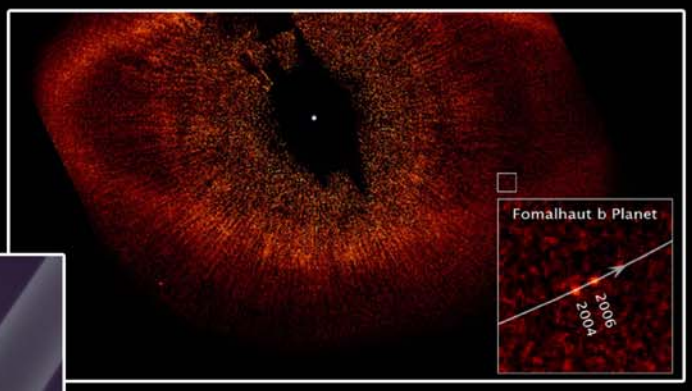
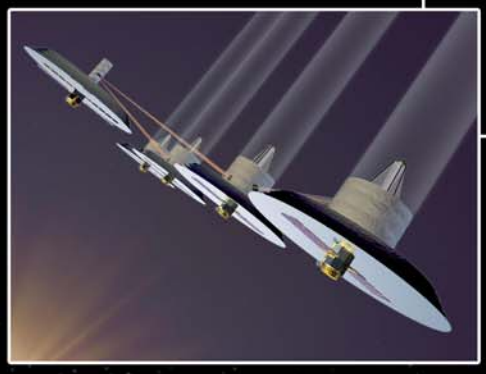
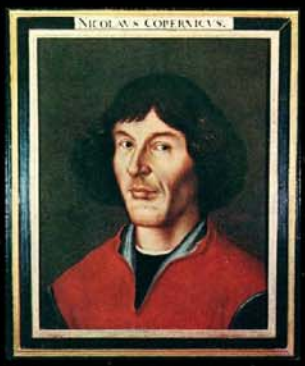
One Step Closer to Completing the Copernican Revolution







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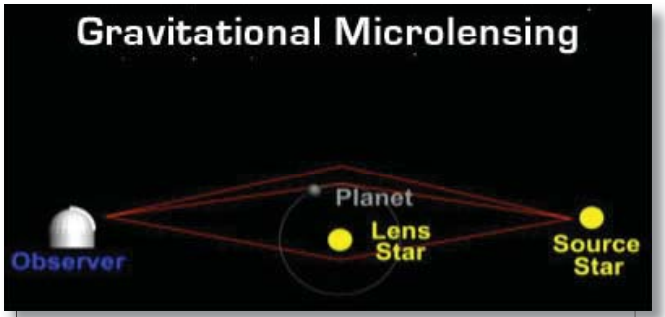
One Step Closer to Completing the Copernican Revolution

— Dr. David C. Black

Legend has it that the first printed copy of De revolutionibus *was placed in Copernicus' hands on the very day that he died, allowing him to take farewell of his life's work. He is reputed to have wakened from a stroke-induced coma, looked at his book, and died peacefully.*

Five hundred and fifty-five years ago, Nicolaus Copernicus published his seminal paper, *De revolutionibus*, showing that contrary to existing beliefs of the time, Earth revolved around the Sun. His work forever changed the place of humanity in the cosmos and shaped the nature of future astronomical research, yet until recently there was only one known planetary system: our solar system. One of the great successes of astronomical research over the past two decades is the discovery of planetary mass companions to other stars. These bodies are commonly referred to as extrasolar planets, or exoplanets. Since the first planetary mass companion to another star was discovered in the 1990s, more than 300 such companions have been discovered.

There are two general methods to detect planetary companions to other stars; one is "indirect," whereby one detects the presence of the companion by virtue of some observable effect it has on its parent star. All the systems discovered to date have been detected by indirect techniques, primarily precise radial velocity measurements that reveal the companion via periodic shifts, with a period of the unseen companion's orbit, in the spectral lines of the star. The other method is "direct," whereby one detects radiation from the planet itself — either thermal radiation from the planet or reflected light from its parent star (just as we see the Moon and Venus in our night sky).



Gravitational microlensing is one of the indirect methods used for detecting extrasolar planets. Microlensing occurs when the gravitational field of a star acts like a lens, magnifying the light of a distant background star. Possible planets orbiting the foreground star can cause detectable anomalies in the lensing event light curve. Credit: NASA.

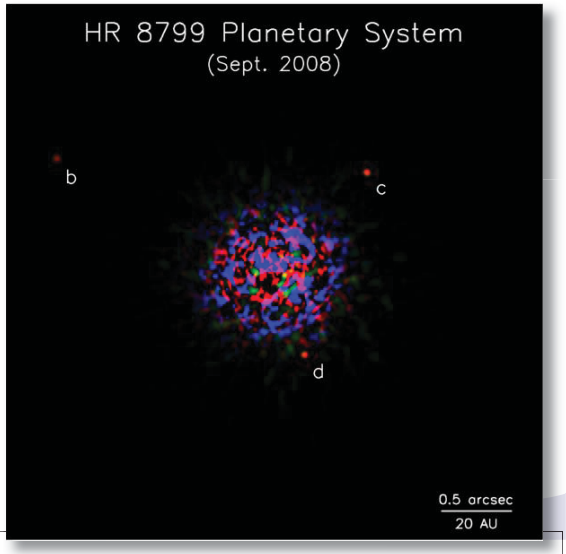
A major cause of the dominance of indirect methods of detecting planets is that planets are intrinsically dim in comparison to the stars around which they revolve. The difficulty is compounded by the fact that when viewed from afar — as by an Earth-bound astronomer, for example — planetary orbits are separated from their central star by small angles, so the light from the star washes out the light from the planet, particularly in visible light where stars typically are brightest. For example, Jupiter is roughly a billion times dimmer than the Sun in visible light. If an astronomer on Alpha Centauri were to look at the solar system, the maximum angular separation between Jupiter and the Sun would be roughly 5 seconds of arc. Putting this in human-scale terms, imagine holding at arm's length a very bright light, and then trying to see a light that is a billion times dimmer and only a thousandth of an inch away from it.

This is the challenge in direct detection in visible light of a true analog to the solar system. The angular separation is less in direct proportion to the distance between the observer and the target star, so direct detection of planetary companions to distant stars is a daunting technical challenge. The challenge for direct detection is in principle less demanding in the infrared part of the spectrum where planets typically are brightest and stars are less bright. Jupiter is only about 40,000 times dimmer than the Sun at a wavelength of 30 micrometers.

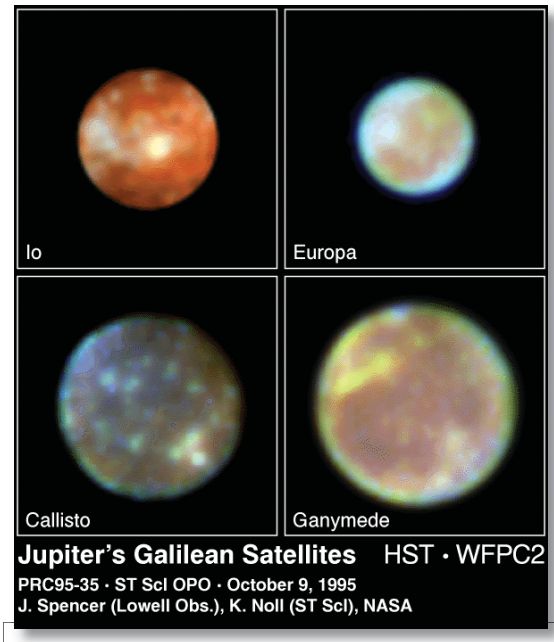
While efforts to directly detect planetary companions to distant stars are demanding, astronomers delight in this type of challenge. There are currently many research groups using a variety of techniques and innovative technologies to image planetary companions to other stars. Two groups, one studying the star Formalhaut and

the other observing a star with the less-personal moniker of HR 8799, have achieved a modicum of success. Both stars are A stars, brighter and more massive than the Sun. A single companion, with an estimated mass of around three Jupiter masses and an orbital period of 872 years, has been detected revolving around Formalhaut. Three companions, with estimated masses around ten times that of Jupiter, have been observed revolving around HR 8799 with orbital periods of 100, 180, and 450 years.

These exciting results are no doubt the tip of a discovery iceberg, and we can expect more direct detections to follow in quick order. While beyond the capability of the current direct detection systems, the recent results bode well for future developments that will allow astronomers to directly detect true analogs to the solar system. Indeed, the image of HR 8799 and its companions is reminiscent of those of Jupiter taken by Galileo some 400 years ago. We can only hope that these modern astronomers will not be placed under house arrest for the remainder of their lives, as was Galileo after he was forced to recant his support of Copernicus' notions of the solar system.



Near-infrared false-color image of the HR 8799 planetary system taken with the W. M. Keck II telescope and adaptive optics. The three planets are labeled b, c, and d. The colored speckles in the center are the remains of the bright light from their parent star after image processing. Credit: Keck Observatory.



Probably the most significent contribution that Galileo Galilei made to science was the discovery of the four satellites around Jupiter that are now named in his honor. Galileo originally thought these bodies were stars, but later determined that they were in fact planetary bodies in orbit around Jupiter. This discovery provided evidence in support of the Copernican system and showed that everything did not revolve around the Earth.

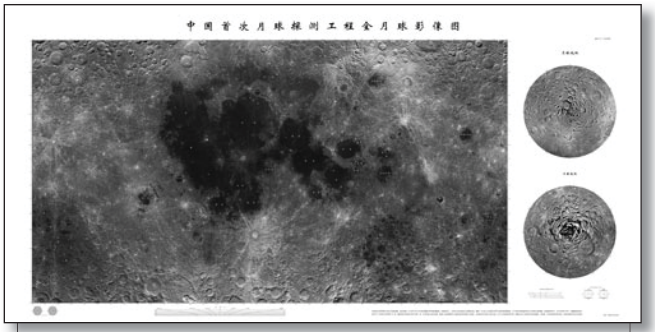
As important as these recent observations are for helping us to understand how our planetary systems and others may have formed and evolved, there is an even more profound aspect to these studies, namely the key role that planets play as abodes for life. As we continue our search for life elsewhere in the solar system, we know that that our hope for finding advanced, potentially intelligent, and technologically capable life forms lies in the study of distant planetary systems.

