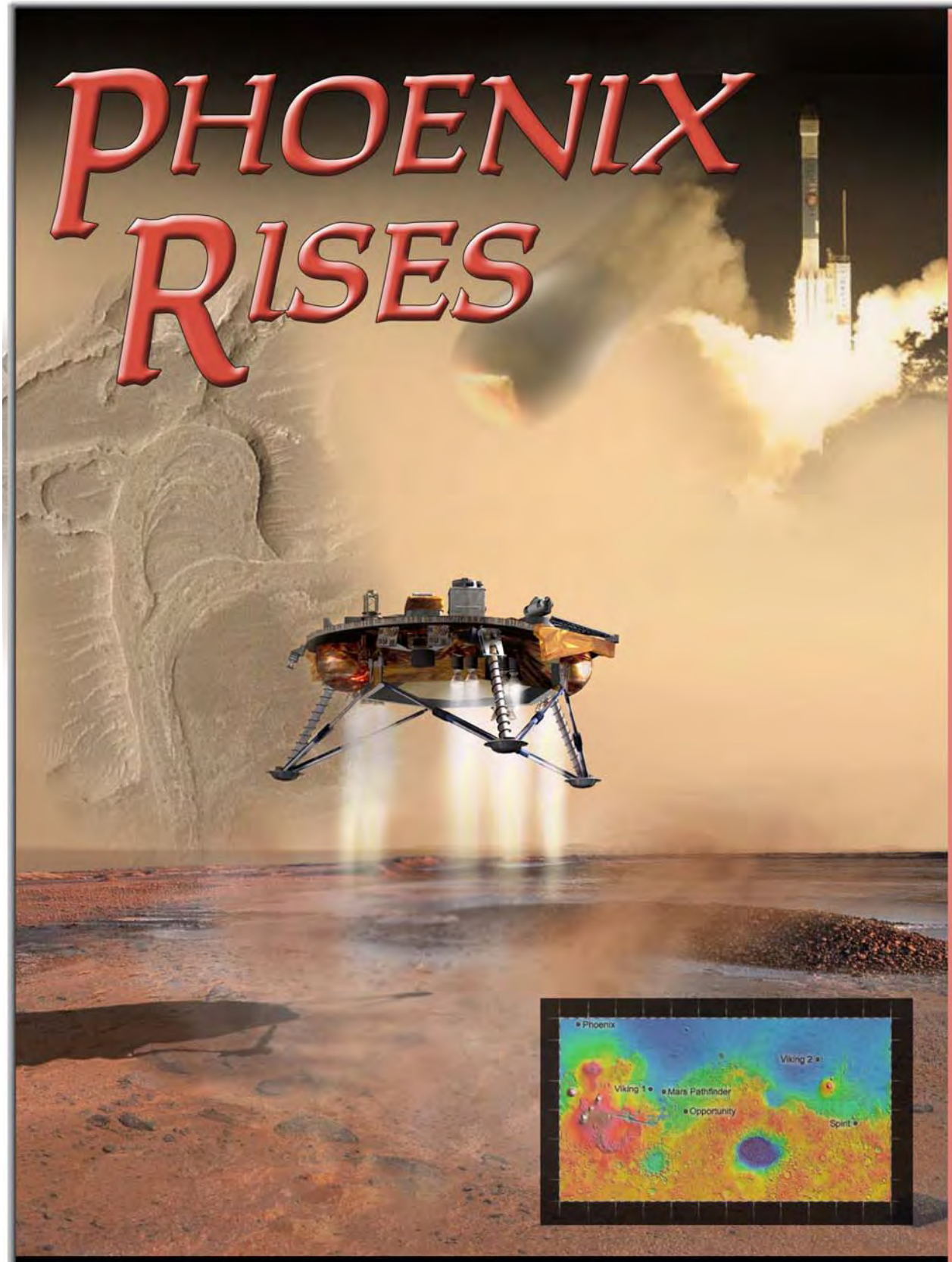
Phoenix Rises



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BULLETIN

August 2007
Issue III

Lunar and Planetary Institute — Universities Space Research Association

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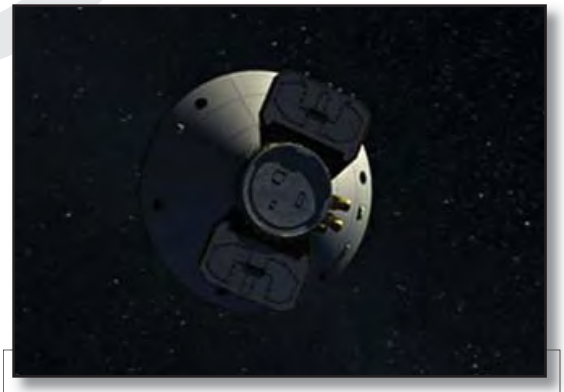
Phoenix Rises

NASA's Phoenix Mars Lander mission blasted off on August 4, aiming for a May 25, 2008, arrival at the Red Planet and a close-up examination of the surface of the northern polar region. Perched atop a Delta II rocket, the spacecraft left Cape Canaveral Air Force Base at 5:26 a.m. Eastern Time into the predawn sky above Florida's Atlantic coast. "[The] launch is the first step in the long journey to the surface of Mars. We certainly are excited about launching, but we still are concerned about our actual landing, the most difficult step of this mission," said Phoenix Principal Investigator Peter Smith.

The Phoenix Mars Lander mission roared into space on August 4 and began its journey to seek evidence of water on our neighboring planet. Photo courtesy of NASA.

The spacecraft established communications with its ground team via the Goldstone, California, antenna station of NASA's Deep Space Network at 7:02 a.m. Eastern Time, after separating from the third stage of the launch vehicle. "The launch team did a spectacular job getting us on the way," said Barry Goldstein, Phoenix project manager at NASA's Jet Propulsion Laboratory. "Our trajectory is still being evaluated in detail; however, we are well within expected limits for a successful journey to the Red Planet. We are all thrilled!"



Artist's concept of Phoenix in space. Image courtesy of NASA/JPL.

The Phoenix Mars mission is the first of NASA's competitively proposed and selected Mars Scout missions, an initiative for lower-cost, competed spacecraft. Named for the resilient mythological bird, the Phoenix mission fits perfectly with the agency's core Mars Exploration Program, whose theme is "follow the water." The University of Arizona was selected to lead the mission in August 2003 and is the first public university to lead a Mars exploration mission.

Phoenix inherited a highly capable spacecraft built for the Mars Surveyor Program 2001 (MSP '01). The mission engineering team developed enhanced spacecraft reliability through extensive testing (i.e., beyond normal integration and environment testing that occurs for all missions). "During the past year we have run Phoenix through a rigorous testing regimen," said Ed Sedivy, Phoenix spacecraft program manager for Lockheed Martin Space Systems, Denver, which built the spacecraft. "The testing approach ran the spacecraft and integrated instruments through actual mission sequences, allowing us to assess the entire system through the life of the mission while here on Earth."

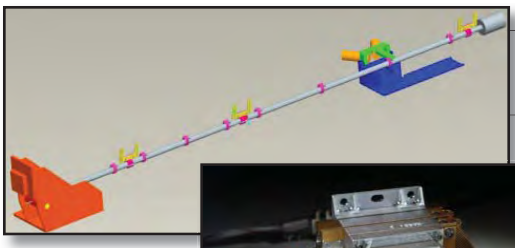
Today, Mars is a cold, dry world with a thin, carbon-dioxide atmosphere. Mars' surface has no liquid water — no rivers, lakes, or oceans. However, evidence exists suggesting Mars was very different in the past. How do we know? What is the evidence? Extensive spacecraft exploration of Mars has revealed geologic features that lead us to believe liquid water once flowed on Mars. Channels connect high and low areas convincing most scientists that water eroded these channels long ago. Gullies are another geologic feature providing evidence of past liquid water on Mars, and scientists are actively debating the formation of these gullies.

