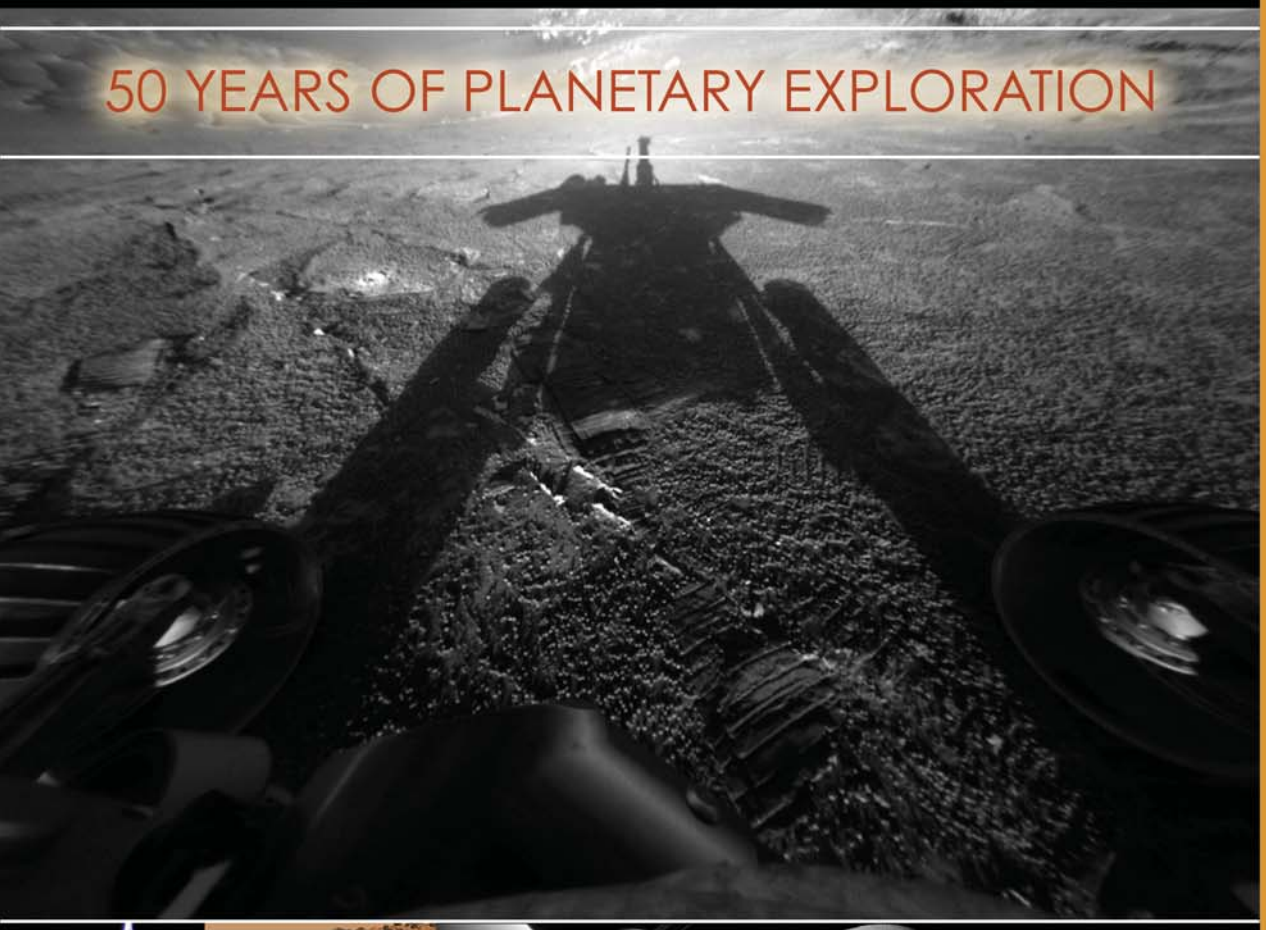
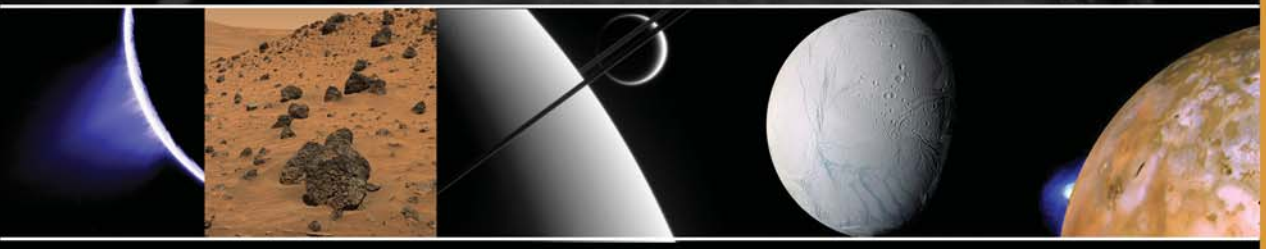
WHAT A LONG, STRANGE TRIP'

50 YEARS OF PLANETARY EXPLORATION





CONTENTS

Lunar and Planetary Information

BULLETIN

April/May 2012
Issues 128/129

Universities Space Research Association — Lunar and Planetary Institute

www.lpi.usra.edu/lpib

What a Long, Strange Trip: 50 Years of Planetary Exploration

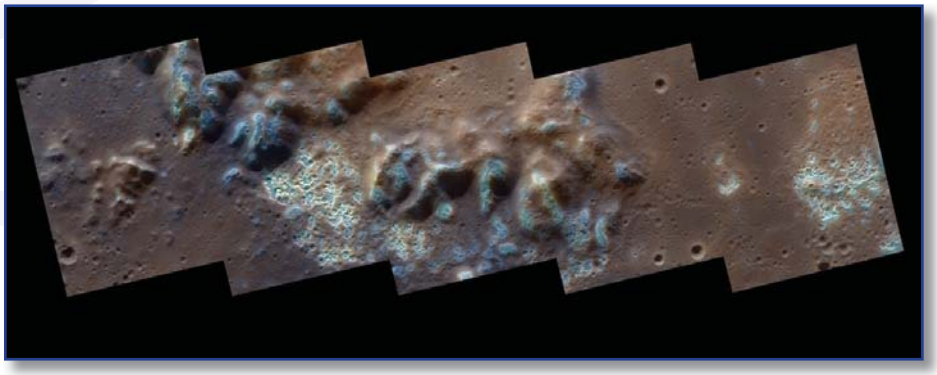
— Andrew Chaikin, Science Journalist and Space Historian

Whatever else might be said of our tiny slice of history, historians of the future will note that in our time humans first undertook the exploration of their own solar system. This year marks the 50th anniversary of the first planetary encounter, when Mariner 2 flew past Venus and found the cloud-hidden world far too hot to allow liquid water. It was just the first of countless revelations to come. During the last half-century Carl Sagan's characterization of us as the generation privileged "to begin in wonder and end in understanding" has been played out in spectacular fashion, as our robotic explorers have probed worlds large and small. On these pages we feature a selection of images from the first 50 years of solar system exploration, featuring "then and now" comparisons between early and later planetary missions.

Mercury: First Look

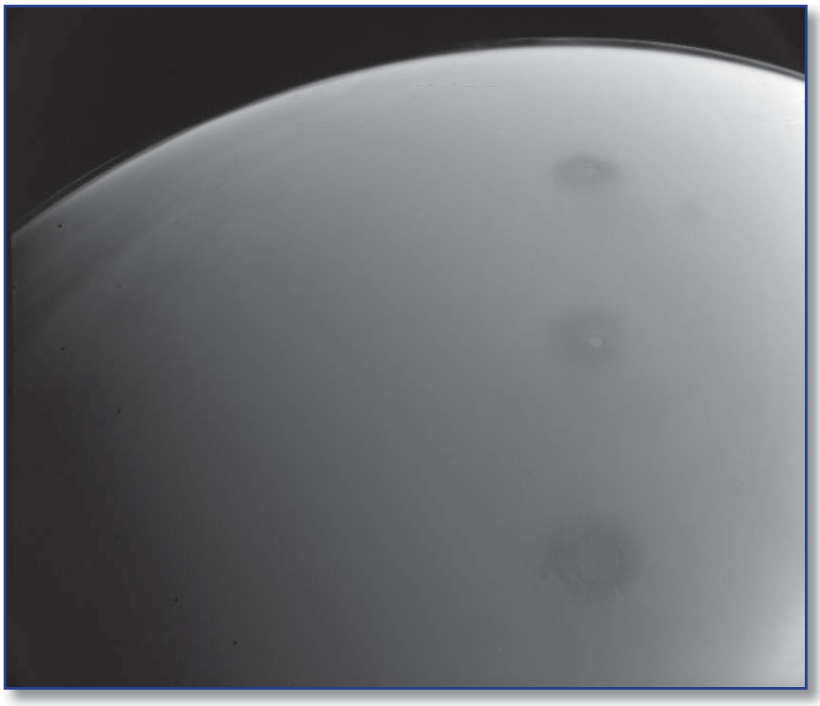
No human eyes had ever seen Mercury close up before Mariner 10 closed in on the innermost planet in March 1974. As Mercury's crescent grew in Mariner's sights, indistinct splotches of light and dark gave way to a moonlike expanse of craters. The planet's resemblance to our Moon proved superficial: Aside from differences in the size distribution of impact craters, there was Mercury's relatively high density, revealed by careful tracking of Mariner 10's flight path. The data indicated that Mercury has the greatest proportion of metal in its interior of all the planets in our solar system. Mariner 10's Mercury was clearly a planet with its own story to tell. Images processed by Ted Stryk.

Mercury: A New Intimacy



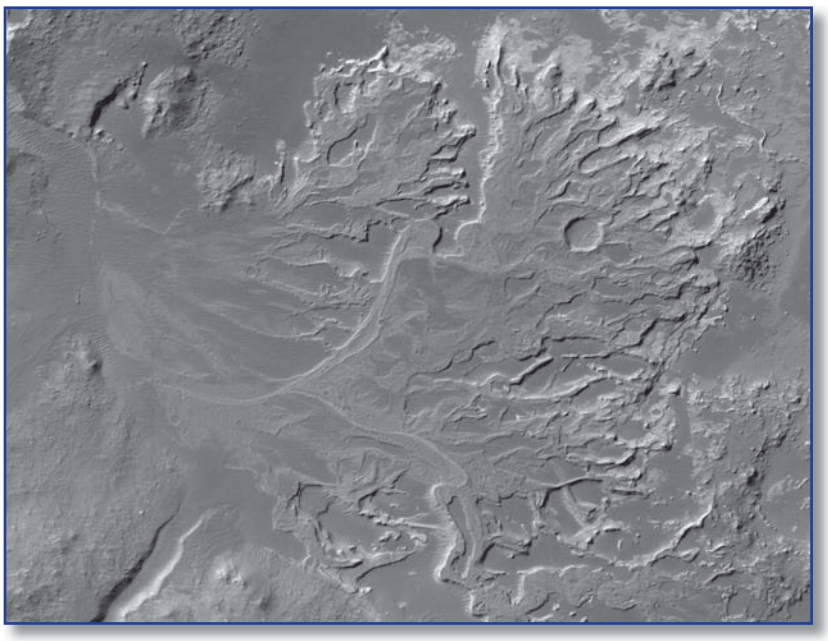
Since becoming the first spacecraft to orbit Mercury in March 2011, MESSENGER has surveyed the planet in unprecedented detail. Among the most surprising findings: Bright, irregular depressions called "hollows" that suggest evaporation from volatile-rich material excavated from the interior. This enhanced-color view shows a portion of Mercury's Raditladi impact basin; individual frames in the mosaic are about 12 miles wide.

Mars: Wonders in the Dust



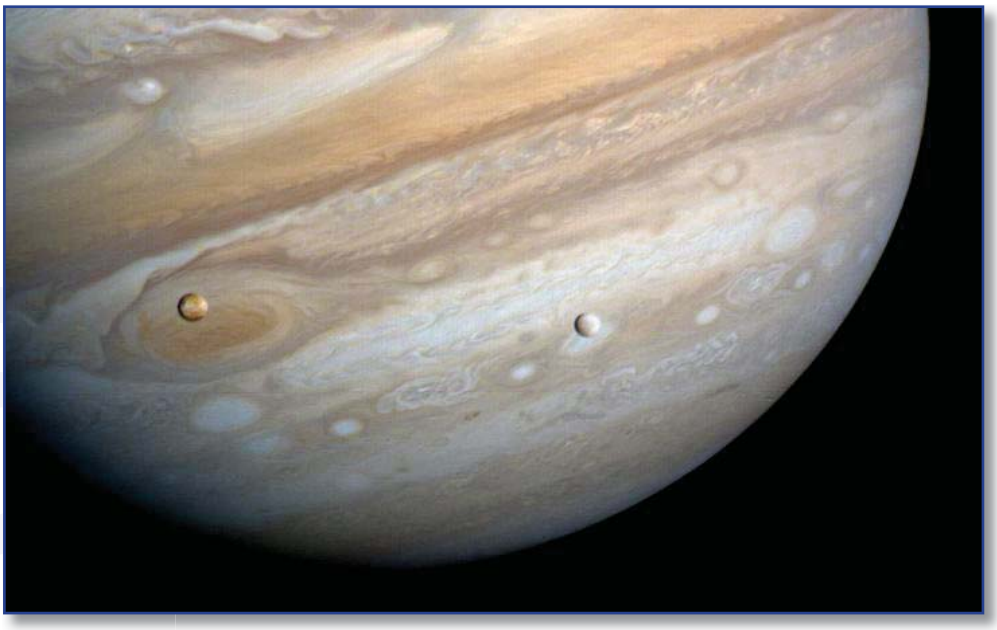
Mars was blanketed by a global dust storm when Mariner 9 arrived in November 1971 to begin the first orbital reconnaissance of the Red Planet. In Mariner's early views, frustrated imaging team members saw a nearly featureless ball, save for a few dark spots. Computer enhancement revealed the spots were craters, which were visible because they lay on the summits of lofty mountains. Later images showed they were giant volcanos, the largest of which towers three times the height of Mount Everest on Earth. In the months that followed, as the dust settled, Mariner 9's cameras revealed a geologic wonderland with giant canyons, layered deposits of dust and ice at the planet's poles, and even winding channels that proved to be dry river valleys. Mariner's unveiling remains one of the most spectacular in the history of exploration. Image processed by the author.

Mars: Relic of a Watery Past



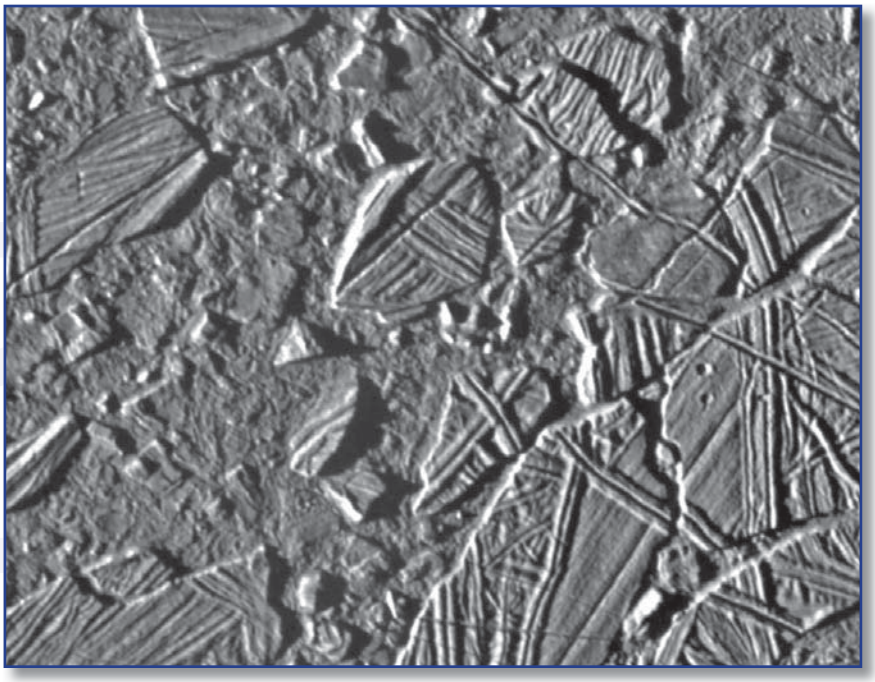
First discovered in 2003, a fossilized river delta inside Eberswalde crater attests to sustained flow of liquid water across the martian surface in the distant past. This view, showing an area about 12 miles across, was acquired by the Context Camera onboard the Mars Reconnaissance Orbiter in June 2010. It's one of countless reasons that Mars exploration continues to surprise us.

Jupiter: A Solar System in Miniature



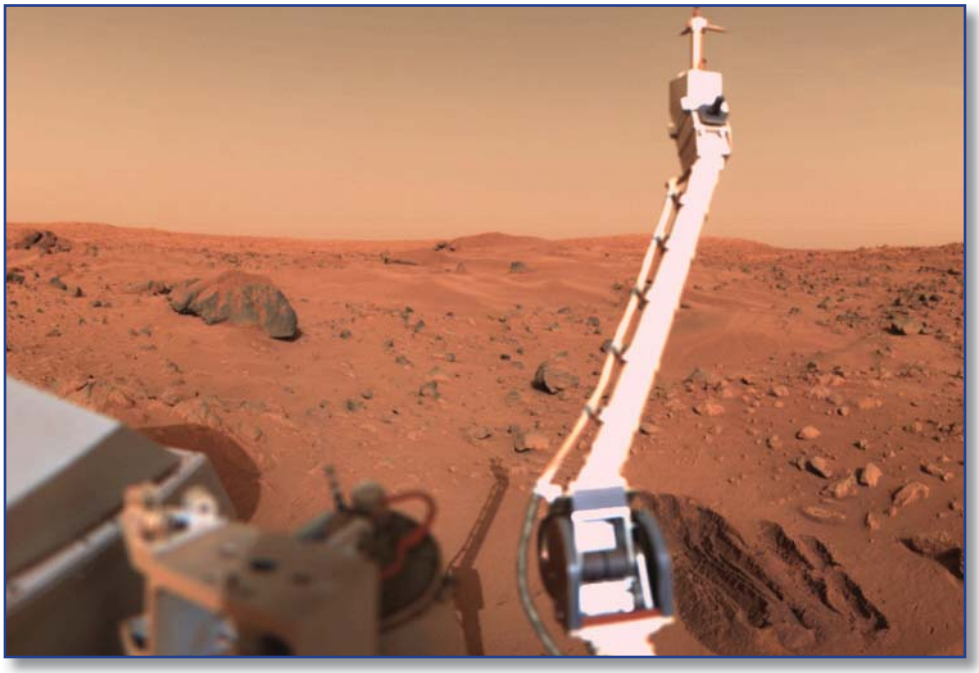
First stop on a historic grand tour of the outer solar system, Jupiter fills our view as Voyager 1 approaches the giant planet in March 1979. Swirling in the cloud-banded atmosphere is the Great Red Spot, a hurricane three times the size of Earth. For all the spectacular details on Jupiter itself, the greatest surprises came when Voyager's cameras zeroed in on the planet's four largest satellites, which had been little more than points of light in the largest Earth-based telescopes. Orange-hued Io (left) was revealed as a fiercely volcanic world, its interior heated by tidal interactions with the planet and neighboring moons. And Europa (right) turned out to be a remarkably smooth white ball, whose icy crust was crisscrossed by dark fractures. Voyager's reconnaissance of Jupiter and its moons showed that it was indeed a solar system in miniature, with enough wonders to occupy scientists indefinitely.

Europa: Tortured Ice



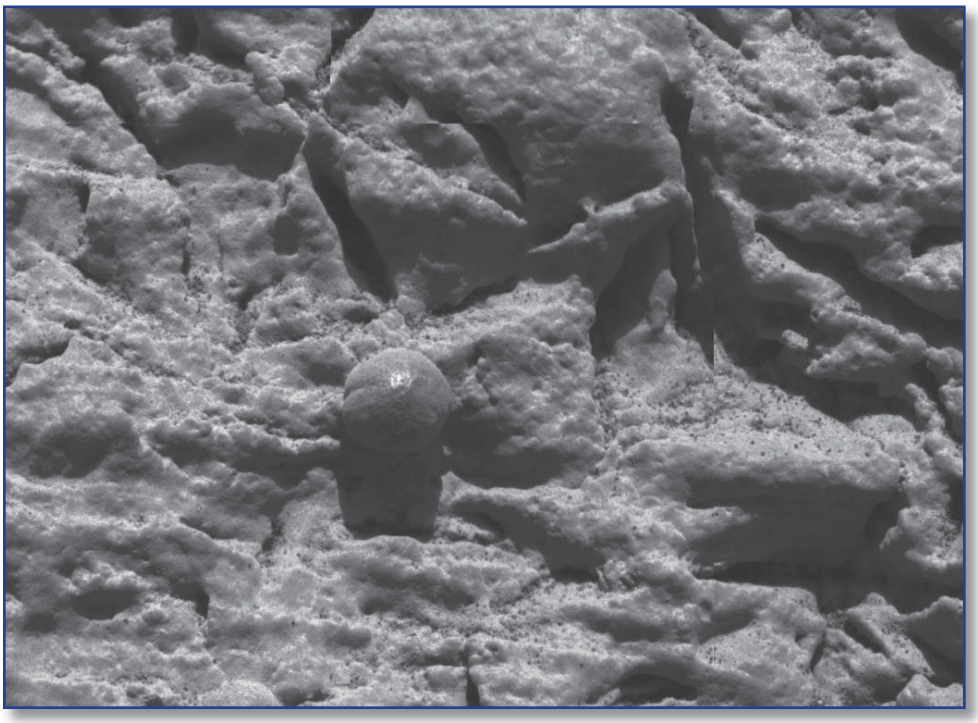
In over five years of operations beginning in December 1995, the Galileo Jupiter orbiter made numerous flybys of the planet's satellites, placing special scrutiny on icy Europa. This image, measuring about 21 miles wide and taken in February 1997, shows what appear to be jumbled plates of ice resembling the broken icepack during spring thaw in Earth's polar seas. Images like this one lend support to the idea that beneath the moon's icy crust lies an ocean of liquid water, which some scientists believe could be home to some form of life. That search is one of the most tantalizing prospects for future exploration.

