new way of thinking about the fundamental origins of cancer."

"This study demonstrates a previously unrecognized connection between stem cells and pediatric brain tumor–derived cells. By viewing tumors as a type of embryonic cell gone awry, it opens up new possibilities for diagnosis and treatment," said Marianne Bronner-Fraser, the Ruddock Professor of Biology.



“We believe that neural stem cells, found normally within our brain and spinal cords, could transform into cancer cells,” said Harley Kornblum, a pediatric neurologist, member of UCLA’s Jonsson Cancer Center and an associate professor of molecular and medical pharmacology and pediatrics at UCLA.

“This work also demonstrates that major advances can be made by combining different scientific perspectives—tumor biology, stem cell, and developmental biology. The joint UCLA-Caltech program fosters this important and cross-disciplinary discovery,” said Bronner-Fraser. □—*RT*

Above: Familiar galaxies can now be seen in a new light—the ultraviolet—since the December release of the first images and data from NASA’s new orbiting space telescope, the Galaxy Evolution Explorer (GALEX). In the Andromeda galaxy, blue regions of young, hot stars that give out a lot of energy in ultraviolet wavelengths trace out the spiral arms where stars are forming. The central bulge consists of older, cooler stars formed long ago. (Compare the visible-light image from the 48-inch Samuel Oschin Telescope at Caltech’s Palomar Observatory, above left.) During its 29-month mission, GALEX will survey the entire extragalactic sky to give astronomers new insights into the early stages of star formation, how galaxies evolve and change, and how the elements we see around us today originated. The GALEX Science Center at Caltech has overall responsibility for the project, with Professor of Physics Christopher Martin as the principal investigator. JPL built the spacecraft with contributions from universities, scientific institutions, and companies worldwide, and is managing the project. Check out more stunning images at http://www.galex.caltech.edu.