

*The*  
**Trouble**  
*with* **Titan**

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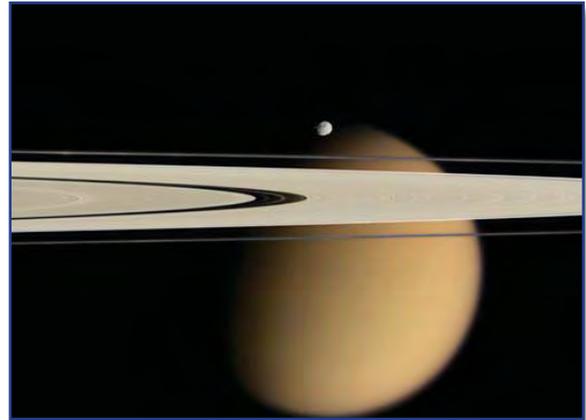
— Paul Schenk, *Lunar and Planetary Institute*

Ever since a methane-rich atmosphere on Titan was confirmed in the 1940s, this large planet-sized moon has been the subject of speculation. Being considerably further from the Sun, it has not held quite the same fascination as Mars. Very little real information was at hand for decades, but its organic-rich surface may hold secrets equally important to our understanding of the origin and development of life. Voyager defined the nature of this body — its size, atmospheric density, and bulk composition — but the surface remained unseen below the orange photochemical haze. The true global exploration of Titan began with arrival of Cassini in 2004, which has been mapping the giant moon in slices ever since.

Despite six years of mapping, the moon seems more complex with each new day. With Cassini we have discovered the basic geography of Titan. Equatorial regions feature broad rugged hills hundreds of meters high, separated by vast “seas” of dark linear dunes probably composed of organic sands. The poles look karst-like and feature lake and sea beds. In the north these are filled with dark liquids, most likely methane and ethane. Temperate latitudes are deeply eroded by vast channel systems, and it is clear that most of the surface is scarred by its interaction with the atmosphere.

Countless river channels and polar lake beds were formed by methane and/or ethane rain, linear dunes by equatorial winds. Brilliant reflections off these lakes demonstrate for the first time that the lake beds are actually wet. Polar clouds are consistent with rainfall in those areas, but we also see deep channels across most of the equatorial regions as well. Perhaps Cassini will see weather patterns change over the next seven years of its extended mission. The small number of impact craters also demonstrates the pervasive erosive power of the atmosphere.

Now, a greater debate has erupted over whether volcanos are responsible for all the methane on Titan. Even though it is nine times further away from the Sun, all the methane should be destroyed by sunlight in a million years. Are volcanos belching methane gas from inside? Is there a vast underground reservoir of methane leaking into the atmosphere? Cassini’s radar maps reveal many flow-like features, but with so much erosion occurring, the resolution of the maps (350 meters at best) is not enough to tell whether they are lava or debris flows. Many of these flow features resemble erosional debris fans seen on Earth’s semi-arid deserts. As of today, no true undeniable volcano has been discovered on Titan. If true, then perhaps Titan is simply “Callisto with weather,” as



The fuzzy tennis ball of Titan’s atmosphere stands in stark contrast to the thin Saturn ring system and the lumpy icy inner moons of Saturn, in this case, Epimetheus. Credit: NASA/JPL/Space Science Institute.



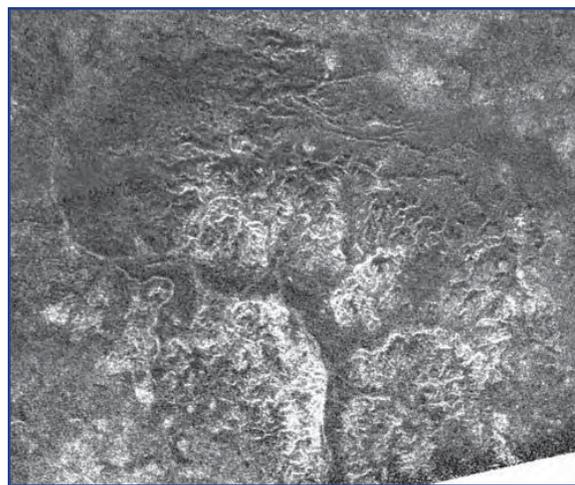
An oblique view of the surface of Titan from the Huygens descent probe, January 2005. These are among the highest-resolution views we have and show the dense drainage patterns formed by methane rainfall and groundwater erosion. This might be any view over tropical wetlands on Earth, except for the lack of deep vegetation. Credit: NASA/JPL.

## Titan continued . . .

suggested by Dr. Jeffrey Moore of NASA's Ames Research Center. On the other hand, perhaps the polar methane lakes and seas are part of a global methane aquifer system that has also been suggested.

As any planetary scientist will tell you, if the surface doesn't tell you what's going on, look inside. Repeat radar coverage suggests that the surface has shifted several kilometers over time. If this is true, it may indicate that there is a liquid water layer under the surface. There are hints in the data of a conductive signal in the electromagnetic field of Titan. Such a signal gave the first direct detection of an ocean under Europa's surface, but here Cassini cannot get much closer than about 1350 kilometers because of the extended atmosphere, and therefore the signals are not very strong.

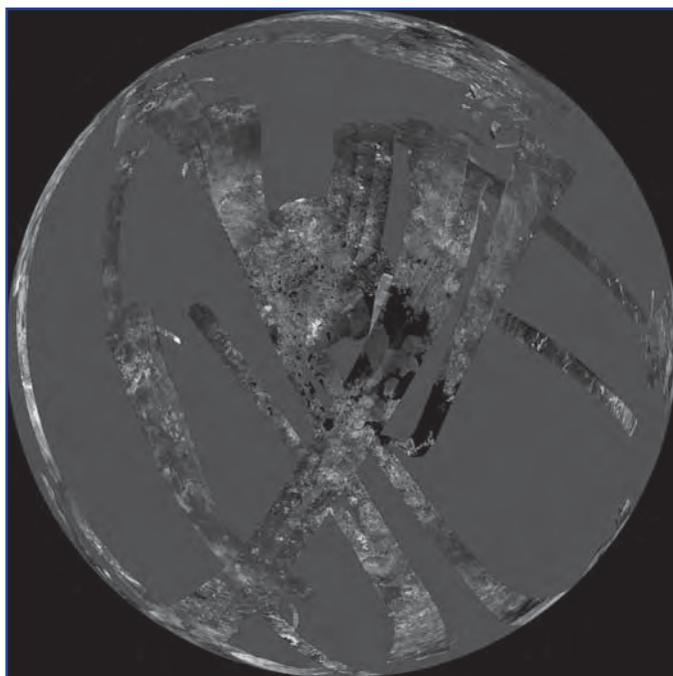
In addition, it turns out that the shape of Titan is a bit "squashed." A team led by Howard Zebker of Stanford University now reports that the poles are about 700 meters lower than the equator. Perhaps the polar seas are merely groundwater, or ground methane, in local surface depressions. Mapping of the gravity field, however, tells us a different story. Gravitational parameter scans tell us how mass is distributed inside a planet. Cassini's distance restriction is such that it has taken years to gather enough gravity data, but at last we know that Titan looks surprisingly similar to Callisto on the inside. This means that unlike Ganymede's iron core and icy mantle, the interior of Titan is largely unmixed, without a dense core, according to the



**Radar image of channels and eroded terrains near Titan's south pole. Smallest features are roughly 500 meters across. Credit: NASA/JPL.**

results reported by Luciano Iess of the Università La Sapienza in Rome and colleagues. The only way this can happen is if Titan has remained relatively cold. This would seem to put an end to the volcano debate, but if we believe that we understand giant icy satellites, we might just be fooling ourselves. The gravity results still support the idea that Titan has a subsurface liquid ocean that is slowly evolving from the deep interior, with methane bubbling up through an icy crust and replenishing the atmosphere.

Whatever the source, Titan's methane is the catalyst for a rich organic chemistry that rains down on the surface. Titan may be the most Earth-like of extraterrestrial bodies that we know of, depending on how the comparison with Mars is made. Mars is dry and the rivers have been silent for eons. Titan is wet and its rivers may be flowing even today, although those rivers flow with methane and ethane, not water. All the water is locked, frozen solid as the bedrock on which the rivers course.



**Current Cassini radar mosaic of the northern hemisphere of Titan. The dark lakes clustered at the north pole are apparently filled with liquid methane, not water! The largest of these lakes is about the size of Lake Superior.**

**T**he atmosphere and surface are awash with hydrocarbons, perhaps even saturated with it if the Huygens probe results are any indication. That is why Titan is viewed as a harbinger of some of the things that may have been happening on Earth in its earliest days. It is certainly true that the surface is probably an ongoing organic chemistry experiment, and many of the reactions necessary to promote the development of living organisms are occurring. Heavy organic molecules like benzene and anthracene are considerably more abundant than expected. This has led to intense speculation, including the possibility of methane-based (rather than water-based) life occurring on Titan today. Now a new report is reputed to make such a claim. As often happens in storytelling, the punch line gets rewritten a little bit each time.

**A**re there methane-generating “bugs” on Titan? Hydrogen-eating organisms that give off methane as a byproduct are known on Earth. If present on Titan, we would not need volcanos to explain the methane lakes and rain and ground aquifers that seem to extend across the globe. They would also have the (predicted) effect of depleting or “eating” hydrogen and probably acetylene and ethane, and a few other things as well, when active. Now, reports that these compounds are less abundant than predicted for ordinary nonbiological photochemistry has the science community and those who follow the latest developments abuzz with excitement.

**I**t is important to note that while acetylene depletion on Titan may be real, the hydrogen result is actually only a computer model. This type of finding requires observational confirmation, hopefully by Cassini itself in the coming few years. It is also true that the chemistry of Titan’s atmosphere is very complex and not at all well understood yet, even under normal circumstances. A nonbiological explanation is equally plausible at this point. In any case, the debate will go a long way toward improving our understanding of organic chemistry on Titan and perhaps Earth as well, regardless of the answer.

**S**ome of the pieces are starting to fall in place on Titan, but until more are locked in we could find ourselves down an exciting but false path. Cassini has a long way to go to find the answers. Fortunately, we have seven more years of Titan exploration ahead of us in the current mission plan, although it is quite likely that we will be left with a set of key unanswered questions about its geologic structure, evolution, and organic chemistry. That’s the trouble with Titan . . . there are too many fascinating questions.



Sunlight glints off the liquid surface of Kraken Mare in this distant backlit view of Titan, taken by Cassini in 2010. Credit: NASA/JPL/University of Arizona/DLR.

## NASA's Airborne Infrared Observatory Sees the "First Light"

The Stratospheric Observatory for Infrared Astronomy (SOFIA), a joint program by NASA and the German Aerospace Center, achieved a major milestone May 26, with its first in-flight night observations. "With this flight, SOFIA begins a 20-year journey that will enable a wide variety of astronomical science observations not possible from other Earth and space-borne observatories," said Jon Morse, Astrophysics Division director in the Science Mission Directorate at NASA Headquarters in Washington. "It clearly sets expectations that SOFIA will provide us with 'Great Observatory'-class astronomical science."

The highly modified SOFIA Boeing 747SP jetliner fitted with a 100-inch diameter reflecting telescope took off from its home base at the Aircraft Operations Facility of NASA's Dryden Flight Research Center. The inflight personnel consisted of an international crew from NASA, the Universities Space Research Association, Cornell University, and the German SOFIA Institute (DSI) in Stuttgart.

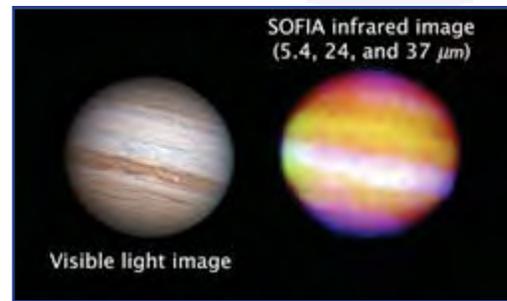
The stability and precise pointing of the German-built telescope met or exceeded the expectations of the engineers and astronomers who put it through its paces during the flight. "The crowning accomplishment of the night came when scientists onboard SOFIA recorded images of Jupiter," said USRA SOFIA senior science advisor Eric Becklin. "The composite image from SOFIA shows heat, trapped since the formation of the planet, pouring out of Jupiter's interior through holes in its clouds."

The highly sensitive Faint Object infraRed CAmera for the SOFIA Telescope (FORCAST) used for these initial observations was operated in flight by its builders, a team led by Cornell's Terry Herter. FORCAST captures in minutes images that would require many hour-long exposures by groundbased observatories blocked from a clear infrared view by water vapor in Earth's atmosphere. SOFIA's operational altitude, which is above more than 99% of that water vapor, allows it to receive 80% or more of the infrared light accessible to space observatories.

For more information about SOFIA, visit [www.nasa.gov/sofia](http://www.nasa.gov/sofia). For more about SOFIA's science mission, visit [www.sofia.usra.edu](http://www.sofia.usra.edu).

This still from the recently released animation shows asteroids observed so far by WISE. As WISE scans the sky from its polar orbit, more and more

asteroids and comets are caught in its infrared vision. The mission has surveyed about three-fourths of the sky; however, data for only about 50% of the sky has been processed for asteroids and comets at this time. Credit: NASA/JPL-Caltech/ULCA/JHU.



Infrared image of Jupiter from SOFIA's first-light flight composed of individual images at wavelengths of 5.4  $\mu\text{m}$  (blue), 24  $\mu\text{m}$  (green,) and 37  $\mu\text{m}$  (red) made by Cornell University's FORCAST camera. A recent visual-wavelength picture of approximately the same side of Jupiter is shown for comparison. The white stripe in the infrared image is a region of relatively transparent clouds through which the warm interior of Jupiter can be seen. Credit: Visual — A. Wesley; Infrared — NASA/USRA/L-3 Communications Integrated Systems.

## WISE Makes Progress on its Space Rock Catalog

NASA's Wide-field Infrared Survey Explorer (WISE) is busy surveying the landscape of the infrared sky, building up a catalog of cosmic specimens — everything from distant galaxies to "failed" stars, called brown dwarfs. Closer to home, the mission is picking out an impressive collection of asteroids and comets, some known and some never seen before. Most of these hang out in the main belt between Mars and Jupiter,

but a small number are near-Earth objects — asteroids and comets with orbits that pass within about 48 million kilometers (30 million miles) of Earth’s orbit. By studying a small sample of near-Earth objects, WISE will learn more about the population as a whole. How do their sizes differ, and how many objects are dark versus light? “We are taking a census of a small sample of near-Earth objects to get a better idea of how they vary,” said Amy Mainzer, the principal investigator of NEOWISE, a program to catalog asteroids seen with WISE.

So far, the mission has observed more than 60,000 asteroids, both main belt and near-Earth objects. Most were known before, but more than 11,000 are new. About 190 near-Earth asteroids have been observed to date, of which more than 50 are new discoveries. All asteroid observations are reported to the NASA-funded International Astronomical Union’s Minor Planet Center, a clearinghouse for data on all solar system bodies at the Smithsonian Astrophysical Observatory.

A network of groundbased telescopes follows up and confirms the WISE finds, including the NASA-funded University of Arizona Spacewatch and Catalina Sky Survey projects, both near Tucson, Arizona, and the NASA-funded Magdalena Ridge Observatory near Socorro, New Mexico. Some of the near-Earth asteroids detected so far are visibly dark, but it’s too early to say what percentage. The team needs time to properly analyze and calibrate the data. When results are ready, they will be published in a peer-reviewed journal. WISE has not found an asteroid yet that would be too dark for detection by visible-light telescopes on the ground.

