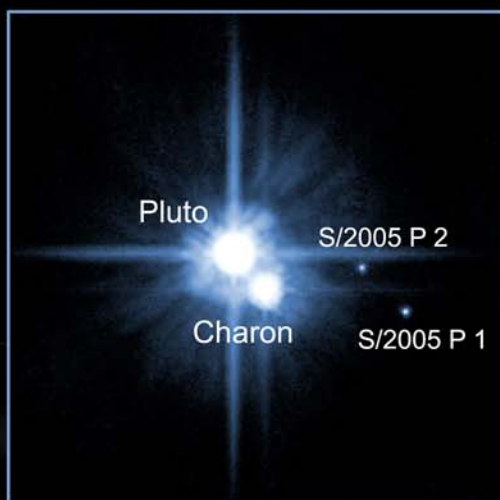


# GOING TO PLUTO: THE NEW HORIZONS MISSION



## Lunar and Planetary Information BULLETIN

Lunar and Planetary Institute — Universities Space Research Association

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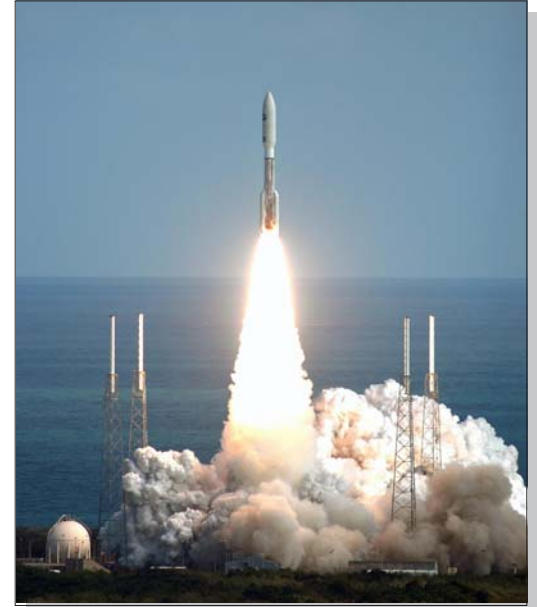
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# GOING TO PLUTO: THE NEW HORIZONS MISSION

— Paul Schenk, Lunar and Planetary Institute

Fastest man-made object to leave Earth. Fastest flight past the Moon's orbit. It was a day of superlatives, but it didn't come easy for those watching. Going back to 1992, there have been at least three attempts to begin building a spacecraft to go to Pluto, the "last" unexplored planet. Only in 2001 was a team and mission chosen that would finally make it past the hurdles of Congress, the Office of Management and Budget (OMB), and NASA management. Once the process finally began, it took only five years from the call for mission proposals to launch day.

Once on the launch pad, things went relatively smoothly until launch day itself, originally set for January 10 but then pushed back until January 17. Although involved with NASA for more than 20 years now, I had never personally witnessed a launch. We arrived at Kennedy Space Center early on the 17th, as directed, and waited outside to the music of *2001 — A Space Odyssey* and a recording of the voice of Neil Armstrong walking on the Moon. We met many of our friends from the team, and together we boarded the fleet of buses to the viewing area. It was warm but windy, a bad omen. The launch window was only three hours long and peak winds kept exceeding the tolerable limits for launch. Every 15 minutes or so the launch commentator announced that the launch time was being pushed back again in hopes the winds would subside. They didn't. Two minutes and 34 seconds before the launch window closed for the day, the winds gusted again, and we left our bleachers disappointed but hopeful that the next day would bring nicer weather.



*New Horizons finally launches.  
Photo courtesy of NASA/KSC.*

The next day we woke to calm and clear weather, but no sooner did we leave our hotel room than the call came. A power outage had scrubbed the launch for the day. The power loss was not at the Cape, but at the command center at the Johns Hopkins Applied Physics Laboratory in Maryland, where violent thunderstorms had been wreaking havoc that morning.

Day 3, January 19, dawned fair. We saddled up for another attempt. We were disappointed to find out that we would be going to a viewing area twice as far from the site as that at which we had witnessed the first scrub. Something about the winds blowing launch exhaust in the wrong direction (not that that concerned any of us!). Oh, well . . . We wanted to see a launch to Pluto and we refused to be denied! We boarded the bus and headed south. The sky now consisted of broken cloud cover. Again we waited, this time for a patch of partly cloudy sky to move over the launch site so the Atlas V rocket could be tracked properly. From our perspective 10 miles away it looked hopeless, but one hour after the launch window opened, the all-clear signal was given and the final four-minute countdown began. During the final minute, the crowd of several hundred onlookers became silent. At T-minus 5 seconds, the crowd took up the count and chanted in unison as the clock counted down to 0. The puff of smoke at the rocket's base told us that the launch was underway. The large rocket and its tiny payload accelerated rapidly. In about 2 minutes it had disappeared from sight except for a razor-thin contrail high up that briefly peeked out from behind the clouds. A cheer went up 45 minutes later when the announcement was made that the spacecraft had separated from its upper stages and was free. (Although the fastest spacecraft to leave Earth, both Galileo and its Jupiter probe and the two Helios Sun-orbiting spacecraft traveled faster during their missions.) Only 9 hours later, the spacecraft had passed the Moon's orbit; 35 days

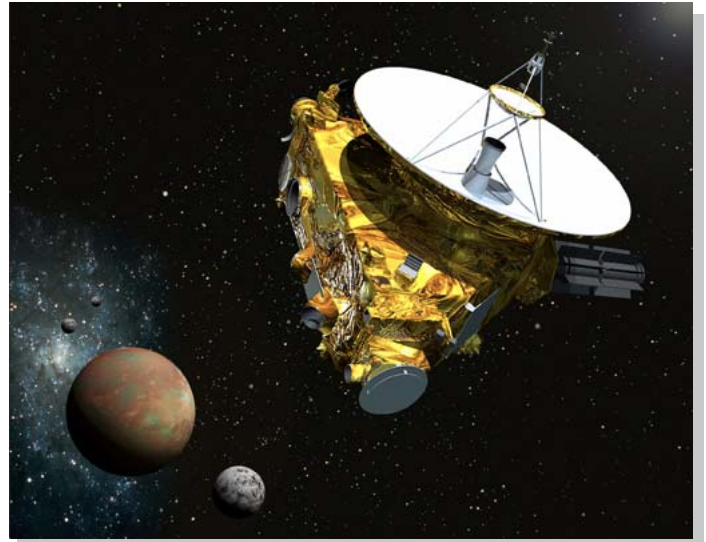


*New Horizons begins its long journey toward  
Jupiter, Pluto, and the Kuiper belt.  
Photo courtesy of Dr. Paul Schenk.*

## GOING TO PLUTO *(continued)*

out, it is halfway to Mars' orbit. Meanwhile, the craft has been undergoing system checkouts as it sets its sights on its first target, Jupiter.

Planning is in earnest for the Jupiter encounter on February 28, 2007. The primary motive for going to Jupiter is to shorten the trip to Pluto by several years by using the giant planet's gravity to accelerate the New Horizons spacecraft. This will require a pass within ~32 jovian radii of the cloud tops, just outside the orbit of Callisto, the outermost of Jupiter's four large moons. Sadly, Callisto will be on the other side of Jupiter at the time, but good views will be had of all four satellites, Io, Europa, Ganymede, and Callisto. The Jupiter flyby also gives New Horizons an important opportunity to validate and calibrate its instrument suite and to rehearse procedures and techniques that will be required during the high-speed flyby of Pluto on July 14, 2015. New Horizons will also be doing some interesting science. It will provide our first look at Io's volcanos since 2001, search for large troughs on Europa, and observe Jupiter and its moons at infrared and ultraviolet wavelengths not seen by Galileo. It will also watch cloud motions on Jupiter and examine the thin rings from new perspectives.



