The PLANETARY REPORT

Volume XXVIII Number 5 September/October 2008

A New Mercury Revealed

FROM THE EDITOR

We were buoyant, exhilarated—and back on Mars after 21 years. At Planetfest '97, I was waiting at the Pasadena Center for Project Manager Tony Spear to arrive and address the thousands who had gathered to watch *Mars Pathfinder* touch down. We'd seen the live feed from JPL and already had cheered the spacecraft's safe arrival.

But our celebrating wasn't over. It's a tradition for Project Managers to come to Planetfest for their rock-star moment to accept the cheers of the multitude, and Tony was due at any minute. Through the dense crowd, friends on the mission team kept swirling by, telling me to make sure I was there when Tony was ready to speak.

Then there he was, raising his arms in a victory salute. When the noise died down, Tony stood behind the lectern and announced that he had a surprise for us all.

We were up for a surprise—as long as it was a good one. We were still smarting from the loss of *Mars '96*, which had carried our *Visions of Mars* CD—and a microdot with the names of all Planetary Society members—straight to the bottom of the Pacific Ocean.

Now Tony was telling us that the *Pathfinder* team had gotten a duplicate microdot and affixed it to their spacecraft. To thank Planetary Society members for their ceaseless support, they had taken us all to Mars.

Cheers mixed equally with tears as the audience rose to their feet with applause, and no one there will ever forget that return to the Red Planet. And we're back again. When *Phoenix* touched down this last May, Planetary Society members landed with it—and *Visions of Mars* finally made it.

These moments are part of our Messages from Earth project that has sent our members to Mars, to Comet Tempel 2, to Saturn, onward to Pluto, and soon, back to the Moon. Aren't you proud to have traveled with them?
—*Charlene M. Anderson*

ON THE COVER:

On January 14, 2008, *MESSENGER* became the first spacecraft to visit Mercury since *Mariner 10* flew by in 1974 and 1975. This color composite view is constructed of images *MESSENGER* captured about 80 minutes prior to closest approach, from roughly 27,000 kilometers (16,800 miles) out. The sunlit area was imaged by *Mariner 10*, but under different lighting conditions. This image and other *MESSENGER* data will give us a detailed, global view of Mercury, revealing much about the planet closest to the Sun. Image: NASA/APL/CIW

BACKGROUND:

The *Phoenix* Mars lander's Surface Stereo Imager (SSI) took this picture in the late afternoon of the 30th Martian day of the mission, or sol 30 (June 25, 2008), just hours after the beginning of Martian northern summer. Because the SSI used its natural-color filters, the color here is what we would see on Mars. The image shows the shadow of the SSI, stretching toward the east as the Sun drops low in the west.
Image: NASA/JPL/University of Arizona/Texas A&M University

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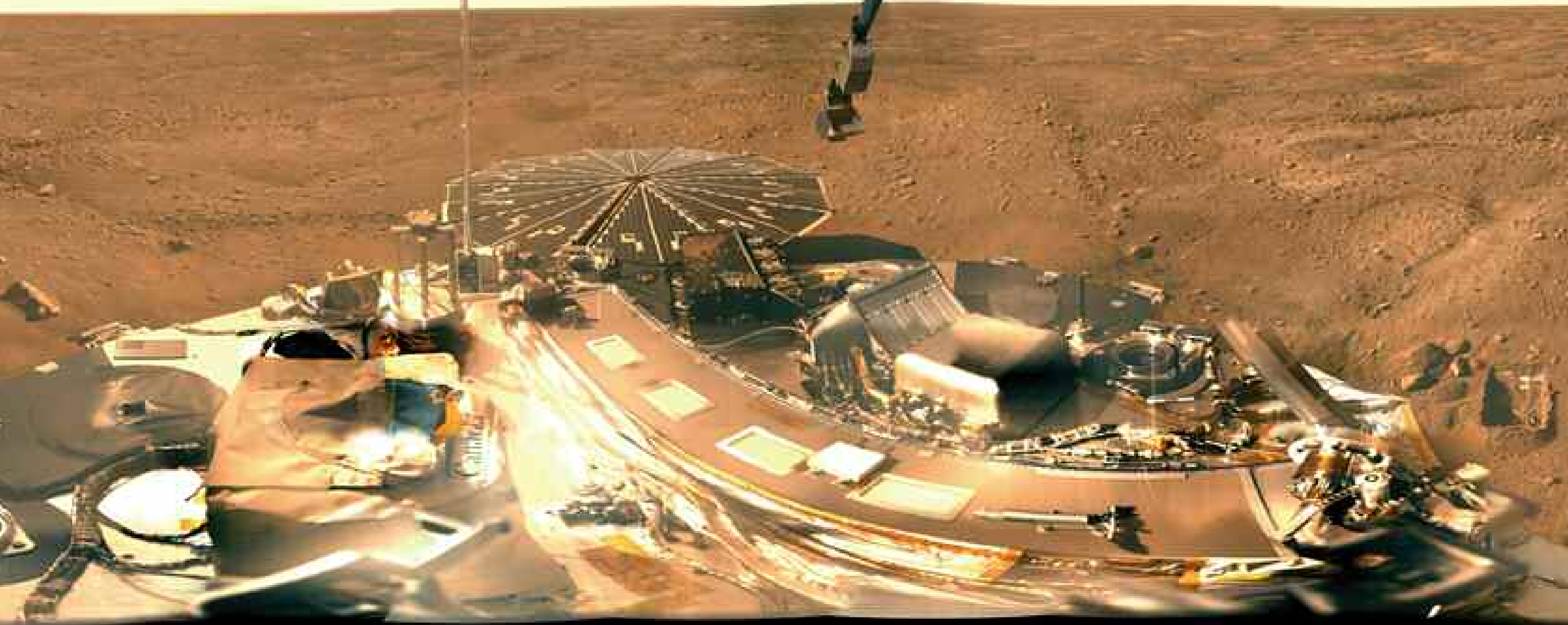
Phoenix—Success