WISE will also study Trojans, asteroids that run along with Jupiter in its orbit around the Sun and travel in two packs — one in front of and one behind the gas giant. It has seen more than 800, and by the end of the mission, should have observed about half of all 4500 known Trojans. The results will address dueling theories about how the outer planets evolved.

With its infrared vision, WISE is good at many aspects of asteroid watching. First, infrared light gives a better estimate of an asteroid’s size. Imagine a light, shiny rock lying next to a bigger, dark one in the sunshine. From far away, the rocks might look about the same size. That’s because they reflect about the same amount of visible sunlight. But, if you pointed an infrared camera at them, you could tell the dark one is bigger. Infrared light is related to the heat radiated from the rock itself, which, in turn, is related to its size. A second benefit of infrared is the ability to see darker asteroids. Some asteroids are blacker than coal and barely reflect any visible light. WISE can see their infrared glow. The mission isn’t necessarily hunting down dark asteroids in hiding, but collecting a sample of all different types. WISE has also bagged about a dozen new comets to date. The icy cousins to asteroids are easy for the telescope to spot because, as the comets are warmed by the Sun, gas and dust particles blow off and glow with infrared light.

More information is available at [www.nasa.gov/wise](http://www.nasa.gov/wise) and [wise.astro.ucla.edu](http://wise.astro.ucla.edu).

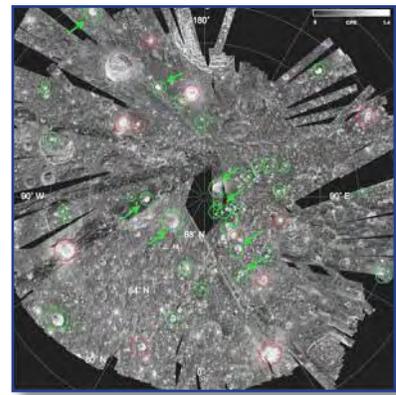
## **NASA Radar Finds Ice Deposits at Moon’s North Pole; Additional Evidence of Water Activity on Moon**

Using data from a NASA radar that flew onboard India’s Chandrayaan-1 spacecraft, scientists have detected ice deposits near the Moon’s north pole. NASA’s Mini-SAR instrument, a lightweight, synthetic aperture radar, found more than 40 small craters with water ice. The craters range in size from 1 to 9 miles (2 to 15 kilometers) in diameter. Although the total amount of ice depends on its thickness in each crater, it’s estimated there could be at least 1.3 million pounds (600 million metric tons) of water ice. “The emerging picture from the multiple measurements and resulting data of the instruments on lunar missions indicates that water creation, migration, deposition, and retention are occurring on the Moon,” said Paul Spudis, principal investigator of the Mini-SAR experiment at the Lunar and Planetary Institute. “The new discoveries show the Moon is an even more interesting and attractive scientific, exploration, and operational destination than people had previously thought.”

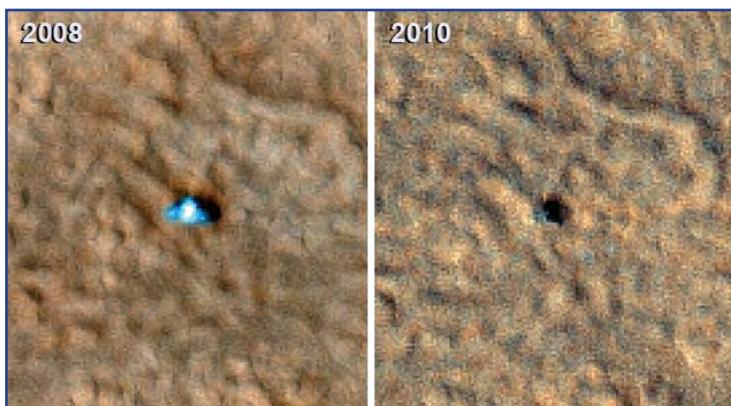
During the past year, the Mini-SAR mapped the Moon's permanently-shadowed polar craters that aren't visible from Earth. The radar uses the polarization properties of reflected radio waves to characterize surface properties. Results from the mapping showed deposits having radar characteristics similar to ice. "After analyzing the data, our science team determined a strong indication of water ice, a finding which will give future missions a new target to further explore and exploit," said Jason Crusan, program executive for the Mini-RF Program for NASA's Space Operations Mission Directorate in Washington.

The results are consistent with recent findings of other NASA instruments and add to the growing scientific understanding of the multiple forms of water found on the Moon. The agency's Moon Mineralogy Mapper discovered water molecules in the Moon's polar regions, while water vapor was detected by NASA's Lunar Crater Observation and Sensing Satellite (LCROSS).

For more information, visit [www.nasa.gov/mini-rf](http://www.nasa.gov/mini-rf), [m3.jpl.nasa.gov](http://m3.jpl.nasa.gov), [www.nasa.gov/lcross](http://www.nasa.gov/lcross), and [www.isro.org/Chandrayaan](http://www.isro.org/Chandrayaan).



**Mini-SAR map of the circular polarization ratio of the north pole of the Moon. The amount of water in these features is estimated to be more than 600 million cubic meters (1 cubic meter = 1 metric ton). Credit: NASA.**



**Two images of the Phoenix Mars lander taken from martian orbit in 2008 and 2010. The 2008 lander image (left) shows two relatively blue spots on either side corresponding to the spacecraft's clean circular solar panels. In the 2010 (right) image scientists see a dark shadow that could be the lander body and eastern solar panel, but no shadow from the western solar panel. Credit: NASA/JPL-Caltech/University of Arizona.**

## Phoenix Mars Lander Does Not Phone Home, New Image Shows Damage

NASA's Phoenix Mars Lander has ended operations after repeated attempts to contact the spacecraft were unsuccessful. A new image transmitted by NASA's Mars Reconnaissance Orbiter shows signs of severe ice damage to the lander's solar panels. "The Phoenix spacecraft succeeded in its investigations and exceeded its planned lifetime," said Fuk Li, manager of the Mars Exploration Program at NASA's Jet Propulsion Laboratory. "Although its work is finished, analysis of information

from Phoenix's science activities will continue for some time to come."

In late May, NASA's Mars Odyssey orbiter flew over the Phoenix landing site 61 times during a final attempt to communicate with the lander. No transmission from the lander was detected. Phoenix also did not communicate during 150 flights in three earlier listening campaigns this year. Earth-based research continues on discoveries Phoenix made during summer conditions at the far-northern site where it landed May 25, 2008. The solar-powered lander completed its three-month mission and kept working until sunlight waned two months later.

Phoenix was not designed to survive the dark, cold, icy winter. However, the slim possibility Phoenix survived could not be eliminated without listening for the lander after abundant sunshine returned. An

image of Phoenix taken in May by the High Resolution Imaging Science Experiment (HiRISE) camera onboard the Mars Reconnaissance Orbiter suggests the lander no longer casts shadows the way it did during its working lifetime. “Before and after images are dramatically different,” said Michael Mellon of the University of Colorado in Boulder, a science team member for both Phoenix and HiRISE. “The lander looks smaller, and only a portion of the difference can be explained by accumulation of dust on the lander, which makes its surfaces less distinguishable from surrounding ground.” It was anticipated that the weight of a carbon dioxide ice buildup could bend or break the lander’s solar panels. Mellon calculated hundreds of pounds of ice probably coated the lander in midwinter.

During its mission, Phoenix confirmed and examined patches of the widespread deposits of underground water ice detected by Odyssey and identified a mineral called calcium carbonate that suggested occasional presence of thawed water. The lander also found soil chemistry with significant implications for life and observed falling snow. The mission’s biggest surprise was the discovery of perchlorate, an oxidizing chemical on Earth that is food for some microbes and potentially toxic for others.

The perchlorate results are shaping subsequent astrobiology research, as scientists investigate the implications of its antifreeze properties and potential use as an energy source by microbes. Discovery of the ice in the uppermost soil by Odyssey pointed the way for Phoenix. More recently, the Mars Reconnaissance Orbiter detected numerous ice deposits in middle latitudes at greater depth using radar and exposed on the surface by fresh impact craters. “Ice-rich environments are an even bigger part of the planet than we thought,” Smith said. “Somewhere in that vast region there are going to be places that are more habitable than others.”

For more information, visit [www.nasa.gov/phoenix](http://www.nasa.gov/phoenix).

## Geometry Drives Selection Date for 2011 Mars Launch

Continuing analysis of the geometry and communications options for the arrival at Mars have led planners for the Mars Science Laboratory, or Curiosity, to choose an Earth-to-Mars trajectory that schedules launch between November 25 and December 18, 2011. Landing will take place between August 6 and August 20, 2012. Due to an Earth-Mars planetary alignment, this launch period actually allows for a Mars arrival in the earlier portion of the landing dates under consideration.

“The key factor was a choice between different strategies for sending communications during the critical moments before and during touchdown,” said Michael Watkins, mission manager at the Jet Propulsion Laboratory (JPL). “The shorter trajectory is optimal for keeping both orbiters in view of Curiosity all the way to touchdown on the surface of Mars. The longer trajectory allows direct communication to Earth all the way to touchdown.”

The simplicity of direct-to-Earth communication from Curiosity during landing has appeal to mission planners, in comparison to relying on communications relayed via NASA’s Mars Odyssey, which has been orbiting Mars since 2001, and NASA’s Mars Reconnaissance Orbiter, in operation since 2006. However, the direct-to-Earth option allows a communication rate equivalent to only about 1 bit per second, while the relay option allows about 8000 bits or more per second.



**This artist's concept from an animation depicts Curiosity, the rover to be launched in 2011 by NASA's Mars Science Laboratory, as it is being lowered by the mission's rocket-powered descent stage during a critical moment of the "sky crane" landing in 2012. Credit: NASA/JPL-Caltech.**

Landing on Mars is always difficult, with success uncertain. After an unsuccessful attempted Mars landing in 1999 without definitive information on the cause of the mishap, NASA put a high priority on communication during subsequent Mars landings.

Curiosity will use several innovations during entry into the martian atmosphere, descent, and landing in order to hit a relatively small target area on the surface and set down a rover too heavy for the cushioning air bags used in earlier Mars rover landings. In a “sky-crane” maneuver during the final minute of arrival, a rocket-powered descent stage will lower Curiosity on a tether for a wheels-down landing directly onto the surface. Even though Curiosity won’t be communicating directly with Earth at touchdown, data about the landing will reach Earth promptly. Odyssey will be in view of both Earth and Curiosity, in position to immediately forward to Earth the data stream it is receiving during the touchdown. Odyssey performed this type of “bent-pipe” relay during the May 25, 2008, arrival of NASA’s Phoenix Mars Lander.

Curiosity will rove extensively on Mars, carrying an analytical laboratory and other instruments to examine a carefully selected landing area. It will investigate whether conditions there have favored development of microbial life and its preservation in the rock record. Plans call for the mission to operate on Mars for a full martian year, which is equivalent to two Earth years.

More information about the Mars Science Laboratory is available at [www.nasa.gov/msl](http://www.nasa.gov/msl).

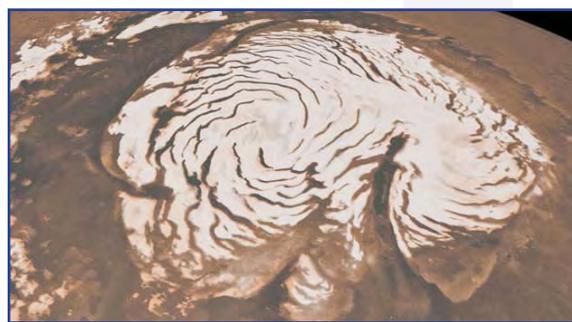
## NASA Spacecraft Penetrates Mysteries of Martian Ice Cap

Data from NASA’s Mars Reconnaissance Orbiter have helped scientists solve a pair of mysteries dating back four decades and provided new information about climate change on the Red Planet. The Shallow Radar (SHARAD) instrument onboard the Mars Reconnaissance Orbiter revealed subsurface geology allowing scientists to reconstruct the formation of a large chasm and a series of spiral troughs on the northern ice cap of Mars.

“SHARAD is giving us a beautifully detailed view of ice deposits, whether at the poles or buried in mid-latitudes, as they changed on Mars over the last few million years,” said Richard Zurek, Mars Reconnaissance Orbiter project scientist at the Jet Propulsion Laboratory.

One of the most distinctive features of the northern ice cap is Chasma Boreale, a canyon about as long as Earth’s Grand Canyon but deeper and wider. Some scientists believe Chasma Boreale was created when volcanic heat melted the bottom of the ice sheet and triggered a catastrophic flood. Others suggest strong polar winds carved the canyon out of a dome of ice. Other enigmatic features of the ice cap are troughs that spiral outward from the center like a gigantic pinwheel. Since the troughs were discovered in 1972, scientists have proposed several hypotheses about how they formed. Data from Mars now points to both the canyon and spiral troughs being created and shaped primarily by wind. Rather than being cut into existing ice very recently, the features formed over millions of years as the ice sheet grew. By influencing wind patterns, the shape of underlying, older ice controlled where and how the features grew.

The Mars Reconnaissance Orbiter was launched on August 12, 2005. SHARAD and the spacecraft’s five other instruments began science operations in November 2006. To view images and learn more about MRO, visit [www.nasa.gov/mro](http://www.nasa.gov/mro).



This image, combining data from two instruments onboard the Mars Global Surveyor, depicts an orbital view of the north polar region of Mars. Credit: NASA/JPL-Caltech/MSSS.



**Lengthy detective work with data Mars Exploration Rover Spirit collected in late 2005 has confirmed that an outcrop called “Comanche” contains a mineral indicating that a past environment was wet and nonacidic, possibly favorable to life. Credit: NASA/JPL-Caltech/Cornell University.**

## Rover Finds Clue to Mars’ Past and Environment for Life

Rocks examined by NASA’s Spirit Mars Rover hold evidence of a wet, nonacidic ancient environment that may have been favorable for life. Confirming this mineral clue took four years of analysis by several scientists. An outcrop that Spirit examined in late 2005 revealed high concentrations of carbonate, which originates in wet, near-neutral conditions, but dissolves in acid.

NASA’s rovers have found other evidence of formerly wet martian environments. However, the data for those environments indicate conditions that may have been acidic. In other cases, the conditions were definitely acidic, and therefore less favorable as habitats for life. Laboratory tests helped confirm the carbonate identification.

“This is one of the most significant findings by the rovers,” said Steve Squyres of Cornell University. Squyres

is principal investigator for the Mars twin rovers, Spirit and Opportunity, “A substantial carbonate deposit in a Mars outcrop tells us that conditions that could have been quite favorable for life were present at one time in that place.”

Spirit inspected rock outcrops, including one scientists called Comanche, along the rover’s route from the top of Husband Hill to the vicinity of the Home Plate plateau, which Spirit has studied since 2006. Magnesium iron carbonate makes up about one-fourth of the measured volume in Comanche. That is a tenfold higher concentration than any previously identified for carbonate in a martian rock. Massive carbonate deposits on Mars have been sought for years without much success. Numerous channels apparently carved by flows of liquid water on ancient Mars suggest the planet was formerly warmer, thanks to greenhouse warming from a thicker atmosphere than exists now. The ancient, dense martian atmosphere was probably rich in carbon dioxide, because that gas makes up nearly all the modern, very thin atmosphere.

It is important to determine where most of the carbon dioxide went. Some theorize it departed to space. Others hypothesize that it left the atmosphere by the mixing of carbon dioxide with water under conditions that led to forming carbonate minerals. That possibility, plus finding small amounts of carbonate in meteorites that originated from Mars, led to expectations in the 1990s that carbonate would be abundant on Mars. However, mineral-mapping spectrometers on orbiters since then have found evidence of localized carbonate deposits in only one area, plus small amounts distributed globally in martian dust.