*Artist rendition of New Horizons craft approaching Pluto and its three moons. Image courtesy of Johns Hopkins University Applied Physics Laboratory/ Southwest Research Institute.*

After Jupiter, New Horizons enters a long eight-year cruise, during which the spacecraft sleeps most of the time, reporting diagnostic engineering data back to Earth once a week. The science and engineering teams won't be sleeping, however. They will be busy preparing for the Pluto encounter in 2015, searching for the Kuiper belt object that will be New Horizons' target after Pluto, and studying Pluto itself in order to learn as much as possible before we get there. We have already learned recently that Pluto has at least three moons, not just one as previously thought. And, as discovered in 1988, Pluto also has a thin atmosphere. Indeed, these may be traits common to many Kuiper belt objects. Thousands of these small icy planetoids populate the region beyond Neptune, forming the vast Kuiper belt, of which Pluto is one of the largest members. The first direct exploration of this remnant of the solar system's birth is underway. Set your calendars for the summer of 2015. Only 4.7 billion kilometers and 3400 days to go!

For more information, visit the New Horizons Web site at <http://pluto.jhuapl.edu>.

*Celebrating the launch are Carter Emmart (Hayden Planetarium), Patsy Tombaugh (wife of Clyde Tombaugh, who discovered Pluto), and Robert Staehle (Jet Propulsion Laboratory).*



*Paul Schenk (far right) and friends gather for the New Horizons launch.*





# NEWS FROM SPACE

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## **COMET TALE DRAWS TO A SUCCESSFUL CLOSE IN UTAH DESERT**

On January 15, NASA's Stardust sample return mission returned safely to Earth when the capsule carrying cometary and interstellar particles successfully touched down at 2:10 a.m. Pacific time in the desert salt flats of the U.S. Air Force Utah Test and Training Range. "Ten years of planning and seven years of flight operations were realized early this morning when we successfully picked up our return capsule off of the desert floor in Utah," said Tom Duxbury, Stardust project manager at NASA's Jet Propulsion Laboratory. "The Stardust project has delivered to the international science community material that has been unaltered since the formation of our solar system."

Stardust released its sample return capsule at 9:57 p.m. Pacific time on January 14, and the capsule entered Earth's atmosphere four hours later. "I have been waiting for this day since the early 1980s when Deputy Principal Investigator Dr. Peter Tsou of JPL and I designed a mission to collect comet dust," said Stardust principle investigator Don Brownlee of the University of Washington, Seattle. "To see the capsule safely back on its home planet is a thrilling accomplishment."

The sample return capsule's cargo of cometary and interstellar dust particles has been transferred to a cleanroom at the NASA Johnson Space Center in Houston, where it is currently being investigated and analyzed. The first look at these samples indicated that thousands of particles had been collected, exceeding expectations. The Stardust mission traveled 2.88 billion miles during its seven-year round-trip odyssey. Scientists believe these precious samples will help provide answers to fundamental questions about comets and the origins of the solar system. The first detailed results from the analyses of these extraterrestrial materials will be presented at the upcoming Lunar and Planetary Science Conference.

For more information about the Stardust mission, visit [www.nasa.gov/stardust](http://www.nasa.gov/stardust) or [stardust.jpl.nasa.gov](http://stardust.jpl.nasa.gov).



*Composite image of Comet Wild 2. Image courtesy of NASA/JPL.*

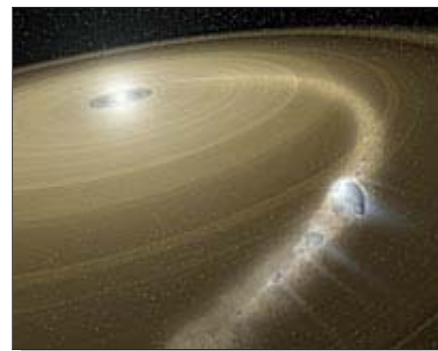
## **SPITZER FINDS POSSIBLE COMET DUST AROUND DEAD STAR**

NASA's Spitzer Space Telescope has spotted what may be comet dust sprinkled around the white dwarf star G29-38, which died approximately 500 million years ago. The findings suggest the dead star, which most likely consumed its inner planets, is still orbited by a ring of surviving comets and possibly outer planets. This is the first observational evidence that comets can outlive their suns.

"Astronomers have known for decades that stars are born, have an extended middle age, and then wither away or explode. Spitzer is helping us understand how planetary systems evolve in tandem with their parent stars," said David Leisawitz, Spitzer program scientist.

Astronomers believe white dwarfs are shrunken skeletons of stars that were once similar to Earth's Sun. As the stars aged over billions of years, they grew brighter and eventually swelled in size to become red giants. Millions of years later, the red giants shed their outer atmospheres, leaving behind white dwarfs. If any planets did orbit in these systems, the red giants would have engulfed at least the inner ones. Only distant outer planets and an orbiting icy outpost of comets would have survived.

"The dust seen by Spitzer around G29-38 was probably generated relatively recently when one such outlying comet may have been knocked into the inner region of the system and ripped into dust shreds by the tidal forces of the star," said astronomer William Reach of the Spitzer Science Center at the California Institute of Technology. Prior to the Spitzer findings, astronomers studying G29-38 noticed an unusual and unknown source of infrared light. Spitzer, with its powerful infrared spectrometer, was able to break this light apart, revealing its molecular makeup. These data told astronomers the light was coming from the same types of dusty minerals found in comets in our solar system. "We detected a large quantity of very small, dirty silicate grains," said astronomer Marc Kuchner of NASA's Goddard Space Flight Center. "The size of these grains tells us they are probably from comets and not other planetary bodies."



## NEWS FROM SPACE *(continued)*

In our own solar system, comets reside in the cold outer fringes in regions known as the Kuiper belt and Oort cloud. Only when something disturbs their orbits, such as another comet or an outer planet, do they begin periodic journeys into the Sun's warmer neighborhood. However, these trips to the tropics often end in destruction. Comets slowly disintegrate as they pass close to the Sun, or they crash into it. They also occasionally crash into planets, as did Comet Shoemaker-Levy 9 when it plunged into Jupiter.

Although the dust seen by Spitzer around the white dwarf is most likely the remains of such a torn-up comet, there may be other explanations. One possibility is that a second wave of planets formed long after the death of the star, leaving a dusty construction zone.

For additional information about the Spitzer Space Telescope, visit [www.spitzer.caltech.edu/spitzer](http://www.spitzer.caltech.edu/spitzer).

### **MARS ROVERS ADVANCE UNDERSTANDING OF THE RED PLANET**

NASA's Mars rovers, Spirit and Opportunity, have been working overtime to help scientists better understand ancient environmental conditions on the red planet. The rovers are also generating excitement about the exploration of Mars outlined in NASA's Vision for Space Exploration. The rovers continue to find new variations of bedrock in areas they are exploring on opposite sides of Mars. The geological information they have collected adds evidence about ancient martian environments that included periods of wet, possibly habitable conditions.

"The extended journeys taken by the two rovers across the surface of Mars have allowed the science community to continue to uncover discoveries that will enable new investigations of the red planet far into the future," said Mary Cleave, Associate Administrator for the Science Mission Directorate at NASA Headquarters. NASA's third mission extension for the rovers lasts through September 2006, if they remain usable that long. During their three-month primary missions, the rovers drove farther and examined more rocks than the prescribed criteria for success.

