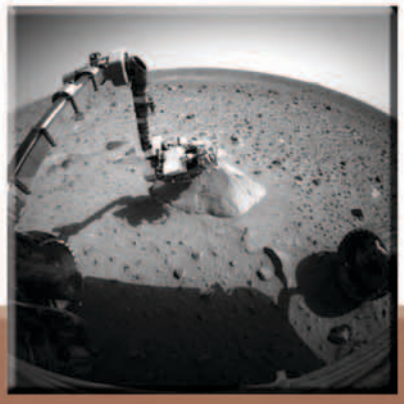
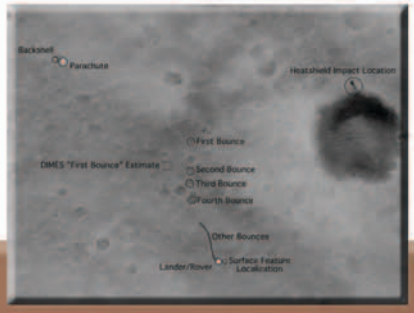
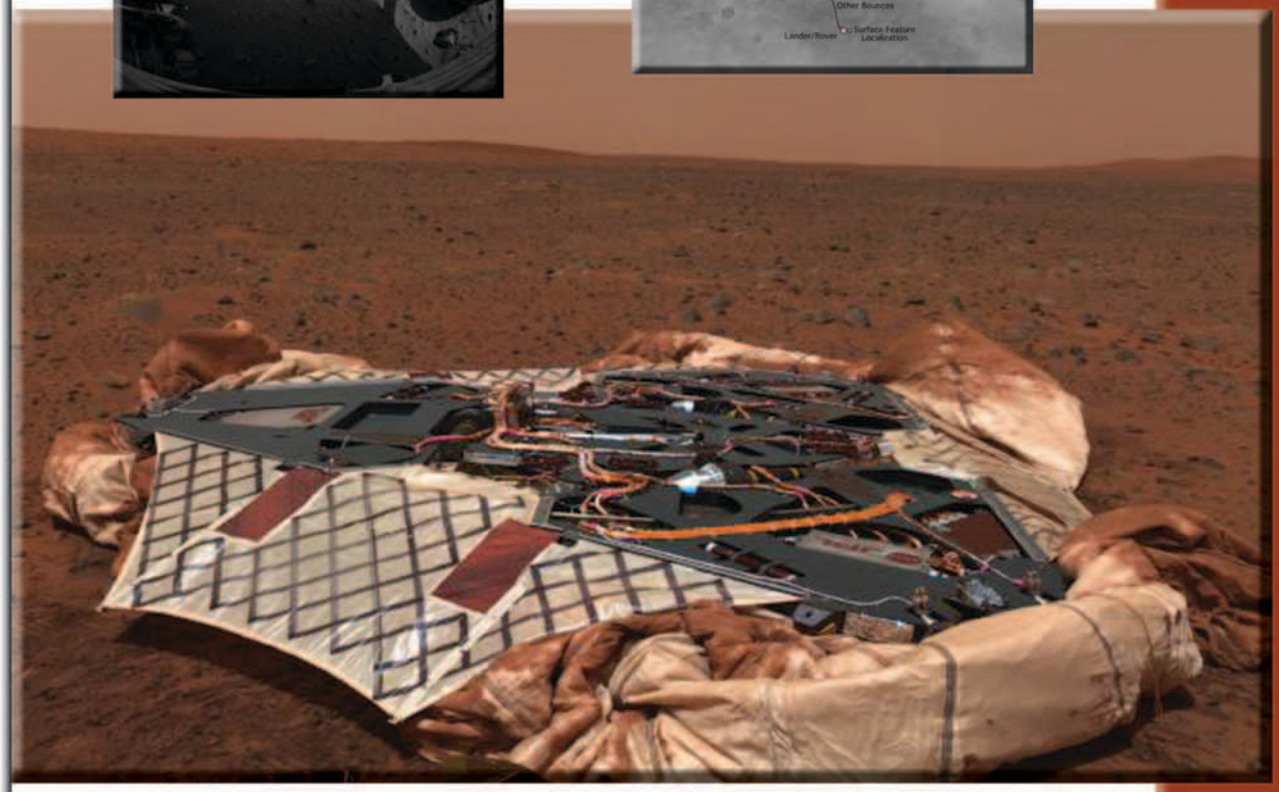
Mars — The Adventure Continues







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Lunar and Planetary Information
BULLETIN

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February 2004
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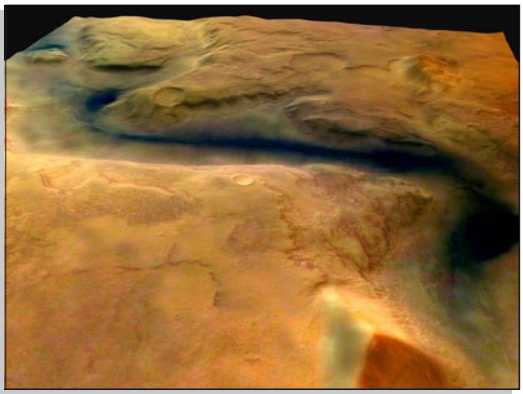
Mars – The Adventure Continues

— Allan Treiman,
Staff Scientist, Lunar and Planetary Institute

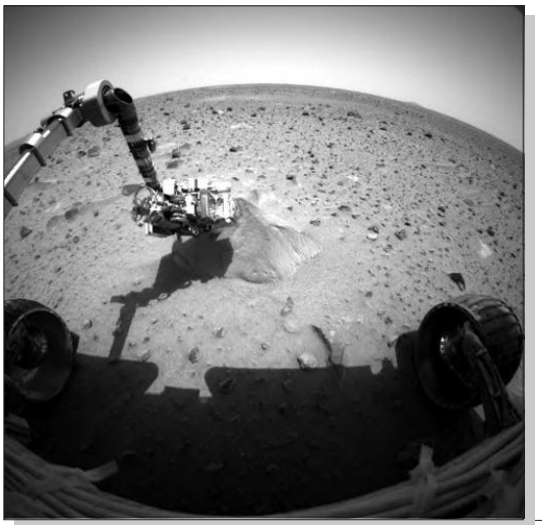
All eyes have been on Mars for the last few months, watching Earth's fleet of spacecraft approach and rendezvous with the Red Planet. We earthlings have done well this year, with three of our five spacecraft still alive. We all regret the losses of *Nozomi* and *Beagle 2*. As of the first of February, both Mars Exploration Rover (MER) landers (Spirit and Opportunity) are alive and well on the surface of Mars, and *Mars Express* has joined *Mars Global Surveyor* and *2001 Mars Odyssey* in orbit.

