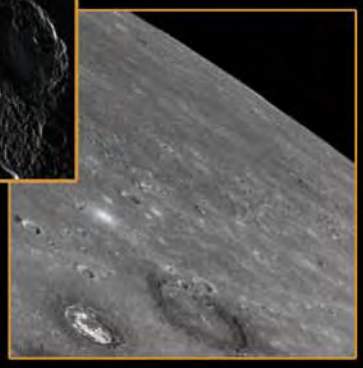
Innermost Planet: MESSENGER Flies by Mercury



Images courstesy of NASA/Johns Hopkins University Applied Physics Laboratory/ Carnegie Institution of Washington

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Innermost Planet: MESSENGER Flies by Mercury

— Paul D. Spudis, Lunar and Planetary Institute

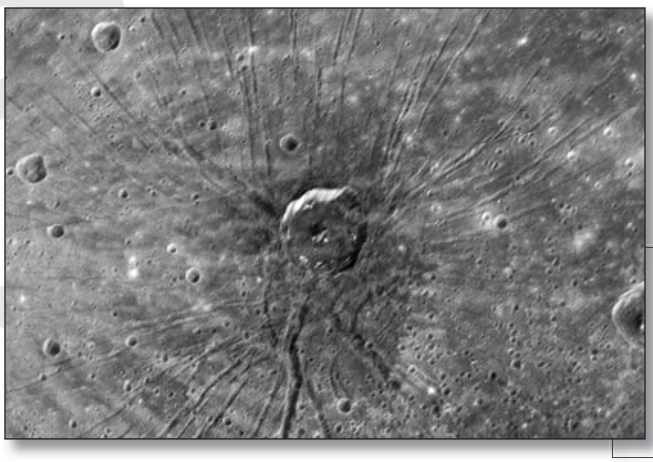
On January 14, 2008, the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft flew by Mercury for the first time since its launch on August 3, 2004. The encounter has allowed us to see a previously unknown part of the planet, providing confirmation and extension of ideas about the planet and a few surprises.

"True" color image of the outgoing hemisphere of Mercury as seen from MESSENGER during its first encounter, January 2008. The light tan region seen at top right is the floor of the enormous (1500 km diameter) Caloris basin. Note that several craters on the basin floor appear to have dark haloes, suggesting varying compositions with depth on the planet.

Mercury is a planet that is difficult to study and to visit. As the planet closest to the Sun, it is very difficult to observe from Earth, so our knowledge of its surface composition and environment is limited. Deep in the gravity well of the solar system, it is a difficult planet to reach, requiring either a very large launch vehicle or very clever mission planning and routing. MESSENGER is using the latter technique, through a carefully planned multiple "bank shot" to fly by Mercury several times before it finally inserts into orbit around the planet in 2011. The flyby last month was the spacecraft's first encounter with Mercury.

Mariner 10 mapped about 40% of the planet, flying by three times in 1973 and 1974. Data returned by the Mariner 10 mission showed Mercury to be a rocky object, covered with craters of all sizes, up to and including very large impact basins. Smooth plains cover parts of the planet, suggesting that volcanic resurfacing has occurred. A series of scarps cut through many features, suggesting that the crust has been compressed globally, indicating an unusual tectonic history. Perhaps most surprisingly, subsequent Earth-based observations suggest that the dark areas near the poles of Mercury contain thick deposits of water ice, the last thing expected to be present on the hottest planet in the solar system!

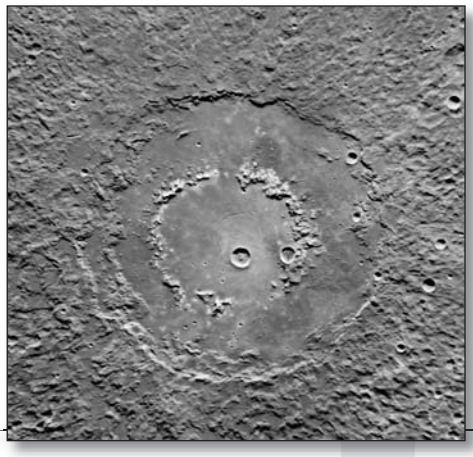
MESSENGER's mission has only begun, but its harvest of data contain some startling surprises. The flyby covered a portion of Mercury previously mapped by Mariner 10, but also mapped much of the previously unseen hemisphere, including the rest of the enormous Caloris basin (Fig. 1). Caloris turns out to be nearly 250 km larger than previously believed, about 1550 km in diameter. The floor of the basin is seen in the new images at high Sun elevation angles, but unusual albedo contrasts are evident; the floor material seems to be of slightly higher albedo than the surrounding basin ejecta. Some craters on this basin floor have dark haloes, suggesting that buried materials of distinct composition within the basin have been exposed by impact (Fig. 1). These observations indicate a protracted and complex geological history for the basin.



An unusual tectonic feature — nicknamed the "Spider" by the MESSENGER imaging team — is found near the center of the Caloris basin (Fig. 2). Several complex fractures radiate outward from a central zone; an unrelated, subsequent impact crater lies upon this tectonic center, its walls influenced

The "Spider," a complex set of fractures found in the center of the Caloris basin. The crater appears to be an unrelated, superposed impact that postdates the tectonic feature. This unusual feature suggests some type of uplift and extension within the basin, after emplacement of the basin fill materials. Scene width ~300 km.

by the preexisting fracture pattern. This feature suggests some type of doming or uplift in the center of the basin, postdating its fill. Combined with the revelation of the previously seen tectonic deformation of the basin, this new feature attests to a long and protracted evolution of the Caloris basin.



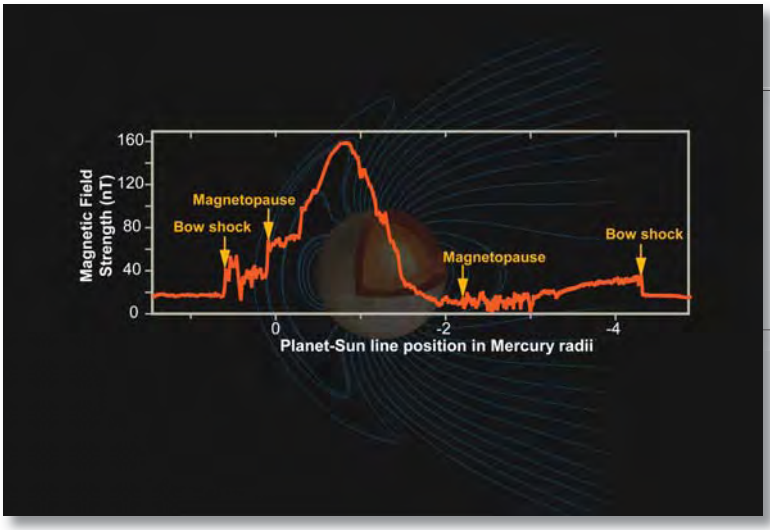
A beautifully preserved two-ring basin on Mercury. The basin (~260 km diameter) appears to be partly filled with later smooth plains materials, which display concentric fractures and subsequent impact craters.

The remainder of Mercury imaged during the flyby shows cratered terrain, smooth plains, and abundant tectonic scarps, similar in scale and scope to those observed by Mariner 10 more than 30 years ago. Numerous rayed craters pepper the surface. Spectacular two-ring basins are found, in a variety of preserved states. Some of these basins display internal features that suggest they have had a complex geological evolution (Fig. 3). Smooth plains are found throughout the imaged hemisphere of Mercury. They fill some craters, bury others, and may occur within very degraded, ancient impact basins.

In addition to imaging, MESSENGER made several measurements of Mercury with a variety of instruments. The spacecraft detected the planet's dipolar magnetic field (Fig. 4), first discovered by Mariner 10, and also mapped its sodium tail, the stream of exospheric sodium atoms that extends from the planet into the space beyond its orbit. The laser altimeter received returns, measuring the topography of the planet during the closest approach on the nighttime hemisphere and detecting cratered terrain with a dynamic range of topography of about 5 km. Finally, measurements were made of the spectral reflectance of different geological units, allowing us to confirm that several compositional units are to be found on its surface. Work continues to understand what all these diverse datasets tell us about the complex geology and history of Mercury.

MESSENGER's first flyby of Mercury has added significantly to our knowledge and understanding of the history and processes of that planet. The spacecraft will fly by Mercury two more times, once this coming October and then again almost a year later, before finally inserting into orbit around Mercury in March 2011. From that vantage, it will map the surface morphology, topography, composition, and other properties to give us a new, global view and understanding of Mercury, its processes and history. The most elusive of planets is becoming unveiled. No doubt many additional surprises await us within these next few, exciting years.