The rovers landed on Mars in January 2004 for missions originally planned to last three months. Spirit has been out of communication since March 22 and is in a low-power hibernation status during martian winter. Opportunity is making steady progress toward a large crater, Endeavour, which is about seven miles away.

For more information, visit [www.nasa.gov/rovers](http://www.nasa.gov/rovers).

## Mars Spacecraft Snaps Photos Chosen by Public

The most powerful camera onboard a NASA spacecraft orbiting Mars has returned the first pictures of locations on the Red Planet suggested by the public. The High Resolution Imaging Science Experiment (HiRISE) camera, onboard NASA's Mars Reconnaissance Orbiter, is nicknamed, "the people's camera." Through a program called HiWish that began in January, scientists have received approximately 1000 suggestions. The first eight images of areas the public selected are available online at [www.nasa.gov/mission\\_pages/MRO/multimedia/images20100331.html](http://www.nasa.gov/mission_pages/MRO/multimedia/images20100331.html).

"NASA's Mars program is a prime example of what we call participatory exploration," NASA Administrator Charles Bolden said. "To allow the public to aim a camera at a specific site on a distant world is an invaluable teaching tool that can help educate and inspire our youth to pursue careers in science, technology, engineering, and math." Since 2006, HiRISE has obtained approximately 13,000 observations covering dozens of square miles, including areas from a student-suggestion program called NASA Quest. However, only about 1% of the martian surface has been photographed.

NASA has provided other opportunities for the public to see and explore Mars. A camera on NASA's Mars Global Surveyor imaged 1086 targets suggested through a public-request program from 2003 until 2006. Launched on November 7, 1996, the probe pioneered the use of aerobraking at Mars and mapped the surface. The original one-year mission was extended four times until November 2006. Another camera onboard NASA's Mars Odyssey orbiter has taken nearly 500 images after receiving approximately 1400 suggestions through a public-request program initiated in 2009. HiRISE is one of six instruments on the Mars Reconnaissance Orbiter. The mission is in an extended science phase, and the spacecraft will continue to take several thousand images a year. The mission has returned more data about Mars than all other spacecraft to the Red Planet combined.

"What we hope is that people become more interested in science and appreciate this opportunity to explore another world," said Alfred McEwen, principal investigator for the camera at the University of Arizona in Tucson. "We appreciate fresh thinking outside the box and look for things we may not have chosen otherwise. It's good to have a lot of eyes on Mars."

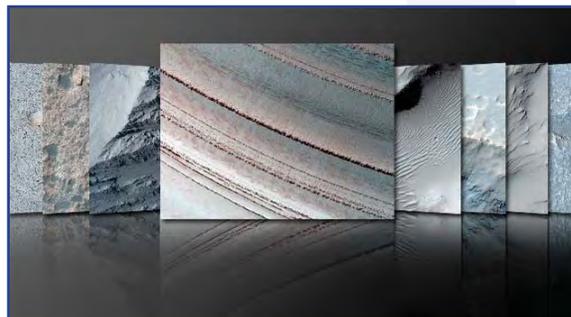
To see more images from HiRISE, visit [hirise.lpl.arizona.edu](http://hirise.lpl.arizona.edu).

## Hayabusa Capsule Recovered Intact

A Japanese space capsule that may contain asteroid dust was recovered from the Australian Outback on June 14, hours after its parent craft ended a seven-year mission in a spectacular fireball. The capsule, along with its mother ship, visited a near-Earth asteroid, Itokawa, five years ago and has logged about 2 billion kilometers (1.25 billion miles) since its launch in May 2003.

With the return of the Hayabusa capsule, which occurred at Australia's remote Woomera Test Range in South Australia, the Japanese Aerospace Exploration Agency (JAXA) has concluded a remarkable mission of exploration — one in which NASA scientists and engineers have played a contributing role.

"Hayabusa is the first space mission to have made physical contact with an asteroid and returned to Earth," said Tommy Thompson, NASA's Hayabusa project manager from the Jet Propulsion Laboratory.



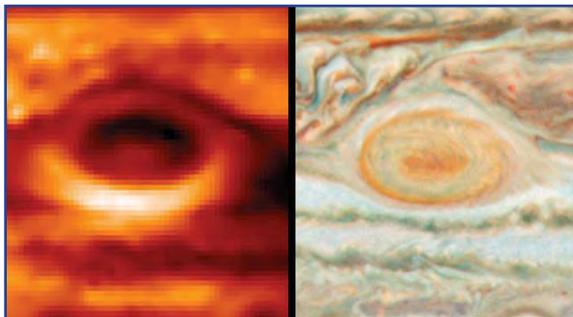
**A composite of the first images of martian sites suggested by the public as part of a participatory exploration program with NASA's Mars Reconnaissance Orbiter. Credit: NASA/JPL-Caltech/University of Arizona.**

“The mission and its team have faced and overcome several challenges over the past seven years. This round-trip journey is a significant space achievement and one which NASA is proud to be part of.”

The 510-kilogram (950-pound) Hayabusa spacecraft rendezvoused with asteroid Itokawa in September 2005. Over the next two-and-a-half months, the spacecraft made up-close and personal scientific observations of the asteroid’s shape, terrain, surface altitude distribution, mineral composition, gravity, and the way it reflected the Sun’s rays. On November 25 of that year, Hayabusa briefly touched down on the surface of Itokawa. That was only the second time in history a spacecraft descended to the surface of an asteroid (NASA’s Near Earth Asteroid Rendezvous-Shoemaker spacecraft landed on asteroid Eros on February 12, 2001). Hayabusa marked the first attempt to sample asteroid surface material. Whether the capsule actually contains any asteroid dust will not be determined until it is opened inside an ultraclean laboratory in Japan later this month.



The Hayabusa capsule has been recovered following its landing in the Australian Outback. Scientists hope the samples contained in the capsule will give them new insights into the make-up of asteroids and help them better understand the early history of the solar system, which formed more than 4.5 billion years ago. Credit: JAXA.



New thermal images from powerful groundbased telescopes show swirls of warmer air and cooler regions never seen before within Jupiter’s Great Red Spot. Credit: NASA/JPL/ESO and NASA/ESA/GSFC.

### See Spot on Jupiter. See Spot Glow.

New thermal images from powerful groundbased telescopes show swirls of warmer air and cooler regions never seen before within Jupiter’s Great Red Spot, enabling scientists to make the first detailed interior weather map of the giant storm system. The observations reveal that the reddest color of the Great Red Spot corresponds to a warm core within the otherwise cold storm system, and images show dark lanes at the edge of the storm where gases are descending into the deeper regions of the planet. These types of data, detailed in a paper published journal *Icarus*, give scientists a sense of the circulation patterns within the solar system’s best-known storm system.

“This is our first detailed look inside the biggest storm of the solar system,” said Glenn Orton, a senior research scientist at NASA’s Jet Propulsion Laboratory (JPL), one of the authors of the paper. “We once thought the Great Red Spot was a plain old oval without much structure, but these new results show that it is, in fact, extremely complicated.” Sky gazers have been observing the Great Red Spot in one form or another for hundreds of years, with continuous observations of its current shape dating back to the nineteenth century. The spot, which is a cold region averaging about 110 K (–260°F), is so wide about three Earths could fit inside its boundaries.

The thermal images obtained by giant 8-meter (26-foot) telescopes used for this study — the European Southern Observatory’s Very Large Telescope in Chile, the Gemini Observatory telescope in Chile, and the National Astronomical Observatory of Japan’s Subaru telescope in Hawaii — have provided an unprecedented level of resolution and extended the coverage provided by NASA’s Galileo spacecraft in the late 1990s. Together with observations of the deep cloud structure by the 3-meter (10-foot) NASA Infrared Telescope Facility in Hawaii, the level of thermal detail observed from these giant observatories is comparable to visible-light images from NASA’s Hubble Space Telescope for the first time.

“One of the most intriguing findings shows the most intense orange-red central part of the spot is about 3 to 4 K (5° to 7°F) warmer than the environment around it,” said Leigh Fletcher, the lead author of the paper, who completed much of the research as a postdoctoral fellow at JPL and is currently a fellow at the University of Oxford in England. “This temperature differential might not seem like a lot, but it is enough to allow the storm circulation, usually counterclockwise, to shift to a weak clockwise circulation in the very middle of the storm. Not only that, but on other parts of Jupiter, the temperature change is enough to alter wind velocities and affect cloud patterns in the belts and zones.”

“This is the first time we can say that there’s an intimate link between environmental conditions — temperature, winds, pressure, and composition — and the actual color of the Great Red Spot,” Fletcher said. “Although we can speculate, we still don’t know for sure which chemicals or processes are causing that deep red color, but we do know now that it is related to changes in the environmental conditions right in the heart of the storm.” Unlocking the secrets of Jupiter’s giant storm systems will be one of the targets for infrared spacecraft observations from future missions, including NASA’s Juno mission.

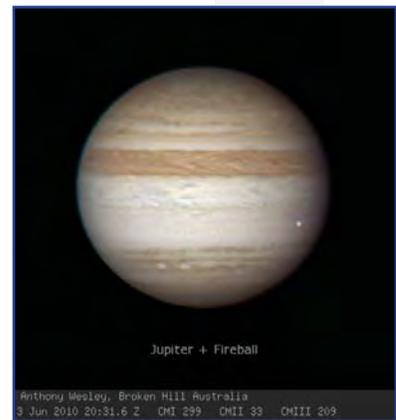
For more information, visit [juno.wisc.edu](http://juno.wisc.edu), [www.naoj.org](http://www.naoj.org), and [www.eso.org/public/science](http://www.eso.org/public/science).

## New Impact on Jupiter

Amateur astronomers play a key but often unheralded role on planetary studies, largely because they can get time at telescopes much easier than professionals. The discovery of a new spot on Jupiter in July last year was a case in point (see previous article). On June 3, Anthony Wesley in Australia, the discoverer of that spot, and Christopher Go in the Philippines independently discovered yet another impact event in Jupiter’s cloud decks.

This fireball at the time of impact is easily seen in the videos from both sites, even though it lasted only a few seconds. Now the dark spot is evident, indicating the object broke up too high in the atmosphere to excavate deep into the cloud deck. Apparently Voyager saw a fireball or two in its long-exposure images in 1979, but this is a first for Earth-bound observers. If these events are as frequent as they now seem, a long-term video surveillance program of Jupiter might just shed some light on the current impact rates in the Jupiter system.

For more information, visit [www.astronomy.com/asy/default.aspx?c=a&id=9918](http://www.astronomy.com/asy/default.aspx?c=a&id=9918).



Color image of impact on Jupiter on June 3, 2010. Credit: Anthony Wesley.

## Cassini and Amateurs Chase Storm on Saturn

With the help of amateur astronomers, the composite infrared spectrometer instrument onboard NASA’s Cassini spacecraft has taken its first look at a massive blizzard in Saturn’s atmosphere. The instrument collected the most detailed data to date of temperatures and gas distribution in that planet’s storms. The data showed a large, turbulent storm, dredging up loads of material from the deep atmosphere and covering an area at least five times larger than the biggest blizzard in this year’s Washington, DC-area storm front nicknamed “Snowmageddon.”

“We were so excited to get a heads-up from the amateurs,” said Gordon Bjoraker, a composite infrared spectrometer team member based at NASA’s Goddard Space Flight Center in Greenbelt, Maryland. Normally, he said, “Data from the storm cell would have been averaged out.”

Cassini’s radio and plasma wave instrument and imaging cameras have been tracking thunder and



Amateur astronomer Christopher Go took this image of Saturn's storm on March 13, 2010. The arrow indicates the location of the storm and the red outlines show where Cassini's composite infrared spectrometer gathered data. Credit: C. Go and NASA/JPL-Caltech/GSFC.

lightning storms on Saturn for years in a band around Saturn's midlatitudes nicknamed "storm alley." But storms can come and go on a timescale of weeks, while Cassini's imaging and spectrometer observations have to be locked in place months in advance. The radio and plasma wave instrument regularly picks up electrostatic discharges associated with the storms, so team members have been sending periodic tips to amateur astronomers, who can quickly go to their backyard telescopes and try to see the bright convective storm clouds. Amateur astronomers, including Anthony Wesley, Trevor Barry, and Christopher Go, received one of those notices in February and were able to take dozens of pictures over the next several weeks.

In late March, Wesley, an amateur astronomer from Australia who was actually the first person to detect the new dark spot caused by an impact on Jupiter last summer, sent Cassini scientists an e-mail with a picture of the storm. "I wanted to be sure that images like these were being seen by the Cassini team just in case this was something of interest to be imaged directly by Cassini or the Hubble Space Telescope," Wesley wrote.

Cassini scientists eagerly pored through the images, including a picture of the storm at its peak on March 13 by Go, who lives in the Philippines. By a stroke of luck, the composite infrared spectrometer happened to be targeting the latitude of the storms. The instrument's scientists knew there could be storms there, but didn't know when they might be active.

Data obtained by the spectrometer on March 25 and 26 showed larger than expected amounts of phosphine, a gas typically found in Saturn's deep atmosphere and an indicator that powerful currents were dredging material upward into the upper troposphere. The spectrometer data also showed another signature of the storm: the tropopause, the dividing line between the serene stratosphere and the lower, churning troposphere, was about 0.5 Kelvin (1°F) colder in the storm cell than in neighboring areas.

"A balloonist floating about 100 kilometers down from the bottom of Saturn's calm stratosphere would experience an ammonia-ice blizzard with the intensity of Snowmageddon," said Brigette Hesman, a composite infrared spectrometer team member who is an assistant research scientist at the University of Maryland. "These blizzards appear to be powered by violent storms deeper down — perhaps another 100 to 200 kilometers down — where lightning has been observed and the clouds are made of water and ammonia."

For more information, visit [www.nasa.gov/cassini](http://www.nasa.gov/cassini).

## PBS Show Investigates Artwork on the Moon

On June 7, PBS enlisted *History Detectives* fans across the nation to solve a 40-year-old mystery: "Who is John F.?" — and did he really help send Andy Warhol's art to the Moon? *History Detectives* posted "Moon Museum" online, two weeks before the segment was scheduled to air in the June 21 broadcast premiere. The producers of the PBS series, a summertime favorite, released the story prior to the season launch in the hopes that online viewers would produce evidence to answer this question.

In "Moon Museum," *History Detectives* reveals the story of how six major artists — Andy Warhol, Claes Oldenburg, Robert Rauschenberg, David Novros, John Chamberlain, and Forrest Myers — all contributed drawings that were then reduced onto a tiny ceramic "mini-canvas," which NASA may have unwittingly smuggled to the Moon onboard the Apollo 12 lunar landing mission in November 1969.

## News from Space *continued . . .*

*History Detectives* delves into the story and narrows the focus to “John F.,” allegedly an elusive Grumman engineer believed to be responsible for sneaking the artwork onboard the Apollo 12 mission by clandestinely affixing it to one of the legs on the lunar module.

For this intriguing investigation, series host and historian Gwendolyn Wright interviews several of the individuals close to these historic events, including retired Apollo 12 astronaut Captain Alan Bean. The story begins with Jade Dellinger, the Florida art curator who purchased a cryptic piece of art in an online auction and contacted *History Detectives* to trace the story behind it. Most revealing is the story of Richard Kupczyk, the Grumman launch pad foreman for the Apollo 12 mission, who speaks out for the first time in 40 years and candidly reveals how, at no risk to the mission, some employees stowed various personal items and objects not approved by NASA onto the lunar module before launch.

