The
PLANETARY REPORT

Volume XXIII Number 6 November/December 2003

We're Going to Mars!

A PUBLICATION OF THE PLANETARY SOCIETY

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From The Editor

Explorers from Earth are fast closing in on Mars. Five spacecraft—*Mars Express*, *Beagle 2*, *Spirit*, *Opportunity*, and *Nozomi*—will soon join *Mars Global Surveyor* and *Odyssey* now orbiting the Red Planet. It is an unprecedented confluence of explorers at another world.

The Planetary Society is riding on two of the spacecraft. With our Red Rover Goes to Mars project, we are on the team for the NASA rovers, *Spirit* and *Opportunity*, and our student astronauts will be at the Jet Propulsion Laboratory during the crucial first weeks of the mission. These are extraordinary times for all Planetary Society members.

Although we are directly involved with the NASA missions, we can't overlook the European, British, and Japanese efforts. In this issue, we detail what will happen during *Spirit* and *Opportunity*'s missions, giving our members a program to follow the progress of their involvement with the project. We simply didn't have the space to cover all the missions in detail. Instead, we have created special sections on our website, *planetary.org*, devoted to *Mars Express*, *Beagle 2*, and *Nozomi*.

The Planetary Society is an international organization, and we recognize that exploring other worlds is an endeavor that involves the entire world. We will use every medium available to spread that message.

—Charlene M. Anderson

On the Cover:

The Mars Exploration Rover has landed, unfolded itself, and stood up in this computer graphic montage. When *Spirit* and *Opportunity* arrive at the Red Planet, their landers will carry the Red Rover Goes to Mars DVD assembly, visible in the bottom view directly in front of the rover's right front tire. Each DVD carries the names of four million Earthlings who signed up to send their names to Mars. Included in that group are the members of The Planetary Society.

Mars Exploration Rover renderings by Daniel Maas/Mass Digital LLC

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Members' **Dialogue**

***Galileo* and Pluto**

I have two comments on the September/October 2003 issue of *The Planetary Report*. First, I found the issue delightful. The information on the *Galileo* mission and some of its many discoveries was fascinating and told with style in a beautiful format. Thank you very much for the fine issue.

On a more somber note, I was angered to learn that funds for the Pluto–Kuiper belt mission have been cut. I thought this was a battle we had won. As you pointed out, this could add three years to the transit time of the probe to Pluto because it will miss the chance for a gravity assist from Jupiter.

Pluto is headed outward from the Sun on its elongated orbit. We have already missed the most active phases of the planet's year because of past delays. As Pluto moves outward, gases will freeze out of its tenuous atmosphere and whatever surface activity there may well come to a halt. The longer we wait, the less there may be to discover.

But the mission should not be further delayed. Once more we see good science suffering while what you aptly called "pork" stays in the NASA budget. It appears we will need to fight yet another engagement in the war for Pluto. Thank you for the "heads up" on this matter.
—JAMES S. VELDMAN,
Joliet, Illinois

How's That Again?

The *Galileo* issue of September/October 2003 is most interesting, as *The Planetary Report* always is. But on page 15 Louis Friedman is quoted as saying, "I also liked the idea that Earth gave *Galileo* a 'gravity assist.' It caused an imperceptible slowing of our planet in its orbit, but I dare say no one has noticed the shorter year."

I tripped over that statement. I thought if a satellite was slowed in its orbit, it would take longer to go around its primary. In this case, the year would be longer. Am I wrong?
—BILL WHITE,
Homestead, Florida

If the "gravity assist" Earth gave to *Galileo* imperceptibly slowed our planet in its orbit, surely no one would have noticed the longer rather than the shorter year as Louis B. Friedman states in his caption on page 15. The error, if it is an error, gave this reader a "levity assist" by revealing the human side of an organization I have supported since its inception.
—MICHAEL J. REYNOLDS,
Milverton, Somerset, England

The shorter year is one of those interesting counterintuitive things that often crops up in orbital mechanics. If you slow an object in its orbit (like a retro-maneuver), then its orbit has less energy and it falls inward. The smaller orbit has a shorter period.
—Louis D. Friedman

An Ironic Note

Tom Sarko is right to lament the lack of resources available on Earth and in orbit that might have saved the *Columbia* Seven [see the September/October 2003 issue], but he is wrong to believe that any good will ever come of this tragedy—after all, no good ever came of the *Challenger* disaster. Despite all the pledges, promises, assurances, and commitments made at that time, we now find ourselves mourning the loss of another seven astronauts.

As for the idea that the International Space Station can be improved, the horrifying truth is that in the age of the space shuttle, NASA never had the ability to build a space station! Billions have been spent and many designs have been submitted, but where, after almost 20 years, have all the modules gone? [There is] no seven-man habitat module, no command/service module, and only one laboratory module, which is a mere 4 by 9 meters. It doesn't compare to the Saturn V modular design of 33 years ago, which was a mind-boggling 10 by 30 meters. A habitat module of this size could accommodate a dozen people.

All of this was forsaken in the name of progress (i.e., the space shuttle), but the irony is that only 33-year-old Russian space technology is keeping the space station program alive in the 21st century. There's a message there for someone.
—SHAUN GOODCHILD,
Bodmin, Cornwall, England

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We Make It Happen!

by Bruce Betts

SPECIAL UPDATE: Introducing the Student Astronauts

The time has finally come. More than five years in the making—coming back from a 2001 mission cancellation, overcoming hurdle after hurdle—the culmination of The Planetary Society's Red Rover Goes to Mars project is upon us. I've given an overview of this project before (see the May/June 2003 issue of *The Planetary Report*). Today, I'm giving a special update: the announcement of our 16 extraordinary Red Rover Goes to Mars Student Astronauts, who will be inside mission operations at the Jet Propulsion Laboratory (JPL) in Pasadena, California, participating with the Mars Exploration Rover teams.

The Project

Red Rover Goes to Mars is a project that really shows off the Society's unique position in space exploration. It is the first educational experiment on board a NASA planetary mission, and it is an official part of the Mars Exploration Rover mission. Originally, the project was an official part of NASA's planned 2001 lander, which was canceled in the wake of the *Mars Polar Lander* and *Mars Climate Orbiter* failures. Then, it was reborn as part of the Mars Exploration Rover mission, which consists of two golf cart–sized rovers that will act as robotic geologists on the surface of Mars starting in early January 2004. All through its saga, Red Rover Goes to Mars has been faithfully supported by the LEGO Company and by our members.

Red Rover Goes to Mars consists of many aspects, including a mini-DVD assembly carrying the names of four million Earthlings (including all Planetary Society members) who wanted to send their names to Mars. The DVD marks only the second privately funded spacecraft hardware to fly on a NASA planetary mission, the first being The Planetary Society's Mars Microphone, which flew on the failed *Mars Polar Lander*. Red Rover Goes to Mars also includes our *Astrobot Diaries*: online journals from our Astrobots on board the Mars Exploration spacecraft. Our developing network of Mars Stations allows anyone with an Internet connection to drive LEGO rovers online. (Go to *redrovergoestomars.org* to learn more about these activities.)

Here I focus on the selection of our Student Astronauts: 16 students from 12 countries and 5 continents who have earned their opportunities to participate in mission operations at JPL. This is not just a program about 16 extraordinary kids—although as you'll see, they all are really amazing in their own right. The Student Astronauts will act as surrogates for the public in planetary mission operations, just as real astronauts act as surrogates for the rest of humanity in the human exploration of space. They are the first members of the general public selected through an open international competition not just to observe but actually to participate in a planetary mission's operations. Their job is to communicate their experiences to the world. Let's learn more about them and how they were selected, shall we?

The Contest

From October 2002 to March 2003, hundreds of children around the world put themselves in the shoes of the Mars Exploration Rover mission scientists. Their task: to plan how they would explore the *Viking 1* landing site with the powerful suite of instruments aboard the Mars Exploration Rovers. The applicants for The Planetary Society's Student Astronaut program studied the rovers' specs, examined the mission goals, investigated the *Viking 1* images, and finally wrote 1,500-word essays justifying their plans for two days of the Mars Exploration Rover mission.