On Mars: The View from Viking 1



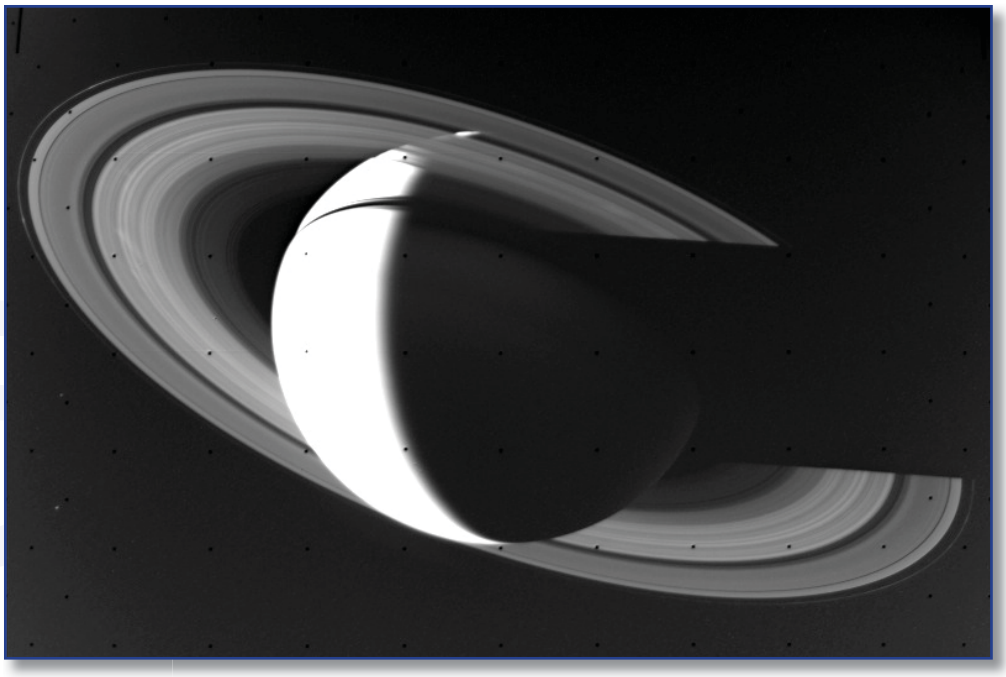
When Viking 1 became the first spacecraft to land successfully on Mars in July 1976, no one was surprised to find that the Red Planet deserved its name, thanks to a pervasive mantle of iron-oxide-rich dust. What was surprising was the complete absence of organic molecules in the soil, even those that had surely been carried to the surface in meteorites, as measured by the craft's onboard gas chromatograph/mass spectrometer. The trenches at lower right are scars from the lander's fruitless search for signs of microbial life, an effort confused by the unexpectedly reactive nature of the ever-present dust. Like so many planetary explorations, the Viking landings raised as many questions as they answered. Image processed by the author.

On Mars: Tiny Clues to Ancient Water



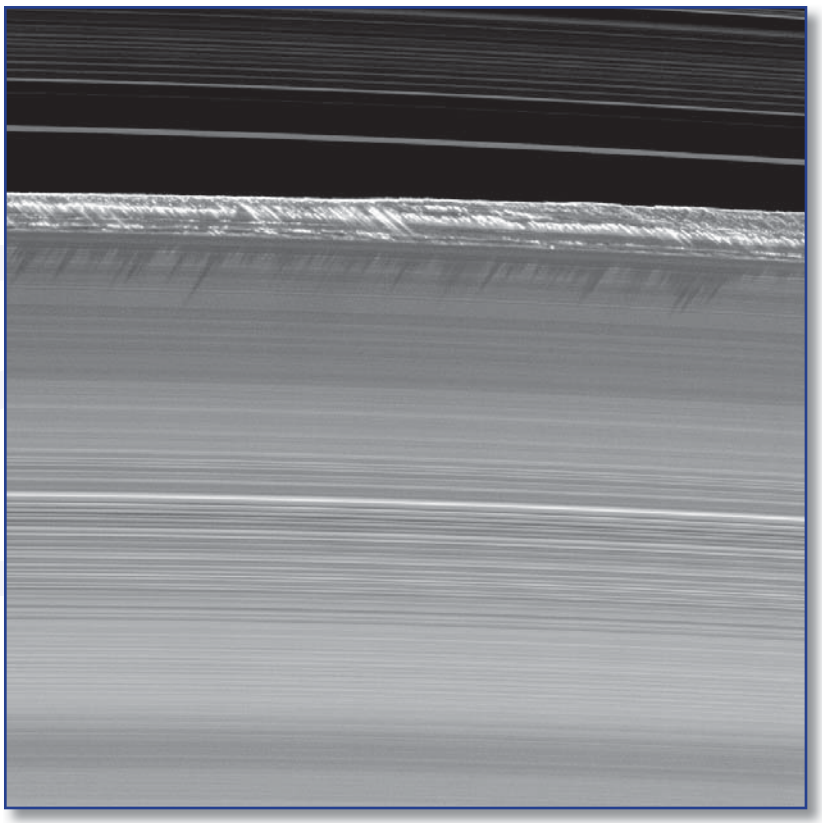
A tiny patch of Mars — a 38-millimeter-wide portion of a rock called Guadalupe — fills this view from the microscopic imager onboard the Mars Exploration Rover Opportunity in early 2004. Opportunity's instruments revealed that the millimeter-sized spheres, composed of the mineral hematite, must have precipitated in standing water. The narrow cavities were once filled by mineral grains that were dissolved away, also by the action of water. Such clues helped scientists determine that Opportunity's landing site in Meridiani Planum had once been a shallow, salty sea, strengthening the idea that this part of Mars may once have been hospitable to life.

A Ringed Crescent



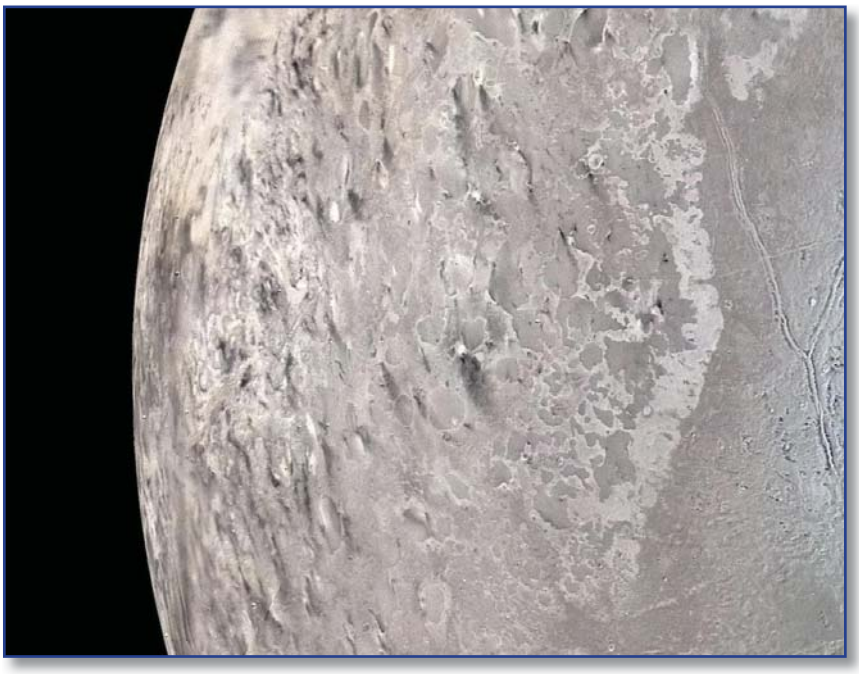
Heading away from Saturn on November 16, 1980, Voyager 1 snapped this picture of the ringed planet as a crescent, a view never before seen by humans. Aside from the planet's butterscotch-hued atmosphere and its menagerie of moons, it was the rings that held Voyager scientists spellbound. Among the surprises were strange waves and kinks, caused by gravitational interactions of ring particles with Saturn's large satellites as well as tiny moonlets orbiting within the rings themselves. Long after the two Voyager flybys were completed in 1981, Saturn cried out for further exploration.

Saturn at Equinox



The longevity of the Cassini orbiter, which arrived at Saturn in 2004 and is still sending back data, has enabled one of the most prolonged and detailed explorations of any planet and its moons. In 2009 Cassini witnessed the equinox, when the Sun crossed the plane of the rings, casting long shadows that revealed previously unseen features. In this image, particles from the B ring have formed mysterious vertical structures rising 1.6 miles above the ring plane like jagged peaks. The particles may have been deflected upward by gravitational effects from large moonlets, perhaps half a mile or more in size, orbiting at the B ring's edge.

Fugitive from the Kuiper Belt



The last surprise of Voyager's grand tour, Neptune's largest satellite Triton turned out to be one of the strangest worlds yet encountered. Nearly 3 billion miles from the Sun, Triton's surface is a cryovolcanic expanse of frozen nitrogen and methane. Scattered streaks are geysers driven by nitrogen escaping from the interior, shedding dark plumes across the moon's pinkish polar ice cap. Scientists believe Triton originated in the vast region beyond Neptune called the Kuiper belt, which if all goes well will be explored by the New Horizons spacecraft following its flyby of Pluto in 2015. If the second half-century of planetary exploration is anything like the first, there will be countless surprises yet to come.

About the Author

Award-winning science journalist and space historian Andrew Chaikin has authored books and articles about space exploration and astronomy for three decades. Writer-director and explorer James Cameron (Avatar, Titanic, Aliens of the Deep) *has called him "our best historian of the space age." Chaikin is best known as the author of* A Man on the Moon: The Voyages of the Apollo Astronauts, *widely regarded as the definitive account of the Moon missions. First published in 1994, this acclaimed work was the primary basis for Tom Hanks' 12-part HBO miniseries,* From the Earth to the Moon, *which won the Emmy for best miniseries in 1998. Chaikin spent eight years writing and researching* A Man on the Moon, *including over 150 hours of personal interviews with 23 of the 24 lunar astronauts. Apollo moonwalker Gene Cernan said of the book, "I've been there. Chaikin took me back."*

Chaikin's newest books, co-written with Victoria Kohl, are Voices from the Moon *(Viking Studio), featuring excerpts from his conversations with Apollo astronauts, and* Mission Control, This is Apollo *(Viking Childrens), a book for young readers illustrated with paintings by Apollo astronaut Alan Bean. Both were published in 2009. Chaikin is also the author of* Air and Space: The National Air and Space Museum Story of Flight, *published in 1997 by Bulfinch Press. Chaikin's illustrated narrative of space exploration,* SPACE: A History of Space Exploration in Photographs, *was published in 2002 by Carlton Books. He co-authored the text for the highly successful collection of Apollo photography,* Full Moon, *which was published by Knopf in 1999.*

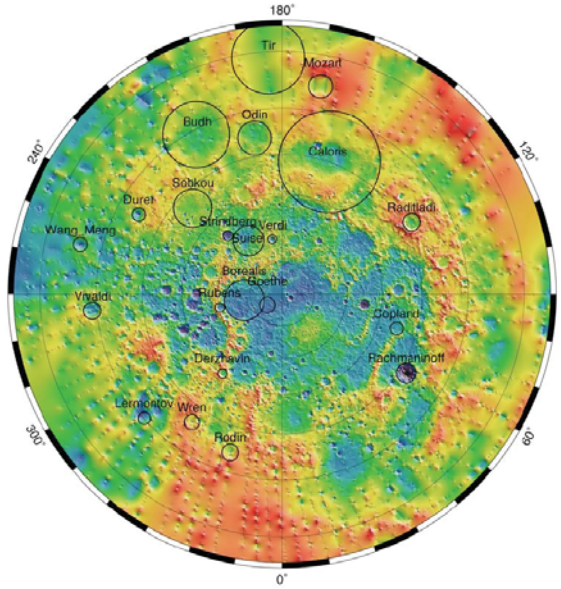
Chaikin collaborated with moonwalker-turned-artist Alan Bean to write Apollo: An Eyewitness Account, *published in 1998 by the Greenwich Workshop Press. He also coedited* The New Solar System, *a compendium of writings by planetary scientists, first published in 1981. His essays include the chapter on human spaceflight in* The National Geographic Encyclopedia of Space, *published in 2004, and* Live from the Moon: The Societal Impact of Apollo *for NASA's 2007 book* The Societal Impact of Spaceflight.

Chaikin is a commentator for National Public Radio's Morning Edition, *and has appeared on* Good Morning America, Nightline, The Colbert Report, *and the NPR programs* Fresh Air *and T*alk of the Nation. *He has been an advisor to NASA on space policy and public communications, and teaches space history for NASA's Academy of Program and Project Engineering Leadership (APPEL). He has also taught about space exploration at Williams College and is an online instructor at Montana State University. A former editor of* Sky & Telescope *magazine, Chaikin has also been a contributing editor of* Popular Science *and has written for* Newsweek, Air&Space/Smithsonian, World Book Encyclopedia, Scientific American, *and other publications.*

A graduate of Brown University, Chaikin served on the Viking missions to Mars at NASA's Jet Propulsion Laboratory, and was a researcher at the Smithsonian's Center for Earth and Planetary Studies before becoming a science journalist in 1980. He is an amateur musician and songwriter, has been an occasional space artist, and is one of the founders of the International Association of Astronomical Artists.

For more information, visit www.andrewchaikin.com.

MESSENGER Provides New Look at Mercury's Landscape, Metallic Core, and Polar Shadows



Polar stereographic projection of the topography of Mercury from the north pole to 5°S. The outlines of selected major impact structures are shown as black circles. Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington.

The Mercury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft completed its one-year primary mission on March 17. Since moving into orbit about Mercury a little over one year ago, the spacecraft has captured nearly 100,000 images and returned data that have revealed new information about the planet, including its topography, the structure of its core, and areas of permanent shadow at the poles that host the mysterious polar deposits.

The latest findings are presented in two papers published online in *Science Express* in March, and in 57 papers presented at the 43rd Lutnar and Planetary Science Conference (LPSC) in The Woodlands, Texas. Team members at LPSC also previewed MESSENGER's extended mission, set to run to March 2013.

"The first year of MESSENGER orbital observations has revealed many surprises," says MESSENGER Principal Investigator Sean C. Solomon, of the Carnegie Institution of Washington. "From Mercury's extraordinarily dynamic magnetosphere and exosphere to the unexpectedly volatile-rich composition of its surface and interior, our inner planetary neighbor is now seen to be very different from what we imagined just a few years ago. The number and diversity of new findings being presented this week to the scientific community in papers and presentations provide a striking measure of how much we have learned to date."

Ranging observations from MESSENGER's Mercury Laser Altimeter (MLA) have provided the first-ever precise topographic model of the planet's northern hemisphere and characterized slopes and surface roughness over a range of spatial scales. From MESSENGER's eccentric, near-polar orbit, the MLA illuminates surface areas as wide as 15 to 100 meters, spaced about 400 meters apart. The spread in elevations is considerably smaller than those of Mars or the Moon, notes MESSENGER Co-investigator Maria T. Zuber of the Massachusetts Institute of Technology, author of one of the papers published in *Science Express*. According to Zuber, the most prominent feature is an extensive area of lowlands at high northern latitudes that hosts the volcanic northern plains. Within this lowland region is a broad topographic rise that formed after the volcanic plains were emplaced. At mid-latitudes, the interior of the Caloris impact basin — 1500 kilometers wide — has been modified so that part of the basin floor now stands higher than the rim. "The elevated portion of the floor of Caloris appears to be part of a quasi-linear rise that extends for approximately half the planetary circumference at mid-latitudes," Zuber writes. "Collectively, these features imply that long-wavelength changes to Mercury's topography occurred after the earliest phases of the planet's geological history."

Scientists have also come up with the first precise model of Mercury's gravity field, which, when combined with the topographic data and earlier information of the planet's spin state, shed light on the planet's internal structure, the thickness of its crust, the size and state of its core, and its tectonic and thermal history. Mercury's core is huge for the planet's size, about 85% of the planetary radius, even

larger than previous estimates. The planet is sufficiently small that at one time many scientists thought the interior should have cooled to the point that the core would be solid. However, subtle dynamical motions measured from Earth-based radar combined with parameters of the gravity field, as well as observations of the magnetic field that signify an active core dynamo, indicate that Mercury's core is at least partially liquid.

Scientists sought to unravel the mystery of the size and state of Mercury's core by studying its effect on long-wavelength variations in the planet's gravity field, and recent results point to a much different interior structure for Mercury from that expected. According to Steven A. Hauck II of Case Western Reserve University, "Mercury's core may not look like any other terrestrial planetary core. The structure certainly is different from that of Earth, which has a metallic, liquid outer core sitting above a solid inner core. Mercury appears to have a solid silicate crust and mantle overlying a solid, iron sulfide outer core layer, a deeper liquid core layer, and possibly a solid inner core." These findings will have implications for how Mercury's magnetic field is generated and for understanding how the planet evolved thermally, Hauck adds.

A chief goal of MESSENGER's primary mission was to understand the nature of the radar-bright deposits at the poles of Mercury. The leading proposal since the deposits were discovered has been that radar-bright material consists dominantly of frozen water ice. "We've never had the imagery available before to see the surface where these radar-bright features are located," says Nancy L. Chabot, instrument scientist for MESSENGER's Mercury Dual Imaging System (MDIS) at the Johns Hopkins University Applied Physics Laboratory (APL). "MDIS images show that all the radar-bright features near Mercury's south pole are located in areas of permanent shadow, and near Mercury's north pole such deposits are also seen only in shadowed regions, results consistent with the water-ice hypothesis."

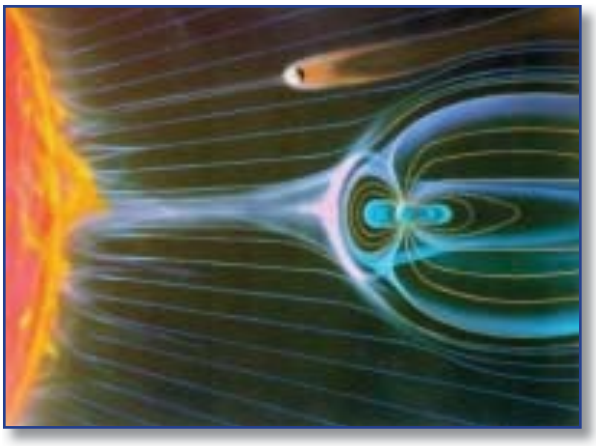
This finding is not definitive proof that those deposits are water ice, says Chabot. And some of the radar-bright deposits are located in craters that provide thermally challenging environments to the water-ice theory. For instance, for the radar-bright material in many of the craters to be water ice would require that there be a thin layer of insulation to keep it colder than the surface, Chabot says. But the MDIS images, combined with ongoing analysis of data from MESSENGER's Neutron Spectrometer and the MLA, will provide a more complete picture of the nature of the deposits.

MESSENGER's second year at Mercury will build upon these and other results from the primary mission phase. Extended mission themes will include more comprehensive measurement of the magnetosphere and exosphere during a period of more active Sun, greater focus on observations at low spacecraft altitudes, and a greater variety of targeted observations. For more information, visit *messenger.jhuapl.edu*.

A Magnetic Surprise for Venus Express

Venus is a rarity among planets — a world that does not internally generate a magnetic field. Despite the absence of a large protective magnetosphere, the near-Venus environment does exhibit a number of similarities with planets such as Earth. The latest, and surprising, example is the evidence for magnetic reconnection in Venus' induced magnetotail. Planets that generate magnetic fields in their interiors, such as Earth, Mercury, Jupiter and Saturn, are surrounded by invisible magnetospheres. Their magnetic fields deflect the charged particles of the solar wind (electrons and protons) as they stream away from the Sun. This deflection creates a magnetosphere — a protective "bubble" around the planet — that ends in an elongated magnetotail on the lee side of the magnetosphere.

Since Venus has no intrinsic magnetic field to act as a shield against incoming charged particles, the solar wind sometimes interacts directly with the upper atmosphere. However, Venus is partially protected by an induced magnetic field. As on Earth, solar ultraviolet radiation removes electrons from the atoms and molecules in the upper atmosphere, creating a region of electrically charged gas known as the ionosphere. This ionized layer interacts with the solar wind and the magnetic field carried by the solar wind. During



Solar wind shaping the magnetospheres of Earth and Venus. Credit: ESA.

the continuous battle with the solar wind, this region of the upper atmosphere is able to slow and divert the flow of particles around the planet, creating a magnetosphere, shaped rather like a comet's tail, on the lee side of the planet.

Spacecraft observations over many decades have shown that magnetic reconnection occurs frequently in the magnetospheres of Earth, Mercury, Jupiter, and Saturn. This process, which converts magnetic energy into kinetic energy, occurs when oppositely directed magnetic field lines break and reconnect with each other. On Earth, this reconnection is responsible for magnetic storms and polar auroras — the so-called northern and southern lights. Until now, reconnection was not generally thought to occur on non-magnetized planets. However, Tielong Zhang and an international team of co-authors have recently reported in *Science Express* that they have found the first evidence of magnetic reconnection in Venus' magnetotail.