For more information, visit the MESSENGER website at *messenger.jhuapl.edu*.



Profile obtained from the MESSENGER magnetometer, showing the principal features of Mercury's global magnetic field. Future encounters and orbital mapping will yield much more detailed and extensive mapping of the planet's magnetic field and its temporal variations.

Orbiting Camera Details Dramatic Wind Action on Mars

Dust devils are vortices of wind that form when air rising from a warm surface encounters shear in the above atmosphere. Martian dust devils can attain gargantuan proportions, reaching the size of terrestrial tornadoes with plumes that tower up to 9 kilometers above the surface. This observation shows a region near the martian equator that is a perfect tablet for the scribblings of dust devils. Credit: NASA/JPL/University of Arizona.

Mars has an ethereal, tenuous atmosphere with less than 1% of the surface pressure of Earth, which challenges scientists to explain complex, wind-sculpted landforms seen with unprecedented detail in images from NASA's Mars Reconnaissance Orbiter. One of the main questions has been if winds on present-day Mars are strong enough to form and change geological features, or if wind-constructed formations were made in the past, perhaps when winds speeds and atmospheric pressures were higher.

The eye-opening new views of wind-driven Mars geology come from the University of Arizona's High Resolution Imaging Science Experiment camera (HiRISE). As the orbiter flies at about 3400 meters per second (7500 mph) between 250 and 315 kilometers (155 to 196 miles) above the martian surface, this camera can see features as small as half a meter (20 inches).

"We're seeing what look like smaller sand bedforms on the tops of larger dunes, and, when we zoom in more, a third set of bedforms topping those," said HiRISE co-investigator Nathan Bridges of NASA's Jet Propulsion Laboratory. "On Earth, small bedforms can form and change on time scales as short as a day."

Scientists discovered miles-long, wind-scoured ridges called "yardangs" with the first Mars orbiter, Mariner 9, in the early 1970s. New HiRISE images reveal surface texture and fine-scale features that are giving scientists insight into how yardangs form. These new images show that some layers in the yardangs are made of softer materials that have been modified by wind, Bridges added. The soft material could be volcanic ash deposits, or the dried-up remnants of what once were mixtures of ice and dust, or something else.

For more information about the Mars Reconnaissance Orbiter spacecraft, visit *www.nasa.gov/mro*.

Giant Storm Eruption at Jupiter Unearths a Buried Past

Detailed analysis of two continent-sized storms that erupted in Jupiter's atmosphere in March 2007 shows that Jupiter's internal heat plays a significant role in generating atmospheric disturbances. Understanding this outbreak could be the key to unlock the mysteries buried in the deep jovian atmosphere. Credit: NASA, ESA, IRTF, and A. Sánchez-Lavega and R. Hueso (Universidad del País Vasco, Spain).

Scientists around the globe have observed an astonishing and rare change in Jupiter's atmosphere —- a huge disturbance churning in the middle northern latitudes of the planet as two giant storms erupted. Jupiter's winds are the strongest at middle northern latitudes, reaching about 600 kilometers per hour (370 miles per hour). Similar phenomena occurred in 1975 and 1990, but this event has never been observed before with high-resolution modern telescopes.

The storm eruption was captured in late March 2007 by NASA's Hubble Space Telescope, the NASA Infrared Telescope Facility in Hawaii, and telescopes in the Canary Islands (Spain). An international team coordinated by Agustín Sánchez-Lavega from the Universidad del País Vasco in Spain presented their findings about this event in the January 24 issue of the journal *Nature*.

The atmosphere of the gaseous giant planet Jupiter is always turbulent. Its circulation is dominated by a pattern of cloud bands alternating with latitude, and by a persistent system of jet streams, both of unknown origin. Changes in the cloud bands are sometimes violent, starting from a localized eruption and followed by the development of a planetary-scale disturbance. The nature of these disturbances and the power source for these jets remains a controversial matter among planetary scientists and meteorologists. The phenomena could be powered by the Sun, as is Earth, by the strong internal heat source emanating from Jupiter's interior, or by a combination of both.

According to the analysis, the bright plumes were storm systems triggered in Jupiter's deep water clouds that vigorously moved upward in the atmosphere and injected a fresh mixture of ammonia ice and water about 30 kilometers (20 miles) above the visible clouds. The storms moved in the peak of a jet stream in Jupiter's atmosphere at 600 kilometers per hour

(375 miles per hour). They disturbed the jet and formed in their wake a turbulent planetary-scale disturbance containing red cloud particles.

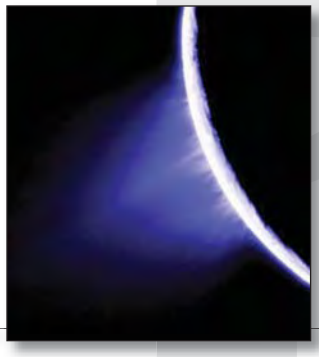
In spite of the energy deposited and the stirring and turmoil generated by the storms, the jet remained practically unchanged when the disturbance ceased, keeping steady against these storms. Models of the disturbance indicate that the jet stream extends deep in the buried atmosphere of Jupiter, more than 100 kilometers (62 miles) below the cloud tops where most sunlight is absorbed.

A comparison of this disturbance with the two previous events in 1975 and 1990 shows surprising similarities and coincidences, all of which remain unexplained. All three eruptions occurred with a periodic interval of about 15 to 17 years. The plumes always appear in the jet peak; the disturbance erupted with exactly two plumes. Finally, the plumes moved with the same speed of the jet peak in all three events. Understanding this outbreak could be the key to unlocking the mysteries buried in the deep jovian atmosphere.

For more images, visit *www.nasa.gov/topics/solarsystem/features/hubble20080123c.html* and *hubblesite.org/newscenter/*.

Saturn Has a "Giant Sponge"

One of Saturn's rings does housecleaning, soaking up material gushing from the fountains on Saturn's tiny ice moon Enceladus, according to new observations from the Cassini spacecraft. "Saturn's A-ring and Enceladus are separated by 100,000 kilometers (62,000 miles), yet there's a physical connection between the two," says William Farrell of NASA's Goddard Space Flight Center. "Prior to Cassini, it was believed that the two bodies were separate and distinct entities, but Cassini's unique observations indicate that Enceladus is actually delivering a portion of its mass directly to the outer edge of the A-ring." Farrell is lead author of a paper on this discovery that appeared in *Geophysical Research Letters* on January 23.



This is a false-color image of jets (blue areas) in the southern hemisphere of Enceladus taken with the Cassini spacecraft narrow-angle camera. It has been processed to reveal the individual jets that comprise the plume. Credit: NASA/JPL/Space Science Institute.

This is the latest surprising phenomenon associated with the ice geysers of Enceladus to be discovered or confirmed by Cassini scientists. Earlier, the geysers were found to be responsible for the content of the E-ring. Next, the whole magnetic environment of Saturn was found to be weighed down by the material spewing from Enceladus, which becomes plasma — a gas of electrically charged particles. Now, Cassini scientists confirm that the plasma, which creates a donut-shaped cloud around Saturn, is being snatched by Saturn's A-ring, which acts like a giant sponge where the plasma is absorbed.

Shot from Enceladus' interior, the gas particles become electrically charged (ionized) by sunlight and collisions with other atoms and electrons. Once electrically charged, the particles feel magnetic force and are swept into the space around Saturn dominated by the planet's powerful magnetic field. There, they are trapped by Saturn's magnetic field lines, bouncing back and forth from pole to pole. The fun ends, however, if their bouncing path carries them inward toward Saturn to the A-ring. There they stick, in essence becoming part of the ring.

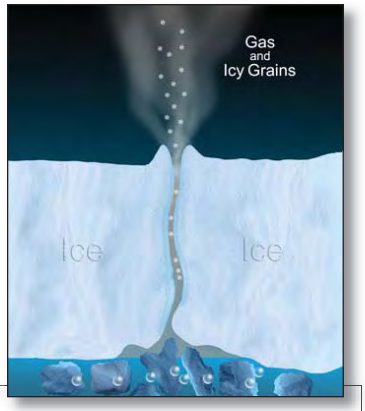
The Cassini observations confirm a prediction by John Richardson and Slobodan Jurac of the Massachusetts Institute of Technology. In the early 1990s, Hubble Space Telescope observations revealed the presence of a large body of water-related molecules in orbit about 240,000 kilometers (almost 150,000 miles) from Saturn. Richardson and Jurac modeled this water cloud and demonstrated it could migrate inward to the A-ring. At the time of their prediction, the source of the water cloud was unknown. The source was not identified until 2005 when Cassini discovered the stunning geysers emitted from Enceladus. Data for the discovery that Saturn's A-ring acts like a sponge were collected in July 2004 when Cassini arrived in orbit around Saturn, making its closest flyby over the A-ring.

