SPIRIT NEARS MARS
Rover landing set for evening of Jan. 3
By Guy Webster

NASA’s robotic Mars geologist, Spirit, embodying America’s enthusiasm for exploration, must run a grueling gauntlet of challenges before it can start examining the Red Planet. Spirit’s twin Mars Exploration Rover, Opportunity, also faces tough Martian challenges. “The risk is real, but so is the potential reward of using these advanced rovers to improve our understanding of how planets work,” said Dr. Ed Weiler, NASA’s associate administrator for space science. Spirit is the first of two golf cart-sized rovers headed for Mars landings in January. The rovers will seek evidence about whether the environment in two regions might once have been capable of supporting life. Engineers at JPL have navigated Spirit to arrive during the evening (in U.S. time zones) of Jan. 3.

Spirit will land near the center of Gusev Crater, a bowl bigger than Connecticut which may have once held a lake. Three weeks later, Opportunity will reach the Meridiani Planum, a region containing exposed deposits of a mineral that usually forms under watery conditions. “We’ve cleared two of the big hurdles, building both spacecraft and launching them,” said Mars Exploration Rover Project Manager Peter Theisinger. “Now we’re coming up on a third, getting them safely onto the ground.” Since their launches on June 10 and July 7 respectively, each rover has been flying tucked inside a folded-up lander. The lander is wrapped in deflated airbags, cocooned within a protective aeroshell and attached to a cruise stage that provides solar panels, antennas and steering for the approximately seven-month journey. Referring to Spirit, the first of the twin rovers to reach Mars, Theisinger said, “The spacecraft’s performance has been excellent; the navigation has been superb.”

Spirit will cast off its cruise stage 15 minutes before hitting the top of the Martian atmosphere at 5,400 meters per second (12,000 mph). Atmospheric friction during the next four minutes will heat part of the aeroshell to about 1,400 °C (2,600 °F) and slow the descent to about 430 meters per second (960 mph). Less than two minutes before landing, the spacecraft will open its parachute. Twenty seconds later, it will jettison the bottom half of its aeroshell, exposing the lander. The top half of the shell, still riding the parachute, will lower the lander on a tether. In the final six seconds, airbags will inflate, retro rockets on the upper shell will fire, and the tether will be cut about 15 meters (49 feet) above the ground.

Several bounces and rolls could take the airbag-cushioned lander about a kilometer (0.6 mile) from where it initially lands. If any of the initial few bounces hits a big rock that’s too sharp, or if the spacecraft doesn’t complete each task at just the right point during the descent, the mission could be over. More than half of all the missions launched to Mars have failed. “We can guarantee success? Of course not,” said JPL Director Dr. Charles Elachi. “But on the other hand, the team deserves it, because we have done everything we know that could be humanly done to ensure success. We have conducted more testing and external reviews for the Mars Exploration Rovers than for any previous interplanetary mission.” Landing safety is the first step for three months of Mars exploration by each rover. Before rolling off its lander, each rover will spend a week or more unfolding itself, rising to full height, and scanning surroundings. At approximately 174 kilograms (384 pounds), Spirit and Opportunity each weigh about 17 times as much as the Sojourner rover of the 1997 Mars Pathfinder mission. They are big enough to roll right over obstacles nearly as tall as Sojourner.

“Think of Spirit and Opportunity as robotic field geologists,” said Dr. Steve Squyres of Cornell University, principal investigator for the rovers’ identical sets of science instruments. “They look around with a stereo, color camera and with an infrared instrument that can classify rock types from a distance. They go to the rocks that seem most interesting. When they get to one, they reach out with a robotic arm that has a handful of tools, a microscope, two instruments for identifying what the rock is made of, and a grinder for getting to a fresh, unweathered surface inside the rock.” To coordinate their work with the rovers, flight team engineers and scientists operating the rovers from JPL will be living on “Martian time” as well.

FORTY-NINE DAYS BEFORE ITS HISTORIC RENDEZVOUS WITH A COMET, JPL’S STARDUST spacecraft successfully photographed its quarry, comet Wild 2 (pronounced Wilt-2), from 25 million kilometers (15.5 million miles) away. The image, the first of many comet portraits it will take over the first four weeks of December, will aid Stardust’s navigators and scientists as they plot their final trajectory toward a Jan. 2 flyby and collection of samples from Wild 2.

“Christmas came early this year,” said Project Manager Tom Dudorph: “Our job is to aim a 5-meter-long (16-foot) spacecraft at a 5.4-kilometer wide (3.3 mile) comet that is closing on it at six times the speed of a bullet. We plan to ‘miss the comet’ by all of 300 kilometers (186 miles), and all this will be happening 389 million kilometers (242 million miles) away from home. By finding the comet as early as and far as away as we did, the complexity of our operations leading up to encounter just dropped drastically.”