For more information about the search for other planetary systems, visit *exoplanets.org*, *planetquest.jpl.nasa.gov*, or *www.space.com/scienceastronomy/extrasolar_planets.html*.

Black served as Director of the Lunar and Planetary Institute from 1988 to 2001, and as President and CEO of the Universities Space Research Association from 2000 to 2005. He is internationally recognized for his research in theoretical astrophysics and planetary science.

Chang'e-1 Completes Mapping of Moon

The head of the China National Space Administration (CNSA), Sun Laiyan, announced that the Chang'e-1 mission had successfully completed its mapping of the whole Moon, and that all the data has now been processed. The scientific objectives of Chang'e-1 were to provide 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. Declaring the mission a success, Sun displayed China's first image of the whole Moon and indicated that data sharing would now begin.



The large image on the left shows a mercator projection of 94% of the Moon's area; the smaller images on the right show the north and south poles. Credit: China National Space Administration.

Chang'e-1 has orbited the Moon 589 times, providing 1.37 terabytes of effective scientific data gathered from November 20, 2007, to July 1, 2008.

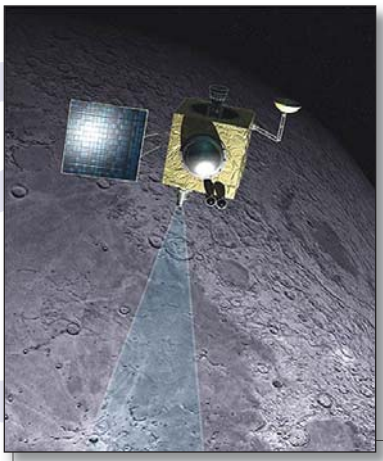
Primary scientists of the mission were Chang'e commander-in-chief Luan Enjie; chief project scientist Ouyang Ziyuan; deputy designer Jian Jingshan; and designer Long Lehao.

Research groups interested in applying for data access should contact the primary data constodians: Chinese University of Hong Kong (Dr. Xu Yangsheng), Tsinghua University (Prof. Lu Jianhua), Harbin Institute of Technology (Tan Liying); and the Chinese Academy of Geological Sciences (Dr. Xiao-tao Chang).

Chen Qiufa, a deputy Minister of MIIT and head of SASTIND, noted that the Chang'e-3 Lunar Rover would launch in late 2011 on a Long March 3B rocket (this will be the first use of a 3B rocket for spacecraft launch and orbit insertion). Chen confirmed that the Chang'e-3 rover will conduct studies of the Moon's geology, topography, and mineral and chemical composition. Chang'e-2 will launch in 2010.

In a ceremony that included top members of MIIT, SASTIND, CAS, CNSA, CASC, the China National Museum, and others, officials released a wall-sized reproduction of an image that included a mercator projection of 94% of the Moon's area and images of the north and south poles.

For more information, visit *www.chinadaily.com.cn/china/china_moon_page.html*.



This artist's concept shows the Indian lunar spacecraft Chandrayaan-1. Credit: ISRO.

India Successfully Launches Chandrayaan-1 Mission to the Moon

On October 22, the Indian Space Research Organisation (ISRO's) successfully launched the 1380-kilogram Chandrayaan-1 spacecraft. Chandrayaan-1 is India's first spacecraft mission beyond Earth's orbit. It aims to further expand our knowledge about Earth's only natural satellite — the Moon. With well-defined objectives, the Chandrayaan-1 mission intends to perform remote sensing of our nearest celestial neighbor for approximately two years using eleven scientific instruments built in India and five other countries.

The primary objectives of Chandrayaan-1 are to place an unmanned spacecraft in an orbit around the Moon, to conduct mineralogical and chemical mapping of the lunar surface, and to upgrade the technological base in India.

On November 8, the spacecraft entered lunar orbit, and on November 14, the Moon Impact Probe successfully impacted the lunar surface. The next steps will be to turn on and thoroughly test the other scientific instruments, and the spacecraft will then enter the full operational phase of the mission, which is expected to last for approximately two years.

There are 11 payloads (scientific instruments) through which Chandrayaan-1 intends to achieve its scientific objectives. They include five instruments designed and developed in India, three instruments from the European Space Agency, one from Bulgaria, and two from the United States.

The Indian payloads of Chandrayaan-1 are the Terrain Mapping Camera (TMC), the Hyperspectral Imager (HySI), the Lunar Laser Ranging Instrument (LLRI), the High Energy X-ray Spectrometer (HEX), and the Moon Impact Probe (MIP). The six international payloads of Chandrayaan-1 include the Chandrayaan-1 Imaging X ray Spectrometer (C1XS), Near-Infrared Spectrometer (SIR-2), Sub Kiloelectronvolt Atom Reflecting Analyser (SARA), Radiation Dose Monitor (RADOM), Miniature Synthetic Aperture Radar (Mini-SAR), and Moon Mineralogy Mapper (M3).

India announced its Moon mission in 2003, also announcing plans to send a man to the Moon in the next few years. Together with China and Japan, India is part of a quickly developing Asian space sector. For more information, visit *www.isro.gov.in/Chandrayaan/htmls/home.htm*.

Mars Phoenix Lander Finishes Successful Work on Red Planet

NASA's Phoenix Mars Lander has ceased communications after operating for more than five months. As anticipated, seasonal decline in sunshine at the robot's arctic landing site was no longer providing enough sunlight for the solar arrays to collect the power necessary to charge batteries that operate the lander's instruments.

Phoenix spacecraft on Mars. Credit: NASA/ JPL-Caltech/University of Arizona.

Mission engineers last received a signal from the lander on November 2. Phoenix, in addition to shorter daylight, encountered a dustier sky, more clouds, and colder temperatures as the northern Mars summer approached autumn. The mission exceeded its planned operational life of three months to conduct and return science data.

While the spacecraft's work has ended, the analysis of data from the instruments is in its earliest stages. "Phoenix has given us some surprises, and I'm confident we will be pulling more gems from this trove of data for years to come," said Phoenix Principal Investigator Peter Smith of the University of Arizona.

Launched August 4, 2007, Phoenix landed May 25, 2008, farther north than any previous spacecraft to land on the martian surface. The lander dug, scooped, baked, sniffed, and tasted the Red Planet's soil. Among early results, it verified the presence of water-ice in the martian subsurface, which the Mars Odyssey orbiter first detected remotely in 2002. Phoenix's cameras also returned more than 25,000 pictures from sweeping vistas to near the atomic level using the first atomic force microscope ever used outside Earth.

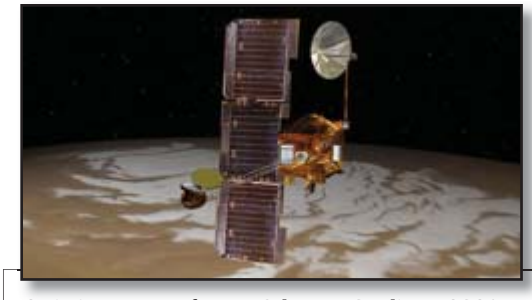
"Phoenix not only met the tremendous challenge of landing safely, it accomplished scientific investigations on 149 of its 152 martian days as a result of dedicated work by a talented team," said Phoenix Project Manager Barry Goldstein at the Jet Propulsion Laboratory. Phoenix's preliminary science accomplishments advance the goal of studying whether the martian arctic environment has ever been favorable for microbes. Additional findings include documenting a mildly alkaline soil environment unlike any found by earlier Mars missions; finding small concentrations of salts that could be nutrients for life; discovering perchlorate salt, which has implications for ice and soil properties; and finding calcium carbonate, a marker of effects of liquid water.

Phoenix findings also support the goal of learning the history of water on Mars. These findings include excavating soil above the ice table, revealing at least two distinct types of ice deposits; observing snow descending from clouds; providing a mission-long weather record, with data on temperature, pressure,

humidity and wind; observations of haze, clouds, frost and whirlwinds; and coordinating with the Mars Reconnaissance Orbiter to perform simultaneous ground and orbital observations of martian weather.

"Phoenix provided an important step to spur the hope that we can show Mars was once habitable and possibly supported life," said Doug McCuistion, director of the Mars Exploration Program at NASA Headquarters. "Phoenix was supported by orbiting NASA spacecraft providing communications relay while producing their own fascinating science. With the upcoming launch of the Mars Science Laboratory, the Mars Program never sleeps." For more information, visit *www.nasa.gov/phoenix* or *phoenix.lpl.arizona.edu*.

NASA's Mars Odyssey Shifting Orbit for Extended Mission



Artist's concept of Mars Odyssey. Credit: NASA/JPL.

The longest-serving of six spacecraft now studying Mars is up to new tricks for a third two-year extension of its mission to examine the most Earthlike of known foreign planets. NASA's Mars Odyssey is altering its orbit to gain even better sensitivity for its infrared mapping of martian minerals. During the mission extension through September 2010, it will also point its camera with more flexibility.

The orbit adjustment will allow Odyssey's Thermal Emission Imaging System to look down at sites when it's mid-afternoon, rather than late afternoon. The multipurpose camera will take advantage of the infrared radiation emitted by the warmer rocks to provide clues to the rocks' identities. On commands from its operations team at JPL and at Denver-based Lockheed Martin Space Systems, Odyssey fired thrusters for nearly 6 minutes on September 30, the final day of the mission's second two-year extension.

Odyssey's orbit is synchronized with the Sun. The local solar time has been about 5:00 p.m. at whatever spot on Mars Odyssey flew over as it made its dozen daily passes from between the north pole region to the south pole region for the past five years. (Likewise, the local time has been about 5:00 a.m. under the track of the spacecraft during the south-to-north leg of each orbit.)

The push imparted by the September 30 maneuver will gradually change that synchronization over the next year or so. Its effect is that the time of day on the ground when Odyssey is overhead is now getting earlier by about 20 seconds per day. A follow-up maneuver, probably in late 2009 when the overpass time is between 2:30 and 3:00 p.m., will end the progression toward earlier times.

While aiding performance of the Thermal Emission Imaging System, the shift to mid-afternoon is expected to stop the use of one of three instruments in Odyssey's Gamma Ray Spectrometer suite. The suite's gamma-ray detector needs a later-hour orbit to avoid overheating of a critical component. The suite's neutron spectrometer and high-energy neutron detector are expected to keep operating.