For more information about Cassini, visit *saturn.jpl.nasa.gov/home/index.cfm*.

Scientists Study "Plumbing" in Plumes of Enceladus

Scientists on the Cassini mission have become out-of-this world "plumbers" as they try to piece together what's happening inside the "pipes" feeding the plumes of Saturn's moon Enceladus. Enceladus is jetting out giant geysers three times the size of the moon, and now scientists are beginning to understand how the ice grains are created and

how they might have formed. "Since Cassini discovered the water vapor geysers, we've all wondered where this water vapor and ice are coming from. Is it from an underground water reservoir or are there some other processes at work? Now, after looking at data from multiple instruments, we can say there probably is water beneath the surface of Enceladus," said Juergen Schmidt, team member on Cassini's Cosmic Dust Analyzer at the University of Potsdam, Germany. This study appeared in the February 7 issue of the journal *Nature*.



This artist's impression shows how the ice particles and water vapor observed spewing from geysers on Saturn's moon Enceladus may be related to liquid water beneath the surface. The presence of liquid water inside Enceladus would have major implications for future studies of the possibility of life in the outer solar system. Credit: NASA/JPL.

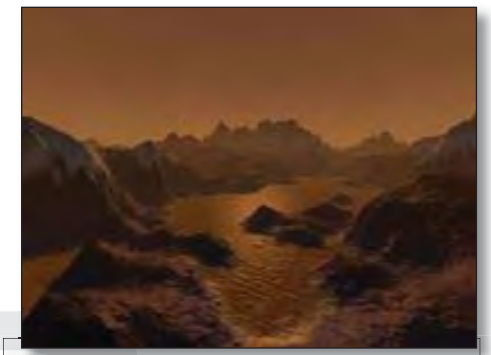
The large number of ice particles observed spewing from the geysers and the steady rate at which these particles are produced require high temperatures, close to the melting point of ice, possibly resulting in an internal lake. The lake would be similar to Earth's Lake Vostok, beneath Antarctica, where liquid water exists locked in ice. The ice grains then condense in the vapor evaporating from the water, streaming through cracks in the ice crust to the surface. The presence of liquid water inside Enceladus would have major implications for future astrobiology studies on the possibility of life on bodies in the outer solar system.

Scientists have studied the plume dynamics since 2005, collecting data from several Cassini remote sensing instruments and those that sample particles directly, like the Cosmic Dust Analyzer. They conclude that an internal lake at a temperature of about 273 Kelvin (32°F) is the best way to account for the material jetting out of the geysers.

At these warm temperatures, liquid water, ice and water vapor mingle. The vapor escapes to the vacuum of space through cracks in Enceladus' ice crust. When the gas expands, it cools and the ice grains that make up the visible part of the plumes condense from the vapor. Pinball-like physics account for the slow speed of the particles. Shooting up through crooked cracks in the ice, the particles ricochet off the walls, losing speed, while the water vapor moves unimpeded up the crevasse.

More information on the Cassini-Huygens mission is available at *saturn.jpl.nasa.gov* and *www.nasa.gov/cassini*.

Titan's Surface Organics Surpass Oil Reserves on Earth



Artist's concept of hydrocarbon pools and icy and rocky terrain on the surface of Saturn's largest moon Titan. Credit: Steven Hobbs.

Saturn's orange moon Titan has hundreds of times more liquid hydrocarbons than all the known oil and natural gas reserves on Earth, according to new data from NASA's Cassini spacecraft. The hydrocarbons rain from the sky, collecting in vast deposits that form lakes and dunes. The new findings from the study led by Ralph Lorenz, Cassini radar team member from the Johns Hopkins University Applied Physics Laboratory, are reported in the January 29 issue of *Geophysical Research Letters*.

"Titan is just covered in carbon-bearing material — it's a giant factory of organic chemicals," said Lorenz. "This vast carbon inventory is an important window into the geology and climate history of Titan." At a balmy –179°C (–290°F), Titan is a far cry from Earth. Instead of water, liquid hydrocarbons in the form of methane and ethane are present on the moon's surface, and tholins probably make up its dunes. The term "tholins"was coined by Carl Sagan in 1979 to describe the complex organic molecules at the heart of prebiotic chemistry.

Cassini has mapped about 20% of Titan's surface with radar. Several hundred lakes and seas have been observed, with each of several dozen estimated to contain more hydrocarbon liquid than Earth's oil and gas reserves. The dark dunes that run along the equator contain a volume of organics several hundred times larger than Earth's coal reserves.

Proven reserves of natural gas on Earth total 130 billion tons, enough to provide 300 times the amount of energy the entire United States uses annually for residential heating, cooling, and lighting. Dozens of Titan's lakes individually have the equivalent of at least this much energy in the form of methane and ethane.

For images and more information, visit *www.nasa.gov/cassini* and *saturn.jpl.nasa.gov*.

Journey to Saturn From Your Computer

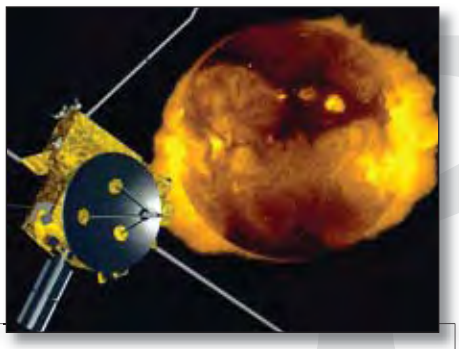
Want a peek at Saturn as seen from space? A new interactive 3-D viewer that uses a game engine and allows users to travel to Saturn and see it the way the Cassini spacecraft sees it is now available online at *saturn.jpl.nasa.gov/multimedia/CASSIE* and *www.nasa.gov/mission_pages/cassini/multimedia/cassie.html*.

The Cassini at Saturn Interactive Explorer (CASSIE) makes the real Cassini mission data fully available in three colorful, easy-to-use expeditions. The "Where is Cassini Now?" expedition shows exactly where the Cassini spacecraft is and what it is doing each moment over the current 24-hour period. Viewers can see the spacecraft move in its orbit and maneuver according to instructions from mission scientists and navigators at NASA's Jet Propulsion Laboratory. With the "Mission Overview" expedition, look back in time as Cassini orbited the Saturn system over the past 3.5 years, and fast-forward into the future to see where it is headed. Users can control two virtual cameras to see Cassini fly by Saturn and its moons.

The "Saturn's Moons" expedition gives an in-depth peek at seven of Saturn's moons, providing useful facts and interactive surface views of each one.

International Solar Mission to End Following Stellar Performance

The joint NASA and European Space Agency Ulysses mission to study the Sun and its influence on surrounding space is likely to cease operations in the next few months. The venerable spacecraft, which has lasted more than 17 years or almost four times its expected mission lifetime, is succumbing to the harsh environment of space.



Artist's concept of Ulysses and the Sun. Credit: NASA.

Ulysses was the first mission to survey the space environment above and below the poles of the Sun. The reams of data Ulysses returned have forever changed the way scientists view our star and its effects.

"I remember when we got those first pictures of Ulysses floating out of the space shuttle Discovery's payload bay back in October of 1990 and thinking we had a great five years ahead of us," said Ed Massey, Ulysses project manager at NASA's Jet Propulsion Laboratory. "I never dared think that we would be receiving invaluable science data on a near continuous basis for more than 17 years. Ulysses has set the bar on solar science data collection quite high."

Science findings and discoveries from the mission were numerous and unprecedented. Examples include taking the first direct measurements of interstellar dust particles and interstellar helium atoms in the solar system and the discovery that the magnetic field leaving the Sun is balanced across latitudes.

Since its Jupiter flyby in 1992, Ulysses has been in a six-year orbit around the Sun. Its long path through space carries it out to Jupiter's orbit and back. The farther it ventures from the Sun, the colder the spacecraft becomes. If it drops to 2°C (36°F), the spacecraft's hydrazine fuel will freeze. This has not been a problem in the past because Ulysses carries heaters to maintain a workable onboard temperature.

The spacecraft is powered by the decay of a radioactive isotope. Over its 17-plus years, the power has been steadily dropping. The spacecraft can no longer run all of its communications, heating and scientific equipment simultaneously. "We expect certain parts of the spacecraft to reach 2 degrees Celsius pretty soon," said Richard Marsden, ESA project scientist and mission manager. This temperature drop will block the fuel pipes, making the spacecraft impossible to maneuver.