Twenty-three National Centers around the world helped with the initial evaluation of the essays, generating a list of 63 finalists from 15 countries. The Planetary Society interviewed 40 of these finalists, finally selecting 16 students on the basis of the quality of their essays, their oral communication skills, and their ability to project their enthusiasm for space exploration. The Student Astronauts hail from 12 countries on 5 continents and range in age from 14 to 17. They are undergoing intensive training conducted over the Internet about geology, remote sensing, past Mars missions, and the Mars Exploration Rovers in order to prepare them for their work at JPL.

The Student Astronauts will come to Pasadena in pairs, each pair spending between one and two weeks working on the mission. While at JPL, the Student Astronauts will have a number of duties, including

- processing and posting images of the DVD assembly, which includes an image of an Astrobot

(continued on page 10)

The Student Astronauts

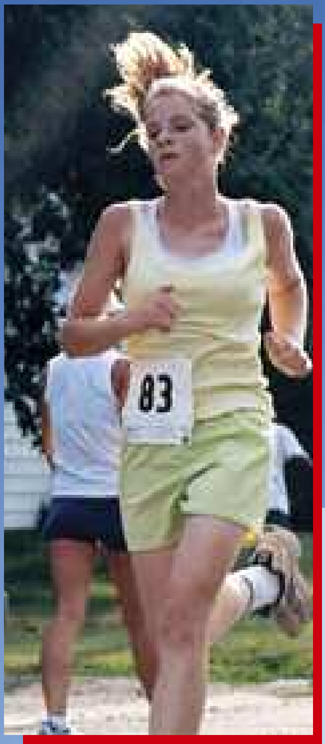
And now (drum roll), we're pleased to introduce the Student Astronauts here and on the following 4 pages.

Abigail Fraeman, Age 16, USA
"The chance to work with scientists as they gain new pictures and data from Mars would be absolutely incredible," Abigail says. She hopes to earn degrees in astronomy or planetary sciences and eventually to become an astronaut. In addition to astronomy and space, Abigail enjoys acting, public speaking, playing violin, and fencing. "I like fencing because it is a 'thinking' sport that depends upon both mental and athletic ability."

Camillia Zedan, Age 16, United Kingdom
"Being a Yorkshire lass, I've always enjoyed mystery; whether it's the untamed foggy moors, or the black beauty of the great majesty above us," says Camillia. She hopes to become an astrophysicist in order to satisfy her "thirst for clarity about the endless possibilities out there." She enjoys reading, has published poetry, likes to play the piano and guitar, and loves "having a laugh with my family and friends."

Cheng-Tao Chung, Age 13, Taiwan
"I like to assemble and disassemble things in order to understand how they function." Cheng-Tao [shown here at Universal Studios] is a budding scientist who undertook the study of English in order to "connect with the world." He's looking forward to "the chance to get together with other fellow Student Astronauts participating in meetings, working in a team, and exchanging ideas." He also enjoys tae kwon do and actively serves his community.

Courtney Dressing, Age 15, USA
"My career goal is to become an astronaut." Courtney hopes one day to be standing on the surface of Mars, but eye problems may prevent her from qualifying. She doesn't perceive this as an impediment. "I can work at the Jet Propulsion Laboratory! I can't think of anything more amazing than exploring space and other planets." She plays flute and piano, enjoys fencing, and studies Russian so that she can "communicate with cosmonauts in their native language."



Janice DeBerg, Age 14, USA
Janice and her family live and work on a pig farm surrounded by bean and corn fields. She enjoys bringing her love of space to her friends. "I am president of my freshman class and am involved in choir, marching band, volleyball, basketball, and track. The highlight of my summer is to represent my county at the State Fair working the exhibits and talent show." She hopes to study medicine and become an emergency room doctor.

Nomathemba Kontyo, Age 15, South Africa
"I love everything about space and share the same love for the ocean," Nomathemba says. "I am a female and live in an impoverished community. Being part of the Mars Exploration Rover mission would show that women could achieve anything they put their minds to." She hopes that her experience will benefit her community and hopes one day to open a computer school in Cape Town. She belongs to her school's astronomy club, plays soccer and chess, and enjoys music and singing.

The Student Astronauts

Dàvid Turczi, Age 15, Hungary

Dàvid has been inspired by books about the *Apollo* missions and *Star Trek* movies. "In the dream-world of science fiction (in which I'm still sunk), I started to see reality and my potential part in it." He is "looking forward to the adventure and the new point of view among the leading scientists of Martian exploration studying Mars directly." His other great love is music; he has studied guitar for seven years.

Rafael Morozowski, Age 16, Brazil

Rafael looks forward to the Student Astronaut program as "a place to live science and use my knowledge in something real, learning science with the very professionals that idealized and invented the whole project." He enjoys drawing, going to the gym, listening to music, and going to the movies. He hopes one day to work in music or movie production, or possibly architecture.

Maciej Hermanowicz, Age 16, Poland

"Exploring the unknown is a wonderful adventure and a huge new experience and I simply cannot wait to taste it. In 20 years' time I will certainly be a scientist." He participates in astronomy clubs and national contests in science and other subjects. "As for my hobbies, they are quite various. I love music and dancing; my favorite music is classical, jazz, and rock 'n' roll. I am a real bookworm as well and I write my own poems and stories." Maciej's younger brother Daniel [at right] was one of the Red Rover Goes to Mars Student Navigators who operated a prototype planetary rover at JPL in 2002.

Kristyn Rodzinyak, Age 16, Canada, currently living in the USA

"A career in the sciences has always been a dream. One day I want to be traveling and doing research on the effects of space on the body." Kristyn is an active kid, enjoying rock climbing, skiing, hiking, camping, playing soccer, and dancing, especially ballet. She's also recently been accepted into the violin section of a Youth Symphony Orchestra. "It is so much fun to have the opportunity to share music."

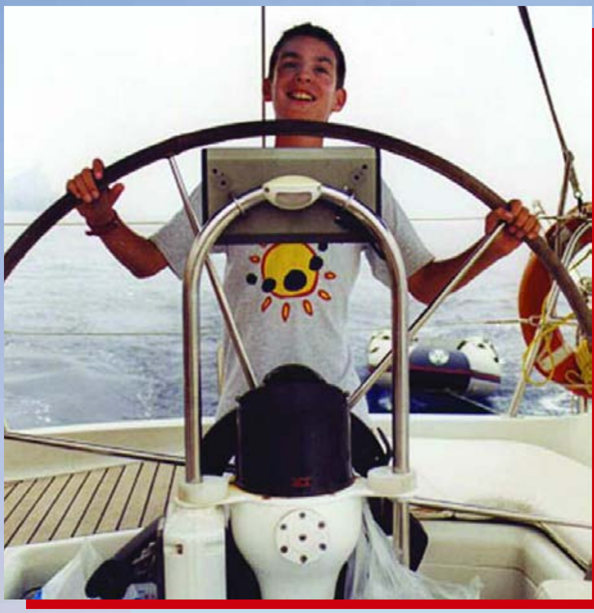
The Student Astronauts

Saatvik Agarwal, Age 14, India

"In the future, I hope to be working at NASA as an astronaut," says Saatvik [shown here at the Kennedy Space Center]. He enjoys school, but "the current year is really hard because in this year for the first time we are tested at a national level." He has "regularly represented my school in quizzes, scientific exhibitions, and lectures." He enjoys reading, watching TV, listening to music, and, particularly, using computers. "I don't think I can live without one! I do animation, edit family photos, make websites, and last but not least, play!"

Wei Lin Tan, Age 14, Singapore

"I've loved Mars from the start. I've always looked forward to practical science and astronomy, because in Singapore, with limited land resources, there aren't many opportunities for students to do anything practical." Wei Lin sees herself as a "typical kid" who enjoys "surfing the net, playing video games, swimming, and reading. I'm also a *Star Wars* fan." She hopes to work either at NASA or in the movies as a director or special effects animator.



Tomás Kogan, Age 13, Spain

"I have always been interested in everything related with space, and investigating the evidence for life on other planets is one of the most interesting aspects. I hope one day to be an aeronautic engineer, working in a company designing aeroplanes or vehicles for space travel." He enjoys playing tennis, soccer, and basketball; going to the movies; hanging out with his friends; and playing with his dog, Luna. He rows and sails whenever he gets back to Buenos Aires, Argentina, where he was born.

