Return to the Moon: A New Perspective

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Return to the Moon: A New Perspective

Sometimes history does repeat itself. Just as 40 years ago as the United States prepared to land the first humans on the Moon, several nations are now beginning their own precursor robotic exploration of the Moon with an eye to the future. Japan and China have both launched advanced orbital mapping missions to the Moon in the past three months, with India and the United States to follow in 2008. Both Asian missions are successfully in orbit and conducting instrument checkouts and calibrations before full-scale mapping begins. They bring a wide variety of scientific investigations across a broad reach of the electromagnetic spectrum to bear on our nearest neighbor, hoping to unlock its secrets. At stake are knowledge of lunar resources, including whether ice exists at the poles, and a clearer understanding of the origins and earliest history of the Moon.

The United States has a strong interest in returning to the Moon with astronauts, and the fleet of orbiting robots, including Lunar Reconaissance Orbiter to launch next summer, will aid in guiding those explorers to the right location. To further aid those who are planning those future expeditions, several groups are digging into the old Apollo records, including planning charts, reports, and images. Many of these resources are now online, including at the Lunar and Planetary Institute, available for all lunar aficionados. The next decade promises to be an exciting one for lunar research. With the new missions underway, we feature in this issue several related reports on these new initiatives and the restoration of the historic records and archives. These include references to online resources that can be enjoyed by all.

KAGUYA at the Moon

The Japanese Selenological and Engineering Explorer (SELENE), "KAGUYA," was successfully launched on September 14, 2007. On October 18, KAGUYA was injected into lunar orbit at an altitude of approximately 100 kilometers.

The major objectives of the mission are to understand the Moon's origin and evolution and to observe the Moon in various ways in order to utilize it in the future. The lunar missions that have been conducted so far have gathered a large amount of information on the Moon, but the mysteries of its origin and evolution have been left unsolved.

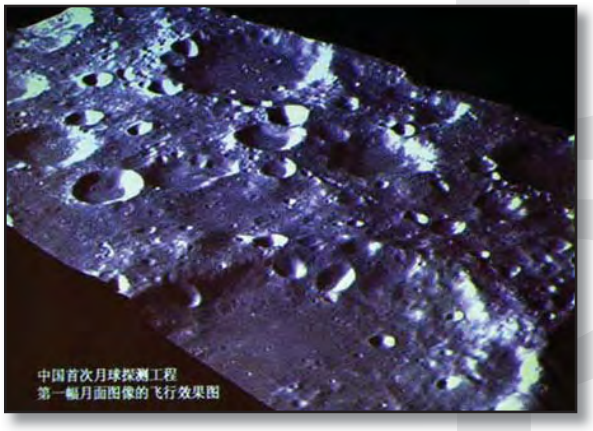
KAGUYA will investigate the entire Moon in order to obtain information on its elemental and mineralogical composition, its geography, its surface and subsurface structure, the remnant of its magnetic field, and its gravity field. The results are expected to lead to a better overall understanding of the Moon's evolution.

At the same time, the observation equipment installed on the orbiting satellite will observe plasma, the electromagnetic field, and high-energy particles. The data obtained in this way will be of tremendous scientific value for exploring the possibility of using the Moon for human endeavors.

Earlier in November KAGUYA returned the world's first high-definition images taken from space. The first images released were of an Earth-rise, a phenomenon seen only from satellites that orbit the Moon. (An Earth-rise cannot be observed by someone on the Moon, as they will always see Earth at the same position.) KAGUYA's images were taken while the spacecraft was approximately 380,000 kilometers from the Earth.

For more information, visit *www.jaxa.jp/projects/sat/selene/index_e.html*.

China Joins Fleet of Lunar Explorers



China launched its much awaited lunar satellite, Chang'e 1, on October 24 from the Xichang Satellite Launch Center in southwest China's Sichuan Province. The milestone lunar orbiter project only cost 1 to 1.4 billion yuan (about 133 to 187 million U.S. dollars). Chang'e 1 is the most sophisticated satellite China has built and maneuvered to date. The satellite weighs about 2300 kilograms, with the fuel accounting for nearly half its total weight.

Chang'e 1, named after a legendary Chinese goddess of the Moon, entered Earth-Moon transfer orbit late in October and entered the Moon's orbit early in November. On November 26, the satellite's first Moon images were released.

Scientific objectives of the Change'e 1 mission include providing a three-dimensional survey of the Moon's surface, analyzing the abundance and distribution of elements on the lunar surface, and investigating the characteristics of lunar regolith and the powdery soil layer on the surface. Chang'e-1 carries eight pieces of probing equipment, including a stereo camera and interferometer, imager and gamma/X-ray spectrometer, laser altimeter, microwave detector, high-energy solar particle detector, and low-energy ion detector.

The lunar probe represents a third milestone in China's space exploration program, following the success of manmade satellites and manned space flights. According to Chinese officials, China will share the achievements of the lunar exploration with the world, but will not be involved in a Moon race with other countries.

For more information about China's Moon Exploration Program, visit *www.chinadaily.com.cn/china/china_moon_page.html*.

India Prepares for the Launch of Chandrayaan-1

Chandrayaan-1, which literally means "Moon Craft," is an unmanned lunar mission by the Indian Space Research Organization (ISRO). The mission includes a lunar orbiter as well as an impactor. The spacecraft will be launched by a modified version of the Polar Satellite Launch Vehicle.

The remote sensing satellite will weigh 1304 kilograms (590 kilograms initial orbit mass and 504 kilograms) and will carry high-resolution remote sensing equipment for visible, near infrared, and soft and hard X-ray frequencies. Over a two-year period, the goal of the mission is to survey the lunar surface to produce a complete map of its chemical characteristics and three-dimensional topography. The polar regions are of particular interest, as they might contain water ice. Scientists hope that Chandrayaan's imagery can be used to select the best location for a future lunar base.

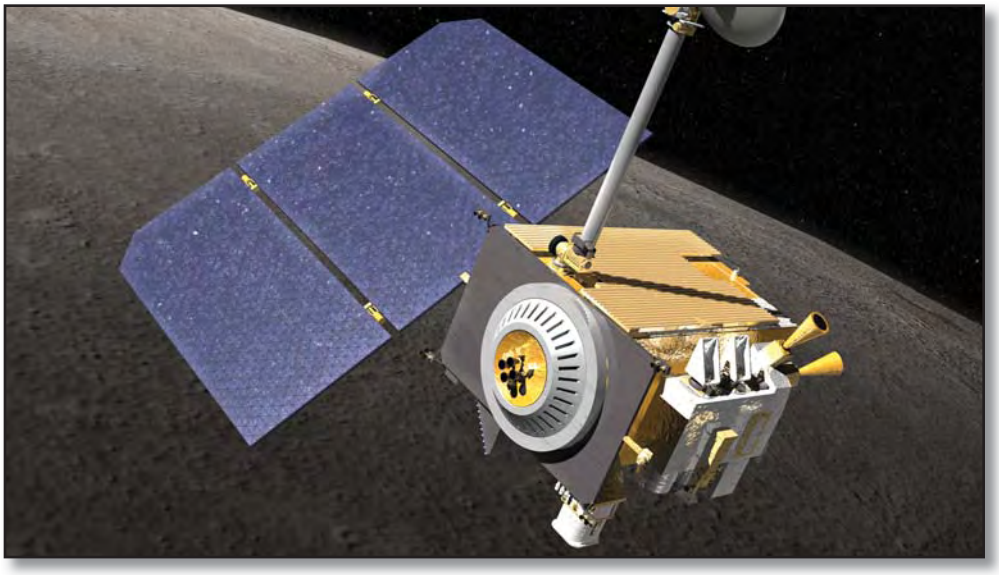
The mission includes five ISRO payloads, along with six payloads from other international space agencies such as NASA, the European Space Agency, and Bulgaria. Among these payloads are the Moon Mineralogy Mapper (M^3) from Brown University and JPL, an imaging spectrometer designed to map the mineral composition of the lunar surface, and the S-band miniSAR from the Applied Physics Laboratory at the Johns