Mars Express entered Mars orbit on December 25, 2003, and is nearly in its planned mapping orbit. We've seen the first scientific appetizers from *Mars Express*, including the first detection of martian water ice by a European spacecraft. This detection is from the OMEGA infrared mineralogical mapping spectrometer, which should provide maps of the mineralogy of the martian surface. Also new are stereo color images from the High/Super Resolution Stereo Color (HRSC) imager, at ~12 meters per pixel in four color bands. These images, and topographic models based on them, will fill in among the absolute elevation points of the Mars Orbiting Laser Altimeter (MOLA) onboard the *Mars Global Surveyor*. Finally, the ground penetrating radar system, MARSIS, will soon start probing Mars' subsurface geology.



This picture of Reull Vallis was taken by the High Resolution Stereo Camera (HRSC) onboard the Mars Express orbiter on January 15, 2004, from a height of 273 kilometers. The area, located east of the Hellas basin at 41°S, 101°E, is 100 kilometers across, with a resolution of 12 meters per pixel, and shows a channel once formed by flowing water. The landscape is seen in perspective. North is toward the farside of the image.
— Photo courtesy of ESA

For geologists and the general public alike, the biggest thrills at Mars (for geologists) are the MER landers: Spirit in Gusev Crater, and Opportunity on Meridiani Planum. Spirit landed safely on January 4, 2004, dead center in its target, the first live landing since *Mars Pathfinder* in 1996! Opportunity landed on January 24, 2004, a little long on the runway but safe on the ground!



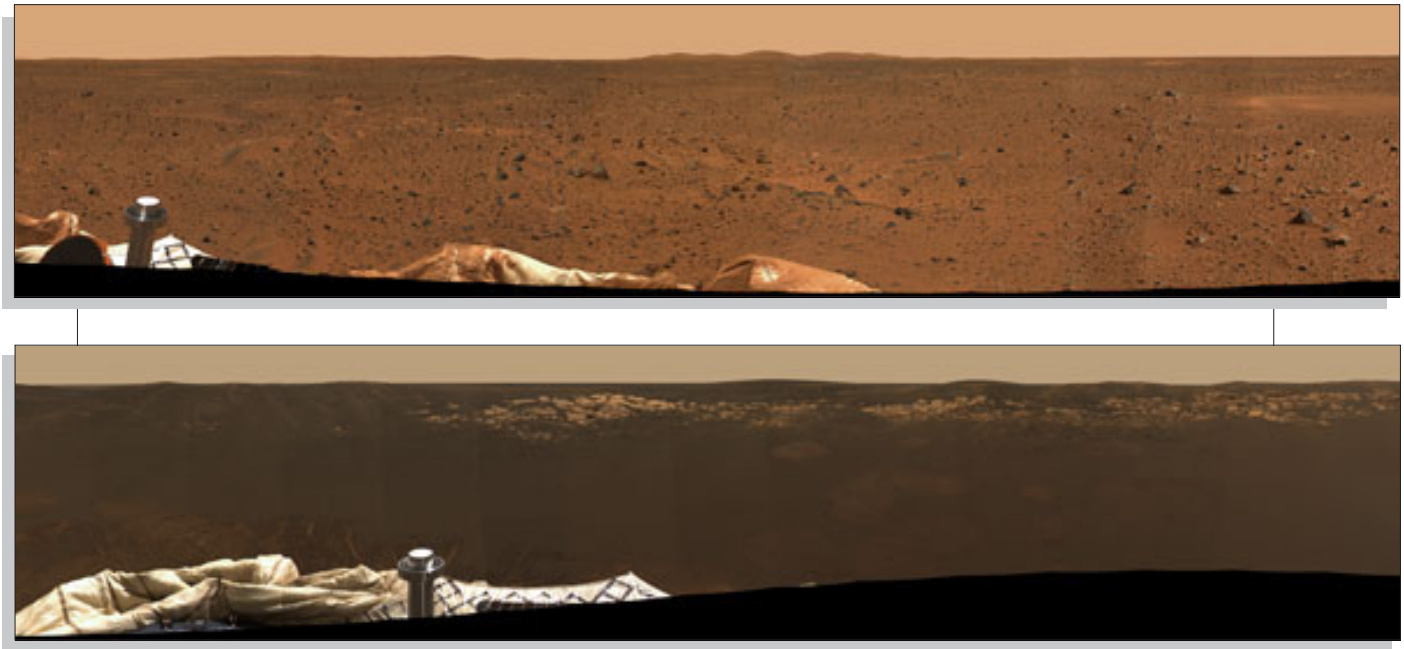
Gusev Crater was chosen so Spirit could study its lake sediments. Gusev is along the ancient river channel Ma'adim Vallis, which enters Gusev from the south and leaves to the north. In between, Gusev's flat interior appears from orbit to be a dried lakebed, once fed by Ma'adim Vallis water, but long since desiccated. The lake deposits would testify to the presence and effects of water on Mars, and even (possibly) hold clues to life on Mars. Seen from Spirit, however, it isn't clear that water stayed in Gusev, or even just passed through. Gusev's interior plains are pocked with occasional impact craters and littered with small dark rocks (none nearby are larger than ~50 centimeters). Light-colored orangish dust forms dunes, partially fills impact craters, and seems to lie beneath some of the rocks. None of the rocks seen so far look much like a lakebed sediment: not light-colored and distinctly layered, but dark and massive, some with holes or bubbles. The hint of lakebed minerals — a detection of carbonate minerals from the mini-TES spectrometer — is sadly ambiguous, as carbonates can form in all sorts of geologic environments.

Spirit probes its first target rock, Adirondack. At the time this picture was taken, the rover had begun analyzing the rock with the alpha particle X-ray spectrometer located on its robotic arm. This instrument uses alpha particles and X-rays to determine the elemental composition of martian rocks and soil. The image was taken by the rover's hazard-identification camera.
— Photo courtesy of NASA/JPL

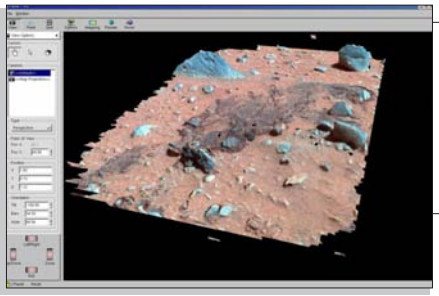
Before its initial communications crash, Spirit collected scientific data on the soil at its touchdown point. The chemical composition (from the AXS instrument) appears similar to soils at the *Mars Pathfinder* site — at least qualitatively, because the Spirit analysis has not yet been calibrated. Even so, its chemistry is like basalt (high Fe, Ca, Cr) mixed with sulfur and chlorine — exactly what the *Viking* and *Mars Pathfinder* landers found. The raw spectrum from Spirit seems to show a significant proportion of nickel, which could represent meteorite material in the soil. The Mössbauer mineral analysis shows lots of ferric (oxidized) iron, which could be in the orangish mineral in the soil. But it also shows lots of olivine and possibly pyroxene, which are typical basalt minerals. Olivine, in particular, would react rapidly with water to form clays and serpentine-group minerals. These results, although preliminary, suggest that Gusev may not be as simple as first advertised.