We Make It Happen!

by Bruce Betts

After a journey of 422 million miles that culminated in a terrifying scream through the Martian atmosphere, *Phoenix* landed successfully in the northern arctic plains of Mars on May 25, 2008. The signal confirming *Phoenix*'s arrival on the surface of Mars came into NASA's Jet Propulsion Laboratory (JPL) at 4:53 p.m. Pacific Daylight Time. Since then, *Phoenix* has had great success studying the Martian arctic up close for the first time. *Phoenix* also carries a message to future explorers: a Planetary Society DVD that includes literature and art about the Red Planet, greetings, and the names of a quarter million Earthlings, including all Planetary Society members.

Landing

Landing on Mars is tough. Surviving the seven-minute plunge through the Martian atmosphere requires a lot to go right; otherwise, a lander becomes just another Martian impactor. That explains the tense mood in mission control, at The Planetary Society's Planetfest '08 in Pasadena, and at Planetfest-affiliated events around the globe. Many hundreds of members and others gathered at Planetfest '08 in Pasadena to witness the dramatic landing and to see the first views of the Martian arctic.

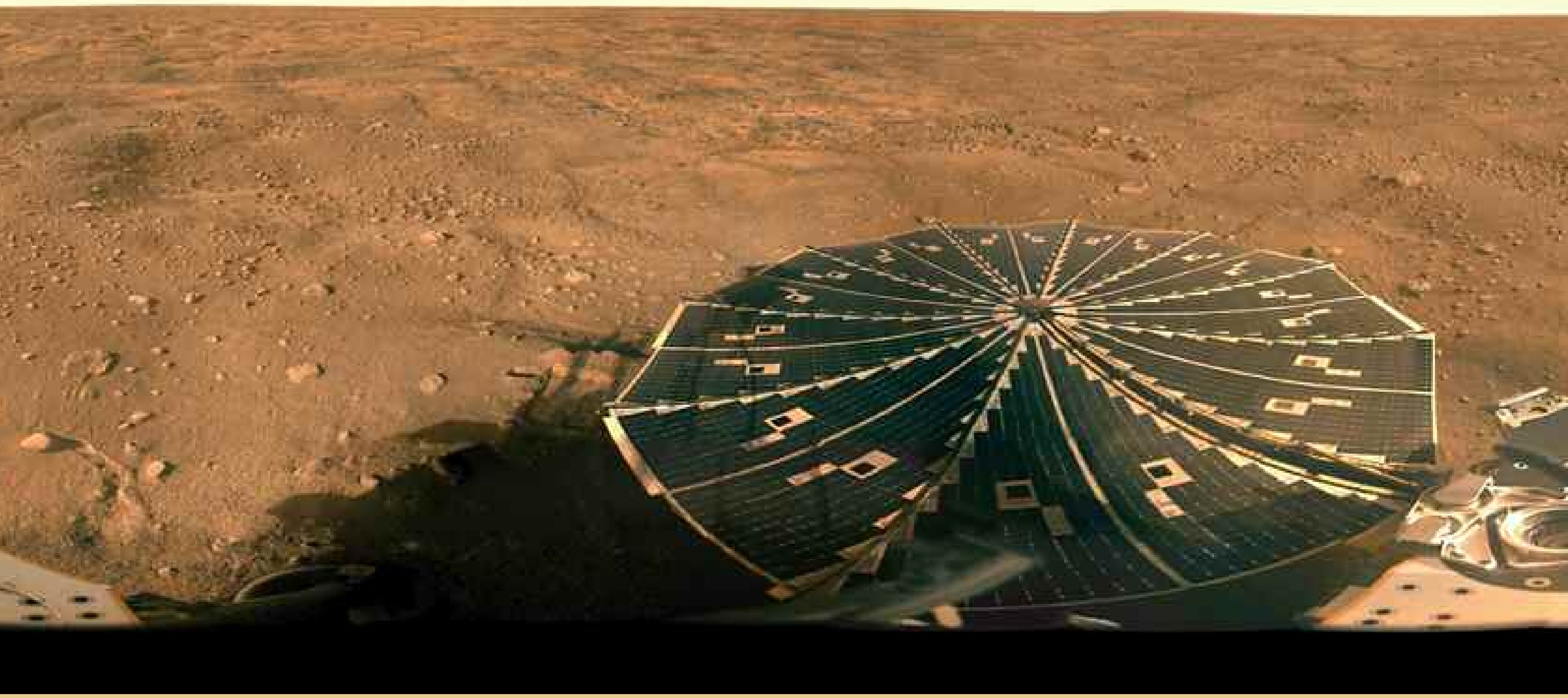
Planetfest also connected space explorers with the public: NASA Administrator Mike Griffin, JPL Director Charles Elachi, *Phoenix* Principal Investigator Peter Smith, *Mars Reconnaissance Orbiter* Project Manager Jim Erickson, and *Mars Express* co-investigator Thomas Duxbury all stopped by and spoke to the crowd at Planetfest. A list of other spectacular speakers entertained and educated the crowd.