Key to the story is an interview with renowned artist Forrest “Frosty” Myers, who created the “Moon Museum” and contributed a drawing. Myers relates to *History Detectives* how Bell Laboratories scientist Fred Waldhauer reduced the artists’ sketches and imprinted them onto the ceramic wafer using the state-of-the-art technology of the time. Now deceased, Waldhauer is the man who knew a Grumman Aircraft engineer willing and able to place the artwork onto the lunar module.

While a select group of elite artists and some of their fans knew of the plan to send art to the Moon, only John F. can confirm whether the mission was accomplished. At the time, he promised to send a telegram to signal his success, and *History Detectives* uncovers that compelling piece of evidence in the segment: the original, cryptic telegram sent to Myers from Cape Canaveral on the date of the 1969 launch, which simply reads, “You’re on. A-OK. All systems are go,” and signed “John F.”

The real identity of John F. remains a mystery, however. Kupczyk suggests it may be a pseudonym to protect the engineer’s real identity; he imagines the name was chosen as a nod to John F. Kennedy, the man who championed the space program.

**PBS’ *History Detectives* investigates whether artwork by Andy Warhol, Claes Oldenburg, Robert Rauschenberg, and other major artists is on the Moon, and releases a special online video asking for help in locating the elusive Grumman engineer “John F.,” who purportedly smuggled the “Moon Museum” onboard Apollo 12 in November 1969. Pictured here is an identical ceramic mini-canvas, which sparked the story after Tampa, Florida, curator Jade Dellinger purchased the curious piece in an online auction. Credit: Jade Dellinger.**



## Next-Generation Suborbital Researchers Conference

February 18–20, 2010, Boulder, Colorado

A new generation of space vehicles capable of economically delivering payloads and researchers is coming online in 2010 and 2011. These vehicles will revolutionize space access by providing frequent, low-cost access to space and the capability to carry research and education crew members. They will also carry experiments for technology demonstrations, for scientist in-the-loop research, and for educational/public outreach demonstrations. Fields including atmospheric science, solar physics, microgravity science, planetary science, space life science, space physics, and education and public outreach stand to benefit from these vehicles.

In anticipation of this groundbreaking suite of opportunities, the Suborbital Applications Researchers Group, chaired by Dr. Alan Stern, hosted the Next-Generation Suborbital Researchers Conference (NSRC) in Boulder, Colorado. Bringing together over 250 participants from academia, research, industry, and government, NSRC 2010 provided a forum for people from many disciplines to meet together and present, collaborate, and discuss the many possibilities provided by suborbital spaceflight.

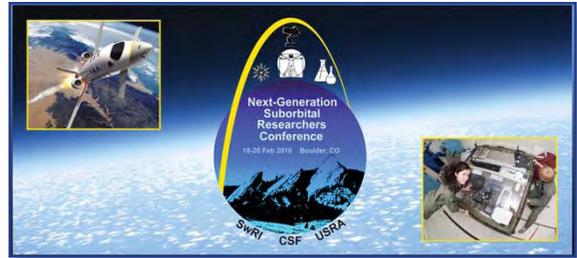
Specifically, NSRC 2010 accomplished the following objectives:

- educated a broad array of research communities to the opportunities that the new wave of human suborbital vehicles offer for research and education missions (REM);
- provided a forum for this broad array of researchers to voice their questions, feedback, and ideas about REM applications and REM user requirements;
- demonstrated strong interest by working researchers and education/public outreach representatives to NASA, the National Institute of Health (NIH), the U.S. Geological Survey (USGS), the National Science Foundation (NSF), industry, and other potential funding entities for REM applications.

The 2.5-day conference included over 80 presentations in 9 sessions and began with keynote addresses from NASA Deputy Administrator Lori Garver, NASA Ames Center Director Dr. Pete Worden, FAA Associate Administrator Dr. George Nield, and Southwest Research Institute Associate Vice President Dr. Alan Stern. NSRC 2010 also included a press conference, public talks by author Andrew Chaikin and former Shuttle Commander and current XCOR Chief Test Pilot Rick Searfoss, and a multistate university student suborbital experiment competition, with a surprise award added by Masten Space Systems of a free payload flight for the first-place team!

On the success of NSRC 2010, conference organizer Dr. Stern remarked, “This really has been a watershed event for both the suborbital industry and the space research and education communities, demonstrating that the level of researcher/educator interest in next-gen suborbital is dramatically growing. In fact, in response to the turnout at NSRC this week, Space Florida and the University of Central Florida have teamed together with us to host a second, larger NSRC meeting February 28 to March 2, 2011, in Orlando, Florida. I’m looking forward to that already.”

To view NSRC 2010 conference presentations and information, please visit [www.boulder.swri.edu/NSRC2010](http://www.boulder.swri.edu/NSRC2010).



## 41st Lunar and Planetary Science Conference

March 1–5, 2010, The Woodlands, Texas



The 41st Lunar and Planetary Science Conference (LPSC), held in March at The Woodlands Waterway Marriott Hotel and Convention Center in The Woodlands, Texas, was a resounding success, setting new records for attendance and number of submitted abstracts. More than 1600 planetary scientists from all over the world gathered this year at the annual meeting, which once again lived up to its well-deserved reputation of being the premiere gathering of planetary scientists in the world. Nearly one-fourth of the participants were students, which indicates the phenomenal resurgence in interest in lunar and planetary science, and reinforces the LPSC as a meeting both accessible and important to young scientists.

The excitement generated by current lunar missions, the wealth of information still being returned from Mars missions, and ongoing data returned from MESSENGER and Cassini all contributed to the variety of research unveiled at the conference, which was co-chaired by Dr. Stephen Mackwell (Lunar and Planetary Institute) and Dr. Eileen Stansbery (NASA Johnson Space Center).

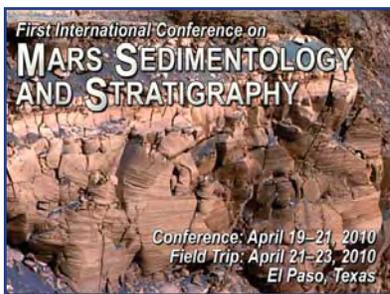
“If you can only attend one planetary meeting in the year, LPSC is definitely the one to go to,” said Dr. Stephen Clifford, Senior Staff Scientist at the Lunar and Planetary Institute. “It has the highest visibility and best attendance of any planetary meeting, which makes it a great place to catch up with colleagues and present the results of your latest research.”

In a reflection of the ever-evolving landscape of current research, the conference sessions this year were designed to focus on planetary processes rather than planetary bodies. Oral and poster sessions covered such diverse topics as planetary differentiation throughout the solar system; the formation of the first solar system solids; terrestrial planet cryospheres; planetary aeolian processes; planetary dynamics and tectonics; impacts on the Moon, Mars, and beyond; igneous and volcanic processes on terrestrial bodies in the solar system; small body origin, evolution, and composition; and planetary atmospheres.

The plenary session on Monday afternoon featured the Masursky Lecture by Dr. Ronald Greeley, entitled “Shifting Sands: Planetary Atmosphere-Surface Interactions,” as well as recognition of the recipients of the 2009 Dwornik Student Awards and the 2010 LPI Career Development Awards. On Monday evening James Green and Laurie Leshin of NASA Headquarters briefed the community on the current status of the Science and Exploration Systems Missions Directorates.

The conference also featured special sessions on the results from recent and current lunar missions, including the Lunar Reconnaissance Orbiter, Lunar Crater Observation and Sensing Satellite, Chandrayaan, and Chang’E-1 missions; as well as special sessions devoted to water in the solar system. With 525 oral presentations and more than 1000 poster presentations, the biggest problem faced by conference attendees was having to choose which sessions to attend, which talks to listen to, and which posters to view, but the larger venue in The Woodlands provided ample opportunities for networking and collaboration with colleagues from all over the world. The complete conference program and abstracts are available at [www.lpi.usra.edu/meetings/lpsc2010](http://www.lpi.usra.edu/meetings/lpsc2010).

Plans are well underway for the 42nd LPSC, which will be held March 7–11, 2011, in The Woodlands. More details and a first announcement should be available by the middle of July at [www.lpi.usra.edu/meetings/lpsc2011](http://www.lpi.usra.edu/meetings/lpsc2011).



## First International Conference on Mars Sedimentology and Stratigraphy

April 19–21, 2010, El Paso, Texas

Mars has preserved sedimentary rocks that record the evolution of its early surface environments. The oldest sedimentary rocks likely exceed 4 billion years and significantly predate the stabilization of the Archean cratons on Earth, which preserve the oldest sedimentary rocks on Earth. Thus, the martian sedimentary record may provide a unique opportunity to study the early environmental evolution of a terrestrial planet. It is during this key time interval that prebiotic chemistry and the origin of life appear to have taken place on Earth. The absence of well-preserved terrestrial sedimentary rocks are a significant barrier to investigating the earliest tectonic, climatic, and biologic processes, and are a powerful motivation for studying such rocks on Mars.

To explore how much we currently know about the martian sedimentary record, and as important, what are the primary open scientific questions, the First International Conference on Mars Sedimentology and Stratigraphy was held April 19–21, 2010, in El Paso, Texas. This conference sought to stimulate the exchange of ideas among the community of scientists with common interests in sedimentary processes and the stratigraphic record of sedimentary rocks on Mars. Topical sessions included weathering processes, provenance, and diagenesis of sediments; transport and depositional processes (fluvial, eolian, lacustrine, evaporitic, volcanoclastic, and impact), both past and present; characterization and origin of vast exposures of layered bedrock; controls on stratigraphic stacking patterns and stratal geometry; and the evolution of sedimentary basins, including patterns of deformation.

The conference discussions led to the definition of seven primary open scientific questions in this area as of 2010:

1. What were/are the mechanisms for sediment production on Mars? Did sediment production process(es) or rates vary through geologic time?
2. What is the composition, both mineralogical and chemical, of modern and ancient martian sediments?
3. How did source-to-sink systems develop on Mars?
4. What were the mechanisms of sediment accumulation and sediment preservation?
5. How can we use the stratigraphic record on Mars to extract information on its planetary evolution? What were the global geochemical cycles for sulfur and carbon, and what role did the sedimentary record play in this cycle?
6. In what ways did martian sedimentary rocks become modified after their deposition?
7. Did martian sedimentary rocks accumulate evidence of indigenous martian biology, and was that evidence preserved through the rocks' postdepositional history?

The conference was convened by John Grotzinger (*California Institute of Technology*) and David Beaty (*Mars Program Office, Jet Propulsion Laboratory*). To view the full conference program and abstracts, visit [www.lpi.usra.edu/meetings/marssed2010](http://www.lpi.usra.edu/meetings/marssed2010).

## **Astrobiology Science Conference 2010** ***Evolution and Life: Surviving Catastrophes and Extremes on Earth and Beyond***

**April 26–29, 2010, League City, Texas**

Astrobiologists from around the world gathered near the NASA Johnson Space Center in League City, Texas, to participate in the Astrobiology Science Conference 2010: Evolution and Life: Surviving Catastrophes and Extremes on Earth and Beyond. The conference was held over four days, from April 26 to 29. Early arrivals on April 25 were also treated to primer lectures on some of the scientific disciplines featured during the conference, as well as a panel discussion relevant to this year's focus: "Top Ten Catastrophes."



Answering the questions surrounding the origin of life and the potential for life in the universe requires an interdisciplinary approach. In their work, astrobiologists must include a vast range of scientific disciplines — from biology and geology to astrochemistry and astronomy. To help highlight how these different fields are combined in order to answer the scientific questions of astrobiology, talks

at AbSciCon are organized into a multitude of sessions that occur simultaneously. The wide array of activities can sometimes be overwhelming as participants rush back and forth between rooms to catch up on the latest scientific discoveries; but it also highlights the diversity of specialties represented by astrobiology and today's astrobiologists themselves.

This year marks the 50th anniversary of Exobiology and Astrobiology at NASA, and to celebrate this, the conference began with a historical overview of the past 50 years of research. The "Greatest Hits" session featured topics like the contributions of astrochemistry to the study of life in the universe; new insights into the infamous Mars meteorite, ALH 84001; studies on the origin of life through systems biology and synthetic biology; and an overview of evidence for the early rise of oxygen on Earth.

The majority of research presented at AbSciCon was covered in fifteen-minute talks in a variety of sessions held each day of the conference. In addition to the 15-minute talks by scientists, AbSciCon also included more in-depth plenary talks, dialogs, and discussions on some of the hottest topics in astrobiology today. The first was a dialog between Steve Benner and Robert Shapiro on the question, "Can we rule out spontaneous generation of RNA as the key step in the origin of life?" Shapiro and Benner took opposing views on whether or not RNA could have been the starting point for Darwinian evolution on Earth. A second dialog, "How Hellish was the Hadean Earth?" featured Stephien Mojzsis and Norman Sleep debating current scientific knowledge of conditions on the early Earth.

The three days of AbSciCon 2010 that followed continued on the same model. Additional dialogs were held on both scientific topics and issues related to funding, administration, and support for astrobiology. A public program, "Progress in the Search for Extraterrestrial Life: A Report from the Explorers," was also presented for AbSciCon participants and members of the general public on the evening of April 27. Participants discussed the future of exploration in our solar system and the scientific benefits of both robotic and human missions.

A new addition to this year's conference was the inclusion of "Lightning Talks." Nearly 300 posters were presented at the meeting, providing a quick overview of hundreds of specific scientific results and advancements in astrobiology. However, scientists who wanted to provide more information and discussion of their work were able to give brief, five-minute overview talks in the Lightning Talks. These

rapid-fire sessions provided the audience with a distilled view of some key research that will shape the future of astrobiology.

The role of astrobiology in NASA's interactions with the public was also highlighted in sessions dedicated to education and outreach initiatives. This dedication to education was presented in outreach activities dedicated to individual research projects as well as more general outreach for astrobiology as a whole. Outreach was also undertaken at the conference itself, with coverage on talks and sessions being provided by *astrobio.net* through Facebook updates and Twitter feeds. This provided participation from people who were not physically in attendance at the conference, and a venue for them to capture highlights of the event and relay their questions to scientists and professionals.

The program for AbSciCon 2010 featured the scientific work of some 2500 researchers in disciplines related to astrobiology. Participants arrived in League City from around the U.S. and every corner of the world, from Sweden to Australia, China to Brazil, and Colombia to Japan. For a complete listing of the topics and talks of AbSciCon 2010, the program and abstracts are available at [www.lpi.usra.edu/meetings/abscicon2010/](http://www.lpi.usra.edu/meetings/abscicon2010/).

## **Second International Planetary Dunes Workshop: Planetary Analogs — Integrating Models, Remote Sensing, and Field Data**

**May 18–21, 2010, Alamosa, Colorado**



Landforms and deposits created by the dynamic interactions between granular material and airflow (aeolian processes) occur on several planetary bodies, including Earth, Mars, Titan, and Venus. The recognition of landforms on other planetary bodies requires use of terrestrial analogs in a well-established methodology for interpretation of landforms observed on orbital and lander images of other planetary bodies.

Based on the paradigm that morphologically similar landforms are formed in essentially the same manner on different planetary surfaces, this approach can indicate the types of surface processes and environments that occur on an unfamiliar landscape, provided that the fundamentals of the landforms and processes are well-understood on Earth.

Dunes and other aeolian bedforms are a prominent part of landscapes shaped by wind action on several planetary bodies in our solar system. Despite the three decades of study of these features, many questions regarding their composition and sediment sources, morphology, age and origins, and dynamics under present and past climatic conditions remain poorly understood. Recently acquired data from orbiters and rovers together with innovative approaches using terrestrial analogs and numerical models are beginning to provide new insights into martian sand dunes, as well as aeolian bedforms on other terrestrial planetary bodies (e.g., Titan).