Hopkins University, which will use scattered radiation to map ice at the lunar poles. Both of these instruments are funded by NASA. Currently scheduled to launch in early April of 2008, the estimated cost of the mission is 3.8 billion Indian rupees (INR), roughly equivalent to $83 million U.S. dollars.

As part of its second Chandrayaan mission, Chandrayaan-2, the ISRO hopes to land a motorized rover on the Moon by 2010 or 2011.

For more information about the Indian space program, visit the ISRO website at *www.isro.org*.

NASA's Lunar Reconnaissance Orbiter



The United States and its partners have begun a program to extend human presence in the solar system, beginning with a return to the Moon. The return to the Moon will enable the pursuit of scientific activities that address our fundamental questions about the history of Earth, the solar system, and the universe — and about our place in them. It will allow us to test technologies, systems, flight operations, and exploration techniques to reduce the risk and increase the productivity of future missions to Mars and beyond. It will also expand Earth's economic sphere to conduct lunar activities with benefits to life on the home planet.

The Lunar Reconnaissance Orbiter (LRO) is the first step in this endeavor, an unmanned mission to create a comprehensive atlas of the Moon's features and resources necessary to design and build a lunar outpost. LRO follows in the footsteps of the predecessors to the Apollo missions — missions designed in part to search for the best possible landing sites (such as the Ranger, Lunar Orbiter, and Surveyor missions). However, building a lunar outpost implies extended periods on the lunar surface and so the goals of LRO go beyond the requirements of these previous missions. LRO focuses on the selection of safe landing sites, identification of lunar resources, and the study of how the lunar radiation environment will affect humans.

LRO is scheduled for launch in 2008, and will enter a circular polar orbit approximately 50 kilometers above the Moon's surface (a little over 30 miles), closer than any other lunar mission. LRO will spend at least one year in low polar orbit around the Moon, collecting detailed information about the lunar environment. The LRO payload, comprising six instruments and one technology demonstration, will provide key datasets to enable a human return to the Moon.

With a comprehensive dataset focused on supporting the extension of human presence in the solar system, LRO will help identify sites close to potential resources with high scientific value, favorable terrain, and the environment necessary for safe future robotic and human lunar missions. All LRO initial datasets will be deposited in the Planetary Data System (PDS), a publicly accessible repository of planetary science information, within six months of primary mission completion. Thereafter, the datasets will be deposited in the PDS every three months. The processed datasets will help the world develop a deeper understanding of the lunar environment, paving the way for a safe human return to the Moon and for future human exploration of our solar system.

For more information, visit *lunar.gsfc.nasa.gov*.

NASA to Establish Nationwide Lunar Science Institute

NASA has announced its intent to establish a new lunar science institute. This effort, with dispersed teams across the nation, will help lead the agency's research activities for future lunar science missions related to NASA's exploration goals.

Named the NASA Lunar Science Institute (NLSI), the effort will be managed from NASA's Ames Research Center. Ames currently manages a similar, distributed NASA Astrobiology Institute.

NLSI's operations are expected to begin March 1, 2008. NLSI will augment other, already established lunar science investigations funded by NASA by encouraging the formation of interdisciplinary research teams that are larger than those currently at work in lunar science.

"I am excited about NLSI," said Alan Stern, associate administrator for NASA's Science Mission Directorate at NASA Headquarters. "As the National Academy of Sciences has told us, the science to be done at the Moon and from the Moon are of high value, and NLSI will help us coordinate and expand a number of in-depth research efforts in lunar science and other fields that can benefit from human and robotic missions that are part of NASA's exploration plans."

NLSI research teams will address current topics in basic lunar science, and perhaps astronomical, solar, and Earth science investigations that could be performed from the Moon. They also will offer a quick response capability for lunar science support to NASA's Exploration Initiative.

A national search for a NLSI director is currently underway. Most work done under NLSI's banner will take place at other NASA centers, universities, and nonprofit research groups around the nations. These groups will be competitively selected after scientific peer review.

Initially, NASA will select four or five teams for grants of $1 to $2 million each for three years, with renewals of up to five years. NASA will solicit team proposals in a 2008 NASA Research Announcement.

The Moon Wiki

— by Chuck Wood

For many of the scientists who have studied it over the last 40 years, the Moon was a mythical source of rocks and soils that were exhaustively investigated. For many researchers, there was a mental disconnect between the samples, which were allocated by a committee and distributed from a building in Houston, and the lunar setting from which they came. With more than 2200 samples returned from only 6 Apollo lunar landing sites, their source locale was less interesting than their microscopic diversity.

Now we are returning to the Moon, and the focus is entirely upon a specific place — a polar crater about which we know little. In preparation, two nations have spacecraft orbiting the Moon, and two more will join them in the next few months. These probes will finally acquire the global, high-resolution image, topographic, compositional, magnetic, and gravity data that will make individual places important in our understanding of the Moon.

The Moon Wiki, a new website created in anticipation of the need-to-know details of individual places on the Moon, is rapidly collecting data tied to named places. For each of more than 2200 named features, including all the official IAU named craters, mountains, and maria, and many informal names such as the Helmet, Valentine Dome, and US 66, there are typically 12 to 24 pieces of information, each tied back to its source. Current data types include name, latitude and longitude, diameter, depth, geologic age, and description, to name just a few.

Where available, an image is provided for each feature, along with links to images from the Lunar Orbiter and Apollo missions, as well as those captured by amateur astronomers and photographers. Similarly, there are direct links to maps such as the Lunar Aeronautic Charts (LAC) of the 1960s and 1970s, and the U.S. Geological Survey geologic maps from the same time period. Some Lunar Topographic Orthophotomaps (LTOs) maps are also available. *The Moon Wiki* is the fastest way to find maps and images for a named feature of interest.

Information on nomenclature — who is honored, who suggested the name, and when the IAU approved it (as well as alternative, invalid, and previous names) — is included. *The Moon Wiki* also includes transcripts from nearly all IAU lunar nomenclature meetings since 1922, and various nomenclatural oddities and trivia, such as the confusingly similar names Crocco, Rocco, Rocca, and Ricco.