About two hours after confirmation that *Phoenix* had landed, the first images came into JPL and the University of Arizona Phoenix Science Operations Center. These images showed the solar arrays fully deployed and some

This image shows the DVD provided by The Planetary Society to the Phoenix *mission, which contains 250,000 names of people who signed up to send their names to Mars. It also contains* Visions of Mars, *a compilation of messages to future Martian explorers, science fiction stories, and art inspired by the Red Planet. The DVD is mounted on the deck of the lander, which sits about one meter above the Martian surface, visible in the background.*

Image: NASA/JPL/University of Arizona

in the Martian Arctic



Above: Amateur image processor James Canvin assembled this version of Phoenix*'s Mission Success Panorama, which includes 150 separate camera pointings taken from sols 13 to 43. This panorama is referred to as "Peter Pan" in honor of the mission's principal investigator, Peter Smith. Capturing a complete 360-degree color view around the lander is one of the mission success criteria for* Phoenix. *Image: NASA/JPL/UA/Texas A&M/color mosaic by James Canvin*

of the patterned arctic terrain around Mars' north pole. *Phoenix* had made it safely, and to just the kind of terrain hoped for—a place to hunt for water ice under the dirt.

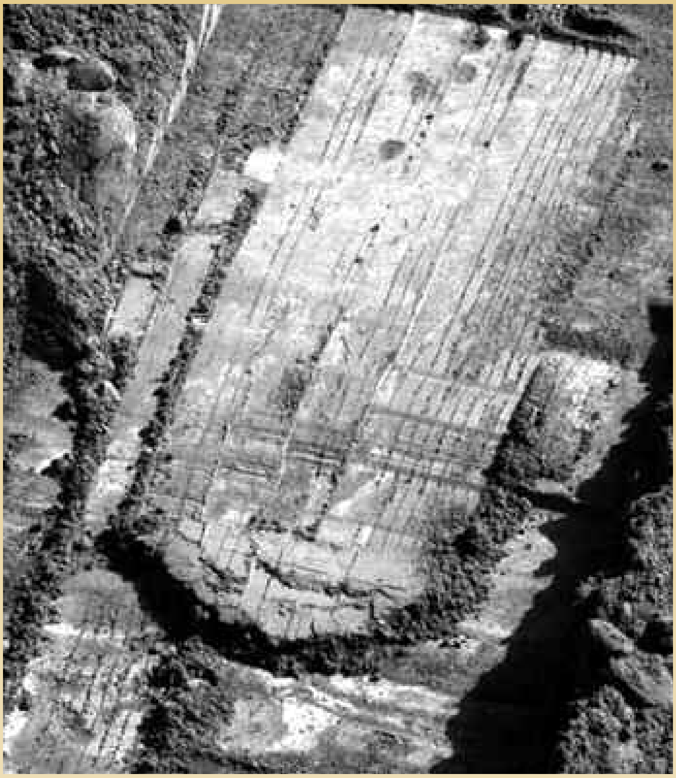
On sol 28 (June 22, 2008), Phoenix *used the scoop on its robotic arm to deliver a sample of soil from the Snow White/Rosy Red trench to the first of its four wet chemistry laboratory cells. In so doing, it spilled dirt on the lander deck and on top of the* Phoenix *DVD.* *Image: NASA/JPL/University of Arizona*

Names and Visions: A DVD for the Ages

When *Phoenix* touched down, it carried a silica glass mini-DVD, provided by The Planetary Society, to the surface of Mars as part of our Messages from Earth program. Contained on the disc are 250,000 names of Earthlings interested in going to Mars. (You can print a certificate showing that you are on Mars at *planetary.org/phoenixdvd*.)

Your name joins the greats of science fiction and Mars science history on the mini-DVD, which includes *Visions of Mars*. This collection of Mars literature and art includes works of fiction by Isaac Asimov, Ray Bradbury, Arthur C. Clarke, and many others, along with historic works by Schiaparelli and Percival Lowell, among others. Also included are works of art with Martian themes and greetings from Carl Sagan, Arthur C. Clarke, Judith Merrill, and Louis Friedman to whomever finds the DVD.