The ball of dirty ice and rock, about as big as three Brooklyn Bridges laid end-to-end, was detected on Nov. 13 by the spacecraft’s optical navigation camera on the very first attempt. The set of images was stored in Stardust’s onboard computer and downloaded the next day where mission navigator Dr. Shyam Bhaskaran processed them and noticed a white blob of light bisecting the base of a triangle made by three stars Stardust uses for deep space navigation. “When I first looked at the picture I didn’t believe it,” said Bhaskaran. “We were not expecting to observe the comet for at least another two weeks. But there it was, very close to where we thought it would be.”

The Wild 2 sighting was verified on Nov. 18 using the second set of optical navigation images downloaded from Stardust. To make this detection, the spacecraft’s camera saw stars as dim as 11th visual magnitude, more than 1,500 times dimmer than a human can see on a clear night.

The early detection of Wild 2 provides mission navigators critical information on the comet’s position and orbital path. Future optical navigation images will allow them to do more fine-tuning. In turn, these new orbital plots will be used to plan the spacecraft’s approach trajectory correction maneuver. A trajectory correction maneuver successfully executed on Dec. 3 placed Stardust on a trajectory that is a little inside the 300 kilometer flyby distance planned for Comet Wild 2. Three more such maneuvers are planned during the next month.

Unlike other orbiting bodies, the paths of comets cannot be precisely predicted because their orbits about the Sun are not solely determined by gravity. The escape of gas, dust and rock from comets provides a “rocket effect” that causes them to stray from a predictable orbital path. The actual orbital path cannot be precisely determined from Earth-based telescopes because the comet is shrouded in a cloud of escaping gas and dust. What is seen from Earth is not the actual 5.4-kilometer-wide (3.3 mile) body composed of rock and ice, but the cloud of debris and gas that envelops it.

“With these images we anticipate we will flyby comet Wild 2 at an altitude of 300 kilometers, give or take about 16 kilometers,” added Bhaskaran. “Without them, we wouldn’t be able to safely get any closer to the comet than several thousand kilometers.”

Stardust will return to Earth in January 2006 to make a soft landing at the U.S. Air Force Utah Test and Training Range. Its sample return capsule, holding microscopic particles of comet and interstellar dust, will be taken to the planetary material curatorial facility at Johnson Space Center, where the samples will be carefully stored and examined.

Stardust’s cometary and interstellar dust samples will help provide answers to fundamental questions about the origins of the solar system. For more information on the mission, visit http://stardust.jpl.nasa.gov.
Ongoing Support Groups
Alcoholics Anonymous—Meetings are available. Call the Employee Assistance Program at ext. 3-4680 for time and location.

Caregivers Support Group—Meets the first Thursday of the month at noon in Building 167-111. For more information, call the Employee Assistance Program at ext. 3-4680.

Codperators Anonymous—Meeting at noon every Wednesday. Call Occupational Health Services at ext. 3-4139.

Gay, Lesbian and Bisexual Group—Meets the first and third Thursdays of the month at noon in Building 167-111. For more information, call the Employee Assistance Program at ext. 3-4680 or Randi Herrer at ext. 3-0644.

Parents Group for Children With Special Needs—Meets the second Thursday of the month at noon in Building 167-111 (The Wellness Place).

Working Parents Support Group—Meets the third Thursday of the month at noon in Building 167-111 (The Wellness Place).

Friday, December 12
TIAA/CREF Enrolment Meeting—This noon workshop in Trailer 1720-137 will assist employees newly eligible for the Caltech (PL) retirement plan with selecting beneficiaries and completing enrollment forms.

Van Kárman Lecture Series—Dr. John Trauger, JPL senior research scientist, Division of Earth and Space Sciences, will present “Pointing the Way to Exoplanet Systems: New Initiatives in Space Astronomy and the Legacy of the Hubble Space Telescope” at 5 p.m. (in the Lecture Hall, 167-100) on January 10. In Building 167 E. Colorado Blvd. For more information, visit http://www.jpl.nasa.gov/events/lectures/d030.html.

Saturday, December 13
Children’s Holiday Party—the Caltech Club’s Women’s sponsors this potluck, held from 11 a.m. to 2 p.m. at Caltech’s Building 257. Please bring your favorite dish to share; the club will provide the paper products and beverages. The event also includes holiday crafts for children and storytelling.