ESA's Venus Express spacecraft follows a near-polar orbit that is ideal for instruments such as the magnetometer and low-energy particle detector to observe the solar wind–ionosphere–magnetotail interaction. Previous missions, such as Pioneer Venus, were either in different orbits or active at different periods of solar activity, so they were not able to detect these reconnection events.

On May 15, 2006, Venus Express was crossing the venusian magnetotail when it observed a rotational magnetic field structure over a period of about three minutes. Calculations based on its duration and speed imply that it was about 3400 kilometers across. The event, which took place about 1.5 Venus radii (about 9000 kilometers) down the tail, is thought to be evidence of a passing plasmoid — a transient magnetic loop structure that is formed by magnetic reconnection in a planetary magnetotail. Further studies of the magnetic field data from Venus Express revealed the signatures of many similar observations of energy exchange between the magnetic field and the plasma in the tail. The data also show that, in many respects, the magnetosphere of Venus is a scaled-down version of Earth's.

Magnetic reconnection occurs in the Earth's magnetotail and plasma sheet at a distance of about 10–30 planetary radii down the magnetotail. Since Earth's magnetosphere is 10 times larger, reconnection at Venus would be expected to occur 1–3 radii down its tail. That is exactly where Venus Express detected the reconnection events.

"Plasmoids are common features in the magnetospheres of planets such as Earth and Jupiter, but they were not expected in the magnetotail of an unmagnetized planet such as Venus," said Tielong Zhang, Principal Investigator for the magnetometer instrument on Venus Express and a Senior Research Scientist at the Space Research Institute in Graz, Austria. "The reconnection splits the magnetotail, causing most of the plasma in the tail to be ejected into space. It also forms a plasmoid structure which heads towards Venus and channels a fraction of the energy flux of the solar wind into the night-side atmosphere. As a result, the magnetic reconnection causes plasma circulation at Venus, similar to what happens in Earth's magnetotail."

The discovery that plasma is lost from the tail as a result of magnetic reconnections provides a possible new mechanism for explaining how and why gases are lost from Venus's upper atmosphere. This has implications for understanding how Venus lost its water after the planet began to experience a runaway greenhouse effect.

"Although the understanding of atmospheric loss is a key to establishing the evolutionary history of planets, the role of magnetic reconnection is still poorly understood because of the scarcity of *in situ* observations at planets other than Earth," said Håkan Svedhem, ESA's Venus Express Project Scientist. "This result confirms that observation of the terrestrial planets by spacecraft such as Venus Express, Mars Express, and Cluster is essential if we are to understand the complex evolution of atmospheres and planets in general."

Venus Express, Europe's first mission to Earth's twin world, is investigating the nature of our closest planetary neighbour. Launched from the Baikonur Cosmodrome in Kazakhstan on November 9, 2005, on a Soyuz-Fregat launcher, it was inserted into Venus orbit on April 11, 2006, and is currently the only spacecraft in orbit around the planet. For more about Venus Express, visit *sci.esa.int/venusexpress*.

South pole of the farside of the Moon as seen from the GRAIL mission's Ebb spacecraft. Credit: NASA/ Caltech-JPL.

GRAIL Videos from Moon's Farside Excites Students

A camera onboard one of NASA's twin Gravity Recovery And Interior Laboratory (GRAIL) lunar spacecraft has returned its first unique view of the farside of the Moon. MoonKAM (Moon Knowledge Acquired by Middle school students) will be used by students nationwide to select lunar images for study. GRAIL consists of two identical spacecraft, recently named Ebb and Flow, each of which is equipped with a MoonKAM. The images were taken as part of a test of Ebb's MoonKAM on January 19.

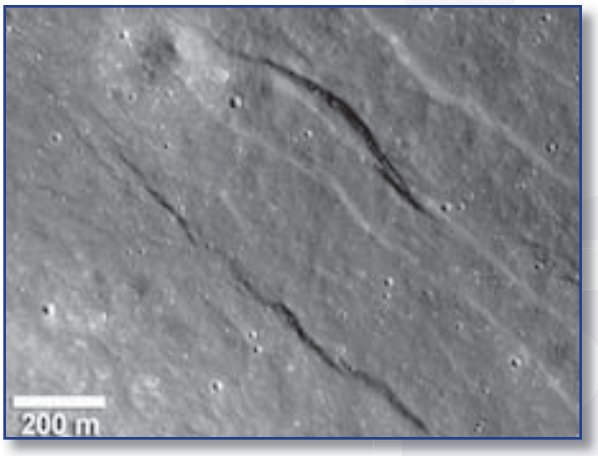
In the video, the north pole of the Moon is visible at the top of the screen as the spacecraft flies toward the lunar south pole. One of the first prominent geological features seen on the lower third of the Moon is the Mare Orientale, a 560-mile-wide (900 kilometers) impact basin that straddles both the Moon's near- and farside. The clip ends with rugged terrain just short of the lunar south pole. To the left of center, near the bottom of the screen, is the 93-mile-wide (149 kilometers) Drygalski crater with a distinctive star-shaped formation in the middle. The formation is a central peak, created many billions of years ago by a comet or asteroid impact. "The quality of the video is excellent and should energize our MoonKAM students as they prepare to explore the Moon," said Maria Zuber, GRAIL principal investigator from the Massachusetts Institute of Technology in Cambridge.

The twin spacecraft successfully achieved lunar orbit this past New Year's Eve and New Year's Day. Previously named GRAIL-A and GRAIL-B, the washing machine-sized spacecraft received their new names from fourth graders at the Emily Dickinson Elementary School in Bozeman, Montana, following a nationwide student naming contest. Thousands of fourth- to eighth-grade students will select target areas on the lunar surface and send requests to the GRAIL MoonKAM Mission Operations Center in San Diego. Photos of the target areas will be sent back by the satellites for students to study. The MoonKAM program is led by Sally Ride, America's first woman in space. Her team at Sally Ride Science and undergraduate students at the University of California in San Diego will engage middle schools across the country in the GRAIL mission and lunar exploration. GRAIL is NASA's first planetary mission carrying instruments fully dedicated to education and public outreach.

Launched in September 2011, Ebb and Flow periodically perform trajectory correction maneuvers that, over time, will lower their orbits to near-circular ones with an altitude of about 34 miles (55 kilometers). During their science mission, the duo will answer longstanding questions about the Moon and give scientists a better understanding of how Earth and other rocky planets in the solar system formed.

To view the 30-second video clip, visit *go.nasa.gov/zZXAPs*. For more information about GRAIL, visit *www.nasa.gov/grail*.

NASA Spacecraft Reveals Recent Geological Activity on the Moon



This image shows the largest of the newly detected graben found in highlands of the lunar farside. The broadest graben is about 500 meters (1640 feet) wide and topography derived from Lunar Reconnaissance Orbiter Camera (LROC) Narrow Angle Camera (NAC) stereo images indicates the graben are almost 20 meters (almost 66 feet) deep. Credit: NASA/ Goddard/Arizona State University/Smithsonian Institution.

New images from NASA's Lunar Reconnaissance Orbiter (LRO) spacecraft show the Moon's crust is being stretched, forming minute valleys in a few small areas on the lunar surface. Scientists propose this geologic activity occurred less than 50 million years ago, which is considered recent compared to the Moon's age of more than 4.5 billion years. A team of researchers analyzing high-resolution images obtained by the Lunar Reconnaissance Orbiter Camera (LROC) show small, narrow trenches typically much longer than they are wide. This indicates the lunar crust is being pulled apart at these locations. These linear valleys, known as graben, form when the Moon's crust stretches, breaks, and drops down along two bounding faults. A handful of these graben systems have been found across the lunar surface.

"We think the Moon is in a general state of global contraction because of cooling of a still hot interior," said Thomas Watters of the Center for Earth and Planetary Studies at the Smithsonian's National Air and Space Museum in Washington, DC, and lead author of a paper on this research appearing in the March issue of the journal *Nature Geoscience*. "The graben tell us forces acting to shrink the Moon were overcome in places by forces acting to pull it apart. This means the contractional forces shrinking the Moon cannot be large, or the small graben might never form."

In August 2010, the team used LROC images to identify physical signs of contraction on the lunar surface, in the form of lobe-shaped cliffs known as lobate scarps. The scarps are evidence the Moon shrank globally in the geologically recent past and might still be shrinking today. The team saw these scarps widely distributed across the Moon and concluded it was shrinking as the interior slowly cooled. Based on the size of the scarps, it is estimated that the distance between the Moon's center and its surface shrank by approximately 300 feet. The graben were an unexpected discovery and the images provide contradictory evidence that the regions of the lunar crust are also being pulled apart.

"This pulling apart tells us the Moon is still active," said Richard Vondrak, LRO Project Scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "LRO gives us a detailed look at that process."

"It was a big surprise when I spotted graben in the farside highlands," said co-author Mark Robinson of the School of Earth and Space Exploration at Arizona State University, principal investigator of LROC. "I immediately targeted the area for high-resolution stereo images so we could create a three-dimensional view of the graben. It's exciting when you discover something totally unexpected and only about half the lunar surface has been imaged in high resolution. There is much more of the Moon to be explored."

For more information about LRO and related images on the finding, visit *www.nasa.gov/LRO*.

NASA Planning Group Takes Key Steps for Future Mars Exploration

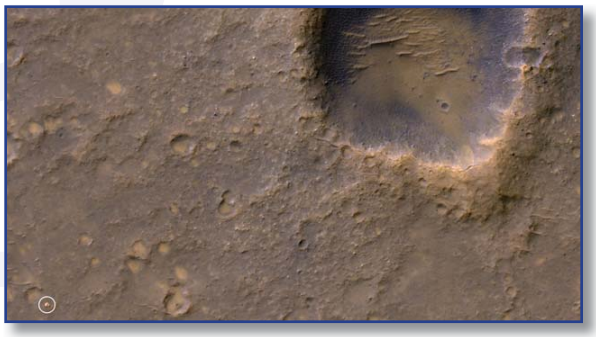
NASA's Mars Program Planning Group (MPPG), established to assist the agency in developing a new strategy for the exploration of the Red Planet, has begun analyzing options for future robotic missions and enlisting the assistance of scientists and engineers worldwide. NASA is reformulating the Mars Exploration Program to be responsive to high-priority science goals and the President's challenge of sending humans to Mars in the 2030s.

"We're moving quickly to develop options for future Mars exploration missions and pathways," said John Grunsfeld, associate administrator for NASA's Science Mission Directorate. "As part of this process, community involvement, including international, is essential for charting the new agency-wide strategy for our future Mars exploration efforts." Grunsfeld leads the agency-wide Mars program reformulation effort along with William Gerstenmaier, associate administrator for the Human Exploration and Operations Directorate, Chief Scientist Waleed Abdalati, and Chief Technologist Mason Peck. In February, Grunsfeld named veteran aerospace engineer Orlando Figueroa to lead the MPPG. In March, the group established an initial draft framework of milestones and activities that will include options for missions and sequences bridging the objectives of NASA's science, human exploration, and operations and technology.

The scientific and technical community across the globe can submit ideas and abstracts online as part of NASA's effort to seek out the best and the brightest ideas from researchers and engineers in planetary science. Selected abstracts will be presented during a workshop in June hosted by the Lunar and Planetary Institute in Houston. The workshop will provide an open forum for presentation, discussion, and consideration of concepts, options, capabilities, and innovations to advance Mars exploration. These ideas will inform a strategy for exploration within available resources, beginning as early as 2018 and stretching into the next decade and beyond. The new strategy also will be designed to maintain America's critical technical skills, developed over decades, to achieve the highest-priority science and exploration objectives.

To view the call for abstracts and workshop information, visit *www.lpi.usra.edu/meetings/marsconcepts2012*. For more information about NASA's Mars programs, visit *www.nasa.gov/mars*.

New Views Show Old NASA Mars Landers



Near the lower-left corner of this view is the three-petal lander platform that NASA's Mars Exploration Rover Spirit drove off in January 2004. Credit: NASA/JPL-Caltech/Univ. of Arizona.

The High Resolution Imaging Science Experiment (HiRISE) camera on NASA's Mars Reconnaissance Orbiter recorded a scene on January 29, 2012, that includes the first color image from orbit showing the three-petal lander of NASA's Mars Exploration Rover Spirit mission. Spirit drove off that lander platform in January 2004 and spent most of its six-year working life in a range of hills about two miles to the east.

Another recent image from HiRISE, taken on January 26, 2012, shows NASA's Phoenix Mars Lander and its surroundings on far-northern Mars after that spacecraft's second martian arctic winter. Phoenix exceeded its planned mission life in 2008, ending its work as solar energy waned during approach of its first Mars winter.

The image showing Spirit's lander platform as a small, bright feature southwest of Bonneville Crater is at *photojournal.jpl.nasa.gov/catalog/PIA15038*. The new image of Phoenix is at *photojournal.jpl.nasa.gov/catalog/PIA15039*. Previous color images from HiRISE have shown the Spirit rover itself, but all previous HiRISE views of the lander that delivered Spirit were in black and white.

Although neither Phoenix nor Spirit still send data to Earth, scientific findings from both missions continue as researchers analyze the wealth of data from the two. A recent report based on inspection of martian soil particles with microscopes on Phoenix concluded that the soil has experienced very little interaction with liquid water over the past 600 million years or more (see *www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_3-2-2012-10-26-2*).

Durable NASA Rover Beginning Ninth Year of Mars Work

This mosaic of images taken in mid-January 2012 shows the windswept vista northward (left) to northeastward (right) from the location where NASA's Mars Exploration Rover Opportunity is spending its fifth martian winter, an outcrop informally named "Greeley Haven." Credit: NASA/JPL-Caltech/Cornell/Arizona State Univ.

Eight years after landing on Mars for what was planned as a three-month mission, NASA's enduring Mars Exploration Rover Opportunity is working on what essentially became a new mission in August 2011. At that time, Opportunity reached a multiyear driving destination, Endeavour Crater. At Endeavour's rim, it has gained access to geological deposits from an earlier period of martian history than anything it examined during its first seven years. It also has begun an investigation of the planet's deep interior that takes advantage of staying in one place for the martian winter.

Opportunity landed in Eagle Crater on Mars on January 25, 2004, Universal Time and EST (January 24, PST), three weeks after its rover twin, Spirit, landed halfway around the planet. In backyard-sized Eagle Crater, Opportunity found evidence of an ancient wet environment. The mission met all its goals within the originally planned span of three months. During most of the next four years, it explored successively larger and deeper craters, adding evidence about wet and dry periods from the same era as the Eagle Crater deposits.

In mid-2008, researchers drove Opportunity out of Victoria Crater, half a mile (800 meters) in diameter, and set course for Endeavour Crater, 14 miles (22 kilometers) in diameter. The trek took three years. In a push to finish it, Opportunity drove farther during its eighth year on Mars — 4.8 miles (7.7 kilometers) — than in any prior year, bringing its total driving distance to 21.4 miles (34.4 kilometers).

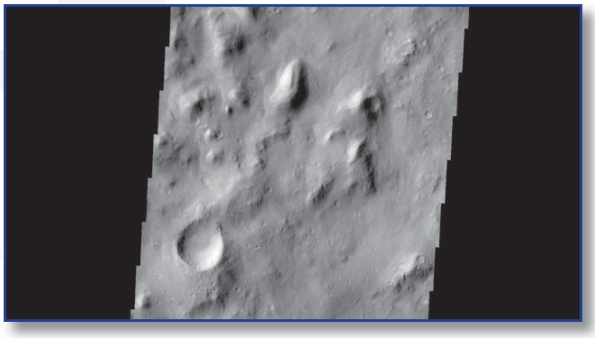
The "Cape York" segment of Endeavour's rim, where Opportunity has been working since August 2011, has already validated the choice of Endeavour as a long-term goal. The first outcrop that Opportunity examined on Cape York differs from any the rover had seen previously. Its high zinc content suggests effects of water. Weeks later, at the edge of Cape York, a bright mineral vein identified as hydrated calcium sulfate provided what the mission's principal investigator, Steve Squyres of Cornell University in Ithaca, New York, calls "the clearest evidence for liquid water on Mars that we have found in our eight years on the planet."

Mars years last nearly twice as long as Earth years. Entering its ninth Earth year on Mars, Opportunity was also heading into its fifth martian winter. Its solar panels have accumulated so much dust since martian winds last cleaned them — more than in previous winters — the rover needs to stay on a Sun-facing slope to have enough energy to keep active through the winter.

All six of Opportunity's wheels are still useful for driving, but the rover will stay on an outcrop called "Greeley Haven" until mid-2012 to take advantage of the outcrop's favorable slope and targets of scientific interest during the martian winter. After the winter, or earlier if wind cleans dust off the solar panels, researchers plan to drive Opportunity in search of clay minerals that a Mars orbiter's observations indicate lie on Endeavour's rim.

"The top priority at Greeley Haven is the radio-science campaign to provide information about Mars' interior," said JPL's Diana Blaney, deputy project scientist for the mission. This study uses weeks of tracking radio signals from the stationary rover to measure wobble in the planet's rotation. The amount of wobble is an indicator of whether the core of the planet is molten, similar to the way spinning an egg can be used to determine whether it is raw or hard-boiled.

For more information about the Mars Exploration Rovers, visit *marsrovers.jpl.nasa.gov*.



The Thermal Emission Imaging System (THEMIS) camera on NASA's Mars Odyssey spacecraft has completed an unprecedented full decade of observing Mars from orbit. Credit: NASA/JPL-Caltech/ASU.

Camera on NASA Mars Odyssey Tops Decade of Discovery

Slightly more than ten years ago, on February 19, 2002, the Thermal Emission Imaging System (THEMIS), a multiband camera on NASA's Mars Odyssey orbiter, began scientific operations at the Red Planet. Since then the camera has circled Mars nearly 45,000 times and taken more than half a million images at infrared and visible wavelengths. "THEMIS has proven itself a workhorse," said Philip Christensen of Arizona State University, Tempe, the camera's principal investigator and designer. "It's especially gratifying to me to see the range of discoveries that have been made using this instrument."

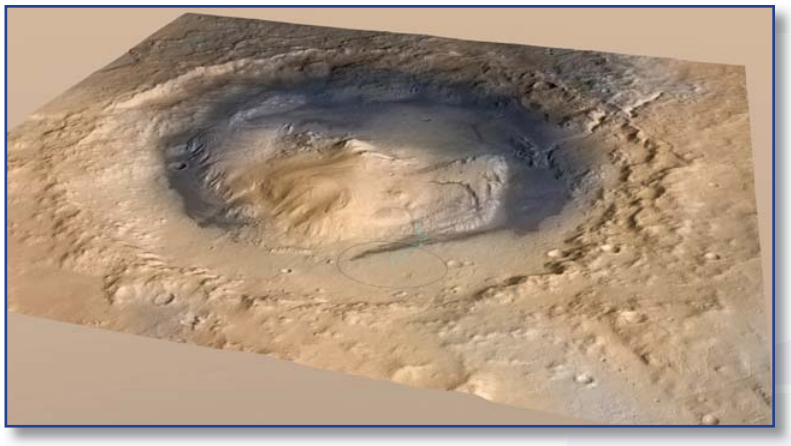
Highlights of science results by THEMIS over the past 10 years include confirmation of a mineral exposure selected as the landing site for NASA's Mars Exploration Rover Opportunity; discovery of carbon-dioxide gas jets at the south polar ice cap in spring; discovery of chloride salt deposits across the planet; development of the best global image map of Mars ever done; identification of safe landing sites for NASA's Mars Phoenix lander by finding the locations with the fewest hazardous boulders; monitoring of dust activity in the martian atmosphere; discovery that a large crater, Aram Chaos, once contained a lake; discovery that Mars has more water-carved channels than previously thought; and discovery of dacite on Mars, a more evolved form of volcanic lava not previously known on the Red Planet.

THEMIS combines a five-wavelength visual imaging system with a nine-wavelength infrared imaging system. By comparing daytime and nighttime infrared images of an area, scientists can determine many of the physical properties of the rocks and soils on the ground.

Mars Odyssey has a two-hour orbit that is nearly "Sun-synchronous," meaning that Odyssey passes over the same part of Mars at roughly the same local time each day. In September 2008 its orbit was shifted toward an earlier time of day, which enhanced THEMIS' mineralogical detection capability.

For more information about the Mars Odyssey mission, visit *mars.jpl.nasa.gov/odyssey*. For more information about THEMIS, visit *themis.asu.edu*.

"Mount Sharp" on Mars Links Geology's Past and Future



Curiosity, the big rover of NASA's Mars Science Laboratory mission, will land in August 2012 near the foot of a mountain inside Gale Crater. Credit: NASA/JPL-Caltech/ESA/DLR/FU Berlin/MSSS.

One particular mountain on Mars, bigger than Colorado's grandest, has been beckoning would-be explorers since it was first sighted from orbit in the 1970s. Scientists have ideas about how it took shape in the middle of ancient Gale Crater and hopes for what evidence it could yield about whether conditions on Mars have favored life. No mission to Mars dared approach it, though, until NASA's Mars Science Laboratory mission, which this August will attempt to place its one-ton rover, Curiosity, at the foot of the mountain. The moat of flatter ground between the mountain and the crater rim encircling it makes too small a touchdown target to have been considered safe without precision-landing innovations used by this mission.

To focus discussions about how Curiosity will explore the mountain during a two-year prime mission after landing, the mission's international Project Science Group has decided to call it Mount Sharp. This informal naming pays tribute to geologist Robert P. Sharp (1911–2004), a founder of planetary science, influential teacher of many current leaders in the field, and team member for NASA's first few Mars missions. Sharp taught geology at the California Institute of Technology (Caltech) from 1948 until past his retirement. *Life* magazine named him one of the 10 best college teachers in the nation.