This image taken by Mars Rover Spirit's panoramic camera (Pancam) shows a patch of bright-toned soil in Gusev Crater that is so rich in silica that scientists propose water must have been involved in concentrating it.

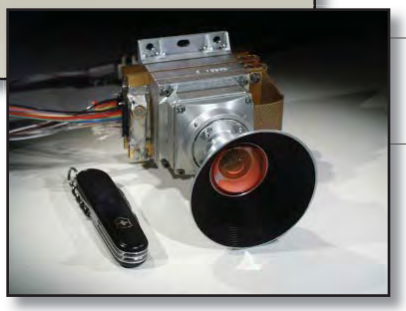
One idea suggests that liquid water, flowing underneath a protective layer of snow, may form martian gullies similar to those on Earth. No evidence exists of liquid water currently flowing on the surface, but evidence of past liquid water on the surface continues to build. Liquid water is important because all known life forms require it to survive. Discoveries made by the Mars Odyssey orbiter in 2002 show large amounts of subsurface water-ice in the northern arctic plains. The Phoenix lander will target this region, becoming the first mission to touch water ice on Mars.

The High Resolution Stereo Camera on ESA's Mars Express obtained this view of an unnamed impact crater located on Vastitas Borealis, a broad plain that covers much of Mars' far northern latitudes. The circular patch of bright material located at the center of the crater is residual water ice.

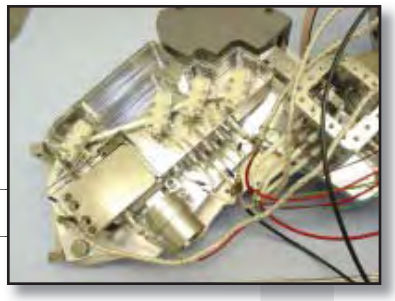
Phoenix carries a complex suite of instruments that are improved variations of those that flew on the lost Mars Polar Lander (MPL). Its science payload consists of a Robotic Arm (RA); Robotic Arm Camera (RAC); Surface Stereoscopic Imager (SSI); Thermal and Evolved Gas Analyzer (TEGA); Microscopy, Electrochemistry, and Conductivity Analyzer (MECA); Mars Descent Imager (MARDI); and Meteorological Station (MET).



An engineering drawing of the Meteorological Station (MET) mast, showing location of the three thermometers as the yellow, u-shaped devices.



Originally designed for the Mars Surveyor 2001 lander, the Mars Descent Imager (MARDI) will produce images of the geology around the landing site. Photo courtesy of NASA/JPL/MLSS.



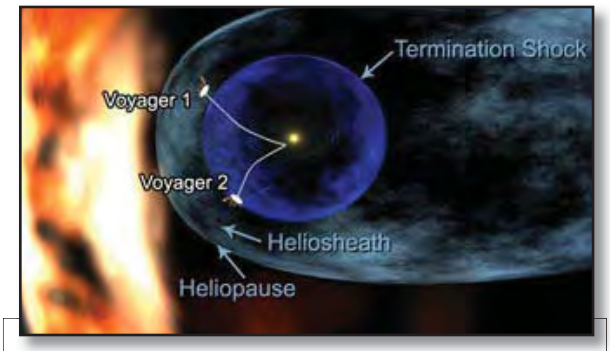
A close-up view of the evolved gas analyzer onboard Phoenix.

The robotic arm will dig to an icy layer believed to lie just beneath the surface. The mission will study the history of the water in the ice, monitor weather of the polar region, and investigate whether the subsurface environment in the far northern plains of Mars has ever been favorable for sustaining microbial life. Samples of soil and ice collected by the robotic arm will be analyzed by instruments mounted on the deck. One instrument will check for water- and carbon-containing compounds by heating soil samples in tiny ovens and examining the vapors that are given off. Another will test soil samples by adding water and analyzing the dissolution products. Cameras and microscopes will provide information on scales spanning 10 powers of 10, from features that could fit by the hundreds into a period at the end of a sentence to an aerial view taken during descent. A weather station will provide information about atmospheric processes in the arctic region.

The Phoenix mission is led by Peter Smith of the University of Arizona, Tucson, with project management at the Jet Propulsion Laboratory and development partnership at Lockheed Martin, Denver. International contributions are provided by the Canadian Space Agency; the University of Neuchatel, Switzerland; the Universities of Copenhagen and Aarhus, Denmark; the Max Planck Institute, Germany; and the Finnish Meteorological Institute.

Additional information on Phoenix is available at *www.nasa.gov/phoenix* and at *phoenix.lpl.arizona.edu*. Additional information on NASA's Mars program is available at *www.nasa.gov/mars*.

Pioneering NASA Spacecraft Mark Thirty Years of Flight



Artist's concept of the two Voyager spacecraft as they approach interstellar space. Image courtesy of NASA/JPL.

NASA's two venerable Voyager spacecraft are celebrating three decades of flight as they head toward interstellar space. Their ongoing odysseys mark an unprecedented and historic accomplishment. Voyager 2 launched on August 20, 1977, and Voyager 1 launched on September 5, 1977. They continue to return information from distances more than three times farther away than Pluto.

"The Voyager mission is a legend in the annals of space exploration. It opened our eyes to the scientific richness of the outer solar system, and it has pioneered the deepest exploration of the Sun's domain ever conducted," said Alan Stern, associate administrator for NASA's Science Mission Directorate. "It's a testament to Voyager's designers, builders and operators that both spacecraft continue to deliver important findings more than 25 years after their primary mission to Jupiter and Saturn concluded."

During their first dozen years of flight, the spacecraft made detailed explorations of Jupiter, Saturn, and their moons, and conducted the first explorations of Uranus and Neptune. These planets were previously unknown worlds. The Voyagers returned never-before-seen images and scientific data, making fundamental discoveries about the outer planets and their moons. The spacecraft revealed Jupiter's turbulent atmosphere, which includes dozens of interacting hurricane-like storm systems, and erupting volcanos on Jupiter's moon Io. They also showed waves and fine structure in Saturn's icy rings from the tugs of nearby moons.

For the past 19 years, the twin Voyagers have been probing the Sun's outer heliosphere and its boundary with interstellar space. Both Voyagers remain healthy and are returning scientific data 30 years after their launches. Voyager 1 currently is the farthest human-made object, at a distance from the Sun of about 9.7 billion miles. Voyager 2 is about 7.8 billion miles from the Sun. Originally designed as a four-year mission to Jupiter and Saturn, the Voyager tours were extended because of their successful achievements and a rare planetary alignment. The two-planet mission eventually became a four-planet grand tour. After completing that extended mission, the two spacecraft began the task of exploring the outer heliosphere.

"The Voyager mission has opened up our solar system in a way not possible before the Space Age," said Edward Stone, Voyager project scientist at the California Institute of Technology. "It revealed our neighbors in the outer solar system and showed us how much there is to learn and how diverse the bodies are that share the solar system with our own planet Earth."

In December 2004, Voyager 1 began crossing the solar system's final frontier. Called the heliosheath, this turbulent area, approximately 8.7 billion miles from the Sun, is where the solar wind slows as it crashes into the thin gas that fills the space between stars. Voyager 2 could reach this boundary later this year, putting both Voyagers on their final leg toward interstellar space.

Each spacecraft carries five currently functioning science instruments that study the solar wind, energetic particles, magnetic fields, and radio waves as they cruise through this unexplored region of deep space. The spacecraft are too far from the Sun to use solar power. They run on less than 300 watts, the amount of power needed to light up a bright light bulb. Their long-lived radioisotope thermoelectric generators provide the power.

"The continued operation of these spacecraft and the flow of data to the scientists is a testament to the skills and dedication of the small operations team," said Ed Massey, Voyager project manager at NASA's Jet Propulsion Laboratory. Massey oversees a team of nearly a dozen people in the day-to-day Voyager spacecraft operations. The Voyagers call home via NASA's Deep Space Network, a system of antennas around the world.