Wednesday, December 31
Volunteer Professionals for Medical Advancement—Meeting at 10:30 a.m. at the Caltech Credit Union, 528 Foothill Blvd., La Cañada.

Tuesday, January 6
JPL Gamers Club—Meeting at noon in Building 301-217.

JPL Genealogy Club—Meeting at noon in Building 301-217.

Wednesday, January 7
Associated Retirees of JPL—Caltech—Meeting at 10 a.m. at the Caltech Credit Union, 528 Foothill Blvd., La Cañada.

Thursday, January 8
JPL Gun Club—Meeting at noon in Building 183-328.
**European Mars mission**

NASA aids European Mars mission

**A EUROPEAN SPACE AGENCY MISSION**

A European space agency's Mars Express and NASA's twin Mars Exploration Rovers will examine the red planet in quite different and complementary ways. “Together, these missions can provide a range of new information about Mars that neither could provide alone,” said Dave Lavery, NASA Headquarters program manager for the Mars Exploration Rovers and for NASA’s participation in Mars Express. “Historically, there have been only three successful landings on Mars. In the span of only one month, we may double that number, and our knowledge of Mars may increase even more.”

Mars Express is expected to release part of its payload, the Beagle 2 lander, on Dec. 19. On Christmas Eve (in U.S. time zones), Beagle 2 will parachute to the Martian surface, and Mars Express will enter orbit around the planet. Beagle 2 will use analytical tests and a robotic arm to search for evidence of past or present life at its landing site. The orbiter will use seven instruments to study Mars’ atmosphere, structure and geology. The science teams for Beagle 2, and for every instrument on Mars Express, include U.S. researchers. Two instruments on Mars Express have components from U.S. partners in the mission.

The Beagle 2 team plans to use JPL’s Mars Odyssey orbiter to relay communications to Earth on the lander’s arrival day and in subsequent weeks.

The U.S. role in Mars Express includes navigational support and software development for the JPL-managed Deep Space Network. One of the Mars Express instruments, with U.S. components, will use radar to seek evidence of underground water, either frozen or liquid.

“This will be the first attempt to study layers far below Mars’ surface,” said JPL’s Dr. William Johnson, manager for the instrument, which was built under the leadership of Dr. Giovanni Picardi, University of Rome, La Sapienza. The instrument, the Mars Advanced Radar for Subsurface and Ionosphere Sounding, is designed to discern boundaries between layers as deep as 10 kilometers (3 miles) under the surface. It will also examine the structure and variability of the Martian ionosphere, the top layer of the atmosphere. The University of Iowa built the transmitter for the radar instrument, JPL built the receiver. Astro Aerospace of Carpinteria, Calif., built the 40-meter (131-foot) antenna. Italy provided the instrument’s digital processing system and software and integrated the parts.

The other Mars Express instrument with key NASA-funded components is the Analyzer of Space Plasma and Energetic Atoms. It will examine interactions between the Martian atmosphere and the solar wind of charged particles streaming away from the Sun. Southwest Research Institute, San Antonio, Texas, built two sensors for it, an electron spectrometer and an ion mass analyzer. Europe provided important tools on the Mars Exploration Rovers. The German Space Agency and the Max Planck Institute for Chemistry, Mainz, Germany, supplied each rover’s alpha particle X-ray spectrometer instrument. The German Space Agency and the University of Mainz supplied the Mossbauer spectrometer. The Neils Bohr Institute, Copenhagen, Denmark, supplied the magnet array for observation by rover cameras. Plans call for Mars Express to relay signals from a NASA rover at least once.

In addition, Europeans make up about one-sixth of the members of the rovers’ science team. In addition, Europeans make up about one-sixth of the members of the rovers’ science team.

**Spirit**

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The 3.1/2-minute difference from Earth’s day length means that, by about two weeks after the rovers land on Mars, team members’ wake-up times and meal times will have shifted by about 9 hours.

Dr. Andrea Donnellan, a geophysicist and deputy manager of JPL’s Earth and Space Sciences Division, says the past decade has seen substantial progress in space-based earthquake research. “We’ve confirmed through space observation the Earth’s surface is constantly moving, periodically resulting in earthquakes, and we can measure both the seismic in quiet motions before and after earthquakes, as well as the earthquakes themselves. These technologies are allowing us to pursue lines of data and research we didn’t know existed only a few years ago.

Two months before the Northridge earthquake, Donnellan and university colleagues published a paper in the journal Nature on ground deformation north of Los Angeles’ San Fernando Valley. Six years of Global Positioning System (GPS) data showed the areas faults were active and building up strain, and indicated the size and style of a potential earthquake there. Following the earthquake, the data made it possible to rapidly determine where the fault ruptured and to measure how the earthquake had deformed Earth’s surface.