The Gamma Ray Spectrometer provided dramatic discoveries of water-ice near the surface throughout much of high-latitude Mars, the impetus for NASA's Phoenix Mars Lander mission. The gamma-ray detector has also mapped global distribution of many elements, such as iron, silicon, and potassium, a high science priority for the first and second extensions of the Odyssey mission. A panel of planetary scientists assembled by NASA recommended this year that Odyssey make the orbit adjustment to get the best science return from the mission in coming years.

For more about the Mars Odyssey mission, visit *mars.jpl.nasa.gov/odyssey*.

Dawn Glides Into New Year

On November 20, the Dawn spacecraft shut down its ion propulsion system as scheduled. The spacecraft is now gliding toward a Mars flyby in February of next year.

"Dawn has completed the thrusting it needs to use Mars for a gravity assist to help get us to Vesta," said Marc Rayman of the Jet Propulsion Laboratory, Dawn's chief engineer. "Dawn will now coast in its orbit around the Sun for the next half a year before we again fire up the ion propulsion system to continue our journey to the asteroid belt."

Dawn's ion engines are vital to the success of the misson's 8-year, 4.9-billion-kilometer (3-billion-mile) journey to asteroid Vesta and dwarf planet Ceres. One of these extremely frugal powerhouses can generate more than 24 hours of thrusting while consuming about 0.26 kilograms (about 9 ounces) of the spacecraft's xenon fuel supply — less than the contents of a can of soda. Over their lifetime, Dawn's three ion propulsion engines will fire cumulatively for about 50,000 hours (more than five years) — a record for spacecraft.

Dawn will begin its 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 utilizing the same set of instruments at two separate destinations, scientists can more accurately formulate comparisons and contrasts. Dawn's science instrument suite will measure shape, surface topography, tectonic history, and elemental and mineral composition, and will seek out water-bearing minerals. In addition, the Dawn spacecraft itself and how it orbits both Vesta and Ceres will be used to measure the celestial bodies' masses and gravity fields.

For more information, visit *www.nasa.gov/dawn* or *dawn.jpl.nasa.gov*.

Artist's rendition of the Juno spacecraft in front of Jupiter. Juno is one of the largest planetary spacecraft ever to be launched. Credit: NASA/University of Wisconsin.

NASA Prepares for New Juno Mission to Jupiter

NASA is officially moving forward on a mission to conduct an unprecedented, in-depth study of Jupiter.

Called Juno, the mission will be the first in which a spacecraft is placed in a highly elliptical polar orbit around the giant planet to understand its formation, evolution, and structure. Underneath its dense cloud cover, Jupiter safeguards secrets to the fundamental processes and conditions that governed our early solar system.

"Jupiter is the archetype of giant planets in our solar system and formed very early, capturing most of the material left after the Sun formed," said Scott Bolton, Juno principal investigator from the Southwest Research Institute in San Antonio. "Unlike Earth, Jupiter's giant mass allowed it to hold onto its original composition, providing us with a way of tracing our solar system's history."

The spacecraft is scheduled to launch onboard an Atlas rocket from Cape Canaveral in August 2011, reaching Jupiter in 2016. The spacecraft will orbit Jupiter 32 times, skimming about 3000 miles over the planet's cloud tops for approximately one year. The mission will be the first solar powered spacecraft designed to operate despite the great distance from the Sun. "Jupiter is more than 400 million miles from the Sun or five times further than Earth," Bolton said. "Juno is engineered to be extremely energy efficient."

The spacecraft will use a camera and nine science instruments to study the hidden world beneath Jupiter's colorful clouds. The suite of science instruments will investigate the existence of an ice-rock core, Jupiter's intense magnetic field, water and ammonia clouds in the deep atmosphere, and explore the planet's aurora borealis.

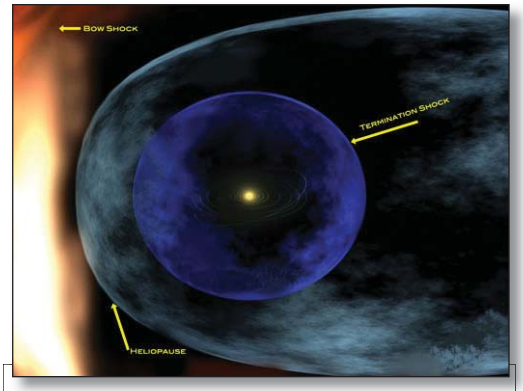
"In Greek and Roman mythology, Jupiter's wife Juno peered through Jupiter's veil of clouds to watch over her husband's mischief," said Professor Toby Owen, co-investigator at the University of Hawaii in Honolulu. "Our Juno looks through Jupiter's clouds to see what the planet is up to, not seeking signs of misbehavior, but searching for whispers of water, the ultimate essence of life."

"Juno's extraordinarily accurate determination of the gravity and magnetic fields of Jupiter will enable us to understand what is going on deep down in the planet," said Professor Dave Stevenson, co-investigator at the California Institute of Technology. "These and other measurements will inform us about how Jupiter's constituents are distributed, how Jupiter formed, and how it evolved, which is a central part of our growing understanding of the nature of our solar system."

The Juno mission is the second spacecraft designed under NASA's New Frontiers Program. The first was the Pluto New Horizons mission, launched in January 2006 and scheduled to reach Pluto and Charon in 2015. For more information about the Juno mission, visit *juno.wisc.edu*.

NASA Spacecraft Ready to Explore Outer Solar System

The first NASA spacecraft to image and map the dynamic interactions taking place where the hot solar wind slams into the cold expanse of space was launched on October 19. The two-year mission began from the Kwajalein Atoll, a part of the Marshall Islands in the Pacific Ocean.



There are several boundaries at the edge of our solar system. The IBEX mission will study these boundaries to help us understand how they protect life on Earth and astronauts in space from the galactic cosmic rays coming from interstellar space. Credit: NASA.

Called the Interstellar Boundary Explorer or IBEX, the spacecraft will conduct extremely high-altitude orbits above Earth to investigate and capture images of processes taking place at the farthest reaches of the solar system. Known as the interstellar boundary, this region marks where the solar system meets interstellar space.

"The interstellar boundary regions are critical because they shield us from the vast majority of dangerous galactic cosmic rays, which otherwise would penetrate into Earth's orbit and make human spaceflight much more dangerous," said David J. McComas, IBEX principal investigator at the Southwest Research Institute in San Antonio.

The story of the outer solar system began to unfold when the Voyager 1 and Voyager 2 spacecrafts left the inner solar system and headed out toward the boundary between our solar system and interstellar space. "The Voyager spacecraft are making fascinating observations of the local conditions at two points beyond the termination shock that show totally unexpected results and challenge many of our notions about this important region," said McComas.

IBEX was launched onboard a Pegasus rocket dropped from under the wing of an L-1011 aircraft flying over the Pacific Ocean. The Pegasus carried the spacecraft approximately 130 miles above Earth and placed it in orbit.

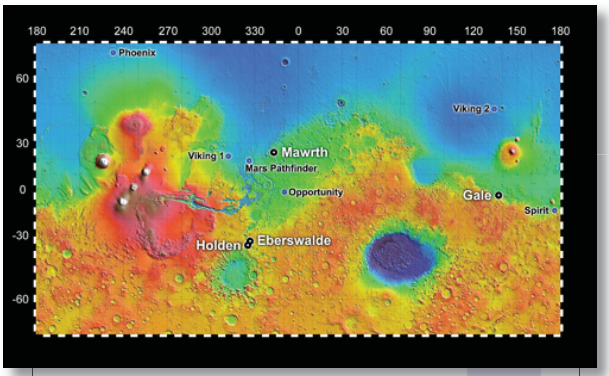
The IBEX mission is the next in NASA's series of low-cost, rapidly developed Small Explorers spacecraft. NASA's Goddard Space Flight Center in Greenbelt, Maryland, manages the Explorers Program for NASA's Science Mission Directorate in Washington. The mission was developed by Southwest Research Institute with national and international partner participation. For more about the mission, visit *www.nasa.gov/ibex*.

Site List Narrows for NASA's Next Mars Landing

Four intriguing places on Mars have risen to the final round as NASA selects a landing site for its next Mars mission, the Mars Science Laboratory. The Mars Science Laboratory is now scheduled to launch in fall of 2011, two years later than previously planned. After completing a recent assessment of the progress it has made in the past three months, the Mars Science Laboratory team concluded that a launch date of October 2009 is no longer feasible because of testing and hardware challenges that must be addressed to ensure mission success.

The agency had a wider range of possible landing sites to choose from than for any previous mission, thanks to the Mars Science Laboratory's advanced technologies, and the highly capable orbiters helping this mission identify scientifically compelling places to explore.

The sites, alphabetically, are Eberswalde, where an ancient river deposited a delta in a possible lake; Gale, with a mountain of stacked layers including clays and sulfates; Holden, a crater containing alluvial fans, flood deposits, possible lake beds and clay-rich deposits; and Mawrth, which shows exposed layers containing at least two types of clay.



Out of more than 30 sites considered as possible landing targets for the Mars Science Laboratory mission, four of the most intriguing places on Mars rose to the final round of the site-selection process. Credit: NASA/JPL-Caltech.

The mission's capabilities for landing more precisely than ever before and for generating electricity without reliance on sunshine have made landing sites eligible that would not have been acceptable for past Mars missions.

"Landing on Mars always is a risky balance between science and engineering. The safest sites are flat, but the spectacular geology is generally where there are ups and downs, such as hills and canyons. That's why we have engineered this spacecraft to make more sites qualify as safe," said JPL's Michael Watkins, mission manager for the Mars Science Laboratory. "This will be the first spacecraft that can adjust its course as it descends through the martian atmosphere, responding to variability in the atmosphere. This ability to land in much smaller areas than previous missions, plus capabilities to land at higher elevations and drive father, allows us consider more places the scientists want to explore."

For their Mars landings in 2004, Spirit and Opportunity needed safe target areas about 70 kilometers (about 40 miles) long. Mars Science Laboratory is designed to hit a target area roughly 20 kilometers (12 miles) in diameter. Also, a new "skycrane" technology to lower the rover on a tether for the final touchdown can accommodate more slope than the airbag method used for Spirit and Opportunity. In addition, a radioisotope power supply, like that used by Mars Viking landers in the 1970s, will enable year-round operation farther from the equator than the solar power systems of more recent missions.

Gale is near the equator, Eberswalde and Holden are farther south, and Mawrth is in the north.