This high-resolution image from the panoramic camera on the Spirit rover shows the region containing the patch of soil scientists examined at Gusev Crater just after Spirit rolled off the Columbia Memorial Station. Using nearly all the science instruments located on the rover's instrument deployment device, or "arm," scientists yielded some puzzling results including the detection of a mineral called olivine and the appearance that the soil is stronger and more cohesive than they expected. Like detectives searching for clues, the science team will continue to peruse the landscape for explanations of their findings.
— Photo courtesy of NASA/JPL/Cornell

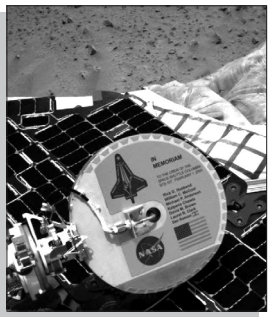
Opportunity recently landed in Meridiani Planum, in the now-famous hematite region. This is a nearly unique area on Mars, identified by the Thermal Emission Spectrometer (TES) onboard *Mars Global Surveyor*, with abundant gray hematite (an iron oxide mineral, Fe_2O_3). Compact masses or large crystals of hematite are lustrous gray or black; hematite powder is brilliant red. Many ways of creating gray hematite involve liquid water, so Opportunity was sent to Meridiani to investigate this hint of ancient martian water in Mars' past. Opportunity landed in a small crater, on a dark pebbly surface (gray hematite?). But the airbag bounce marks and pull-back streaks expose a dark red soil (red hematite?). The crater walls have small dark dunes, scattered dark rocks, and exposed layered bedrock: rocks in place, the geologists' Holy Grail. But . . . the bedrock is lighter in color than the dunes and pebbles! By the time you read this, we may know the identity of the dark surface, red soil, light bedrock, and the spherical grains seen within. For now, quoting Gilbert and Sullivan, "Things are seldom as they seem!" With both rovers now on the prowl, the first true exploration of the surface of Mars is underway.



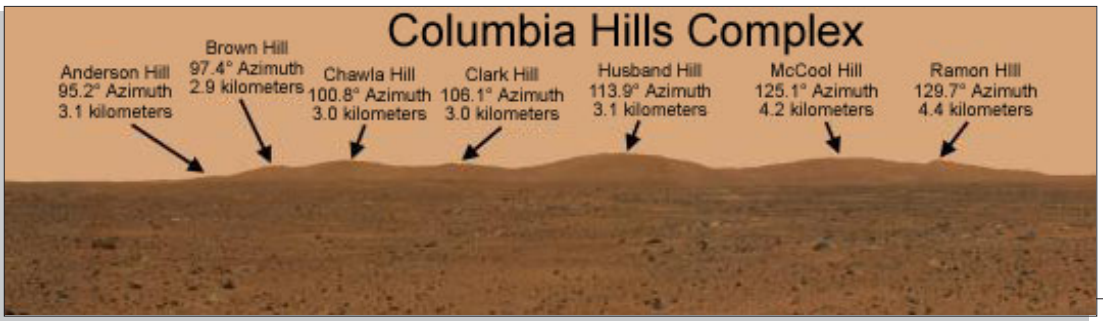
These medium-resolution images show portions of the first 360° panoramic views of the martian surface taken by Spirit at Gusev Crater (top image) and by Opportunity at Meridiani Planum (bottom image). The two sites display remarkable differences in their landscapes.
— Photos courtesy of NASA/JPL/Cornell



A three-dimensional color model created using data from Spirit's panoramic camera shows images of airbag drag marks on the martian surface. The triangular rock in the upper left corner is approximately 20 centimeters (8 inches) tall. The meatball-shaped rock in the upper right corner is approximately 10 centimeters (4 inches) tall. The dark portion of the surface, or "trough," is approximately 1 centimeter (0.4 inches) deep at its deepest point. This model is displayed using software developed by NASA's Ames Research Center.
— Photo courtesy of NASA/JPL/Cornell

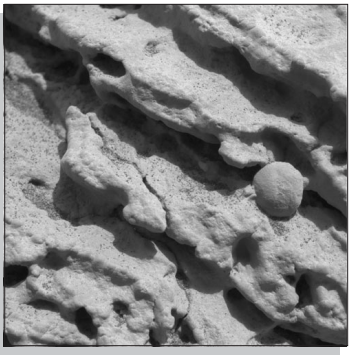


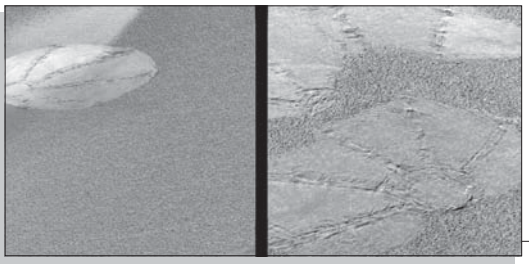
A plaque commemorating the astronauts who died in the tragic accident of the the space shuttle Columbia is mounted on the back of the Mars Exploration Rover Spirit's high-gain antenna. The plaque was designed by Mars Exploration Rover engineers. The astronauts are also honored by the new name of the rover landing site, the Columbia Memorial Station. This image was taken on Mars by Spirit's navigation camera.
— Photo courtesy of NASA/JPL



An image taken from Spirit's PanCam looking west depicts the nearby hills dedicated to the final crew of the space shuttle Columbia. Arranged alphabetically from left to right, "Anderson Hill" is the most northeast of Spirit's landing site and 3 kilometers away. Next are "Brown Hill" and "Chawla Hill," both 2.9 kilometers distant. Next is "Clark Hill" at 3 kilometers. "Husband Hill" and "McCool Hill," named for Columbia's commander and pilot respectively, are 3.1 and 4.2 kilometers distant. "Ramon Hill" is furthest southeast of Spirit's landing site, 4.4 kilometers away.
— Photo courtesy of NASA/JPL/Cornell