The spacecraft are so distant that commands from Earth, traveling at light speed, take 14 hours one-way to reach Voyager 1 and 12 hours to reach Voyager 2. Each Voyager logs approximately 1 million miles per day. Each of the Voyagers carries a golden record that is a time capsule with greetings, images, and sounds from Earth. The records also have directions on how to find Earth if the spacecraft is recovered by something or someone.

NASA's next outer planet exploration mission is New Horizons, which is now well past Jupiter and headed for a historic exploration of the Pluto system in July 2015.

For a complete listing of Voyager discoveries and mission information, visit *www.nasa.gov/voyager*.

NASA Mission to Asteroid Belt Rescheduled for September Launch

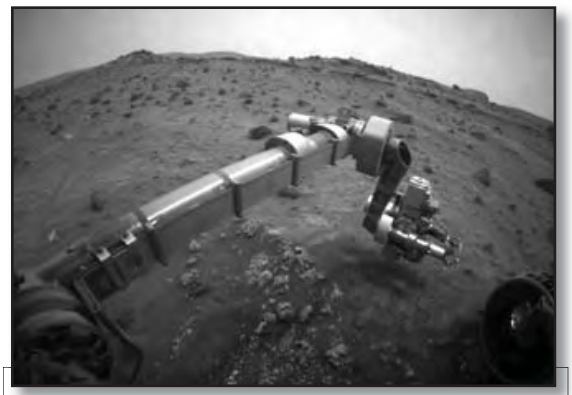
The launch of NASA's Dawn spacecraft, a mission that will explore the two largest objects in the asteroid belt in an effort to answer questions about the formation of our solar system, has been rescheduled to September. The launch was originally scheduled for July.

Artist's concept showing the Dawn spacecraft with Ceres and Vesta. Image courtesy of William K. Hartmann/UCLA.

The decision was made to move the launch to September after careful review by NASA's Science Mission Directorate officials, working with Dawn mission managers, the Dawn principal investigator, and with the concurrence of the NASA Administrator. Primary reasons for the move were a combination of highly limited launch opportunities for Dawn in July and the potential impact on launch preparations for the Phoenix Mars Lander mission, which was launched in early August (see cover story this issue). A September launch for Dawn maintains all the science mission goals a July launch would have provided.

For more information about the Dawn mission, visit *www.nasa.gov/dawn*.

Dust Storm Situation on Mars Improves; Spirit Resumes Using Robotic Arm



Spirit moved its robotic arm during the rover's 1277th martian day (Aug. 6) for the first time in 20 days. Credit: NASA/JPL-Caltech/Cornell.

Slight clearing of still-dusty martian skies has improved the energy situation for both Spirit and Opportunity, allowing controllers to increase the rovers' science observations. Spirit has been commanded to move its arm for the first time in nearly three weeks. It will position the arm's microscopic imager to take a series of photographs of two soil targets and one rock target. Opportunity's planned science observations are for studies of the atmosphere.

Having explored Mars for three-and-a-half years in what were missions originally designed for three months, the rovers have been facing perhaps their biggest challenge. Since June, a series of severe martian summer dust storms has affected both Opportunity and Spirit. The dust in the martian atmosphere over Opportunity has blocked 99% of direct sunlight to the rover, leaving only the limited diffuse sky light to power it. Scientists feared the storms might continue for weeks.

If the sunlight had been further cut back for an extended period, the rovers would not have been able to generate enough power to keep themselves warm and operate at all, even in a near-dormant state. The rovers use electric heaters to keep some of their vital core electronics from becoming too cold. NASA engineers

have been taking proactive measures to protect the rovers, including suspending driving and science observations.

Energy production from solar arrays increased to 295 watt hours on Spirit's 1276th martian day, or sol, which ended early Aug. 6, and to 243 watt hours on Opportunity's sol 1255, which ended midday on Aug. 5. The solar panels generate electricity from sunlight. The dust storms had cut daily output as low as 261 watt hours on Spirit and 128 watt hours on Opportunity in recent weeks, compared with levels above 700 watt hours per sol before the current series of storms began. One hundred watt hours is what it takes to run a 100-watt bulb for one hour.

The increased output from the solar panels, although slight, allowed Opportunity to fully charge its batteries and Spirit to bring its batteries to nearly full charge. Also, the temperature of the core electronics module on Opportunity, which was of concern when it fell to minus 35 degrees Fahrenheit (minus 37 Celsius), increased to minus 28.1 degrees Fahrenheit (minus 33.4 degrees Celsius).

A possible outcome of the storm is that one or both rovers could be damaged permanently or even disabled. "Conditions are still dangerous for both rovers and could get worse before things get better," said John Callas, rover project manager at NASA's Jet Propulsion Laboratory. "We will continue our cautious approach to the weather and configure the rovers to maintain a high state of charge on the batteries. Communication sessions with both rovers will remain limited until the skies clear further." Engineers will assess the capability of each rover after the storm clears.

For more information about the dust storms and the rovers, visit *marsrovers.nasa.gov/home/*.

Digital Archive Casts New Light on Apollo-Era Moon Pictures

For nearly 40 years, the complete photographic record from the Apollo Moon project sat in a freezer at NASA's Johnson Space Center in Houston, almost untouched, until now.

Detailed image of the lunar surface, east of Paracelsus crater. Photo taken on the Apollo 15 mission, July 1971. Photo courtesy of NASA/ASU.

A new digital archive — created through a collaboration between Arizona State University and NASA — is making available on the Internet high-resolution scans of original Apollo flight films. These startling images will be accessible to both researchers and the general public, to browse or download, at *apollo.sese.asu.edu*.

The Moon images filmed by astronauts during NASA's Apollo program have never been seen in high-resolution detail by the public, or even by most lunar scientists. The new digital scanning project at ASU will use the original Apollo flight films. Previous scanning projects have been limited in scope, and none have used the original films that came back from the Moon.

Mark Robinson, professor of geological sciences in the School of Earth and Space Exploration at Arizona State University, is the lead scientist on the project. It's appropriate, as the Moon has long been a focus in his career. In grade school Robinson avidly followed the Apollo missions, and after becoming a scientist, he worked on Clementine, a robotic Moon mission in 1994.

Today, Robinson is the principal investigator for the Lunar Reconnaissance Orbiter Camera (LROC) — a suite of three separate, high-resolution imagers onboard NASA's Lunar Reconnaissance Orbiter, due for launch in October 2008. "The scanning project fulfills a long-held wish of mine," says Robinson. "It'll give everyone a chance to see this unique collection of images with all the clarity they had when taken."

For more information and background, read the complete story at *clas.asu.edu/newsevents/newsreleases/2007/ApolloImages_08012007.htm*.

Spacecraft Tandem Provide New Views of Venus

As NASA's MESSENGER departed from Venus on June 5 to continue its journey toward Mercury, its Wide Angle Camera captured a sequence of 50 images (480-nm wavelength filter) showing the planet disappearing in the distance. Initially, images were acquired at a rate of one every 20 minutes and then, with increasing distance, the timing interval was increased to 60 minutes. Image courtesy of NASA/APL.

NASA's MErcury Surface, Space Environment, GEochemistry, and Ranging (MESSENGER) spacecraft and the European Space Agency's Venus Express recently provided the most detailed multipoint images of the venusian atmosphere ever seen. The images result from a June 5 flyby of Venus by MESSENGER during its long journey to Mercury. Venus Express already was in orbit at the planet. The two spacecraft carry sets of instruments employing different observation techniques that complement each other.

The data collected at Venus are now being analyzed by teams on both sides of the Atlantic and, as can be appreciated in the first images that have been released, already hints at the potential of the results to come.