Dr. Timothy N. Titus (*U.S. Geological Survey*), along with Lori Fenton (*Carl Sagan Center*), Nick Lancaster (*Desert Research Institute*), Andrew Valdez (*National Park Service*), and Rose Hayward (*U.S. Geological Survey*), convened this workshop as a means of bringing together terrestrial and planetary researchers with interests in planetary dunes from diverse backgrounds in image analysis, modeling, and terrestrial analog studies. The small group setting was designed to facilitate intensive discussion of problems and issues in an attempt to identify the most promising approaches to understanding these dune systems and to develop a collaborative interdisciplinary research agenda.

## Meeting Highlights *continued . . .*

The sessions on bedform activity demonstrated that there are several features that identify aeolian activity/transport, e.g., scours and ripples. The use of automated change detection algorithms are a promising approach in the search for active dunes and ripples. Atmospheric models are improving in their ability to predict aeolian activity, and are currently being used to interpret observations.

The session on the sources and transport of aeolian grains focused on three common themes: methods for identifying sources and pathways, sources of aeolian materials, and mineralogical maturity. The use of thermal infrared (TIR) and near-infrared (NIR) remote sensing was discussed. Many components of sand seas are better identified using TIR, especially on Earth. Windows in the methane absorption spectrum on Titan may allow some NIR spectroscopic investigation of dune substrates and dune distribution. *In situ* observations of martian sedimentary processes from the Mars Exploration Rovers reveal small-scale dynamics that affect large-scale processes. Sources of aeolian materials vary depending on the planetary body. River and stream sediment is a major source for Earth. Bedrock is another source for Earth and probably Mars. The sources for Titan are yet to be determined, but a better understanding of the composition and transport pathways might help to identify possible sources. On Earth, the mineralogical maturity of sediments is reflected by their quartz content. But what does mineralogical maturity mean on Mars?

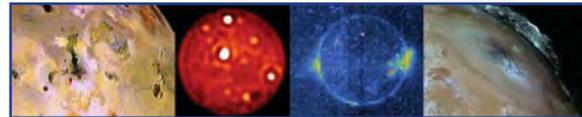
The session on dunes, water, and ice focused on niveo-aeolian processes both on Earth and Mars. A variety of observations suggest that the Mars polar erg contains water ice just below a thin surface covering of desiccated sand. Determining the sources of the ice, and whether the ice is mobile, were two of the outstanding questions. The question of analogs for the polar erg also arose. The Antarctic is dry and cold and therefore more closely presents the processes. However, Iceland — which is wet and cold — is a better example of the Mars polar mineralogy with basaltic sand dunes.

The poster session spanned all topics of interest, ranging from terrestrial analogs to dune migration rates.

To view the complete program and abstracts for this workshop, visit [www.lpi.usra.edu/meetings/dunes2010/](http://www.lpi.usra.edu/meetings/dunes2010/).

### Io Workshop 2010

May 25–26, 2010, Provo, Utah



Mountains covered by snow, not sulfur, greeted the attendees of a one- and-a-half day Io workshop at Brigham Young University in Provo, Utah, at the end of May (the snowfall set a latest-in-the-season record at the Salt Lake City airport). Nonetheless, the attendees got right to work Tuesday morning with discussions of ongoing geologic mapping and distributions of ionian hotspots. In particular, David Williams of Arizona State University reported that several Io map products are in the publication pipeline and that mapping databases compiled in this process can be made available in electronic form to interested parties. After a break, presentations focused on specific hotspots such as Pele and Loki, with workers presenting integrated displays of Voyager, Galileo, and even Cassini data, exploiting each for its respective advantages. In a provocative talk, Krishan Khurana of UCLA interpreted magnetic field data to infer a very large melt fraction in the asthenosphere of Io, not far from a “magma ocean.” Later talks focused on thermal emission studies of terrestrial hotspot analogs and analysis of (ongoing) groundbased imaging of ionian hotspots.

Tuesday afternoon’s presentations concerned Io’s atmosphere. Groundbased interferometry and spectroscopy of Io were used to constrain atmospheric chemistry (SO<sub>2</sub>, SO, NaCl abundances), density, and temperature. Numerical models of volcanic plumes on Io, including the effects of ionization and vent geometry, produced surface deposit patterns that strongly resembled those observed at ionian hotspots. The remainder of the day was taken up by a planetarium/animation show and dinner up in the mountains at Sundance.

Wednesday morning was devoted to future missions. Alfred McEwen of the University of Arizona presented his ambitious Io Volcano Observer (IVO) mission, which if selected would be the first Discovery-class mission to the outer solar system (i.e., beyond the asteroids). After gravity assists from Venus and Earth (twice), IVO would insert into Jupiter orbit in 2022 and engage in six roughly north-south flybys, ultimately returning about 100 times the Galileo Io dataset. Instruments include a narrow/wide-angle camera, THEMIS-derived thermal mapper, dual fluxgate magnetometers, INMS/PIA spectrometers and ion analyzers, and an optional Lyman-Alpha mapper. Steve Vance of the Jet Propulsion Laboratory reported on Io opportunities for the joint ESA/NASA Europa Jupiter System Mission, with proposed arrival in 2026. The Europa orbiter would have four initial flybys of Io, although many instruments would not be collecting data at that stage of the mission. Monitoring of Io from Europa orbit could return a substantial volume of high-resolution imaging (2.5–25 km/pixel, up to ~100 km/pixel for the infrared).

As the discussion wrapped up, most attendees grabbed their backpacks and loaded up into vans headed out to Tabernacle Butte, a tuff cone with adjoining lava flows and tubes, on the margins of (paleo-) Lake Bonneville in the Black Rock Desert. This field trip was designed to show off a potential “analogue for volatile-containing mafic eruptions on Io.”

More information on the workshop, including an agenda and pictures of the workshop and field trip, can be found at [pirlwww.lpl.arizona.edu/~jani/ioworkshop2010/secondannouncement](http://pirlwww.lpl.arizona.edu/~jani/ioworkshop2010/secondannouncement).

## Upcoming Spacecraft Encounters

Date	Target Body	Spacecraft	Website
June 21, 2010	Titan	Cassini	<a href="http://saturn.jpl.nasa.gov">saturn.jpl.nasa.gov</a>
July 7, 2010	Titan	Cassini	<a href="http://saturn.jpl.nasa.gov">saturn.jpl.nasa.gov</a>
July 10, 2010	Lutetia (asteroid)	Rosetta	<a href="http://webservices.esa.int/blog/blog/5">webservices.esa.int/blog/blog/5</a>
Aug. 13, 2010	Enceladus	Cassini	<a href="http://saturn.jpl.nasa.gov">saturn.jpl.nasa.gov</a>
Sept. 24, 2010	Titan	Cassini	<a href="http://saturn.jpl.nasa.gov">saturn.jpl.nasa.gov</a>
Oct. 16, 2010	Pallene	Cassini	<a href="http://saturn.jpl.nasa.gov">saturn.jpl.nasa.gov</a>
Nov. 4, 2010	P/Hartley 2 (comet)	Deep Impact (EPOXI)	<a href="http://epoxi.umd.edu/1mission/index.shtml">epoxi.umd.edu/1mission/index.shtml</a>
Nov. 11, 2010	Titan	Cassini	<a href="http://saturn.jpl.nasa.gov">saturn.jpl.nasa.gov</a>
Nov. 30, 2010	Enceladus	Cassini	<a href="http://saturn.jpl.nasa.gov">saturn.jpl.nasa.gov</a>
Dec. 21, 2010	Enceladus	Cassini	<a href="http://saturn.jpl.nasa.gov">saturn.jpl.nasa.gov</a>
Dec. 2010	Venus (orbit)	Akatsuki	<a href="http://www.jaxa.jp/projects/sat/planet_c/index_e.html">www.jaxa.jp/projects/sat/planet_c/index_e.html</a>
Feb. 14, 2011	P/Tempel 1 (comet)	Stardust-NExT	<a href="http://stardustnext.jpl.nasa.gov/">stardustnext.jpl.nasa.gov/</a>
July 2011	Vesta	Dawn	<a href="http://dawn.jpl.nasa.gov/mission/">dawn.jpl.nasa.gov/mission/</a>

*“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](mailto:shupla@lpi.usra.edu).*

## NASA Supplemental Education Proposals for Research Investigations

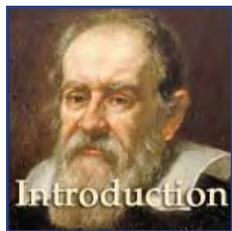
NASA is offering Education or Outreach awards for Principal Investigators (PIs) of selected research investigations as supplements to their research awards. Two different pathways are offered: \$15K/year education pathway proposals and \$10K/year outreach pathway proposals. The parent research award must have more than 12 months remaining at the time of submission of an education or outreach supplement proposal. For additional details concerning the submission of supplement proposals, please see Supplemental Outreach Awards for ROSES Investigators and Supplemental Education Awards for ROSES Investigators.

- Notice of Intent is requested by August 4, 2010
- Full proposals are due on September 1, 2010

For more information, visit the guides available at [science.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-smd-e-po-evaluation-factors](http://science.nasa.gov/researchers/education-public-outreach/explanatory-guide-to-smd-e-po-evaluation-factors). Questions about the supplement program are welcome and may be directed to Larry Cooper at [HQ-SMD-ROSES-EPO@hq.nasa.gov](mailto:HQ-SMD-ROSES-EPO@hq.nasa.gov).

## Moon Zoo

Moon Zoo is an online citizen science project. The project uses high-resolution images from the Lunar Reconnaissance Orbiter Camera (LROC) on NASA’s LRO spacecraft. Moon Zoo asks the participants to classify and measure the shape of features on lunar surface. Besides delivering high-quality data that will address many lunar science questions, Moon Zoo is a new tool to promote lunar and space exploration and engage the public in learning about processes involved in scientific discoveries. For more information, visit [www.moonzoo.org](http://www.moonzoo.org).



## Virtual Tour of Galilean Satellites

In honor of the 400th anniversary of the discovery of the four Galilean satellites, LPI scientist Paul Schenk has put together a virtual online tour of the moons, with high-resolution images and descriptions. Visit [www.lpi.usra.edu/galileoAnniv](http://www.lpi.usra.edu/galileoAnniv).

## New LPI Solar System Activities

A variety of new Juno activities, geared toward middle-school students, is available online. Students are introduced to the members of our solar system family and create outdoor



## Spotlight on Education *continued . . .*

and indoor scale models of their sizes and distances; discover Jupiter's monumental size, mass, and gravitational pull; see the planets for themselves through a night viewing; uncover Jupiter's unique personality traits, including its dynamic weather, mysterious interior, and amazing magnetic field; enact cultural and science stories about our origins; and create scrapbooks as a concluding activity. The activities are available at [www.lpi.usra.edu/education/explore/solar\\_system](http://www.lpi.usra.edu/education/explore/solar_system).

### New NASA Website Launches Kids on Mission to Save Our Planet

Climate change can be a daunting topic for most adults to grasp, let alone kids. A new NASA website can help our future explorers and leaders understand how and why their planet is changing and what they can do to help keep it habitable. Geared toward students in grades 4 through 6, the multimedia-rich Climate Kids site uses age-appropriate language, games, and humorous illustrations and animations to help break down the important issue of climate change. Climate Kids can be found at [climate.nasa.gov/kids](http://climate.nasa.gov/kids).

### 3rd Annual NASA Lunar Science Forum

Registration is open for the 3rd annual NASA Lunar Science Forum, hosted by the NASA Lunar Science Institute on July 20–22, 2010, at the NASA Ames Conference Center, Moffett Field, California. This year's forum will feature sessions on scientific results from the Lunar Reconnaissance Orbiter and Lunar Crater Observation and Sensing Satellite, as well as the presentation of the annual Shoemaker medal and associated keynote lecture. As in past years, science sessions are structured to report on both recent results and future opportunities for lunar science, education, and outreach. Individuals conducting — or interested in becoming involved in — lunar E/PO are invited to join a workshop on July 18 and 19. Details will be forthcoming. Registration for the Lunar Science Forum can be found at [lunarscience2010.arc.nasa.gov/welcome](http://lunarscience2010.arc.nasa.gov/welcome); registered participants are invited to submit abstracts.

### Education and Public Outreach Symposium

**Boulder, Colorado, July 31–August 4, 2010**

This meeting will focus on space and Earth science education and outreach. The meeting brings together two hands-on, ASP-sponsored symposia. In addition, there will be a weekend workshop on teaching astronomy for teachers in grades 3–12 and those who work with them.

- ***Cosmos in the Classroom:*** Teaching Introductory Astronomy and Planetary Science to Non-Science Majors (August 1–4)
- ***Earth and Space Science:*** Making Connections in Education and Public Outreach (August 1–4)
- ***In the Footsteps of Galileo:*** A Hands-On Workshop on Astronomy for Teachers in Grades 3–12 (and Those Who Work With Them) (July 31–August 1)



Onsite registration is available for all events, but those who register in advance get a reduced rate. For more information about the Astronomical Society of the Pacific and this year's events, visit [www.astrosociety.org/events/meeting.html](http://www.astrosociety.org/events/meeting.html).

## New “Discoveries in Planetary Science” PowerPoints

The DPS Education Subcommittee announces the second release of “Discoveries in Planetary Science” classroom PowerPoints, covering six new topics:

- Discovery of a Rocky Exoplanet
- Lunar Water
- Jupiter Impact Event
- Oceans on Enceladus
- The TC3 Meteorite
- 2012 Doomsday Rumors



PowerPoints and PDF files can be downloaded from [dps.aas.org/education/dpsdisc](http://dps.aas.org/education/dpsdisc). Planetary scientists with recent or upcoming results of broad interest are encouraged to submit them for consideration by providing an initial draft using the template provided on the website. For more information, contact Nick Schneider and Dave Brain at [dpsdisc@aas.org](mailto:dpsdisc@aas.org).

## Windows to the Universe Welcomes Collaborators



Windows to the Universe has moved to a new home — the National Earth Science Teachers Association (NESTA) — and is offering new capabilities and opportunities for partnership. The project and website moved to the NESTA in mid-April. The new URL is [windows2universe.org](http://windows2universe.org). The move is designed to help make the site an open educational resource and to allow scientists, university faculty,

K–12 educators, and others to contribute content more readily in support of the geoscience education community. Collaborators will be able to build on the site’s extensive content base and capabilities and will receive training and support from project staff to create new material. Scientists planning an observational campaign, for example, can help update or extend site content that’s relevant to their research, as well as report on their project as it unfolds through the site’s easy-to-use Postcards from the Field. Programs and organizations will be able to leverage these same resources, the site’s large audience, and the new capabilities that will be developed to promote their own research, resources, and programs.

## Astronomical Society of the Pacific Podcasts

ASP offers two podcasts series involving interviews with and talks by leading astronomers:

*Astronomy Behind the Headlines* features short interviews and links to related resources about the latest discoveries in astronomy and space science. To listen to the latest episode, access related resources, and subscribe via iTunes or XML, go to [www.astrosociety.org/abh/](http://www.astrosociety.org/abh/).

*The Silicon Valley Astronomy Lectures* feature complete talks by noted astronomers, recorded in both audio-only and video formats. Speakers include David Morrison, who discusses the public fears of 2012 and how they have been enflamed by the media; Paul Kalas, whose group took the first visible-light image of a planet around another star; and Lynn Rothschild, an astrobiologist who explores some of the most hostile places on Earth. Find the audio podcasts, and instructions for accessing video versions, at [www.astrosociety.org/education/podcast/](http://www.astrosociety.org/education/podcast/).