As a clay-bearing site where a river once flowed into a lake, Eberswalde Crater offers a chance to use knowledge that oil industry geologists have accumulated about locations of the most promising parts of a delta to look for any concentrations of carbon chemistry that is crucial to life.

The mountain inside Gale Crater could provide a route for the rover to drive up a 5-kilometer (3-mile) sequence of layers, studying a transition from environments that produced clay deposits near the bottom to later environments that produced sulfate deposits partway up.

Running water once carved gullies and deposited sediments as alluvial fans and catastrophic flood deposits in Holden Crater, a site that may also present the chance to evaluate layers deposited in a lake. Exploration of key features within this target area would require drives to the edge of a broad valley, and then down into the valley.

Mawrth Valley is an apparent flood channel near the edge of vast martian highlands. It holds different types of clays in clearly layered context, offering an opportunity for studying the changes in wet conditions that produced or altered the clays. The clay signatures are stronger than at the other sites, and this is the only one of the four for which the science target is within the landing area, not nearby.

For additional information, visit *mars.jpl.nasa.gov/msl*.

NASA Spacecraft Detects Buried Glaciers on Mars

Artist's concept of a martian glacier. Credit: NASA/JPL.

NASA's Mars Reconnaissance Orbiter has revealed vast martian glaciers of water ice under protective blankets of rocky debris at much lower latitudes than any ice previously identified on the Red Planet. Scientists analyzed data from the spacecraft's ground-penetrating radar and reported in the November 21 issue of the journal *Science* that buried glaciers extend for dozens of miles from the edges of mountains or cliffs. A layer of rocky debris blanketing the ice may have preserved the underground glaciers as remnants from an ice sheet that covered middle latitudes during a past ice age. This discovery is similar to massive ice glaciers that have been detected under rocky coverings in Antarctica.

"Altogether, these glaciers almost certainly represent the largest reservoir of water ice on Mars that is not in the polar caps," said John W. Holt of the University of Texas at Austin, lead author of the report. "Just one of the features we examined is three times larger than the city of Los Angeles and up to half a mile thick. And there are many more. In addition to their scientific value, they could be a source of water to support future exploration of Mars."

Scientists have been puzzled by what are known as aprons — gently sloping areas containing rocky deposits at the bases of taller geographical features — since NASA's Viking orbiters first observed them on the martian surface in the1970s. One theory has been that the aprons are flows of rocky debris lubricated by a small amount of ice. Now, the shallow radar instrument on the Mars Reconnaissance Orbiter has provided scientists an answer to this martian puzzle. "These results are the smoking gun pointing to the presence of large amounts of water ice at these latitudes," said Ali Safaeinili, a shallow radar instruments team member with NASA's Jet Propulsion Laboratory.

Radar echoes received by the spacecraft indicated radio waves pass through the aprons and reflect off a deeper surface below without significant loss in strength. That is expected if the apron areas are composed of thick ice under a relatively thin covering. The radar does not detect reflections from the interior of these deposits as would occur if they contained significant rock debris. The apparent velocity of radio waves passing through the apron is consistent with a composition of water ice.

Scientists developed the shallow radar instrument for the orbiter to examine these midlatitude geographical features and layered deposits at the martian poles. "We developed the instrument so it could operate on this kind of terrain," said Roberto Seu, leader of the instrument science team at the University of Rome La Sapienza in Italy. "It is now a priority to observe other examples of these aprons to determine whether they are also ice." The rocky debris blanket topping the glaciers apparently has protected the ice from vaporizing, which would happen if it were exposed to the atmosphere at these latitudes.

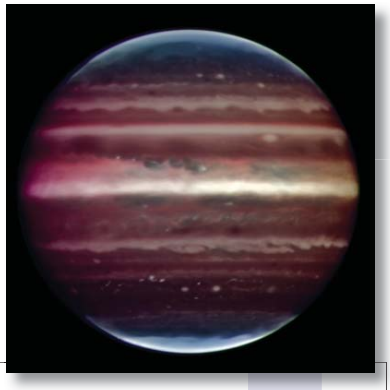
For more information about the Mars Reconnaissance Orbiter mission, visit *www.nasa.gov/mro*.

New Image-Correction Technique Provides Sharpest Groundbased Picture Ever Taken of a Planet

A record two-hour observation of Jupiter using a superior technique to remove atmospheric blur has produced the sharpest whole-planet picture ever taken from the ground. The series of 265 snapshots obtained with the Multi-Conjugate Adaptive Optics Demonstrator (MAD) prototype instrument mounted on the European Southern Observatory's (ESO) Very Large Telescope (VLT) reveal changes in Jupiter's smog-like haze, probably in response to a planet-wide upheaval more than a year ago.

Being able to correct widefield images for atmospheric distortions has been the dream of scientists and engineers for decades. The new images of Jupiter prove the value of the advanced technology used by MAD, which uses two or more guide stars instead of one as references to remove the blur caused by atmospheric turbulence over a field of view 30 times larger than existing techniques.

"This type of adaptive optics has a big advantage for looking at large objects, such as planets, star cluster, or nebulae," said lead researcher Franck Marchis, a research astronomer at the University of California, Berkeley, and the SETI Institute in Mountain View, California. "While regular adaptive optics systems provide excellent correction in a small field of view, MAD provides good correction over a larger area of sky."

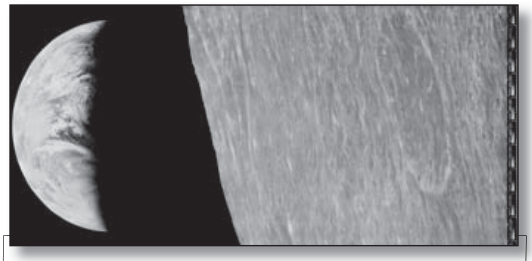


This stunning image of Jupiter was taken in infrared light on the night of August 17, 2008, with the Multi-Conjugate Adaptive Optics Demonstrator (MAD) prototype instrument mounted on ESO's Very Large Telescope. Credit: ESO/F. Marchis, M. Wong, E. Marchetti, P. Amico, S. Tordo.

MAD allowed the researchers to observe Jupiter for almost two hours on August 16 and 17, a record duration according to the observing team. Conventional adaptive optics systems using a single Jupiter moon as reference cannot monitor Jupiter for so long because the moon moves too far from the planet. The Hubble Space Telescope cannot observe Jupiter continuously for more than about 50 minutes, because its view is regularly blocked by the Earth during Hubble's 96-minute orbit.

Using MAD, astronomers tracked two of Jupiter's largest moons, Europa and Io — one on each side of the planet — to provide a good correction across the full disk of the planet. With this unique series of images, the team found a major alteration in the brightness of the equatorial haze, which lies in a 16,000-kilometer-wide belt over Jupiter's equator. More sunlight reflecting off upper atmospheric haze means that the amount of haze has increased, or that it has moved up to higher altitudes. This conclusion came after comparison with images taken in 2005 using the Hubble Space Telescope. The Hubble images, taken at infrared wavelengths very close to those used for the VLT study, show more haze in the northern half of the bright Equatorial Zone, while the 2008 VLT images show a clear shift to the south.

For more information about ESO's telescopes and instrumentation, visit *www.eso.org/public/astronomy/teles-instr*.



This Lunar Orbiter 1 image of Earth has been recovered by the Lunar Orbiter Image Recovery Project. Credit: NASA/LOIRP.

NASA Restores Historic Lunar Orbiter Image

NASA has released a newly restored 42-year-old image of Earth. The Lunar Orbiter 1 spacecraft took the iconic photograph of Earth rising above the lunar surface in 1966. Using refurbished machinery and modern digital technology, NASA produced the image at a much higher resolution than was possible when it was originally taken. The data may help the next generation of explorers as NASA prepares to return to the Moon.

In the late 1960s, NASA sent five Lunar Orbiter missions to photograph the surface of the Moon and gain a better understanding of the lunar environment in advance of the Apollo program. Data were recorded on large magnetic tapes and transferred to photographic film for scientific analysis. When these images were first retrieved from lunar orbit, only a portion of their true resolution was available because of the limited technology available.

The Lunar Orbiter Image Recovery Project, located at NASA Ames Research Center, is taking analog data from original recorders used to store the data on tape and 1500 of the original tapes, converting the data into digital form, and reconstructing the images. The first restored image confirms that data from the original tapes can be retrieved from the newly restored tape drives from the 1960s when combined with software from 2008.

Future images will be made publically available when they are fully processed and calibrated. The intent of this project is to facilitate, wherever possible, the broadest dissemination and public use of these images.

As the images are processed, they will be submitted to the Planetary Data System, which NASA's Space Science Mission Directorate sponsors in cooperation with the Jet Propulsion Laboratory. The images also will be calibrated with standard mapping coordinates from the U.S. Geological Survey's Astrogeology Research Program in Flagstaff.

NASA will launch the Lunar Reconnaissance Orbiter in 2009 to map the Moon's surface. The restoration of the Lunar Orbiter images to high-quality images will provide the scientific community with a baseline to measure and understand changes that have occurred on the Moon since the 1960s. These data could help mission planners assess the long-term risk to lunar inhabitants from small meteor impacts and establish longitude and latitude lines for lunar mapping.

"This effort was made possible by the vision and dedication of Apollo-era NASA employees, independent researchers, and a true veteran team of engineers and young students," said Dennis Wingo, the program lead for the project.

For more information about the Lunar Orbiter Image Recovery Project, visit *www.nasa.gov/topics/moonmars/features/LOIRP*.

Racers Get Ready! NASA's Great Moonbuggy Registration Begins

Student racers from the University of Evansville in Evansville, Indiana, speed to victory in the college division of the Great Moonbuggy Race in 2008. Credit: NASA.

Registration is open for NASA's 16th annual Great Moonbuggy Race, which will take place April 3–4, 2009, in Huntsville, Alabama. Each year, NASA challenges high schools and colleges across the country and the world to design and build lightweight, human-powered moonbuggies. Innovative students put their own spin on the historic lunar rovers that carried Americans across the surface of the Moon during the Apollo era. Builders with "the right stuff" then converge on Huntsville to test their engineering savvy — and their endurance.

The race was founded at NASA's Marshall Space Flight Center in Huntsville in 1994. The U.S. Space and Rocket Center hosts the two-day event. The nationally renowned space museum and tourist attraction constructs a punishing course — a half-mile of hills and craters simulating the lunar surface — on the looping sidewalks and paths around its grounds.