Shih-Han Chen, Age 16, Taiwan, living in the United Kingdom
"I have always had a dream of becoming an astronaut.
I would like to use my knowledge about science to solve the greatest mystery of space science, is Earth the only planet containing life?" Shih-Han has spent his life shuttling back and forth between Taiwan and England. He enjoys performing on the electronic organ and also enjoys sports, particularly football, because of the teamwork involved: "Sometimes the victory or defeat only lies between whether the team co-

Vignan Pattamatta, Age 14, India
"I was brought up in a scientific environment, as my parents are scientists," Vignan says, and he aspires to be a project scientist on a NASA mission. He enjoys reading, traveling, and promoting space science through leadership and public speaking. "I greatly look forward to seeing how scientists work in mission operations. When I come back to India, I shall start a band of aspiring scientists who will, someday, really control a spacecraft and land on Mars!"

Susini de Silva, Age 17, Sri Lanka
"I've had a love for space science since I was small. I have a sort of craze to learn more about space, the universe, and extraterrestrial life. I even have a small hope to work with NASA someday." She enjoys writing poetry and stories, swimming, and playing with her dogs. She also loves music because "it makes me cool down when I go mad about something." Susini [shown here behind a model space suit at Malaysia's National Science Center] isn't sure what profession she's aiming for, but she's "interested to become someone like an engineer or a pilot."

(continued from page 5)

and secret codes to be decoded by the public as another fun part of Red Rover Goes to Mars.

- processing daily images of the panoramic camera calibration target, which also functions as an educational sundial. Normal sundials don't move. This one does, so the students will run software to add the appropriate hour markings. They will post the processed images and captions on the Internet.
- participating in the missions' science planning meetings as part of the magnet team, monitoring the condition of the magnets.
- posting daily online journals about their experiences in mission operations, acting as the world's eyes and ears inside mission operations.

What's Next?

The Student Astronauts will start arriving in Pasadena shortly before the landing of the first Mars Exploration Rover, *Spirit*, on January 3 (January 4 in some locations), 2004. They will participate at JPL with *Spirit* and with its sister craft, *Opportunity* (set to land January 24/25), through January and February. Look for their reports here and at our website, *planetary.org*.

Bruce Betts is director of projects at The Planetary Society. Emily Stewart Lakdawalla, science and technology coordinator for The Planetary Society, contributed to this report.

World Watch

by Louis D. Friedman

Washington, DC—The big issue dominating NASA and US space policy is the future of human spaceflight. The *Columbia* Accident Investigation Board report and NASA's own internal studies are complete, and there is little doubt that changes will be made to the shuttle that will permit the remaining three orbiters to fly again.

But for how long, and for what purpose? The shuttle is necessary to complete construction of the space station. It is the only vehicle with a large enough payload bay to accommodate the structural elements of the station. (The space station was designed that way.) But beyond the construction, should alternative ways be found to deliver crew and to conduct space station missions? Beyond even that, what is the future of human spaceflight—is it to remain in Earth orbit at the space station?

These are the critical policy questions now being considered, both in a high-level policy review by the Bush administration and in the US Congress. The Planetary Society is attempting to influence the policy decision in favor of setting a proactive and positive goal of human exploration beyond Earth orbit and particularly leading to Mars.

We have met with both administration and congressional staff, and Society leaders have testified before the House of Representatives Science Committee and the Senate Commerce, Science, and Transportation Committee. (The testimony and other opinion pieces on this subject are available on the Society's website.) In addition, we organized a workshop several months ago with other organizations to focus on the space transportation requirements for human exploration beyond Earth orbit. (See "Propelling Humans Beyond Earth Orbit" in the July/August 2003 issue of *The Planetary Report.*)

Various interests and experts in the aerospace community offer many technical solutions. Among them are greater use of international launch vehicles such as Proton, Soyuz, and Ariane 5; separating crew and cargo and using existing US expendable launch vehicles such as Atlas 5 and Delta 4; adapting the shuttle's large booster and solid rockets to create a new heavy-lift launch vehicle for cargo; and developing in-space propulsion systems for transfers out of Earth orbit on interplanetary trajectories, such as in-orbit assembly of spacecraft stages, adaptation of solar-electric, and use of nuclear-electric propulsion.

The Society focus is exploration. The need there is to define the goals of human spaceflight before settling on technical solutions. Almost everyone who supports a human space program at all agrees that Mars is the goal for humans in the foreseeable future. There are adherents of a human Mars mission goal with no intermediate steps, as well as those who would build up intermediate goals for human spaceflight moving outward from the space station to astronomical platforms in interplanetary space, the Moon, asteroids, and then Mars.

Even the opinions of the members of our own Board of Directors span the spectrum of views. We agree, however, that a human program should be guided by exploration, not technology, and exploration leads to Mars. While debate may continue on how to get to Mars, we are urging that the human-to-Mars goal be adopted in the administration's developing space policy, and we have launched a campaign on our website to that end.

Members will be hearing a lot about this over the next year, and we at the Society hope you will participate in creating a worldwide program that sets a vision for the future of humans on other worlds.

Follow the Society's efforts and find out how you can participate in this discussion at our website, *planetary.org*.

Beijing, China—On October 14, China launched its first taikonaut—Lieutenant Colonel Yang Liwei—into orbit, becoming the third country in history to put a human in space. Just 21 hours after blasting off, the *Shenzhou-5* with Yang came hurtling back through the atmosphere toward Earth, parachuting down and landing on the grasslands of Inner Mongolia. The successful mission established China as a spacefaring nation, and the world took notice.

Just as the future of human spaceflight is getting attention now in the United States, Russia, and Europe, China too will soon move beyond the excitement of its first successful human flight to decide the purpose of its human space program. Within hours of Yang's safe return, the heads of China's space program told reporters that the *Shenzhou-5* launch was the first step toward a specific set of goals. China faces difficult economic questions and shares with all countries the need to justify cost and risk for human spaceflight. We will continue to follow China's plans and report them here and on *planetary.org*.

Louis D. Friedman is executive director of The Planetary Society.

The HUMAN Side of Mars Rover Exploration

by Jim Bell

Above:** Author Jim Bell (left) looks on as fellow team members John Grant of the Smithsonian Institution and Jim Rice of Arizona State University (ASU) point over the head of ASU's Sheri Klug to* Spirit *on the launchpad.* ***Photo: Emily Stewart Lakdawalla

One sunny day last June, I found myself standing atop a grassy hill overlooking a beautiful Florida beach. I noticed that my heart was racing and I felt queasy. Just a few miles away sat a powerful controlled bomb—a rocket—only minutes from a fiery attempt to escape the bonds of Earth's gravitational pull. But it wasn't just any rocket—this rocket was going to Mars. And it wasn't carrying just any payload—this rocket was carrying to Mars the hardware and hopes of hundreds of friends, colleagues, and coworkers, scientists and engineers, many of whom had spent more than 10 years working to realize the events about to unfold. As the countdown got below 60 seconds, I suddenly realized that it was carrying more than just a rover.

That first Mars Exploration Rover (MER) launch on the afternoon of June 10, 2003 went flawlessly, carrying the just-named *Spirit* rover to a rendezvous with planetary history among the rocks and soils of the floor of an ancient crater named Gusev, nearly 500 million kilometers (about 311 million miles) away (as the cruise stage flies). Almost a month later, the second rover, named *Opportunity*, lit up the night skies above Cocoa Beach, Florida as its Delta rocket roared off the launchpad and sent the spacecraft toward its own distinctly different destiny within the plains of Sinus Meridiani. *Opportunity* set the record for the latest launch of a Mars spacecraft within the roughly 20-day "launch window," as weather and rocket insulation problems caused the original launch date to

Left: Spirit ***soared into a perfect blue sky on June 10, 2003.***
Photo: Steve Squyres, Cornell University