Each of the 2200 wiki pages concludes with links to relevant publications on the *Lunar Photo of the Day* and to professional papers available in the NASA/Smithsonian Astrophysics Data System.

One other unique component of *The Moon Wiki* is a growing list of more than 250 scientists who have studied the Moon, from Aristarchus and other ancient Greeks to today's investigators. The basis of the lunar scientist pages is a collection of 208 Polaroid pictures of lunar scientists who visited the office of Johnson Space Center scientist Jeff Warner from 1978 to 1981. We invite people shown in these photos to add information about their lunar careers to the wiki.

Amazingly, this vast compilation is being done without funding and with a handful of volunteers from three countries. These individuals are nominally amateur astronomers, but in real life a chemical engineer, a retired physicist, a planetarium educator, a retired businessman, a computer consultant, and me (a sometimes lunar scientist).

The Moon Wiki is less than six months old and is still actively growing. As a wiki it is easy for individuals to contribute and edit material. We hope you will visit and add information to make it a more valuable resource.

For more information, visit *The Moon Wiki* website at *the-moon.wikispaces.com*.

New Lunar Science and Exploration Website Available from the LPI

— by David Kring

After a 35-year hiatus, NASA is returning humans to the Moon. The agency and its partners in academia, industry, and the international community are engaged in an exciting new exploration initiative designed to study the lunar surface robotically beginning in 2008 and with crewed landers before 2020.

To support that activity, the Lunar and Planetary Institute (LPI) has developed a new web-based information portal for the lunar science and exploration community. This new website provides access to everything "lunar" from the earliest Apollo-era documents to the most recent lunar research reports.

The site is designed for a broad range of users, including exploration architects, lunar scientists, students, and the general public. Information is organized under several specific categories: (1) Lunar Mission Summaries; (2) Apollo-Era Documents; (3) Lunar Samples; (4) Lunar Images; (5) Lunar Surface; (6) Lunar Meteorites; (7) Exploration Strategies; (8) Constellation Hardware; (9) Landing Site Studies; (10) Computational Tools; and (11) Educational Products. Data can also be accessed through a new LPI Lunar Search Engine, which provides links to both USRA-LPI documents and information at other lunar-related sites.

This is a living web-based system. As the exploration initiative grows, the content of this portal will expand appropriately, providing a one-stop source of information.

Highlights of the website include a new Lunar Orbiter Photo Gallery, with new views of over 2600 Lunar Orbiter images. This photo gallery greatly expands the 675-plate Digital Lunar Orbiter Photographic Atlas of the Moon. Another new feature is a set of computational tools, the first of which allows users to calculate the sizes of craters produced on the lunar surface as a function of impact parameters.

For more information, visit the website at *www.lpi.usra.edu/lunar/*.

NASA's Dawn Spacecraft Enroute to Shed Light on Asteroid Belt

Nearly enveloped by the smoke after ignition, the Delta II rocket carrying NASA's Dawn spacecraft rises from the smoke and fire on the launch pad. Credit: NASA.

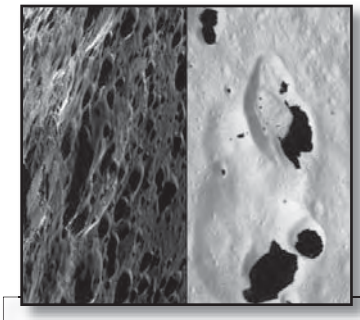
NASA's Dawn spacecraft is on its way to study a pair of asteroids after lifting off Thursday, September 27, from the Cape Canaveral Air Force Station at 7:34 a.m. EDT (4:34 a.m. PDT). Mission controllers at NASA's Jet Propulsion Laboratory received telemetry on schedule at 9:44 a.m. EDT (6:44 a.m. PDT) indicating Dawn had achieved proper orientation in space and its massive solar array was generating power from the Sun.

"Dawn has risen, and the spacecraft is healthy," said the mission's project manager Keyur Patel of JPL. Spacecraft controllers immediately began testing and calibrating the myriad spacecraft systems and subsystems, ensuring Dawn is ready for the long journey ahead.

"Dawn will travel back in time by probing deep into the asteroid belt," said Dawn Principal Investigator Christopher Russell, University of California, Los Angeles. "This is a moment the space science community has been waiting for since interplanetary spaceflight became possible." Dawn's 4.8-billion-kilometer (3-billion-mile) odyssey includes exploration of asteroid Vesta in 2011 and the dwarf planet Ceres in 2015. These two icons of the asteroid belt have been witness to much of our solar system's history. By using Dawn's instruments to study both asteroids, scientists more accurately can compare and contrast the two. Dawn's science instrument suite will measure elemental and mineral composition, shape, surface topography, and tectonic history, and will also seek water-bearing minerals. In addition, the Dawn spacecraft and how it orbits Vesta and Ceres will be used to measure the celestial bodies' masses and gravity fields.

The spacecraft's engines use a unique, hyperefficient system called ion propulsion, which uses electricity to ionize xenon to generate thrust. The 30-centimeter-wide (12-inch) ion thrusters provide less power than conventional engines but can maintain thrust for months at a time. To learn more about Dawn and its mission to the asteroid belt, visit *www.nasa.gov/dawn*.

Saturn's Moon Iapetus is the Yin-and-Yang of the Solar System



The image on the left is a close-up view showing mountainous terrain that reaches about 10 kilometers (6 miles) high along the unique equatorial ridge of Iapetus. The image on the right shows terrain in the transition region between the moon's dark leading hemisphere and its bright trailing hemisphere. Credit: NASA/JPL/Space Science Institute.

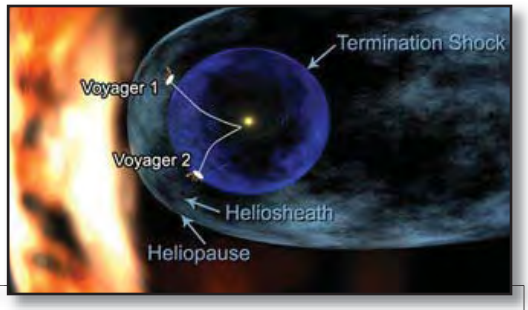
Scientists on the Cassini mission to Saturn are poring through hundreds of images returned from the September 10 flyby of Saturn's two-toned moon Iapetus. Pictures returned late Tuesday and early Wednesday show the moon's yin and yang — a white hemisphere resembling snow, and the other as black as tar.

Images show a surface that is heavily cratered, along with the mountain ridge that runs along the moon's equator. Many of the close-up observations focused on studying the strange 20-kilometer-high (12-mile) mountain ridge that gives the moon a walnut-shaped appearance.

"The images are really stunning," said Tilmann Denk, Cassini imaging scientist at the Free University in Berlin, Germany, who was responsible for the imaging observation planning. "Every new picture contained its own charm. I was most pleased about the images showing huge mountains rising over the horizon. I knew about this scenic viewing opportunity for more than seven years, and now the real images suddenly materialized."