Space-based instruments can image Earth movements to within fractions of an inch, measuring the slow buildup of deformation along faults, and mapping ground deformation after an earthquake. Two primary tools are the space-based GPS navigation system and Interferometric Synthetic Aperature Radar (InSAR). The latter compares satellite radar images of Earth taken at different times to detect ground movement.

InSAR complements surface measurements because it lets us look at whole regions in a spatial context. An InSAR mission is also an important component of EarthScope, a jointly led initiative by the National Science Foundation, NASA and the U.S. Geologic Survey.

**EarthScope**

EarthScope studies the North American continents structure and evolution, and the physical processes that control earthquakes and volcanic eruptions. According to Dr. James Whitcomb, section head for Special Projects, Earth Sciences Division, National Science Foundation, Arlington, Va.

Precise Earth surface-motion data measure strain and provide a first approximation of where earthquakes are likely to occur, notes Dr. Brad Hager, a Massachusetts Institute of Technology professor and co-author of the 1993 Nature paper. “In California, patterns of ground deformation are complicated by the complex interactions between fault systems. Interpreting this data requires computer models that can estimate how much deformation has accumulated and identify regions where strain should be released, but hasn’t been.”

University of California, Davis, researcher Dr. John Rundle says the complexity of earthquakes requires they be studied as part of the full Earth system. “Most natural events result from interrelated Earth processes over various lengths and magnitudes.” Northridge earthquake, scientists at NASA and other institutions say maturing space-based technologies, new ground-based techniques and more complex computer models are rapidly advancing our understanding of earthquakes and earthquake processes.

**Progress, promise in space-based quake research**

By Alan Buis

NARLY 10 YEARS AFTER LOS ANGELES was shaken by the devastating, magnitude 6.7 Northridge earthquake, scientists at NASA and other institutions say maturing space-based technologies, new ground-based techniques and more complex computer models are rapidly advancing our understanding of earthquakes and earthquake processes.

**News Sentinel**

The U.S. Geological Survey, Menlo Park, Calif., says as these technologies are validated they will be transferred to end users. “Such data and models improve understanding of earthquake and volcanic processes, substantially refining seismic hazard maps and resulting in more appropriate, earthquake-resistant construction codes and more targeted retrofitting strategies.”

**Radar image shows ground deformation after an earthquake.**

**Radargram of a shake zone.**

**Spirit**

Continued from page 1

The 3 1/2-minute difference from Earth’s day length means that, by about two weeks after the rovers land on Mars, team members’ wake-up times and meal times will have shifted by about 9 hours.

Added Weiler: “One of NASA’s three prime goals is the search for life on Earth, water is the key to life. Where there is water on Earth, we find life, wherever that water is. Mars Odyssey has shown us that there’s lots of frozen water on Mars, especially above 60 degrees north latitude and below 60 degrees south latitude.”

But life can’t just exist in water; water has to persevere for a long time of life so there can be a chance to come into being and hopefully evolve. These rivers will look for clues of the perseverance of water in the past. They will answer questions about whether the surface was once suitable for life, and if successful, Spirit and Opportunity will help humankind take a giant leap forward in our understanding of Mars’ potential as a site for past or current life.”

Even if we ultimately learn that Mars never harbored life as we know it on Earth, scientific exploration of the Red Planet can assist in understanding the history and evolution of life on our own home world. Much if not all of the evidence for the origin of life here on Earth has been obliterated by the incredible pace of weathering and global tectonics that have operated over billions of years. Mars, by comparison, is a composite world with some regions that may have histories similar to Earth’s crust, while others serve as a frozen garden of the solar system’s early days.

Thus, even if life never developed on Mars—something that we cannot answer today—scientific exploration of the planet may yield critical information undatable by any other means about the pre-biotic chemistry that led to life on Earth. Mars as a fossil graveyard of the chemical conditions that fostered life on Earth is an intriguing possibility times. These processes have variables that can’t be readily observed, so understanding them requires computers.”

NASA’s QuakeSim project is developing a similar forecasting methodology. Its tools simulate earthquake processes, and manage and model the increasing quantities of data available. “We’re focusing on observing and understanding earthquakes in space and time, and developing methods that use patterns of small earthquakes to forecast larger ones,” Rundle explains. “New simulations of earthquakes on Califor- nia’s active faults are providing considerable insight, showing earthquakes tend to “cluster” in space and time due to their interactions. That is, an earthquake on one fault section can turn on or off earthquake activity on nearby fault sections, depending on the relative orientation of the faults. Simula-

tions have led researchers to conclude that fault system geometry determines earthquake activity patterns.”