Opportunity began its third year on January 24. It is examining bedrock exposures along a route between the Endurance and Victoria Craters. Opportunity found evidence of a long-ago habitat of standing water on Mars. On January 3, Spirit passed its second anniversary inside the Connecticut-sized Gusev Crater. Initially, Spirit did not find evidence of much water, and hills that might reveal more about Gusev's past were still mere bumps on the horizon. By operating eight times as long as planned, Spirit was able to climb up those hills, examine a wide assortment of rocks and find mineral fingerprints of ancient water.

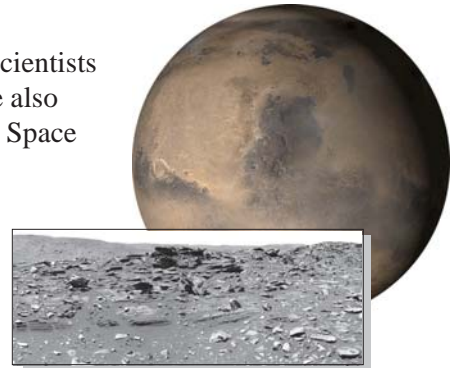
While showing signs of wear, Spirit and Opportunity are still being used to their maximum remaining capabilities. On Spirit, the teeth of the rover's rock abrasion tool are too worn to grind the surface off any more rocks, but its wire-bristle brush can still remove loose coatings. The tool was designed to uncover three rocks, but it exposed interiors of 15 rocks. On Opportunity, the steering motor for the front right wheel stopped working eight months ago. A motor at the shoulder joint of the rover's robotic arm shows symptoms of a broken wire in the motor winding. Opportunity can still maneuver with its three other steerable wheels. Its shoulder motor still works when given extra current, and the arm is still useable without that motor.

The rovers are two of five active robotic missions at Mars, which include NASA's Mars Odyssey and Mars Global Surveyor and the European Space Agency's Mars Express orbiters. The orbiters and surface missions complement each other in many ways. Observations by the rovers provide ground-level understanding for interpreting global observations by the orbiters. In addition to their own science missions, the orbiters relay data from the martian surface.

For images and information about the rovers and their discoveries, visit [www.nasa.gov/mars](http://www.nasa.gov/mars).

### **NASA'S HUBBLE DISCOVERS NEW RINGS AND MOONS AROUND URANUS**

The Hubble Space Telescope photographed a new pair of rings around Uranus and two new, small moons orbiting the planet. The largest ring is twice the diameter of the planet's previously known rings. The rings are so far from the planet, they are being called Uranus' "second ring system." One of the new moons shares its orbit with one of the rings. Analysis of the Hubble data also reveals that the orbits of Uranus' family of inner moons have changed significantly over the past



## NEWS FROM SPACE *(continued)*

decade. “The detection of these new interacting rings and moons will help us better understand how planetary systems are formed and sustained, which is of key importance to NASA’s scientific exploration goals,” said Dr. Jennifer Wiseman, program scientist for Hubble at NASA Headquarters.

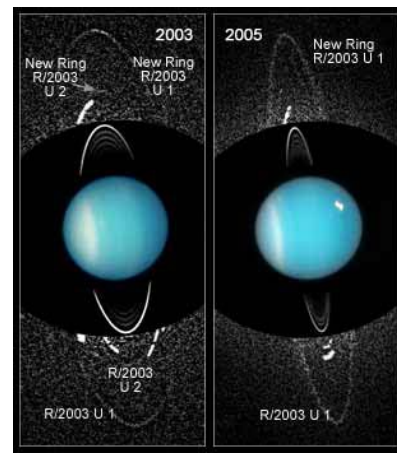
Since dust orbiting Uranus is expected to be depleted by spiraling away, the planet’s rings must be continually replenished with fresh material. “The new discoveries demonstrate that Uranus has a youthful and dynamic system of rings and moons,” said Mark Showalter of the SETI Institute. Showalter and Jack Lissauer of NASA’s Ames Research Center propose that the outermost ring is replenished by a 12-mile-wide newly discovered moon, named Mab, which they first observed using Hubble in 2003. Meteoroid impacts continually blast dust off the surface of Mab. The dust then spreads out into a ring around Uranus. Mab’s ring receives a fresh infusion of dust from each impact. Nature keeps the ring supplied with new dust while older dust spirals away or bangs back into the moon.

Showalter and Lissauer believe the discovery of the second ring, which orbits closer to the planet than the outer ring, provides further evidence that collisions affect the evolution of the system. This second ring has no visible body to resupply it with dust. The ring may be a telltale sign of an unseen belt of bodies a few feet to a few miles in size. Showalter proposes that a previous impact to one of Uranus’ moons could have produced the observed debris ring.

Uranus’s first nine rings were discovered in 1977 during observations of the planet’s atmosphere. During the Voyager encounters, two other inner rings and 10 moons were discovered. However, no one noticed the outer rings, because they are extremely faint and much farther from the planet than expected. Showalter was able to find them by a careful analysis of nearly 100 Voyager images.

Because the new rings are nearly transparent, they will be easier to see when they tilt edge-on. The new rings will increase in brightness every year as Uranus approaches its equinox, when the Sun shines directly over the planet’s equator. When it happens in 2007, all of the rings will be tilted edge-on toward Earth and easier to study.

For images and information about Hubble, visit [www.nasa.gov/hubble](http://www.nasa.gov/hubble).



*Image credit: NASA, ESA, and M. Showalter (SETI Institute).*

### *Solicitation for Contributions*

Contributions to the *Lunar and Planetary Information Bulletin (LPIB)* are solicited from the planetary community and beyond. Articles exploring issues related to planetary science and exploration are welcome. Of special interest are articles describing Web-based research and educational tools, meeting highlights and summaries, and descriptions of new space missions that may be of interest to our readers. Peer-reviewed research articles, however, are not appropriate for publication in the *LPIB*. The *LPIB* is published quarterly and serves the planetary research community, science libraries, educators, students, and lay readers interested in space-science-related research. Suggested topics can be e-mailed to the editors, who will provide guidelines for formatting and content.

*Dr. Paul Schenk,*  
Scientific Editor ([schenk@lpi.usra.edu](mailto:schenk@lpi.usra.edu))  
*Renée Dotson,*  
Production Editor ([dotson@lpi.usra.edu](mailto:dotson@lpi.usra.edu))

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The *Bulletin* welcomes articles dealing with issues related to planetary science and exploration. The copy deadline for the next issue is **April 10, 2006**. Articles or announcements should be submitted via e-mail to [lpibed@lpi.usra.edu](mailto:lpibed@lpi.usra.edu).

To be added to the list to receive notification by e-mail of future issues, please send your e-mail address to [lpibed@lpi.usra.edu](mailto:lpibed@lpi.usra.edu).

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

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# IN MEMORIAM

## PETR JAKEŠ —

Petr Jakeš, Research Scientist at the Institute of Geochemistry of Charles University in Prague, died on November 29, 2005. He was 65 years old.

His diverse research activities included economic and general geology, volcanology, petrology, planetology, and geochemistry of terrestrial and lunar rocks and meteorites, and in recent years was involved with the Mars rover project. He also founded a private laboratory (MDI Technologies) at which he applied his knowledge of superheated melts to produce basalt fibers for weaving fireproof fabric.



Jakeš received a M.Sc. degree from Charles University in Prague in 1962, and then began his Ph.D. study at the Institute of Geology of the Czechoslovak Academy of Science. In 1967 he left the Institute and continued his studies at the Australian National University in Canberra (under A. J. R. White and A. E. Ringwood), receiving his Ph.D. in 1970. From 1970 to 1972 he worked at the Lunar Science Institute (now the Lunar and Planetary Institute) in Houston on materials returned by Apollo missions from the Moon.