High school teams will compete April 3. College teams will take the course April 4. Prizes are awarded to the three teams in each division that finish with the fastest race times. NASA and industry sponsors present additional awards for innovative buggy design, team spirit, best newcomer, and other achievements.

Participation in the race has increased annually from just eight college teams in 1994 to 46 high school and college teams in 2008, with hundreds of students coming from 17 states, the District of Columbia, Puerto Rico, Canada, India, and Germany to participate.

Participating institutions may register up to two moonbuggies and teams each year. Registration for the 2009 race closes February 1. For complete rules, moonbuggy design parameters, and registration, visit *moonbuggy.msfc.nasa.gov*.

NASA Invites Students to Name New Mars Rover

NASA is looking for the right stuff, or in this case, the right name for the next Mars rover. NASA, in cooperation with Walt Disney Studios Motion Pictures' movie WALL-E from Pixar Animation Studios, will conduct a naming contest for its car-sized Mars Science Laboratory rover.

The contest began Tuesday, November 18, and is open to students 5 to 18 years old who attend a U.S. school and are enrolled in the current academic year. To enter the contest, students will submit essays explaining why their suggested name for the rover should be chosen.

Essays must be received by January 25, 2009. In March 2009, the public will have an opportunity to rank nine finalist names via the Internet as additional input for judges to consider during the selection process. NASA will announce the winning rover name in April 2009.

Disney will provide prizes to students submitting winning essays, including a trip to NASA's Jet Propulsion Laboratory in Pasadena, California, where the rover is under construction. The grand prize winner will have an opportunity to place a signature on the spacecraft and take part in the history of space exploration.

Did Mars once have an environment capable of supporting life? NASA hopes that its next rover will help to further unravel that mystery. Credit: NASA.

Information about the contest is available at *marsrovername.jpl.nasa.gov*.

Karen McNamara works with the Stardust sample return capsule in the Space-Exposed Hardware Lab at NASA's Johnson Space Center prior to transfer to the Smithsonian Institution's National Air and Space Museum. Credit: NASA/JSC.

Stardust Capsule On Display at Smithsonian

Having returned the world's first particles from a comet, NASA's Stardust sample return capsule has joined the collection of flight icons in the Smithsonian's National Air and Space Museum in Washington. The capsule went on public display in the museum's Milestones of Flight Gallery on October 1, the 50th anniversary of NASA.

Stardust, comprising a spacecraft and capsule, completed a seven-year, three-billion-mile journey in 2006. A tennis racket-like, aerogel-lined collector was extended to capture particles as the spacecraft flew within 150 miles of Comet Wild 2 in January 2004. Carrying the collected particles, the capsule returned to Earth on January 15, 2006, landing in Utah. Two days later, it was transported to a curatorial facility at the NASA Johnson Space Center (JSC) in Houston.

"Very few people get to build something, launch it into space, see it be successful, and then get it back in their hands," said Karen McNamara, JSC recovery lead for the Stardust mission. "To be able to share this with the public is phenomenal."

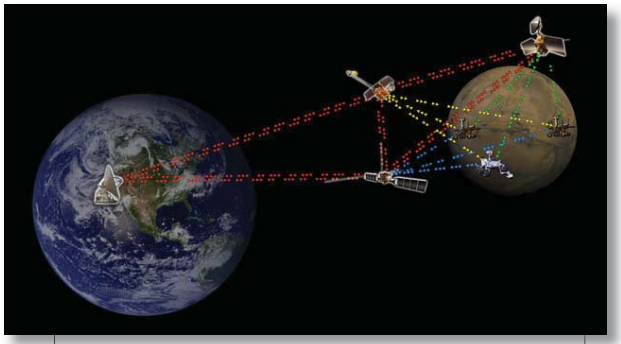
"The Smithsonian Institution's National Air and Space Museum is delighted to add to the National Collection the Stardust return capsule," said Roger Launius, senior curator of the Division of Space History at the museum. "As one of the premier space science missions of the recent past, Stardust will take its place alongside other iconic objects from the history of air and spaceflight. I look forward to helping to impart more knowledge to our visitors about the makeup of the universe using this significant and path-breaking object."

After successfully completing its mission, the Stardust spacecraft (now without it's return capsule) will use its flight-proven hardware to perform a new, previously unplanned investigation. The mission, called Stardust-NExT, will revisit Comet 9P/Tempel 1. This investigation will provide the first look at the changes to a comet nucleus produced after a close approach to the Sun. It also will mark the first time a comet ever has been revisited.

"Usually, when a piece of your spacecraft goes into the Smithsonian that means the mission's over," said Stardust-NExT project manager Rick Grammier of the Jet Propulsion Laboratory. "But the Stardust spacecraft is still doing the job for NASA and in February 2011, it will fly within 120 miles of the comet."

For more information about the Stardust mission, visit *www.nasa.gov/stardust*.

NASA Successfully Tests First Deep Space Internet



Artist's concept of the "Interplanetary Internet." Credit: NASA/JPL.

NASA has successfully tested the first deep space communications network modeled on the Internet. Working as part of a NASA-wide team, engineers from NASA's Jet Propulsion Laboratory used software called Disruption-Tolerant Networking (DTN) to transmit dozens of space images to and from a NASA science spacecraft located about 20 million miles from Earth.

"This is the first step in creating a totally new space communications capability, an interplanetary Internet," said Adrian Hooke, team lead and manager of space-networking architecture, technology, and standards at NASA Headquarters in Washington, DC.

NASA and Vint Cerf, a vice president at Google Inc., in Mountain View, California, partnered 10 years ago to develop this software protocol. The DTN sends information using a method that differs from the normal Internet's Transmission-Control Protocol/Internet Protocol (TCP/IP) communication suite, which Cerf co-designed.

The Interplanetary Internet must be robust to withstand delays, disruptions, and disconnections in space. Glitches can happen when a spacecraft moves behind a planet, or when solar storms and long communication delays occur. The delay in sending or receiving data from Mars takes between 3.5 and 20 minutes at the speed of light.

Unlike TCP/IP on Earth, the DTN does not assume a continuous end-to-end connection. In its design, if a destination path cannot be found, the data packets are not discarded. Instead, each network node keeps the information as long as necessary until it can communicate safely with another node. This store-and-forward method, similar to basketball players safely passing the ball to the player nearest the basket, means information does not get lost when no immediate path to the destination exists. Eventually, the information is delivered to the end user.

"In space today, an operations team must manually schedule each link and generate all the commands to specify which data to send, when to send it, and where to send it," said Leigh Torgerson, manager of the DTN Experiment Operations Center at JPL. "With standardized DTN, this can all be done automatically."

Engineers began a month-long series of DTN demonstrations in October. Data were transmitted using NASA's Deep Space Network in demonstrations occurring twice a week. Engineers use NASA's Epoxi spacecraft as a Mars data-relay orbiter. Epoxi is on a mission to encounter Comet Hartley 2 in two years. There are 10 nodes on this early interplanetary network. One is the Epoxi spacecraft itself and the other nine, which are on the ground at JPL, simulate Mars landers, orbiters, and ground mission-operations centers.

In the next few years, the Interplanetary Internet could enable many new types of space missions. Complex missions involving multiple landed, mobile, and orbiting spacecraft will be far easier to support through the use of the Interplanetary Internet. It also could ensure reliable communications for astronauts on the surface of the Moon.

"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 Forum at LPSC: Reaching Audiences through New Media

Lunar and Planetary Science Conference,
Sunday, March 22, 2009, 8:30 a.m. to 4:30 p.m.
Reaching Audiences through New Media: Lessons We Are Learning from the International Year of Astronomy
Immersive new media technologies such as collaborative web environments, social networks, virtual worlds, and inexpensive and accessible production tools are changing the way that people interact, work, learn, and teach. These provide high-impact opportunities for reaching an audience of young adults that largely is not accessed by, or accessing, NASA. What have we learned about these tools of interaction and communication? Join us to explore new media pathways, and to reflect on what we are learning from employing new media through NASA mission and International Year of Astronomy venues. The r**egistration fee of $65.00** will include continental breakfast and lunch. To register, please go to *https://www.lpi.usra.edu/meetings/registration/?mtg=lpscepo2009*.

NASA Postdoctoral Fellows

NASA offers approximately 60 postdoctoral fellowships annually. The NASA Postdoctoral Program (NPP) offers unique research opportunities to highly talented national and international scientists and engineers to engage in ongoing NASA research in aeronautics, astrobiology, astrophysics, earth science, exploration systems, heliophysics, planetary science, and space operations. Apply at *nasa.orau.org/postdoc*.

Pre-Service Earth and Space Science Institutes for College Faculty

The Faculty Institutes in NASA Earth and Space Science Education (FINESSE) engage community college and university faculty in content and practices for preparing future teachers. In these free two-day participant-driven workshops, NASA Earth and space scientists and educators share Earth and space science activities, data, and resources related to key science topics from the national science standards. Participants receive a $300 stipend, lunches, and more. The Institutes occur in conjunction with the 2009 American Astronomical Society, Association for Science Teacher Education, and National Association for Community College Teacher Education Preparation conferences. For more information, go to *www.lpi.usra.edu/education/facultyInstitutes*.

Space Science Is for Everyone: Creating and Using Accessible Resources in Educational Settings

This collection of helpful hints and resources is based on seven highly successful "Exceptional Space Science Materials for Exceptional Students" workshops, the expertise of the participants, and product testing in classrooms following these workshops. The brochure is offered as a tool for science, technology, engineering, and mathematics educators who are working with students with disabilities. This publication can be downloaded at *www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Space_Science_Is_for_Everyone.html*.

Monthly NASA Hot Topics and Featured Objects for IYA 2009

The vision of the International Year of Astronomy 2009 is to help the citizens of the world rediscover their place in the universe through the daytime and nighttime sky, and thereby engage a personal sense of wonder and discovery. During each month of the IYA, NASA will highlight some of its key space science missions, space science discoveries, and night-sky wonders that your audiences can discover with their own observations and explorations, and you can connect them to related NASA resources and events.

Upcoming topics are **January —** *Telescopes and Space Probes*; **February —** *Our Solar System;* and **March —** *Observing at Night and in the Day*.

The site is located at *astronomy2009.nasa.gov/news.htm*.