This flyby was nearly 100 times closer to Iapetus than Cassini's 2004 flyby, bringing the spacecraft to about 1640 kilometers (1000 miles) from the surface. The moon's irregular walnut shape, the mountain ridge that lies almost directly on the equator, and Iapetus' brightness contrast are among the key mysteries scientists are trying to solve. For more information about the Cassini mission, and to view raw images from the Iapetus flyby, visit *saturn.jpl.nasa.gov* or *ciclops.org*.

Pioneering NASA Spacecraft Mark Thirty Years of Flight



Artist's concept of the two Voyager spacecraft as they approach interstellar space. Credit: 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."

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.

For a complete listing of Voyager discoveries and mission information, go to *www.nasa.gov/voyager* or *voyager.jpl.nasa.gov*.

NASA Extends Operations for Its Long-Lived Mars Rovers

As it finished its second martian year on Mars, NASA's Mars Exploration Rover Spirit was beginning to examine a group of angular rocks given informal names corresponding to peaks in the Colorado Rockies. Credit: NASA/JPL-Caltech.

NASA has extended, for a fifth time, the activities of the Mars Exploration Rovers, Spirit and Opportunity. The decision keeps the trailblazing mobile robotic pioneers active on opposite sides of Mars, possibly through 2009. This extended mission and the associated science are dependent upon the continued productivity and operability of the rovers.

The twin rovers landed on Mars in January 2004, 47 months ago, on missions originally planned to last 90 days. In September, Opportunity began descending into Victoria Crater in Mars' Meridiani Planum region. At approximately 800 meters wide (half a mile) and 70 meters deep (230 feet), it is the largest crater the rover has visited. Spirit climbed onto a volcanic plateau in a range of hills that were on the distant horizon from its landing site.

"After more than three-and-a-half years, Spirit and Opportunity are showing some signs of aging, but they are in good health and capable of conducting great science," said John Callas, rover project manager at NASA's Jet Propulsion Laboratory.

For more information about the Mars rovers, visit *marsrover.nasa.gov*.

Mars Express: 5000 Orbits and Counting

On December 25, 2003, Europe's first Mars orbiter arrived at the Red Planet. Four years later, Mars Express continues to rewrite the textbooks as its instruments send back a stream of images and other data. On November 23, the spacecraft reached another milestone in its remarkable career by completing 5000 orbits of Mars.

During its mission to investigate martian mysteries, the orbiter has revolutionized our knowledge of Mars, probing every facet of the Red Planet in unprecedented detail. Some of the most visually astonishing results have been returned by the High-Resolution Stereo Camera (HRSC), which has produced breathtaking, three-dimensional color images of

This image of the martian north polar ice cap shows layers of water ice and dust for the first time in perspective view. Here we see cliffs that are almost 2 kilometers high, and the dark material in the caldera-like structures and dune fields could be volcanic ash. Credit: ESA/DLR/FU Berlin (G. Neukum).

the diverse martian surface — from giant volcanos to sinuous valleys and ice-modified craters.

While the camera has been imaging the surface in exquisite detail, other instruments have been examining different aspects of the planet's environment. One of the most significant results from the Visible and Infrared Mineralogical Mapping Spectrometer, OMEGA, has been the discovery of clays, hydrated minerals that formed early in the planet's history, when liquid water was fairly abundant. However, the presence of sulfates and iron oxides suggests that the planet subsequently became colder and drier, with only episodic eruptions of water onto the surface.

It has so far identified the presence of water ice deposits several kilometers underground and revealed fine, layered material near the poles. Similar soundings of the north polar cap have confirmed that it is dominated by water ice, with variable amounts of dust. The larger southern cap seems less dusty, but, with a maximum thickness of 3.7 kilometers, it contains enough ice to produce a global ocean 11 meters deep.

At the poles, OMEGA has measured the surface composition and produced unprecedented maps of water ice and carbon dioxide ice. Further insights into the martian poles have come from the Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS), which is revealing for the first time the secrets of the planet's subsurface.

The multi-frequency radar has also been probing the upper atmospheric layer (the ionosphere) and found that the distribution of charged particles is linked with patchy magnetic fields in the martian crust. Although Mars' atmosphere is very thin, it plays an important role in the planet's evolution, and new breakthroughs have been made possible by Mars Express. The Planetary Fourier Spectrometer (PFS) has made the most complete map to date of its chemical composition. Evidence for the presence of methane could indicate that volcanic activity, or even simple lifeforms, may still be present today.

Meanwhile, the Ultraviolet and Infrared Atmospheric Spectrometer, SPICAM, has provided the first complete vertical profile of the atmosphere's carbon dioxide density and temperature. It has revealed a nightglow and aurorae at mid-latitudes, produced the first ozone map, and discovered the highest clouds ever observed on Mars. The Energetic Atoms Analyser (ASPERA) has confirmed that the solar wind is slowly stripping atoms from the atmosphere down to an altitude of 270 kilometers, although the rate of loss is surprisingly slow.

The MaRS radio science experiment has studied surface roughness by pointing the craft's high-gain antenna at the planet and recording the echoes. It has also been used to measure small changes in the spacecraft's orbit caused by gravity anomalies. Some of the most marked increases in surface gravity have been found over the volcanic Tharsis ridge, indicating a higher-than-average crustal density. Another discovery has been the existence of an ionospheric layer created by meteors burning up in the atmosphere.

With the mission already extended until at least 2009 and the possibility of further extensions into the next decade, ESA is keen to ensure that Mars Express will continue to provide the best possible scientific return.

For more about the Mars Express mission, visit *www.esa.int/SPECIALS/Mars_Express/*.

Ulysses Catches Record for Catching Comets by Their Tails

When it was launched 17 years ago, scientists and mission engineers for the Ulysses project knew they should expect, well, the unexpected. After all, the joint NASA/European Space Agency-managed spacecraft was going where no spacecraft had gone before — above and below the Sun's poles. But the surprises the team expected were wholly in the area of solar research — which would make sense, as the primary mission of the Ulysses spacecraft is to characterize the Sun and its influence on the space environment. That was before the spacecraft met up with some of the solar system's most mysterious and beautiful deep-space nomads.

"Ulysses has flown through and acquired data from the tails of comets on three separate occasions," said Edward J. Smith of NASA's Jet Propulsion Laboratory Smith serves as the U.S. project scientist for the Ulysses mission. "No other spacecraft in history has done that."

Ulysses' first cometary tail encounter occurred in 1996. Back then, Comet Hyakutake was dazzling scientists and the public alike with its noteworthy appearances in the nighttime spring sky. On May 1, 1996, while Ulysses was cruising through space studying the solar wind, its data suddenly went wild for a few hours.

Like its mythical namesake, Ulysses has ventured into unexplored territory, seeking knowledge of the world around us. Credit: Artwork by David Hardy.