Jakeš returned to Czechoslovakia, but for political reasons, was fired from the Institute of Geology, and so acquired a position as a mapping geologist at the Central Geological Survey (now Czech Geological Survey) in Prague. During his years at the Survey, he was able to return to his scientific research and was eventually promoted to the position of Deputy Director for Geological Research. From 1990 to 1992, he returned to the Lunar and Planetary Institute as a visiting scientist. Upon his return to Prague, he began a teaching position at the Faculty of Science of Charles University.

Jakeš was author or coauthor of more than 90 scientific papers and coauthored several textbooks; the 1980 volume *Geochemistry* is still considered one of the leading volumes in the field. Jakeš also authored or coauthored several popular books on geology, volcanology, and geological hazards, and was a regular contributor to newspapers and radio broadcasts. After the “Velvet Revolution” in Czechoslovakia he initiated a television series in which the achievements of Czech scientists were popularized.

In 1999, the asteroid (10170) 1999 DA1, discovered by M. Tichý a Z. Moravec at the observatory at Klee, was named Petrjakeš in honor of Jakeš’ contributions to planetology and Earth science. He was not only intelligent, but witty and entertaining as well, and will be greatly missed. In the text that follows, two of his colleagues and friends share their fond memories with us.

### **Petr Jakeš: A Remembrance** by S. Ross Taylor

Petr came to the Australian National University in 1968, escaping from Czechoslovakia during the brief “Prague Spring.” He became a Ph.D. student with (Ted) Ringwood in the Research School of Earth Sciences, but soon changed supervisors to work with Alan White in the Geology Department. Petr was full of ideas and quickly made a mark with his outgoing personality. He was interested in science far beyond his thesis. After Canberra he went back to Prague and then to the LSI [the Lunar Science Institute, now the Lunar and Planetary Institute]. Petr and I had like interests on many topics. We talked about many geological topics including the geochemistry of sedimentary rocks that eventually resulted in an interesting paper [1]. But Petr had a mercurial mind and soon was interested in other things. I turned up at LSI in 1973 for a year with a charge from Joe Chamberlin, then Director, to make some sense of the mass of data that was accumulating on lunar rocks. As I struggled to make some sense of the Moon, I would usually start my day in the elegant surroundings of the old West mansion [the former location of the LPI] chatting or just gossiping to Petr (always enjoyable, sometimes scandalous, lots of political jokes but always good-natured; a great way to generate ideas). We slowly began to focus on the lunar trace element data; why were all those trace elements in the highland rocks, and why was Eu missing in the basalts? The end result was the Taylor-Jakes model for the geochemical evolution of the Moon [2] that still seems to be robust. Petr was a stimulating and often Rabelaisian colleague and it was a pity that he went back to the rigors of life in Prague as it then was; he would have flourished in the freer intellectual climate in the West.

**References:** [1] Jakeš P. and Taylor S. R. (1974) Excess Eu content in Precambrian sedimentary rocks and continental evolution. *Geochim. Cosmochim. Acta*, 38, 739–745. [2] Taylor S. R. and Jakeš P. (1974) The geochemical evolution of the Moon. *Proc. Lunar Sci. Conf. 5th*, pp. 1287–1306; (1977) Geochemical evolution of the Moon revisited. *Proc. Lunar Sci. Conf. 8th*, pp. 433–446.

### **Recollections of Petr Jakeš** by Arch Reid

I first met Petr Jakeš in 1968 when he was a doctoral student at ANU and I was a visiting postdoc; those were exciting times in the company of a large number of people with great abilities and enthusiasm for the Earth sciences. Even among this group, Petr stood out with his zest for new ideas and for life in general, and with his often colorful language (having learned English, with a penchant for pithy Anglo-Saxon words and phrases, from Mike Rhodes).

After ANU, Petr for some time alternated between communist Czechoslovakia and the United States, particularly the Houston area, where he spent productive time at LPI (including the old LSI where he joined Harold Urey and Ross Taylor as visitors), at the Johnson Space Center, and at the University of Houston. This dichotomy in lifestyle was frequently illuminated by Petr’s insightful and very humorous storytelling. He was in a unique position to appreciate the foibles and the benefits of the Houston way of life, and he plunged with great joy into the fun and the science of dealing with the first lunar samples. I only wish he had written a memoir of this time in history, and of the experiences and the contrasts that he lived through and participated in. One recollection I have is of Petr at a party in the home of one of the Apollo astronauts, passing himself off as a communist spy just to see their reactions. His mind was constant bubble of ideas; for example, he took over the supervision of one of my better graduate students, and then led him into a much more interesting research project. His conversational style was confrontational in a humorous way; people would later remark, “Did he really say that?” Perhaps as a result of his particular background, he had a curious and very perceptive eye for American culture. On a visit back to Houston with a television filming crew from Prague, the first place he took them was the Saturday afternoon Cajun dancing at Petey’s, located across the street from Ellington Air Force Base. In all aspects — his science, his diverse accomplishments, his personality, and his life — Petr Jakeš was interesting, exciting, fun, and always somewhat larger than life.

# SPOTLIGHT ON EDUCATION

“Spotlight on Education” highlights events and programs that provide opportunities for space 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 South Central Organization of Researchers and Educators at [score@lpi.usra.edu](mailto:score@lpi.usra.edu).

## 2006 LPSC E/PO CONFERENCE: PUBLIC UNDERSTANDING OF PLANETARY SCIENCE

The Education/Public Outreach pre-LPSC workshop will take place on Sunday, March 12, from 8:30 a.m. to 2:30 p.m. in the Lecture Hall at the Lunar and Planetary Institute.

*How many stars are in our solar system?*

*Which is closer, Pluto or the stars?*

*How many times each year does the Earth go around our Sun?*

This year’s workshop will focus on what the public knows — or believes they know — about planetary science. Presentations explore where the public glean its knowledge about our solar system, results from recent surveys of the public’s understanding of planetary science, and what research tells us about the best way to present science — and tackle misconceptions — for a lay audience. Participants will brainstorm approaches to presenting scientific results and concepts during interactive sessions.

The workshop, designed to support NASA’s goal to make its science content available to all educators and students, is hosted by the South Central Organization of Researchers and Educators and the Structure and Evolution of the Universe Forum, part of NASA’s Science Mission Directorate’s Education Support Network. Scientists, E/PO leads, and formal and informal educators are invited and encouraged to participate. The workshop is free. Attendees must register using the electronic registration form that will be provided on the LPSC Web site ([www.lpi.usra.edu/meetings/lpsc2006](http://www.lpi.usra.edu/meetings/lpsc2006)). For more information, contact Stephanie Shipp at [shipp@lpi.usra.edu](mailto:shipp@lpi.usra.edu).

## COLLEGE ASTRONOMY TEACHING EXCELLENCE WORKSHOP

Do you teach college astronomy? Are you interested in learning new ways to engage students in the study of our universe? The College Astronomy Teaching Excellence Workshop, sponsored by the NASA JPL Navigator and Spitzer Education and Public Outreach Programs and Pima Community College, will help faculty improve instruction and create productive learning environments using interactive lectures, peer instruction, demonstrations, collaborative groups, and tutorials. Participants will be acquainted with the latest research about how students learn, and will define and set measurable learning goals and objectives for students in astronomy courses. The audience also learn how to write more effective multiple-choice tests and implement authentic assessment strategies including portfolio assessment, performance tasks, and concept maps with the goal of constructing a syllabus and assignments that improve student achievement. The weekend workshop is from 9:00 a.m. to 5:00 p.m. on February 11–12, 2006, at Pima Community College’s Community Campus in Tucson, Arizona. Preregistration is strongly encouraged online at [astronomy101.jpl.nasa.gov](http://astronomy101.jpl.nasa.gov). For more information, please contact Gina Brissenden at [caper@as.arizona.edu](mailto:caper@as.arizona.edu) or at 520-626-9480.