Klumpke-Roberts Award

For outstanding contributions to the public understanding and appreciation of astronomy

The Astronomical Society of the Pacific bestows the annual Klumpke-Roberts Award on those who have made outstanding contributions to the public understanding and appreciation of astronomy. Past awardees have included Carl Sagan, Isaac Asimov, Chesley Bonestall, Timothy Ferris, Walter Sullivan, Heidi Hammel, and the staffs of *Sky & Telescope* and *Astronomy* magazines. The nomination deadline for the 2009 awards is **December 15, 2008**. For more information, go to *161.58.115.79/membership/awards/klumpke.html*.

A number of student programs are available in the lunar and planetary sciences. Through these programs, students are given the invaluable opportunity to work one-on-one with mentors in their chosen research fields, gaining hands-on experience and enriching their professional careers.

LPI Summer Intern Program in Lunar and Planetary Science

The Lunar and Planetary Institute invites undergraduates with at least 50 semester hours of credit to experience cutting-edge research in the lunar and planetary sciences. As a Summer Intern, you will 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 LPI is located near Johnson Space Center, on the south side of Houston, Texas. The LPI provides, on NASA's behalf, leadership in the scientific community for research in lunar, planetary, and solar system sciences, and linkage with related terrestrial programs.

The 10-week program runs from June 8, 2009 to August 14, 2009. The deadline for applying for the 2009 program is **January 23, 2009.** For more information, including eligibility and selection criteria, areas of research, and an online application form, please visit *www.lpi.usra.edu/lpiintern*.

NASA Undergraduate Student Research Project

NASA's Undergraduate Student Research Project is accepting applications for 10-week summer 2009 internships. These internships offer students the opportunity to work alongside NASA scientists and engineers at NASA's field centers, laboratories, and test facilities. The application deadline for the summer 2009 session is **January 23, 2009**. For more information, visit *www.epo.usra.edu/usrp/*.

NASA's Planetary Geology and Geophysics Undergraduate Research Program (PGGURP)

PGGURP was started almost 30 years ago to allow undergraduates the chance to explore the field of planetary sciences and decide if it is a career path they'd like to follow. PGGURP's goals are to provide incentive and development of future planetary geoscientists; broaden the base of students who participate in planetary geoscience; introduce students interested in the traditional sciences to planetary science; and give potential planetary geoscientists a chance to explore the exciting field of planetary research.

The program consists of an eight-week summer internship, in which qualified students are matched with a NASA-funded planetary scientist. Care is taken to match the skills of the student with the needs of the NASA mentor. Internships take place at the NASA-funded scientist's home institution; in the past, sites have included the NASA Ames Research Center, the Jet Propulsion Laboratory, the U.S.G.S. Astrogeology Branch in Flagstaff, Arizona, and many others.

The application deadline is **February 23, 2009**. For more information, visit *www.acsu.buffalo.edu/~tgregg/pggurp.html*.

California Institute of Technology Summer Undergraduate Research Fellowships (SURF)

Caltech's Summer Undergraduate Research Fellowships program introduces students to research under the guidance of seasoned research mentors at Caltech and JPL. Students experience the process of research as a creative intellectual activity. SURF is modeled on the grant-seeking process: students collaborate with potential mentors to define and develop a project; applicants write research proposals for their projects; a faculty committee reviews the proposals and recommends awards; students carry out the work over a 10-week period in the summer, mid-June to late August; and at the conclusion of the program, they submit a technical paper and give an oral presentation at SURF Seminar Day, a symposium modeled on a professional technical meeting.

The deadline for all application materials is **February 22, 2009.** For more information, visit *www.surf.caltech.edu*.

Research Experiences for Undergraduates (REU) Program, American Museum of Natural History

This program, funded by the National Science Foundation, offers the opportunity of a summer internship, complete with stipend, and additional funds for subsistence, for qualified undergraduates to pursue specific projects in conjunction with Museum scientists in the physical sciences. Included in the program are a general orientation to the Museum; a series of weekly meetings at which students will discuss their research, present informal progress reports, and participate in discussions and seminars; as well as graduate and research career opportunities. At the conclusion of the internship, students deliver oral presentations of their work, and prepare publication-quality research papers.

The application deadline is **February 15, 2009**. For more information, visit *rggs.amnh.org/pages/academics_and_research/fellowship_opportunities#REU*.

SAO Summer Intern Program

The Smithsonian Astrophysical Observatory (SAO) Summer Intern Program is a nine- or ten-week-long program, depending on the availability of Harvard housing. In 2009 the program will likely run from Sunday, June 7, through Saturday, August 15. The program is funded by the National Science Foundation and the Smithsonian Institution. Undergraduate students interested in a career in astronomy, astrophysics, physics, or related physical sciences are encouraged to apply.

The application deadline is **February 2, 2009.** For more information, visit *hea-www.harvard.edu/REU/REU.html*.

NASA Earth and Space Science Fellowship (NESSF) Program

NASA announces a call for proposals to the NASA Earth and Space Science Fellowship (NESSF) program for the 2009–2010 academic year. This call for proposals solicits applications from accredited U.S. universities on behalf of individuals pursuing Master of Science (M.Sc.) or Doctoral (Ph.D.) degrees in Earth and space sciences, or related disciplines. The purpose of NESSF is to ensure continued training of a highly qualified workforce in disciplines needed to achieve NASA's scientific goals. The deadline for new applications is **February 3, 2009**. For more information go to *nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={758A1856-D5EE-C8AC-1D29-D8DD649CB8FF}&path=open*.

S. Ross Taylor Appointed Honorary Companion of the Order of Australia

Dr. S. Ross Taylor, emeritus professor and visiting fellow at the Australian National University, has been appointed an Honorary Companion of the Order of Australia, the highest civilian award given in that country. The citation is "for outstanding service to science, particularly in the fields of geochemistry and cosmochemistry as a researcher, writer, and educator."

One of the original visiting scientists at the Lunar Science Institute (now the Lunar and Planetary Institute), over the past 40 years Taylor has been considered to be one of the world's preeminent geochemists, pioneering several analytical methods, and has been a dominant force in the field of trace element and lunar geochemistry. He carried out the first analysis of the Moon rock samples brought back by Apollo 11 in 1969 and remained a principal investigator for NASA for the next 20 years.

Taylor set up research programs for studying the chemical composition of continental rocks and has been a pioneer in the study of Earth's crust and lithosphere. He developed the "andesite model" of the continental crust and his use of the mass spectrometer in examining trace elements in geological materials was groundbreaking, beginning the field of ultratrace element geochemistry. Taylor's research and writings have addressed many of the fundamental questions facing Earth scientists, including the origin and composition of the Earth, Moon, planets, and their satellites; the origin, constitution, and evolution of the Earth's continents; and the consequences of meteorite and asteroid impacts on the evolution of planets.

The Meteoritical Society Announces 2009 Award Winners

The Meteoritical Society
International Society for Meteoritics and Planetary Science

The Council of the Meteoritical Society met in Matsue, Japan, during their annual meeting and selected the winners of the four major awards to be given in 2009:

The *Leonard Medal* is for outstanding, original contributions to the science of meteoritics. **Lawrence Grossman** has been selected for his leadership role in study of vapor-solid formative processes in the early solar system and in the study of the history of refractory materials in meteorites.

The *Barringer Medal and Award* is for outstanding work in the field of impact cratering, and/or work that has led to a better understanding of impact phenomena. **Wolf Uwe Reimold** has been selected for his studies of the Vredefort impact structure in South Africa, as well as contributions to many fields, including shock metamorphism, petrology and geochemistry of impact melt basalts, analysis of lunar rocks and meteorites, as well as his detailed studies of other terrestrial impact craters.

The *Service Award* is for advancing the Society's goals to promote research and education in meteoritics and planetary science. **Derek W. G. Sears** is recognized because, over the course of a decade as Editor of the society journal, he transformed it into the highly respected international scientific journal that we have today.

The *Nier Prize* is for a significant research contribution in the field of meteoritics and closely allied fields by a young scientist under the age of 35. **Gordon Osinski** is recognized for his advances in understanding of petrology and field aspects of impact cratering.

DPS Prize Winners for 2008

The Division for Planetary Sciences (DPS) of the American Astronomical Society has announced its 2008 prize winners:

Michael A'Hearn is the winner of the *Gerard P. Kuiper Award* for outstanding contributions to planetary science. He is the Principal Investigator of NASA's Deep

Impact Mission. Noteworthy among his accomplishments is a landmark paper that analyzed 85 comets observed over 17 years, confirming the distinct compositional groupings of comets related to place of formation.

Jon D. Giorgini is the winner of the 2008 *Harold Masursky Award for Meritorious Service to Planetary Science*. A specialist at the NASA Jet Propulsion Laboratory, Giorgini developed and implemented the online Horizons system that is used by the international scientific community to generate real-time, accurate ephemeris information for more than 400,000 solar system bodies, including the Sun, planets and their satellites, comets, asteroids, and spacecraft.

G. Jeffrey Taylor is the winner of the *Carl Sagan Medal for Excellence in Public Communication in Planetary Science*. At the University of Hawaii, Taylor has developed several major educational tools including educational videos; a book, and curriculum materials for use in schools with the Lunar Sample Disk. His most ambitious outreach project is *Planetary Science Research Discoveries* (*www.psrd.hawaii.edu*), an educational website that he started in 1996 with Linda Martel.

Planetary Geology Division of the Geological Society of America Announces 2008 Award Winners

The Planetary Geological Division of the Geological Society of America administers several annual awards for planetary geologist and students. This year's winners include:

G. K. Gilbert Award: **Phillip Christensen, Arizona State University**
The award is named for G. K. Gilbert, who 100 years ago clearly recognized the importance of a planetary perspective in solving terrestrial geologic problems. The award is usually presented annually to career research scientists for outstanding contributions to the solution of fundamental problems in planetary geology in the broadest sense, which includes geochemistry, mineralogy, petrology, geophysics, geologic mapping, and remote sensing.