## Former LPI Intern Becomes NASA Deputy Associate Administrator for Exploration

Laurie Leshin, an alumna of the Lunar and Planetary Institute (LPI) summer intern program (class of 1985), was named as the new Deputy Associate Administrator of the Exploration Systems Mission Directorate at NASA Headquarters, effective January 2010.

Leshin previously served as the deputy center director for science and technology at NASA's Goddard Space Flight Center in Greenbelt, Maryland. She led the formulation of strategy and the start of new missions since 2008 as Goddard's senior scientist, while providing extensive scientific guidance to lunar architecture and other human spaceflight planning activities.

Leshin joined NASA in August 2005 as the director of Goddard's Sciences and Exploration Directorate. She came to the agency from Arizona State University, where she was The Dee and John Whiteman Dean Distinguished Professor of Geological Sciences and director of the Center for Meteorite Studies.

Through her research, Leshin sought to decipher the record of water in objects in our solar system. A primary part of the research involved using meteorites from Mars to assess the history of water and the potential for life on the Red Planet. She has been on science teams for several NASA missions, including the Mars Polar Lander and the upcoming Mars Science Laboratory.

Earlier this year, Leshin also led the NASA Innovation and Technology Study Group, a team of 15 that made recommendations on how NASA could increase focus on innovative activities and technologies needed to advance the agency's mission. She earned a bachelor of science degree in chemistry at Arizona State University in 1987 and a doctorate in geochemistry from the California Institute of Technology in 1994.

Prior to coming to NASA, Leshin received the agency's Distinguished Public Service Medal, the highest award for non-NASA personnel. The International Astronomical Union has recognized her contributions to planetary science with the naming of asteroid 4922 Leshin.

## Koeberl Named as Director of Museum of Natural History

The Austrian Minister of Culture and Education has appointed Dr. Christian Koeberl as the new director general of the Natural History Museum in Vienna, Austria.

After earning his Ph.D. in astronomy and chemistry from the University of Graz, Koeberl joined the staff at the University of Vienna, beginning in 1983 as a Research Assistant, culminating with his most recent position as the head of the Department of Lithospheric Research and Chair of Impact Research and Planetary Geology.



A frequent Visiting Scientist at the LPI in the late 1980s and early 1990s, Koeberl has been the recipient of many prestigious awards, including being named as a Fulbright Senior Visiting Scholar, a Fellow of the Geological Society of South Africa, Full Member of the Austrian Academy of Sciences, and the recipient of the Barringer Medal and Award of the Meteoritical Society. In 2006 an asteroid (15963) was named after him.

Koerberl's primary goals for the Vienna Natural History Museum are to improve the research activities and the research infrastructure, enable better cooperation between the University and the Museum, improve the way the permanent collections are displayed, modernize the meteorite hall, and increase the Museum's visibility for international tourists.

## NASA's Digital Learning Network Teachers Earn Prestigious Award

The United States Distance Learning Association recognized NASA's Digital Learning Network (DLN) for its superior instructors by presenting the program with the Silver Award for Distance Learning Teaching.



Seventeen agency instructors from across NASA's 10 field centers were recognized for their performance. The DLN enables students, the next generation of explorers, to connect with scientists, engineers, and researchers without leaving the classroom. The program uses interactive videoconferencing to provide distance-learning events to educate students through demonstrations and real-time interaction with NASA experts at various locations across the agency.

"It is such an honor for NASA to be recognized for the teaching talent that our DLN coordinators possess," said Jim Stofan, NASA's acting associate administrator for Education. "We have always known they are top quality and dedicated educators, and now so does the world of distance learning through this recognition."

For more information about NASA's Digital Learning Network, visit [dln.nasa.gov/dln](http://dln.nasa.gov/dln).



## NASA Ames Center Director Receives Arthur C. Clarke Award

The director of NASA's Ames Research Center, S. Pete Worden, was recognized by The Arthur C. Clarke Foundation for his leadership in space exploration.

Worden has written or co-written more than 150 scientific technical papers in astrophysics, space sciences, and strategic studies. He also served as a scientific co-investigator for two NASA space science missions. Before becoming Ames center director, he was a research professor of astronomy, optical sciences and planetary sciences at the University of Arizona. His primary research was on the development of large space optics for national security and scientific purposes, and near-Earth asteroids.

The award recognizes initiatives or new inventions with recent impact or particular promise for satellite communications and society. "Like Sir Arthur, Pete Worden was 'in at the beginning' of countless courageous departures — among them the Strategic Defense Initiative, the revitalization of civil space exploration and Earth monitoring, and programs to get mankind at a working distance from Near Earth Objects," The Arthur C. Clarke Foundation's Chairman Tedson J. Meyers said.

For Worden's biography, visit [www.nasa.gov/centers/ames/about/centerdirector.html](http://www.nasa.gov/centers/ames/about/centerdirector.html). For more about The Arthur C. Clarke Foundation, visit [www.clarkefoundation.org](http://www.clarkefoundation.org).

## LPI Welcomes Summer Interns



The Lunar and Planetary Institute (LPI) is pleased to announce the selection of the 2010 class of the LPI Summer Intern Program in Planetary Science. Now in its 33rd year, the highly competitive program offers undergraduates the opportunity to experience cutting-edge research in lunar and planetary science, working one-on-one with scientists at the LPI and the NASA Johnson Space Center on a project of current interest in planetary science. This year's program will run from June 7 through August 13.

Selected students are Aaron Bauer (*Williams College*), Tiffany Engle (*Sam Houston State University*), Joel Hecker (*University of Cincinnati*), Kristin Johnson (*Youngstown State University*), Abigail Koss (*Massachusetts Institute of Technology*), Adam Koster (*Calvin College*), Cameron Mercer (*Middlebury College*), Sean Murphy (*Lafayette College*), William Vaughan (*University of Chicago*), Katelyn Verner (*Southern Methodist University*), Kathryn Volk (*Northern Illinois University*), and Annie Wintzer (*University of Florida*).

The LPI also welcomes the Lunar Exploration Summer Interns. This program provides students with an opportunity to be involved in exploration activities, thus effectively training a new generation of space exploration leaders. Working in teams, the interns will identify sites on the lunar surface where the nation's science priorities can be accomplished. The ten-week program runs June 1 through August 6. Applications were accepted from graduate students in geology, planetary science, and related programs, as well as undergraduates with at least 50 semester hours of credit.



The Lunar Exploration Summer Intern Program is supported by funding from the LPI and the NASA Lunar Science Institute at NASA Ames Research Center.

The students chosen to participate in this year's program are Jean-Francois Blanchette-Guertin (*University of British Columbia*), Patrick Donohue (*University of Notre Dame*), Jessica Flahaut (*ENS Lyon*), Zachary Gallegos (*University of New Mexico*), Noah Hammond (*University of California Santa Cruz*), Christine Jilly (*University of Hawaii at Manoa*), Ross Potter (*Imperial College London*), Priyanka Sharma (*University of Arizona*), and Audrey Souchon (*University of Paul Sabatier Toulouse III*).

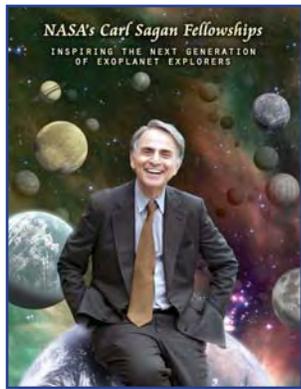
More information about these programs is available at [www.lpi.usra.edu/lpiintern/](http://www.lpi.usra.edu/lpiintern/) and [www.lpi.usra.edu/lunar\\_intern/](http://www.lpi.usra.edu/lunar_intern/).



## Space Operations Award Goes to Mars Rover Team

The team that operates NASA's Mars rovers Spirit and Opportunity has received the 2010 International Space Ops Award for Outstanding Achievement. The citation for the award says, "For remarkable success in meeting unique and varied challenges of operating a rover on Mars and establishing a model for future in-situ operations."

The Mars Exploration Rover Project landed the twin rovers on the Red Planet in January 2004 for missions that were initially planned to last for three months. The team has operated the rovers for more than six years, making major science discoveries, driving a combined total of more than 27.5 kilometers (17 miles) over often-challenging terrain, and tending them through three martian winters and potentially mission-ending dust storms.



## NASA Announces 2010 Carl Sagan Fellows

NASA has selected seven scientists as recipients of Carl Sagan Postdoctoral Fellowships in exoplanet exploration for 2010. The Sagan Fellowships support outstanding recent postdoctoral scientists in conducting independent research broadly related to the science goals of NASA's Exoplanet Exploration Program. That program's primary goal is to discover and characterize planetary systems and Earth-like planets around other stars.

"The Sagan Fellowship identifies and supports the most promising young scholars who are passionate about the scientific search for and study of planets beyond our solar system," said Charles Beichman, executive director of the NASA Exoplanet Science Institute at the California Institute of Technology in Pasadena. "These young scientists combine interest in the

fields of astronomy, astrobiology or geophysics with expertise in theory, observation, or state-of-the-art instrumentation. They are following a trail blazed by Carl Sagan — after whom the fellowship program is named — that may one day lead to the discovery of life on worlds other than Earth."

A full description of the 2010 fellows and their projects is available at [nexsci.caltech.edu/sagan/2010postdocRecipients.shtml](http://nexsci.caltech.edu/sagan/2010postdocRecipients.shtml).

## Science Team from Ames Research Center Wins 2009 NASA Software of Year Award

The World Wind Java computer program developed at the NASA's Ames Research Center is the winner of NASA's 2009 Software of the Year Award.



Software engineers at Ames created the NASA World Wind Java Software Development Kit and Web Mapping Services Server. NASA World Wind Java is an open-source platform used to display NASA and U.S. Geological Survey data on virtual three-dimensional globes of Earth and other planets. The displayed information comes from satellites, aerial photography, and topographic and geographic data. The software was developed with support from the Research Institute of Advanced Computer Science (RIACS), one of the institutes managed by the Universities Space Research Association.

NASA World Wind is user-friendly, using button or mouse controls to rotate, pan, and zoom through models. The program engages the public to learn more about our planet and NASA technology. To better enable government, commercial enterprises, and individual developers to build the applications they need, the NASA World Wind Java Software Development Kit is released under the NASA Open Source Agreement and allows all users to review and test the software source code.

For more information, visit [worldwind.arc.nasa.gov/java](http://worldwind.arc.nasa.gov/java).



## Lunine Elected as Member of National Academy of Sciences

Dr. Jonathan Lunine, a professor in the University of Arizona's department of planetary sciences, was recently elected a member of the National Academy of Sciences. This election is considered one of the highest honors a U.S. scientist or engineer can achieve.

Lunine's research involves spacecraft missions and the exploration of planets, moons, and other celestial bodies in our solar system and beyond. He is especially interested in studying the formation and evolution of planets, brown dwarf stars, and the prerequisites for extraterrestrial life.

Lunine joins 72 new members and 18 foreign associates from 14 countries selected to the National Academy of Sciences in recognition of their distinguished and continuing achievements in original research. Those elected this year bring the total number of active members to 2097. Lunine is the only newly elected member from Arizona.

He has authored the books *Earth: Evolution of a Habitable World* and *Astrobiology: A Multidisciplinary Approach*. He is also a fellow of the American Geophysical Union and the American Association for the Advancement of Science, and an elected member of the International Academy of Astronautics.

## DPS Prize Winners Announced



The Division for Planetary Sciences of the American Astronomical Society has announced the winners of the 2010 DPS prizes:

**Gerard P. Kuiper Prize** for outstanding contributions to the field of planetary science:

*Jeff Cuzzi, NASA Ames Research Center*

**Harold C. Urey Prize** for outstanding achievement in planetary research by a young scientist:

*Jonathan Fortney, University of California, Santa Cruz*

**Harold Masursky Award** for outstanding service to planetary science and exploration:

*Alan Tokunaga, University of Hawaii*

**Carl Sagan Medal** for outstanding communication by an active planetary scientist to the general public:

*Carolyn Porco, Space Science Institute*

**Jonathan Eberhart Planetary Sciences Journalism Award** to recognize and stimulate distinguished popular writing on planetary sciences:

*George Musser, Scientific American*

## Brian Mason

Brian Harold Mason, 92, a Smithsonian scientist who was internationally known for his study of meteorites and Moon rocks and who was the first to discover that a rock found in Antarctica came from the Moon, died of renal failure on December 3 at his home in Maryland. Born in 1917 in Port Chalmers, Dunedin, New Zealand, Mason grew up in Christchurch. In 1936, he graduated from New Zealand's University of Canterbury, from which he later received master's degrees in chemistry and geology. He received a doctorate in geochemistry from the University of Stockholm in 1943.



Mason wrote one of the fundamental books in the field, *Principles of Geochemistry*, in 1952, and it was still being used in classrooms 30 years later. In 1962, he wrote what became a standard text on meteorites, and in 1970, he co-wrote a 179-page report on the lunar rocks collected by Apollo astronauts. He edited a seminal book of mineralogy that described every mineral known to science, where each was found, and all its physical properties. While examining meteorites collected by U.S. expeditions to Antarctica, he wrote in his notes that they seemed to be rocks from the Moon, an idea that astrophysicists had said was impossible. Unwilling to show up other scholars in the field, his published comment was that they “had a passing resemblance to certain Apollo 15 lunar rocks.” Within a year, other scientists agreed. It wasn't the first or last time his work forced a reconsideration of an entire field.

By 1953, Mason was at the American Museum of Natural History in New York, where his first task was to reorganize its large meteorite collection. Finding the method of classification difficult and time-consuming, he developed a system based on determining the composition of the rock-forming mineral olivine. In 1965, he moved to Washington to join the Smithsonian. He became a U.S. citizen in the 1970s. Mason retired in 1984, but he continued to work on emeritus status, researching and writing at his office. Among his many honors, he won the Leonard Medal from the Meteoritical Society in 1972 and the Roebling Medal from the Mineralogical Society of America in 1993. In recognition of his many accomplishments, an asteroid appearing between Mars and Jupiter was named 12926Brianmason. Two minerals, brianite and stenhuggarite (from the Swedish “stenhuggar,” meaning “mason”), also carry his name.

### Brian Mason: A Personal Note

Brian always retained a very youthful appearance. I first became aware of this in 1946. I was among a group of freshman students who were gossiping before the first lecture of the year. At 10:00 a.m. one of the youngest looking of the group, indistinguishable from the students, got up and delivered the lecture. That was my first introduction to Brian, newly arrived back in Christchurch, New Zealand, with a Ph.D. from Sweden.

When I was thinking about doing a Ph.D. myself, Brian suggested joining him at Indiana University. Almost my first task was to help him to proofread the first edition of *Principles of Geochemistry*, a marvelous introduction to what was then a brand new subject. Toward the end of my course, Brian left Bloomington to become mineral curator at the Museum of Natural History in New York. The upshot was that I became his sole Ph.D. student.

In the 1970s, at the Australian National University in Canberra, Brian became a frequent visitor, analysing meteorite samples on my spark source mass spectrometer. The most exciting moment was the discovery of the bizarre groups of rare earth patterns in the Allende calcium-aluminum inclusions, most notably those of the celebrated Group II.

It was indeed a great privilege to have studied and worked with Brian, who gave me such a good introduction to geochemistry and who always remained both a good friend and an inspiration to me.

— S. Ross Taylor, Canberra, Australia



## Gero Kurat

Gero Kurat, the former head of the Mineralogical-Petrographical Department and curator of the meteorite collection at the Natural History Museum in Vienna, Austria, died on November 27 at the age of 71. Kurat was a pioneer in meteorite research, a gifted mineralogist, petrologist, and geochemist. He was among the first meteorite researchers to combine petrographic observations of meteorite textures with quantitative electron microprobe analyses. But he also made important contributions to the chemistry and mineralogy of lunar and terrestrial rocks.