The particular orbital geometry of Venus Express when MESSENGER skimmed past Venus on June 5 meant that the two spacecraft were not at the same location (with respect to the surface of the planet) at the exact same time. MESSENGER made its closest approach at a distance of about 338 km from the planet over the planetary coordinates 12.25°S and 165°E, on the nightside of the planet. Meanwhile, Venus Express was behind the horizon, almost right above the South Pole, at about 35,000 km from Venus. So how could they make true joint observations of the same regions and phenomena? Scientists came up with a highly creative solution.

The scientists used a computer simulation based on real atmospheric data about Venus obtained from previous ground and space observations. Knowing the speed of the local winds, which depend both on the altitude and the latitude, they were able to predict where a particular set of clouds would be at a given point in time. For their observation, the Venus Express scientists selected a cloud that — moving west by about 90° longitude every day — was visible to Venus Express and would be in view of MESSENGER 12 hours later, at the time of its closest approach. The same cloud became visible again for Venus Express 12 hours after MESSENGER's closest approach, this time on the nightside.

The VIRTIS imaging spectrometer onboard Venus Express probed the cloud at several wavelengths. The observations provided a view of the cloud at about 45–50 km altitude from the planet. The Mercury Laser Altimeter (MLA) instrument on board MESSENGER probed the same cloud structure at 50–75 km from the surface. Such an observation — a typical example of atmospheric structure at Venus — with cross-sections obtained at different altitudes and with different instruments, is a unique opportunity for researchers hoping to solve the puzzle of the venusian atmosphere's dynamics and composition.

For more information and images, visit the MESSENGER website at *www.nasa.gov/messenger* or the Venus Express website at *sci.esa.int/science-e/www/area/index.cfm?fareaid=64*.

Speeding Bullet Star Leaves Enormous Streak Across Sky

NASA's Galaxy Evolution Explorer has spotted a surprisingly long comet-like tail behind a star streaking through space at supersonic speeds. The star, named Mira after the Latin word for "wonderful," has been a favorite of astronomers for approximately 400 years. It is a fast-moving, older red giant that is shedding massive amounts of surface material.

The space-based Galaxy Evolution Explorer scanned the popular star during its ongoing survey of the entire sky in ultraviolet light. Astronomers then noticed what looked like a comet with a gargantuan tail. Material

Mira and its tail. Image courtesy of NASA.

blowing off Mira is forming a wake 13 light years long, or about 20,000 times the average distance of Pluto from the Sun. Nothing like this has been seen before around a star.

"I was shocked when I first saw this completely unexpected, humongous tail trailing behind a well-known star," said Christopher Martin of the California Institute of Technology. "It was amazing how Mira's tail echoed on vast, interstellar scales the familiar phenomena of a jet's contrail or a speedboat's turbulent wake." Martin is the principal investigator for the Galaxy Evolution Explorer and lead author of a paper appearing about the discovery in the August 15 edition of *Nature*.

Astronomers say Mira's tail offers a unique opportunity to study how stars like our Sun die and ultimately seed new solar systems. As Mira hurtles along, its tail sheds carbon, oxygen, and other important elements needed to form new stars, planets, and possibly even life. This tail material, visible for the first time, has been released over the past 30,000 years.

"This is an utterly new phenomenon to us, and we are still in the process of understanding the physics involved," said co-author Mark Seibert of the Observatories of the Carnegie Institution of Washington in Pasadena. "We hope to be able to read Mira's tail like a ticker tape to learn about the star's life."

Billions of years ago, Mira was similar to our Sun. Over time, it began to swell into what is called a variable red giant — a pulsating, puffed-up star that periodically grows bright enough to see with the naked eye. Mira eventually will eject all its remaining gas into space, forming a colorful shell called a planetary nebula. The nebula will fade with time, leaving only the burnt-out core of the original star, which will then be called a white dwarf.

Compared to other red giants, Mira is traveling unusually fast, possibly due to gravitational boosts from other passing stars. It now plows along at 291,000 miles per hour. Racing along with Mira is a small, distant companion thought to be a white dwarf. The pair, also known as Mira A (the red giant) and Mira B, orbit slowly around each other as they travel together in the constellation Cetus, 350 light years from Earth.

In addition to Mira's tail, the Galaxy Evolution Explorer also discovered a bow shock, a type of buildup of hot gas, in front of the star, and two sinuous streams of material emanating from the star's front and back. Astronomers think hot gas in the bow shock is heating the gas blowing off the star, causing it to fluoresce with ultraviolet light. This glowing material then swirls around behind the star, creating a turbulent, tail-like wake. The process is similar to a speeding boat leaving a choppy wake or a steam train producing a trail of smoke.

Mira's tail only glows with ultraviolet light, which might explain why other telescopes have missed it. The Galaxy Evolution Explorer is very sensitive to ultraviolet light and also has an extremely wide field of view, allowing it to scan the sky for unusual ultraviolet activity. "It is amazing to discover such a startlingly large and important feature of an object that has been known and studied for more than 400 years," said James D. Neill of the California Institute of Technology.

For additional graphics and information about the Galaxy Evolution Explorer, visit *www.nasa.gov/galex*.

NASA Selects Astrophysics Projects for New Science on the Moon

NASA has selected four proposals focusing on astrophysics priorities in lunar science to facilitate the nation's exploration program. The proposed studies are part of a NASA effort to develop new opportunities to conduct important science investigations during the planned renewal of human exploration of the Moon.

The newly announced proposals for concept studies may lead to experiments placed on the Moon that would allow for unprecedented tests of Einstein's General Theory of Relativity, instruments to probe the early evolution of structure in the universe, and observation of X-rays produced by the charged particles the

Sun emits, known as the solar wind. Instruments based on these concept studies also would provide unique information on the interior structure of the Moon and on Earth-Moon interactions.

"We're very excited by the proposals the scientific community sent us to advance lunar science through astrophysics," said Alan Stern, associate administrator for NASA's Science Mission Directorate, Washington. "The Moon figures prominently in NASA's exploration goals, and these projects each give us a way to expand our knowledge of the Moon and our universe on a greater scale."

Two concept studies propose the placement of suitcase-sized instruments at various locations on the Moon so the distance from Earth to the Moon can be determined to the submillimeter level. These observations will yield a wealth of science, including precision tests of general relativity and greater understanding of the structure of the Moon and Earth-Moon interactions. The proposals are "A Lunar Laser Ranging Array for the 21st Century" from the University of Maryland at College Park (Douglas Currie, Principal Investigator); and "Precision Lunar Laser Ranging" from NASA's Goddard Space Flight Center in Greenbelt, Maryland (Stephen Merkowitz, Principal Investigator).

A third concept study proposes to place a small radio telescope array on the Moon to study particle acceleration in celestial objects such as supernovae, quasars, and the solar corona. It also will serve as a pathfinder for a future possible radio telescope to measure the growth of structure in the early universe. The study is "Radio Observatory for Lunar Sortie Science" from the Naval Research Laboratory in Washington. Joseph Lazio is Principal Investigator.

The fourth project will measure X-ray emissions caused by the solar wind and its interactions with Earth's magnetosphere. It also will help improve future measurements of low-energy X-ray emission from our galaxy. "Lunar-Based Soft X-ray Science" is the study from Goddard. Michael Collier is Principal Investigator.

Details on NASA's lunar research programs are available at *www.nasa.gov/exploration*.

NASA Robots Practice Moon Survey in the Arctic Circle

Two NASA robots surveyed a rocky, isolated polar desert within a crater in the Arctic Circle. The study will help scientists learn how robots could evaluate potential outposts on the Moon or Mars. The robots, K10 Black and K10 Red, carried 3-D laser scanners and ground-penetrating radar. The team arrived at Haughton Crater at Devon Island, Canada, on July 12 and operated the machines until August 3. Scientists chose the polar region because of the extreme environmental conditions, lack of infrastructure and resources, and geologic features. Additionally, Haughton Crater is geographically similar to Shackleton Crater at the South Pole of the Moon. Both are impact craters that measure roughly 12.4 miles in diameter.