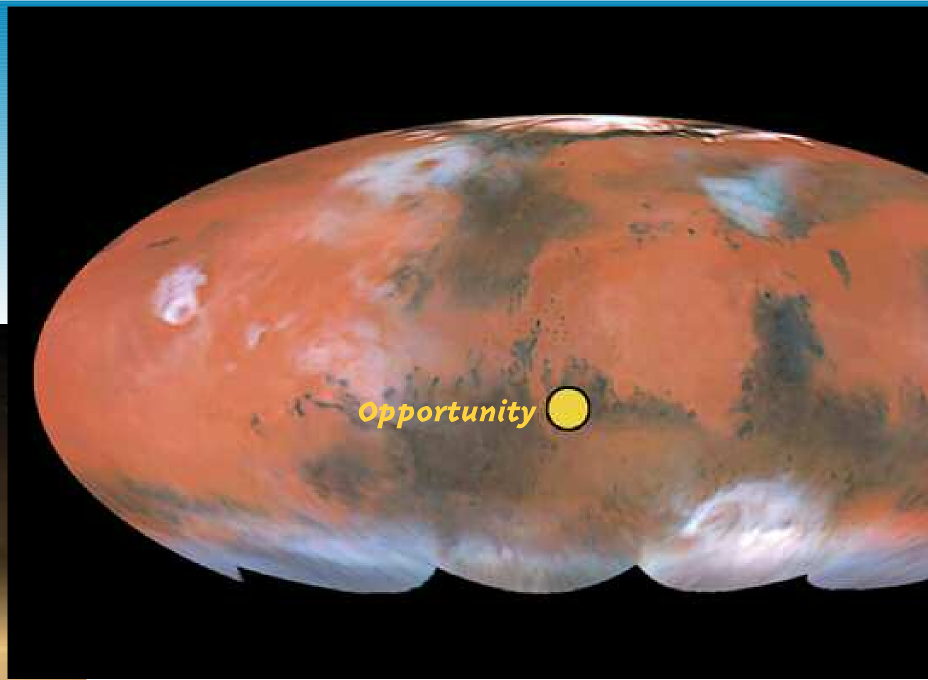
Right: Opportunity***, the second Mars Exploration Rover, blasted off from Cape Canaveral the night of July 7, 2003.***
Photo: JPL/NASA

slip first by a day, then by a week, then by two weeks. As Mars missions go, it was perilously close to being a missed *Opportunity*. Finally, on July 7, that mission also got off to a picture-perfect and on-course beginning.

No Time to Relax

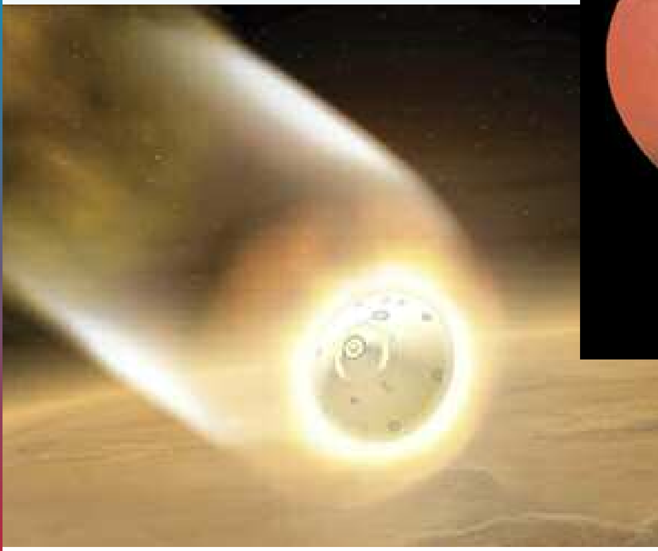
MER Principal Investigator and chief science honcho Steve Squyres, a planetary science colleague and friend from Cornell University, likes to terrify his team sometimes by reminding us all that between the two rover missions there are six main critical and highly risky events that must all unfold perfectly in order for us to succeed. The first two—the *Spirit* and *Opportunity* launches—went off without a hitch, thanks to the experience and expertise of the Air Force/Boeing Delta rocket crew. Except for an occasional minor course correction and thruster firing on the way and a few modest instrument checks, the cruise to Mars generally is a quiet and relaxed time for the spacecraft. Between launch and landing, Isaac Newton really is in control of the mission. Back on Earth, it's anything but quiet and relaxing as we struggle to finish the software and sometimes bumble through grueling real-time mission simulations designed to find out where humans and hardware and software break down. We'd much rather find as many flaws and bugs as we can now, we figure, to minimize the number of new ones we'll discover in January, when they really count.

Scary Mission Events 3 and 4, of course, are the two



Four hemispheric images of Mars, captured by the Hubble Space Telescope during Mars' closest approach to Earth in 1999, have been combined to form this global map, known as a Mollweide projection. The landing sites for Opportunity *(Meridiani Planum) and* Spirit *(Gusev crater) are overlaid upon it.*

Map: Steve Lee, University of Colorado; Jim Bell, Cornell University; Mike Wolff, Space Science Institute; and NASA



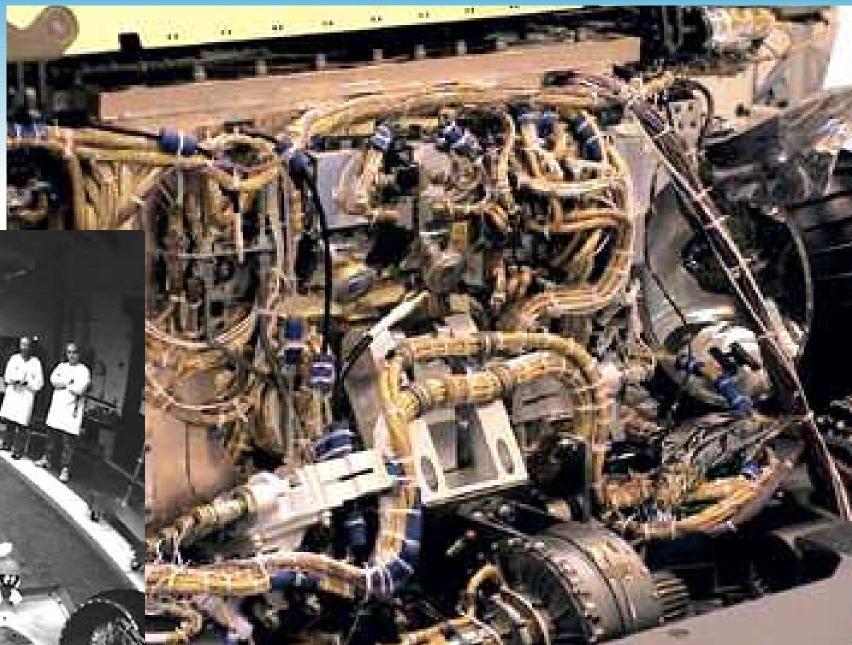
An aeroshell, along with a precise angle of entry, will protect Spirit *and* Opportunity *from burning up as they screech into the Martian atmosphere from interplanetary space.* *Illustration: JPL/NASA*

landings themselves. Landing on another planet is never easy, and humanity's success rate so far for Mars is less than 50 percent. Each spacecraft comes screaming in from interplanetary space at more than 5 kilometers per second (more than 12,000 miles per hour), has to hit the atmosphere at a precise angle to allow friction to slow it down but not burn it up, and then has to perform a Rube Goldberg–like series of pyro firings, latch releases, parachute and airbag deployments, and other onboard computer processing tasks, all of which are crammed into the most important 2 minutes of the entire mission. If all goes well, about an hour after first contact with the upper atmosphere of the planet, each rover will be safely on the ground. There are thousands of things that could go wrong, but the system has been tested in numerous simulations and real airbag drops. It's as robust a landing system as it can be, given that the only real tests are the ones that will happen on Mars in January. Still, it's an inherently risky set of events that we're relying on. No one can truly have a warm and fuzzy feeling about rolling these particular dice.

Once we're safely on the surface, there is still one more scary set of events, and these are scary partly because so little is known about how they will proceed. Like *Mars Pathfinder*, the *Spirit* and *Opportunity* rovers are carried to Mars inside a lander structure that unfolds, like a flower petal, after landing. Unlike *Pathfinder*, though, the MER landers do not carry science instruments but are instead simply "pallets" with rovers on top. After bouncing, landing, and unfolding, each lander and rover will be sitting atop a pile of deflated airbags that themselves might be on top of rocks or dunes, possibly tilting the whole structure. The scary part is that we then have to tell the rover to disconnect from the lander and somehow drive off onto the ground. We don't know exactly which way we'll drive off because that depends on what obstacles are around us. We don't know exactly how far we'll have to drop off the lander down to the ground, because that depends on the state of the airbags and the tilt of the lander. And we don't really know how long it will take to get off the lander. It's a methodical, conservative process that includes a number of real-time go/no-go decisions among flight engineers back on Earth. In some scenarios, it might take only 6 or 7 Martian days (sols) to get six wheels in the dirt, whereas in other scenarios it might take more than 10 sols. We'll spend part of this time looking around and taking some big panoramic mosaics to try to get the feel for the place before heading out.