Kurat was born on November 19, 1938, in Klagenfurt, Austria. He studied petrology at the University of Vienna, where he received his Ph.D. in 1963. In 1962, Kurat entered the Natural History Museum, Vienna (NHMV) as a volunteer and was appointed custodian at the Mineralogical-Petrographical Department in 1963. From 1968 until his retirement in 2003, he was head of the Mineralogical-Petrographical Department and curator of the meteorite collection of the NHMV. During his directorship the department evolved from a historical institution to a worldwide known research institution focusing on meteorite research and competing with foreign universities and research institutions. Despite chronic financial shortages, Kurat managed to expand the collections with innovative funding arrangements, and also acquire the necessary research equipment that allowed him and his staff to participate in international research programs, such as the study of lunar rocks.

With the passing of Kurat, the Meteoritical Society lost not only a dedicated scientist who served it in many different functions (e.g., as President), but also one of their best petrographers, and an unusually active and devoted scientist with a warm and pleasant personality, who was always ready for a joke and a good glass of wine. He will be missed by his many friends from all around the world — which he left far too soon.

[Ed. note: For a longer version of this article, visit [www.meteoriticalsociety.org](http://www.meteoriticalsociety.org).]

— Franz Brandstätter, Vienna; Christian Koeberl, Vienna; and Herbert Palme, Germany

## Finn Ulff-Møller

Finn Ulff-Møller passed away last October at the age of 59. Ulff-Møller started his career studying terrestrial iron and associated sulfides, working as a graduate student on samples from the Disko area in Greenland. After obtaining his Ph.D. in geology from the University of Copenhagen in 1983, he worked several summers in Greenland prospecting for different mineral companies. During this period he discovered a 10-ton boulder of terrestrial iron on Disko Island, the largest such find since 1870. From 1986 to 1989, he was a postdoc at the Geological Museum of the University of Copenhagen and a visiting scientist at the Geophysical Laboratories at the Carnegie Institution.

Ulff-Møller attended his first Meteoritical Society meeting in Albuquerque in 1984, where he presented a paper on metal segregation in planetoids, inspired by his earlier studies of terrestrial iron. From 1991 to 1996 he worked in Kaare Rasmussen's research group on meteorites at Odense University, where he taught solid-state chemistry and focused his studies on equilibria and phase relations of silicates in iron meteorites and mesosiderites. After leaving Odense, he moved to the University of California, Los Angeles, where he worked in John Wasson's group. He studied the bulk chemistry of irons and the mineralogy of pallasites, and helped develop models for the formation of these groups. When he returned to Denmark a couple of years later, he worked as a computer programmer and taught popular courses on meteorites and the origin of the solar system.

## Zdeněk Ceplecha

Well-known Czech meteor astronomer Zdeněk Ceplecha passed away on December 4 at the age of 80. He received his Ph.D. in astronomy in 1952 from Charles University in Prague, then went on to earn a D.Sc. in astrophysics in 1967.



Ceplecha was famous for the observation and analysis of the Příbram meteorite fall in 1959 — the first photographed meteorite fall and the first meteorite with a known orbit. He also contributed to many fields of meteor astronomy, including classification of fireballs and meteors, atmospheric fragmentation of meteoroids, fireball spectroscopy, dark flight of meteorites, and the influx of meteoritic material on Earth. The European fireball network, which he founded in 1963, is still active today and the methods he invented are still in use. His review article, “Meteor Phenomena and Bodies,” which he published with several co-authors in 1998, is still among the most cited papers in the field.

Ceplecha was a recipient of many awards, including the G. P. Merrill Award from the U.S. National Academy of Sciences, the Laureate of the State Award, and the Gold Medal for Physical Sciences from the Czechoslovak Academy of Sciences. Asteroid 2198 was named “Ceplecha” in his honor.



## Aaron Cohen

Spaceflight pioneer Aaron Cohen, a former director of NASA’s Johnson Space Center (JSC) in Houston, died on February 25 after a lengthy illness. He was 79.

Cohen had a 33-year career with NASA. He was a steady hand at the helm of JSC as NASA recovered from the shuttle Challenger tragedy and returned the space shuttle to flight. Cohen left the agency in 1993 to accept an appointment as a professor at his alma mater, Texas A&M University. At the time, he was serving as acting deputy administrator at NASA Headquarters in Washington.

Cohen joined NASA in 1962 and served in key leadership roles critical to the success of the flights and lunar landings of the Apollo program. From 1969 to 1972, Cohen was the manager for the Apollo Command and Service Modules. He oversaw the design, development, production, and test flights of the space shuttles as manager of NASA’s Space Shuttle Orbiter Project Office from 1972 to 1982. After serving as Director of Engineering at JSC for several years, he was named director of the center in 1986, serving in that post until 1993.

Cohen’s many honors include the highest award given for federal executives, the Presidential Rank of Distinguished Executive, which he received in 1982 and 1988. He was presented NASA’s highest honor, the Distinguished Service Medal, three times. Cohen was a member of the National Academy of Engineering and a fellow of the American Astronautical Society and the American Institute of Aeronautics and Astronautics. He was a distinguished alumnus of Texas A&M, from which he earned a bachelor’s in Mechanical Engineering in 1952. He earned a master’s in Applied Mathematics from Stevens Institute of Technology in 1958. He also was a recipient of honorary doctorates from Stevens Institute and from the University of Houston–Clear Lake.

## **Eric Essene**

Eric J. Essene, a highly regarded and widely cited professor emeritus of geological sciences, died at his home on May 20 following a courageous battle with kidney cancer. He was 71 years old.

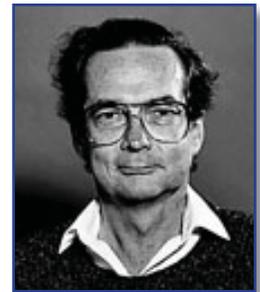


Essene received his Bachelor of Science in geology from the Massachusetts Institute of Technology in 1961 and his Ph.D. from the University of California, Berkeley, in 1967. He was a National Science Foundation postdoctoral fellow at Cambridge University from 1967 to 1968, and a research fellow at the Australian National University in Canberra from 1968 to 1970. He joined the University of Michigan as an assistant professor in 1970, where he enjoyed a very productive and distinguished career, retiring in 2009 as the William C. Kelly Chair of Geological Sciences. Author of well over 200 scientific publications in peer-reviewed journals, Essene made numerous and profound contributions in broad areas of mineralogy, petrology, and geochemistry.

Considered by many of his peers to be the most influential petrologist of his generation, Essene received numerous awards and honors, including the 2010 Penrose Medal, the top prize awarded by the Geological Society of America to individuals who significantly advance the study of geosciences. Perhaps one of his most enduring legacies is his direction and co-direction of over 100 M.S. and Ph.D. students, many of whom have gone on to stellar careers in the geosciences and are themselves training the next generation of geoscientists.

## **Floyd Herbert**

Floyd Herbert passed away on May 12, 2010, following a series of lung infections that could not be cured. Born and raised in California, Herbert graduated from the California Institute of Technology and attended graduate school in Tucson. A co-investigator on the Voyager mission, Herbert was champion of the ultraviolet spectral region for use in understanding the physics of the upper atmospheres and magnetospheric properties and interactions of Uranus, Neptune, and Triton. His passion was the study of the many intricacies of the Io plasma torus. Earlier in his career, Herbert worked at Kitt Peak, then went to the Lunar and Planetary Laboratory at the University of Arizona where he conducted research on early planetary heating and the magnetospheres of the outer planets. His early career focused on the interaction of the Moon, Mercury, and asteroids with magnetospheric phenomena, in particular heating of the interior and shielding of the surface from the solar wind.



## **Ardis Nier**

Ardis Nier passed away in December after suffering cardiac arrest. She was the widow of renowned physicist Alfred O. C. Nier, who determined the age of Earth, performed a key experiment that determined that uranium-235 could be made into an atomic bomb, measured the masses of most of the elements on the periodic table, and analyzed the atmosphere of Mars during NASA's 1976 Viking mission to the planet. In honor of her late husband, Ardis Nier established a scholarship in his name at the University of Minnesota, and in 1995 created an endowment to fund the Nier Prize of the Meteoritical Society. Her philanthropy and support of the Physics and Geology Departments at the University of Minnesota, as well as the Meteoritical Society, were much appreciated among the scientific community.

## Books



### ***Europa.***

Edited by Robert T. Pappalardo, William B. McKinnon, and Krishan K. Khurana.

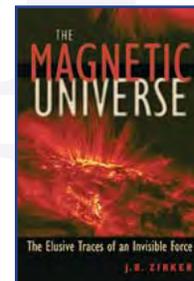
University of Arizona Press, 2009. 720 pp., Hardcover, \$85.00. [www.uapress.arizona.edu](http://www.uapress.arizona.edu)

Few worlds are as tantalizing and enigmatic as Europa, whose complex icy surface intimates the presence of an ocean below. Europa beckons for our understanding and future exploration, enticing us with the possibilities of a water-rich environment and the potential for life beyond Earth. This new volume in the Space Science Series, with more than 80 contributing authors, reveals the discovery and current understanding of Europa's icy shell, subsurface ocean, presumably active interior, and myriad inherent interactions within the Jupiter environment. *Europa* is the foundation upon which the coming decades of scientific advancement and exploration of this world will be built, making it indispensable for researchers, students, and all who hold a passion for exploration.

### ***The Magnetic Universe: The Elusive Traces of an Invisible Force.***

By J. B. Zirker. Johns Hopkins University Press, 2009. 312 pp., Paperback, \$35.00. [www.press.jhu.com](http://www.press.jhu.com)

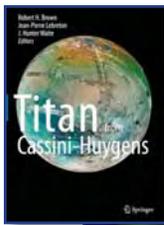
Magnetic fields permeate our vast universe, urging electrically charged particles on their courses, powering solar and stellar flares, and focusing the intense activity of pulsars and neutron stars. Magnetic fields are found in every corner of the cosmos. For decades, astrophysicists have identified them by their effects on visible light, radio waves, and X-rays. Zirker summarizes our deep knowledge of magnetism, pointing to what is yet unknown about its astrophysical applications. In clear, nonmathematical prose, Zirker follows the trail of magnetic exploration from the auroral belts of Earth to the farthest reaches of space. He guides readers on a fascinating journey of discovery to understand how magnetic forces are created and how they shape the universe. He provides the historical background needed to appreciate exciting new research by introducing readers to the great scientists who have studied magnetic fields. Students and amateur astronomers alike will appreciate the readable prose and comprehensive coverage of *The Magnetic Universe*.



### ***The Seventh Landing: Going Back to the Moon, This Time to Stay.***

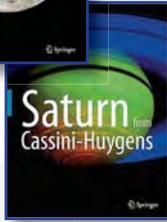
By Michael Carroll. Springer, 2009. 200 pp., Hardcover, \$29.95. [www.springer.com](http://www.springer.com)

Just 40 years ago, in July 1969, one of humankind's greatest dreams was accomplished. Men flew safely to the Moon, landed and walked on its surface, and then returned home. There were six Moon landings by the Apollo team in that time period, but when the last one blasted off the surface of the Moon to return home, our dreams of establishing a permanent presence on the Moon were put on hold to deal with other priorities. For a while, those dreams seemed to be dead, and many looked back at the Apollo era with nostalgia, and a great sense of loss at its ending. But today we are making big plans again, and this time, our plans include not only setting up a permanent settlement on the Moon but preparing the way for an eventual trip to Mars. Many countries, in fact, are contributing to this effort, some as part of an international venture with the United States spearheading the effort, some making plans to go on their own. The "seventh landing" on the Moon will begin a new era in spacefaring. See how we are going to accomplish this quest in this stunning and beautifully written book by veteran space writer and artist Michael Carroll, which includes interviews with a dozen Apollo and shuttle astronauts and Soviet cosmonauts.



***Titan from Cassini-Huygens.***

Edited by Robert Brown, Jean Pierre Lebreton, and Hunter Waite. Springer, 2010. 535 pp. with CD-ROM, Hardcover, \$119.00. [www.springer.com](http://www.springer.com)



***Saturn from Cassini-Huygens.***

Edited by Michele Dougherty, Larry Esposito, and Stamatios M. Krimigis. Springer, 2009. 805 pp. with CD-ROM, Hardcover, \$119.00. [www.springer.com](http://www.springer.com)

These books review our current knowledge of Saturn and its largest moon, Titan, featuring the latest results obtained by the Cassini-Huygens mission. Global author teams address Saturn's and Titan's origin and evolution, internal structure, composition and chemistry, atmosphere and ionosphere, and magnetosphere and magnetospheric interactions. The books close with an outlook beyond the Cassini-Huygens mission. Colorfully illustrated, these volumes will serve as a

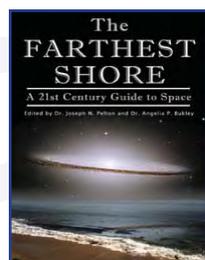
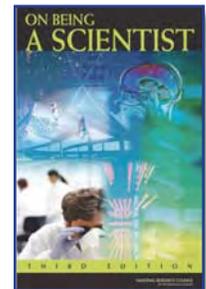
reference to researchers as well as an introduction for students.

***On Being a Scientist: A Guide to Responsible Conduct in Research, 3rd edition.***

By the Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. National Academies Press, 2009. 82 pp., Paperback, \$12.95. [www.nap.edu](http://www.nap.edu)

The scientific research enterprise is built on a foundation of trust. Scientists trust that the results reported by others are valid. Society trusts that the results of research reflect an honest attempt by scientists to describe the world accurately and without bias. But this trust will endure only if the scientific community devotes itself to exemplifying and transmitting the values associated with ethical scientific conduct.

This book was designed to supplement the informal lessons in ethics provided by research supervisors and mentors and describes the ethical foundations of scientific practices and some of the personal and professional issues that researchers encounter in their work. It applies to all forms of research — whether in academic, industrial, or governmental settings — and to all scientific disciplines. This edition reflects developments since the publication of the original edition in 1989 and a second edition in 1995. A continuing feature of this edition is the inclusion of a number of hypothetical scenarios offering guidance in thinking about and discussing these scenarios. *On Being a Scientist* is aimed primarily at graduate students and beginning researchers, but its lessons apply to all scientists at all stages of their scientific careers.

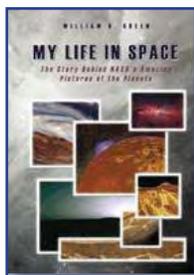


***The Farthest Shore: A 21st Century Guide to Space.***

Edited by Joseph N. Pelton and Angelia P. Buckley. Apogee Books, 2010. 416 pp., Paperback, \$31.95. [www.apogeebooks.com](http://www.apogeebooks.com)

*The Farthest Shore* is a comprehensive new guide to space systems and exploration as we reach anew into space in the twenty-first century. Inside, everyone from a questing student to a sci-fi fan can find out about all aspects of space, from how we use space to deal with global warming to the latest in space tourism. Experts assembled from around the world, from astronauts and astrophysicists to space zoologists, will tell us about the different ways we can use space to survive on Earth,

explore the unknown cosmos, or create totally new industries. This book, largely written in narrative form, contains a series of interesting stories about how we use space in dozens of ways that continue to expand wider and wider every year. *The Farthest Shore* is written so that everyone from high school students to news reporters, from sci-fi fans to space groupies, can acquire a broad-based understanding of all the things that outer space represents to humans today — and tomorrow. It is unique in its wide, thorough, and international approach, with authors drawn from around the world.