This sharp, close-up image taken by the microscopic imager on Opportunity's instrument deployment device, or "arm," shows a rock target dubbed "Robert E," located on the rock outcrop at Meridiani Planum, Mars. Scientists are studying this area for clues about the rock outcrop's composition.
— Photo courtesy of NASA/JPL/Cornell/USGS





The circular shapes seen on the martian surface in these images are "footprints" left by Opportunity's airbags during landing as the spacecraft gently rolled to a stop. Opportunity landed at approximately 9:05 p.m. PST on Saturday, January 24, 2004, Earth-received time. The circular region of the flower-like feature on the right is about the size of a basketball. Scientists are studying the prints for more clues about the makeup of martian soil. The images were taken at Meridiani Planum by the panoramic camera on Opportunity.
— Photo courtesy of NASA/JPL

These and other images from Spirit and Opportunity during the current Mars Exploration Rover (MER) mission can be found at **http://www.jpl.nasa.gov/mer2004/index.html**

Resources for Researchers

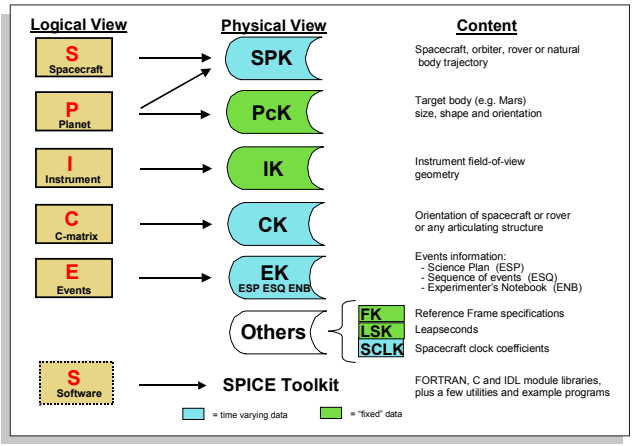
Put Some SPICE In Your Life

— Charles H. Acton, Jet Propulsion Laboratory/California Institute of Technology

In the early 1980s, NASA — on the advise of the National Research Council of the National Academy of Sciences — embarked on implementing better means for archiving and providing access to the data returned from space science missions. The Planetary Data System is one result of this. Further supporting the planetary science community is an allied information system known as "SPICE." SPICE provides scientists and engineers access to a variety of mostly geometry-related information, such as target-body ephemerides, spacecraft trajectory and orientation, instrument pointing and field-of-view specifications, reference frame specifications, and time-conversion capabilities.

The name "SPICE" comes from Spacecraft, Planet, Instrument, C-matrix, and Events. The diagram below shows the types of ancillary data made available through SPICE. Note that this system also includes a collection of software collectively known as the SPICE Toolkit. The principle component of the SPICE Toolkit is a subroutine library. A SPICE customer typically includes a few modules from this library in their own application program to access ancillary data from one or more SPICE data files (also known as SPICE "kernels") and to then compute derived geometric quantities of interest such as latitude and longitude, altitude, and lighting angles.

Starting with *Magellan*, SPICE has or will be used on almost every NASA planetary mission (*Lunar Prospector* was the one exception). It is also used on some non-U.S. missions (e.g., *Mars '96* and *Mars Express*, with *Venus Express*, *SMART-1*, *Rosetta*, and *MUSES-C* as some future possibilities). SPICE has also been used on some non-planetary missions such as *Genesis*, and is used by astronomers at some observatories.



SPICE is used extensively by flight project instrument teams to both plan their observations and to help analyze and document their archival data products. But scientists worldwide can obtain the SPICE data — and the extensive software that is used to derive quantities from those data —to help further interpret or reinterpret archived space science data. Scientists and engineers may use SPICE to help design a new mission, or to evaluate the chances for obtaining desirable observations from an existing trajectory design.

SPICE data (**ftp://naif.jpl.nasa.gov/pub/naif**) and SPICE Toolkit software (**ftp://naif.jpl.nasa.gov/pub/naif/toolkit/**) are freely distributed worldwide from the NAIF node of NASA's Planetary Data System. The SPICE Toolkit is available for most popular computing environments, and comes ready-built, well-tested, and highly documented. The SPICE library is available in ANSI FORTRAN 77 (SPICELIB) and ANSI C (CSPICE). It will shortly be available as a suite of interfaces for Interactive Data Language (Icy), and will later be offered as MATLAB interface modules.

A collection of SPICE tutorial packages provides — in viewgraph format — key design and usage descriptions. Some "open book" programming lessons to help get new users well introduced to using SPICE are also available (**ftp://naif.jpl.nasa.gov/pub/naif/toolkit_docs/Tutorials/office/**).

All SPICE products and related information will be available through a user-friendly Web site by the end of March; the URL will be advertised in a future issue of the *Bulletin*.

Learning to use SPICE is not a trivial endeavor, but those needing access to the kinds of information available within SPICE will find substantial capability under their control as they learn SPICE interfaces bit-by-bit. The extensive documentation and tutorials provided help newcomers get going with SPICE, as does the consultation offered by the NAIF Team. NAIF's commitments to portability of code and data, and to never changing or removing SPICE library modules, means customers can concentrate on their own work. With strong backing by NASA and JPL sponsors, SPICE will be consistently available for many years and many missions.

Those interested in keeping up to date with SPICE development and NAIF plans may sign up for SPICE news at
http://naif.jpl.nasa.gov/mailman/listinfo/spice_announce.
Another in a series of SPICE Tutorial Workshops will be offered in spring 2004; SPICE news will provide information about this once plans are developed.

Those interested in discussing SPICE issues with colleagues may sign up with the SPICE Discussion system at
http://naif.jpl.nasa.gov/mailman/listinfo/spice_discussion.