## LPI 2006 EDUCATOR FIELD EXPERIENCE

### THE HEAT FROM WITHIN: EARTHLY INSIGHTS INTO PLANETARY VOLCANISM

Middle-school science educators — and other science teachers — are invited to join planetary scientists on this week-long NASA-sponsored field-based workshop July 9–17, 2006. The field experience will investigate different volcano types in the Bend and Crater Lake regions of Oregon to build an understanding of volcanic features, patterns, and processes on Earth. These field investigations will serve as analogs for understanding the

planetary processes that produce volcanos on planetary bodies in our solar system, including Mars, the Moon,

Venus, and even the moons of Jupiter, Saturn, and Neptune. The experience will be divided between the field and classroom. Classroom time includes presentations, discussion, and laboratory work; participants will work with classroom-tested, hands-on inquiry-based activities and resources that will enhance Earth and space science teaching. Participants receive lesson plans, supporting resources, and presentations. Please encourage educators to apply for this enriching experience!

A limited number of grants are available to cover registration. Applications are due on March 24, 2006. For more information or to access the application form, go to [www.lpi.usra.edu/education/fieldtrips/2006/](http://www.lpi.usra.edu/education/fieldtrips/2006/).





## SPOTLIGHT ON EDUCATION (continued)

### **SUN-EARTH DAY 2006 — ECLIPSE: IN A DIFFERENT LIGHT**

Mark your calendar! The 2006 Sun-Earth Day, March 29, coincides with the total solar eclipse that will take place that day. Since the eclipse is only visible from Brazil, the Atlantic Ocean, Northern Africa, and Central Asia, it will be broadcast live via satellite and Internet. For those in the United States, the actual eclipse will take place at approximately 6:00 a.m. Eastern Standard Time (3:00 a.m. Pacific Standard Time). An archived version of the Web cast will be available soon after the live viewing. Scientists are encouraged to involve local classrooms or learning centers to experience this amazing event! Resources for museums, planetariums, parks, youth clubs, and community organizations are available in the Public Outreach section at [sunearthday.nasa.gov/2006/outreach/index.php](http://sunearthday.nasa.gov/2006/outreach/index.php). Educators are invited to visit the Sun Earth Day Web site for activities and resources at [sunearthday.nasa.gov](http://sunearthday.nasa.gov).



### **VISUALLY IMPAIRED STUDENTS CAN "TOUCH THE SUN"**

Touch the Sun allows blind and visually impaired students to experience images of the Sun and solar activity by feeling transparent raised textures bonded to the pictures. These raised patterns embossed over the colorful images in the book translate shapes, places of solar and magnetic activity, and other details of the Sun and space weather, allowing visually impaired people to develop an understanding of solar phenomena. Touch the Sun incorporates Braille and large-print descriptions for each of the book's 16 photographs, so it is accessible to readers of varying visual abilities. Approximately 2500 copies will be printed. The majority will be distributed free to blind and visually impaired students, with the assistance of the National Organization of Parents of Blind Children, a division of the National Federation of the Blind. The remainder will be available for public purchase. For more information, visit [www.nasa.gov/vision/universe/solarsystem/kids\\_touch\\_the\\_sun.html](http://www.nasa.gov/vision/universe/solarsystem/kids_touch_the_sun.html).

### **MISSIONS IN THE SPOTLIGHT — MAKING THE MOST OF AN EDUCATIONAL OPPORTUNITY**

The *Stardust* mission sample return capsule successfully landed, delivering long-awaited pristine cometary materials. Resources for teachers and other educators, including fact sheets, models, videos, and a suite of activities for children of all ages, can be found at [stardust.jpl.nasa.gov/classroom/products.html](http://stardust.jpl.nasa.gov/classroom/products.html) or [stardust.jpl.nasa.gov/classroom/kids.html](http://stardust.jpl.nasa.gov/classroom/kids.html).



The *New Horizons* mission to Pluto and the Kuiper belt began its long journey in mid-January. The spacecraft will travel 3 billion miles, flying past Pluto in the summer of 2015, moving at about 30,000 miles (48,279 kilometer) per hour. It will continue flying out of the solar system, passing by other Kuiper belt objects on the way. The Web site offers a diverse suite of educational activities and materials, including an educator's guide, fact sheets, posters, resource lists, and contact information for local solar system ambassadors who are prepared to bring the excitement of the mission into the classroom and community centers. Activities for children include simulating the discovery of Pluto; exploring the relative sizes, distances, orbit, and spin of the Sun, Earth, and Moon; and making a Pluto globe. Invite educators to visit [pluto.jhuapl.edu/education/educators.html](http://pluto.jhuapl.edu/education/educators.html).



### **YOUNG NATURALIST AWARDS**

The American Museum of Natural History 2006 Young Naturalist Awards invites students in grades 7–12 to participate in a research-based essay contest to promote participation and communication in science. Two winners from each grade will be selected to receive cash scholarship awards and an expense-paid trip to New York City for the awards ceremony. Children are asked to conduct their own scientific expedition in astronomy, Earth science, or biology. The expedition will provide original data, questions, and observations. The expedition should provide the child with a new understanding about the question that was investigated. The essay about the expedition should contain artwork and/or photographs that help to illustrate the findings. Connect with a local teacher and become a mentor for interested students!

The deadline for the contest is May 1, 2006. Winning essays will be published on the American Museum of Natural History Web site by September 30. For more information, contact Christine Economos, Young Naturalist Awards administrator, at [yua@amnh.org](mailto:yua@amnh.org) or call 212-496-3498 or visit [www.amnh.org/nationalcenter/youngnaturalistawards/](http://www.amnh.org/nationalcenter/youngnaturalistawards/).

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

# RESOURCES FOR RESEARCHERS

## PLANETARY SCIENCE ON THE WEB: FORUMS AND BLOGS

— Jason Perry, Lunar and Planetary Laboratory,  
University of Arizona

It has been only 12 short years since the first great Internet “event,” the impact of Comet Shoemaker-Levy 9 with the planet Jupiter in 1994. The Internet has grown considerably since then. Since the beginning of the Internet age, however, chat forums and personal Web sites have been a popular way for special-interest communities to communicate with one another. In recent years, planetary science has seen its own set of Internet communities spring up with the help of Web forums and blogs.

One of the most important developments that has led to the refinement of these communities (apart from the development of creative theories) has been the release of raw images on the Web, as compressed JPEGs, as soon as they are returned from the spacecraft. This tactic first started with the Mars Exploration Rover (MER) mission as a way to share the joy of exploration with the general public. This method of data release was extended to the Cassini mission and will be used again with the HiRISE camera on the Mars Reconnaissance Orbiter. Quickly, new communities sprang up to discuss and share (unofficially) processed views produced by forum participants, as well as to discuss and debate the official releases from space missions as they happened.

One of the more popular of these Web communities is the Unmanned Spaceflight.com Web forum. This site, run by Doug Ellison, started in February 2004 as a forum for discussing MER images as they showed up on the Web. Members of the forum process the JPEGs into anaglyphs, color images, and panoramas; one user, Michael Howard, developed a tool for downloading the images and creating these products automatically. Since then, the forum has expanded to include discussion of all planetary bodies and missions. Unlike a number of forums that preceded it, Unmanned Spaceflight.com has managed to stay above the fray of fringe theories thanks to the management of the site by Ellison and the participation of members of several mission teams, including Cassini, MER, and New Horizons.