"Bob Sharp was one of the best field geologists this country has ever had," said Michael Malin, of Malin Space Science Systems, San Diego, principal investigator for two of Curiosity's 10 science instruments and a former student of Sharp's. "We don't really know the origins of Mount Sharp, but we have plans for how to go there and test our theories about it, and that's just how Bob would have wanted it."

Caltech Provost Edward Stolper, former chief scientist for the Mars Science Laboratory, said, "For much of his more than 50 years at Caltech, Bob Sharp was the central figure in its programs in the geological and planetary sciences. One of his major contributions was the building of a program in planetary sciences firmly rooted in the principles and approaches of the geological sciences. Moreover, through his own work on the Jet Propulsion Laboratory's early missions to Mars and the work of others that he influenced, he also had a major influence on planetary science and exploration at JPL. Recognition of this remarkable scientist and leader by the naming of Mount Sharp is highly fitting, and I hope it will serve to perpetuate his legacy."

The Mars Science Laboratory spacecraft was launched November 26, 2011, bound for landing beside Mount Sharp inside Gale Crater on the evening of August 5 (PST; early August 6, EST and Universal Time). The mission will use Curiosity to investigate whether the area has ever offered environmental conditions favorable for fostering microbial life, including chemical ingredients for life and energy for life.

Mount Sharp rises about 3 miles (5 kilometers) above the landing target on the crater floor, higher than Mount Rainier above Seattle, although broader and closer. It is not simply a rebound peak from the asteroid impact that excavated Gale Crater. A rebound peak may be at its core, but the mountain displays hundreds of flat-lying geological layers that may be read as chapters in a more complex history billions of years old. Twice as tall as the sequence of colorful bands exposed in Arizona's Grand Canyon, the stack

of layers in Mount Sharp results from changing environments in which layers are deposited, younger on top of older, eon after eon, and then partially eroded away.

Several craters on Mars contain mounds or mesas that may have formed in ways similar to Mount Sharp, and many other ancient craters remain filled or buried by rock layers. Some examples, including Gale, hold a mound higher than the surrounding crater rim, indicating that the mounds are remnant masses inside once completely filled craters. This presents a puzzle about how environmental conditions on Mars evolved.

Some lower layers of Mount Sharp might tell of a lake within Gale Crater long ago, or wind-delivered sediments subsequently soaked by groundwater. Liquid water is a starting point in describing conditions favorable for life, but just the beginning of what Curiosity can investigate. Higher layers may be deposits of wind-blown dust after a great drying-out on Mars.

Possible explanations for how erosion shaped the mountain after layers were deposited include swirling winds carving away the edges, and perhaps later wet episodes leaving channels down the sides and fresher sediments on the crater floor. Clues about those episodes present Curiosity with other potentially habitable environments to investigate.

For more information, visit *marsprogram.jpl.nasa.gov/msl*.

This view highlights tectonic faults and craters on Dione, an icy world that has undoubtedly experienced geologic activity since its formation. Credit: NASA/JPL/Space Science Institute.

Cassini Detects Hint of Fresh Air at Dione

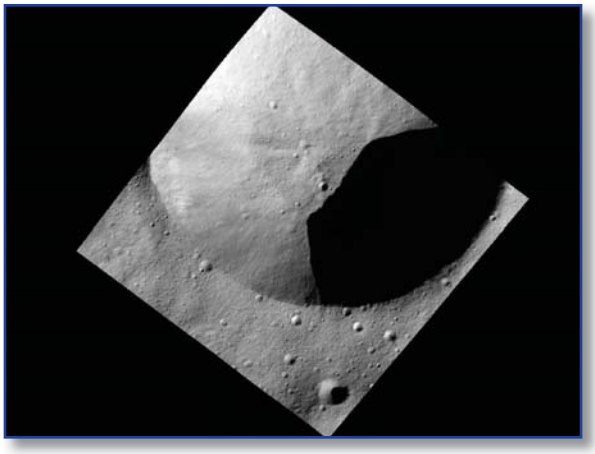
NASA's Cassini spacecraft has "sniffed" molecular oxygen ions around Saturn's icy moon Dione for the first time, confirming the presence of a very tenuous atmosphere. The oxygen ions are quite sparse — one for every 0.67 cubic inches of space (11 cubic centimeters) or about 2550 per cubic foot (90,000 per cubic meter) — show that Dione has an extremely thin neutral atmosphere. At the Dione surface, this atmosphere would only be as dense as Earth's atmosphere 300 miles (480 kilometers) above the surface. The detection of this faint atmosphere, known as an exosphere, is described in a recent issue of the journal *Geophysical Research Letters*.

"We now know that Dione, in addition to Saturn's rings and the moon Rhea, is a source of oxygen molecules," said Robert Tokar, a Cassini team member based at Los Alamos National Laboratory in New Mexico, and the lead author of the paper. "This shows that molecular oxygen is actually common in the Saturn system and reinforces that it can come from a process that doesn't involve life." Dione's oxygen appears to derive from either solar photons or energetic particles from space bombarding the moon's water ice surface and liberating oxygen molecules, Tokar said. But scientists will be looking for other processes, including geological ones, that could also explain the oxygen.

Several solid solar system bodies — including Earth, Venus, Mars, and Saturn's largest moon Titan — have atmospheres. But they tend to be typically much denser than what has been found around Dione. However, Cassini scientists did detect a thin exosphere around Saturn's moon Rhea in 2010, very similar to Dione. The density of oxygen at the surfaces of Dione and Rhea is around 5 trillion times less dense than that at Earth's surface.

Tokar said scientists suspected molecular oxygen would exist at Dione because NASA's Hubble Space Telescope detected ozone. But they didn't know for sure until Cassini was able to measure ionized molecular oxygen on its second flyby of Dione on April 7, 2010, with the Cassini plasma spectrometer. On that flyby, the spacecraft flew within about 313 miles (503 kilometers) of the moon's surface. Cassini scientists are also analyzing data from Cassini's ion and neutral mass spectrometer from a very close flyby on December 12, 2011. The ion and neutral mass spectrometer made the detection of Rhea's thin atmosphere, so scientists will be able to compare Cassini data from the two moons and see if there are other molecules in Dione's exosphere.

For more information about the Cassini mission, visit *www.nasa.gov/cassini* and *saturn.jpl.nasa.gov*.



This image, one of the first obtained by NASA's Dawn spacecraft in its low-altitude mapping orbit, shows part of the rim of a fresh crater on the giant asteroid Vesta. Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA.

Dawn Obtains First Low-Altitude Images of Vesta

NASA's Dawn spacecraft has sent back the first images of the giant asteroid Vesta from its low-altitude mapping orbit. The images, obtained by the framing camera, show the stippled and lumpy surface in detail never seen before, piquing the curiosity of scientists who are studying Vesta for clues about the solar system's early history. At this detailed resolution, the surface shows abundant small craters, as well as textures such as small grooves and lineaments that are reminiscent of the structures seen in low-resolution data from the higher-altitude orbits. This fine scale also highlights small outcrops of bright and dark material. A gallery of images can be found online at *www.nasa.gov/mission_pages/dawn/multimedia/gallery-index.html*.

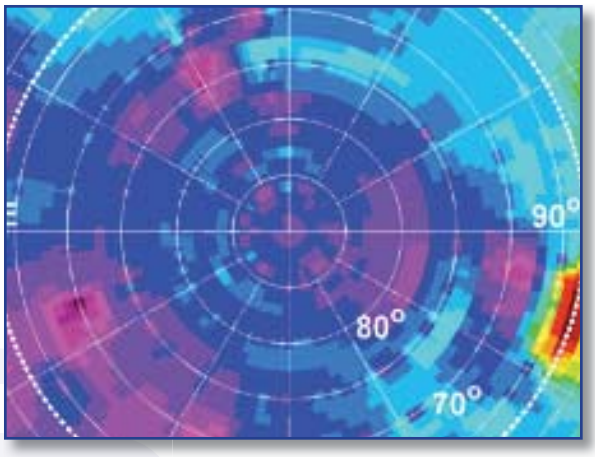
The Dawn mission has recently received confirmation that 40 extra days have been added to its exploration of the giant asteroid Vesta, the second most massive object in the main asteroid belt. The extension allows for extra observations at Dawn's current low-altitude mapping orbit (average altitude 130 miles, or 210 kilometers). The additional time enables the gamma-ray and neutron detector to build the best possible maps of the elemental composition of Vesta's surface and improve data for the gravity experiment, the two primary scientific investigations at the low-altitude orbit. The spacecraft's camera and spectrometer are also obtaining additional high-resolution images. Additional time will also be spent in the planned second high-altitude mapping orbit later this summer. When Dawn arrived at Vesta in July 2011, much of the northern hemisphere was in shadow. But with the passage of time, more of that area will bask in sunshine. Dawn will still arrive at the dwarf planet Ceres at the same originally scheduled target date in February 2015.

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

Vesta Likely Cold and Dark Enough for Ice

Although generally thought to be quite dry, roughly half of the giant asteroid Vesta is expected to be so cold and to receive so little sunlight that water ice could have survived there for billions of years, according to the first published models of Vesta's average global temperatures and illumination by the Sun.

"Near the north and south poles, the conditions appear to be favorable for water ice to exist beneath the surface," says Timothy Stubbs of NASA's Goddard Space Flight Center and the University of Maryland.



New modeling shows that, under present conditions, Vesta's polar regions are cold enough (less than about 145 K) to sustain water ice for billions of years, as this map of average surface temperature around the asteroid's south pole indicates. Credit: NASA/GSFC/UMBC.

Stubbs and Yongli Wang of the Goddard Planetary Heliophysics Institute at the University of Maryland published the models in the January 2012 issue of the journal *Icarus*. The models are based on information from telescopes including NASA's Hubble Space Telescope.

Vesta, the second-most massive object in the asteroid belt between Mars and Jupiter, probably does not have any significant permanently shadowed craters where water ice could stay frozen on the surface all the time, not even in the roughly 300-mile-diameter (480-kilometer-diameter) crater near the south pole, the authors note. The asteroid isn't a good candidate for permanent shadowing because it is tilted on its axis at about 27°, which is even greater than Earth's tilt of roughly 23°. In contrast, the Moon, which does have permanently shadowed craters, is tilted at only about 1.5°. As a result of its large tilt, Vesta has seasons, and every part of the surface is expected to see the Sun at some point during Vesta's year.

The presence or absence of water ice on Vesta tells scientists something about the tiny world's formation and evolution, its history of bombardment by comets and other objects, and its interaction with the space environment. Because similar processes are common to many other planetary bodies, including the Moon, Mercury, and other asteroids, learning more about these processes has fundamental implications for our understanding of the solar system as a whole. This kind of water ice is also potentially valuable as a resource for further exploration of the solar system.

Although temperatures on Vesta fluctuate during the year, the model predicts that the average annual temperature near Vesta's north and south poles is less than roughly –200°F (145 K). That is the critical average temperature below which water ice is thought to be able to survive in the top 10 feet or so (few meters) of the soil, which is called regolith. Near Vesta's equator, however, the average yearly temperature is roughly –190°F (150 K), according to the new results. Based on previous modeling, that is expected to be high enough to prevent water from remaining within a few meters of the surface. This band of relatively warm temperatures extends from the equator to about 27° north and south in latitude.

So far, Earth-based observations suggest that the surface of Vesta is quite dry. However, the Dawn spacecraft is getting a much closer view. Dawn is investigating the role of water in the evolution of planets by studying Vesta and Ceres, two bodies in the asteroid belt that are considered remnant protoplanets — baby planets whose growth was interrupted when Jupiter formed. Dawn is looking for water using the gamma ray and neutron detector (GRaND) spectrometer, which can identify hydrogen-rich deposits that could be associated with water ice.

"Our perceptions of Vesta have been transformed in a few months as the Dawn spacecraft has entered orbit and spiraled closer to its surface," says Lucy McFadden, a planetary scientist at NASA Goddard and a Dawn mission co-investigator. "More importantly, our new views of Vesta tell us about the early processes of solar system formation. If we can detect evidence for water beneath the surface, the next question will be is it very old or very young, and that would be exciting to ponder."

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

Kepler Mission Finds Three Smallest Exoplanets

This artist's concept depicts an itsy bitsy planetary system — so compact, in fact, that it's more like Jupiter and its moons than a star and its planets. Credit: NASA/JPL-Caltech.

Astronomers using data from NASA's Kepler mission have discovered the three smallest planets yet detected orbiting a star beyond our Sun. The planets orbit a single star, called KOI-961, and are 0.78, 0.73, and 0.57 times the radius of Earth. The smallest is about the size of Mars. All three planets are thought to be rocky like Earth but orbit close to their star, making them too hot to be in the habitable zone, which is the region where liquid water could exist. Of the more than 700 planets confirmed to orbit other stars — exoplanets — only a handful are known to be rocky.

"Astronomers are just beginning to confirm the thousands of planet candidates uncovered by Kepler so far," said Doug Hudgins, Kepler program scientist at NASA Headquarters in Washington. "Finding one as small as Mars is amazing, and hints that there may be a bounty of rocky planets all around us."

Kepler searches for planets by continuously monitoring more than 150,000 stars, looking for telltale dips in their brightness caused by crossing, or transiting, planets. At least three transits are required to verify a signal as a planet. Follow-up observations from groundbased telescopes also are needed to confirm the discoveries. The latest discovery comes from a team led by astronomers at the California Institute of Technology in Pasadena. The team used data publicly released by the Kepler mission, along with follow-up observations from the Palomar Observatory, near San Diego, and the W. M. Keck Observatory atop Mauna Kea in Hawaii. Their measurements dramatically revised the sizes of the planets from what was originally estimated, revealing their small nature. The three planets are very close to their star, taking less than two days to orbit around it. The KOI-961 star is a red dwarf with a diameter one-sixth that of our Sun, making it just 70% bigger than Jupiter.

"This is the tiniest solar system found so far," said John Johnson, the principal investigator of the research from NASA's Exoplanet Science Institute at the California Institute of Technology in Pasadena. "It's actually more similar to Jupiter and its moons in scale than any other planetary system. The discovery is further proof of the diversity of planetary systems in our galaxy."

Red dwarfs are the most common kind of star in our Milky Way galaxy. The discovery of three rocky planets around one red dwarf suggests that the galaxy could be teeming with similar rocky planets. "These types of systems could be ubiquitous in the universe," said Phil Muirhead, lead author of the new study from Caltech. "This is a really exciting time for planet hunters."

For information about the Kepler mission, visit *www.nasa.gov/kepler*.

Organics Probably Formed Easily in Early Solar System

Complex organic compounds, including many important to life on Earth, were readily produced under conditions that likely prevailed in the primordial solar system. Scientists at the University of Chicago and NASA's Ames Research Center came to this conclusion after linking computer simulations to laboratory experiments. Fred Ciesla, assistant professor in geophysical sciences at the University of Chicago,

simulated the dynamics of the solar nebula, the cloud of gas and dust from which the Sun and the planets formed. Although every dust particle within the nebula behaved differently, they all experienced the conditions needed for organics to form over a simulated million-year period.

Artist's concept of a solar nebula. Scientists widely believe that the solar system was formed from a cloud of dust and gas particles known as a nebula. Credit: NASA.

"Whenever you make a new planetary system, these kinds of things should go on," said Scott Sandford, a space science researcher at NASA Ames. "This potential to make organics and then dump them on the surfaces of any planet you make is probably a universal process." Although organic compounds are commonly found in meteorites and cometary samples, their origins presented a mystery. Ciesla and Sandford describe how the compounds possibly evolved in the March 29 edition of *Science Express*. However, the importance of the role these compounds may have played in giving rise to the origin of life remains poorly understood.

Sandford has devoted many years of laboratory research to the chemical processes that occur when high-energy ultraviolet radiation bombards simple ices like those seen in space. "We've found that a surprisingly rich mixture of organics is made," Sandford said. These include molecules of biological interest, including amino acids, nucleobases, and amphiphiles, the building blocks of proteins, RNA and DNA, and cellular membranes, respectively. Irradiated ices should have produced these same sorts of molecules during the formation of the solar system, he said.

But a question remained. Could icy grains traveling through the outer edges of the solar nebula, in temperatures as low as –405°F (less than 30 K), become exposed to UV radiation from surrounding stars? Ciesla's computer simulations reproduced the turbulent environment expected in the solar nebula. This "washing machine" action mixed the particles throughout the nebula, and sometimes lofted them to high altitudes within the cloud, where they could become irradiated.

"Taking what we think we know about the dynamics of the outer solar nebula, it's really hard for these ice particles not to spend at least part of their time where they're going to be exposed to UV radiation," Ciesla said. The grains also moved in and out of warmer regions in the nebula. This completes the recipe for making organic compounds: ice, irradiation, and warming. "It was surprising how all these things just naturally fell out of the model," Ciesla said. "It really did seem like this was a natural consequence of particle dynamics in the initial stage of planet formation."

For more information about the NASA Ames Astrochemistry Laboratory, visit *www.astrochemistry.org*.

Hubble's 22nd Anniversary Image Shows Turbulent Star-Making Region

Several million young stars are vying for attention in a new NASA Hubble Space Telescope image of a raucous stellar breeding ground in 30 Doradus, a star-forming complex located in the heart of the Tarantula nebula. The new image comprises one of the largest mosaics ever assembled from Hubble photos and includes observations taken by Hubble's Wide Field Camera 3 and Advanced Camera for Surveys. NASA and the Space Telescope Science Institute (STScI) in Baltimore released the image in celebration of Hubble's 22nd anniversary.

A new view of 30 Doradus, one of the largest mosaics ever assembled from Hubble photos, to celebrate HST's 22nd anniversary. Credit: NASA, ESA, ESO, D. Lennon and E. Sabbi (ESA/STScI), J. Anderson, S. E. de Mink, R. van der Marel, T. Sohn, and N. Walborn (STScI), N. Bastian (Excellence Cluster, Munich), L. Bedin (INAF, Padua), E. Bressert (ESO), P. Crowther (Sheffield), A. de Koter (Amsterdam), C. Evans (UKATC/STFC, Edinburgh), A. Herrero (IAC, Tenerife), N. Langer (AifA, Bonn), I. Platais (JHU) and H. Sana (Amsterdam).

30 Doradus is the brightest star-forming region in our galactic neighborhood and home to the most massive stars ever seen. The nebula is 170,000 light-years away in the Large Magellanic Cloud, a small satellite galaxy of the Milky Way. No known star-forming region in our galaxy is as large or as prolific as 30 Doradus. Collectively, the stars in the image are millions of times more massive than our Sun. The image is roughly 650 light-years across and contains some rambunctious stars, including one of the fastest-rotating stars and the highest-velocity stars ever observed by astronomers.

The nebula is close enough to Earth that Hubble can resolve individual stars, giving astronomers important information about the stars' birth and evolution. Many small galaxies have more spectacular starbursts, but the Large Magellanic Cloud's 30 Doradus is one of the only star-forming regions that astronomers can study in detail. The star-birthing frenzy in 30 Doradus may be fueled partly by its close proximity to its companion galaxy, the Small Magellanic Cloud.

The image reveals the stages of star birth, from embryonic stars a few thousand years old and still wrapped in cocoons of dark gas, to behemoths that die young in supernova explosions. 30 Doradus churns out stars at a furious pace over millions of years. The region's sparkling centerpiece is a giant, young star cluster named NGC 2070, only 2 million to 3 million years old. Its stellar inhabitants number roughly 500,000. The cluster is a hotbed for young, massive stars. Its dense core, known as R136, is packed with some of the heftiest stars found in the nearby universe, weighing more than 100 times the mass of our Sun.

The image was made using 30 separate fields, 15 from each camera. Both cameras made these observations simultaneously in October 2011. The colors in the image represent the hot gas that dominates regions of the image. Red signifies hydrogen gas and blue represents oxygen. For related images, video, and more information about Hubble, visit *www.nasa.gov/hubble* and *hubblesite.org*.

43rd Lunar and Planetary Science Conference
March 19–23, 2012, The Woodlands, Texas

The 43rd Lunar and Planetary Science Conference (LPSC), held in March at The Woodlands Waterway Marriott Hotel and Convention Center in The Woodlands, Texas, was another huge success. While the attendance figures (1761) were slightly under last year's (1789), a new record was set for number of abstracts submitted (1943). This year's meeting had an unprecedented number of student attendees, with students making up more than 30% of the total attendance, which illustrates that the LPSC is a meeting that is both accessible and important to young scientists.

In honor of the completion of the first 50 years of nuclear-powered spaceflight, which began with the launch of the Transit 4A satellite in June 1961, this year's LPSC was held in conjunction with the Nuclear and Emerging Technologies for Space (NETS) topical meeting, which took place on March 21–23, 2012. Nuclear power has been an enabling technology for the most ambitious planetary missions in history. The goal of holding the meetings together, with a joint plenary session mid-week, was to allow the planetary science community to learn more about the latest developments in nuclear power and propulsion, and see how new technologies could help their exploration efforts in the future.

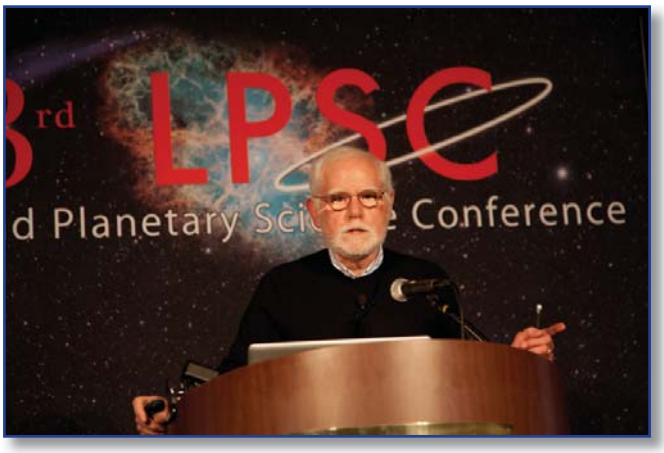
LPSC, co-chaired by Stephen Mackwell of the Lunar and Planetary Institute and Eileen Stansberry of the NASA Johnson Space Center, began with the usual Sunday night registration and reception. This year the reception was held in the Waterway Ballrooms, giving participants an opportunity to meet and greet more of their friends and colleagues in a roomier environment. Many participants have said that one of the appealing qualities of the meeting is that it feels as much like a homecoming or reunion event as a scientific conference, and this was in evidence on Sunday night from the smiles, hugs, and earnest conversations held among attendees.