The NASA/ESA project team approved a plan to temporarily shut off the main spacecraft's X-band transmitter. This would release 60 watts of power, which could be channeled to the science instruments and the heater. The team planned to turn the transmitter back on when data was to be transmitted back to Earth. This would have made it possible to run Ulysses for up to another two years.

Unfortunately, during the first test of this approach in January, the power supply to the radio transmitter failed to turn back on. Engineers believe the fault can be traced to the transmitter's power supply, meaning that the extra energy they hoped to gain cannot be routed to the heater and science instruments. "The decision to switch the transmitter off was not taken lightly. It was the only way to continue the science mission," Marsden said.

For more information about NASA's Ulysses mission, visit *ulysses.jpl.nasa.gov*.

NASA's Quest to find Water on the Moon Moves Closer to Launch

In 2009, LCROSS will separate into two parts and create a pair of impacts on the permanently dark floor of one of the Moon's polar craters. The spent Centaur upper stage of the Atlas V rocket will hit the Moon, causing an explosion of material from the crater's surface. Credit: NASA.

Cameras and sensors that will look for the presence of water on the Moon have completed validation tests and been shipped to the manufacturer of NASA's Lunar Crater Observation and Sensing Satellite.

The science instruments for the satellite, which is known as LCROSS, departed NASA's Ames Research Center for the Northrop Grumman Corporation's facility in Redondo Beach, California, to be integrated with the spacecraft. LCROSS is scheduled to launch with the Lunar Reconnaissance Orbiter onboard an Atlas V rocket from Cape Canaveral, Florida, by the end of 2008.

"The goal of the mission is to confirm the presence or absence of water ice in a permanently shadowed crater at the Moon's south pole," said Anthony Colaprete, LCROSS principal investigator at Ames. "The identification of water is very important to the future of human activities on the Moon."

In 2009, LCROSS will separate into two parts and create a pair of impacts on the permanently dark floor of one of the Moon's polar craters. The spent Centaur upper stage of the Atlas V rocket will hit the Moon, causing an explosion of material from the crater's surface. The instruments onboard the satellite will analyze the plume for the presence of water ice or water vapor, hydrocarbons, and hydrated materials. The satellite then will fly through the plume on a collision course with the lunar surface. Both impacts will be visible to Earth and lunar-orbiting instruments.

For more information about the Lunar Crater Observation and Sensing Satellite mission, visit *lcross.arc.nasa.gov*. For more information about the Lunar Reconnaissance Orbiter, visit *lunar.gsfc.nasa.gov*.

New NASA Mission to Reveal Moon's Internal Structure and Evolution

At the December meeting of the American Geophysical Union, NASA's Associate Administrator for the Science Mission Directorate, Alan Stern, announced the selection of a new mission that will peer deep inside the Moon to reveal its anatomy and history.

Artist's concept of the GRAIL mission. GRAIL will fly twin spacecraft in tandem orbits around the Moon for several months to measure its gravity field in unprecedented detail. Credit: NASA/JPL.

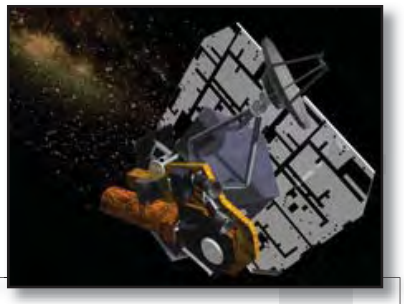
The Gravity Recovery and Interior Laboratory (GRAIL) mission is a part of NASA's Discovery Program. It will cost $375 million and is scheduled to launch in 2011. GRAIL will fly twin spacecraft in tandem orbits around the Moon for several months to measure its gravity field in unprecedented detail. The mission will also answer long-standing questions about Earth's Moon and provide scientists with a better understanding of how Earth and other rocky planets in the solar system formed. "GRAIL's revolutionary capabilities stood out in this Discovery mission competition owing to its unsurpassed combination of high scientific value and low technical and programmatic risk," Stern said. "GRAIL also offers to bring innovative Earth studies techniques to the Moon as a precursor to their possible later use at Mars and other planets."

Scientists will use the gravity field information from the two satellites to X-ray the Moon from crust to core to reveal the Moon's subsurface structures and, indirectly, its thermal history. The study technique GRAIL will use was pioneered by the joint U.S.-German Earth observing Gravity Recovery and Climate Experiment (GRACE) mission, which was launched in 2002. The GRACE satellites measure gravity changes related to the movement of mass within Earth, such as the melting of ice at the poles and changes in ocean circulation. As with GRACE, both GRAIL spacecraft will be launched on a single launch vehicle.

GRAIL's principal investigator is Maria Zuber of the Massachusetts Institute of Technology. Zuber's team of expert scientists and engineers includes former NASA astronaut Sally Ride, who will lead the mission's public outreach efforts. A camera onboard each spacecraft will allow students and the public to interact with observations from the satellites. Each GRAIL spacecraft will carry the cameras to documents their views from lunar orbits.

For more information about NASA's Discovery Program, visit *discovery.nasa.gov*.

NASA's Deep Impact Begins Hunt for Alien Worlds



Artist's concept of Epoxi, which uses the Deep Impact spacecraft. Credit: NASA/JPL.

NASA's Deep Impact spacecraft is aiming its largest telescope at five stars in a search for alien (exosolar) planets as it enters its extended mission, called Epoxi. Deep Impact made history when the mission team directed an impactor from the spacecraft into comet Tempel 1 on July 4, 2005. NASA recently extended the mission, redirecting the spacecraft for a flyby of comet Hartley 2 on October 11, 2010.

As it cruises toward the comet, Deep Impact will observe five nearby stars with "transiting exosolar planets," so named because the planet transits, or passes in front of, its star. The Epoxi team, led by University of Maryland astronomer Michael A'Hearn, directed the spacecraft to begin these observations on January 22. The planets were discovered earlier and are giant planets with massive atmospheres, like Jupiter in our solar system. They orbit their stars much closer than Earth does the sun, so they are hot and belong to the class of exosolar planets nicknamed "Hot Jupiters."

However, these giant planets may not be alone. If there are other worlds around these stars, they might also transit the star and be discovered by the spacecraft. Deep Impact can even find planets that don't transit, using a timing technique. Gravity from the unseen planets will pull on the transiting planets, altering their orbits and the timing of their transits. "We're on the hunt for planets down to the size of Earth, orbiting some of our closest neighboring stars," said Epoxi Deputy Principal Investigator Drake Deming of NASA's Goddard Space Flight Center. Epoxi is a combination of the names for the two extended mission components: the exosolar planet observations, called Extrasolar Planet Observations and Characterization (Epoch), and the flyby of comet Hartley 2, called the Deep Impact Extended Investigation (Dixi). Goddard leads the Epoch component.

More than 200 exosolar planets have been discovered to date. Most of these are detected indirectly, by the gravitational pull they exert on their parent star. Directly observing exosolar planets by detecting the light reflected from them is very difficult, because a star's brilliance obscures light coming from any planets orbiting it. However, sometimes the orbit of an exosolar world is aligned so that it eclipses its star as seen from Earth. In these rare cases, called transits, light from that planet can be seen directly.

For information about Epoxi, visit *www.nasa.gov/mission_pages/epoxi*.

International Group Plans Strategy for Mars Sample Return Mission

NASA and an international team are developing plans and seeking recommendations to launch the first Mars mission to bring soil samples back to Earth. The ability to study soil from Mars here on Earth will contribute significantly to answering questions about the possibility of life on the Red Planet. Returned samples will also increase understanding of the useful or harmful properties of martian soil, which will support planning for the eventual human exploration of Mars.

The International Mars Architecture for Return of Samples (IMARS) task force recently met in Washington to lay the foundation for an international collaboration to return samples from Mars. NASA hosted the meeting, and participants included representatives from more than half a dozen countries and NASA, the European Space Agency (ESA), the Canadian Space Agency, and the Japan Aerospace Exploration Agency (JAXA). IMARS is a committee of the International Mars Exploration Working Group (IMEWG). The group was formed in 1993 to provide a forum for the international coordination of Mars exploration missions.

"The potential paradigm-changing science from Mars samples makes this mission a high priority of the National Academy of Sciences," said Doug McCuistion, NASA's Mars Exploration Program director, Science Mission Directorate, Washington. "The exciting progress being made by the IMARS team is contributing directly to making this mission a reality in the next decade, All spacefaring nations have a standing invitation from IMEWG to participate in IMARS."

Scientists reviewed past engineering work on a Mars sample return mission, international science priorities, and sample receiving facility requirements. The IMARS team made significant progress in many of the key issues associated with the integration of science and engineering challenges. The team established a common strategy for launching a Mars sample return mission and achieving scientific objectives that can be met only by returning martian soil to Earth.