Visions of Mars, originally launched with the failed *Mars '96*, has finally succeeded in reaching the surface of the Red Planet. It is the first "library" on Mars, awaiting discovery by future explorers. You can find pictures



This view of Snow White from the lander's Surface Stereo Imager was captured on sol 58 (July 23, 2008). The image was taken after the lander's robotic arm performed a series of scrapings in preparation for collecting a sample from a hard subsurface layer where soil may contain frozen water. The trench is 4 to 5 centimeters (about 2 inches) deep, about 23 centimeters (9 inches) wide, and roughly 60 centimeters (24 inches) long. Image: NASA/JPL/University of Arizona/Texas A&M University

of the installed disc and information about it at the link on page 5, or check out the article in the July/August 2007 issue of *The Planetary Report*. Not only have our names and *Visions of Mars* touched down on Mars, but Mars also has touched back, with Martian soil dropped on the DVD during operations by *Phoenix*'s robotic arm scoop (see picture on page 5).

Phoenix Reaches Out to Water Ice

After a characterization phase, during which *Phoenix*'s instruments and systems were checked out and tested, *Phoenix* deployed its robotic arm and began digging. Very soon afterward, the team confirmed that they had found water ice. The initial evidence came in the form of images taken less than one month after the lander set down near the Red Planet's north pole. On sol 24 (a "sol" is the Martian day, lasting about 24 hours and 40 minutes), which corresponded to June 15, 2008, the *Phoenix* team had noticed chunks that had been left at the bottom of a trench dubbed Dodo-Goldilocks northwest of the lander. When the lander imaged the trench again on sol 24, the chunks were gone, convincing the science team that the chunks were clumps made up largely of water ice rather than topsoil.

On July 31, NASA announced that the Thermal Evolved Gas Analyzer (TEGA) had confirmed water ice. The TEGA takes samples placed in it by the robotic arm, heats them in one-time-use ovens, and then analyzes what bakes out of the samples. The oven doors did not function perfectly, and getting samples into the ovens proved challenging, but samples are now successfully making it into the ovens, and work is proceeding.

Although both theoretical arguments and measurements made by *Mars Odyssey* led researchers to expect water ice under the soil, this is the first time a spacecraft has touched and "tasted" the water ice, enabling analyses to take place. All life on Earth requires liquid water, so studying the water ice and geologic makeup of this site is part of *Phoenix*'s assessment of its past or present habitability potential for life.

This amazing image was captured as* Phoenix *came in for its Mars landing on May 25, 2008. The HiRISE camera on* Mars Reconnaissance Orbiter *pointed at* Phoenix*, which is seen here against the background of the Heimdall crater, about 10 kilometers (6 miles) across. The dramatic view makes it appear as if* Phoenix *is falling into the crater, but in fact* Phoenix *was about 20 kilometers (12 miles) closer to HiRISE than to Heimdall, and it landed nowhere near the crater. The photo was taken 20 seconds after* Phoenix*'s parachute opened. Image: NASA/JPL/University of Arizona

Digging in the Dirt

Phoenix has also completed its first scientific analyses on Martian dirt samples, finding that the dirt is not much different from dirts on Earth. The team performed its first wet chemistry analysis on Martian dirt and found nothing about it that would not support life as we know it—another sign of habitability.

The soil appears to be a close analog to surface soils found in the dry upper valleys in Antarctica. At *Phoenix*'s landing site, the soil is very basic, with a pH of between eight and nine. The team also found a variety of components of salts, including magnesium, sodium, potassium, and chloride.

Phoenix also has (a) analyzed samples in its optical microscope—a part of the Microscopy, Electrochemistry and Conductivity Analyzer (MECA) instrument—(b) completed its three-color, 360-degree Stereo Surface Imager (SSI) panorama of the landing site; (c) studied samples with its Atomic Force Microscope; and (d) collected daily data on clouds, dust, winds, temperatures, and pressures in the atmosphere. In addition, it has taken the first nighttime atmospheric measurements.

Still More to Do

The mission will end when the Sun is so low in the Martian sky that *Phoenix* no longer receives sufficient solar power. Formally, the mission has received a one-month NASA funding extension to its three-month nominal mission, until at least the end of September. More extensions are expected if all keeps working. The northern autumnal equinox will arrive on Mars on December 26, 2008, bringing winter darkness to the north pole and the certain conclusion of the *Phoenix* mission.

Phoenix has traveled a long way from Earth, as well as a long way scientifically since its landing. Mars still offers much for this intrepid spacecraft to extract before it meets its wintery end, and the biggest discoveries may be yet to come.

Bruce Betts is director of projects for The Planetary Society.

LINKS

***Phoenix* Mars Mission home page**
http://phoenix.lpl.arizona.edu/

Sol-by-Sol Summary on The Planetary Society's website
http://planetary.org/explore/topics/phoenix/sols.html

Phoenix* DVD and *Visions of Mars
http://planetary.org/phoenixdvd

***Phoenix* landing and other Planetary Radio shows:**
http://planetary.org/radio

What's Up?