Participants enjoy greeting old friends and colleagues during the Sunday night reception.

On Monday morning, the scientific sessions began. The conference featured five (very!) full days of oral and poster sessions, featuring such topics as lunar volatiles, impact melts, remote sensing, planetary dynamics and tectonics, volcanism, isotopes, hydrated minerals, and much, much more. Special sessions included the latest results from the MESSENGER and Dawn missions; new discoveries and seasonal changes on Titan and the icy satellites of Saturn; and hydrologic processes involving the transport of volatiles on Earth, Mars, Titan, and a number of other solar system bodies. The complete program and abstracts are available at *www.lpi.usra.edu/meetings/lpsc2012*.

Participants circulate among hundreds of posters during the poster session and exhibitor showcase.

The LPI Career Development Award is given to graduate students who are the first author of an abstract submitted to LPSC and selected for presentation.



Jim Head discusses the history of the martian climate during the Masursky Lecture.

The plenary session on Monday afternoon featured the Masursky Lecture by Jim Head of Brown University, entitled "Mars Climate History: A Geological Perspective." The session also recognized the recipients of the 2011 Dwornik Student Awards and the 2012 LPI Career Development Awards.

One of the highly anticipated special events was the Monday evening NASA Headquarters Briefing, during which John Grunsfeld (Associate Admininistrator of NASA's Science Missions Directorate, SMD) and Jim Green (Director of SMD's Planetary Science Division) spoke to a packed house about the recent budget cuts in planetary science, and the effects they would have in the near-term on research and missions. After the conclusion of the presentations and the subsequent Q&A, participants stopped to take a few moments to remember those in the community that had passed away over the last year, with special tributes being given to Mike Drake and Ron Greeley.

On Tuesday, scientists had an opportunity during the lunchtime Community Forum event to voice their concerns about the budget situation and offer ideas for ways to become a unified voice and work together, not only to lobby Congress to restore planetary funding, but also to find ways to engage the public in supporting funding for planetary science.

On Wednesday evening, the NETS attendees joined the crowd as their meeting was kicked off with an opening plenary session. Ralph McNutt, Michael Meyer, and Steve Squyres presented an in-depth look at what nuclear power sources have offered to science missions in the past, how they are being employed today, and what might be on the horizon for the future. A NETS tutorial session held earlier in the day offered planetary scientists an introduction to nuclear systems and nuclear technology. The tutorial was designed to better prepare LPSC attendees who were unfamiliar with nuclear systems to attend the NETS technical sessions.

Wednesday evening also featured the Fourth Annual Women in Planetary Science Symposium. The symposia were started by the late Dr. Susan Niebur, who created the popular Women in Planetary Science blog. The event, which quickly filled

John Grunsfeld and Jim Green spoke to LPSC attendees at Monday night's NASA Headquarters Briefing.

Tuesday's Community Forum called for a plan of action among planetary scientists. Pictured left to right are Stephen Mackwell, LPSC co-chair; Andrew Chaikin, moderator; and panelists Steve Squyres, representing the Planetary Decadal Survey; Laurie Leshin, President of the Planetary Sciences Section of the AGU; Dan Britt, Chair of the Division of Planetary Sciences of the AAS; Ed Scott, President of the Meteoritical Society; and Simon Kattenhorn, Chair of the Planetary Geology Division of GSA.

NETS opening plenary. Pictured left to right: Stephen Mackwell, Leonard Dudzinski, Wade Carroll, Ralph McNutt Jr., Michael Meyer, and Steve Squyres.

to capacity and had a lengthy waiting list, featured a question and answer session with a panel of four distinguished female scientists, all of whom are actively involved with space missions: Victoria Hamilton, Sarah Milkovich, Jessica Sunshine, and Louise Prockter.

Thursday and Friday continued with another poster session and many more oral sessions, including the heavily attended Dawn special sessions (one of which was standing room only). Other topics covered later in the week included lunar chronology, lunar petrology and geochemistry, small body studies, water on Mars, secondary processes in chondrites, planetary brines and alteration, presolar grains, Mars aeolian and polar processes, and planetary differentiation. The conference concluded on Friday afternoon with a closing celebration in the Acqua Lounge.

Plans are already underway for the 44th LPSC, which will be held March 18–22, 2013. Mark your calendars! Meeting announcements and other details will be available at *www.lpi.usra.edu/meetings/lpsc2013/*.

"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.

Continuing the Year of the Solar System (YSS)

Spanning a martian year — 23 months — the Year of the Solar System celebrates the amazing discoveries of numerous NASA missions as they explore our near and distant neighbors and probe the very outer edges of our solar system. Each month, from October 2010 to August 2012, audiences explore different aspects or our solar system — its formation, volcanism, ice, life — weaving together activities, resources, and ideas that teachers, clubs, and organizations can use to engage audiences. Visit *solarsystem.nasa.gov/yss*.

The topic for March was Shadows of the Sun. The focus was the celebration of Sun-Earth Day and preparation for a rare transit of Venus! Between June 5 and 6, 2012, people around the world will see the planet Venus move across the front of the Sun, creating the last Venus transit as seen from Earth until the year 2117!

April featured Ice!, as we explored ice and its properties, where it is located, and what it tells us about the planets and moons in our solar system.

May focuses on New Data, New Ideas. Join us as we explore this scientific process of gathering new data and formulating new ideas.

Get Involved! Share Your YSS Events and Stories: Advertise your YSS Events on the YSS Calendar. Share your YSS stories through the YSS story space, and Flickr and YouTube. Visit *solarsystem.nasa.gov/yss/getinvolved.cfm*.

Link to YSS from Your Website: We invite you be a YSS partner during the Year of the Solar System! Post the YSS graphic element on your website and link to the YSS page. You can find YSS graphics at *solarsystem.nasa.gov//yss/display.cfm?Year=2010&Month=12&Tab=Downloads*.
Ideas? Feedback? Contact us! *planetaryforum@lpi.usra.edu*

Sun-Earth Day

Sun-Earth Day is comprised of a series of programs and events that occur throughout the year culminating with a celebration on or near the spring equinox; in 2012, the annual celebration was on March 19. The focus in 2012, however, is on the upcoming June transit of Venus, which will be visible on June 5 or 6, depending on your location. Check out the site for educational programs, activities, resources, and more, and plan your own Sun-Earth Day celebration! Visit *sunearthday.nasa.gov/2012/about/about.php*

Center for Astronomy Education Teaching Excellence Workshops

The Center for Astronomy Education, or CAE, announces a series of educator workshops for astronomy and space science educators. Advanced workshops are available for participants who have taken part in previous CAE workshops.

The overarching goal of these workshops is for participants to become familiar with research-validated active engagement teaching strategies and assessment materials, as well as how to implement them in their college courses, through role-playing, modeling, practice, and more! To accomplish this goal, participants will learn how to create productive learning environments beginning with a brief review of research on the nature of teaching and learning. Most workshop time will be spent with participants playing the roles of student, instructor, and critical friend to practice implementing active engagement strategies such as interactive lectures, think-pair-share, interactive demonstrations and videos, collaborative groups, lecture-tutorials, and ranking tasks. CAE is funded through the NASA JPL Exoplanet Exploration Program. For more information and to register for workshops online, visit *astronomy101.jpl.nasa.gov/workshops/index.cfm*.

Communicating Science, a National Conference on Science Education and Public Outreach

This national Astronomical Society of the Pacific Conference will take place in Tucson, Arizona, August 4–8, 2012. Join this three-day symposium on the joys and challenges of communicating our understanding of the universe and science in general — whether in the classroom, in a museum or nature center, to general and specific audiences, through books and magazines, on the web, via festivals and fairs, on radio and television, or through the social media. Preceding the symposium will be a two-day workshop, “In the Footsteps of Galileo,” a national workshop of educators in grades 3–12 and in informal settings.

Anyone involved or with an interest in science education and public outreach (EPO) and science communication is welcome, including scientists and EPO professionals from NASA and NSF projects, planetariums, museums, science centers, universities, scientific organizations, research institutions, parks, nature centers, and afterschool settings; K–14 teachers and instructors; administrators; education

researchers and program evaluators; book authors, science journalists, podcasters, bloggers, public information officers, webmasters; amateur astronomers doing outreach; and those interested in these fields of endeavor. For more information or to register, please go to *www.astrosociety.org/events/meeting.html*.

Announcing New EarthSpace Website

www.lpi.usra.edu/earthspace/

EarthSpace is a community web space for anyone to find and share information about teaching Earth and space sciences in the undergraduate classroom. It includes materials for the undergraduate classroom, such as lectures, homework assignments, labs, course syllabi, and demos; news regarding the latest funding opportunities, policy news, important programs and products, workshops, and meetings; educational research — the latest innovations on teaching undergraduates; and a moderated listserv and monthly newsletter for undergraduate educators.

Not only does EarthSpace allow you to share classroom assets with your colleagues, this new site can automatically cross-post your materials to other digital libraries and virtual higher education clearinghouses, giving you a national platform. EarthSpace is supported by the NASA Science Mission Directorate Education and Public Outreach Forums in Heliophysics and Planetary Science and is hosted by the Lunar and Planetary Institute.

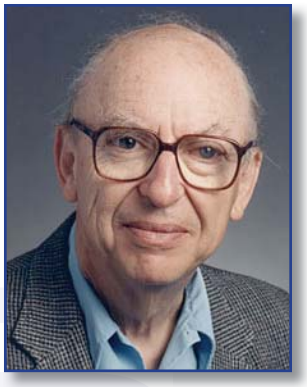
Sudbury Field Camp

2012 Fall Session
Monday, October 1, 2012–Friday, October 5, 2012

The Short Course and Field School at the Sudbury Impact Structure is a week-long classroom and field training program based in Sudbury, Ontario. The 2012 fall session will be held from Monday, October 1, through Friday, October 5. The goal of the program will be to introduce students to impact cratering processes and observe, in the field, the attributes of an immense basin-sized impact structure. Sudbury is known for spectacular shatter cones, tremendously thick melt-bearing impact breccias (the Onaping Formation), and a differentiated impact melt sheet (the Sudbury Igneous Complex). Skills developed during the program should better prepare students for their own thesis studies in impact cratered terrains, whether they be on Earth, the Moon, Mars, or some other solar system planetary surface.

The field camp is being organized under the auspices of the NASA Lunar Science Institute (NLSI), which is designed, in part, to train a new generation of explorers for the Moon and beyond. The activity is being led by an NLSI international partner, the Canadian Lunar Research Network, and coordinated with the LPI-JSC Center for Lunar Science and Exploration.

The application deadline is May 11, 2012. For more information, or to submit an application, visit *www.lpi.usra.edu/nlsi/sudbury/*.



James R. Arnold, 1923–2012

James R. Arnold, nuclear chemist and visionary scientist, died Friday, January 6, 2012, from complications of Alzheimer's disease. He was 88 years old. Arnold was founding chairman of the University of California–San Diego's (UCSD) chemistry department and first director of the California Space Institute.

Arnold was born in Metuchen, New Jersey, on May 5, 1923. At age 16, he entered Princeton University, where he earned his doctoral degree in chemistry in 1946. His doctorate was awarded for his work on the Manhattan Project, the military program that produced the atomic bomb and stirred the fears of nuclear fallout that led him to join the Union of Concerned Scientists.

After earning his doctorate, he helped University of Chicago chemist Willard Libby develop radiocarbon dating in 1949. In 1955, Arnold joined the faculty at Princeton, where he expanded his investigations into the planetary sciences by studying the effects on meteorites of cosmic rays, the high-energy particles that speed through space. His work produced a method for recording the age of rocks, which helped scientists understand "how long a meteorite has been a rock in space and where it might have come from," Arnold once explained. His research on cosmic rays drew him to UCSD, where he founded the chemistry department in 1960. He became a longtime consultant to NASA, where he helped the young agency as early as 1959 in setting science priorities for missions, including the Apollo missions to the Moon. He first served on a NASA committee in 1959, just three months after the space agency was established.

"I have known Jim Arnold for over 60 years. He was a dedicated and imaginative scientist," said Gerald Wasserburg, emeritus professor of geology and geophysics at Caltech. "He was a lover of the Pogo comic strip and of Buck Rogers, who ignited his passion for shooting people into space and colonizing it." Arnold and Wasserburg, along with Paul Gast and Bob Walker, whom their colleagues called the "Four Horsemen," helped to establish the national lunar sample research program and fostered its remarkable contributions to planetary science over the decades since Apollo 11. Arnold was in Houston for the arrival of the first lunar samples and carried some of them back to his laboratory at UCSD where his group studied them, sometimes while watching astronauts on subsequent missions on television as they collected the rocks Arnold's group would study next.

For over two decades, Arnold and colleagues traced the history of lunar material being bombarded by cosmic rays and extended our record of the energy output of the Sun by millions of years, thus significantly increasing our understanding of the age and composition of the Moon and also of the history and evolution of the solar system. The continued legacy of this work on lunar material led to major discoveries even in recent years. For his contributions, NASA awarded him in 1970 its top medal for "exceptional scientific achievement." Arnold also received the Department of Energy's E. O. Lawrence Award in chemistry and metallurgy.

Arnold founded the California Space Institute in 1979 to foster innovation in space research and was its director for the first 10 years. In 1980, Eleanor Helin and Eugene Shoemaker named an asteroid after him, (2143) Jimarnold, after he created a computer model describing how meteorites traverse the asteroid belt between Mars and Jupiter. He held UCSD's Harold Urey Chair in chemistry from 1983 until his retirement in 1993. The annual Jim Arnold Lecture recognizes his contribution by inviting an interesting speaker who has made significant contributions to chemistry and the space sciences to campus each spring. In his last decades, Arnold advocated the colonization of space.

— Text courtesy of UCSD and BAAS

Susan Niebur, 1978–2012

Susan Niebur, former NASA Program Scientist and founder of the Women in Planetary Science project, passed away on February 6, 2012, surrounded by family and friends. She will be remembered for her untiring work to bring people together and to find ways to help everyone to be able to live up to their potential, for the passion and incredible energy she brought to everything she did, for the constant encouragement and inspiration she provided to others, and for her wonderful and unfailing smile.

Niebur got her Ph.D. in physics at Washington University's McDonnell Center for Space Sciences in 2001. While a student, she founded the American Physical Society's Forum on Graduate Student Affairs and served as its first chair; founded and led the first peer mentoring group at Washington University; co-created and administered the first National Doctoral Program Survey; and served as President, Vice President, Regional Coordinator, and first Alumni Affairs Coordinator for the National Association of Graduate-Professional Students. She started her career at NASA Headquarters straight out of graduate school as a Presidential Management Intern in the Office of Space Science and became the Discovery Program Scientist in 2003. During her five-year service at NASA Headquarters she co-founded the first-ever Early Career Fellowships and Workshops for Planetary Scientists, held at annual meetings of the American Astronomical Society's Division for Planetary Science and the Lunar and Planetary Science Conference.

In 2006 Niebur left NASA and founded Niebur Consulting, to pursue research in space science policy, the history of space science missions, mission leadership, and the place of women in the current landscape of planetary exploration. (Her publications on these topics can be found at *susanniebur.wordpress.com/publication-list/*.) She also consulted for major aerospace companies and research institutions on proposal strategy and planning. In addition, she worked tirelessly to promote community outreach projects, providing several forums for those whose voices aren't always heard. In 2008, she founded the Women in Planetary Science project ("Women make up half the bodies in the solar system. Why not half the scientists?," *womeninplanetaryscience.wordpress.com/*), a community-building portal to promote networking and facilitate sharing of resources to remove barriers to success. As part of that project she ran a series of interviews entitled "51 Women in Planetary Science," which represents a goldmine of information for anyone interested in learning about options available when pursuing a career in a planetary-science-related field. She also introduced the first Women's Networking Breakfast, a hugely successful annual event at the Lunar and Planetary Science Conference, which, over just a few years, has grown from an overflowing hotel breakfast room to a large conference room, also overflowing.

Among her numerous honors is the Public Service Award from the NASA Planetary Science Division in November 2011, for her "exemplary leadership abilities [that] have helped many women in the field, both planetary and astrophysics" (Planetary Science Division Director Dr. Jim Green). She was also extremely active in advocating for cancer research and raising awareness about Inflammatory Breast Cancer, a rare and very aggressive form of cancer. She fought that disease with all she had, documenting her journey on the site *ToddlerPlanet.wordpress.com* with compelling forthrightness, and was one of the creators of the online support network Mothers with Cancer about "Raising Children, Fighting Cancer, Living Life!" (*motherswithcancer.wordpress.com/*). Her tremendous contribution to social media and cancer advocacy has been widely recognized, including the Bloganthropy Annual Award for "using social media to make a difference" in 2011.

Her story has been shared thousands of times over. Even though she has died, her story remains, as does what she called her mantra: "All that survives after our death are publications and people. So look carefully after the words you write, the thoughts and publications you create, and how you love others. For these are the only things that will remain."

More information on Susan and links to her websites can be found at *solarsystem.nasa.gov/people/profile.cfm?Code=NieburS*.

Anthony "Tony" Calio, 1929–2012

Anthony (Tony) Calio, age 82, died of heart failure at his home on Whidbey Island, Washington, on January 14, 2012. Per his wishes, he was buried at sea. Calio was born in Philadelphia, Pennsylvania, and earned a B.S. degree in physics from the University of Pennsylvania in 1953. He served in the Army Chemical Corps at Fort Detrick, Maryland, during the Korean War.

Calio had an extraordinarily productive career spanning four decades. He started out working in the nuclear power industry, first for Westinghouse in Pittsburgh, Pennsylvania, and then for the American Machine and Foundry Company in Alexandria, Virginia. He co-founded the Mount Vernon Research Company in 1961 and built a business developing space flight equipment.

Calio spent 18 years with the National Aeronautics and Space Administration (NASA). In 1964, he helped establish NASA's Electronics Research Center in Boston. He joined the Apollo Program Office at the Johnson Space Center in 1969, and assumed responsibility for managing all scientific aspects of the Apollo and Skylab programs. He was awarded an honorary doctorate from Washington University in St. Louis for his work on the Apollo program. After completing a Sloan Fellowship at Stanford University Graduate School of Business in 1975, he returned to NASA Headquarters, where he pioneered early applications of civil remote sensing from space.

In 1981, Calio was nominated by President Reagan to become the Deputy Administrator of the National Oceanic and Atmospheric Administration (NOAA). He became the Administrator of NOAA in 1985 and served until 1987. During his tenure at NOAA, he led the modernization of the National Weather Service. He served as the United States Whaling Commissioner, and helped to gain approval for the international moratorium on commercial whaling in 1986.

Calio retired from government service in 1987 and joined private industry. He was Senior Vice President of the Planning Research Corporation in McLean, Virginia for four years. He joined Hughes Aircraft Company in 1991, where he assisted in the creation of an information technology subsidiary. After Raytheon purchased the Hughes aerospace and defense businesses, he stayed on to facilitate the transition to the new organization. He retired from Raytheon in January 1999.

— Text courtesy of Legacy.com

Credit: NASA.

Grunsfeld to Head NASA Science Directorate

NASA has named physicist and former astronaut John Grunsfeld as the new associate administrator for the Science Mission Directorate at the agency's headquarters in Washington. Grunsfeld took the reins of the office early this year. He succeeds Ed Weiler, who retired from NASA last September. Grunsfeld had been serving as the deputy director of the Space Telescope Science Institute in Baltimore, which manages the science program for the Hubble Space Telescope and is a partner in the forthcoming James Webb Space Telescope. His background includes research in high-energy astrophysics, cosmic-ray physics, and in the emerging field of exoplanet studies with specific interest in future astronomical instrumentation. A veteran of five space shuttle flights, Grunsfeld visited Hubble three times as an astronaut, performing a total of eight spacewalks to service and upgrade the observatory.

Grunsfeld graduated from the Massachusetts Institute of Technology in 1980 with a bachelor's degree in physics. Returning to his native Chicago, he earned a master's degree and, in 1988, a doctorate in physics from the University of Chicago using a cosmic-ray experiment on space shuttle Challenger for his doctoral thesis. From Chicago, he joined the faculty of the California Institute of Technology as a Senior Research Fellow in Physics, Mathematics, and Astronomy. He joined NASA's Astronaut Office in 1992. He logged over 58 days in space on five shuttle missions, including 58 hours and 30 minutes of spacewalk time. He first flew to space onboard Endeavour in March 1995 on a mission that studied the far-ultraviolet spectra of faint astronomical objects using the Astro Observatory. His second flight was onboard Atlantis in January 1997. Grunsfeld then flew three shuttle missions — onboard Discovery in December 1999, Columbia in March 2002, and Atlantis in May 2009 — that successfully serviced and upgraded the Hubble Space Telescope. He served as the payload commander on the 2002 mission and lead spacewalker in charge of Hubble activities on the 2009 flight. In 2004 and 2005, he served as the commander and science officer on the backup crew for Expedition 13 to the International Space Station.

"It is an honor and a privilege to be offered the opportunity to lead NASA's Science Mission Directorate during this exciting time in the agency's history," Grunsfeld said. "Science at NASA is all about exploring the endless frontier of Earth and space. I look forward to working with the NASA team to help enable new discoveries in our quest to understand our home planet and unravel the mysteries of the universe." For Grunsfeld's NASA astronaut biography, visit *www.jsc.nasa.gov/Bios/htmlbios/grunsfel.html*.