For more information about NASA's Mars Program, visit *www.nasa.gov/mars*. For more information about the European Space Agency, visit *www.esa.int*.

NASA Delays Mars Scout Mission to 2013

An artist's rendering of a sample return mission blasting off from Mars. Credit: NASA/JPL.

NASA has announced that the next mission in the Mars Scout program, originally planned for launch in 2011, is now targeted for launch in 2013. The schedule slip is because of an organizational conflict of interest that was discovered in one of the mission proposal team's Phase A Concept Study. This was the shortest delay for the mission possible because opportunities to send spacecraft to Mars occur only once every 26 months.

NASA will fund current proposals to meet a new launch date in 2013. Revised proposals will be due in August 2008, and the evaluation and selection will take place in December 2008. In November, NASA postponed the Scout mission's evaluation, selection, and announcement so the agency could resolve an organizational conflict of interest. The conflict of interest was discovered shortly after the concept study reports were received.

The extent of the conflict was severe enough that NASA determined its only recourse was to stop the evaluation and reconstitute the entire review panel that provides the technical and cost analyses for mission selections.

"We regret the delay, but NASA is taking this step to be proactive in preventing problems early on," said Mars Exploration Program Director Doug McCuistion, NASA Headquarters. "Because these are cost-capped missions, it is better to address the schedule risk now rather than put the winning proposer at a cost and schedule disadvantage from the start. Delaying the next Scout mission and allowing the mission teams to replan their proposed missions for 2013 reestablishes an acceptable schedule to meet a Mars launch date. It will also reduce the risk of cost overruns driven by the tight mission schedule that would have resulted if launch had remained in 2011."

In the first round of the Mars Scout 2006 competition, two missions for 2011 were originally selected from 26 proposals for further evaluation in a concept study phase. The selected missions were Mars Atmosphere and Volatile EvolutioN mission (MAVEN), principal investigator Bruce Jakosky of the University of Colorado, Boulder; and The Great Escape mission (TGE), principal investigator Jim Burch of the Southwest Research Institute, San Antonio. Both missions would provide similar measurements of Mars' upper atmosphere, including its dynamics and evolution, which have been given a high priority by the scientific community.

For more information about future Mars missions, visit *mars.jpl.nasa.gov/missions/future*.

NASA and the Beatles Celebrate Anniversaries by Beaming Song "Across the Universe" Into Deep Space

For the first time ever, NASA beamed a song — The Beatles "Across the Universe" — directly into deep space at 4:00 p. m. Pacific Time on Monday, February 4. The transmission over NASA's Deep Space Network commemorated the 40th anniversary of the day The Beatles recorded the song, as well as the 50th anniversary of NASA's founding and the group's beginnings. Two other anniversaries were also honored: The launch 50 years ago of Explorer 1, the first U.S. satellite, and the founding 45 years ago of the Deep Space Network, an international network of antennas that supports missions to explore the universe.

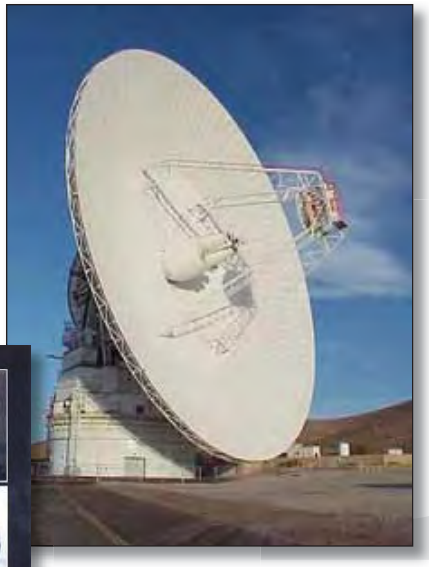
Technicians at NASA's Jet Propulsion Laboratory, where the Deep Space Network is managed, sent the command that started the transmission. The transmission is being aimed at the North Star, Polaris, which is located 431 light years away from Earth. The song will travel across the universe at a speed of 186,000 miles per second. Former Beatle Sir Paul McCartney expressed excitement that the tune, which was principally written by fellow Beatle John Lennon, was being beamed into the cosmos. "Amazing! Well done, NASA!" McCartney said in a message to the space agency. "Send my love to the aliens. All the best, Paul."

Lennon's widow, Yoko Ono, characterized the song's transmission as a significant event. "I see that this is the beginning of the new age in which we will communicate with billions of planets across the universe," she said.

It is not the first time Beatles music has been used by NASA; in November 2005, McCartney performed the song "Good Day Sunshine" during a concert that was transmitted to the International Space Station. "Here Comes the Sun," "Ticket to Ride," and "A Hard Day's Night" are among other Beatles' songs that have been played to wake astronaut crews in orbit.

February 4 was declared "Across The Universe Day" by Beatles fans to commemorate the anniversaries. As part of the celebration, the public around the world was invited to participate in the event by simultaneously playing the song at the same time it was transmitted by NASA.

For information about the Deep Space Network, visit *deepspace.jpl.nasa.gov*/dsn/.



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,
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 lunar and planetary science and exploration. The copy deadline for the next issue is April 11, 2008. 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*.

To be added to the postal mailing list to receive notification by postcard of future issues, please send your name, address, and phone number to LPIB Notifications, 3600 Bay Area Blvd., Houston TX 77058-1113, USA.

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Gordon A. McKay

Gordon A. McKay, 62, passed away on February 8, 2008. Born in Titusville, Pennsylvania, McKay graduated from Rice University and received his Ph.D. from the University of Oregon. He worked as a planetary scientist at NASA Johnson Space Center for nearly 30 years to discover the origins of the Moon and Mars. He was internationally known for his experimental work, duplicating in the laboratory the important processes that formed the solar system.

Beginning his career as a Ph.D. student on the first lunar samples returned to Earth by the Apollo astronauts and ending it in a role of exceptional leadership at a NASA review panel, McKay devoted his life to public service and the advancement of scientific knowledge. His decades of research yielded numerous major contributions and international recognition in lunar and martian petrology and geochemistry, most notably in the area of petrogenesis — how the lunar rocks were formed. He began his formal association with NASA in 1977 as a two-year post-doc, and spent a year at NASA Headquarters as a management fellow before permanently joining the NASA family at the Johnson Space Center.

Over his career, McKay served on and led innumerable review panels, study teams, and working groups. In recent years, he also developed close working relationships with Japanese researchers, spending seven months at the University of Tokyo working on martian meteorites, another area of his expertise. Most recently, he was assisting NASA with its future lunar and Mars exploration plans.

In addition to his scientific contributions, McKay was a respected and well-loved manager for nearly two decades in the Astromaterials Research and Exploration Science Division at JSC, fondly but firmly "herding cats" (as he often described it) to help NASA achieve its goals. He also had a passionate commitment to educating and inspiring young scientists, mentoring dozens of interns and students over the years. In addition to his professional service, McKay also believed in public service, serving as an El Lago City Councilman.

Edward Chao

Edward Ching-Te Chao, 88, a geologist with the U.S. Geological Survey for 45 years whose identification of two dense forms of minerals in nature paved the way for scientists to understand the structure of the Earth's mantle, died of congestive heart failure on February 3, 2008, at his home in Fairfax County.

Chao studied a variety of substances, including minerals of the Meteor Crater in Arizona, rocks in the Ries Crater in southwestern Germany, ore deposits in Inner Mongolia, and Moon rocks collected by astronauts in the late 1960s. He was the first person to recognize two high-pressure forms of silica in nature: coesite and stishovite. For this work, Chao was awarded the Wetherill Medal of the Franklin Institute in 1965.

The identification and description of both minerals was "a really huge discovery for this field of high-pressure minerology and had very important implications for geophysics," said Russell J. Hemley, director of the Geophysical Laboratory at the Carnegie Institution of Washington. The discovery of those minerals, found beneath the Earth but never before seen on its surface, helped scientists understand the role that meteors play in the formation of the planet. "He founded the field of impact metamorphism," said Ahmed El Goresy, professor of cosmochemistry at the University of Bayreuth in Germany.

Chao was born in Suzhou, China, and moved to the United States in 1945 to teach Chinese to U.S. troops. When World War II ended, he graduated from the University of Chicago and received a doctoral degree in geology there in 1948. He moved to Alexandria to work for the Geological Survey, where he stayed until he retired in 1994.