***My Life in Space: The Story Behind NASA's Amazing Pictures of the Planets.***  
By William B. Green. BookSurge Publishing, 2009. 248 pp., Paperback, \$47.99. [www.amazon.com](http://www.amazon.com)

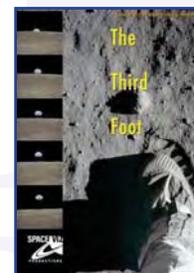
*My Life in Space: The Story Behind NASA's Amazing Pictures of the Planets*, by award-winning author William B. Green, presents a compilation of intimate and revealing anecdotes that take the reader deep behind the scenes of the famous space agency's unmanned missions to reveal the methods, techniques, and personalities responsible for NASA's rich and spectacular collection of pictures of the planets and beyond. With more than 20 years' experience managing teams working on various unmanned space missions, author Green brings a rare, insider's look into the inner workings of one of the world's most comprehensive efforts to document our solar system, its planets, moons, and the universe. With almost 60 illustrations, including dramatic photographs taken by NASA spacecraft over the past four decades, and photos taken in many of the operations areas supporting the historic space missions, *My Life in Space* promises surprises with every turn of the page.

## DVDs

### ***The Third Foot.***

Produced by Space Viz Productions, 2009, one disc. \$29.99. [www.amazon.com](http://www.amazon.com)

*The Third Foot* is based on an exclusive Space Viz interview with Apollo 11 astronaut Buzz Aldrin. Archival footage and audio are blended with new animations to round out his take on the past, present, and future of manned space exploration. Bonus materials including animations, a slide show, and trailers are included. Running time 60 minutes.



## For Kids!



### ***Famous Scientists Poster.***

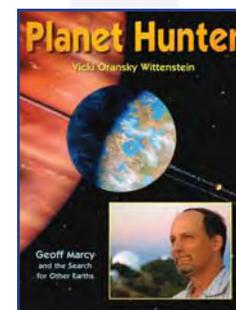
Produced by Spaceshots. 24-inch x 36-inch poster, \$13.00. [www.spaceshots.com](http://www.spaceshots.com)

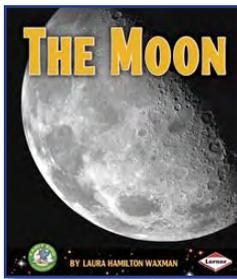
This educational chart shows famous scientists through the ages. A nice reference for children and adults.

### ***Planet Hunter: Geoff Marcy and the Search for Other Earths.***

By Vicki Oransky Wittenstein. Boyds Mills Press, 2010. 48 pp., Hardcover, \$17.95. [www.boydsmillpress.com](http://www.boydsmillpress.com)

He has discovered more planets than anyone in history. In this inspiring true story, Geoff Marcy's love of space helped him overcome struggles in his studies until finally he became an astronomer. But he was not on track to make major discoveries. Eventually, he went back to the questions that thrilled him as a boy: Are we alone? Do Earth-like planets orbit the stars in the night sky? It would not be easy to find a planet outside our solar system. Others had tried and failed, but Marcy never gave up. Since 1995, he and his colleagues have discovered nearly half of the 380 known "extrasolar" planets. Stunning paintings transport the reader to the exotic worlds that he and others have found. For grades 4–6.





**The Moon.**

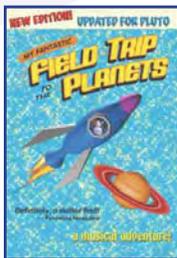
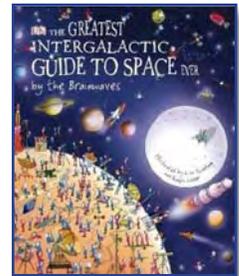
By Laura Hamilton Waxman. Lerner Publications, 2010. 48 pp., Hardcover, \$26.60. [www.lernerbooks.com](http://www.lernerbooks.com)

This lively and informative book introduces beginning readers to the Moon's orbit around Earth, phases of the Moon and eclipses, the Moon's effect on tides, and more. For ages 7–11.

**The Greatest Intergalactic Guide to Space Ever by the Brainwaves.**

By Claire Watts. Dorling Kindersley Publishing, 2009. 64 pp., Hardcover, \$19.99. [www.dk.com](http://www.dk.com)

More delightful fun with the Brainwaves. This time they blast off into space to bring the science to you — in fabulously fun and funny text. Stars, galaxies, black holes, nebulae, asteroids, and more are discussed in clear text, meant to engage and entertain readers of all ages.



**My Fantastic Field Trip to the Planets DVD (Updated for Pluto).**

Produced by Library Video Company, 2009, one disc. \$16.95. [www.libraryvideo.com](http://www.libraryvideo.com)

Children will learn all about the planets and solar system as they follow a young boy in his toy rocket on a live-action musical adventure. Traveling inside his toy rocket, young Jake's survival depends on the help of friendly planets, who magically talk and sing. The planets help Jake make it through the dangerous asteroid belt and get back home before his mother discovers that he is gone. Features original songs, stunning visual effects, and a kid-friendly look at why Pluto is no longer a planet. Running time

90 minutes. For grades 2–5.

**Space Junkyard Board Game.**

Produced by Mayday Games, 2009. \$34.95. [maydaygames.com](http://maydaygames.com)

Space has become a giant dumping ground for jettisoned components and derelict spacecraft. But the tide could be turned by clever star pilots hoping to expand their tiny ships. Navigating through a sea of asteroids and recyclable parts, pilots collect resources and salvaged ship modules in a quest to build the largest and most complete starship. With amazing new artwork and enhanced space theme by artist Orlando Ramirez, this game promises to fill the vacuum of the science fiction game genre. For ages 10 and up.



**Hubble Space Telescope (HST) Space Craft Science Kit.**

Produced by Space Craft International. Laser-cut paper and foil model, \$9.95. [www.spacecraftkits.com](http://www.spacecraftkits.com)

The Hubble Space Telescope (HST) Space Craft Science Kit is very realistic, and it's hard to tell from a distance that it's made of paper. Many of its parts have bonded metal foil and look like they're made of metal. The model features blue- and gold-foil solar panels. Internal details include reflective primary and secondary mirrors along with printed trusses and baffles. Information online includes instructions for modifying the completed model to install new instruments as astronauts did first in December 1993, and again on later upgrade missions. Assembled model is about 10 inches (26 cm) overall. Scale is approximately 1/65. This model is available as an online kit with assembly instructions and information available on the website.

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.

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## July

- 4–8 **Australian Earth Sciences Convention 2010**, Canberra, Australia. <http://www.aesc2010.gsa.org.au/>
- 5–9 **Asia Oceania Geosciences Society 2010**, Hyderabad, India. <http://www.asiaoceania.org/society/>
- 13–15 **Planetary Decadal Survey Meeting: Steering Group**, Washington, DC. [http://sites.nationalacademies.org/SSB/CurrentProjects/ssb\\_052412](http://sites.nationalacademies.org/SSB/CurrentProjects/ssb_052412)
- 13–15 **Second Workshop on Binaries in the Solar System**, Poznan, Poland. <http://www.boulder.swri.edu/binaries2-mtg/>
- 14–16 **Workshop on Dust Spectroscopy and Dust Astronomy (Dusty Visions 2010)**, Göttingen, Germany. [http://www.mpi-hd.mpg.de/dustgroup/dusty\\_visions\\_2010/](http://www.mpi-hd.mpg.de/dustgroup/dusty_visions_2010/)
- 18 **First Annual Lunar Graduate Conference (LunGradCon 2010)**, Mountain View, California. <http://lasp.colorado.edu/ccldas/lgc2010/>
- 18–22 **IAU Symposium 282: From Interacting Binaries to Exoplanets: Essential Modeling Tools**, Tatranská Lomnica, Slovakia. <http://www.astro.sk/IB2E/>
- 18–25 **38th Scientific Assembly of the Committee on Space Research (COSPAR)**, Bremen, Germany. <http://www.cospar-assembly.org/>
- 19 **Next Generation Lunar Scientists and Engineers (NGLSE) Workshop**, Mountain View, California. <http://lunarscience.arc.nasa.gov/events/nextgenworkshop>
- 20–22 **NASA Lunar Science Forum**, Mountain View, California. <http://lunarscience2010.arc.nasa.gov/>
- 21–23 **2010 HST Calibration Workshop**, Baltimore, Maryland. <http://www.stsci.edu/institute/conference/cal10>
- 23–24 **Two-Day Field Trip to Santa Fe Impact Structure and Valles Caldera**, Albuquerque/Santa Fe, New Mexico. <http://epswww.unm.edu/sftrip/>
- 26–29 **Fourth Europa Jupiter System Mission (EJSM) Instrument Workshop**, Pasadena, California. <http://opfm.jpl.nasa.gov/InstrumentWorkshop/>
- 26–30 **73rd Annual Meeting of the Meteoritical Society**, New York, New York. <http://www.lpi.usra.edu/meetings/metsoc2010/>

- 31–Aug 4 **122nd Annual Meeting of the Astronomical Society of the Pacific**, Boulder, Colorado. <http://www.astrosociety.org/events/meeting.html>

## August

- 3–4 **3rd Meeting of the Small Bodies Assessment Group**, Pasadena, California. <http://www.lpi.usra.edu/sbag/meetings/>
- 3–7 **10th International Colloquium on Atomic Spectra and Oscillator Strengths for Astrophysical and Laboratory Plasmas**, Berkeley, California. <http://sprg.ssl.berkeley.edu/labastro/ASOS10/index.html>
- 8–13 **2010 Meeting of the Americas**, Foz do Iguaçu, Brazil. <http://www.agu.org/meetings/ja10/>
- 11–14 **Planetary Systems Beyond the Main Sequence**, Bamberg, Germany. <http://www.sternwarte.uni-erlangen.de/conf2010-1st.pdf>
- 13–15 **SETIcon: A National Convention About the Search for Life in the University in Science Fact and Science Fiction**, Santa Clara, California. <http://www.seticon.com/>
- 16–22 **Astronomy and Astrophysics in Antarctica**, Xi'an, China. <http://aag.bao.ac.cn/Academic/xian/index.html>
- 21–27 **IMA 2010: Planetary Mineralogy Special Sessions**, Budapest, Hungary. [http://www.ima2010.hu/?my\\_view=nice&p=sp3pl](http://www.ima2010.hu/?my_view=nice&p=sp3pl)
- 21–27 **International Mineralogical Association (IMA2010): Bonds and Bridges**, Budapest, Hungary. <http://www.ima2010.hu/>
- 23–27 **Detection and Dynamics of Transiting Exoplanets**, Observatoire de Haute-Provence, France. <http://www.obs-hp.fr/ohp2010/>
- 30– Sep 2 **Venus, Our Closest Earth-like Planet: From Surface to Thermosphere – How Does It Work?**, Madison, Wisconsin. <http://www.venus.wisc.edu/workshop/index.html>
- 30–Sep 3 **25th Summer School and International Symposium on the Physics of Ionized Gases**, Donji Milanovac, Serbia. <http://webhost.rcub.bg.ac.rs/~spig2010/>
- 30–Sep 4 **Astronomy and Power: How Worlds Are Structured**, Gilching, Germany. <http://seac-2010.vhs-gilching.org/index.php>

## September

- 2 **Eighth Meeting of the Venus Exploration and Analysis Group (VEXAG)**, Madison, Wisconsin. <http://www.lpi.usra.edu/vexag/>
- 6–9 **Herschel and the Formation of Stars and Planetary Systems**, Göteborg, Sweden. <http://www.chalmers.se/rss/EN/research/research-groups/radio-astronomy/herschel-formation-stars>
- 6–10 **Advances in Plasma Astrophysics**, Giardini Naxos, Italy. <http://plasma.oact.inaf.it/>
- 6–10 **Joint European and National Astronomy Meeting**, Lisbon, Portugal. <http://www.jenam2010.org/>
- 7–10 **Exploring the Diversity of Planetary Atmospheres**, Exeter, United Kingdom. <http://www.exeter.ac.uk/research/excellence/keythemes/extrasolarplanets/exoclimesconference/>
- 14–16 **Annual Meeting of the Lunar Exploration Analysis Group (LEAG 2010)**, Washington, DC. <http://www.lpi.usra.edu/meetings/leag2010>
- 15–17 **Seventh International Workshop on Planetary, Solar, and Heliospheric Radio Emissions (PREVII)**, Graz, Austria. <http://pre7.oeaw.ac.at/>
- 16–17 **Outer Planets Assessment Group (OPAG) Meeting**, Boulder, Colorado. <http://www.lpi.usra.edu/opag/>
- 19–25 **European Planetary Science Congress 2010**, Rome, Italy. <http://meetings.copernicus.org/epsc2010/>
- 20–22 **Journées 2010 — “Systèmes de référence spatio-temporels”: New Challenges for Reference Systems and Numerical Standards in Astronomy**, Paris, France. <http://syrtre.obspm.fr/journees2010/>
- 20–24 **The 10th European VLBI Network Symposium and EVN Users Meeting: VLBI and the New Generation of Radio Arrays**, Manchester, United Kingdom. <http://www.jodrellbank.manchester.ac.uk/meetings/evn2010/>
- 22–24 **First Planetary Crater Consortium Meeting**, Flagstaff, Arizona. <http://www.planetarycraterconsortium.nau.edu/>
- 27–29 **Fourth Mars Science Laboratory Landing Site Community Workshop**, Pasadena, California. <http://marsoweb.nas.nasa.gov/landingsites/>
- 27–Oct 1 **61st International Astronautical Congress**, Prague, Czech Republic. <http://www.iac2010.cz/en/welcome>

## October

- 4–8 **5th Alfvén Conference on Plasma Interaction with Non-Magnetized Planets/ Moons and Its Influence on Planetary Evolution**, Sapporo, Japan. <http://www.ep.sci.hokudai.ac.jp/~alfven5/>
- 4–8 **42nd Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society (DPS 2010)**, Pasadena, California. <http://dps.aas.org/meetings/2010/>
- 5–6 **Robotic Science from the Moon: Gravitational Physics, Heliophysics and Cosmology**, Boulder, Colorado. <http://lunar.colorado.edu/workshop.php>
- 10–12 **WittFest: Origins and Evolution of Dust**, Toledo, Ohio. <http://wittfest.net/Welcome.html>
- 11–14 **Science with the Hubble Space Telescope — III**, Venice, Italy. <http://www.stecf.org/conferences/HST3/>
- 11–15 **IAU Symposium 276: The Astrophysics of Planetary Systems: Formation, Structure, and Dynamical Evolution**, Torino, Italy. [http://iaus276.oato.inaf.it/IAUS\\_276/index.htm](http://iaus276.oato.inaf.it/IAUS_276/index.htm)
- 11–15 **First Moscow Solar System Symposium (1M-S3)**, Moscow, Russia. <http://ms2010.cosmos.ru/>
- 16–18 **The 3rd International Congress on Image and Signal Processing (CISP'10) and The 3rd International Conference on BioMedical Engineering and Informatics (BMEI'10)**, Yantai, China. <http://cisp-bmei2010.ytu.edu.cn/>
- 25–29 **In the Spirit of Lyot 2010: Direct Detection of Exoplanets and Circumstellar Disks**, Paris, France. <http://lyot2010.lesia.obspm.fr/>
- 25–29 **7th International Conference on the Inspiration of Astronomical Phenomena**, Bath, United Kingdom. <http://www.insapvii.org/>
- 31–Nov 3 **Geological Society of American Annual Meeting**, Denver, Colorado. <http://www.geosociety.org/meetings/2010/>

## November

- 1–5 **International Young Astronomer School on High Angular Resolution Techniques (2010)**, Paris, France. <http://ufe.obspm.fr/rubrique256.html>

## December

- 13–17 **Fall Meeting of the American Geophysical Union**, San Francisco, California. <http://www.agu.org/meetings/fm10/>