In the Sky—September and October 2008

Jupiter is extremely bright and high in the southern sky in the evening. Early in September, Venus, Mars, and Mercury are clustered close together very low in the west shortly after sunset; try binoculars to pick them out. Venus is the brightest. Venus and Jupiter, both extremely bright, grow closer in the sky in the evening throughout September and October, and they will be very close by the end of November.

Random Space Fact

On April 8, 2008, Sergey Volkov became the first person to fly in space whose father also had flown in space—Alexander Volkov. Later this year, Richard Garriott, son of Owen Garriott, is scheduled to be the second. He will return to Earth with Sergey Volkov, who is on board the International Space Station.

Trivia Contest

Our March/April contest winner, from Garner, Kansas, wishes to remain anonymous. Congratulations!

The Question was: What is the approximate altitude of a geostationary satellite (one that stays over one point of the equator all the time, frequently used for things like satellite TV and communications)?

The Answer is: Approximately 22,300 miles (35,800 km).

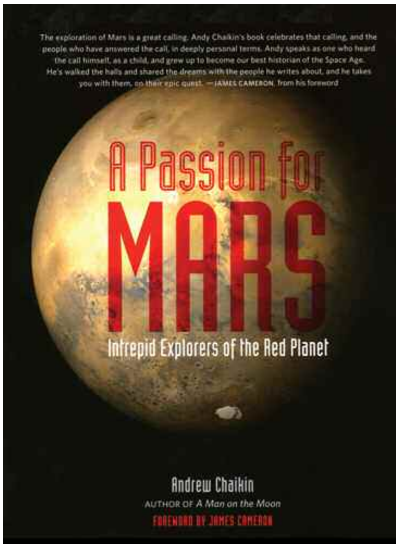
Try to win a free year's Planetary Society membership and a Planetary Radio T-shirt by answering this question:

What is Mars' obliquity (axial tilt) at present?

E-mail your answer to *planetaryreport@planetary.org* or mail your answer to *The Planetary Report*, 65 North Catalina Avenue, Pasadena, CA 91106. Make sure you include the answer and your name, mailing address, and e-mail address (if you have one). Submissions must be received by January 1, 2009. The winner will be chosen by a random drawing from among all the correct entries received.

For a weekly dose of "What's Up?" complete with humor, a weekly trivia contest, and a range of significant space and science fiction guests, listen to Planetary Radio at *planetary.org/radio.*

OUT OF THIS WORLD BOOKS



A Passion for Mars
by Andrew Chaikin
Abrams, 280 pp.,
$35.00 (October 2008),
hardcover

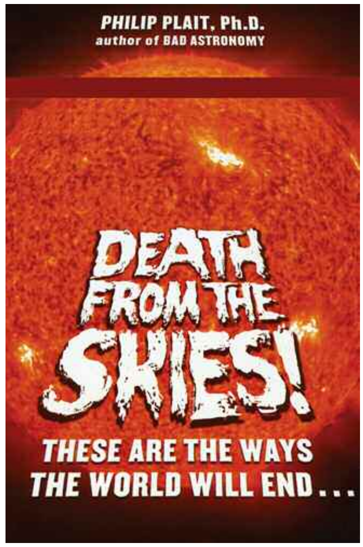
"Mars beckons," Carl Sagan wrote years ago in a document for The Planetary Society—and it truly does. I have met scores of individuals who feel some special and personal "ownership" of, or "kinship" with, the Red Planet. It is like no other world for us humans, because it is the only world accessible to us that was, or will be, an abode for life. I believe that the future of humans as a multiplanet species will be determined on that world.

By telling the stories of some of the Mars explorers who justifiably can make a special claim to the planet, Andrew Chaikin tells us the story of Mars itself. The first three chapters feature two of the Society's founders (Bruce Murray and Carl Sagan) and an early member of our Board of Directors (Tom Paine).

Chaikin tells readers about other Mars exploration giants, such as Tim Mutch, Jerry Soffen, and Mike Malin. Many Mars explorers are not featured in chapters of their own, but Chaikin works them in by giving personal accounts of various missions and different episodes of scientific discovery concerning Mars, drawing heavily on his experience as a student intern in the *Viking* mission. He also devotes a section to the "Mars Underground," which both spawned a new generation of Mars enthusiasts and helped the older generation cope with the disappointment of failing to find life when the first landers arrived.

Chaikin draws readers into the compelling quest to understand the possibilities of life on Mars by relating the personal stories of key figures involved in that quest. The book is loaded with inspirational black-and-white and color images chronicling the exploration of the Red Planet. All that is missing is an explanation of where all this exploration is leading . . . but that is another book.

—Louis D. Friedman, Planetary Society Executive Director



Death from the Skies! These Are the Ways the World Will End . . .
by Philip Plait
Viking, 312 pp.,
$24.95 (October 2008),
hardcover

In *Death from the Skies*! Philip Plait discusses various possibilities for planetwide death and destruction. Despite its ominous title, however, this book concerns more than the ways the world could end. Plait uses the intriguing concept of death from above to draw readers in, and once he has them, he explains many of the universe's most fascinating phenomena.