Credit: NASA.

Figueroa Named as Chair of New Mars Program Planning Group

Former veteran NASA program manager Orlando Figueroa has been named to lead a newly established Mars Program Planning Group (MPPG) tasked to reformulate the agency's Mars Exploration Program. Figueroa's first assignment was to develop a draft framework.

Figueroa, a consultant with more than 30 years of aerospace experience, will lead the scientific and technical team to develop an integrated strategy for NASA's Mars Exploration Program in light of current funding constraints. The team's initial focus will be on a possible 2018–2020 robotic mission. The program's official framework will be developed in

consultation with the science community and international partners and is expected to be released for full review as early as this summer.

The MPPG will report to John Grunsfeld, Associate Administrator of NASA's Science Mission Directorate. Grunsfeld is chairing the overall, agency-wide reformulation strategy along with William Gerstenmaier, Associate Administrator for the Human Exploration and Operations Directorate, NASA Chief Scientist Waleed Abdalati, and NASA Chief Technologist Mason Peck. The MPPG will ensure that America maintains the critical technical skills developed over decades needed to achieve the highest priority science and exploration objectives.

NASA has a recognized track record of successful Mars missions. The rover Opportunity, which landed on Mars in 2004, is still operating despite an official mission timeline of 90 days. There are also two NASA satellites orbiting the Red Planet: the Mars Reconnaissance Orbiter and Mars Odyssey. The duo continue to return unprecedented science data and images. This August, NASA will land the Mars Science Laboratory, "Curiosity," on the planet's surface. This roving science laboratory will assess whether Mars was or is today an environment able to support life. In 2013, NASA will launch the Mars Atmosphere and Volatile Evolution orbiter, the first mission devoted to understanding the martian upper atmosphere.

NASA will continue to gather critical information to help scientists understand the Red Planet. These data will be used in future years to meet President Obama's challenge to send humans to Mars in the mid-2030s. NASA already has been developing technology that will improve precision in landing and the ability to conduct scientific analysis remotely, handle and collect samples, and transmit larger volumes of data back to Earth.

Mars exploration is a top priority for NASA. America's investment in exploring Mars during the past decade totals $6.1 billion. NASA Administrator Charlie Bolden directed Grunsfeld to lead the agency-wide team in order to optimize a coordinated strategy of Mars exploration and continue America's leadership role in the exploration of the Red Planet within available future budgets.

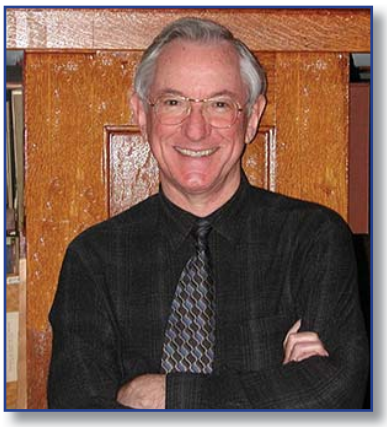
For more information about NASA's Mars programs, visit *www.nasa.gov/mars*.

NASA Announces Senior Leadership Changes

NASA Administrator Charles Bolden recently announced changes to his senior leadership team. Associate Administrator Chris Scolese was named director of NASA's Goddard Space Flight Center in Greenbelt, Maryland, and Robert Lightfoot, director of the agency's Marshall Space Flight Center in Huntsville, Alabama, will serve as acting associate administrator. Both assumed their new responsibilities on March 5.

Scolese, who has been with NASA since 1987, succeeds Robert Strain, who announced his decision to return to private industry in January. Lightfoot joined NASA in 1989 as a test engineer and program manager at Marshall. Lightfoot's deputy, Gene Goldman, will serve as Marshall's acting center director. As associate administrator, Lightfoot will be the agency's highest-ranking civil servant, responsible for oversight and integration of NASA's broad efforts in human space flight, science and aeronautics. At Goddard, Scolese will lead a major U.S. laboratory for developing and operating unmanned scientific spacecraft.

Scolese served as the agency's acting administrator in 2009 and was previously NASA's chief engineer. Lightfoot began his NASA career as a test engineer and manager for the space shuttle main engine technology test bed program, and then served in leadership positions at Marshall, Stennis Space Center in Bay St. Louis, Mississippi, and NASA Headquarters. Both men are highly honored NASA leaders, earning the Presidential Rank Award of Meritorious Executive and agency medals for outstanding leadership.



Columbia University Names Solomon as Director of Lamont-Doherty Earth Observatory

Columbia University has named Sean C. Solomon, a leading geophysicist whose research has combined studies of the deep Earth with missions to the Moon and the solar system's inner planets, to be director of Columbia's Lamont-Doherty Earth Observatory. Solomon, a research scientist and director emeritus at the Carnegie Institution in Washington, DC, currently leads the MESSENGER mission to Mercury. From 1996 to 1998, he was president of the American Geophysical Union, the world's largest organization of Earth and space scientists.

Research at Lamont focuses on Earth itself — its oceans, atmosphere, and deep interior — but Lamont scientists also sent the first seismometers to the Moon in 1969, and their work on plate tectonics in the 1960s revolutionized the study of how all planets evolve. The observatory is a key part of Columbia's Earth Institute, which aims to mobilize science as part of a broadly interdisciplinary approach to maintaining a sustainable planet.

Solomon, 66, is the principal investigator for NASA's MESSENGER mission to Mercury, which entered orbit last year and is now mapping Mercury's surface and delving into the planet's origins, atmosphere, magnetic field, and interior. Some of his other projects are household names in space science: the Magellan mission to Venus and the Mars Global Surveyor mission. He is also a co-investigator for NASA's GRAIL spacecraft mission, which is now mapping the Moon's gravitational field. Back on Earth, Solomon is a veteran of numerous oceanographic cruises aimed at studying mid-ocean ridges and the dynamics of the deep subsurface. Most recently, he has been involved in the PLUME project, which is using seismology on land and at sea to study the deep origins of the volcanic processes that have formed the Hawaiian Islands.

Solomon has been a member of both the National Academy of Sciences and the American Academy of Arts and Sciences, and is the recipient of numerous awards. These include the Geological Society of America's G.K. Gilbert Award for solving broad problems in planetary geology, and the American Geophysical Union's Harry H. Hess Medal, given for outstanding research on the evolution of Earth and other planets. Last fall, when he stepped down as a director at Carnegie, colleagues arranged to have a previously discovered asteroid named after Solomon. Asteroid 25137 Seansolomon, about a mile and half wide, is currently orbiting the Sun between Mars and Jupiter.

Credit: Denver Museum of Nature & Science.

Grinspoon Selected as First Astrobiology Chair

NASA and the Library of Congress have announced the selection of David H. Grinspoon to be the first Baruch S. Blumberg NASA-Library of Congress Chair in Astrobiology. The chair, selected through an international competition, is named for the late Nobel Laureate and founding director of the NASA Astrobiology Institute, Baruch "Barry" Blumberg. Applications are solicited by the Library of Congress and reviewed by a panel jointly established by the Library and NASA. The prestigious position was created in November 2011.

Grinspoon will be in residence for a year beginning November 2012 at the library's scholarly research organization, the Kluge Center, in Washington. He is the curator of astrobiology in the Department of Space Sciences at the Denver Museum of Nature and Science. Grinspoon is a well-known researcher in planetary science and the author of the award-winning book *Lonely Planets: The Natural Philosophy of Alien Life.*

Astrobiology is the study of the origins, evolution, distribution, and future of life in the universe. It addresses three fundamental questions: How did life begin and evolve? Is there life elsewhere? What is the future of life on Earth and beyond? The institute's mission is to promote interdisciplinary research in astrobiology, train the next generation of astrobiologists, and provide scientific and technical leadership for NASA space missions.

At the library, Blumberg was a founding member of the Scholar's Council, a 12-member group of distinguished scholars who advise the Librarian of Congress on matters of scholarship. He was awarded the 1976 Nobel Prize in physiology or medicine for discovery of the Hepatitis B virus and development of a vaccine to prevent Hepatitis B infection. He was the founding director of the NASA Astrobiology Institute, serving from 1999 to 2002.

Grinspoon will examine choices facing humanity as we enter the Anthropocene Era, the epoch when human activities are becoming a defining characteristic of the physical nature and functioning of Earth. His research will include studies of the role of planetary exploration in fostering scientific and public understanding of climate change and the power of astrobiology as a model of interdisciplinary research and communication.

For more information about NASA's Astrobiology Program, visit *astrobiology.nasa.gov*. For more information about the Kluge Center of the Library of Congress, visit *www.loc.gov/loc/kluge*.

LPI Announces Career Development Award Winners

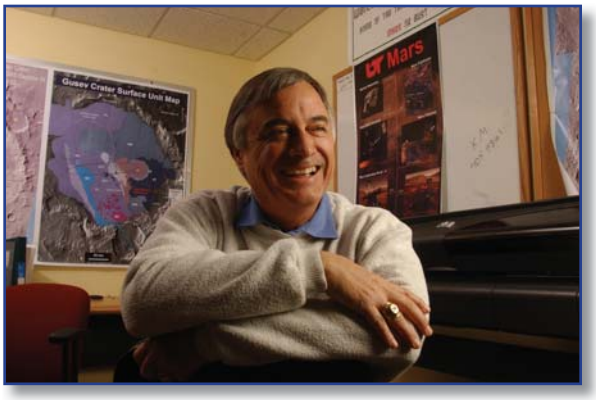
The Lunar and Planetary Institute (LPI) is proud to announce the winners of the fifth LPI Career Development Award. The award is given to graduate students who submitted a first-author abstract to the 43rd Lunar and Planetary Science Conference (LPSC), and recipients received an $1000.00 travel stipend to help cover their expenses for attending the conference.

The 43rd LPSC was held in March at The Woodlands Waterway Marriott Hotel & Convention Center in The Woodlands, Texas. Nearly 2000 participants from all over the world gathered for the annual meeting, which provided an invaluable opportunity for students not only to present their own research, but also to hear and see firsthand the latest-breaking results from other researchers in their field. Opportunities were also provided for students to meet and network with an international group of distinguished researchers.

Congratulations to the 2012 recipients: Rebecca Bast, *Westfälische Wilhelms-Universität Münster, Germany;* Robert Beauford, *University of Arkansas;* Elmar Buhl, *Albert-Ludwigs-Universität Freiburg, Germany;* Michael Chaffin, *University of Colorado at Boulder;* Carolyn Crow, *University of California, Los Angeles;* Dirk Elbeshausen, *Forshung Museum für Naturkunde, Germany;* Amy L. Fagan, *University of Notre Dame;* Roger R. Fu, *Massachusetts Institute of Technology;* Emmanuel Jacquet, *Laboratoire de Minéralogie et Cosmochimiedu Muséum, France;* Matthew E. Sanborn, *Arizona State University;* Stephen Seddio, *Washington University in St. Louis;* Bhairavi Shankar, *University of Western Ontario, Canada;* Priyanka Sharma, *University of Arizona;* Matthew R. Smith, *University of Washington;* Veerle

Jasmin Sterken, *MPIK-Staubgruppe, Germany;* Kun Wang, *Washington University in St. Louis;* Nathan Robert Williams, *Arizona State University;* Kelsey Young, *Arizona State University;* Gang Yu, *Harvard University;* and Michael R. Zanetti, *Washington University in St. Louis.*

The LPI maintains a highly focused education effort chartered to engage, excite, and educate the public about lunar and planetary science and invests in the development of future generations of scientists. The LPI Career Development Award has been provided from the generous endowments that the LPI has received over the past year from those in the community who are equally committed to the education of students in lunar and planetary science.



Credit: University of Tennessee at Knoxville.

McSween Receives Lawrence Smith Medal

Congratulations to Harry (Hap) Y. McSween Jr., recipient of the 2012 J. Lawrence Smith Medal awarded by the National Academy of Sciences (NAS). McSween, Chancellor's Professor and Distinguished Professor of Science at the University of Tennessee, is being honored for his pioneering studies of the igneous and metamorphic histories of the parent planets of the chondritic and achondritic meteorites, with particular emphasis on his work on the geological history of Mars based on studies of martian meteorites and spacecraft missions to the planet. The medal and prize of $25,000 are awarded every three years for original and meritorious investigations of meteoric bodies. This award was established as a gift from Sarah Julia Smith in memory of her husband and has been presented since 1888. McSween, along with 16 others who have made major contributions to science, were recognized in a ceremony on April 30, during the National Academy of Sciences' 149th annual meeting.

Credit: From *www.hawking.org.uk/gallery.html*.

Hawking Accepts Prestigious NSS Award

The National Space Society (NSS) is pleased to announce Dr. Stephen Hawking as the 14th recipient of the Robert A. Heinlein Memorial Award. The award was presented to Hawking at a special ceremony at the Cooks Branch Conservancy in Montgomery, Texas, on Wednesday, March 28, and was given in recognition of his outstanding and continuing public efforts in support of human space development and settlement.

In the last decade, Hawking has repeatedly and publicly advocated the need to move part of humanity off the Earth in order to avoid the destruction of the human race, either through self-destructive actions such as nuclear war, or natural phenomena such as asteroid collision, or, eventually, the death of our nearest star, the Sun. "I believe that the long-term future of the human race must be in space," says Hawking. "It will be difficult enough to avoid disaster on planet Earth in the next hundred years, let alone the next thousand, or million. The human race shouldn't have all its eggs in one basket, or on one planet. Let's hope we can avoid dropping the basket until we have spread the load."

The Robert A. Heinlein Memorial Award, named after the author widely recognized as the "dean of science fiction writers," honors those individuals who have made significant, lifetime contributions to the creation of a free, spacefaring civilization. Those individuals whose actions have involved personal, social, or financial risk are particularly meritorious. It is one of the highest honors bestowed upon an individual by the National Space Society because the award winner is chosen by vote of all of the Society's members and chapters.

Credit: NASA.

Kouveliotou Receives 2012 Dannie Heineman Prize in Astrophysics

Dr. Chryssa Kouveliotou, an astrophysicist at NASA's Marshall Space Flight Center in Huntsville, Alabama, has been selected as the 2012 recipient of the Dannie Heineman prize in astrophysics, jointly awarded each year by the American Institute of Physics and the American Astronomical Society. The citation for the Heineman prize recognizes Kouveliotou "for her extensive accomplishments and discoveries in the areas of gamma ray bursts and their afterglows, soft gamma ray repeaters, and magnetars. The citation particularly mentions her collaborative efforts and "her effectiveness and insights in using multi-wavelength observations."

The Heineman Prize is named after the late Dannie N. Heineman, a Belgian-American engineer, business executive, and philanthropic sponsor of scientific endeavors. The prize was established in 1979 by the Heineman Foundation for Research, Education, Charitable and Scientific Purposes.

Kouveliotou, a NASA astrophysicist since 2004 and longtime collaborator with the agency's science mission, has been the principal investigator on numerous research projects in the United States and Europe. She is currently a coinvestigator on the Gamma-ray Burst Monitor, an instrument flying aboard the Fermi Gamma-ray Space Telescope; a Swift associated scientist, and a member of a NuSTAR Science Topical Team. Over her career she has worked on multiple missions: the International Sun Earth Explorer-3, the Solar Maximum Mission, and the Burst And Transient Source Experiment (BATSE), which flew on NASA's Compton Gamma-Ray Observatory. Throughout her career, Kouveliotou has made numerous contributions to the fields of astronomy and astrophysics. Her research has expanded scientific understanding of fleeting, transient phenomena in the Milky Way galaxy and throughout the high-energy universe. Besides determining the unique properties of the highly energetic emissions from gamma-ray bursts — the brightest and most powerful events in the universe — she was part of the team that first revealed the extragalactic nature of these sources. She and her team made the first confirmed detection of ultradense neutron stars called magnetars — the cinders of stars left over after a supernova — which have incredibly powerful magnetic fields.

Kouveliotou has received many awards for her work, including the Rossi Prize in 2003, the Descartes Prize in 2004, and the NASA Space Act Award in 2005. She has published 368 papers in refereed journals and has been among the top ten most-cited space science researchers in published journals worldwide.

Gerstenmaier Receives AIAA Von Karman Award

The American Institute for Aeronautics and Astronautics (AIAA) has honored William H. (Bill) Gerstenmaier, associate administrator for the Human Exploration and Operations Mission Directorate, with the Von Karman Lectureship in Astronautics. The award is given annually to someone who has performed notably and distinguished themselves technically in the field of astronautics. Gerstenmaier

Credit: NASA.

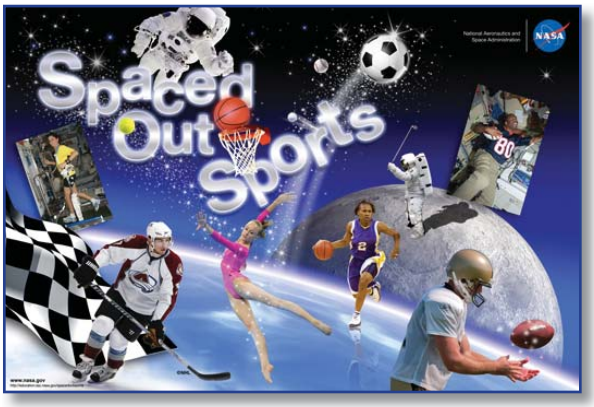
was recognized for his 30 years of accomplishment in human spaceflight, culminating in the leadership of the Space Shuttle and International Space Station Programs.

As part of the award, Gerstenmaier delivered the speech "Global Outpost in Space: A Platform for Discovery — The International Space Station" during the AIAA's 50th Aerospace Sciences Meeting in Nashville, Tennessee. The award is named for Theodore von Karman, an early astronautics pioneer responsible for breakthroughs in understanding supersonic and hypersonic airflow characterization and the value of the swept wing design.

Gerstenmaier began his NASA career in 1977 at the Glenn Research Center in Cleveland performing aeronautical research, after receiving a B.S. aeronautical engineering from Purdue University. In 1988, he became head of the Orbital Maneuvering Vehicle (OMV) Operations Office, Systems Division at the Johnson Space Center. Gerstenmaier also served as Shuttle/Mir Program Operations Manager from 1995 to 1997. In 1998, he became manager of Space Shuttle Program Integration. In December 2000, he was named deputy manager of the International Space Station Program, becoming the associate administrator for space operations in 2005. Currently, he heads the agency's Human Exploration and Operations Mission Directorate.

NASA Announces Student Winners in Space Game Design Challenge

Three school student teams in the fifth through eighth grades have been selected as the winners of NASA's second annual Spaced Out Sports challenge. The students designed science-based games that will be played by astronauts onboard the International Space Station (ISS). The games illustrate and apply Newton's laws of motion by showing the differences between Earth's gravity and the microgravity environment of the space station. The challenge is part of a broader agency education effort to engage students in science, technology, engineering, and mathematics (STEM) activities. To design their game, students use up to five items from a two-page list of objects onboard the ISS. The list includes such items as socks, exercise putty, bungees, cotton swabs, tape, rubber bands, zipper-top bags, chocolate-covered candies, and drink bags.



Students at Pierremont Elementary MOSAICS Academy in Manchester, Missouri, earned the top prize with their game "Starfield." In this activity, astronauts will travel through a course to gather "power stars" and throw them through a "black hole target." Second-place honors went to students at East Brook Middle School in Paramus, New Jersey, for their "Outstanding Obstacles" game. It calls on astronauts to race through obstacles including "hair band shooting" and "ring toss." The third-place winners are students at Tyngsborough Middle School in Tyngsborough, Massachusetts, for their "Learning Takes You Around the World" game, in which astronauts will propel through rings, collecting slips of paper.

The Spaced Out Sports challenge is a NASA Teaching from Space activity and was first offered in 2010. Using an accompanying curriculum, teachers lead students through a study of Newton's laws, highlighted by hands-on activities and video podcasts featuring NASA scientists and engineers explaining how the laws are used in the space program.

For information about Teaching from Space, visit *www.nasa.gov/education/tfs*. For information about NASA's Science and Sports curriculum and related resources, visit *education.ssc.nasa.gov/spacedoutsports*.

NASA Announces 2012 Carl Sagan Fellows

NASA has selected six planet hunters as the recipients of the 2012 Carl Sagan Exoplanet Postdoctoral Fellowships, named after the late astronomer. The fellowship was created to inspire the next generation of explorers seeking to learn more about planets, and possibly life, around other stars. The Sagan Fellowship's primary goal is to support outstanding recent postdoctoral scientists in conducting independent research related to the science goals of NASA's Exoplanet Exploration Program. These fellows will discover and characterize planetary systems and Earth-like planets around other stars, known as exoplanets.

The 2012 Carl Sagan Fellows (left to right, starting with the top row): Christian Schwab, Rebecca Martin, Nikole Lewis, Jean-Michel Desert, Catherine Espaillat, and Sarah Ballard. Credit: NASA/JPL-Caltech.

Previous Sagan Fellows have already contributed significant discoveries in exoplanet exploration. One recent discovery found visual evidence for two exoplanets from NASA's Hubble Space Telescope archives that went undetected from images taken in 1998. The program, created in 2008, awards selected postdoctoral scientists with annual stipends of $65,500 for up to three years, plus an annual research budget of up to $16,000.