"Drill Hill" in Haughton Crater (Devon Island, Canada). Image courtesy of NASA.

"We are learning about the awesome potential of human and robot teams," said S. Pete Worden, director of NASA's Ames Research Center in Moffett Field, California, where the group that conducted the survey is based. "Studying how humans and robots can maximize scientific returns in sites such as Devon Island will prepare us to walk on the Moon and Mars."

NASA is planning to send astronauts back to the Moon by 2020. Prior to establishing a lunar outpost, the agency must conduct detailed surveys at a variety of locations to produce maps, look for minerals and water ice, and learn other details. NASA plans to accomplish its surveys with an automated orbiting spacecraft, not a robotic lander, but the agency still has a keen interest in advancing the laser scanning technology. Most of the lunar sites are on harsh terrain and in permanently shadowed areas. It is not unusual for site surveys to require thousands of measurements and hundreds of hours to complete. A robot can reduce mission cost and improve mission effectiveness by allowing ground control to conduct surveying tasks.

"A typical scenario involves multiple rovers autonomously surveying a region while humans supervise and assess data from a remote location," said Terry Fong, director of the Intelligent Robots Group at Ames. The robots are using different techniques than the goal-directed traverses and isolated sampling tasks that Mars scientific rovers have used to explore the Red Planet. K10 Black and K10 Red used a mix of information previously obtained by aerial and satellite imaging and data that the robot survey team gathered.

The 3-D laser scanner can map topographic features as far as 3280 feet away. The ground-penetrating radar, which NASA's Jet Propulsion Laboratory developed, can map below ground as deep as 16.4 feet. "The robots are covering the area in lawnmower-like paths at human walking speeds to systematically map above and below ground," said Fong.

The practice survey in Haughton Crater took place at an area called Drill Hill. The robots covered approximately 120 acres of terrain. Researchers commanded the robots remotely from the Haughton-Mars base camp more than two miles away from Drill Hill. The robots navigated using the Global Positioning System, stereo cameras, laser scanners, and Sun trackers. Each of the four-wheel-drive machines weighs 165 pounds and can carry a payload up to 110 pounds.

A key objective of the Drill Hill survey is to test the instruments and software on the robots as well as the equipment and software that humans will use at lunar outposts and ground control to supervise the robots. Engineers at NASA's Johnson Space Center in Houston will assess advanced robot driving techniques using a multi-screen cockpit. Ames will test software that makes high-resolution maps for interactive display in 3-D. NASA's Exploration Technology Development Program sponsored the robotic site survey at Haughton Crater.

For more information, visit *haughton2007.arc.nasa.gov*.

Cassini Finds Possible Origin of One of Saturn's Rings

Cassini scientists may have identified the source of one of Saturn's more mysterious rings. Saturn's G ring likely is produced by relatively large, icy particles that reside within a bright arc on the ring's inner edge. The particles are confined within the arc by gravitational effects from Saturn's moon Mimas. Micrometeoroids collide with the particles, releasing smaller, dust-sized particles that brighten the arc. The plasma in the giant planet's magnetic field sweeps through this arc continually, dragging out the fine particles, which create the G ring.

A movie sequence of Saturn's G ring over a full orbital revolution captures its single bright arc on the ring's inner edge. Image courtesy of NASA/JPL/Space Science Institute.

The finding is evidence of the complex interaction between Saturn's moons, rings, and magnetosphere. Studying this interaction is one of Cassini's objectives. The study appeared in the August 2 issue of the journal *Science* and was based on observations made by multiple Cassini instruments in 2004 and 2005. "Distant pictures from the cameras tell us where the arc is and how it moves, while plasma and dust measurements taken near the G ring tell us how much material is there," said Matthew Hedman, a Cassini imaging team associate at Cornell University, and lead author of the *Science* paper.

Saturn's rings are an enormous, complex structure, and their origin is a mystery. The rings are labeled in the order they were discovered. From the planet outward, they are D, C, B, A, F, G, and E. The main rings — A, B, and C — from edge-to-edge, would fit neatly in the distance between Earth and the Moon. The most transparent rings are D — interior to C — and F, E, and G, outside the main rings.

Unlike Saturn's other dusty rings, such as the E and F rings, the G ring is not associated closely with moons that either could supply material directly to it — as Enceladus does for the E ring — or sculpt and perturb its

ring particles — as Prometheus and Pandora do for the F ring. The location of the G ring continued to defy explanation, until now.

Cassini images show that the bright arc within the G ring extends one-sixth of the way around Saturn and is about 250 kilometers (155 miles) wide, much narrower than the full 5955-kilometer width (3700 miles) of the G ring. The arc has been observed several times since Cassini's 2004 arrival at the ringed planet and thus appears to be a long-lived feature. A gravitational disturbance caused by the moon Mimas exists near the arc. As part of their study, Hedman and colleagues conducted computer simulations that showed the gravitational disturbance of Mimas could indeed produce such a structure in Saturn's G ring. The only other places in the solar system where such disturbances are known to exist are in the ring arcs of Neptune.

Cassini's magnetospheric imaging instrument detected depletions in charged particles near the arc in 2005. According to the scientists, unseen mass in the arc must be absorbing the particles. "The small dust grains that the Cassini camera sees are not enough to absorb energetic electrons," said Elias Roussos of the Max Planck Institute for Solar System Research in Germany, and member of the magnetospheric imaging team. "This tells us that a lot more mass is distributed within the arc." The researchers concluded that there is a population of larger, as-yet-unseen bodies hiding in the arc, ranging in size from that of peas to small boulders. The total mass of all these bodies is equivalent to that of an ice-rich, small moon that's about 100 meters wide (328 feet wide).

Joe Burns, a co-author of the paper from Cornell University and a member of the imaging team, said, "We'll have a super opportunity to spot the G ring's source bodies when Cassini flies about 600 miles from the arc 18 months from now."

G ring movies and images, along with other Cassini information, are available at *www.nasa.gov/cassini*, *saturn.jpl.nasa.gov*, and *ciclops.org*.

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, meeting highlights and summaries, and descriptions of new space missions that may be of interest to our readers. Peer-reviewed research articles, however, are not appropriate for publication in the LPIB. 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,
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The Lunar and Planetary Information Bulletin is published by the Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058.

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Production Editor: Renée Dotson
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 October 12, 2007. Articles or announcements should be submitted via e-mail to *lpibed@lpi.usra.edu*.

To be added to the list to receive notification by e-mail of future issues, please send your e-mail address to *lpibed@lpi.usra.edu*.

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ISSN 1534-6587

NASA Administrator Announces Senior Leadership Appointments

On August 10, NASA Administrator Michael Griffin named Richard J. Gilbrech as associate administrator for the Exploration Systems Mission Directorate, the NASA division designing the next generation of spacecraft to return astronauts to the Moon and eventually journey to Mars. Gilbrech currently serves as the director of NASA's Stennis Space Center in Mississippi. Griffin also named Robert D. Cabana, deputy director of NASA's Johnson Space Center in Houston, to replace Gilbrech as center director at Stennis.

Gilbrech will succeed Scott Horowitz, who will leave his position in early October to pursue interests outside NASA. "Scott Horowitz is someone who has seen it all and done it all in aerospace — Ph.D. researcher, fighter pilot, test pilot, astronaut, and the possessor of a brilliant system engineer's mind," Griffin said. "He was the perfect choice to kick-start NASA's effort to replace the shuttle and return to the Moon; the Ares I always will be seen as Scott's brainchild. I will forever consider him to be both a good friend and a valued colleague. But I respect his need to move on.

"We are incredibly fortunate to have as his replacement someone of Rick Gilbrech's training, talent, and experience," Griffin continued. "Rick was our 'go to guy' when we needed someone to head a tiger team to deal with the loss of the shuttle PAL ramp foam on STS-114. With experience in both institutional and project management, Rick's willingness to take on this challenge will ensure the Exploration Systems Mission Directorate remains in good hands."