In addition to Web forums, blogs have become another popular forum of communications in recent years. Blogs (short for “Web logs”) are collections of posts from one or more authors on subjects ranging from their lives, the news, entertainment, etc. Blogs are often seen as a non-mainstream source of news, information, and entertainment because of their constantly updating nature. Blogs on planetary science have not been nearly as popular as Web forums, although some, like the Cosmic Mirror, have been effective as news aggregators.

Forums and blogs are not only effectively used by the general public, but these sites have also been used as another form of outreach by various missions. For example, a number of members of the New Horizons science team have participated in the Unmanned Spaceflight.com forum. These team members have answered questions from the general public and provided information on the current status of the mission during its final year of development as well as the events since the January 19 launch. In this way, members of the forum feel like participants in the upcoming exploration of the jovian and plutonian systems, rather than observers, much like the availability of images from the Mars rovers did for Mars exploration. Such outreach activities are an inexpensive way for planetary missions to reach a global audience that clamors for new information from these missions beyond what is provided on the boilerplate mission Web sites.

There are a few things to keep in mind when participating in these forums and blogs. When reading, one has to be mindful of the writer. While the sites above do cultivate a culture of at least reasonable science (fortunately, most members don’t react to a strange rock by concluding that it is an alien washing machine), theories are sometimes presented without a high level of training or sufficient information to back it up. Also, most forums have open memberships, so the chance for misinformation or erroneous speculation to be presented does exist, and caution must prevail when evaluating the analysis presented on these sites. When participating on forums and blogs, remember that these posts can be read by anyone, including the general public and those within the planetary science community. Most journal regulations against prepublication and other embargo issues apply to the Web, so caution must be exercised regarding what is posted on a blog or forum.

A number of Web forums and blogs today provide a more scientifically comfortable environment than those that existed previously, thanks to the increased availability of data and information and the increasing participation of members of the planetary science community. While misinformation, reliability, and scientific concerns remain, many Web forums and blogs are becoming an increasing friendly place for the discussion of planetary science.

### WEB SITES OF INTEREST:

Unmanned Spaceflight.com Web Forum  
<http://www.unmannedspaceflight.com>

Midnight Mars Browser  
(tool for downloading and processing raw JPEGs from MER)  
<http://midnightmarsbrowser.blogspot.com/>

Astronomie.de (German Astronomy Forum)  
<http://forum.astronomie.de/>

Cosmic Mirror  
<http://www.astro.uni-bonn.de/~dfischer/mirror/>

# NEW AND NOTEWORTHY

These products are available from booksellers or the publisher listed.  
Please note that the LPI does not offer these products through its Order Department.

## Books

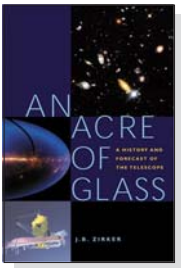
### *The Titans of Saturn: Leadership and Performance Lessons from the Cassini-Huygens*

**Mission.** By Bram Groen and Charles Hampden-Turner. Cyan Communications, 2005. 288 pp., Hardcover, \$29.95. [www.cyanbooks.com](http://www.cyanbooks.com)

The story behind the brilliant success of the Cassini-Huygens space mission to Saturn's largest moon, Titan, details a monumental achievement that took 15 years to accomplish. Sponsored jointly by NASA and the European and Italian Space Agencies (ESA and ISA), the Huygens probe was sent to explore Titan's atmosphere, which is similar to that of primitive Earth around four billion years ago, in search of new data that may unlock the secrets to how life began on Earth. The probe's touchdown on the surface of Titan in January 2005 marked the farthest a manmade spacecraft has successfully landed from Earth. As well as being a fantastic scientific story, this chronicle captures the dynamics and management innovations that enabled this group of highly diverse people to fight against great odds and obstacles to triumph together.



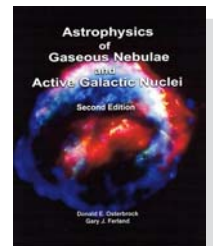
*An Acre of Glass: A History and Forecast of the Telescope.* By J. B. Zirker. Johns Hopkins University Press, 2005. 344 pp., Hardcover, \$30.00. [www.press.jhu.edu](http://www.press.jhu.edu)



Ever since Galileo glimpsed the moons of Jupiter through his tiny telescope, astronomers have striven to understand how the universe is constructed and how it evolves. Every increase in the size and power of telescopes has led to new discoveries. Within the last century, telescopes have enabled us to learn about pulsars, quasars, gamma-ray bursters, black holes, and the acceleration of the universe's expansion. *An Acre of Glass* describes how recent innovations in telescope technology have led to the construction of giant, groundbased observatories and to an explosive development of astronomy. Zirker shows us how telescopes past, present, and future are built and describes the exciting science they reveal — from planets beyond our solar system to supermassive black holes at the core of distant galaxies. For every striking image revealed through these enormous telescopes, technicians and scientists must overcome unique and incredible challenges. How many pack animals does it take to get a telescope to the top of a mountain? How do you make the shape of a 6-foot-wide mirror accurate to within 1000th the thickness of a human hair? Zirker answers these questions and more, providing fascinating technical details about how a telescope is made and what the next generation can hope to see.

*Astrophysics of Gaseous Nebulae and Active Galactic Nuclei.* By Donald E. Osterbrock and Gary J. Ferland. University Science Books, 2005. 496 pp., Hardcover, \$64.50. [www.uscibooks.com](http://www.uscibooks.com)

Thoroughly revised, expanded, and updated throughout, this new edition is a graduate-level text and reference book on gaseous nebulae, nova and supernova remnants, and the emission-line regions in Seyfert galaxies, radio galaxies, quasars, and other types of active galactic nuclei. Much of the new data and many of the new images are from the Hubble Space Telescope and some of the largest groundbased telescopes in the world. Two wholly new chapters have been added, one on infrared astronomy and the other on X-ray astronomy, reflecting the great advances in these fields. This new edition also contains two completely new appendices, one a long primer on the quantum-mechanical concepts used in the analysis of nebular emission-line spectra, and the other a briefer description of molecular spectra. Large amounts of new data on dust in nebulae and quasars, and the photo-dissociated regions containing neutral atoms, molecules, and dust within and around them, have also been added to the book. This updated, larger edition will be valuable to anyone seriously interested in astrophysics.



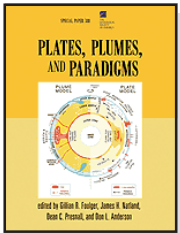


**First Man: The Life of Neil A. Armstrong.** By James R. Hansen. Simon & Schuster, 2005. 784 pp., Hardcover, \$30.00. [www.simonsays.com](http://www.simonsays.com)

On July 20, 1969, the world stood still to watch 38-year-old American astronaut Neil A. Armstrong become the first person ever to step on the surface of another heavenly body. Upon his return to Earth, Armstrong was honored and celebrated for his monumental achievement. He was also misunderstood. Armstrong's accomplishments as an engineer, a test pilot, and an astronaut have long been a matter of record, but Hansen's unprecedented access to private documents and unpublished sources and his interviews with more than 125 subjects (including more than 50 hours with Armstrong himself) yield this first in-depth analysis of an elusive American celebrity still renowned the world over. Hansen vividly recreates Armstrong's career in flying, from his 78 combat missions as a naval aviator flying over North Korea, to his formative transatmospheric flights in the rocket-powered X-15, to his piloting Gemini VIII to the first-ever docking in space. For a pilot who cared more about flying to the Moon than he did about walking on it, Armstrong's storied vocation exacted a dear personal toll, paid in kind by his wife and children. For the 36 years since the Moon landing, rumors have swirled around Armstrong concerning his dreams of space travel, his religious beliefs, and his private life. Personal, technological, epic, and iconic elements blend to form the portrait of a great but reluctant hero who will forever be known as history's most famous space traveler.