The 2012 Sagan Fellows are Sarah Ballard, who will work at the University of Washington, Seattle, to investigate exoplanetary habitability by characterizing parent stars with the smallest potential planet candidates from NASA's Kepler mission; Jean-Michel Desert, who will work at the California Institute of Technology, Pasadena, to explore the atmospheres of planets in multiple planet systems and low-mass planets in the habitable zones of their parent stars; Catherine Espaillat, who will work at the Harvard Smithsonian Center in Cambridge, Massachusetts, to find the youngest extrasolar systems by looking for gaps in dusty disks around the parent stars; Nikole Lewis, who will work at the Massachusetts Institute of Technology, Cambridge, to study the chemistry of exoplanet atmospheres by linking three-dimensional chemical, dynamical, and radiative processes; Rebecca Martin, who will work at the University of Colorado, Boulder, to improve our understanding of the formation and survival of exoplanetary systems; and Christian Schwab, who will work at Yale University, New Haven, Connecticut, to design a new high-precision instrument to detect and characterize Earth-like planets.

A full description of the 2012 fellows and their projects is available at *nexsci.caltech.edu/sagan/2012postdocRecipients.shtml*. More information about the NASA Exoplanet Science Institute is available at *nexsci.caltech.edu*.

NASA Selects Next Class of Student Ambassadors

NASA recently inducted 100 high-performing interns into the 2012 NASA Student Ambassadors Virtual Community. Their selection is part of the agency's effort to engage undergraduate and graduate students in science, engineering, mathematics, and technology (STEM) research and interactive opportunities.

Office of Education Infrastructure Division

NASA Student Ambassador Virtual Community

An Innovative Solution to Support the STEM Workforce of Tomorrow

This fourth group of student ambassadors, known as Cohort IV, includes interns from 34 states and 73 universities. Members of this virtual community will interact with NASA personnel, share information, make vital professional connections, collaborate with peers, represent NASA in a variety of venues, and help inspire and engage future interns. Through the community's website, participants access tools needed to serve as a student ambassador, blog, announcements, member profiles, forums, polls, and career resources.

NASA managers and mentors nominated the recipients from hundreds of current interns and fellows across the agency. NASA's internships are among the most exciting research and educational opportunities available to college students. This online initiative also serves as a vehicle for recognizing outstanding student contributions. The community elevates the visibility and contribution of the ambassadors, providing increased involvement with the agency's exploration and STEM education missions.

For more information about the NASA Student Ambassadors Virtual Community and to see an interactive U.S. map containing the names and schools of the 2012 Cohort IV participants, visit *intern.nasa.gov/intern/*.

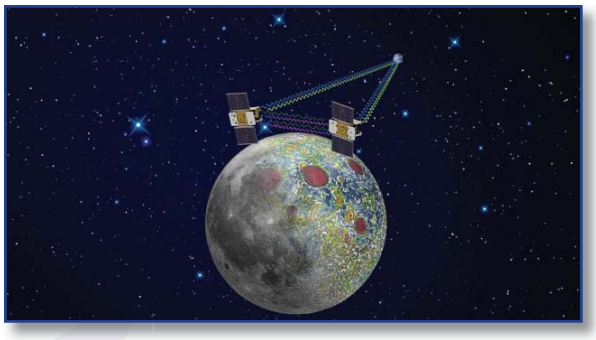
Students who participated in NASA's National Community College and Aerospace Scholars program in 2011 planned simulated Mars rover missions. Credit: NASA/JPL-Caltech.

Community College Scholars Selected to Design Rovers

Community college students will have the chance to design robotic rovers in cooperation with NASA. Ninety-two students from schools in 24 states have been selected to travel to a NASA center, including NASA's Jet Propulsion Laboratory, to develop rovers through the National Community College Aerospace Scholars program. The initiative provides hands-on opportunities to inspire interest in science, technology, engineering, and mathematics (STEM) disciplines.

Students will visit either JPL from May 1 to 3, or NASA's Johnson Space Center in Houston from May 9 to 11. The teams will establish fictional companies pursuing Mars exploration. Each team will develop, design, and build a prototype rover, then use their prototypes to navigate a course, collect rocks and water, and return to a home base. Participants were selected based on completion of interactive web-based assignments throughout the school year. The onsite experience this spring includes a tour of NASA facilities and briefings from agency scientists and engineers.

The program is based on the Texas Aerospace Scholars program, originally created in partnership with NASA and the Texas educational community. Aerospace Scholars programs are designed to encourage students to enter careers in science and engineering and ultimately join the nation's technical workforce. For a complete list of the student participants, their states and the community colleges they represent, visit *go.nasa.gov/nccas*.



Using a precision formation-flying technique, the twin GRAIL spacecraft will map the Moon's gravity field, as depicted in this artist's rendering. Credit: NASA/JPL-Caltech.

Montana Students Pick Winning Names for Moon Craft

Twin NASA spacecraft that achieved orbit around the Moon on New Year's Eve and New Year's Day have new names, thanks to elementary students in Bozeman, Montana. Their winning entry, "Ebb and Flow," was selected as part of a nationwide school contest that began in October 2011. The names were submitted by fourth graders from the Emily Dickinson Elementary School. Nearly 900 classrooms with more than 11,000 students from 45 states, Puerto Rico, and the District of Columbia participated in the contest. Previously named Gravity Recovery And Interior Laboratory, or GRAIL-A and -B, the washing-machine-sized spacecraft began science operations in March, after a launch in September 2011.

"The 28 students of Nina DiMauro's class at the Emily Dickinson Elementary School have really hit the nail on the head," said Maria Zuber, GRAIL principal investigator from the Massachusetts Institute of Technology in Cambridge. "We were really impressed that the students drew their inspiration by researching GRAIL and its goal of measuring gravity. Ebb and Flow truly capture the spirit and excitement of our mission."

Zuber and Sally Ride, America's first woman in space and CEO of Sally Ride Science in San Diego, selected the names following the contest, which attracted 890 proposals via the Internet and mail. The contest invited ideas from students ages 5–18 enrolled in U.S. schools. Although everything from spelling and grammar to creativity was considered, Zuber and Ride primarily took into account the quality of submitted essays.

GRAIL is NASA's first planetary mission carrying instruments fully dedicated to education and public outreach. Each spacecraft carries a small camera called GRAIL MoonKAM (Moon Knowledge Acquired by Middle school students). Thousands of students in grades five through eight will select target areas on the lunar surface and send requests for study to the GRAIL MoonKAM Mission Operations Center in San Diego. The winning prize for the Dickinson students is to choose the first camera images. Dickinson is one of nearly 2000 schools registered for the MoonKAM program, which is led by Ride and her team at Sally Ride Science in collaboration with undergraduate students at the University of California in San Diego.

Launched in September 2011, Ebb and Flow will be placed in a near-polar, near-circular orbit with an altitude of about 34 miles (55 kilometers). During their science mission, the duo will answer longstanding questions about the Moon and give scientists a better understanding of how Earth and other rocky planets in the solar system formed. For more information, visit *https://moonkam.ucsd.edu/*.

Educators Selected to Fly on SOFIA Airborne Observatory

Twenty-six educators from the United States have been selected for research flights onboard NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA). As participants in the Airborne Astronomy Ambassadors program, the educators will partner with professional astronomers using SOFIA for scientific observations in 2012 and 2013. SOFIA is a modified Boeing 747SP jetliner equipped with a 100-inch (2.5-meter) diameter telescope. The observatory enables the analysis of infrared light to study the formation of stars and planets; chemistry of interstellar gases; composition of comets, asteroids, and planets; and supermassive black holes at the center of galaxies.

From left, Terry Herter, principal investigator of FORCAST, and SOFIA staff scientist James De Buizer discuss an infrared image with Airborne Astronomy Ambassadors Theresa Paulsen and Marita Beard. Credit: NASA/SOFIA/N. Veronico.

"The unique design of SOFIA gives educators hands-on experience with world-class astronomical research," said John Gagosian, SOFIA program executive at NASA Headquarters in Washington. "Working with astronomers, educators participate in a research project from beginning to end and integrate that unique perspective with classroom lessons and public outreach programs."

SOFIA's Airborne Astronomy Ambassadors program is a yearly professional development opportunity extended to educators through a competitive, peer-reviewed process. This year's educators are Melvin Gorman and Gordon Serkis, Chinle Junior High School in Chinle, Arizona; Ira Harden and Vincente Washington, City Honors College Preparatory Charter School in Inglewood, California; Clifford Gerstman and Susan Groff, Middle College High School in Santa Ana, California; Mike Cimino, Heritage Middle School, and John Clark, Deltona High School in Deltona, Florida; Randi Brennon, Hawaii Academy of Arts and Sciences in Pahoa, Hawaii; Jo Dodds, Twin Falls Senior High School in Twin Falls, Idaho; Ralph Peterson, North Gem High School in Bancroft, Idaho; Jennifer Carter and Claudett M. Edie, Rowan County Senior High School in Morehead, Kentucky; Chelen Johnson, Breck School in Golden Valley, Minnesota; Matt Oates, Dilworth STEM Academy in Sparks, Nevada; Dan Ruby, Fleischmann Planetarium and Science Center in Reno, Nevada; Ryan Munkwitz and John Walsh, Southampton Intermediate and High School in Southampton, New York; James Johnson, Children's Center for Treatment & Education in Custer City, Pennsylvania; Adriana Alvarez and Mariela Aguirre, Alicia R. Chacon International School in El Paso, Texas; David V. Black, Walden School of Liberal Arts in Provo, Utah; Carolyn Bushman, Wendover Jr./Sr. High School in Wendover, Utah; Sarah Scoles, National Radio Astronomy Observatory, and Anne Smith, Green Bank Middle School in Green Bank, West Virginia; and Constance Gartner, Wisconsin School for the Deaf in Delavan, Wisconsin.

SOFIA is a joint project of NASA and the German Aerospace Center (DLR), and is based and managed at NASA's Dryden Aircraft Operations Facility in Palmdale, California, for NASA's Science Mission Directorate. NASA's Ames Research Center in Moffett Field, California, manages the SOFIA science and mission operations in cooperation with the Universities Space Research Association (USRA) and the German SOFIA Institute (DSI) at the University of Stuttgart. For more information, visit *www.nasa.gov/SOFIA*, *www.sofia.usra.edu*, or *www.dlr.de/en/sofia*.

NASA's Cassini-Huygens mission to Saturn was awarded the 2012 National Air and Space Museum Trophy for Current Achievement. Pictured (from left to right) — Wayne Clough, secretary of the Smithsonian; Robert Mitchell, Cassini program manager; and Gen. Jack Dailey, director of the museum. Credit: Smithsonian National Air and Space Museum.

Cassini Mission Receives Air and Space Museum Award

The Smithsonian's National Air and Space Museum has bestowed its highest group honor, the Trophy for Current Achievement, on NASA's Cassini mission to Saturn. The annual award recognizes outstanding achievements in the fields of aerospace science and technology. Established in 1985, the award has been presented to seven NASA planetary mission teams.

Launched in 1997, the Cassini spacecraft entered Saturn's orbit in June 2004 with the European Space Agency's (ESA) Huygens probe bolted to its side. In December 2004, the spacecraft successfully released Huygens, which entered the atmosphere of Saturn's largest moon, Titan. Cassini completed its

prime mission in 2008 and has been extended twice. It is now in its so-called solstice mission, which will enable scientists to observe seasonal changes in Saturn and its moons during the planet's northern summer solstice. The mission will last through September 2017.

The Cassini spacecraft carries 12 science instruments and investigations, with an additional six onboard Huygens. Cassini mission highlights to date include the discovery of four new moons and two new rings around Saturn. Cassini observed spraying water vapor and icy particle jets from the moon Enceladus. In Saturn's northern hemisphere, the spacecraft watched the evolution of a monster storm, a sign of seasonal change from northern winter into northern spring. Cassini and Huygens has also revealed new characteristics about Titan, the only body in the solar system other than Earth with stable liquid on its surface.

For more information about the mission, visit *www.nasa.gov/cassini*. Images of the award and a Cassini historical video are available at *go.nasa.gov/GH6qbA*. For a full listing of previous awardees, visit *www.nasm.si.edu/research/aero/trophy/nasm.cfm*.

Roger Hunter (left), the Kepler project manager at Ames Research Center, and Jim Fanson (middle), the former project manager for the mission, accepted the 2012 Aviation Week Laureate Award on behalf of the team at a ceremony in Washington. Frank Morring Jr., a senior editor at Aviation Week, is at right. Credit: Courtesy of Aviation Week.

Kepler Mission Wins Aviation Week Award

NASA's Kepler mission has been named the winner of the 2012 Aviation Week Laureate Award in the Space category. Accepting the award on behalf of the Kepler mission team were Roger Hunter, Kepler project manager at NASA's Ames Research Center, Moffett Field, California, and James Fanson, who was the Kepler project manager during mission development at NASA's Jet Propulsion Laboratory in Pasadena, California. Fanson is currently the assistant director for JPL's Optical Systems, Astronomy, Physics and Space Technology Directorate.

Aviation Week's annual Laureate Awards recognize individuals and teams for their extraordinary accomplishments. Their achievements embody the spirit of exploration, innovation, vision, or any combination of these attributes that inspire others to strive for significant, broad-reaching progress in aviation and aerospace. Previous winners in the Space category include the Radar Imaging Commercialization Team; the International Space Station program managers; Elon Musk, co-founder of SpaceX; and Yoshisada Takizawa, Selene project manager, Japan Aerospace Exploration Agency.

Launched on March 6, 2009, the Kepler spacecraft has detected more than 2300 planet candidates and confirmed 61 as planets. The early findings contain more than 200 Earth-sized planet candidates and more than 900 that are smaller than two times the size of Earth. Of the 46 planet candidates found in the habitable zone, the region in the planetary system where liquid water could exist, 10 of these candidates are smaller than twice the size of Earth.

Kepler is a space observatory trailing Earth around the Sun, currently at a distance of more than 30 million miles (48 million kilometers). Kepler's task is to measure the change in brightness of more than 150,000 stars looking for the telltale signature of a planet passing, or transiting, in front of its host star. Three transits are required to verify a signal as a planet. Kepler also recently won the Space Foundation's John L. "Jack" Swigert, Jr., Award for Space Exploration. More information about Kepler is available at *www.nasa.gov/kepler*.

NASA Ames Honored for 2011 NASA Government Invention of the Year

NASA's Ames Research Center, Moffett Field, California, has won the 2011 NASA Government Invention of the Year. Ames received the award for developing Toughened Uni-piece Fibrous Reinforced Oxidation-Resistant Composite (TUFROC), a low-cost, lightweight, two-piece, thermal protection system (TPS) for use on space vehicles during atmospheric reentry at hypersonic speed. TUFROC, a patented technology invented by David A. Stewart and Daniel B. Leiser of Ames, has been successfully demonstrated on the X-37B Reusable Launch Vehicle.

The technology consists of a high-temperature, impregnated carbonaceous cap mechanically attached to a lightweight fibrous silica-base material. The key innovations enable the integration of the surface treated carbon cap with the silica-base insulation, which otherwise would fail from mechanical, chemical, or thermal factors. TUFROC is the first lightweight, low-cost, flight-proven, reusable TPS with sustained operational capabilities at temperatures above 3000°F.

Each NASA field center submits nominations for the awards, which are evaluated by NASA's Inventions and Contributions Board. The board determines which nominations qualify for each category, ranks the nominees, and makes recommendations to the NASA Office of the General Counsel for review and approval.

NASA's Twitter Account Receives Shorty Award

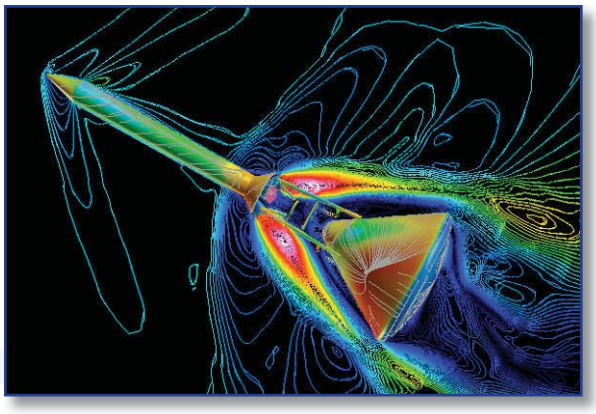
NASA's activities in social media were recognized when the agency's official Twitter feed, @NASA, received a Shorty Award for the best government use of social media. The Shorty Awards honor the best of social media across sites such as Twitter, Facebook, Tumblr, YouTube, Foursquare, and others. NASA's nomination cited multiple aspects of the agency's social-media efforts, including the popular "Angry Birds in Space" game and encouragement of science among young people. The award is NASA's third for social media. The agency won the Shorty Award in 2009 for its use of Twitter for the Mars Phoenix Lander mission, and astronaut Doug Wheelock was awarded the Real Time Photo of the Year in 2011 for his "Moon from Space" picture.

NASA uses many social media sites to communicate its mission to a wide range of followers. The @NASA twitter account has more than 2 million followers, and NASA maintains presences on Facebook, Google+, Flickr, and other popular platforms. NASA Socials, formerly known as NASA Tweetups, allow social media followers to attend functions and interact with NASA's engineers and scientists. To view all of NASA's social media sites, visit *www.nasa.gov/connect*. For more information about the Shorty Awards, visit *shortyawards.com*.

NASA Announces Aeronautics Research Institute

NASA's Ames Research Center will host a virtual institute to solicit and foster innovative ideas that address technological challenges facing aviation and the U.S. air transportation system today and in the future. Jaiwon Shin, NASA's associate administrator for aeronautics research in Washington, and Ames Director S. Pete Worden signed an agreement establishing the NASA Aeronautics Research Institute (NARI).

NARI will be comprised of multi-institutional, multi-disciplinary research teams creating new tools and technologies for reducing air traffic congestion and environmental impacts, improving safety and designing aircraft with unconventional capabilities. One goal of the institute is to stimulate collaboration between technical disciplines and among NASA, academic institutions, and other government and



Computation fluid dynamics study of cone. Credit: NASA.

industry organizations dedicated to aeronautics research. With $10 million per year to distribute for early stage concepts, the institute will complement NASA's existing research programs. As a virtual institute, NARI will facilitate technical exchanges, solicit research proposals, award research grants, and use advanced communication technologies such as web-based seminars to disseminate research findings.

NASA's Aeronautics Research Mission Directorate will provide policy guidance for the institute, including review and approval of implementation plans; review and concurrence for interagency agreements; and compliance with agency requirements. Ames, which also manages similar virtual institutes focused on astrobiology and lunar science, will host NARI in its NASA Research Park and provide staff and infrastructure for the institute.

"We Are The Explorers" Video Showcases Legacy of Exploration, Future NASA Missions

A new video produced by NASA and narrated by actor Peter Cullen of *Transformers* fame celebrates humankind's inherent need to explore through the past, present, and future. "We Are the Explorers" shows how humanity constantly has reached for new heights, broken new boundaries, and taken steps that previously were considered impossible. The video highlights NASA's tradition of exploration, from the Mercury, Gemini, and Apollo programs, to the space shuttle and International Space Station. It looks ahead to vehicles being built now that will take humans farther than they ever have gone, including the new Orion crew vehicle and Space Launch System. "NASA and its missions — historic, present, and future — have the ability to inspire," said NASA Associate Administrator for Human Exploration and Operations Bill Gerstenmaier. "This video celebrates not only the historic steps we have made as an agency, but also the great journeys that await us as we operate the orbiting laboratory that is the International Space Station and build the vehicles necessary to expand human exploration beyond low-Earth orbit."

The video is available to view on a variety of NASA and social media websites. It also can be freely used by teachers and students for educational purposes. To view the video, visit *go.nasa.gov/wearetheexplorers* or *www.youtube.com/watch?v=e7DEw70LVWs*.

The Epic Struggle Between Birds and Pigs Moves to Space with a NASA Science Twist

For nearly three years, millions of gamers have used physics in the battle between birds and pigs in the video game "Angry Birds." In cooperation with NASA, Finland-based Rovio Entertainment,

creator of the Angry Birds franchise, announced its newest game, "Angry Birds Space," on March 8. NASA and Rovio are working together to teach people about physics and space exploration through the internationally successful puzzle game. Game developers have incorporated concepts of human space exploration into the new game. From the weightlessness of space to the gravity wells of nearby planets, players use physics as they explore the various levels of the game set both on planets and in microgravity.

"This collaboration began with a simple Twitter exchange about birds and pigs in space, and it has grown into a tremendous outreach and education opportunity," said David Weaver, Associate Administrator for Communications at NASA Headquarters in Washington. "Games are fun and entertaining, but they also can be inspirational and informative. This ongoing collaboration with Rovio and Angry Birds is an exciting way to get people engaged with NASA's missions of exploration and discovery, and get students energized about future careers in science and technology."

Onboard the International Space Station, Flight Engineer Don Pettit of NASA created a video using Angry Birds Space to explain how physics works in space, including demonstrating trajectories in microgravity by catapulting an Angry Bird through the space station. The video was shown earlier this year to an audience at the South by Southwest Conferences and Festivals, an annual convention of original music, independent films, and emerging technologies in Austin, Texas. For more information about Angry Birds Space, visit *www.angrybirds.com/space*.

NASA Releases First Multi-Player Facebook Game

NASA has launched its first multi-player online game to test players' knowledge of the space program. Who was the first American to walk in space? Who launched the first liquid-fueled rocket? These are only a few of the questions players can answer in Space Race Blastoff. Available on Facebook, Space Race Blastoff tests players' knowledge of NASA history, technology, science, and pop culture. Players who correctly answer questions earn virtual badges depicting NASA astronauts, spacecraft, and celestial objects. Players also earn points they can use to obtain additional badges to complete sets and earn premium badges. NASA chose to make the game available through Facebook to take advantage of the social media site's large audience and enable players to compete against others. Individuals also can play solo games.

Once in the game, players choose an avatar and answer 10 multiple-choice questions. Each correct answer earns 100 points, with a 20-point bonus to the player who answers first. The winner advances to the bonus round to answer one additional question for more points. Correctly answering the bonus question earns the player a badge.