The easy-to-read explanations are not overly technical, yet they are more than cursory overviews. One would not expect humor and lightheartedness in a book about the end(s) of the world, but Plait interjects levity throughout his presentation. Numerous asides, scattered throughout, debunk related topics of pseudoscience.

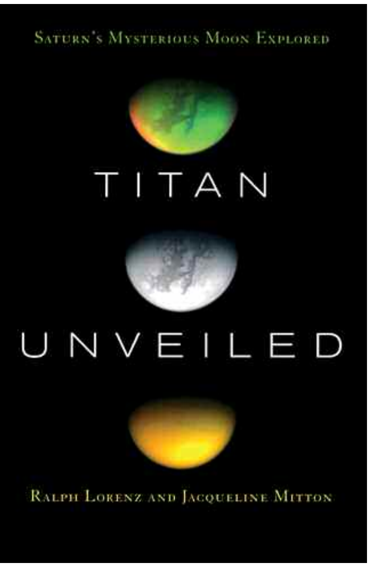
The breadth of the subject matter is impressive, from possible asteroid impacts and the end of the universe to alien invasion—which Plait makes clear he doesn't believe has happened yet. He also covers topics such as solar flares, the death of the Sun, supernovae, gamma ray bursts, and black holes.

Each chapter covers one threat to our existence, or at least aspects of our existence. Chapters open with brief fictional scenarios of Earth encountering a particular death scenario. The author then provides the background material needed to understand that threat. This leads to explanations of a vast variety of phenomena, from energy production in the Sun, to the history of our solar system, to fantastic astrophysical phenomena such as supernovae and black holes.

Each chapter ends with an assessment of how much we should worry about the phenomenon described in the chapter, and the book ends with a summary of all the scenarios. Plait concludes that asteroid impact and phenomena related to solar flares merit caution and preparation, if not worry. Readers will be relieved to know that the other scenarios, ones that truly could ruin humanity's day, are deemed to be extremely improbable or will occur billions of years in the future.

Though Plait may draw readers in with his sensational

title, he follows through with well-informed discussions of captivating topics that provide a wealth of science content. The death scenarios may leave some readers in a bit of a dark state of mind, but at least their minds will be well informed.
—Bruce Betts, Planetary Society Director of Projects



Titan Unveiled: Saturn's Mysterious Moon Explored
by Ralph Lorenz and Jacqueline Mitton
Princeton University Press, 243 pp., $29.95, hardcover

The pair of scientist-writers who brought us *Lifting Titan's Veil* provide, in this volume, highlights of data and experiences from the *Cassini-Huygens* mission to Saturn and Titan. That mission sought to discover exactly what lies below the thick shroud of hydrocarbon haze that obscures the surface of the solar system's second-largest moon.

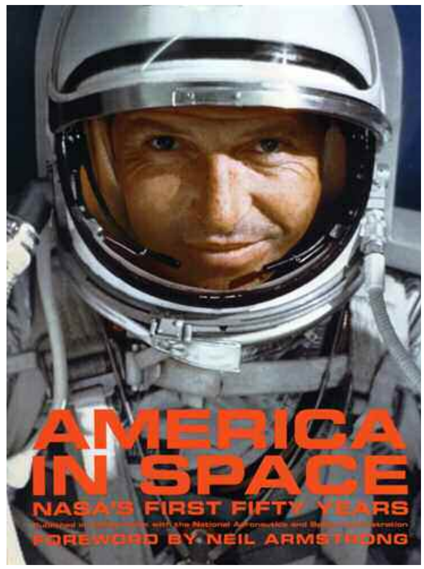
Although *Titan Unveiled* imitates the style of the earlier book, it can stand alone. It begins with an introduction to what was known before the arrival of *Cassini-Huygens* at Titan and then recounts the exciting events of the first two years of the mission. The highlight of those years was the descent and landing of the European Space Agency's *Huygens* probe, which revealed Titan to be a bizarrely familiar world, one with a fluid-carved landscape of mountains, rivers, and seabeds, but with methane as the fluid and water ice as the rocks.

Ralph Lorenz is intimately familiar with both the orbiter and the probe components of *Cassini-Huygens*, having constructed with his own hands one small part of the probe (the penetrometer, a device that showed the surface on which *Huygens* landed to have been wet sand covered with a few cobbles) and having been a member of the orbiter's radar instrument team. The book is filled with anecdotes from Lorenz's own experiences; these are separated from the main text as sidebars titled "Ralph's Log." Both the personal stories and main text are eminently readable, enjoyable, and even dramatic, making the book difficult for a reader to put down once he or she has entered its pages and the world of Titan.

Woven into the engrossing narrative is an accurate and detailed account of the current state of understanding of Titan science. My one quibble with the book is the quality of the photographs; most of the images included as halftones within the text are almost illegibly dark, failing to do justice to *Cassini*'s sharp-eyed camera and radar mapper. A few of the images are repeated on eight color plates in the center of the book, but they are not referenced in the text.