A NASA/Department of Energy-funded research team reports promising results from an experiment to forecast earth- quakes in southern and central California from 2000 to 2010. It uses mathematical methods to forecast likely locations of earthquakes above magnitude 5 by processing data on earth- quakes of about magnitude 3 from the past decade. The high-risk regions identified in the forecast are refined from those already identified by the government as susceptible to large earthquakes. Five earthquakes greater than magnitude 5 have occurred since the research was completed, all in those high-risk regions.

Dr. Wayne Thatcher, a senior research geophysicist at the U.S. Geological Survey, Menlo Park, Calif., says as these technologies are validated they will be transferred to end users. “Such data and models improve understanding of earthquake and volcanic processes, substantially refining seismic hazard maps and resulting in more appropriate, earthquake-resistant construction codes and more targeted retrofitting strategies.”

**Radar image shows ground deformation after an earthquake.**

**Radargram of a shake zone.**
Next Universe, January 4, 2004

Due to JPL holidays coming up at the end of the year, the Mars Exploration Rovers’ landings, this issue of Universe will be the last one published in 2003.

The deadline to submit classified ads for the Jan. 9 issue is Monday, Dec. 22.

For on-Lab news, log on to http://dailyplanet.jpl.nasa.gov

View this and previous issues of Universe online at http://universe.jpl.nasa.gov

Plassings

AD LANDSGAARD, 72, retired safety tower operator at JPL’s Edwards Air Force Base facility, died Nov. 4. He was survived by his wife, Maris, his 11 children and their families.

Services were held at Good Shepherd Church, 201 E. Altadena Drive, Arcadia. In lieu of flowers, tax-deductible donations are designated for cancer research organizations, and to the American Cancer Society, 130 S. Sierra Madre Blvd., Suite 202, Pasadena, CA 91101.

FRED GERRRACH, 77, a retired engineer from the former Design Engineering Group, died Nov. 15 in Covina. A long-time advocate of rocket engines, joined the Lab in 1957 and retired in 1968.

He is survived by his wife, Rosemary; sons Kirk and Mark; daughter Carrie; eight grandchildren; and seven great-grandchildren.

Services were scheduled for Nov. 21 at Forest Lawn in Covina Hills.

RICHARD HAGA, 66, retired technical group supervisor in Section 314, died Nov. 20. Haga joined JPL in 1969 and had been on long-term disability since 1996. He retired in 2002. He is survived by his wife, Sharon, sons Roger and Gregory, and daughter Christy and four grandchildren.

Private services were private.

Letters

The strength we have gathered through experiences in our lives is due in large part to the help we have received, and to the strength that has been given to us by that help. We are thankful to all who have helped us make it through a difficult time. Our family, Larry, Linda, Tim, Tiffany and their children, are grateful.

Thank you to Todd J. Bryant. The wreath you sent to Jennifer, thank each of you for your support.

My family and I would like to thank all our friends and coworkers for their kind and compassionate support during the recent passing of my dad. The plant you sent will be a wonderful living memorial.

Your support was greatly appreciated.

Glen Tayuak, Section 353

Retirees

The following JPL employees retired in December.


MARTIN, kick out, 35 years, Sec. 33, 1970-2003.

 Classifieds

For Sale

FUTON, fantastic condition, 72"x 36", $45. 970-8456, Steve.

BOOK CASE, mahogany, solid wood, 4 shelves, excellent condition, $200/obo. 626/798-4821.

OVERSTOCKED, let’s clear out!!! All items must go. 626/798-0659.

BABY CRIB, maple, Sears mattress, new, used only $10, 200-4265.

SOFA/LOVESEAT, Rattan, 2 yrs. old, like new, exc. cond., $23. 952-8455.

RUG, oriental, barely used, 8x4, dark blue and tan, $30; purple, $20. 626/798-0659.


ginkoleaf.net/futon, $300. 626/798-4265.

CLOTHES, men’s; down-filled jacket, ski or hunt, leather gloves, size 9, new, $100. 626/790-4555.

BOOTS, leather, size 6, blk., worn once, paid $145, $50. 626/355-1949.

CARD SHUFFLER, Johnson, collectible item, working, $100. 626/798-0659.

WATERMILL, small, 4' in diameter, $50. 626/798-0659.

MISCELLANEOUS, air cleaner, Sears, Hepa, like new, $60; MISC: air cleaner, $25. 626/798-0659.

[The rest of the classifieds are redacted for privacy.]