The Instruments

Once we do get those wheels dirty, the real fun begins. The rovers were designed to be essentially trained robotic field geologists. Each of them can traverse up to 100 meters a day, and each carries a suite of instruments not unlike what a human field geologist would carry for a walk or



Above: The Hazcams gaze down from the direct center of this mesh of wires on the Mars Exploration Rover.
Photo: JPL/NASA

Left: Hazcam captured this fish-eye view of Earth (including terrestrial life-forms) from a test lander.
Photo: JPL/NASA

low-altitude flight over unknown terrain. The instruments on *Spirit* and *Opportunity* include the following:

✦ Cameras—and lots of them. Each rover carries 9 separate cameras, and a tenth is carried by the lander to take pictures of the landing site during descent. Of the 9 rover cameras, 2 pairs are very wide angle (fish-eye) black-and-white stereo cameras, called Hazcams because they are designed to help characterize potential hazards while the rover is driving. Two more pairs are mounted atop a 1.5-meter mast in the front of each rover. One of these pairs is a set of wide-angle black-and-white stereo cameras, called Navcams because their main purpose is to provide quick stereo coverage of lots of terrain around the rovers so that the topography can be modeled and navigated. The two remaining cameras on the mast are a pair of stereo color cameras called Pancams, which are designed to obtain very high resolution multispectral images of Mars using wavelengths ranging from near the ultraviolet to wavelengths near the infrared.

Finally, the ninth rover camera is a small microscopic imager on the rover's arm designed to take black-and-white images of regions only a few tens of millimeters (a few inches) across at a scale comparable to a geologist's hand lens. Images from all the cameras will provide information on the geology and topography of each landing site. In addition, the Pancams' color capabilities provide a limited amount of compositional information, especially about the iron-bearing minerals in the planet's rocks and soils.

✦ Spectrometers—three of them. One, mounted deep inside the rover, uses the camera mast as a periscope to detect infrared (heat) radiation from rocks and soils. That information helps determine the kinds of minerals that are there. The two others are mounted on the rover's arm. One measures the abundance of different elements in the soil (silicon, iron, calcium, aluminum, etc.), and the other is designed specifically to identify iron-bearing minerals, long known to be present on Mars and responsible for the planet's reddish color, but still not well identified in specific detail.

✦ A rock abrasion tool (RAT). This is mounted on the rover's arm and is designed to scrape coatings or rinds off rocks so that the spectrometers and microscope can investigate the composition and mineralogy of the rock itself, not of the dusty, dirty coatings known to cover many Martian rocks.

✦ Several other instruments and systems used for science measurements, such as magnets to trap or deflect different components of the magnetic airborne dust, wheels for trenching and rock-scraping experiments, and a variety of calibration targets that provide essential reference information for the cameras and spectrometers. The Pancams' calibration target actually serves a dual role as both a color/grayscale calibration object and a beautiful interplanetary sundial designed to help teach schoolchildren about seasons, orbits,

Spirit and Opportunity are well equipped to search for clues to Mars' ancient climate and water history. The stereo color Pancams will search for the most interesting rocks and soils, then the Microscopic Imager, Mössbauer, and Alpha Particle X-Ray Spectrometers will examine those selections in greater detail. The Rock Abrasion Tool (RAT) is programmed to grind away the outer coating of rocks to see what lies underneath. Pancam's color and grayscale calibration target also serves as an interplanetary sundial that will teach children about celestial timekeeping.

Illustrations: Cornell University/Maas Digital LLC

and other aspects of celestial timekeeping.

Testing, Testing. . .

Perhaps the most grueling and intensive activity that the team went through prior to launch was a series of laboratory measurements that were carefully designed to calibrate the science instruments. First by itself, then after assembly on the rover, each instrument was subjected to the same kinds of extreme cold and near-vacuum conditions that it will encounter on Mars. In fact, to play it safe, we had to prove that the instruments would work in even harsher conditions than the ones we expect to encounter on Mars.

Team members spent many months working to cover 24-hour, 7-day shifts inside cold, loud basement labs surrounded by vacuum pumps and test chambers, carefully measuring how the instruments performed and pointing them at rocks and other targets of known characteristics, to make sure we had the accuracy and sensitivity that we'll need on the surface of Mars. It was certainly not the glamorous side of space exploration, but to do the science that we eventually want to do with these rovers, this kind of grunt work is absolutely essential.

The calibration tests culminated in a series of thermal vacuum measurements in which each complete flight rover was placed into a huge vacuum chamber and pumped down to Mars temperatures and pressures. We operated all the systems, found problems, opened the chamber, fixed them, found some more, fixed them, and didn't stop until we had the whole system shaken down. It was both exhausting and exhilarating to be working so close to machines that would soon be roving on the surface of another world.

Why Go at All?

When the rovers get to Mars, all these instruments will have to work together, and work well, for us to address the science goals of the mission. But why are we sending these rovers to Mars, after all? Because it's inspirational and educational, and because it probably is one of the coolest projects my colleagues and I will ever work on in our scientific and engineering careers? Sure. But more important, we're trying to do what all scientists try to do: make observations and measurements to test specific hypotheses, chew on the data for a while (but not too long!), revise or abandon some hypotheses and form new ones, and then go out and make some new observations to test those. It is the communal process of testing and refining these hypotheses that leads to knowledge and understanding.

The main hypotheses about Mars that we are testing are ones that have been developed, refined, and heavily debated over the past few decades based on results from telescopes, meteorite studies, and missions such as *Mariner*, *Viking*, *Mars Global Surveyor*, and *Mars Odyssey*. For example, some scientists have hypothesized that Mars once had a thicker atmosphere, making temperatures warmer for long periods of geologic time.

Above: One of the many tests the spacecraft underwent before launch was a check of the landers' deployment mechanisms. Photo: JPL/NASA

Left: In the Jet Propulsion Laboratory's calibration facility, Jim Bell sweated bullets as he adjusted the mounting on one of the Pancams now headed for Mars. Photo: Heather Arneson, Cornell University

Others have countered that any thick atmosphere must have been lost very early in the planet's history as a result of impacts or solar wind interactions. Some claim that Mars once had abundant liquid water flowing across its surface, possibly for long periods in standing bodies like lakes or oceans. Others claim that the only compelling evidence for water indicates that it was short-lived on the surface and then quickly seeped back underground or escaped to space. Another debate concerns whether Mars once had extensive crustal alteration and surface/subsurface hydrothermal systems or instead has been geologically more like the Moon than the Earth. Still another is whether Mars has always been a sterile world or if there is evidence for past or even present life on Mars. The debates rage, fueled by new data and new discoveries, as well as by the apparently insatiable appetite of the public to know more about the planet, in the hope that by the process of exploration we will learn new things about ourselves and our home planet.

We'll test many of these hypotheses with the instruments on *Spirit* and *Opportunity* by seeing at first hand the geology of each landing site. *Spirit*'s site in Gusev crater was chosen because it is hypothesized that the crater once was a water-filled lake. *Opportunity*'s landing site is in an area where deposits of putatively water-formed minerals were discovered during previous missions. Can we see evidence of sediments or water-carved features preserved in the geology? Do we see the kinds of marker minerals that are diagnostic of long-standing, water-rich environments? Is there other evidence to support or refute the concept of a warm and wet Mars—the kind of place where biologic processes could have possibly occurred? (Or—it's a long shot—could they still be occurring?) Can we confirm on the ground what we think we see in the composition and geology of these places from orbiting spacecraft, which of course can cover much more area than the rovers do?

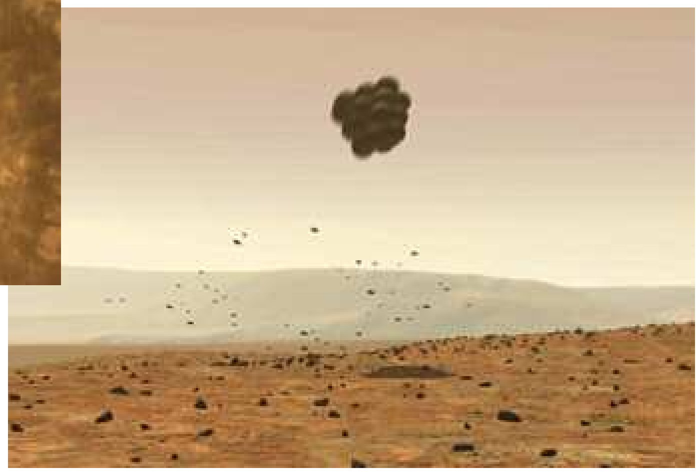
All this potential, all these unanswered science questions, the endless meetings and viewgraph presentations, the long hours away from home and family, all this effort expended by hundreds and hundreds of people around the world simply in the name of science and exploration and knowledge and cooperation—all that—is what was balled up in the pit of my stomach as I watched *Spirit* lift off from Cape Canaveral on that sunny day in June. As the rocket cleared the tower and we jumped and waved our arms and cried with joy, that's when I realized that what was really inside that rocket wasn't just a machine. It was carrying you and me and, ultimately, the future to Mars.