Stephen Dwornik Best Student Presentation Awards:
The Dwornik Award was started in 1991 with a generous endowment by Dr. Stephen E. Dwornik, who wished to encourage U.S. students to become involved with NASA and planetary science. The 2008 award winners were selected from student presentations made at the 39th Lunar and Planetary Science Conference, held in March:

Best Oral Presentation: **Leah H. Roach**, Brown University, "Constraints on the Rate of Sulfate Phase Changes in Valles Marineris Interior Layered Deposits"

Honorable Mention: **Joshua T. S. Cahill**, University of Hawaii, "Radiative Transfer Modeling of Geophysically Targeted Lunar Impact Crater Central Peaks"

Best Poster Presentation: **Brian C. Hahn**, SUNY-Stony Brook, "Martian Surface Heat Production and Crustal Heat Flow from Mars Odyssey Gamma-Ray Spectrometry"

Honorable Mention: **Melissa K. Bunte**, Arizona State University, "Geologic Mapping of the Zal Region of Io"

Honorable Mention: **Stephanie Brown**, Massachusetts Institute of Technology, "Predicting Mercury's Ancient Crustal Composition"

Pellas–Ryder Best Student Paper Award: **Mathieu Touboul**

Touboul M., Kleine T., Bourdon B., Palme H., and Wieler R. (2007) Late formation and prolonged differentiation of the Moon inferred from W isotopes in lunar metals. Nature, 450, 1206–1209.

This award, which is jointly sponsored by the Meteoritical Society and the Planetary Division of the Geological Society of America, is for undergraduate and graduate students who are first author of a planetary

science paper published in a peer-reviewed scientific journal. Any first author of a paper published on a topic listed on the cover of *Meteoritics & Planetary Science* who was a student when the paper was submitted is eligible for consideration for this award.

Eugene Shoemaker Award for Student Research: **James Darling,** University of Bristol, United Kingdom

The Eugene M. Shoemaker Impact Cratering Award is for undergraduate or graduate students of any nationality, working in any country, in the disciplines of geology, geophysics, geochemistry, astronomy, or biology. The award is to be applied for the study of impact craters, either on Earth or on the other solid bodies in the solar system; specific areas of study may include but shall not necessarily be limited to impact cratering processes, the bodies (asteroidal or cometary) that make the impacts, or the geological, chemical, or biological results of impact cratering.

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,
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Production Editor: Renée Dotson
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 16, 2009. Articles or announcements should be submitted via e-mail to *lpibed@lpi.usra.edu*.

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

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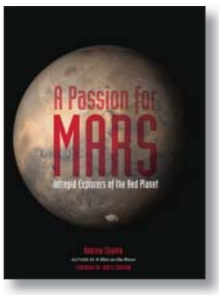
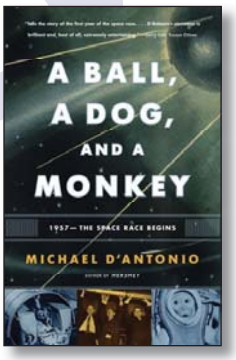
BOOKS



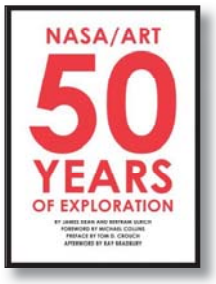
A Passion for Mars: Intrepid Explorers of the Red Planet. Andrew Chaikin. Harry N. Abrams, Inc., 2008. 280 pp., Hardcover, $35.00. *www.hnabooks.com*

The quest for Mars is chronicled by bestselling author Andrew Chaikin in this story of a passionate band of Earthbound explorers caught in the irresistible pull of the Red Planet. They include celebrated figures: astronomer Carl Sagan, who champions the idea of life on Mars; rocket scientist Wernher von Braun, drawing up plans for human Mars expeditions; and science-fiction author Ray Bradbury, standard-bearer for Mars' crucial place in human destiny. Readers also meet the rogue grad students known as the "Mars Underground," keepers of the flame when Mars falls off NASA's radar; biologist Jerry Soffen, looking for signs of life in a martian meteorite; geologist Mike Malin, who defies skeptics to reveal a Mars no one imagines; and many others, including Chaikin himself, who served on the first Viking Mars landing and covered Mars exploration as a science journalist. Based on extensive interviews, illustrated with compelling images, and animated by the author's own passion, Chaikin's account will resonate with anyone who has ever dreamed of a journey to Mars.



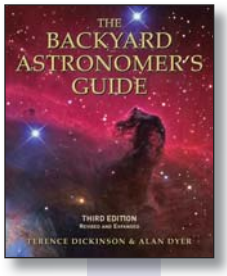
A Ball, a Dog, and a Monkey: 1957 — The Space Race Begins. Michael D'Antonio. Simon & Schuster, 2008. 320 pp., Paperback, $15.00. *www.simonandschuster.com*

When the Soviet Union launched the first orbital satellite, Sputnik I, Americans panicked. The Soviets had nuclear weapons, the Cold War was underway, and now the U.S.S.R. had taken the lead in the space race. Members of Congress and the press called for an all-out effort to launch a satellite into orbit. With dire warnings about national security in the news almost every day, the armed services saw space as the new military frontier. But President Eisenhower insisted that the space effort, which relied on military technology, be supervised by civilians so that the space race would be peaceful. The Navy's Vanguard program flopped, and the Army, led by ex-Nazi rocket scientist Wernher von Braun and a martinet general named J. Bruce Medaris (whom Eisenhower disliked), took over. Meanwhile, the Soviets put a dog inside the next Sputnik, and Americans grew more worried as the first animal in space whirled around Earth. Throughout 1958 America went space crazy. The news media flocked to the launch pads on the swampy Florida coast, and reporters reinvented themselves as space correspondents. And finally the Army's rocket program succeeded. Determined not to be outdone by the Russians, America's space scientists launched the first primate into space, a small monkey they nicknamed Old Reliable for his calm demeanor. And then at Christmastime, Eisenhower authorized the launch of a secret satellite with a surprise aboard. *A Ball, a Dog, and a Monkey* memorably recalls the infancy of the space race, a time when new technologies brought ominous danger but also gave us the ability to realize our dreams and reach for the stars.



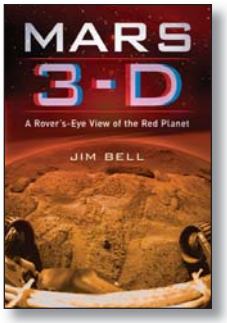
NASA/ART: 50 Years of Exploration. James Dean and Bertram Ulrich. Harry N. Abrams, Inc., 2008. 176 pp., Hardcover, $40.00. *www.hnabooks.com*

Artists, like astronauts, are constantly probing into the unknown. It is fitting that, shortly after the establishment of NASA in 1958, the NASA Art Program was created on the principle that artists are uniquely equipped to interpret and document the experience of space exploration. In the program's early years, artists as diverse as Robert Rauschenberg, Andy Warhol, Norman Rockwell, and James Wyeth participated. Over time, the Art Program has commissioned work from many of the world's most distinguished artists. The collection includes works by Alexander Calder, Nam June Paik, William Wegman, Mike and Doug Starn, Vija Celmins, and Annie Leibovitz. Along with a two-year touring exhibition with the Smithsonian Institution Traveling Exhibition Service (SITES), *NASA/Art* celebrates the 50th anniversary of NASA in October 2008 with an expanded selection of the best work created for the NASA Art Program, and stands as a lasting record of the impact of space exploration on the artistic imagination.



The Backyard Astronomer's Guide, Third Edition. Terence Dickinson and Alan Dyer. Firefly Books Ltd., 2008. 368 pp., Hardcover, $49.95. *www.fireflybooks.com*

This newest edition of *The Backyard Astronomer's Guide* includes the latest data and answers the questions most often asked by home astronomers, from beginners to experienced stargazers. The authors provide expert guidance on the right types of telescopes and other equipment; photographing the stars through a telescope; and star charts, software, and other references. Topics include daytime and twilight observing, and planetary and deep-sky observing. With over 500 color photographs and illustrations, this book is a valuable, beautiful and user-friendly astronomy reference. This edition includes a 20-page full-color *Atlas of the Milky Way*, a chapter on astrophotography with digital cameras, assessments of a wide range of new telescopes, an accessory catalog, and practical appendices.



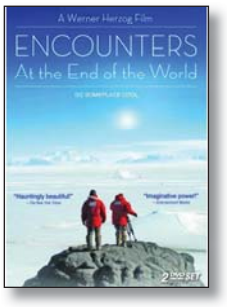
Mars 3-D: A Rover's Eye View of the Red Planet. Jim Bell. Sterling Publishing, 2008, 160 pp., Hardcover, $19.95. *www.sterlingpublishing.com*

What would it be like to visit Mars — to explore the distinctive, untouched terrain that inspired astronomers and stirred so many sci-fi writers' imaginations? Two highly capable robotic geologists — Spirit and Opportunity — made that amazing voyage, and spent the last four years roaming the Red Planet's unique landscape. Thanks to 120 stunning 3-D and color images shot by these rovers, we can come along — and right now, it's the closest we can get to actually setting foot on Mars. These superrealistic pictures pop off the page, allowing us to see for ourselves the rocks, craters, valleys, and other geologic configurations that define the martian terrain. Compelling and accessible text guides us on this exhilarating tour, revealing the thrill of each discovery, along with the perils and near misses. Featuring a fold-out flap with embedded 3-D viewer (which actually allows customers to view the three-dimensional images right in the store), it's the perfect gift for any armchair astronomer.

DVDs

Eyes on the Skies: 400 Years of Telescopic Discovery. Produced by ESA/Hubble, 2008, one disc. *www.eyesontheskies.org*

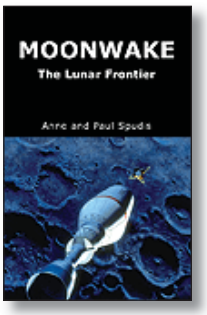
The invention of the telescope has been by far the most revolutionary development in the history of astronomy. For thousands of years, astronomers had to rely on their eyes in unraveling the mysteries of the universe. The telescope revealed an incredible wealth of astronomical riches, and led to a dramatic increase of knowledge about the wider world we live in. *Eyes on the Skies* explores the many facets of the telescope — the historical development, the scientific importance, the technological breakthroughs, and also the people behind this groundbreaking invention, their triumphs and failures. The film is presented by Dr. J (aka Dr. Joe Liske) from ESO, host of the *Hubblecast* video podcast. The DVD runs for more than 50 minutes and contains subtitles in several languages.