Development of the SPICE system was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

News from Space

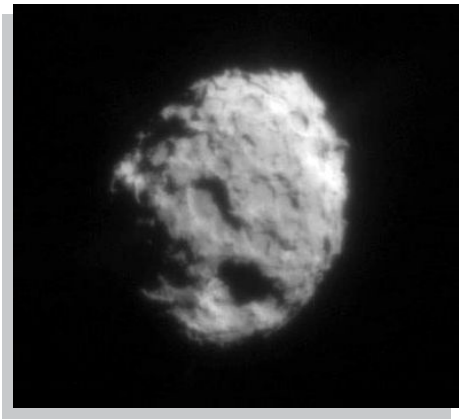
Recent Comet Missions Provide Surprises

It has been more than 18 years since the scientific community was disappointed by the U.S. administration's unwillingness to fund a mission to Comet Halley in 1986, but NASA has succeeded in visiting comets twice now in the past two years, with more to come. Since the historic *Vega* and *Giotto* encounters with Halley in March 1986, comets have been consigned to the dust bin of space exploration. *Deep Space 1* broke that drought in September 2001 as it streaked by Borrelly (officially Comet 19P/Borrelly) at a distance of 2171 kilometers, with a best resolution of 47 meters. The first scientific results of that encounter were published in the January 2004 issue of *Icarus*. The spacecraft saw a body that was not unlike Halley. Borrelly is shaped like a knobby bowling pin 3 kilometers wide and 8 kilometers long (about half the size of Halley). There is evidence of some pitting, but the surface is relatively smooth with some knobs and discoloration. The spacecraft also saw several jets of gas and dust rising from the surface at high speed and detected numerous compounds composed of nitrogen, carbon, hydrogen, and oxygen (e.g., carbon monoxide and hydrogen cyanide, compounds often found in comets).

Comet 1P/Halley, encountered by Vega and Giotto in March 1986.

Comet 19P/Borrelly as seen by Deep Space 1 in September 2001.

A little over two years later, on January 2 of this year, NASA's *Stardust* mission (*http://stardust.jpl.nasa.gov/*) successfully completed its dust-gathering mission to Comet Wild 2 (pronounced "Vilt 2"), passing a scant 236 kilometers from its nucleus. In the course of obtaining the first direct sample of dust from a comet, to be returned to Earth in 2006, the spacecraft observed jets of gas and dust similar to the other two comets. It also observed the nucleus directly, which proved to be about 5 kilometers across and rather spherical. But the unprecedented 20-meter-resolution images revealed a small world much different from the comets observed previously. Wild 2 proved to be much lumpier, with numerous deep rounded pits. The origin of these pits is unclear (many do not look like standard impact craters), but we can be sure that the team scientists will develop some interesting ideas as they analyze the images over the next few months, and after the samples are returned.



Stardust passed within 236 kilometers of the nucleus of Comet 81P/Wild 2 in January 2004.

Comets originate from the outer edges of the solar system and may be relics of the formation of the solar system. Two missions are on track for future comet exploration. The European Space Agency's *Rosetta* mission (*http://sci.esa.int/science-e/www/area/index.cfm?fareaid=13*) will be launched this month to a rendezvous with, and landing on, Comet 67P/Churyumov-Gerasimenko. NASA's *Deep Impact* mission (*http://deepimpact.jpl.nasa.gov/index.html*), to be launched late this year, will attempt to create an impact crater in Comet Temple 1 in 2005 and measure its composition and structure. Alas, the *CONTOUR* mission that was scheduled to visit several different comets was lost shortly after launch last year due to an engine malfunction. We can expect, however, that comets will continue to amaze us and provide fundamental revelations about the origins of our solar system. It has taken 40 years since the birth of the space age, but comets are finally receiving the recognition they deserve.

SPOTLIGHT ON EDUCATION

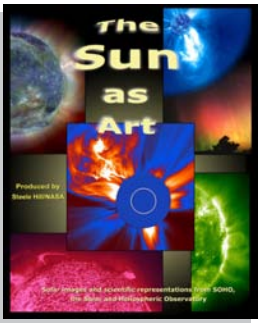
"Spotlight on Education" highlights events and programs that provide opportunities for space scientists to become involved in education and public outreach and to engage science educators and the community. If you know of space science educational programs or events that should be included, please contact the Lunar and Planetary Institute at outreach@lpi.usra.edu.

RESOURCES

The most recent issue of **Voyages in Education and Public Outreach**, the Office of Space Science quarterly education and public outreach newsletter, is available on line at *http://spacescience.nasa.gov/education/news/index.htm*.

Topics include

- presentation of the second series of awards in NASA's Minority University and College Education and Research Partnership Initiative in Space Science (MUCERPI) program,
- the "Sun as Art" exhibit of Solar and Heliospheric Observatory (SOHO) images designed to entertain and generate interest in the Sun,
- information about a variety of space science outreach products and programs.



More than a dozen international spacecraft are exploring our solar system, providing an unprecedented number of opportunities to generate student interest and excitement! The Solar System Exploration Forum offers the **Extreme Exploration Learning Resources Database**, a collection of resources and activities that captures the science and excitement of these missions and brings it into classrooms. These materials have been identified by educators as "best of" activities related to upcoming solar system events. By initiating a search keyed to either celestial body or grade level, educators can generate a rich list of classroom activities and mission connections.

You can access the Resources Database at *http://solarsystem.nasa.gov/educ/extreme.cfm*.

UPCOMING WORKSHOPS AND CONFERENCES

Cosmos in the Classroom 2004: A Working Symposium on Teaching Astronomy to Non-Science Majors will be held at Tufts University in Medford, Massachusetts, July 16–18, 2004. Present and future introductory college (and advanced high school) astronomy teachers, including instructors from community colleges and smaller four-year colleges, part-time instructors, and graduate students are invited to attend. Through discussions, poster sessions, hands-on workshops, and presentations, symposium participants will examine what modern research reveals about teaching and learning and how these results apply to teaching introductory astronomy for non-science majors. "Best practices" and new resources for teaching such courses will be explored. Discussions will encompass exciting discoveries and new ideas emerging from astronomy and space-science research and how best to translate these revelations into meaningful classroom experiences. The particular needs and access issues for underserved students and groups will be explored. For more information, visit the symposium Web page at *http://www.astrosociety.org/events/cosmos.html*.

Learning from the Frontier: Getting Planetary Data in the Hands of Educators will take place at the Lunar and Planetary Institute on March 14, 2004. This year's workshop, co-hosted by the Solar System Exploration Forum and by the Broker/Facilitators of the South Central Organization for Researchers and Educators (SCORE), continues the series that explores issues in education and public outreach. Participants will examine data availability and use in support of NASA's goal of making science content available to educators and students. The workshop will focus on electronic access to planetary data for educational use, including curricula, tools, and interfaces that enable their effective use in educational settings, particularly in grades 5–14, and in informal settings such as museums, planetariums, and science centers. Presentations, panel discussions, and open discussions will involve planetary scientists, data managers, education product developers, and educational end-users. The workshop will highlight user needs, identify common issues and challenges, and explore solutions from successful programs utilizing planetary image data as well as analogs in Earth science. Scientists, data managers, and education and outreach specialists interested in this issue are encouraged to participate in this free workshop. To register, visit *http://www.lpi.usra.edu/meetings/lpsc2004/lpsc2004.educ.cfm*. For more information contact Stephanie Shipp at *shipp@lpi.usra.edu*.