At the time of the unexpected encounter, Ulysses was hundreds of millions of miles from Comet Hyakutake and far beyond the visible tail. As their analysis began ruling out other possibilities, the science team came to a startling conclusion — Hyakutake's tail extended more than 480 million kilometers (300 million miles, or three times the distance from Earth to the Sun), making it the longest comet tail ever recorded.

The once-in-a-lifetime chance encounter with a comet tail happened again in 2004 when Ulysses flew through the ion tailings of Comet McNaught-Hartley. Unlike Hyakutake, Comet McNaught-Hartley seemed to be at the wrong location for Ulysses to intercept its tail. By chance, an eruption of particles from the surface of the Sun, called a coronal mass ejection, carried cometary material to Ulysses. Such a collision has recently been observed for the first time by NASA's Stereo spacecraft (*www.nasa.gov/mission_pages/stereo/news/encke.html*). A movie (*www.nasa.gov/mpg/191284main_encke_scienceatnasa.mpg*) shows the disruption and reformation of periodic comet Encke's tail.

Ulysses racked up its third, and perhaps most scientifically revealing, comet tail encounter this past February when it again flew through the ion tailings of a comet named McNaught (a different comet than the one encountered in 2004, but discovered by and named after the same astronomer). The nucleus of this Comet McNaught was some 257 million kilometers (160 million miles) from the spacecraft during encounter. Ulysses' solar wind ion composition spectrometer instrument, developed by University of Michigan heliophysicist George Gloeckler, found that even at such a great distance, the tail had filled the solar outflow with unusual gases and molecules. In response, the solar wind that usually measures about 700 kilometers per second (435 miles per second) at that distance from the Sun was less than 400 kilometers per second (249 miles per second) inside the comet's tail, as measured by one of Ulysses' instruments called "Solar Wind Observations Over the Poles of the Sun."

More information about the Ulysses mission is available at *ulysses.jpl.nasa.gov*.

Astronomers Say Moons Like Ours Are Uncommon

This artist's animation sequence shows bodies as big as mountain ranges smashing together. Such collisions form the basis of the planet-building process. An even bigger collision between Earth and a body the size of Mars is thought to have created our Moon. Credit: NASA/JPL-Caltech/T. Pyle (SSC-Caltech).

The next time you take a moonlit stroll, or admire the full, bright-white Moon looming in the night sky, you might count yourself lucky. New observations from NASA's Spitzer Space Telescope suggest that moons like Earth's — that formed out of tremendous collisions — are uncommon in the universe, arising at most in only 5 to 10 percent of planetary systems.

"When a moon forms from a violent collision, dust should be blasted everywhere," said Nadya Gorlova of the University of Florida, Gainesville, lead author of a new study that appeared on November 20 in the *Astrophysical Journal*. "If there were lots of moons forming, we would have seen dust around lots of stars — but we didn't."

It's hard to imagine Earth without a moon. Our familiar white orb has long been the subject of art, myth, and poetry. Wolves howl at it, and humans have left footprints in its soil. Life itself might have evolved from the ocean to land thanks to tides induced by the Moon's gravity.

Scientists believe the Moon arose about 30 to 50 million years after our Sun was born, and after our rocky planets had begun to take shape. A body as big as Mars is thought to have smacked into our infant Earth, breaking off a piece of its mantle. Some of the resulting debris fell into orbit around Earth, eventually coalescing into the Moon we see today. The other moons in our solar system either formed simultaneously with their planet or were captured by their planet's gravity.

Gorlova and her colleagues looked for the dusty signs of similar smash-ups around 400 stars that are all about 30 million years old — roughly the age of our Sun when Earth's Moon formed. They found that only 1 out of the 400 stars is immersed in the telltale dust. Taking into consideration the amount of time the dust should stick around, and the age range at which moon-forming collisions can occur, the scientists then calculated the probability of a solar system making a moon like Earth's to be at most 5 to 10 percent.

"We don't know that the collision we witnessed around the one star is definitely going to produce a moon, so moon-forming events could be much less frequent than our calculation suggests," said George Rieke of the University of Arizona, Tucson, a co-author of the study.

In addition, the observations tell astronomers that the planet-building process itself winds down by 30 million years after a star is born. Like our Moon, rocky planets are built up through messy collisions that spray dust all around. Current thinking holds that this process lasts from about 10 to 50 million years after a star forms. The fact that Gorlova and her team found only 1 star out of 400 with collision-generated dust indicates that the 30-million-year-old stars in the study have, for the most part, finished making their planets.

"Astronomers have observed young stars with dust swirling around them for more than 20 years now," said Gorlova. "But those stars are usually so young that their dust could be left over from the planet-formation process. The star we have found is older, at the same age our Sun was when it had finished making planets and the Earth-moon system had just formed in a collision."

For moon lovers, the news isn't all bad. For one thing, moons can form in different ways. And, even though the majority of rocky planets in the universe might not have moons like Earth's, astronomers believe there are billions of rocky planets out there. Five to 10 percent of billions is still a lot of moons.

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

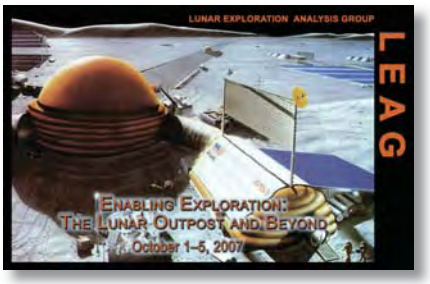
The Bulletin welcomes articles dealing with issues related to lunar and planetary science and exploration. The copy deadline for the next issue is January 11, 2008. Articles or announcements should be submitted via e-mail to *lpibed@lpi.usra.edu*.

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.

ISSN 1534-6587

LEAG Workshop on Enabling Exploration: The Lunar Outpost and Beyond October 1–5, 2007



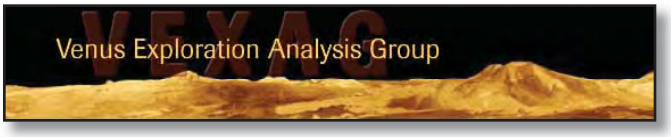
The Lunar Exploration Analysis Group (LEAG) met in early October to discuss the theme "Enabling Exploration: The Lunar Outpost and Beyond." The meeting began with a summary of the existing lunar architecture, with updates from several lunar program architects at NASA Headquarters: Marguerite Broadwell, Geoff Yoder, Jim Green, and Michael Hawes. Reports from several other groups that shape lunar exploration were provided, including the Constellation Office (Jeff Hanley), NASA Advisory Council (Brad Jolliff), and the Outpost Science and Exploration Working Group (Kelly Snook).

The goal of the remainder of the workshop was to "to define pathways to offset the costs and risks of achieving the next step in space exploration." This goal was investigated within several topical areas, including international partnerships; *in situ* resource utilization and outpost sustainment demonstrations; the role of robotic missions, commerce, sample return, and lunar exploration; the role of technology in field exploration and astronaut training; and site selection and the lunar outpost.