Space Race Blastoff was developed by Scott Hanger, Todd Powell, and Jamie Noguchi of NASA's Internet Services Group in the Office of Communications. Play the game now at *apps.facebook.com/spacerace*.

BOOKS

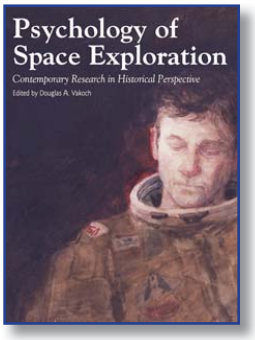
A More Perfect Heaven: How Copernicus Revolutionized the Cosmos.

By Dava Sobel. Walker & Company, 2011. 288 pp., Hardcover, $25.00. *www.walkerbooks.com*

By 1514, the reclusive cleric Nicolaus Copernicus had written and hand-copied an initial outline of his heliocentric theory — in which he defied common sense and received wisdom to place the Sun, not Earth, at the center of our universe, and set Earth spinning among the other planets. Over the next two decades, Copernicus expanded his theory through hundreds of observations, while compiling in secret a book-length manuscript that tantalized mathematicians and scientists throughout Europe. For fear of ridicule, he refused to publish. In 1539, a young German mathematician, Georg Joachim Rheticus, drawn by rumors of a revolution to rival the religious upheaval of Martin Luther's Reformation, traveled to Poland to seek out Copernicus. Two years later, the Protestant youth took leave of his aging Catholic mentor and arranged to have Copernicus's manuscript published, in 1543, as *De revolutionibus orbium coelestium (On the Revolutions of the Celestial Spheres)* — the book that forever changed humankind's place in the universe. In her elegant, compelling style, Sobel chronicles, as nobody has, the conflicting personalities and extraordinary discoveries that shaped the Copernican Revolution. At the heart of the book is her play *And the Sun Stood Still*, imagining Rheticus's struggle to convince Copernicus to let his manuscript see the light of day. As she achieved with her bestsellers *Longitude* and *Galileo's Daughter,* Sobel expands the bounds of narration, giving us an unforgettable portrait of scientific achievement, and of the ever-present tensions between science and faith.

Psychology of Space Exploration: Contemporary Research in Historical Perspective.

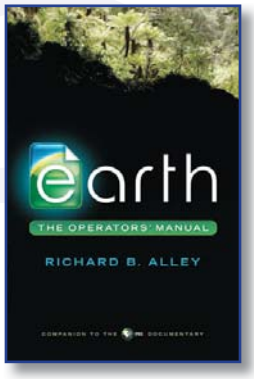
Edited by Douglas Vakoch. NASA, 2011, 264 pp., Paperback, $27.00. *bookstore.gpo.gov*



Through essays on topics including survival in extreme environments and the multicultural dimensions of exploration, readers will gain an understanding of the psychological challenges that have faced the space program since its earliest days. An engaging read for those interested in space, history, and psychology alike, this is a highly relevant read as we stand poised on the edge of a new era of spaceflight. Each essay also explicitly addresses the history of the psychology of space exploration.

Earth: The Operator's Manual.

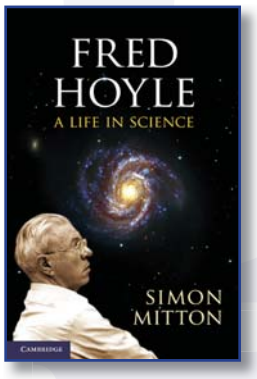
By Richard Alley. W. W. Norton & Company, 2011. 479 pp., Hardcover, $27.95. *books.wwnorton.com*



The book, companion to a PBS series, shows that humans are causing global warming and offers a path to the future. Since the discovery of fire, humans have been energy users and always will be. And this is a good thing — our mastery of energy is what separates us from the rest of the animal kingdom and has allowed us to be the dominant species on the planet. However, this mastery comes with a price: We are changing our environment in a profoundly negative way by heating it up. Using one engaging story after another, coupled with accessible scientific facts, world authority Alley explores the fascinating history of energy use by humans over the centuries, gives a doubt-destroying proof that already-high levels of carbon dioxide are causing damaging global warming, and surveys the alternative energy options that are available to exploit right now. These new energy sources might well be the engines for economic growth in the twenty-first century.

Fred Hoyle: A Life in Science.

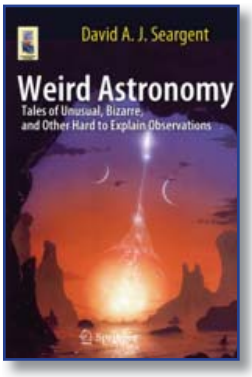
By Simon Mitton. Cambridge University Press, 2011. 384 pp., Paperback, $36.99. *www.cambridge.org*



The scientific life of Fred Hoyle (1915–2001) was truly unparalleled. During his career he wrote groundbreaking scientific papers and caused bitter disputes in the scientific community with his revolutionary theories. Hoyle is best known for showing that we are all, literally, made of stardust in his paper explaining how carbon, and then all the heavier elements, were created by nuclear reactions inside stars. However, he constantly courted controversy and two years later he followed this with his "steady state" theory of the universe. This challenged another model of the universe, which Hoyle called the "big bang" theory. Hoyle was also famous among the general public. He popularized his research through radio and television broadcasts and wrote best-selling novels. Written from personal accounts and interviews with Hoyle's contemporaries, this book gives valuable personal insights into Hoyle and his unforgettable life.

Weird Astronomy: Tales of the Unusual, Bizarre and Other Hard to Explain Observations.

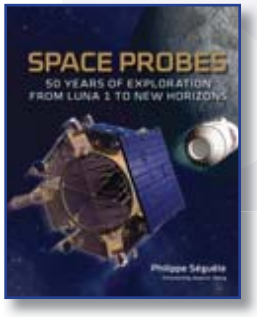
By David Seargent. Springer, 2011. 304 pp., Paperback, $39.95. *www.springer.com*



You go out for a night's observing and look up at the sky. There are all the usual suspects — a splattering of stars, the Moon, Venus, maybe Mercury and Mars. Perhaps you can identify some of the constellations. If you are using binoculars or a small telescope, you can see many wonders not revealed to the naked eye but still well known to telescope users for centuries. But what if you look up and see something completely new, something unexplainable? Do your eyes deceive you? Are you really seeing what you think you are seeing? What should you do? In this fascinating account of the many oddball things people — from novice astronomers to certified experts — have observed over the years, you will be introduced to a number of unusual — and sometimes still unexplainable — phenomena occurring in our usually familiar and reassuring skies. What exactly did they see? What discoveries followed these unusual sightings? What remains unexplained? In addition to the accounts, you will find scattered throughout the book a number of suggested astronomy projects that you can do yourself. The projects range from very basic to a bit more challenging, but all are fun and all are very instructive about unusual sightings. Be sure to try them!

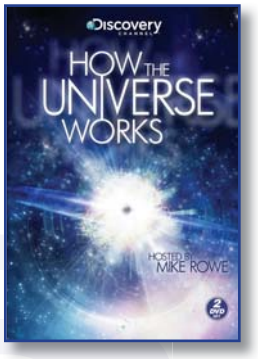
Space Probes: 50 Years of Exploration from Luna 1 to New Horizons.

By Philippe Séguéla. Firefly Books, 2011. 376 pp., Hardcover, $49.95. *www.fireflybooks.com*



Space Probes is the first complete and fully illustrated history of the international space exploration program. Thoroughly up to date, it is organized by destination and includes every space probe launched by all countries active in space exploration — the United States, the USSR/Russia, the European Union, Japan, China, and India. Each probe is described as to its objective, its technology, the hurdles overcome, the successes and failures of the mission, the information gained, and the lessons learned. Fascinating photographs and technical drawings give an inside view of each mission, and special features focus on key engineers and physicists and the fruits of their research. The book also includes sections on the Apollo Space Program, the USSR–USA space race, and a cross-referenced chronological index of all the probes. Engaging and accessible, *Space Probes* is a comprehensive and expertly researched encyclopedia of humanity's space explorations, an adventure that has not finished astonishing us.

DVD



How the Universe Works.

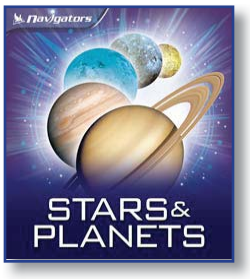
Produced by Discovery Channel, 2011, $19.95. *store.discovery.com*

How the Universe Works will give you a front-row seat to the inner workings of our world. See how stars were engineered, how deadly black holes can be, and get the scoop on the big bang theory. Watch as scientists discuss all that is alien, extreme plants, and immense explosions also known as supernovas. This DVD is a must-have for anyone interested in the science of the universe and all that it encompasses. This eight-hour program is on two discs and is hosted by Mike Rowe from the Dirty Jobs television series.

FOR KIDS!!!

Stars & Planets.

By Mike Goldsmith. Kingfisher, 2011. 48 pp., Paperback, $8.99. *us.macmillan.com*



This intergalactic travelogue takes space lovers where they have never gone before. They visit Mars, disappear inside a black hole, dodge asteroids, and speculate on the future of human endeavors in space, all without leaving their chairs. With links to the best space-related information on the Internet, this book is — you guessed it — a blast! For ages 9–12.

LEGO® Space Moon Buggy.

LEGO®. 37 pieces, $4.99. *shop.lego.com*

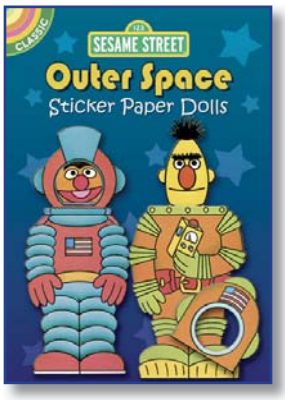
Rock and rove on the Moon! Explore the lunar landscape with this super six-wheeler that was made for the Moon. Activate the digging tool to collect rock samples. Report your findings back to the space station on Earth with the satellite dish. This set includes an astronaut in spacesuit, digging tool, and satellite dish. Space Moon Buggy measures over two inches wide and three inches tall. For ages 5–12.

Space Walk "Easy-Up" Wall Mural.

Available from the Space Store. 32" × 52" mural with removable adhesive tabs, $139.95. *www.thespacestore.com*

Who wouldn't want this stunning image of an astronaut doing a spacewalk with the Earth in the background? Easy-Up Wall Murals are printed on high quality eco-friendly material and install in minutes with removable adhesive tabs. They can be removed and reinstalled, and no tools or trimming required. Safe on walls, removes in minutes, great for a bedroom or family room. Note that this mural is typically produced when ordered, so please allow one to three weeks for order.

Sesame Street Classic Outer Space Sticker Paper Dolls.
Dover Publications, 2011. 4 pp., Paperback, $2.00. *store.doverpublications.com*



Bert and Ernie are preparing for their greatest adventure ever — exploring the galaxy! With this fun little book, you can help the best friends dress for their trip to the stars. There are stickers of three different space suits, a pair of robot costumes, and a slimy green monster. Since the stickers are reusable, you can dress up Bert and Ernie again, and again, and again. A Dover original, for ages 3 and up.

The *Lunar and Planetary Information Bulletin* collects, synthesizes, and disseminates current research and findings in the planetary sciences to the research community, science libraries, educators, students, and the public. The *Bulletin* is dedicated to engaging, exciting, and educating those with a passion for the space sciences while developing future generations of explorers.

The *Bulletin* welcomes articles dealing with issues related to planetary science and exploration. Of special interest are articles describing web-based research and educational tools, meeting highlights and summaries, and descriptions of space missions. Peer-reviewed research articles, however, are not appropriate for publication in the *Bulletin*. 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 (*rdotson@hou.usra.edu*)

Copy deadline for the next issue: July 15, 2012

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*, or visit *www.lpi.usra.edu/publications/newsletters/lpib/subscribe/index.cfm*.

The *Bulletin* is published quarterly by the Lunar and Planetary Institute (LPI), 3600 Bay Area Boulevard, Houston TX 77058. Material in this issue may be copied without restraint for library, abstract service, education, or personal research purposes.

ISSN 1534-6587

The LPI is operated by the Universities Space Research Association under a cooperative agreement with the Science Mission Directorate of the National Aeronautics and Space Administration. Any opinions, findings, and conclusions or recommendations expressed in this issue are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration.

Calendar 2012

May

2–3 **Exploration Telerobotics Symposium,** Greenbelt, Maryland. *http://telerobotics.gsfc.nasa.gov/*

6–10 **43rd Annual Meeting of the American Astronomical Society Division on Dynamical Astronomy,** Mount Hood, Oregon. *http://dda.harvard.edu/*

8–11 **Revealing Evolution of Protoplanetary Disks in the ALMA Era,** Kyoto, Japan. *http://www.kusastro.kyoto-u.ac.jp/kyoto_disk/*

15–17 **Mars Recent Climate Change Workshop,** Moffett Field, California. *http://spacescience.arc.nasa.gov/mars-climate-workshop-2011/*

16–20 **Asteroids, Comets, Meteors (ACM) 2012,** Niigata, Japan. *http://chiron.mtk.nao.ac.jp/ACM2012/*

20–25 **Japan Geoscience Union Meeting (JpGU) 2012,** Chiba City, Japan. *http://www.jpgu.org/meeting_e*

21–22 **Workshop on Extraterrestrial Life: Beyond Our Expectations?,** Vienna, Austria. *http://www.univie.ac.at/EPH/exolife/fileadmin/template/exolife/docs/workshop_final.pdf*

21–25 **Third Conference on Early Mars: Geologic, Hydrologic, and Climatic Evolution and the Implications for Life,** Lake Tahoe, Nevada. *http://www.lpi.usra.edu/meetings/earlymars2012/*

22–24 **IAF/AIAA Global Space Exploration Conference,** Washington, DC. *http://www.glex2012.org/index.html*

23–25 **NRC Committee on Astrobiology and Planetary Science,** Washington, DC. *http://sites.nationalacademies.org/SSB/SSB_067577*

27–Jun 3 **Planetary Origins and Frontiers of Exploration,** The Weizmann Institute of Science, Israel. *http://www.weizmann.ac.il/conferences/frontiers/*

31–Jun 1 **The 46th Canadian Meteorological and Oceanograpgic Society Congress,** Montreal, Canada. *http://www.cmos.ca/congress2012*

June

3–6 **Transiting Planets in the House of the Sun: A Workshop on M Dwarf Stars and Their Planets,** Maui, Hawaii. *http://www.soest.hawaii.edu/GG/FACULTY/GAIDOS/haleakala.html*

4–6 **Moving Forward in Space,** Philadelphia, Pennsylvania. *https://sites.google.com/a/temple.edu/forward-in-space/home*

4–7 **Joint Space Resources Roundtable (SRR) and Planetary & Terrestrial Mining Sciences Symposium (PTMSS) Meeting,** Golden, Colorado. *http://www.isruinfo.com*

4–8 **Multiwavelength Surveys: A Vintage Decade,** Hunter Valley, Australia. *http://www.atnf.csiro.au/research/conferences/2012/SCCSV/index.html*

5–7 **Mars — Connecting Planetary Scientists in Europe,** Budapest, Hungary. *http://www.konkoly.hu/MPSE/*

6–8 **Dust, Atmosphere and Plasma Environment of the Moon and Small Bodies (DAP-2012),** Boulder, Colorado. *http://ldap2012.colorado.edu/*

10–15 **The Origins of Stars and Planetary Systems,** Hamilton, Canada. *http://origins.physics.mcmaster.ca/oi_planets/*

12–13 **Ices and Organics in the Inner Solar System Conference,** Los Angeles, California. *http://planets.ucla.edu/?p=3726*

12–14 **Concepts and Approaches for Mars Exploration,** Houston, Texas. *http://www.lpi.usra.edu/meetings/marsconcepts2012/*

12–15 **Third International Planetary Dunes Workshop,** Flagstaff, Arizona. *http://www.lpi.usra.edu/meetings/dunes2012/*

16–17 **9th International Planetary Probe Short Course (IPPW-9),** Toulouse, France. *http://www.planetaryprobe.eu/*

18–21 **Ultraviolet Astronomy: HST and Beyond,** Kauai, Hawaii. *http://uvastro2012.colorado.edu/*

18–22 **Volcano-Ice Interations on Earth and Other Planets Conference III,** Fairbanks, Alaska. *http://volcanoes.dickinson.edu/iavcei_iacs_viic/events2012.html#june*

18–22 **2012 NASA Planetary Science Summer School,** Pasadena, California. *http://pscischool.jpl.nasa.gov*

18–22 **International Planetary Probe Workshop IPPW-9,** Toulouse, France. *http://www.planetaryprobe.eu*

24–29 **Goldschmidt 2012: Earth in Evolution,** Montreal, Canada. *http://www.vmgoldschmidt.org/2012/index.htm*

24–29 **CPS 9th International School of Planetary Sciences: Across the Earth Into Exoplanets,** Kobe, Japan. *https://www.cps-jp.org/~pschool/pub/2012-06-24/index.html*

24–29 **Cool Stars 17,** Barcelona, Spain. *http://www.coolstars17.net/welcome.html*

25–28 **Comparative Climatology of Terrestrial Planets,** Boulder, Colorado. *http://www.lpi.usra.edu/meetings/climatology2012/*

25–29 **Planetary Data: A Workshop for Users and Software Developers,** Flagstaff, Arizona. *http://astrogeology.usgs.gov/groups/Planetary-Data-Workshop*

25–29 **ESLAB Symposium on Formation and Evolution of Moons,** Noordwijk, The Netherlands. *http://www.sciops.esa.int/index.php?project=CONF2011&page=MOONS*

26–28 **1st Annual International Space Station (ISS) Research and Development and Conference,** Denver, Colorado. *http://www.astronautical.org/node/96*

July

1–6 **SPIE Astronomical and Instrumentation,** Amsterdam, The Netherlands. *http://spie.org/x13662.xml*

2–15 **Nordic-NASA Summer School "Water, Ice and the Origin of Life in the Universe,"** Reykjavik, Iceland. *http://www.nordicastrobiology.net/Iceland2012/*

10–12 **NASA Small Bodies Assessment Group Meeting #7,** Pasadena, California. *http://www.lpi.usra.edu/sbag/*

13–15 **Second Conference on the Lunar Highlands Crust,** Bozeman, Montana. *http://www.lpi.usra.edu/meetings/lunarhighlands2012/*

14–15 **LunarGradCon2012,** Moffett Field, California. *http://lasp.colorado.edu/ccldas/lgc2012*

14–22 **39th COSPAR Scientific Assembly,** Mysore, India. *http://www.cospar-assembly.org/*

16–20 **Characterizing and Modeling Extrasolar Planetary Atmospheres — Theory and Observation,** Heidelberg, Germany. *http://www.mpia-hd.mpg.de/exoplanets2012*

17–19 **NASA Lunar Science Forum,** Moffett Field, California. *http://lunarscience.nasa.gov/LSF2012*

23–27 **2012 Sagan Summer Workshop: Working with Exoplanet Light Curves,** Pasadena, California. *http://nexsci.caltech.edu/workshop/2012/*

August

4–8 **Communicating Science: A National Conference on Science Education and Public Outreach,** Tucson, Arizona. *http://www.astrosociety.org/events/meeting.html*

6–10 **Fifth Cosmic Dust Meeting,** Kobe, Japan. *https://www.cps-jp.org/~dust/*

12–17 **75th Annual Meeting of the Meteoritical Society,** Cairns, Australia. *http://shrimp.anu.edu.au:16080/metsoc2012/Welcome.html*

13–17 **AOGS-AGU (WPGM) Joint Assembly,** Sentosa Island, Singapore. *http://www.asiaoceania.org/aogs2012/public.asp?page=home.htm*

20–31 **IAU XXVIII General Assembly,** Beijing, China. *http://www.astronomy2012.org*

27–29 **Double-Diffusive Systems,** Santa Cruz, California. *http://dd2012.soe.ucsc.edu*

27–31 **IAG/AIG International Conference on Geomorphology,** Paris, France. *http://www.geomorphology-iag-paris2013.com/en*

27–31 **Instabilities and Structures in Proto-Planetary Disks,** Marseille, France. *http://wiki.oamp.fr/ispp/IsppWorkShop*

27–31 **Formation, Detection, and Characterization of Extrasolar Habitable Planets,** Beijing, China. *http://www.iau.org/science/meetings/future/symposia/1030/*

September

3–7 **ESO@50 — The First 50 Years of ESO,** Garching, Germany. *http://www.eso.org/sci/meetings/2012/ESOat50.html*

3–7 **Planet Formation and Evolution 2012,** Munich, Germany. *http://www.usm.uni-muenchen.de/people/preibisch/planets2012/index.html*

4–7 **GALEX Fest: Exploring the UV Universe,** Pasadena, California. *http://www.galex.caltech.edu/galexfest/*

10–12 **The Mantle of Mars: Insights from Theory, Geophysics, High-Pressure Studies, and Meteorites,** Houston, Texas. *http://www.lpi.usra.edu/meetings/marsmantle2012/*

10–12 **World Congress and Expo on Biowaivers and Biosimilars,** San Antonio, Texas. *http://www.omicsonline.org/biosimilars2012/*

10–12 **1970–2010: The Golden Age of Solar System Exploration,** Rome, Italy. *http://goldenage2012.ifac.cnr.it/index.php/goldenage2012/goldenage2012*

19–21 **Third Planetary Crater Consortium Meeting,** Flagstaff, Arizona. *http://www.PlanetaryCraterConsortium.nau.edu*

23–28 **European Planetary Science Congress 2012,** Madrid, Spain. *http://www.epsc2012.eu/*

25–28 **Searching for Life Signatures,** San Marino, Italy. *http://luth7.obspm.fr/Life-Signatures-25-28-Sep2012.pdf*