Students from Dunbar Middle School in Dickinson, Texas, explore a tactile map of the Moon's surface. This map, and other materials for visually impaired and blind students, was developed at the Edinboro University of Pennsylvania.

Demonstrations of Outreach Programs and Activities will be presented at the open house and registration of the 35th Lunar and Planetary Science Conference on March 14, 2004. The Lunar and Planetary Institute will host developers of interactive educational activities, programs, and products. This year's featured programs include a variety of Internet-based resources, materials, and hands-on activities designed for solar system exploration by students, educators, and the general public. Other topics include mission-based activities and products, programs that integrate planetary data and images into the curriculum, computer-based astronomy activities, and products designed to allow students and the general public with disabilities to access space science and mission information.

Interested in becoming more involved in space science education and public outreach? NASA's OSS Support Network encompasses a nationwide network of Broker/Facilitators and Education Forums that are prepared to assist space science investigators in developing high-quality, high-impact E/PO programs. For more information about the network, or to contact the Broker/Facilitator in your region, please visit http://spacescience.nasa.gov/education/index.htm.

Solicitation for Contributions

Contributions to the *Lunar and Planetary Information Bulletin (LPIB)* are solicited from the planetary community and beyond. Articles exploring issues related to planetary science and exploration are welcome. Of special interest are articles describing Web-based research and educational tools (such as those described in the current issue) and new space missions that may be of interest to our readers. The *LPIB* is published quarterly and serves the planetary research community, science libraries, educators, students, and lay readers interested in space-science-related research. Suggested topics can be e-mailed to the editors, who will provide guidelines for formatting and content.

Dr. Paul Schenk
Scientific Editor (schenk@lpi.usra.edu)
Renée Dotson
Production Editor (dotson@lpi.usra.edu)

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Graphic Design: Leanne Woolley

The *Bulletin* welcomes articles dealing with issues related to planetary science and exploration. The copy deadline for the next issue is **April 2, 2004**. Articles or announcements should be submitted via e-mail to lpibed@lpi.usra.edu.

To be added to the mailing list to receive notification of future issues, please send your address (along with phone, fax, and e-mail), to LPIB Editor, 3600 Bay Area Boulevard, Houston TX 77058-1113, USA, or send an e-mail message to *lpibed@lpi.usra.edu*.

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LPI Summer Intern Alumni

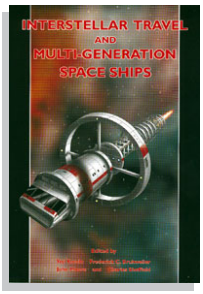
Since 1977, groups of undergraduate student interns have spent part of their summer performing research at the Lunar and Planetary Institute or with the NASA Johnson Space Center Astromaterials group. For many interns, this was a defining moment in their careers, when they decided whether or not to follow an academic path. While past interns can be found all over the world and in a wide variety of occupations, all share the common bond of that summer in Houston.

At the suggestion of past Summer Interns, the LPI has initiated an LPI Summer Intern Alumni Program, in which all past interns are contacted and a database created to allow past interns to contact each other, rebuilding past friendships. Plans are underway to establish an LPI Summer Intern Alumni Association, with officers elected by the interns themselves. The Alumni Association will work with the LPI administration to organize activities and meetings. An inaugural reception in honor of past interns will be held at the 35th Lunar and Planetary Science Conference (www.lpi.usra.edu/meetings/lpsc2004) during the week of March 15–19, 2004 (conference registration on Sunday, March 14). For more information, contact the LPI at alumni@lpi.usra.edu (phone: 281-486-2182).

New and Noteworthy

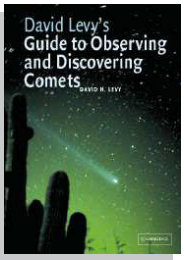
These products are available from booksellers or the publisher listed.
Please note that the LPI does not offer these products through its Order Department.

Books



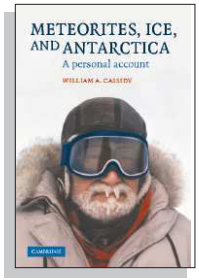
Interstellar Travel and Multi-Generational Space Ships. Edited by Yoji Kondo, Frederick C. Bruhweiler, John Moore, and Charles Sheffield. Apogee Books, 2003. 128 pp., Hardcover, $24.95. *www.cgpublishing.com*

Instead of blindly following popular preconceptions and biases about matters that we have not yet had the chance to test or verify, this volume examines our current state of knowledge, as well as our present state of ignorance, on subjects related to interstellar travel. The science and technology of the future that would be available for building interstellar spaceships would indeed be quite different from those imagined from the perspectives of the early twenty-first century. Nevertheless, it is a good idea to start thinking about what it will take to mount such an undertaking so that we can begin exploring various scientific and engineering possibilities now — rather than wait endlessly for "the right time" to come.



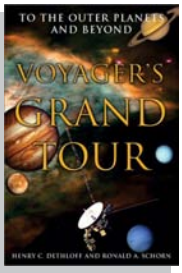
David Levy's Guide to Observing and Discovering Comets. By David H. Levy. Cambridge University Press, 2003. 188 pp., Paperback, $17.00. *www.cup.org*

David Levy has held a lifelong passion for comets and is one of the most successful comet discoverers in history. In this book he describes the observing techniques that have been developed over the years — from visual observations and searching, to photography, to electronic charge-coupled devices (CCDs). He combines the history of comet hunting with the latest techniques, showing how our understanding of comets has evolved over time. This handbook is suitable for amateur astronomers, from those who are casually interested in comets and how to observe them, to those who want to begin and expand an observing program of their own. Drawing widely from his own extensive experience, Levy describes how enthusiastic amateurs can observe comets and try to make new discoveries themselves.



Meteorites, Ice, and Antarctica: A Personal Account. By William A. Cassidy. Cambridge University Press, 2003. 364 pp., Hardcover, $30.00. *www.cup.org*

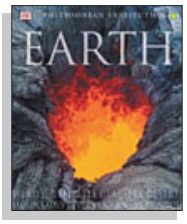
Bill Cassidy led meteorite recovery expeditions in the Antarctic for 15 years and his searches have resulted in the collection of thousands of meteorite specimens from the ice. This personal account of his field experiences on the U.S. Antarctic Search for Meteorites Project reveals the influence the work has had on our understanding of the Moon, Mars, and the asteroid belt. Cassidy describes the hardships and dangers of fieldwork in a hostile environment, as well as the appreciation he developed for its beauty.