From 1960 to 1977, Dr. Chao worked on meteor and lunar studies. Detailed to NASA to work on designing the lunar sampling program, Dr. Chao was a member of the preliminary examination teams and a principal investigator for the Apollo research programs. For the Apollo 12 mission, he was sequestered with the astronauts to analyze the lunar rocks that were brought back. His research in the areas of terrestrial and lunar impacts was rewarded with the Barringer Medal by the Meteoritical Society in 1992, whose citation called him the "quintessential founder of a new area of research in metamorphic petrology: impact metamorphism of natural rocks." The mineral chaoite, which was discovered in the Reis Crater, was named for him.

Spotlight on Education

"Spotlight on Education" highlights events and programs that provide opportunities for planetary 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's Education Department at shupla@lpi.usra.edu.

Education/Public Outreach Forum: Reaching the Moon

Our Moon is easily seen by people of all cultures, everywhere around the world. The year 2008 will see the launch of three new missions to the Moon: Lunar Reconnaissance Orbiter (LRO), Lunar Crater Observation and Sensing Satellite (LCROSS), and Chandrayaan-1. These will join Kaguya and Chang'e 1, ushering in an unparalleled period of lunar discovery. These missions will characterize surface materials to identify potential resources, photograph and map the lunar landscape to determine future landing sites, define the lunar environment, and search for water in permanently shadowed polar regions, in preparation for future human exploration. How should educators and scientists leverage their efforts and the upcoming missions, to share the Moon with their audiences?

The Education/Public Outreach LPSC Forum for scientists and space science educators will take place on Sunday, March 9, at the Lunar and Planetary Institute. Registration for the Forum is free, but advanced registration is required. Lunch is being provided for the Education Forum courtesy of Sky-Skan, Inc. An agenda for the day will be e-mailed to all registered participants by March 1, 2008.

Please note that the workshop will be held at the Lunar and Planetary Institute, not at the conference hotel. For more information, visit *www.lpi.usra.edu/education/lpsc_2008* or contact Christine Shupla (shupla@lpi.usra.edu; 281-486-2135).

Carl Sagan Medal for Excellence in Public Communication in Planetary Science

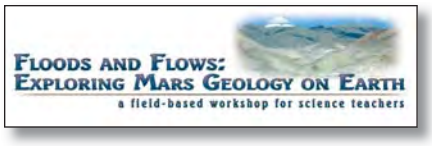
Nominate a fellow scientist for their involvement in public outreach. The Carl Sagan Medal for Excellence is awarded annually by the Division for Planetary Sciences of the American Astronomical Society, to recognize and honor outstanding communication by an active planetary scientist to the general public. It is to be awarded to scientists whose efforts have significantly contributed to a public understanding of, and enthusiasm for, planetary science. The Sagan Medal consists of a medal with citation and a cash award. The recipient of the Sagan Medal is expected to present a public lecture on a subject in planetary science of his or her choosing. For more information, visit *dps.aas.org/prizes/sagan*.

Undergraduate Research Internship Opportunity

NASA's University Student Research Program offers research experiences at NASA Centers to undergraduates who are U.S. citizens. Applications are now available for 2008 fall sessions. Applicants must be sophomores, juniors, or seniors at the start of the internship, with an academic major or course work concentration in engineering, mathematics, computer science, or physical or life sciences. For more information, visit *www.nasa.gov/audience/forstudents/postsecondary/programs/Undergraduate_Student_Research_Project.html.*

NASA-Sponsored Field-Based Workshop

The Lunar and Planetary Institute invites educators to apply to attend "Floods and Flows: Exploring Mars Geology on Earth," from July 13–19, 2008. This fieldtrip for intermediate-grade-level science teachers (other educators are invited) visits the site of Ancient Glacial Lake Missoula and traces its flood waters through Montana, Idaho, and into Washington. From this field experience and accompanying classroom activities,



participants will build an understanding of surface processes on Earth, including water flow, volcanism, glaciation, and sedimentation. Attendees will extend their understanding to interpret what the features on the surface of Mars suggest about the past environments and history of the Red Planet. The experience will be divided between the field and lab, where participants work with classroom-tested, hands-on inquiry-based activities and resources that can be used to enhance Earth and space science teaching in the classroom. Participants receive lesson plans, supporting resources, and presentations. A limited number of grants are available to cover registration. Applications are due April 7, 2008. For more information, go to *www.lpi.usra.edu/education/fieldtrips/2008/*.

Astronomy Day and Space Day

Planetary scientists interested in public outreach may want to become involved in their community's celebration of Astronomy Day, May 10, 2008 (Astronomy Week is May 5–11), or Space Day, May 2, 2008. Many planetariums, museums, and amateur astronomy clubs hold events to involve the public in astronomy, and may welcome a volunteer with your knowledge and skills. For more information on Astronomy Day, visit *www.astroleague.org/al/astrotoday/astrotoday.html*, and for information on Space Day, visit *www.spaceday.org/index.html*. You can find a list of local clubs and organizations at *www.skyandtelescope.com/community/organizations*.

International Year of Astronomy

In the year 2009, the world will celebrate the International Year of Astronomy as it commemorates the 400th anniversary of Galileo's use of a telescope to study the skies, and Kepler's publication of *Astronomia Nova*. 2009 is also the anniversary of many other historic events in science, including Huygen's 1659 publication of *Systema Saturnium*.

In 2008 at the annual meeting of the Astronomical Society of the Pacific (May 31–June 4 in conjunction with the American Astronomical Society meeting), education and outreach professionals will gather to discuss international, regional, and local programs for the International Year of Astronomy in 2009, which celebrates the 400th anniversary of the astronomical telescope. If you are interested in planning activities in 2009, this meeting is an excellent chance to learn more about what various institutions and organizations are proposing to do, and to coordinate your ideas with colleagues around the country and the world. For more information, go to *astronomy2009.us/*.

NASA Planetary Science Summer School Applications

NASA is accepting applications from science and engineering post-docs, recent Ph.D.s, and doctoral students for its 20th Annual Planetary Science Summer School, which will hold two separate sessions this summer (July 21–25 and August 4–8) at the Jet Propulsion Laboratory in Pasadena, California.

During the program, student teams will carry out the equivalent of an early mission concept study, prepare a proposal authorization review presentation, present it to a review board, and receive feedback. At the end of the week, students will have a clearer understanding of the life cycle of a space mission; relationships between mission design, cost, and schedule; and the tradeoffs necessary to stay within cost and schedule while preserving the quality of science.

Applications are due May 1, 2008. Partial financial support is available for a limited number of individuals. Further information is available at *pscischool.jpl.nasa.gov*.

New and Noteworthy

Books

The Lunar Exploration Scrapbook: A Pictorial History of Lunar Vehicles. Robert Godwin. Apogee Books, 2007. 224 pp., Hardcover, $36.95. *www.apogeespacebooks.com*

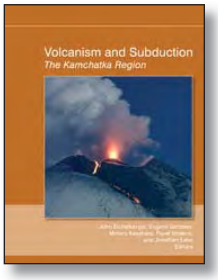
In his latest book, *The Lunar Exploration Scrapbook*, noted editor and writer Godwin has distilled years of research into an unprecedented look at the many machines considered by the United States for lunar exploration. The book comprises over 200 three-dimensional wire-frame texture-mapped models of lunar vehicles. This includes more than 80 lunar landers, 80 rovers and mobile laboratories, and more than 50 lunar flying vehicles designed between1938 and 1972. Astronaut Richard Gordon, Command Module Pilot of Apollo 12, sums up the whole publication with his comment, "This book should be on the desk of everyone working on the next lunar lander."

The Mystery of the Missing Antimatter. Helen R. Quinn and Yossi Nir. Princeton University Press, 2008. 292 pp., Hardcover, $29.95. *press.princeton.edu*

In the first fractions of a second after the Big Bang lingers a question at the heart of our very existence: Why does the universe contain matter but almost no antimatter? The laws of physics tell us that equal amounts of matter and antimatter were produced in the early universe — but then, something odd happened. Matter won out over antimatter; had it not, the universe today would be dark and barren. But how and when did this occur? Authors Quinn and Nir guide readers into the very heart of this mystery, and along the way offer an exhilarating grand tour of cutting-edge physics. They explain both the history of antimatter and recent advances in particle physics and cosmology; they discuss the enormous, high-precision experiments that particle physicists are undertaking to test the laws of physics at their most fundamental levels, and how their results reveal tantalizing new possibilities for solving this puzzle at the heart of the cosmos. This book is at once a history of ideas and an exploration of modern science and the frontiers of human knowledge.