As with previous LEAG meetings, this forum brought together academic, governmental, and private sector interests to discuss progress in lunar exploration, share ideas and information, and form collaborations. The meeting provided an opportunity to integrate diverse interests in lunar exploration to reduce risk and cost of establishing a permanent presence on the Moon through novel and innovative ideas, technologies, and partnerships. Discussion throughout the workshop was very good and involved contributions from all disciplines.

An agenda of oral presentations and invited speakers' electronic presentations are available at *www.lpi.usra.edu/meetings/leag2007/presentations/*. In addition, contributed presentations are available at *www.lpi.usra.edu/meetings/leag2007/pdf/poster_session_I.pdf* and *www.lpi.usra.edu/meetings/leag2007/pdf/poster_session_II.pdf*.

Venus Exploration Analysis Group November 4–5, 2007



The Venus Exploration Analysis Group (VEXAG) met in Greenbelt, Maryland, on November 4–5, 2007. VEXAG was established by NASA in July 2005, and is a community-based forum designed to provide scientific input and technology development plans for planning and prioritizing the exploration of Venus over the next several decades, including a Venus surface sample return.

Major highlights of the meeting included the presentation to NASA of the findings in the recently completed "Venus Exploration Goals and Objectives 2007." At the workshop, NASA Headquarters announced plans for a Science Definition Team to be selected during 2008 to help refine scientific questions, possible mission architectures, and required technology development for a future Flagship-class mission to Venus.

Presentations given at the workshop included results from the ongoing Venus Express mission and the recent MESSENGER flyby of Venus. Also presented were issues related to the atmosphere and climate on Venus and comparisons with Earth.

Many of the presentations, as well as the 2007 VEXAG report on the goals and objectives of Venus exploration, can be found at the VEXAG website at *www.lpi.usra.edu/vexag*.

Outer Planets Assessment Group November 8–9, 2007

The Outer Planet Assessment Group (OPAG) met in Greenbelt, Maryland, on November 8–9, 2007. Approximately 70 were in attendance. OPAG was established by NASA in late 2004 to identify scientific priorities and pathways for exploration in the outer solar system.

Among the highlights of the workshop were a report by Curt Neiber on the status of the Flagship mission studies and reviews. Four mission targets were studied, including Europa, Titan, the Jupiter system, and Enceladus. The reports of the review process are now complete and are under consideration by NASA Headquarters.

It was also reported that the Jupiter Data Analysis Program will be expanded to include missions other than New Horizons. A report was also presented on the status of European Space Agency (ESA) studies of future mission concepts. Both Titan and Jupiter mission proposals were selected for further study.

Detailed studies of possible comet sample return missions and augmented solar power for the outer solar system missions were also presented. Some of these studies are documented on the OPAG website at *www.lpi.usra.edu/opag/*.

Workshop on Water in Planetary Basalts November 14–15, 2007

The abundance of water in planetary basalts is a crucial constraint on their phase equilibria, and critical for determining the water content of planetary mantles. Recent advances in analytical methods now allow determination of water contents down to the ppm level, which allow analyses of minerals previously considered to be anhydrous. For instance, a recent study (*Saal et al.*, 2007) detected water in lunar glasses previously considered dry. Similarly, the presence of nominally hydrous minerals in the SNC meteorites continues to fuel debate over how much water is in martian basalts, and therefore the martian mantle. There is, however, little agreement on the abundances of water in planetary basalts, or the effects of that water on their equilibria.

Dr. Justin Filiberto of the Lunar and Planetary Institute convened this workshop as a means of bringing together terrestrial and planetary researchers who have focused on water in basaltic systems through analytical, experimental, and theoretical approaches. The workshop featured invited talks from terrestrial and planetary petrologists as well as contributed talks across these disciplines.

The session on analytical investigations showed how much water was present in martian, terrestrial, and lunar samples. An extremely exciting talk by Saal et al. of Brown University showed that there could be large amounts of water in the green glass source region; however, better constraints on the modeling are needed before definitive values can be assigned. One of the main conclusions drawn from this session was that the abundance of water in the shergottite source region is similar to the mid-ocean ridge basalt (MORB) source region (hundreds of ppm).

The session on subduction zones featured modeling and experimental results about how much water is in subduction zones, where it came from, and its effects on basalt genesis. The final session, water in the mantle, focused on the effect of water on phase equilibrium and liquidus temperatures for martian and terrestrial systems. The effect of water on liquidus temperatures was highly debated, and concluded with the consensus that there are bulk compositional effects, although further work is needed on this subject.

To view the complete program and abstracts for this workshop, go to *www.lpi.usra.edu/meetings/basalts2007/*.

Spotlight on Education

"Spotlight on Education" highlights events and programs that provide opportunities for lunar and 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.

Lunar Eclipse

February 20, 2008, will feature a total lunar eclipse. This is an opportunity for planetary scientists to participate in public observing sessions, conduct lectures and activities, and facilitate telescope viewings of the Moon. For more information about the eclipse, go to *sunearth.gsfc.nasa.gov/eclipse/LEmono/TLE2008Feb21/TLE2008Feb21.html*.

Meetings on Student Collaboration Opportunities

Scientists are invited to attend community workshops at the upcoming AGU and AAS Meetings on Student Collaboration opportunities within NASA's Science Mission Directorate. These workshops will take place on Sunday, December 9, 2007, at AGU, and on Monday, January 7, 2008, at AAS. A Student Collaboration Definition Team (SCDT) was initiated by NASA in February 2007 to provide community perspectives to NASA's Science Mission Directorate (SMD) on participation of college and university students in NASA's science missions. These Student Collaboration community workshops offer the opportunity for space and Earth science community members and educators to learn about SMD Student Collaborations and provide further input to the SCDT. The specific emphasis during these workshops is to discuss the outcome and draft white paper of the SCDT. For more information, go to *lasp.colorado.edu/education/features/student_collaborationfeature.htm*.

LPSC Education Workshops

A full-day workshop for scientists and educators on our exploration of the Moon will take place on Sunday, March 9, 2008, as a part of the 39th annual Lunar and Planetary Science Conference (LPSC). Additional educator workshops are also planned. Details and registration will be available with the second LPSC announcement. For more information about LPSC, go to *www.lpi.usra.edu/meetings/lpsc2008*.

Sun-Earth Day

Sun-Earth Day on March 20, 2008, includes programs and events with a focus on space weather around the world. Middle schools are invited to participate in Solar Week in Spring 2008 to learn about solar science, solar energy, and career choices. For more information, go to *sunearthday.nasa.gov/2008/about/index.php*.

ASP 2008 Awards for Astronomy Educators

The Astronomical Society of the Pacific (ASP) is now accepting nominations for the Society's 2008 awards honoring accomplishments in astronomy education and public outreach, including awards for excellence in college science teaching, for outstanding contributions to the public understanding and appreciation of astronomy, and for a recent Ph.D. thesis considered unusually important to astronomy. Recipients receive a cash award and engraved plaque, as well as travel and lodging to accept the award at the Society's annual meeting. The deadline for nominations is December 15, 2007. For more information, go to *www.astrosociety.org/membership/awards/awards.html*.