Jim Bell is a professor of astronomy at Cornell University in Ithaca, New York and is the lead scientist for the Pancam color camera investigation on the Mars Exploration Rovers. Jim's favorite choice for the rovers' names—Calvin and Hobbes—didn't get very far in the competition.

ARRIVING AT THE RED PLANET— A REAL NAIL-BITER!

by Melanie Melton Knocke

Six seconds before landing, three rocket-assisted deceleration (RAD) motors, or retro-rockets, will fire, suspending the spacecraft about 15 meters (50 feet) above the surface.
Illustration: JPL/NASA



Cut free from the backshell and parachute, the lander finally hits the surface of Mars. Protective airbags will cushion its fall and roll it to a stop within 1 kilometer (0.6 mile) from where it first touched ground.
Illustration: JPL/NASA

The launch probably was the most nerve-wracking part of the entire Mars Exploration Rover (MER) mission, but almost as worrying is the phase of entry, descent, and landing. During this 6-minute period, the spacecraft will go from traveling 5.4 kilometers per second (about 12,000 miles per hour) to a state of rest on the Martian surface. It will leave the weightless, cold vacuum of space, travel through the searing heat of atmospheric entry, and then bounce to a stop on the hard Martian surface. All of this must be done automatically, without any intervention from controllers on Earth. The only thing controllers can do at this point is listen for a series of tones from the spacecraft itself and telemetry from the orbiting *Mars Global Surveyor* spacecraft that will signal the completion of each critical step along the way.

Here is a blow-by-blow account of the landing process; everything that needs to happen before *Spirit* and *Opportunity* can begin their scientific exploration of the Martian surface. (The times shown below are approximate and will differ slightly for each mission because of the different landing site elevations.)

85 MINUTES BEFORE ENTRY INTO THE MARTIAN ATMOSPHERE: ENTRY TURN BEGINS

The spacecraft, which has been traveling to Mars with its solar panels pointed toward the Sun, will begin a turn to place its heat shield in the proper orientation for entry into the Martian atmosphere. The turn will take approximately 14 minutes.

15 MINUTES BEFORE ENTRY: CRUISE STAGE SEPARATION

The cruise stage, a doughnut-like ring that sits atop the aeroshell and contains solar panels, thrusters, sun sensors, and antenna used during the journey to Mars, is no longer needed. It will separate from the aeroshell and burn up in the atmosphere.

ENTRY—5 MINUTES, 45 SECONDS BEFORE LANDING: FIRST ENCOUNTER WITH THE MARTIAN ATMOSPHERE

When the spacecraft first encounters the Martian atmosphere, it will be approximately 130 kilometers (80 miles) above the planet's surface and traveling at a speed of 5.4 kilometers per second (about 12,000 miles per hour).

DESCENT—4 MINUTES BEFORE LANDING: PEAK HEATING

At this moment, the spacecraft will be experiencing its hottest temperatures as it passes through the atmosphere. The heat shield will protect the enclosed rover from the heat generated by friction between the fast-moving spacecraft and the ever-thickening atmosphere.

3 MINUTES, 43 SECONDS BEFORE LANDING: PEAK DECELERATION

The spacecraft will now be experiencing forces up to seven times that of Earth's gravity (7 gs) as drag from the atmosphere slows it down.

1 MINUTE, 41 SECONDS BEFORE LANDING: PARACHUTE DEPLOYMENT

When the spacecraft is roughly 8 kilometers (5 miles) above the surface and traveling about 400 meters per second (900 miles per hour), a parachute will be fired from a mortar located at the top of the backshell. This parachute fully deploys almost instantly, further slowing the spacecraft's descent.

1 MINUTE, 21 SECONDS BEFORE LANDING: HEAT SHIELD SEPARATION

With the spacecraft having passed through the majority of the atmosphere, the heat shield is no longer needed. Six separating nuts will be activated, and push-off springs will separate the heat shield from the backshell. It will fall away and land a few kilometers from the spacecraft's targeted landing site.

1 MINUTE, 11 SECONDS BEFORE LANDING: LANDER SEPARATION

The lander—which up to this point has been tucked safely inside the backshell—is lowered by strong cables away from the backshell. The lander must be free of the backshell so that its airbags have room to inflate.

1 MINUTE, 1 SECOND BEFORE LANDING: BRIDLE DESCENT COMPLETE

The bridle now will be fully extended, with the lander hanging 20 meters below the backshell. This backshell-bridle-lander combination is still attached to the parachute.

37 SECONDS BEFORE LANDING: RADAR GROUND ACQUISITION

The first readings from the onboard radar system will be taken, detecting that the lander is approximately 2.4 kilometers (1.5 miles) above the surface of Mars.

30 SECONDS BEFORE LANDING: FIRST DESCENT IMAGE ACQUIRED

When the lander is approximately 2 kilometers (about 1 mile) above the surface, the first of three images will be taken using the Descent Image Motion Estimation Subsystem (DIMES). These images will help the lander determine its horizontal velocity with respect to the surface.

8 SECONDS BEFORE LANDING: START AIRBAG INFLATION

While the lander remains hanging from the parachute-backshell-bridle combination, its airbags inflate, surrounding it in a protective cocoon. The lander is now approximately 280 meters above the surface.

6 SECONDS BEFORE LANDING: RAD/TIRS ROCKET FIRING

Because the Martian atmosphere is so thin, the parachute can slow the descending lander only to a speed of about 75 meters per second (about 170 miles per hour). The lander would not survive if it hit the ground traveling that fast, so 6 seconds before landing, a set of three rocket-assisted deceleration (RAD) motors will fire for about 3 seconds. These rockets will bring the lander to a halt approximately 15 meters above the surface. At the same time, an inertial measuring unit within the backshell will be taking measurements to determine if the backshell is tilted with respect to the ground. If necessary, one to three transverse impulse rocket system (TIRS) motors will fire to bring the spacecraft back to level.

3 SECONDS BEFORE LANDING: BRIDLE CUT

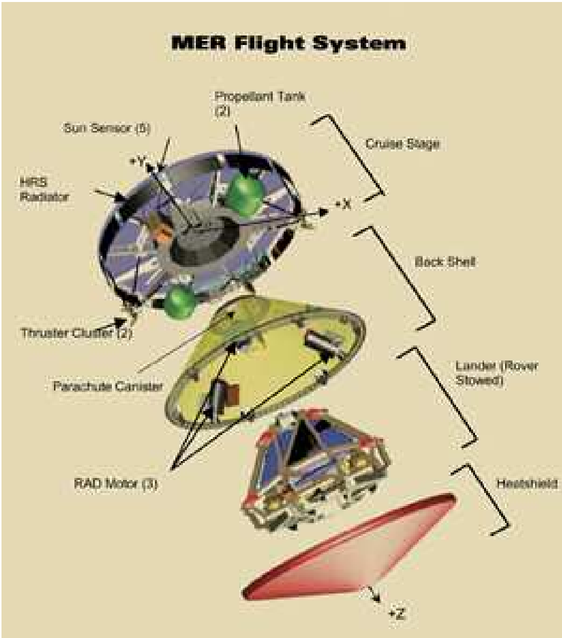
The bridle attaching the lander to the backshell is cut while the RAD motors are still firing. The heavier lander, encased in airbags, will fall free, while the parachute, backshell, and bridle are carried away in the last moments of RAD firing.

LANDING!

Now the bouncing begins! Once on the ground, the amount of time it will take the lander to stop bouncing and rolling will depend entirely on the terrain it encounters. Still encased in airbags, the lander should come to a rest within 1 kilometer (0.6 miles) of its original touchdown point.