Human Missions to Mars: Enabling Technologies for Exploring the Red Planet. Donald Rapp. Springer, 2008. 520 pp., Hardcover, $139.00. *www.springer.com*

This book looks at human missions to Mars from an engineering perspective. Topics discussed include the pros and cons of robotic exploration vs. human exploration; how space missions are planned and how they may be achieved as a sequence of separate steps; the complex issues relating to the outward journey to Mars and the return leg; a wide range of elements critical to a human Mars mission; the possible utilization of any resources indigenous to Mars; the range of previous Mars mission studies and their technologies; and how NASA is planning for its return to the Moon, and the use of the Moon as a stepping stone to Mars. Finally the author presents a detailed analysis of why, in his opinion, the current NASA approach will fail to send humans to Mars before 2080. The book includes appendices describing the use of solar energy on the Moon and on Mars and the value of indigenous water on Mars. This book was written for space scientists and engineers, intermediate-level undergraduates, and postgraduate researchers studying every aspect of human missions to Mars.



Volcanism and Subduction: The Kamchatka Region. Edited by John Eichelberger, Evgenii Gordeev, Minoru Kasahara, Pavel Izbekov, and Jonathan Lees. American Geophysical Union, 2007. 350 pp., Hardcover, $127.00. *www.agu.org*

Volcanism and Subduction covers coupled magmatism and tectonics in the Kamchatka region, where the torn North Pacific slab dives into hot mantle. Senior Russian and American authors grapple with the dynamics of the cusp with perspectives from the west and east of it, respectively, while careful tephrostratigraphy yields a remarkably precise record of behavior of storied volcanos such as Kliuchevskoi and Shiveluch. Toward the south, Japanese researchers elucidate subduction earthquake processes with unprecedented geodetic resolution. Looking eastward, new insights on caldera formation, monitoring, and magma ascent are presented for the Aleutians. This is one of the first books of its kind printed in the English language. Readers beginning research in the region will find in this book a useful context and introduction to the region's scientific leaders. Others who wish to apply lessons learned in the North Pacific to their areas of interest will find the volume a valuable reference.

After Sputnik: 50 Years of the Space Age. Edited by Martin Collins. Smithsonian Books, 2007. 256 pp., Hardcover, $35.00. *www.sipress.si.edu*

Space exploration has changed the way we look at our universe, our planet, and even the people around us. After Sputnik explores the first 50 years of achievements in space with a guided tour of the artifacts in the collection of the National Air and Space Museum. This is the premier collection of space artifacts in the world, and includes most U.S. artifacts; major Russian artifacts on loan; and most recently, Burt Rutan's Space Ship One. In addition, the museum's popular culture collection and an art collection include objects such as a 1930s Buck Rogers stopwatch and Norman Rockwell's famous painting, *Suiting Up*. Using a selection of 180 to 200 objects, this book tells the artifact stories to convey a sense of what it was like to be there when the object was in use, accompanied by dramatic photographs. The artifacts range from the famous, such as John Glenn's Friendship 7 Mercury spacecraft and the Mars Pathfinder lander and Sojourner rover, to the equally rare, but less well-known, such as the Surveyor 3 camera returned from the Moon and Gordon Cooper's space boots.

Robots in Space: Technology, Evolution and Interplanetary Travel. Roger D. Launius and Howard E. McCurdy. Johns Hopkins University Press, 2007. 336 pp., Hardcover, $35.00. *www.press.jhu.edu*

In *Robots in Space*, Launius and McCurdy tackle questions of interplanetary travel with rigorous scholarship and disciplined imagination, jumping comfortably among the worlds of rocketry, engineering, public policy, and science fantasy to expound upon the possibilities and improbabilities involved in trekking across the Milky Way and beyond. They survey the literature, fictional as well as academic studies; outline the progress of space programs in the United States and other nations; and assess the current state of affairs to offer a conclusion startling only to those who haven't spent time with Asimov, Heinlein, and Clarke: To traverse the cosmos, humans must embrace and entwine themselves with advanced robotic technologies. Their discussion is as entertaining as it is edifying and their assertions are as sound as they are fantastical.

DVD

Magnificent Desolation. Presented by HBO Home Video, 2007, 40 minutes, one disc. $19.98. *store.hbo.com*

Only 12 humans have walked on the Moon. You're next! Presented and narrated by Tom Hanks, *Magnificent Desolation: Walking on the Moon* is an IMAX documentary film that transports the viewer to the lunar surface, where they can walk alongside the 12 extraordinary astronauts who have been there, experiencing what they saw, heard, and felt.

Online Resource

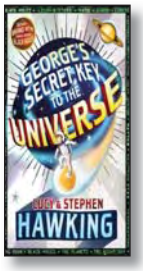
SciVee. *www.scivee.tv*

SciVee is about the free and widespread dissemination and comprehension of science. Created for scientists, by scientists, SciVee moves science beyond the printed word and lecture theater, taking advantage of the Internet as a communication medium where scientists young and old have a place and a voice. SciVee is operated in partnership with the Public Library of Science (PLoS), the National Science Foundation (NSF), and the San Diego Supercomputer Center (SDSC). SciVee allows scientists to communicate their work as a multimedia presentation incorporated with the content of their published article. Other scientists can freely view uploaded presentations and engage in virtual discussions with the author and other viewers. SciVee also facilitates the creation of communities around specific articles and keywords. This medium can be used to meet peers and future collaborators that share particular research interests.

FOR KIDS!!!

Astronaut on the Moon Night Light. From Illuminart. $25.95. *www.thespacestore.com*

Illuminart's nightlights are handmade in Wilton, New Hampshire, from photographic quality art, medical glass, and all top-shelf components. This stunning image of Astronaut Gene Cernan on the Moon is 4" wide by 3.5" high.



George's Secret Key to the Universe. Lucy and Stephen Hawking. Simon & Schuster Children's Publishing, 2007. 304 pp., Hardcover, $17.99. *www.simonsays.com*

Stephen Hawking, author of the multi-million-copy bestselling *A Brief History of Time*, and his daughter Lucy explain the universe to readers of all ages. George's parents, who have always been wary of technology, warn him about their new neighbors: Eric is a scientist and his daughter, Annie, seems to be following in his footsteps. But when George befriends them and Cosmos, their supercomputer, he finds himself on a wildly fun adventure, while learning about physics, time, and the universe. With Cosmos' help, he can travel to other planets and a black hole. But what would happen if the wrong people got their hands on Cosmos? George, Annie, and Eric aren't about to find out, and what ensues is a funny adventure that clearly explains the mysteries of science. Garry Parsons' energetic illustrations add humor and interest, and his scientific drawings add clarity; there are also eight four-page full-color inserts of scientific photos. For ages 8 and up.

Spark™ Talking Telescope. From Discovery Channel. $34.95. *shopping.discovery.com*

Take your child on a tour of the solar system and introduce the wonders of space. The Spark™ Talking Telescope includes 20 vivid, full-color slides depicting the wonders of the solar system, both manmade and natural. This educational toy features beautiful NASA imagery and narrates more than 200 fun facts, and includes seven Spark™ cards that illustrate the scientific process of discovering the solar system. Fact and quiz modes help teach about the solar system, and a full-color parents' "Lab Assistant" guide is included. This talking telescope lets your child explore space and make their own stellar discoveries, just like a real astronomer. For ages 5 and up.

Way Cool Science Series DVDs: Rockfinders and Spacetrekkers. Produced by Mazzarella Media, 2003, 27 minutes, one disc each. $14.95 each. *www.mazz.com*

Rockfinders: What are rocks? How are rocks formed? These are just some of the questions that science enthusiast Max Orbit explores in this fun-filled, activity packed program. Rockfinders introduces kids to the fascinating world of rocks, minerals and fossils. For grades 3–6.

Spacetrekkers: This DVD introduces elementary-age children to our solar system. Science enthusiast Max Orbit helps viewers learn about the planets, moons, asteroids, comets, and more. On their journey breathtaking footage, incredible telescopic photos and colorful animation are used to show viewers the many fascinating aspects of our solar system. For grades 3–6.