**Plates, Plumes, and Paradigms (Geological Society of America Special Paper 388).** Edited by Gillian R. Foulger, James H. Netland, Dean C. Presnell, and Don L. Anderson. Geological Society of America, 2005. 881 pp., Paperback, \$180.00. [www.geosociety.org](http://www.geosociety.org)



This compendium of work on hotspot volcanism documents the development, current state, and future prospects of all branches of the subject. It contains extensive and indispensable reference resources in the form of hotspot, tectonic, volcano, and tomographic maps and cross sections of Earth. Some chapters outline the history of the plume hypothesis and other theories for the genesis of hotspots; several provide tutorials that will be valuable to students and cross-disciplinary scientists; and other chapters present innovative models and theories for individual localities, volcano genesis processes, and related global observations. Many of these include subject reviews, making them doubly valuable to specialists and nonspecialists alike. The book is fully interdisciplinary, encompassing geophysics, geochemistry, noble gases, heat, temperature, tectonics, petrology, mantle dynamics, impacts, and syntheses reconciling several branches of Earth science. The book will enjoy a long lifetime of usefulness and functions as a reference work for students, scholars, and informed lay people. With over 150 color plates, it makes a valuable addition to the library of anyone fascinated by volcanos — one of nature's most exciting and extraordinary phenomena.

**Worlds on Fire: Volcanoes on the Earth, the Moon, Mars, Venus and Io.** By Charles Frankel. Cambridge University Press, 2005. 384 pp., Hardcover, \$40.00. [www.cup.org](http://www.cup.org)

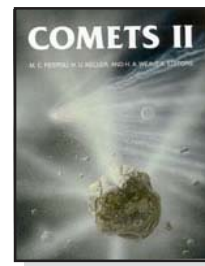
Anyone who has ever thought that volcanos and volcanism were restricted to the planet Earth should open any page of this book to discover that some of the most spectacular explosions in the solar system are not occurring close to home. Frankel provides a detailed tour that describes such volcanic landmarks as the Moon's Aristarchus plateau, Mars' tallest volcano Olympus Mons, the double-cratered Sapas Mons on Venus, and the churning lava lake of Io's Pele caldera. Illustrated with the most recent imagery from spacecraft, this volume introduces the reader to the wonders and excitement of space exploration.



## NEW AND NOTEWORTHY (continued)

**Comets II.** Edited by M. C. Festou, H. U. Keller, and H. A. Weaver. University of Arizona Press, 2005. 780 pp., Hardcover, \$85.00. [www.uapress.arizona.edu](http://www.uapress.arizona.edu)

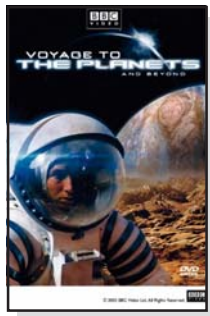
The study of comets is a field that has seen tremendous advances in recent years, far surpassing the knowledge reflected in the original *Comets* volume published as part of the Space Science Series in 1982. This new volume, with more than 70 contributing authors, represents the first complete overview of comet science in more than a decade and contains the most extensive collection of knowledge yet assembled in the field. *Comets II* situates comet science in the global context of astrophysics for the first time by beginning with a series of chapters that describe the connection between stars and planets. It continues with a presentation of the formation and evolution of planetary systems, enabling the reader to clearly see the key role played in our own solar system by the icy planetesimals that were the seeds of the giant planets and transneptunian objects. The book presents the key results obtained during the 1990s, in particular those collected during the apparition of the exceptional Comets C/Hyakutake and C/Hale-Bopp in 1996–1997. The latest results obtained from the in situ exploration of Comets P/Borrelly and P/Wild 2 are also discussed in detail. Each topic is designed to be accessible to students or young researchers looking for basic, yet detailed, complete and accurate information on comet science. With its emphasis on the origin of theories and the future of research, *Comets II* will enable scientists to make connections across disciplinary boundaries and will set the stage for discovery and new understanding in the coming years.



## DVDs

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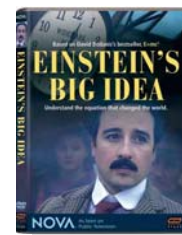
**Voyage to the Planets and Beyond.** Presented by the British Broadcasting Corporation, 2005. 120 minutes, one disc, \$19.98. [www.bbcamerica.com](http://www.bbcamerica.com)



Imagine trying to capture an icy block from Saturn's rings or drill on the disintegrating surface of a comet. This program reveals for the first time the danger and spectacle of what it would be like for astronauts to land on and explore the other planets in the solar system. Their mission lasts for six years, extending the boundaries of what has been achieved in space travel to date. Combining the latest scientific thinking and the real-life experiences of astronauts with drama and spectacular CGI, *Voyage to the Planets and Beyond* propels us into the not-too-distant future. Includes 50-minute feature examining the history of space exploration and 25 minutes of behind-the-scenes footage.

**Einstein's Big Idea.** Presented by NOVA/WGBH, 2005. 112 minutes, one disc, \$19.95. [www.shopwgbh.org](http://www.shopwgbh.org)

Everyone's heard of it, but what does  $E = mc^2$ , the world's most famous equation, really mean? And why did it change the world? With brilliant period recreations, NOVA dramatizes how an obscure young patent clerk, Albert Einstein, came up with his shattering 1905 discovery that the realms of matter and energy are inescapably linked. An accessible, suspenseful epic, *Einstein's Big Idea* reveals the roots of his astonishing breakthrough in the human stories of men and women whose innovative thinking across four centuries helped lead to  $E = mc^2$ , and ultimately unleashed the power of the atom. Here are stories rich with achievement and failure, feuds and duplicity, love and rivalry, politics and revenge: Michael Faraday, the penniless blacksmith's son who fought the ridicule of the scientific establishment; Antoine Lavoisier, the cool-headed experimenter who fell victim to the guillotine; and Lise Meitner, the physicist who weathered Nazi persecution and personal betrayal on her path to discovering the splitting of the atom. As one discovery builds on the next, *Einstein's Big Idea* shows how Einstein's saga began with the personal lives of these pioneers and their years of persistence, ingenuity, sacrifice, and heroic struggle against the odds. Starring Aidan McArdle as Einstein and Shirley Henderson as Einstein's first wife, Mileva Maric.



The success of recent spacecraft missions to Mars is resulting in an explosion of new scientific data that are revolutionizing almost every aspect of our understanding of the planet. *The Mars Journal* is a new, peer-reviewed online open access scholarly journal that is published formally as *Mars, The International Journal of Mars Science and Exploration*. This journal is aimed at accelerating the pace of Mars research and exploration and supporting the growing Mars community by providing rapid peer review and publication of scholarly papers and supporting online data, free and open full-text access to all papers and online data, and an authoritative and interdisciplinary forum that includes Mars science, technology, and policy. The journal's editor is David Paige and the assistant editor is Carey Tanner.