Although there will be great cheering at this point, there is still much to be done before *Spirit* and *Opportunity* can make their first forays onto ruddy soil. For the engineers responsible for these landings, however, the most nerve-wracking part of the mission will be over.

Melanie Melton Knocke is a web editor for the Society's website, planetary.org.



This "exploded" diagram of the Mars Exploration Rover's cruise configuration gives a clearer view of the spacecraft's parts.
Diagram: JPL/NASA

Questions and Answers

How do scientists tell the difference between extrasolar planets and brown dwarfs?
—Ivy Emerson, Dayton, Ohio

Scientists do not agree yet on how to distinguish between extrasolar giant planets and brown dwarfs. The dividing line between a brown dwarf and a star occurs around 75 Jupiter masses. Below that, sustained nuclear fusion does not occur for basic hydrogen. But what is the dividing line between brown dwarfs and planets? Scientists don't agree because they do not fully understand how these bodies form. Therefore, many scientists consider that definitions based on formation mechanisms are to be avoided. They also do not know the precise fundamental parameters—such as age, mass, and chemical composition—of many of the brown dwarfs and extrasolar planets that have been discovered so far.

In May 2002, this topic was discussed at an international symposium on brown dwarfs held in Hawaii. There, it was proposed that the dividing line between planets and brown dwarfs could be put at either 13 or 4 Jupiter masses. Below 13 Jupiter masses, not even the most fragile element, deuterium, can be destroyed by nuclear reaction. Thus, according to this definition, planets never have nuclear reactions, but brown dwarfs do. Another kind of transition occurs around 4 Jupiter masses involving what primarily provides the internal pressure that keeps the object from collapsing more. Below 4, it is metallic hydrogen, and above 4 the primary outward pressure comes from something called *electron degeneracy* (a result of only one electron being allowed to occupy each energy state in an atom). One interesting result is that at 4 Jupiter masses or below, increases in mass increase the size of the object, whereas from 4 to 75 Jupiter masses, increases in mass actually decrease the size of the object.

Another focal point in the discussions was whether to be classified as a planet, a body should be required to orbit a normal star (that is, a main sequence star similar to the Sun), and, further, whether the orbits of planets should be nearly circular, as is the case of our solar system. Most extrasolar planets known so far do not have nearly circular orbits.

If we accept that the boundary between brown dwarfs and planets is based primarily on mass, we face two problems. First, some very low mass, free-floating objects that are not orbiting stars have been found in regions of recent (a few million years old) star formation. Not every scientist agrees that these objects are planets, even though their masses are likely to be below 13 Jupiter masses. Second, some planetary systems found around solar-type stars have planets with masses above and below 13 Jupiters. It is awkward to call the more massive members of a planetary system brown dwarfs.

We may have to accept that there is not a hard boundary line between brown dwarfs and planets, and that scientists will have to exercise subjective judgment to classify objects. Classifications of specific objects may change as we learn more about them. For example, the companion to the nearby star Gliese 229 was classified as a brown dwarf when it was discovered in 1995. However, a recent analysis indicates that it could be relatively young and have a mass equivalent to about 7 Jupiters. It may be reclassified as a planet if the mass is confirmed to be below 13 Jupiters.

It is not surprising that new discoveries bring some confusion in the terminology of celestial objects. For now, I am among those adopting the mass boundary at 13 Jupiter masses to separate brown dwarfs from planets, regardless of how the objects form and where they are located.
—EDUARDO MARTIN,
University of Hawaii

An enormous gas planet dominates the sky of this rocky, alien world. The scientific jury is still out on what differentiates a giant planet from a brown dwarf. Eduardo Martin places the dividing line for planets at objects below 13 Jupiter masses.

Illustration: David Egge

"Stand by, We're Landing on Titan" by Christopher P. McKay [see the March/April 2003 issue of* **The Planetary Report] talks about Titan's nitrogen/methane atmosphere and its similarities to Earth's air. But where does a planet or moon get its nitrogen? And why don't Venus, Mars, and other bodies have much—or any?***
—Roger S. Dring,
Booragoon, Western Australia

Most of the nitrogen in interstellar space is in the form of N_2. This is an extremely volatile compound, and the rocky asteroids and icy comets that formed the Earth-like planets would have very little N_2 in them. However, nitrogen also can be bound up in less volatile forms such as amino acids in organic material.

We think that most of the nitrogen in comets and asteroids is in organic materials. These asteroids and comets brought the nitrogen to Venus, Earth, Mars, and Titan. Venus has about the same total amount of nitrogen in its atmosphere as Earth does, but on Venus it's swamped by the very large amount of carbon dioxide (CO_2) there. Mars has very little nitrogen. We think that the initial amount there was much higher, but we don't know how much higher. The nitrogen on Mars may have escaped to space, or it may be trapped as nitrates in the subsurface. On Earth, the nitrogen would all turn to nitrates as well if it weren't for the action of bacteria that form N_2.

Titan probably got its N_2 from comets (as opposed to asteroids). A comet striking Titan would create a large explosion. In the explosion's aftermath, all the comet's nitrogen would be converted to N_2, and half of its carbon would be converted to methane. The other half would be converted to CO_2.
—CHRISTOPHER P. McKAY,
NASA Ames Research Center

Factinos

A team of scientists from the United States and British Columbia has precisely measured the mass of the oldest known planet in the Milky Way with the Hubble Space Telescope. At an estimated age of 13 billion years, the planet is more than twice as old as Earth. It formed around a young, Sun-like star barely one billion years after the Big Bang. "Our Hubble measurement offers tantalizing evidence that planet formation processes are quite robust and efficient at making use of a small amount of heavier elements. This implies that planet formation happened very early in the universe," said Steinn Sigurdsson of Pennsylvania State University.

The new findings, which show that the object is 2.5 times the mass of Jupiter, end a long debate over whether this object is a planet or a brown dwarf by confirming that it is a planet.
—from the Space Telescope Science Institute

Earth-based radar has parted the smoggy atmosphere of Titan, Saturn's largest moon, to reveal evidence of liquid hydrocarbon lakes on its surface. The observations (which were made in November and December of both 2001 and 2002) were reported by a Cornell University–led research team working with the Arecibo Telescope in Puerto Rico.

The radar observations, published in the October 17, 2003 issue of *Science*, included specular—or mirrorlike—glints from Titan that had properties consistent with liquid hydrocarbon surfaces.

The team's leader, Donald Campbell of Cornell, notes that for more than two decades, scientists have speculated that the interactions of the Sun's ultraviolet radiation with methane in Titan's upper atmosphere—photochemical reactions similar to those that cause urban smog—could have resulted in large amounts of liquid and solid hydrocarbons raining onto the satellite's surface. He explains that radar signals would reflect from liquid surfaces on Titan, similar to sunlight glinting off the ocean.

However, Campbell does not rule out that the reflections could be from very smooth solid surfaces. "The surface of Titan is one of the last unstudied parcels of real estate in the solar system, and we really know very little about it," he says.
—from Cornell University

Stars rich in heavy metals tend to harbor planets, reported Debra Fischer of the University of California, Berkeley, and Jeff Valenti of the Space Telescope Science Institute. The researchers performed a comparison of 754 nearby stars like our Sun—some with planets and some without—and found that the more iron and other metals there are in a star, the greater the chance that it has a companion planet. Fischer and Valenti presented their findings at the July 2003 meeting of the International Astronomical Union in Sydney, Australia.

"Astronomers have been saying that only five percent of stars have planets, but that's not a very precise assessment," said Fischer. "We now know that stars which are abundant in heavy metals are five times more likely to harbor orbiting planets than are stars deficient in metals. If you look at the metal-rich stars, 20 percent have planets. That's stunning."

Iron and other elements heavier than helium—what some scientists lump together as "metals"—are created by fusion reactions inside stars and sown into the interstellar medium by supernova explosions. Thus, although metals were extremely rare in the early history of the Milky Way galaxy, each successive generation of stars became richer in these elements, increasing the chances of forming a planet.

"Stars forming today are much more likely to have planets than early generations of stars," said Valenti. "It's a planetary baby boom."
—from the University of California, Berkeley

Society News

Member Names Make Deep Impact

In 2005, when a copper ball blasts into a comet, leaving a crater more than 25 meters deep and 100 meters in diameter, our members will be there! Thanks to the *Deep Impact* Team, the names of all current Society members as of October 1, 2003 have been included on a disc attached to the *Deep Impact* impactor, which will collide with comet Tempel 1 on July 4, 2005. The mission is designed to give us our first look inside a comet by punching through the highly modified outer layer, perhaps revealing clues to our early solar system.