Encounters at the End of the World. Produced by Image Entertainment, 2008, two discs. $27.98. *www.image-entertainment.com*

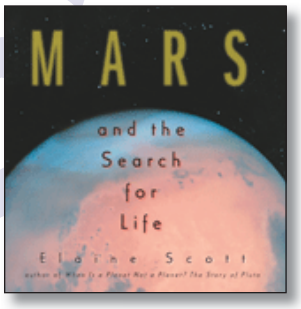
There is a hidden society at the end of the world. One thousand men and women live together under unbelievably close quarters in Antarctica, risking their lives and sanity in search of cutting-edge science. Now, for the first time, an outsider has been admitted. In his first documentary since *Grizzly Man*, filmmaker Werner Herzog, accompanied only by his cameraman, traveled to Antarctica, with rare access to the raw beauty and raw humanity of the ultimate Down Under. *Encounters at the End of the World*, Herzog's latest meditation on nature, explores this land of fire, ice, and corrosive solitude.

FOR KIDS!!!



Moonwake: The Lunar Frontier. Anne and Paul Spudis. Xlibris, 2006. 132 pp., Paperback, $17.84. *www2.xlibris.com/bookstore/index.asp*

For Mike, Toni, Laura, and Jason, adjusting to life on another planet is dangerous and exciting. Moonwake is a fictional base on the Moon, but what they encounter there is very real. Mike quickly learns that living on the Moon is anything but ordinary and boring. His mechanical skill presents opportunity but also danger for himself and his friends. Toni, a long-time lunar resident, has her life turned upside down when Mike, Laura, and Jason come to Moonwake. The small lunar colony quickly realizes they must deal with the excitement and life-threatening adventures of these teenage Moon explorers. Whether trapped in a lava tube, riding out a radiation storm, or falling from a decaying orbit, the friends hold together to survive this new world.



Mars and the Search for Life. Elaine Scott. Clarion Books, 2008. 64 pp., Hardcover, $17.00. *www.houghtonmifflinbooks.com*

Despite the fondest desires of science-fiction fans, everyone knows Mars isn't inhabited by little green men. In fact, Mars is a desolate, hostile world, with unbearably cold temperatures, no atmosphere to speak of, and violent dust storms. But could there ever have been life there, in some form? And if so, what happened to it? And could life exist there again one day? Maybe even human life? Elaine Scott takes readers on a journey through history and space and then into an exciting future as she explores the growing body of evidence that water — and therefore the potential for life — was present on Mars at one time. Even more titillating, the possibility of human habitation now hovers on the horizon, maybe within the next 30 years— an exciting prospect for young readers, some of whom may be among those first colonists.

The Mystery of Shooting Stars DVD. Produced by Fogware Publishing, 2007, one disc. $19.99. *www.fog-ware.com*

Explore where shooting stars come from. Combine the elements of a good-natured, inquisitive traveler named Tol Stilts, Dr. Iz, an energetic scientist, a sleepy radio flyer, and the whimsical imaginations of children. Together they wander their universe in search of explanations regarding life's wonderful mysteries. Blending live action sequences with digital animation, this educational video will engage the young viewer with song and delight, embracing their imagination while teaching.

Astronaut Little People Shape Book. Giovanni Caviezel. Barrons Educational Series, Inc., 2008. 10 pp., Hardcover, $10.99. *www.barronseduc.com*

Kids see themselves in *Little People Shape Books'* big, imaginative cover illustrations. This new addition to the series of children's favorites will inspire very young boys and girls with thoughts about what they might like to become when they grow up. The sturdy board book is die-cut so that when closed it takes the shape of the child who appears on the front cover, decked out in an appropriate costume. The story on the inside panels is easy for beginning readers, and direct enough for preschoolers to understand when the book is read aloud to them. There are bright color illustrations on every page. When closed, the book presents an attractive, layered, three-dimensional effect. For ages 4–7.

Calendar 2008–2009

December 2008

1–3 **Sixth Canadian Space Exploration Workshop**, Saint-Hubert, Canada. *www.asc-csa.gc.ca/eng/events/2008/csew2008.asp*

1–5 **GUAS-Subaru Asian Winter School 2008**, Tokyo, Japan. *optik2.mtk.nao.ac.jp/winter08/*

15–19 **2008 Fall AGU Meeting**, San Francisco, California. *www.agu.org/meetings/fm08/*

January 2009

4–8 **213th Meeting of the American Astronomical Society**, Long Beach, California. *www.aas.org/meetings/aas213/*

12–13 **Inaugural Meeting of the Small Bodies Assessment Group (SBAG)**, Adelphi, Maryland. *www.lpi.usra.edu/sbag/*

14–16 **VII Reunion Anual de la Sociedad Chilena de Astronomia (Sochias)**, Santiago, Chile. *www.sochias.cl/reunion/*

15–19 **Launch Conference of the International Year of Astronomy**, Paris, France. *www.astronomy2009.fr/opening*

19–23 **The Role of Astronomy in Society and Culture (IAU Symposium 260)**, Paris, France. *iaus260.obspm.fr/*

February

9–13 **International Workshop on Europa Lander: Science Goals and Experiments**, Moscow, Russia. *www.iki.rssi.ru/conf/2009elw/*

10–12 **Space Nuclear Systems Forum**, Houston, Texas. *www.lpi.usra.edu/meetings/nuclear2009/*

13–19 **New Views on the Earth's Interior**, London, United Kingdom. *www.minersoc.org/pages/groups/minphys/minphys.html#views*

26–27 **Venus Geochemistry: Progress, Prospects, and New Missions**, Houston, Texas. *www.lpi.usra.edu/meetings/venus2009*

26–28 **Titan 2009: Third Workshop on "Titan Chemistry: Observations, Experiments, Computations, and Modeling,"** San Juan, Puerto Rico. *www.chem.hawaii.edu/Bil301/Titan2009.html*

March

2–6 **Planet Formation and Evolution: The Solar System and Extrasolar Planets**, Tuebingen, Germany. *www.tat.physik.uni-tuebingen.de/~fgp/Conf09/*

3–4 **Mars Exploration Program Analysis Group (MEPAG)**, Washington, DC. *mepag.jpl.nasa.gov/meeting/mar-09/index.html*

23–27 **40th Lunar and Planetary Science Conference**, The Woodlands, Texas. *www.lpi.usra.edu/meetings/lpsc2009/*

April

2–4 **Conference on Micro-Raman Spectroscopy and Luminescence Studies in the Earth and Planetary Sciences**, Mainz, Germany. *www.lpi.usra.edu/meetings/spectroscopy2009/*

3–5 **CONTACT 2009**, Mountain View, California. *www.contact-conference.org*

6–10 **Astrophysical Magnetohydrodynamics**, Kiljava, Finland. *agenda.albanova.se/conferenceDisplay.py?confId=884*

19–24 **European Geosciences Union General Assembly**, Vienna, Austria. *meetings.copernicus.org/egu2009/*

20–23 **Microanalysis of Particles II**, Westmont, Illinois. *www.microbeamanalysis.org/meetings/topical/Particles2009/index.htm*

21–23 **Missions for Exoplanets: 2010–2020**, Pasadena, California. *exep.jpl.nasa.gov/exep_workshop.cfm*

27–30 **First IAA Planetary Defense Conference: Protecting Earth from Asteroids**, Granada, Spain. *www.congrex.nl/09c04/*

27–May 1 **Relativity in Fundamental Astronomy: Dynamics, Reference Frames, and Data Analysis (IAU Symposium 261)**, Virginia Beach, Virginia. *www.aas.org/divisions/meetings/iau/*

May

2–5 **American Astronomical Society Division on Dynamical Astronomy Meeting**, Virginia Beach, Virginia. *dda.cfa.harvard.edu/meetings/2009/*

10–15 **Bolides and Meteorite Falls**, Prague, Czech Republic. *www.bolides09.com/*

11–15 **International Conference on Comparative Planetology: Venus — Earth — Mars**, Noordwijk, The Netherlands. *www.rssd.esa.int/eslab-2009/*

16–21 **Japan Geoscience Union Meeting**, Chiba City, Japan. *www.jpgu.org/meeting_e/*

24–27 **Joint Assembly of the AGU, GAC, MAC, CGU: The Meeting of the Americas**, Toronto, Canada. *www.agu.org/meetings/ja09/*

June

13–19 **7th International Planetary Probe Short Course**, Barcelona, Spain. *www.planetaryprobe.eu/*

15–29 **Seventh Serbian Conference on Spectral Line Shapes in Astrophysics**, Zrenjanin, Serbia. *www.scslsa.matf.bg.ac.yu/*

21–26 **Goldschmidt Conference 2009: Challenges to Our Volatile Planet**, Davos, Switzerland. *www.goldschmidt2009.org/*

21–26 **Evolution of Planetary and Stellar Systems: Dynamical Interactions with DNC Lin**, Prato, Italy. *users.monash.edu.au/~ro/LinFest/*

22–26 **First International Conference on Adaptive Optics for Extremely Large Telescopes**, Paris, France. *ao4elt.lesia.obspm.fr/*

July

5–10 **Gordon Conference on the Origin of Solar Systems**, South Hadley, Massachusetts. *www.grc.org/programs.aspx?year=2009&program=origins*

6–11 **Seventh International Conference on Geomorphology (ANZIAG)**, Melbourne, Australia. *www.geomorphology2009.com/*

13–18 **72nd Annual Meeting of the Meteoritical Society**, Nancy, France. *www.lpi.usra.edu/meetings/metsoc2009/*

27–31 **Magnetospheres of the Outer Planets 2009**, Cologne, Germany. *mop2009.uni-koeln.de/*

August

2–7 **42nd IUPAC Congress: Chemistry Solutions**, Glasgow, Scotland. *www.rsc.org/ConferencesAndEvents/RSCConferences/IUPAC2009/*

3–14 **IAU XXVII General Assembly**, Rio de Janeiro, Brazil. *www.astronomy2009.com.br/*

11–15 **Sixth Annual Meeting and Exhibition of the Asia Oceania Geosciences Socity (AOGS 2009)**, Suntec City, Singapore. *www.asiaoceania.org/aogs2009/index.asp*

23–29 **International Association of Geomagnetism and Aeronomy (IAGA) 11th Scientific Assembly**, Sopron, Hungary. *www.iaga2009sopron.hu/*

24–26 **International Conference on Space Technology**, Thessaloniki, Greece. *www.icspacetechnology.com/*

30–Sept 5 **Natural Dynamos**, Stará Lesná, Slovakia. *rebel.ig.cas.cz/Tatry2009/*