Calendar 2007

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*

4–5 Go for Lunar Landing: From Terminal Descent to Touchdown, Tempe, Arizona. *http://ser.sese.asu.edu/GO/*

8–9 Brown-Vernadsky Microsymposium 47: Early Climate and Weathering on Mars, Houston, Texas. *http://www.planetary.brown.edu/html_pages/micro47.htm*

10–14 39th Lunar and Planetary Science Conference (LPSC 2008), League City, Texas. *http://www.lpi.usra.edu/meetings/lpsc2008/*

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

26–28 Science with the Giant Magellan Telescope, Canberra, Australia. *http://www.mso.anu.edu.au/GMTMeeting/*

27 Understanding the Poles of the Earth, Moon and Mars, Paris, France. *http://www7.nationalacademies.org/ssb/IGY_Paris_event.html*

31–Apr 3 From Exoplanets to Galaxy Clusters: Science with Astro-WISE, Leiden, The Netherlands. *http://www.lorentzcenter.nl/lc/web/2008/299/info.php3?wsid=299*

April

8–12 Exploring the Solar System and the Universe, Bucharest, Romania. *http://www.astro.ro/~centenar/*

11–12 Peering into the Cradle of Life: Processes and Habitats on the Archean Earth, Vienna, Austria. *http://archenv.geo.uu.nl/*

13–18 European Geosciences Union General Assembly 2008, Vienna, Austria. *http://meetings.copernicus.org/egu2008/*

15–17 2008 Astrobiology Science Conference (AbSciCon 2008), Santa Clara, California. *http://abscicon.seti.org*

20–23 American Association of Petroleum Geologists Annual Convention and Exhibition: Deliver the Conventional; Pursue the Unconventional, San Antonio, Texas. *http://www.aapg.org/sanantonio/*

21–23 Ground Truth from Mars: Science Payoff from a Sample Return Mission, Albuquerque, New Mexico. *http://www.lpi.usra.edu/meetings/msr2008/*

21–23 Mars Water Cycle Workshop, Paris, France. *http://www.aero.jussieu.fr/info-pratique/seminaire/MarsWC-Site/Homepage.html*

28–May 1 AAS Division on Dynamical Astronomy, Boulder, Colorado. *http://dda.harvard.edu/*

29–May 2 Planetary Dunes Workshop: A Record of Climate Change, Alamogordo, New Mexico. *http://www.lpi.usra.edu/meetings/dunes2008*

30–May 2 Symposium on Geophysics and Remote Sensing in Determination of Near-Surface Structures (GARS2008), Izmir, Turkey. *http://web.deu.edu.tr/gars2008/en.html*

May

5–8 The Science of Solar System Ices (ScSSI): A Cross-Disciplinary Workshop, Oxnard, California. *http://www.lpi.usra.edu/meetings/scssi2008/*

7–8 Fifth Meeting of the Venus Exploration Analysis Group (VEXAG), Greenbelt, Maryland. *http://www.lpi.usra.edu/vexag*

12–16 SpaceOps 2008: Protecting the Earth, Exploring the Universe, Heidelberg, Germany. *http://www.aiaa.org/content.cfm?pageid=230&lumeetingid=1436&viewcon=overview*

26–29 The Solar System Bodies: From Optics to Geology, Kharkiv, Ukraine. *http://www.astron.kharkov.ua/conference/ssb/08/index.php*

27–30 2008 Joint Assembly, Fort Lauderdale, Florida. *http://www.agu.org/meetings/ja08/*

28–30 Far-Infrared Astronomy from Space: A Community Workshop About the Future, Pasadena, California. *http://www.ipac.caltech.edu/irspace/*

31–Jun 4 Preparing for the International Year of Astronomy: A Hands-On Symposium and Associated Workshops, St. Louis, Missouri. *http://www.astrosociety.org/events/meeting.html*

June

1–5 American Astronomical Society 212th Meeting, St. Louis, Missouri. *http://www.aas.org/meetings/*

1–6 Solar Variability, Earth's Climate and the Space Environment, Bozeman, Montana. *http://solar.physics.montana.edu/SVECSE2008/*

8–11 Fifth Annual Planetary and Terrestrial Mining Sciences Symposium (PTMSS), Montreal, Quebec. *http://www.ptmss.com/*

9–12 2008 RASC-AL Forum, Cape Canaveral, Florida. *http://www.lpi.usra.edu/rascal/*

16–18 Extra-Solar Super-Earths, Nantes, France. *http://www.sciences.univ-nantes.fr/geol/SuperEarths2008/*

16–19 ASTRONET Infrastructure Roadmap Symposium: Towards a Strategic Plan for European Astronomy, Liverpool, United Kingdom. *http://www.astro.livjm.ac.uk/~airs2008/index.html*

16–20 Asia Oceania Geosciences Society, Busan, Korea. *http://www.asiaoceania.org/aogs2008/*

23–27 Sixth International Planetary Probe Workshop, Atlanta, Georgia. *http://www.planetaryprobe.org/*

26–28 International Conference on 100 Years Since the Tunguska Phenomenon: Past, Present, and Future, Moscow, Russia. *http://tunguska.sai.msu.ru/*

29–Jul 3 Ninth International Conference on Permafrost, Fairbanks, Alaska. *http://nicop.org*

July

6–11 Astronomical Polarimetry 2008: Science from Small to Large Telescopes, Quebec, Canada. *http://www.astro.umontreal.ca/astropol2008/*

8–11 Polar Research: Arctic and Antarctic Perspectives in the International Polar Year, St. Petersburg, Russia. *http://www.scar-iasc-ipy2008.org/*

13–20 37th COSPAR Scientific Assembly, Montreal, Canada. *http://www.cospar-assembly.org/*

14–18 Asteroids, Comets, Meteors 2008, Baltimore, Maryland. *http://acm2008.jhuapl.edu/*

20–23 NLSI Lunar Science Conference, Moffett Field, California. *http://www.lpi.usra.edu/meetings/nlsc2008/*

20–24 Australian Earth Sciences Convention 2008, Perth, Western Australia. *http://www.iceaustralia.com/aesc2008/*

20–26 International Symposium on Topical Problems of Nonlinear Wave Physics (NWP-2008), Nizhny Novgorod, Russia. *http://www.nwp.sci-nnov.ru/*

27–Aug 2 Dynamics of Solar System Bodies, Tomsk, Russia. *http://sibeclipse2008.nxt.ru*

28–Aug 1 Symposium on Saturn After Cassini-Huygens, London, United Kingdom. *http://www.saturnaftercassini.org*

28–Aug 1 71st Annual Meeting of the Meteoritical Society (MetSoc 2008), Matsue, Japan. *http://www.lpi.usra.edu/meetings/metsoc2008/*

29–Aug 1 2008 Western Pacific Geophysics Meeting, Cairns, Australia. *http://www.agu.org/meetings/wp08/*

August

3–8 International Radiation Symposium (IRS2008), Iguassu Falls, Brazil. *http://www.irs2008.org.br*

6–14 33rd International Geological Congress, Oslo, Norway. *http://www.33igc.org*

10–14 Symposium at IGC33: Environments and Consequences of Impacts of Asteroids and Comets, Oslo, Norway. *http://www.33igc.org*

11–16 Sixth International Conference on Case Histories in Geotechnical Engineering, Arlington, Virginia. *http://campus.umr.edu/6icchge/*

18–22 Large Meteorite Impacts and Planetary Evolution IV, Vredefort Dome, South Africa. *http://www.lpi.usra.edu/meetings/lmi2008/*

24–29 XV International Conference on the Origin of Life, Florence, Italy. *http://www.dbag.unifi.it/issol2008/*

25–29 Extrasolar Planets in Multi-Body Systems: Theory and Observations, Torun, Poland. *http://www.astri.uni.torun.pl/~workshop/*

September

7–12 Eleventh Conference on Electromagnetic and Light Scattering, Hatfield, England. *http://www.els-xi-08.org/*

8–12 Future Ground Based Solar System Research: Synergies with Space Probes and Space Telescope, Portoferraio, Italy. *http://www.arcetri.astro.it/~elba2008/*

8–12 Cosmic Dust - Near & Far, Heidelberg, Germany. *http://www.mpia-hd.mpg.de/DNF08/*

15–17 Workshop on the Early Solar System Impact Bombardment, Houston, Texas. *http://www.lpi.usra.edu/meetings/bombardment2008*

18–21 International Meteor Conference 2008, Sachticka, Slovakia. *http://www.imo.net/imc2008/*

22–26 European Planetary Science Congress 2008, M nster, Germany. *http://meetings.copernicus.org/epsc2008/*

29–Oct 3 59th International Astronautical Congress, Glasgow, Scotland. *http://www.iafastro.com/index.php?id=78*

October

5–9 2008 Joint Meeting of the Geological Society of America: Celebrating the International Year of Planet Earth, Houston, Texas. *https://www.acsmeetings.org/2008/*

5–10 IAGA International Symposium: Space Weather and Its Effects on Spacecraft, Cairo, Egypt. *http://iaga.cu.edu.eg/*

11–15 40th Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society, Ithaca, New York. *http://www.aas.org/dps/meetings.html*

20–24 Second Workshop on Mars Valley Networks, Moab, Utah. *mailto:workshops@si.edu*

26–31 2008 Huntsville Workshop: The Physical Processes for Energy and Plasma Transport Across Magnetic Boundaries, Huntsville, Alabama. *http://hsvworkshop.msfc.nasa.gov/*