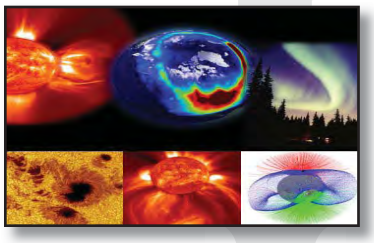
LPI Career Development Award

The Lunar and Planetary Institute (LPI) is proud to announce its first **LPI Career Development Award**. This award will be given to four graduate students who have submitted a first-author abstract for presentation at the 39th Lunar and Planetary Science Conference (LPSC). A travel stipend of $750 will be awarded to the top four applicants to help cover their travel expenses for attending the LPSC in March. The application deadline for the LPI Career Development Award is January 15, 2008. For more information, go to *www.lpi.usra.edu/features/cda_award/*.

LPI 2008 Summer Intern Program

The LPI invites undergraduates with at least 50 semester hours of credit to experience cutting-edge research in the lunar and planetary sciences. Summer Interns work one-on-one with a scientist at the LPI or at the NASA Johnson Space Center on a research project of current interest in lunar and planetary science. The Summer Intern Program allows participants to experience a real research environment, to learn from top-notch lunar and planetary scientists, and to preview careers in research. The 10-week program runs from June 2, 2008, to August 8, 2008. Interns receive a $3500.00 stipend plus housing and a $1000.00 travel expense reimbursement. For more information, go to *www.lpi.usra.edu/lpiintern/*.

New REU Site Program in Solar and Space Physics



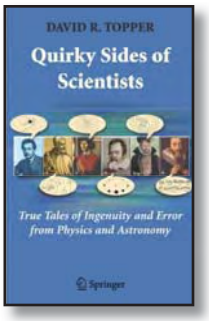
The University of Colorado and its partners invite applications for a summer Research Experience for Undergraduates program for highly motivated students interested in solar and space physics. Project opportunities span the field of solar and space physics, from instrument hardware to data analysis to modeling of the Sun-Earth system. Program is open to current sophomore and junior undergraduate students who are U.S. citizens or permanent residents. The program will run from June 8, 2008, through August 3, 2008. Successful applicants will receive stipend, room and board, and travel allowance. Application review begins January 7, 2008. For more information, go to *lasp.colorado.edu/reu*.

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

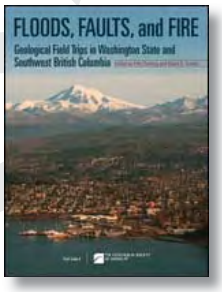
New and Noteworthy

Books

Quirky Sides of Scientists: True Tales of Ingenuity and Error from Physics and Astronomy. David R. Topper. Springer, 2007. 223 pp., Hardcover, $39.95. *www.springer.com*



This book contains historical narratives of scientific behavior that reveal the often irrational way scientists arrive at and assess their theories. There are stories of Einstein's stubbornness leading him to reject a correct interpretation of an experiment and miss an important deduction from his own theory, and Newton missing the important deduction from one of his most celebrated discoveries. Copernicus and Galileo are found suppressing information. A theme running throughout the book is the notion that what is obvious today was not so in the past. Scientists seen in their historical context shatter myths and show them to be less modern than we often like to think of them. The author is an award-winning professor of history at the University of Winnipeg where, since 1970, he has taught courses in the history of science and the history of art.



Floods, Faults, and Fire: Geological Field Trips in Washington State and Southwest British Columbia. Edited by Pete Stelling and David S. Tucker. Geological Society of America, 2007. 256 pp., Paperback, $35.00. *www.geosociety.org/bookstore*

The 10 geological field guides presented in this volume explore key areas of the geologist's paradise that is Washington State and British Columbia. These trips investigate a wide variety of geologic and geographic terrains, from the dry steppe of the channeled scablands and Columbia River basalt group to the east, across the glaciated and forested Cascade arc and Coast Mountains, to the geologically complex islands in the west. This guidebook may be unique in that four of the trips utilize boats to reach remote field areas and are therefore rarely visited by geologists. Although the these trips were guided during the 2007 GSA Cordilleran Section meeting, the guides have been written to ensure that people can easily guide their own trips long after the meeting ended. The result provides an excellent source of exciting, thought-provoking geologic adventures for years to come.

The Scientific Context for Exploration of the Moon: Final Report. Committee on the Scientific Context for Exploration of the Moon, National Research Council. National Academies Press, 2007. 120 pp., Paperback, $28.00. *www.nap.edu*

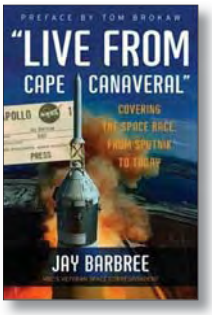
Because of the Moon's unique place in the evolution of rocky worlds, it is a prime focus of NASA's space exploration vision. Currently NASA is defining and implementing a series of robotic orbital and landed missions to the Moon as the initial phase of this vision. To realize the benefits of this activity, NASA needs a comprehensive, well-validated, and prioritized set of scientific research objectives. To help establish those objectives, NASA asked the National Research Council to provide guidance on the scientific challenges and opportunities enabled by sustained robotic and human exploration of the Moon during the period 2008–2023 and beyond. This final report presents a review of the current understanding of the early Earth and Moon; the identification of key science concepts and goals for Moon exploration; an assessment of implementation options; and a set of prioritized lunar science concepts, goals, and recommendations. An interim report was released in September 2006.

Complete Course in Astrobiology. Edited by Gerda Horneck and Petra Rettberg. Wiley-VCH, 2007. 434 pp., Paperback, $90.00. *www.wiley-vch.de/publish/en*

This up-to-date resource is based on lectures developed by experts in the relevant fields and carefully edited by the leading astrobiologists within the European community. Aimed at graduate students in physics, astronomy, and biology and their lecturers, the text begins with a general introduction to astrobiology, followed by sections on basic prebiotic chemistry, extremophiles, and habitability in our solar system and beyond. A discussion of astrodynamics leads to a look at experimental facilities and instrumentation for space experiments and, ultimately, astrobiology missions, backed in each case by the latest research results from this fascinating field. This book includes a CD-ROM with additional material.

Shooting for the Moon: The Strange History of Human Spaceflight. By Bob Berman. Lyon's Press, 2007. 224 pp., Hardcover, $24.95. *www.lyonspress.com*

This book provides an accessible and detailed look into one of the most intriguing programs ever: the American lunar program. From the pioneer efforts of test pilots in the early space program, to the worldwide exhilaration behind man's first walk on the Moon, to the devastation behind the disastrous Challenger accident and the new visions the government now has for the program, Berman recounts for the lay reader all the advances and setbacks that have taken place during the immense growth of the space program.