Before being named director of Stennis in 2006, Gilbrech was deputy director of the agency's Langley Research Center in Hampton, Virginia, and deputy director of NASA's Engineering Safety Center located at Langley. Gilbrech began his career at the Stennis Space Center in Mississippi in 1991. He earned a bachelor's degree in aerospace engineering from Mississippi State University, Starkville, and master's and doctoral degrees from the California Institute of Technology, Pasadena.

As director of the Stennis Space Center, Cabana will oversee all operations of NASA's primary center for rocket propulsion testing and the Applied Research and Technology Project Office. Stennis is a multi-agency center with operations or offices for 30 government agencies. "With the spacecraft engine development work planned during the next few years, Stennis is a key to our future beyond low Earth orbit, and replacing Rick as its director is a difficult task," Griffin said. "We are lucky to have in Bob Cabana a highly experienced center deputy, test pilot, astronaut and engineer to fill this position. Few people have given more to NASA and to spaceflight than Bob. While he can do anything and could fill nearly any job at NASA, I am personally thrilled that he has accepted this opportunity to step up to the next level of our agency's senior management."

Cabana was selected as an astronaut in 1985, flying twice as a space shuttle pilot and twice as commander, accumulating more than 1000 hours in space. Cabana served in a number of management positions supporting the astronaut office and the International Space Station program, as well as serving as NASA liaison to the Russian space agency. He has served as the Johnson Space Center deputy director in Houston since 2004. He is a native of Minnesota and a 1971 graduate of the U.S. Naval Academy in Annapolis, Maryland.

For information about NASA and other agency programs, visit *www.nasa.gov*.

GSA Award Winners

The Geological Society of America has recently announced their 2007 medal and award recipients.

The Penrose Medal was awarded to Dr. Kevin C. A. Burke of the University of Houston. The Penrose Medal was established in 1927 by R. A. F. Penrose Jr., to be awarded in recognition of eminent research in pure geology, for outstanding original contributions or achievements that mark a major advance in the science of geology.

The winner of the 2007 G. K. Gilbert Award is Dr. Maria T. Zuber of the Massachusetts Institute of Technology. This award is named for G. K. Gilbert, who 100 years ago clearly recognized the importance of a planetary perspective in solving terrestrial geologic problems. The G. K. Gilbert Award is presented annually for outstanding contributions to the solution of fundamental problems in planetary geology in the broadest sense, which includes geochemistry, mineralogy, petrology, geophysics, geologic mapping, and remote sensing.

These and many other medals and awards will be presented at the 2007 GSA Annual Meeting in Denver in October.

DPS Award Winners

The Division for Planetary Sciences of the American Astronomical Society is pleased to announce the following recipients of DPS prizes for 2007:

The Gerard P. Kuiper Prize has been awarded to Dr. Andrew Ingersoll, California Institute of Technology, for theoretical and observational contributions to the study of planetary atmospheres.

The Harold Masursky Award has been presented to Dr. Thomas Gehrels, University of Arizona, for his efforts in developing the Space Sciences Series of the University of Arizona Press.

The Harold C. Urey Prize goes to Dr. Francis Nimmo, University of California–Santa Cruz, for fundamental contributions to the understanding of terrestrial planets and icy satellites and their evolution.

Meteoritical Society Awards

The following Meteoritical Society awards were presented at the annual meeting in Tucson earlier this month.

The recipient of the Leonard Medal was Dr. Michel Maurette of the Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse (CSNSM). Maurette was recognized not only for his initial work with radiation effects in lunar soils, but particularly his search for and analyses of cosmic dust in polar and near-polar ice deposits.

The Barringer Award was presented to Dr. Christian Koeberl, University of Vienna. Koeberl is recognized not only for his work with tektites and a large number of impact craters around the world, but also for the role he plays as a strong advocate for integrated international research projects in the field of impact crater research.

The Nier Prize was given to Dr. Thorsten Kleine of ETH Zürich in recognition of the work he has done in developing better chronology for early solar system materials, ranging from planetary accretion to core formation.

The Meteoritical Society Service award was presented to John Schutt. Schutt was the first mountaineer to work with the United State's Antarctic Search for Meteorites (ANSMET) program, starting in 1980 and continuing until today. Over the past 25 field seasons, he has safe-guarded hundreds of scientists in the hazardous environment of Antarctica, spending the equivalent of more than 5 full years of his life camping out in fabric tents on the East Antarctic icesheet. Schutt has probably recovered more meteorites than any single person in history, and all his samples have been made available to the world's science community. No individual in history has personally recovered more samples of Mars; in this sense, he is to Mars what Apollo astronauts were to the Moon.

ADS Announces New Project Manager

After 14 years as project manager of the NASA Astrophysics Data System, Dr. Guenther Eichhorn has left the position of Project Manager for NASA's Astrophysics Data System (ADS) to pursue a career in the publishing world. Eichhorn has worked on the ADS since 1993, and he oversaw its development into an indispensable aid to astronomical research worldwide. The ADS staff and the astronomical community at large are thankful for his dedication and contribution to this important project.

Following Eichhorn's departure, Dr. Alberto Accomazzi has been appointed to the role of ADS Project Manager. Accomazzi is a veteran member of the ADS team, having worked on the project for the past 13 years as a software developer and system architect. In addition to his outstanding technical skills, Accomazzi has an excellent standing with the ADS Team and has their full confidence and support. His experience and intimate knowledge of the ADS guarantees a smooth transition in leadership and continuity in the day-to-day operations of the project.

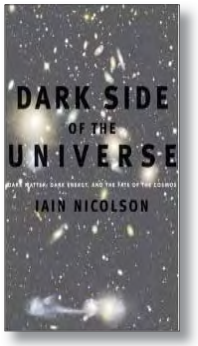
The ADS is a NASA-funded project that maintains three bibliographic databases containing more than 5.6 million records: Astronomy and Astrophysics, Physics, and arXiv e-prints. The main body of data in the ADS consists of bibliographic records, which are searchable through abstract service query forms, and full-text scans of much of the astronomical literature, which can be viewed through a browser interface. Integrated in its databases, the ADS provides access and pointers to a wealth of external resources, including electronic articles, data catalogs, and archives. The ADS currently has links to over 5.8 million records maintained by its collaborators.

For more information about the ADS, visit their website at *www.adsabs.harvard.edu*.

Books

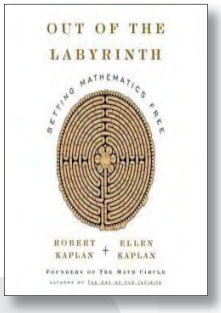
The Moon. Michael Carlowicz. Abrams, 2007. 240 pp., Hardcover, $19.95. *www.hnabooks.com*

As our nearest cosmic neighbor, the Moon has been an object of worship; a fount of myths; the subject of countless films, books, and works of art; and the focus of our early ventures into space. It is a source of wonder for us in its many guises and phases, sizes and colors. Full of spectacular images, *The Moon* explores how our celestial sister works her magic on the Earth, how she has profoundly influenced our beliefs and our cultures, and how she continues to affect our oceans and our science. This is the full picture, from the Moon's fiery and violent birth four billion years ago to the near future, when we will once again stand on its dusty surface.



Dark Side of the Universe: Dark Matter, Dark Energy, and the Fate of the Cosmos. Iain Nicolson. Johns Hopkins University Press, 2007. 192 pp., Hardcover, $35.00. *www.press.jhu.edu*

Once we thought the universe was filled with shining stars, dust, planets, and galaxies. We now know that more than 98% of all matter in the universe is dark. It emits absolutely nothing yet bends space and time, keeps stars speeding around galaxies, and determines the fate of the universe. But dark matter is only part of the story. Scientists have recently discovered that the expansion of the universe is speeding up, driven by a mysterious commodity called dark energy. Depending on what dark matter and energy happen to be, our seemingly quiet universe could end its days in a Big Rip, tearing itself apart, or a Big Crunch, collapsing down to a universe the size of nothing, ready to be reincarnated in a Big Bang once again. For the general reader and armchair astronomer alike, Nicolson's fascinating account shows how our ideas about the nature and the content of the universe have developed. He highlights key discoveries, explains underlying concepts, and examines current thinking on dark matter and dark energy.