Voyager's Grand Tour: To the Outer Planets and Beyond. By Henry C. Dethloff and Ronald A. Schorn. Smithsonian Institution Press, 2003. 272 pp., Hardcover, $34.95. *www.sipress.si.edu*

Since their 1977 launch, the *Voyager 1* and *2* probes have discovered strange new worlds and transmitted streams of revolutionary data and eye-popping images that have exploded long-held theories and raised new questions about our solar system. With unfettered access to NASA archives and imagery, and interviews with *Voyager* scientists and engineers, the authors have produced the only comprehensive account of one of mankind's foremost scientific and engineering achievements. Readers are invited into *Voyager's* inner circle, conceiving, launching, and directing the craft as it discovers rings around Jupiter, geysers on Triton, and intriguing possibilities of extraterrestrial life. Beyond all expectations, *Voyager* is still transmitting 7 billion miles away as it continues out of our solar system into interstellar space, sparking the imagination of a new generation of space visionaries and enthusiasts.

Earth. Edited by James F. Luhr. DK Publishing, 2003. 520 pp., Hardcover, $50.00. *us.dk.com*

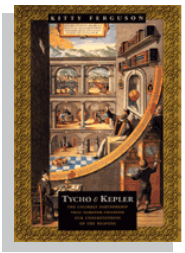


This survey of our planet provides insight into the forces and processes that formed our environment and that continue to influence its evolution. With thousands of photographs and visual catalogs of the features and phenomena that take place on Earth, from rocks, minerals, and mountains to tropical rain forests and the different types of clouds, Earth contains the most up-to-date ideas on how our world works, a compelling review on the health of the planet, and images of the world's most stunning features.

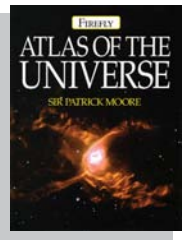
The Space Environment: Implications for Spacecraft Design, Revised and Expanded Edition. By Alan C. Tribble. Princeton University Press, 2003. 248 pp., Paperback, $45.00. *www.pupress.princeton.edu*

The breakup of the space shuttle *Columbia* as it reentered Earth's atmosphere on February 1, 2003, reminded the public — and NASA — of the grave risks posed to spacecraft by everything from insulating foam to space debris. Here, Alan Tribble presents a singular, up-to-date account of a wide range of less-conspicuous but no less consequential environmental effects that can damage or cause poor performance of orbiting spacecraft. Conveying a wealth of insight into the nature of the space environment and how spacecraft interact with it, he covers design modifications aimed at eliminating or reducing such environmental effects as solar absorptance increases caused by self-contamination, materials erosion by atomic oxygen, electrical discharges due to spacecraft charging, degradation of electrical circuits by radiation, and bombardment by micrometeorites. This book is unique in that it bridges the gap between studies of the space environment as performed by space physicists and spacecraft design engineering as practiced by aerospace engineers.

Tycho & Kepler: The Unlikely Partnership that Forever Changed our Understanding of the Heavens. By Kitty Ferguson. Walker & Company, 2003. 300 pp., Hardcover, $28.00. *www.walkerbooks.com*



Set in a turbulent and colorful era in European history, at the turning point when medieval gave way to modern, *Tycho & Kepler* is both a highly original dual biography and a masterful recreation of how science advances. From Tycho's fabulous Uraniborg Observatory on an island off the Danish coast, to the court of the Holy Roman Emperor, Rudolph II, to the religious conflict of the Thirty Years' War that rocked all of Europe, to Kepler's extraordinary leaps of understanding, Ferguson recounts a fascinating interplay of science and religion, politics and personality. Her insights recolor the established personalities of Tycho and Kepler, and her book opens a rich window onto our place in the universe.



Firefly Atlas of the Universe. By Sir Patrick Moore. Firefly Books Ltd., 2003. 288 pp., Hardcover, $45.00. *www.fireflybooks.com*

This volume is an encyclopedic examination of the stars, planets, and universe with the latest, most comprehensive information currently available. The book features the latest images from the Hubble Space Telescope, which are put into context with clear and detailed text. In seven extensive sections, the book illustrates and explains the history and current state of astronomy and space exploration, the solar system, the Sun, the stars, the origin and nature of the universe, star maps, and observing tips for beginner and advanced astronomers.

DVDs

Failure is Not an Option. Presented by The History Channel, 2003. 100 minutes, one-volume DVD set, $29.95. *www.historychannel.com*

Based on Gene Kranz's acclaimed memoir of the same name, *Failure is Not an Option* offers an extraordinary behind-the-scenes look at the early years of NASA, highlighting defining moments such as John Glenn's historic first flight, the Moon landing, and the "successful failure" of *Apollo 13*. Kranz and other NASA veterans recall the "whiz kid" atmosphere in the beginning, where people in their twenties were put in positions of enormous responsibility, and show how the extraordinary exploits of the astronauts were supported by equally impressive work on the ground. Narrated by actor Scott Glenn (star of the film *The Right Stuff*), *Failure is Not an Option* is a gripping account that adds an important new perspective to the story of the space race.

Posters

Mars: The Red Planet Poster. By Sky & Telescope, 2003. 24" × 36" poster, $14.95. *skyandtelescope.com/shopatsky/*

Polar ice caps, gullies, dunes, volcanos, and canyon mesas are just a few of the spectacular landforms featured on this color poster of Mars. These images, acquired by *Mars Global Surveyor's* Mars Orbiter Camera, reveal why the Red Planet continues to fascinate us.

Textures of Mars Poster. By Sky & Telescope, 2003. 24" × 36" poster, $14.95. *skyandtelescope.com/shopatsky/*

Seen through the eyes of visiting spacecraft, Mars reveals an incredible array of fascinating landforms — some familiar, some decidedly otherworldly. This high-quality art poster showcases some of the planet's most intriguing features including craters, gullies, dune fields, and more. A Mars fact sheet is included.

ONLINE RESOURCES

Astronomical Pseudo-Science: A Skeptic's Resource List.
Online resource.
www.astrosociety.org/education/resources/pseudobib.html

A new annotated guide with over 200 skeptical resources about astrology, UFOs, Moon hoaxes, faces on the planets, crop circles, and other examples of "fiction science" is now available on the education Web pages of the nonprofit Astronomical Society of the Pacific. The guide lists and reviews articles, books, and Web sites that provide ammunition for teachers, scientists, youth leaders, television news producers, newspaper editors, and anyone who gets questions about "unsolved mysteries" relating to astronomy. Among such topics is whether the full Moon causes crazy behavior, whether the entire universe could be less than 10,000 years old, and whether an alien spaceship landed at Roswell, New Mexico.