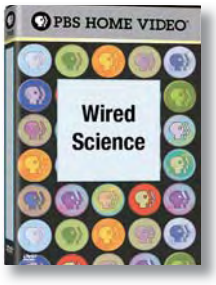
"Live from Cape Canaveral": Covering the Space Race, From Sputnik to Today. By Jay Barbree. Harper Collins, 2007. 336 pp., Hardcover, $26.95. *www.harpercollins.com*

Some 50 years ago, while a cub reporter, Jay Barbree caught space fever the night that *Sputnik* passed over Georgia. He moved to the then-sleepy village of Cocoa Beach, Florida, right outside Cape Canaveral, and began reporting on rockets that fizzled as often as they soared. In *"Live from Cape Canaveral,"* Barbree — the only reporter who has covered every mission flown by astronauts — offers his unique perspective on the space program. He shares affectionate portraits of astronauts as well as some of his fellow journalists and tells some very funny behind-the-scenes stories — many involving astronaut pranks. Barbree also shows how much the space program and its press coverage have changed over time. Warm and perceptive, he reminds us just how thrilling the great moments of the space race were and why America fell in love with its heroic, sometimes larger-than-life astronauts.

Astronautics: A Historical Perspective of Mankind's Efforts to Conquer the Cosmos, Book 1 — Dawn of the Space Age. By Ted Spitzmiller. Apogee Books, 2007. 232 pp., Paperback, $24.95. *www.apogeebooks.com*

Dawn of the Space Age chronicles our desire to know more about the cosmos and dreams of reaching into its depths. It describes the initial discoveries, inventions, and engineering innovations that became the foundation of rocket technology. It follows the two preeminent countries in their quest for the "ultimate weapon" that would provide the path to space, and describes the decisions that resulted in the first artificial satellite programs in the United States and the former Soviet Union. It follows the events that shaped the initial thrust into space as represented by the first Soviet Sputniks and the shocked response by the Americans, and details the belated and often failure-prone launches that humbled a great nation. The book describes the first attempts to reach the Moon and the planets and explains the techniques and physics involved. It illustrates the engineering requirements of the first manned spacecraft and the selection and experiences of the first spacefarers.

DVD



Wired Science. Presented by PBS, 2007, 60 minutes, one disc. $24.99. *www.shoppbs.org*

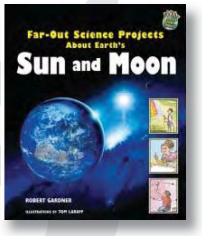
Wired Science brings Wired magazine's cutting-edge vision, stylish design, and irreverent attitude to the screen with breakout ideas, recent discoveries, and the latest innovations. This pilot episode takes the viewer into the world of meteorite hunters, where space, commerce, and art intersect; travels to Yellowstone National Park to harvest viruses that may hold the key to a technology revolution; and dives underwater to find NEEMO, NASA's extreme astronaut training facility. Meet rocket-belt inventors, stem cell explorers, and the developer of an electric car that goes from zero to 60 in under four seconds.

Online Resource

Earth Portal. *www.earthportal.org*

The Earth Portal is a comprehensive online resource for timely, objective, science-based information about the environment. It is a means for the global scientific community to come together to produce the first free, expert-driven, massively scaleable information resource on the environment, and to engage civil society in a public dialogue on the role of environmental issues in human affairs. It contains no commercial advertising and reaches a large global audience. The Earth Portal consists of three components, *The Encyclopedia of Earth*, *EarthForum*, and *EarthNews*.

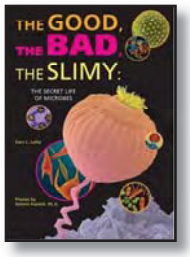
FOR KIDS!!!



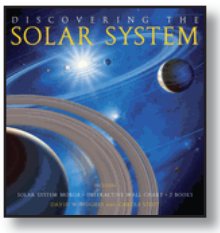
Far-Out Science Projects About Earth's Sun and Moon. Robert Gardner. Enslow Publishers, Inc., 2007. $23.93. *www.enslow.com*

Careful observation of the Sun and Moon can answer many questions we have about our planet. What causes day and night? Why do the seasons change? What causes the changing shape of the Moon? How can you tell time by watching shadows from the Sun? Gardner guides young students in their observations, using simple science experiments. Detailed explanations follow the experiments to explain the science used in each experiment, along with unique ideas for science fair projects. This book supports the National Science Education Standards for K–4 Earth and Space Science. For ages 9–12.

The Good, the Bad, and the Slimy: The Secret Lives of Microbes. Sara Latta. Enslow Publishers, Inc., 2006. $31.93. *www.enslow.com*



Bacteria, viruses, and fungi . . . microbes are everywhere! You may think they are all harmful, but most microbes are beneficial. These tiny organisms are too small for us to see, but they impact our lives every day. Learn how microbes live in and on our bodies, help make food, live in extreme environments, and even change history. Latta, with a master's degree in microbiology, tells of the fascinating world of the unseen microbes in our lives. For ages 5 and up.



Discovering the Solar System. David Hughes and Carol Stott. Barron's Educational Series, Inc., 2006. $29.99. *barronseduc.com*

This sturdy portfolio-style kit will be a hit with the whole family, a fun way for kids and adults to discover the composition and workings of our solar system. It contains parts for a desktop mobile of the solar system that is easy to put together, and shows the positions of all planets in relation to the Sun. The kit also includes an interactive wall chart designed for keeping track of interplanetary space probes as they occur, plus two fascinating spiral-bound books, *The History of the Solar System* and *Interplanetary Missions 1955–2055*. The dramatic wall chart unfolds to 30" × 10 3/4", is printed in vivid color on laminated stock, and comes with stickers designed for marking the progress of interplanetary science as it unfolds and is reported to the world by NASA and other space agencies. Here is modern science at its most exciting, presented in a way that every member of the family can understand and enjoy.

Mars 2020 Game. Talicor, Inc. $30.00. *www.aristoplay.com*

Learn tons of facts with over 500 multiple-choice questions related to space science and technology. Choose a spaceship and a crew member and try to land on Mars first. Along the orbital path, players must answer questions to fix malfunctions that occur. Kids love the "cool" spaceship playing pieces and becoming a crew member. Mars 2020 captures the excitement, the challenge, and the science involved in reaching the Red Planet. Mars even continues to orbit throughout the game, which provides an added challenge. Unexpected messages from Mission Control add excitement to the play. For ages 8 and up.

Calendar 2007

December

6–8 SOFIA's 2020 Vision: Scientific and Technological Opportunities Workshop, Pasadena, California www.sofia-vision.caltech.edu/

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

January 2008

7–10 46th AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada www.aiaa.org/content.cfm?pageid=230&lumeetingid=1065

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

20–25 Gordon Research Conference: Origin of Life, Ventura, California www.grc.org/programs.aspx?year=2008&program=origin

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

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

February

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

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

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

18–29 Physics and Astrophysics of Planetary Systems Winter School and Workshop, Les Houches, France www-laog.obs.ujf-grenoble.fr/heberges/Houches08/index.htm

20–22 International Space University's 12th Annual Symposium on Space Solutions to Earth's Global Challenges, Strasbourg, Alsace, France 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 content.asce.org/conferences/earth2008/welcome.html

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

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

April

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

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

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

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

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

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

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

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

May

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

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

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

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