Members can search for their names and make personalized certificates at *http://deepimpact.jpl.nasa.gov/sendyourname/search.html*. The mission will continue to take names at *http://deepimpact.jpl.nasa.gov/sendyourname/index.html* until January 2004.

—Bruce Betts, Director of Projects

Join the Discovery Team

Did you know that for just cents a day you can play an even greater role in advancing planetary science and exploration around the globe?

You can make that happen by joining our dedicated corps of Discovery Team Members. You simply pledge to contribute a small amount of money each month to the Society—$10, $20, and $50 a month are common pledges.

With a simple automatic monthly deduction from your credit card or bank account, you can ensure that the Society has the steady and reliable funding we need to advocate new missions of discovery, conduct valuable scientific experiments, and develop and launch our own mission to space.

Gifts from Discovery Team Members enable the Society to plan ahead, to seize opportunities big and small, and to engage in advocacy, knowing that we have the resources available to move nimbly and effectively.

You can join the Discovery Team or find out more about it by visiting our website at *http://planetary.org* or calling our Membership Department at 1-800-9WORLDS (1-800-996-7537).

—Andrea Carroll,
Director of Development

Wild About Mars!

January 3–4 at the Pasadena Convention Center

It's a great time for space exploration! In the next few months, *Stardust* will fly through comet Wild 2, *Nozomi* and *Mars Express* will reach Mars orbit, and *Beagle 2* and the twin Mars Exploration Rovers, *Spirit* and *Opportunity*, will land on the Red Planet.

In keeping with our rich tradition of exciting the world about space exploration, The Planetary Society will host a unique public celebration tied to these events. We are excited to present our "Wild About Mars Weekend"—Saturday and Sunday, January 3–4, 2004—to celebrate *Stardust*'s fly-through of comet Wild 2 and witness *Spirit*'s touchdown on the Red Planet.

Be a part of history, and join us at the Pasadena Convention Center as we witness and celebrate these encounters.

On Saturday night, you will hear from *Stardust* project managers and scientists as they discuss the dangers and uncertainties of a particle return mission. Then stay for the dramatic landing as *Spirit* bounces onto the surface of Mars. Share the moment with other Planetary Society members and hear from our Student Astronauts, who are our eyes and ears inside mission operations.

On Sunday, *Spirit* mission scientists will update us with the latest developments and a panel of experts will partake in a lively discussion about the future of human space exploration. Throughout the weekend, expect visits from special guests Ray Bradbury and Bill Nye the Science Guy, along with a few surprises.

For more information, visit our website at *planetary.org* or call Lu Coffing at 626-793-5100, extension 234.

Volunteer Network News

We are currently seeking new Regional Volunteer Coordinators worldwide. Regional Coordinators are responsible for coordinating the activities of Society volunteers in their area (defined variously as a city, part of a state, or an entire country). The Society's Volunteer Network has been quite active over the past several months, conducting events to promote Society membership, hosting educational programs, and supporting Society-generated events. Check our website for news of some of the recent activities.

We encourage all members, including current volunteers and current Regional Coordinators, to apply or reapply for the positions. Applications can be found on our website at *http://www.planetary.org/html/society/Volunteers/volunteers.html*. The deadline for applications is January 31, 2004.

We hope you will be inspired to get involved actively in The Planetary Society by becoming a Regional Coordinator, helping to plan activities in your area!

—Lonny Baker,
Global Volunteer Leader

UNIQUE HOLIDAY GIFTS!

Deep Space Mysteries: 2004 Wall Calendar
Each month, enjoy awe-inspiring, full-color images from deep space. This 2004 wall calendar is produced by the creators of *Astronomy* magazine
2 lb. **#520 $12.00**

Pale Blue Dot Poster
In February 1990, *Voyager 1* looked back at its home planet for the last time. The image of Earth as a tiny bluish dot inspired Carl Sagan to write one of his best-known essays, which starts off his book *Pale Blue Dot*. The poster features Carl's timeless words and the full frame of the profound image captured by *Voyager 1*.
12" x 30" **1 lb. #326 $10.00**

The Year in Space: 2004 Desk Calendar
A dazzling photograph awaits you each week as you plan your daily appointments. This planner includes 52 weekly calendars, 12 monthly calendars, a full-year planning calendar, and a four-year, long-range calendar. 1 lb. **#523 $12.00**

"Is Anybody Out There?" Poster
This astounding image, obtained by the Two Micron All Sky Survey, reveals only a fraction of the 400 billion stars in our own Milky Way galaxy.
16" x 39" 1 lb. **#320 $13.50**

***Winds of Mars* and the Music of Johann Sebastian Bach**
This audio CD features digitally simulated sounds of the winds of Mars heard between 17 of Bach's finest compositions, played on piano. Liner notes explain the production of the Martian sounds and offer a general history of Mars exploration.
1 lb. **#785 $15.00**

Mars in 3D Poster
Red/blue glasses included.
12" x 39" 1 lb. **#306 $13.50**

Panoramic View of Mars Poster
10" x 36" 1 lb. **#328 $13.50**

An Explorer's Guide to Mars Poster
24" x 37" 1 lb. **#505 $15.25**

Explore the Planets Poster
34" x 22" 1 lb. **#310 $11.50**

Solar System in Pictures
Nine 8" x 10" mini-posters.
1 lb. **#336 $11.25**

***Pathfinder* Images of Mars**
20 slides. 1 lb. **#215 $7.50**

"Worlds to Discover 2000" Presentation
Adaptable to multiple grade levels.
2 lb. **#791 $45.95**

"Worlds to Discover Addendum 2000"
1 lb. **#795 $6.95**

***Cosmos 1* Team Jacket**
Special order only (allow 6–8 weeks for delivery).
Adult sizes: M, L, XL 1 lb. **#573 $60.00**

***Cosmos 1* T-Shirt**
Adult sizes: S, M, L, XL, XXL 1 lb. **#570 $25.00**

"Is Anyone Out There?" T-Shirt
Adult sizes: S, M, L, XL, XXL 1 lb. **#586 $19.95**

Future Martian T-Shirt
Child sizes: S, M, L 1 lb. **#565 $13.50**

Spacecraft Science Kits
Build your own spacecraft and learn how it works. Each sold separately.
1 lb. **$15.75**

#524 *Galileo*
#525 Hubble Space Telescope
#529 Keck Telescope
#530 *Lunar Prospector*
#531 *Mars Global Surveyor*
#538 *Magellan*
#560 *Voyager*

Mini Mars Polar Lander Science Kit
1 lb. **#778 $3.00**

***Craters!* A Multi-Science Approach to Cratering and Impacts**
By William K. Hartmann with Joe Cain.
224 pages (softcover). 2 lb. **#109 $24.95**

We're Saving Space for You! Bumper Sticker
1 lb. **#695 $3.00**

***Cosmos 1* Thermal Mug**
2 lb. **#575 $18.00**

Planetary Society Mug
2 lb. **#607 $10.00**

Planetary Society Key Chain
1 lb. **#677 $16.00**

Planetary Society Cap
Our *planetary.org* cap is 100% cotton with an adjustable Velcro band. 1 lb. **#673 $13.50**

Planetary Society Lapel Pin
1 lb. **#680 $3.00**

The Planetary Society License Plate Holder
1 lb. **#675 $5.25**

***Planetary Report* Binder**
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Striking images and new information about Mars have become part of our daily lives. As this regular stream of fresh data answers certain questions, it also generates many more. An ever-growing fleet of spacecraft explorers at the Red Planet will soon make it a less elusive place. *Martian Mysteries* is Hilda Green Demsky's vision of our ruddy neighbor's fascinating features.

After winning a Christa McAuliffe Fellowship, Hilda Green Demsky was invited to watch a space shuttle launch from Kennedy Space Center. This, along with films of outer space taken by astronauts, inspired her to merge abstract elements of art and science to create a series of paintings exploring the wonders of the universe. A member of the International Association of Astronomical Artists, Demsky has received many awards, among them a Fulbright Fellowship to paint in the Netherlands and a National Endowment for the Arts Fellowship to paint in Italy.

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