The book's publication schedule unfortunately meant that Lorenz and Mitton could tell the story of *Cassini-Huygens* only as far as the T16 flyby on July 22, 2006, which yielded the first radar image to cross Titan's north polar lake district. That image finally delivered evidence supporting the current presence of surface reservoirs of liquid hydrocarbons on Titan. Readers can only hope that Lorenz and Mitton will be able to team up yet again, some years from now, to conclude the trilogy with a book that details the discoveries enabled by *Cassini* through the rest of its primary mission, and on into its Equinox Mission at Saturn.
—Emily Lakdawalla, Planetary Society Science and Technology Coordinator

America in Space: NASA's First Fifty Years
Edited by Steven J. Dick, Robert Jacobs, Constance Moore, Anthony M. Springer, and Bertram Ulrich
Abrams, 347 pp., $50.00, hardcover



Rapid spurts of growth happen not only to children and gawky teenagers but also to civilizations and their technologies. An example of the latter is illustrated dramatically in *America in Space: NASA's First Fifty Years*, a heavy, large-format coffee-table book. Its October 2007 debut was timed to launch the year-long celebration of the fiftieth birthday of NASA, which collaborated in the book's publication. Originally priced at $50.00, it is now available for less. The volume covers the history of NASA from its creation on October 1, 1958 as a response to the launching of *Sputnik 1* one year prior.

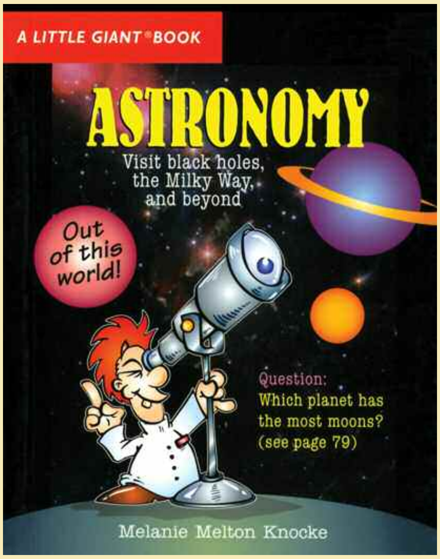
Neil Armstrong's thought-provoking foreword on the evolution of transportation sets the tone for this visual history of the United States' space agency. *America in Space* is written and edited by Steven J. Dick, NASA's chief historian, and a team of experienced colleagues. Their historical essays and captions describe more than 400 photos from the agency's extraordinary archives. Together, the words and images tell the inspiring story of the first half-century of America's Space Age.

The book is divided into four chapters. The first two describe the early days—the formation of NASA's predecessor, the National Advisory Committee for Aeronautics (NACA); its transformation into NASA; and the accompanying great advances in aeronautic technology. Chapter 3, titled "One Small Step," constitutes the bulk of the book. It is subdivided into sections devoted to the *Mercury*, *Gemini*, and *Apollo* projects and the space shuttle. The *Apollo* section contains photos of Skylab and of the first step toward international cooperation in space: *Apollo-Soyuz*. Female astronauts first appear in the shuttle photos. This section culminates with pictures of Russians and Americans working on the International Space Station.

The last chapter, "Voyages in Space and Time," illustrates the steady march, via robotic spacecraft, away from the confines of the Earth/Moon system. Striking images from our solar system include stunning close-up views of the Red Planet as seen by rovers and orbiters at Mars, along with classic portraits of the other planets, the Sun, and more, including gorgeous views of our own planet taken by Earth-observing satellites and shuttle astronauts. The book ends with awesome deep-space imagery from the Hubble Space Telescope, including the Ultra Deep Field, a look back in time at the universe as it appeared shortly after the Big Bang. This hard-to-believe image says it all in terms of how far our explorations have taken us since the days of propeller airplanes and the first satellites.

America in Space showcases an important part of the legacy of mid-20th-century America and therefore will be of interest even to those not fascinated with space exploration. Readers already interested in space will find great enjoyment in this massive photo album of the people, places, and things that have made possible humankind's greatest adventure.

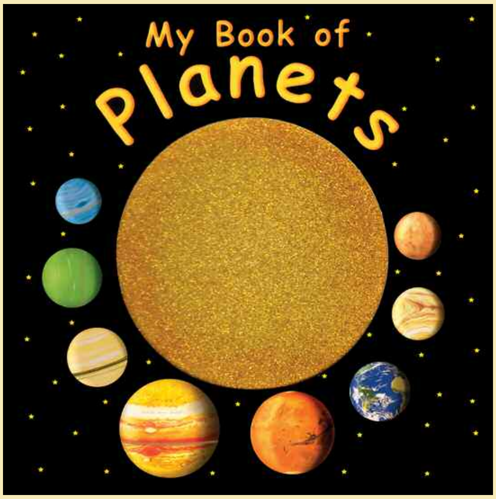
—Donna Stevens, The Planetary Report *Associate Editor*



A Little Giant Book: Astronomy
by Melanie Melton Knocke
Sterling, 352 pp., $6.95, softcover

Did you know that Eris is the most distant solar system object ever observed? That Titan is the only moon, besides Earth's, on which a spacecraft has landed? That we can't see black holes directly, so we must find them through trickery? This book is packed with such facts about our Sun, its planets, and smaller bodies in our own solar system, along with the menagerie of bodies elsewhere in our galaxy. The final third of the book is a guide for observing the night sky, including information about how to use a telescope and facts about the constellations.