## FOR KIDS!!!

***Neil, Buzz, and Mike Go to the Moon.*** By Richard Hilliard. Boyds Mills Press, 2005. 32 pp., Hardcover, \$16.95. [www.boydsmillpress.com](http://www.boydsmillpress.com)



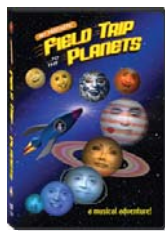
Here is the exciting story of Apollo 11 and the three men who made the historic flight to the moon: Neil Armstrong, Buzz Aldrin, and Michael Collins. When they were boys, each had dreamed of flying planes. Their dreams came true when they joined the United States military, flying and testing new types of aircraft. They eventually became members of a select group of flyers called the Astronauts Corps, which would venture into space. From Project Mercury to Project Apollo, this picture book featuring simple text, bold illustrations, and informative sidebars, follows the inspiring journey of three genuine American heroes. For ages 9–12.

***Paper Galaxy: Out-of-This-World Projects to Cut, Fold & Paste.*** By M. D. Prins. Sterling Publishing Company, 2005. 128 pp., Hardcover, \$19.95. [www.sterlingpub.com](http://www.sterlingpub.com)

Welcome to the paper galaxy, a cosmic collection of fantastic three-dimensional, modular paper projects. Some are realistic (a meteorite), others fanciful (an alien ship), and they range from very simple to elaborate. Just copy or trace the pattern — the instructions tell you how — and then cut, paste, and paint the paper to construct Sun bursts, stars, black holes, moons, comets, even Martians that you can decorate with antennae! And once you've made a few, take a tip on hanging and displaying your handiwork. Budding astronomers and artists will love every one . . . because they're all out of this world! For ages 9–12.



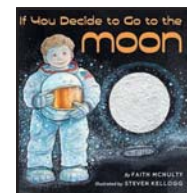
***My Fantastic Field Trip to the Planets DVD.*** Produced by Wonderscape Entertainment, 2005. 70 minutes, one disc, \$14.98. [www.fantasticfieldtrip.com](http://www.fantasticfieldtrip.com)



Blast off with Jake on a live-action, musical outer space adventure featuring ten original songs. Traveling inside his toy rocket, Jake's survival depends on the help of nine friendly planets, who magically talk and sing. Will Jake make it through the dangerous asteroid belt? Can he get back home before his mother discovers that he is gone? Songs combine fun lyrics about the planets with memorable melodies. Kids learn the songs and know the planets. This DVD features 20 all-new, kid-friendly space videos from NASA and a space quiz to test a child's knowledge of the planets. A printable "Certificate of Merit" that can be customized with a child's name and the date on any PC or Mac computer is included.

***If You Decide to Go to the Moon.*** By Faith McNulty. Scholastic Press, 2005. 48 pp., Hardcover, \$16.99. [shop.scholastic.com](http://shop.scholastic.com)

What is it like to travel to the Moon and back? Budding astronauts will find out with this fun and informative book that covers everything from what to pack, what liftoff feels like ("at first you'll feel heavy; don't worry"), and returning to Earth. This book includes a four-color gatefold spread that will further transport your child out of this world. For ages 9–12.





# CALENDAR 2005–2006

Information was valid as of this issue's publication and is subject to change without notice.  
For more information see the Web sites listed.

## March

- 1–3 Planet Formation and Evolution Studies: Various Approaches — One Goal, Heidelberg, Germany.  
<http://www.mpia.de/PSF/PlanetWorkshop/>
- 5–8 Earth & Space 2006, League City, Texas.  
<http://www.asce.org/conferences/space06/>
- 6–10 SCOSTEP 11th Quadrennial Solar Terrestrial Physics Symposium “Sun, Space Physics and Climate,” Rio de Janeiro, Brazil. <http://www.abc.org.br/scostep2006/>
- 11–14 6th International Conference on High Energy Density Laboratory Astrophysics, Houston, Texas.  
<http://www.hedla.org/home.html>
- 13–17 37th Lunar and Planetary Science Conference, League City, Texas. <http://www.lpi.usra.edu/meetings/lpsc2006>
- 26–30 The Astrobiology Science Conference, Washington, DC.  
<http://abscicon.arc.nasa.gov/index.html>
- 31–Apr. 4 IAU Symposium 233: Solar Activity and its Magnetic Origin, Cairo, Egypt. <http://www.iaus233.edu.eg/>
- 7–15 Dynamical Processes in Space Plasmas, Beer-Sheva, Israel.  
<http://physics.bgu.ac.il/~gedalin/Isradynamics/>
- 8–11 Origin and Distribution of Life in the Universe — A Nordic Perspective, Stockholm, Svenska.  
<http://astrobiology.molbio.su.se/conferences/2006/index.html>
- 8–12 First International Conference on Impact Cratering in the Solar System, Noordwijk, The Netherlands.  
<http://www.rssd.esa.int/index.php?project=TOP&page=craters>
- 14–17 Geological Association of Canada Annual Meeting, Montreal, Canada.  
<http://www.gac.ca/ANNMEET/annmeet.html>
- 21–23 Workshop on Surface Ages and Histories: Issues in Planetary Chronology, Houston, Texas.  
<http://www.lpi.usra.edu/meetings/chron2006/>
- 23–26 2006 AGU Joint Assembly, Baltimore, Maryland.  
<http://www.agu.org/meetings/ja06/>

## April

- 2–7 European Geosciences Union General Assembly 2006, Vienna, Austria. <http://meetings.copernicus.org/egu2006/>
- 3–6 22nd National Space Symposium, Colorado Springs, Colorado. <http://www.spacesymposium.org/>
- 3–7 Geological Society of America Conference on Backbone of the Americas: Patagonia to Alaska, Mendoza, Argentina.  
<http://www.geosociety.org/meetings/06boa/>
- 3–7 RAS National Royal Astronomy Meeting 2006, Leicester, United Kingdom.  
<http://www.nam2006.le.ac.uk>
- 9–12 AAPG 2006 Annual Convention, Houston, Texas.  
<http://www.aapg.org/houston/index.cfm>
- 24–25 Inside Aerospace, Washington, DC.  
<http://www.insideaerospace.org/>
- 24–28 Strategies for Life Detection, Bern, Switzerland.  
[http://www.issi.unibe.ch/workshops/Life\\_Detect/](http://www.issi.unibe.ch/workshops/Life_Detect/)
- 25–28 Space Environment Center Space Weather Week, Boulder, Colorado. <http://www.sec.noaa.gov/swww/>
- 28–2 June Planetary Science: Challenges and Discoveries, Blois, France.  
<http://opserv.obspm.fr/confs/Blois2006/index.htm>

## June

- 2–3 Bethe Centennial Symposium on Astrophysics, Ithaca, New York.  
<http://astro.cornell.edu/~dong/bethe.htm>
- 4–8 208th Meeting of the American Astronomical Society and 2006 Meeting of the Canadian Astronomical Society, Calgary, Alberta, Canada.  
<http://www.ism.ucalgary.ca/meetings/aas06/>
- 8–14 Impact Craters as Indicators for Planetary Environmental Evolution and Astrobiology, Ostersund, Sweden.  
<http://www.geo.su.se/Lockne2006>
- 19–23 SpaceOps 2006 — Earth, Moon, Mars and Beyond, Rome, Italy.  
<http://www.spaceops2006.org/>
- 25–29 AAS Division on Dynamical Astronomy, Halifax, Nova Scotia, Canada.  
<http://dda.harvard.edu/meetings/2006/>
- 27–30 ICSO 2006 Sixth International Conference on Space Optics, Noordwijk, The Netherlands.  
<http://www.congrex.nl/06a05/main.html>

## May

- 1–5 ASPRS 2006 Conference, “Prospecting for Geospatial Information Integration,” Reno, Nevada.  
<http://www.asprs.org/reno2006/>