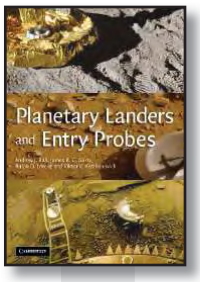
Out of the Labyrinth: Setting Mathematics Free. Robert Kaplan and Ellen Kaplan. Oxford University Press, 2006. 256 pp., Hardcover, $25.00. *www.oup.com*

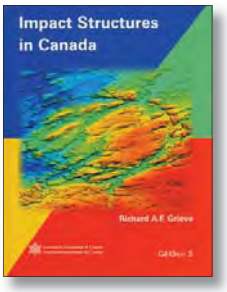
Robert and Ellen Kaplan — the founders of The Math Circle, the popular learning program begun at Harvard in 1994 — reveal the secrets behind their highly successful approach, leading readers out of the labyrinth and into the joyous embrace of mathematics. This book offers an engaging and practical guide for parents and educators, and a delight for anyone interested in sharing the pleasures of mathematics. The authors argue that math should be taught as the highest form of intellectual play, an endeavor to be explored and enjoyed by children (or adults) of any age. One by one, they dismantle the many barriers to appreciating mathematics, from the self-defeating belief that mathematical talent is inborn, to the off-putting language of mathematics, to the question of why anyone should care. Enhanced throughout with puzzles, practical equations, and colorful anecdotes from their own classrooms, *Out of the Labyrinth* will delight readers with its engaging exploration of mathematics. It will allow students, parents, teachers, and others to wrestle with the accessible mysteries of math — and discover their inner math genius.

Planetary Landers and Entry Probes. Andrew Ball, James Garry, Ralph Lorenz, and Viktor Kerzhanovich. Cambridge University Press, 2007. 362 pp., Hardcover, $130.00. *www.cambridge.org/us*

This book provides a concise but broad overview of the engineering, science, and flight history of planetary landers and atmospheric entry probes designed to explore the atmospheres and surfaces of other planets.

It covers engineering aspects specific to such vehicles that are not usually treated in traditional spacecraft engineering texts. Examples are drawn from over 30 different lander and entry probe designs that have been used for lunar and planetary missions since the early 1960s. The authors provide detailed illustrations of many vehicle designs from different international space programs, and give basic information on their missions and payloads, irrespective of the mission's success or failure. Several missions are discussed in more detail to demonstrate the broad range of the challenges involved and the solutions implemented. This will form an important reference for professionals, academic researchers, and graduate students involved in planetary science, aerospace engineering, and space mission development.





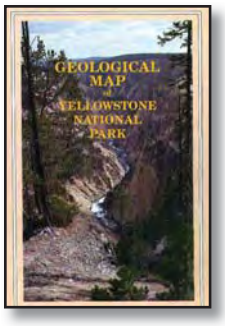
Impact Structures in Canada. Richard A. F. Grieve. Geological Association of Canada, 2006. 219 pp., Hardcover, CDN $60.00. *www.gac.ca*

This book compiles, synthesizes, and distills the knowledge base from published and unpublished data and information from the extensive program of study of Canadian impact structures, the program's partners, and other researchers. It represents a time-slice of integrated knowledge on Canadian impact structures as it stands today. Detailed information is provided on Brent, Carswell, Charlevoix, Clearwater, Couture, Deep Bay, Eagle Butte, Elbow, Gow, Haughton, Holleford, Ile Rouleau, La Moinerie, Manicouagan, Maple Creek, Mistastin, Montagnais, New Quebec, Nicholson, Pilot, Presqu'île, Saint Martin, Slate Islands, Steen River, Sudbury, Viewfield, Wanapitei, and West Hawk.

Living Off the Land in Space: Green Roads to the Cosmos. Gregory L. Matloff, Les Johnson, and C. Bangs. Springer, 2007. 250 pp., Hardcover, $27.50. *www.springer.com*

A number of new space-propulsion technologies — including the solar sail, the solar-electric rocket, solar-thermal propulsion, aerocapture, tethers, and advanced chemical propulsion — are becoming operational or are in an advanced state of development. This book draws parallels with the settlement of terrestrial frontiers to investigate how new space-propulsion techniques may help future space settlers exploit extraterrestrial resources to establish independence from Earth. *Living Off the Land in Space*, a collaboration among two space scientists and an artist, is illuminated with many NASA-derived computer-generated images, including drawings, and presents the human (as well as technological) side of space settlement.

Maps



Geologic Map of Yellowstone National Park. Available from the Montana State University Department of Earth Sciences. 23-inch by 36-inch folded map, $5.00. *www.montana.edu/wwwes/maps/GeolMapYellowstone.htm*

This map includes updated, simplified, reduced versions of the USGS 1972 Geological Map and Surficial Geologic Map of Yellowstone National Park. This map was intended for general use by the interested layperson, but serves well for student field trips and other educational activities. One side includes the Geological Map at a scale of about 1:250,000, the legend of mapable formations and groups, a Geologic Time Scale, a Tectonic Map emphasizing basement rock, volcanic rock, and named structures, and schematic diagrams of caldera formation and eruptive volumes. The reverse shows the Surficial Geology, a satellite image, and several photographs of outstanding features. Explanatory text accompanies all maps and diagrams.

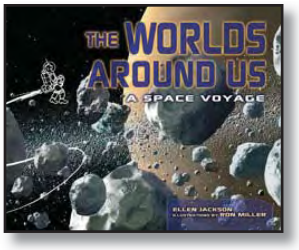
FOR KIDS!!!

Solar System Science Cards & Information Sheet. Phlare, 2007. $9.99. *www.phlare.com*

Phlare's newest product focuses on the solar system with 25 beautiful question-and-answer cards and an 18" × 24" information sheet. The product uses imagery and science from myriad solar missions, including Galileo, Cassini, Voyager, STEREO, and Magellan, to show the solar system as it has never been seen. From fiery Io to smoggy Titan, from mysterious Mercury to gorgeous Saturn, this product covers the planets, dwarf planets, comets, meteors, the Moon and moons, extrasolar planets, the Sun, and much more. The information sheet shows the scale of planets and dwarf planets and their orbits on one side and on the back covers the Sun, the formation of the solar system, water and life in the solar system, and describes solar missions. This product provides a great way to learn about and learn to appreciate our solar system.

Space Patrol — My Little Sand Box Playset. BE Good Company, 2007. $26.95. *www.begoodcompany.com*

Help little ones build a foundation for expanding their imaginations. This little sandbox is a junior astronaut's dream! In the 10" × 10" box filled with ultrafine black sand, you'll find a die-cast Moon rover, two astronauts, two asteroids, a bag of rocks, a digging shovel, space bucket, a crater, and a U.S. flag, plus a 20" × 20" space play mat. It's a great way for kids to have creative fun, all packed in a neat little box. So dig in! Ages 3 and above.



The Worlds Around Us: A Space Voyage. By Ellen Jackson. Millbrook Press, 2007. 40 pp., Hardcover, $23.93. *www.lernerbooks.com*

Have you ever glanced at the night sky and dreamed about visiting another planet? What are other worlds like? Could you play baseball on the Moon? Are there really diamonds on Neptune? Grab your spacesuit, load up the rocket, and get ready to blast off. *The Worlds Around Us* takes you on a fun-filled, fascinating tour of our solar system. Ron Miller's detailed planetscapes make you feel as if you've just stepped off a spaceship into an alien world, and Jackson's fun-filled text enhances the experience by telling you exactly what you'd be feeling. Fact boxes add lots of solid information to the fun. For grades 3 through 6.