NEW FOR KIDS

Spacekids.com. Presented by Space.com.
www.spacekids.com

This colorful and educational Web site for kids, parents, and teachers includes links to space images, an overview of the solar system, news, mission information, homework help, an ask-the-experts feature, and games.

Hugg-a-Planet Mars. By Hugg-a-Planet, 2003. Soft pillow toy, $14.95. *www.huggaplanet.com*

Over 400 places are labeled on this soft, spherical model of Mars. A fact sheet about the planet is included.

Solar System Exploration Timeline 2003–2006 Mini-Poster. Available from the NASA Solar System Exploration Education and Public Outreach Forum.
sseforum.jpl.nasa.gov/index.cfm

As of January 2004, a fleet of more than a dozen spacecraft is making headlines from across the solar system. NASA plans to land two rovers on Mars, probe the rings and moons of Saturn, fly through the tail of a comet, and return tiny fragments of the Sun to Earth. Then we're off to Mercury and the asteroid belt. NASA is also preparing a spacecraft for our first closeup look at Pluto and beyond. This timeline highlights major upcoming exploration launches and events from mid-2003 through 2006. A PDF file (3.6 MB) for this 11" × 17" mini-poster is available to download and print at sseforum.jpl.nasa.gov/library/posters/sse_timeline_v06.pdf.

Mars Mini-Globe Project. Available from the United States Geological Survey Astrogeology Research Program. *astrogeology.usgs.gov*

This Mars Mini-Globe Project consists of three sheets with instructions for creating the Viking and Global Surveyor Mars globes using tennis balls. Print out the pages, cut out the "flower petal" patterns representing the two hemispheres, and glue them onto a tennis ball. A PDF file (7.3 MB) is available to download and print at astrogeology.usgs.gov/Gallery/MapsAndGlobes/large/mars_mini_globes.pdf.

Calendar 2004

Information was valid as of this issue's publication and is subject to change without notice. For more information see the Web sites listed.

February

6–8 **Workshop on Europa's Icy Shell: Past, Present, and Future,** Houston, Texas. *http://www.lpi.usra.edu/meetings/europa2004*

9–13 **Conference on Sun-Earth Connections: Multiscale Coupling in Sun-Earth Processes,** Kona, Hawai'i. *http://csec.jhuapl.edu/*

12–16 **American Association for the Advancement of Science Annual Meeting**, Seattle Washington. *http://www.aaas.org/meetings/index.html*

14–19 **Medical Imaging**, San Diego, California. *http://spie.org/conferences/programs/04/mi/*

16–17 **The Impact of Active Galaxies on the Universe at Large,** London, UK. *http://www.astro.physics.ox.ac.uk/~kmb/royalsocietydm.html*

16–19 **Planetary Timescales: From Stardust to Continents**, Weston Australia. *http://msowww.anu.edu.au/PSI/white_conference.html*

18 **Space at the Crossroads,** Washington, DC. *http://www.spacecrossroads.org/*

23–25 **International Association of Science and Technology for Development: Modelling, Identification and Control,** Grindelwald, Switzerland. *http://www.iasted.org/conferences/2004/switzerland/mic.htm*

23–26 **2004 Planetary Defense Conference: Protecting Earth from Asteroids,** Garden Grove, California. *http://www.leonidstorm.com/conferences/planetdef/*

March

7–10 **Earth & Space 2004: 9th ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments,** Houston, Texas. *http://www.asce.org/conferences/space04*

11–13 **34th Annual International Arctic Workshop 2004**, Boulder, Colorado. *http://www.colorado.edu/INSTAAR/AW2004/*

15–19 **35th Lunar and Planetary Science Conference,** League City, Texas. *http://www.lpi.usra.edu/meetings/lpsc2004*

28–April 1 **Astrobiology Science Conference 2004 (AbSciCon),** Moffet Field, California. *http://abscicon2004.arc.nasa.gov/*

29–April1 **National Space Symposium,** Colorado Springs, Colorado. *http://spacesymposium.org/national04/*

29–April 2 **Royal Astronomical Society National Astronomy Meeting,** Milton Keynes, UK. *http://physics.open.ac.uk/NAM/*

30–April 2 **5th International Conference on Space Optics**, Toulouse, France. *http://dag.distinguez-vous.com/cnes/icso2004/*

April

12–16 **SPIE Defense and Security Symposium**, Orlando, Florida. *http://spie.org/conferences/calls/04/or/*

18–21 **AAPG Annual Meeting**, Dallas, Texas. *http://www.aapg.org/meetings/dallas04/index.html*

19–21 **AIAA International Air & Space Symposium**, Washington, DC. *http://www.airandspacesymposium.com/*

2—April 2 **European Geosciences Union (EGU) 1st Assembly**, Nice, France. *http://www.copernicus.org/EGU/EGU.html*

May

1–6 **75th Annual Scientific Meeting, Aerospace Medical Association**, Anchorage, Alaska. *http://www.asma.org/meetinginfo.html*

17–21 **Eighth International Conference on Space Operations**, Montreal, Canada. *http://www.spaceops2004.org/index_e.shtml*

17–21 **2004 Joint Assembly AGU, CGU, SEG and EEGS**, Montreal, Canada. *http://www.agu.org/meetings/sm04/*

19–21 **Planetary Nebulae Beyond the Milky Way,** ESO — Garching, Germany. *http://www.eso.org/gen-fac.meetings/extgalpn04/*

20–22 **23rd Annual Society for Scientific Exploration Meeting**, Las Vegas Nevada. *http://www.scientificexploration.org/meetings.html*

23–28 **Imaging and Geospatial Information Society: 2004 Annual Conference,** Denver, Colorado. *http://www.asprs.org/denver2004/index.html*

30–June 3 **204th American Astronomical Society Meeting**, Denver Colorado. *http://www.aaas.org/meeting/meeting_dates.html*

June

4–6 **3rd International Workshop on Cometary Astronomy**, Paris, France. *http://www2.iap.fr/saf/IWCAIII/*

9–11 **GeoMod 2004: From Mountains to Sedimentary Basins**, Emmetten — Lake Lucern, Switzerland. *http://www.orgs.trieste.it/GeoMod/*

14–19 **Multi-Wavelength Investigations of Solar Activity**, St. Petersburg, Russia. *http://sun.stanford.edu/IAU223/*

14–19 **Physics and Astrophysics in Space,** Frascati, Italy. *http://frontierscience.lfn.infn.it/2004/top.htm*

27–July 2 **Eleventh International Symposium, Water Rock Interaction**, Saratoga Springs, New York. *http://www.outreach.psu.edu/C&I/WRI/*

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