Comets, Stars, the Moon, and Mars: Space Poems and Paintings. By Douglas Florian. Harcourt Children's Books, 2007. 56 pp., Hardcover, $16.00. *www.harcourtbooks.com*

Blast off with Florian's new high-flying compendium, which features 20 whimsical poems about space. From the Moon to the stars, from Earth to Mars, this is an exuberant celebration of our celestial surroundings that's certain to become a universal favorite among aspiring astronomers everywhere. Includes die-cut pages and a glossary of space terms. For ages 5 to 10.

Calendar 2007

September

10–13 From the Sun Towards the Earth: Living with a Star, Boulder, Colorado. http://www.lmsal.com/lws2007/

12–14 Seventh IAA International Conference on Low-Cost Planetary Missions (LCPM7), Pasadena, California http://lcpm7.jpl.nasa.gov/

13–14 Origin and Differentiation of the Earth: Past to Present (Royal Society Discussion Meeting), London, UK http://www.royalsoc.ac.uk/event.asp?id=4164

18–20 AIAA Space 2007 Conference & Exposition, Long Beach, California http://www.aiaa.org/content.cfm?pageid=230&lumeetingid=1808&viewcon=submit

18–20 NASA Astrobiology Institute Field Workshop: Biosignatures in Ancient Rocks, Sudbury, Ontario, Canada http://psarc.geosc.psu.edu/RESEARCH/New_Conference/Ontario_new.htm

19–20 Discovery at 15: Looking Back, Moving Forward, Huntsville, Alabama http://discovery.nasa.gov/Discovery15/

19–21 50 Years in Space: Aerospace Conference Celebrating 50 Years of Space Technology, Pasadena, California http://www.galcit.caltech.edu/space50/

19–21 IGEP 5th Planet Formation Workshop, Braunschweig, Germany http://www.igep.tu-bs.de/forschung/planetenentstehung/projekte/planets2007/index_en.html

22–26 Bridging the Gap II: Effect of Target Properties on the Impact Cratering Process, Saint-Hubert, Canada http://www.lpi.usra.edu/meetings/gap2007/

24–27 4th Alfvén Conference: The Importance of Plasma Processes in Planetary Physics and Astrophysics, Arcachon, France http://alfven2007.cesr.fr/

24–27 Astrophysics in the Next Decade, Tucson, Arizona http://cadcwww.dao.nrc.ca/cadcbin/get_meetings?meeting_no=2096

24–28 58th International Astronautical Congress, Hyderabad, India http://www.iac2007.org.in/index.aspx

25 Exploration of the Moon: A UK Perspective, Milton Keynes, UK http://www.open.ac.uk/planetarygeology/p8_1.shtml

October

1–5 From Planets to Dark Energy: The Modern Radio Universe, Manchester, United Kingdom http://www.jb.man.ac.uk/mru2007/

1–5 LEAG Workshop on Enabling Exploration: The Lunar Outpost and Beyond, Houston, Texas http://www.lpi.usra.edu/meetings/leag2007/

3–6 Hothouse, Icehouse, and Impacts: The Late Eocene Earth, Monte Conero (Ancona), Italy. http://geosociety.org/penrose/07italy.htm

7–12 39th Annual Meeting of the Division for Planetary Sciences of the American Astronomical Association (DPS 2007), Orlando, Florida. http://www.aas.org/dps/meetings.html

14–16 New Horizons in Astronomy: Frank N. Bash Symposium 2007 (BASH '07), Austin, Texas http://www.as.utexas.edu/new_horizons/

18–19 10th Mars Crater Consortium Meeting, Flagstaff, Arizona http://www.marscraterconsortium.nau.edu/MCCMeeting.htm

19–20 Planets: Geophysical and Astrophysical Perspectives on Their Structure and Formation, Saratoga Springs, New York http://cms.skidmore.edu/planets/

22–24 7th European Workshop on Astrobiology, Turku, Finland http://www.astro.utu.fi/conf/EANA07/

22–26 9th ILEWG International Conference on Exploration and Utilisation of the Moon, Sorrento, Italy http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=40925

22–26 Exoplanets: Detection, Formation, and Dynamics, Suzhou, China. http://iaus249.nju.edu.cn/

25–27 Space Resources Roundtable IX, Golden, Colorado. http:/www.ISRUinfo.com

28–31 2007 GSA Annual Meeting and Exposition, Denver, Colorado. http://www.geosociety.org/meetings/2007/

29–30 The Second Magellan Science Symposium: The Newest Science from Magellan, Cambridge, Massachusetts http://cfa-www.harvard.edu/events/2007/smss/

November

4–5 Fourth Meeting of the Venus Exploration Analysis Group, Greenbelt, Maryland
http://www.lpi.usra.edu/vexag/

5–7 Workshop on the Chronology of Meteorites and the Early Solar System, Kauai, Hawai'i
http://www.lpi.usra.edu/meetings/metchron2007/

5–8 First International Conference on the Exploration of Phobos and Deimos, Moffett Field, California
http://www.lpi.usra.edu/meetings/phobosdeimos2007/

6–7 Workshop on Planetary Atmospheres, Greenbelt, Maryland
http://www.lpi.usra.edu/meetings/patm2007/

8–9 OPAG Meeting, Greenbelt, Maryland
http://www.lpi.usra.edu/opag/

12–16 European Mars Science and Exploration Conference (EMSEC): Mars Express and ExoMars, Noordwijk, The Netherlands
http://www.rssd.esa.int/index.php?project=TOP&page=conf_mars07

13–15 Astrophysics 2020: Large Space Missions Beyond the Next Decade, Baltimore, Maryland
http://www.stsci.edu/institute/conference/astro2020

14–15 Workshop on Water in Planetary Basalts, Houston, Texas
http://www.lpi.usra.edu/meetings/basalts2007/

December

3–4 Titan: Atmosphere and Space Environment (Royal Society Discussion Meeting), London, UK
http://www.royalsoc.ac.uk/event.asp?id=4168

6–7 NASA Ames Meeting on Formation, Composition and Early Evolution of Outer Giant and Dwarf Planets and of Their Satellites, Mountain View, California
http://spacescience.arc.nasa.gov/agu/

10–14 Fall Meeting of the American Geophysical Union, San Francisco, California http://www.agu.org/meetings/

January 2008

8–12 211th Meeting of the American Astronomical Society, Austin, Texas http://www.aas.org/meetings/aas211/

20–25 Gordon Research Conference: Origin of Life, Ventura, California http://www.aas.org/meetings/aas211/

22–25 Chapman Conference on Solar Wind Interaction with Mars, San Diego, California
http://www.agu.org/meetings/chapman/2008/acall/

22–25 Terrestrial Planets: Evolution Through Time, Ahmedabad, India http://www.prl.res.in/~djconf08/

February

4–5 Workshop on Martian Gullies: Theories and Tests, Houston, Texas
http://www.lpi.usra.edu/meetings/gullies2008/

10–14 Space Technology and Applications International Forum, Albuquerque, New Mexico
http://www.unm.edu/~isnps/staifhome.html

18–22 International Astronomical Union Symposium 251: Organic Matter in Space, Hong Kong, China
http://www.hku.hk/science/iau251/

20–22 International Space University's 12th Annual Symposium on Space Solutions to Earth's Global Challenges, Strasbourg, Alsace, France
http://www.isunet.edu/index.php?option=com_content&task=view&id=344&Itemid=298

March

3–5 International Conference on Engineering, Science, Construction, and Operations in Challenging Environments, Long Beach, California
http://content.asce.org/conferences/earth2008/welcome.html

10–14 39th Lunar and Planetary Science Conference (LPSC 2008), League City, Texas

24–26 Titan — Observations, Experiments, Computations, and Modeling, Miami, Florida
http://www.chem.hawaii.edu/Bil301/Titan2008.html

LPIB