The book's tiny but thick format (it's about 10 by 13 by 2 centimeters, or 4 by 5 by 1 inch) and lively prose clearly indicate its intended youthful audience (the publisher states 8–12 years); it would fit well in most Christmas stockings. It might be devoured by young children who enjoy, for example, enunciating the lengthy Latin names of dinosaur genera. However, the weightiness of the facts and the lack of illustrations—except in the section about observing the night sky and constellations—seem to aim it at an older audience. It's the sort of book that could be picked up for a few minutes a day, to add to the reader's knowledge of space facts or serve as a quick reminder, and would be an excellent source of fodder for space trivia or quiz games.



My Book of Planets
by Elise See Tai, illustrated by Kuo Kang Chen
Scholastic, 18 pp., $5.99, board book

Introduce your baby to the solar system with this board book, which features a page on the Sun and on each of the planets, with peep-through holes inviting little fingers to reach in, turn the page, and discover the next object out from the Sun. Each page features a fact, such as "Mercury is a rocky planet," then asks "Which planet is next?" Fans of Pluto should beware: this book ends with the controversial statement that "Neptune is the farthest planet from the Sun." With or without Pluto, the book helped me teach my toddler to point and say "pananet!" whenever she spies a round object on a dark field. *—EL*

World Watch

Washington, D.C.—NASA's fiscal year (FY) 2009 budget is stuck in congressional limbo, and it is likely that the U.S. Congress will resort to a continuing resolution, which will find the space agency and other federal agencies with the same budgets they had last year. This will put at risk NASA's space and Earth science program, as well as the Vision for Space Exploration (VSE).

One reason is the looming U.S. presidential election, which has distracted attention from business at hand. Until the new administration takes charge, the federal government will operate under last year's dollar figures. The Bush administration will submit a cursory 2010 budget and let the successor administration deal with problems from FY 2009 and introduce its own 2010 budget.

Congress did make progress on the FY 2009 budget; the House of Representatives passed a NASA authorizing bill, and the Senate worked on its own version. Both the House and Senate appropriations committees passed their NASA bills. In a normal year, those bills would be resolved by a conference committee, but this year, political disputes between Congress and the administration are impeding progress—hence the continuing resolution.

The spending bills proposed by both houses of Congress would have raised NASA's budget about three percent above the level proposed by the administration—for a total of around $17.8 billion. Both space and Earth sciences would receive more money in this budget, which likely won't pass.

Congress tinkered with the administration's proposed budget for the Exploration Systems division, which includes the Constellation Moon program, robotic precursors to human flight, and the private Commercial Orbital Transportation System. Congress mostly increased the requested amounts.

The Exploration program is the heart of the Vision for Space Exploration goal to return astronauts to the Moon before they set out for Mars, but the VSE depended for its implementation on regular increases to NASA's budget. The promised increases have not materialized, and to keep the VSE on track, NASA managers have been forced to cannibalize other programs.

These are the actions The Planetary Society has been fighting so hard to reverse. We will keep you informed as our campaign continues.

Moscow, Russia—The problems with the NASA budget pale in comparison with those being experienced in Russia. Despite a similar scope and some recent increases to the Russian space program, its annual budget is less than 10 percent of that of the United States: $1.3 billion compared with about $17 billion.

An article in *Pravda* bitterly commented, "Russia, the world's first space power, lags behind not only the USA, but such newcomers to the industry as the European Space Agency, China, Japan, and France. The space agencies of these countries spend about $3.5 billion a year on space exploration. India currently invests a little less than $1 billion in its space programs. It is not ruled out that the Asian country will outstrip Russia soon."

This smaller budget means that Russia is behind on development of its modules for the International Space Station, and its space science program has experienced a long hiatus. Next year, Russia plans to launch the *Radioastron* spacecraft to Earth orbit, as well as the Phobos sample return mission, which will carry The Planetary Society's Living Interplanetary Flight Experiment (LIFE), a Chinese Mars orbiter, and possibly a Russian-Finnish small-station lander for Mars. Until these missions are accomplished, however, there will be uncertainty about the future of Russian space science.

I recently returned from meetings in Russia convinced that financial support and political commitment to the Phobos sample return project are strong; however, the job of getting all instruments and subsystems developed and tested in time remains uncertain. Rather than flying before fully ready, Russia would postpone the launch to the next Mars opportunity, in 2011.

Meanwhile, as it seeks more and more commercial customers, Russia is putting some money into launch infrastructure. Still, government funding for national objectives in space science and exploration remains modest and is increasing slowly. Leaders in the Russian space industry continue to speak of ambitious robotic and human lunar programs, but the funding for these does not appear to be committed.

Louis D. Friedman is executive director of The Planetary Society.

The Importance of Observing Earth

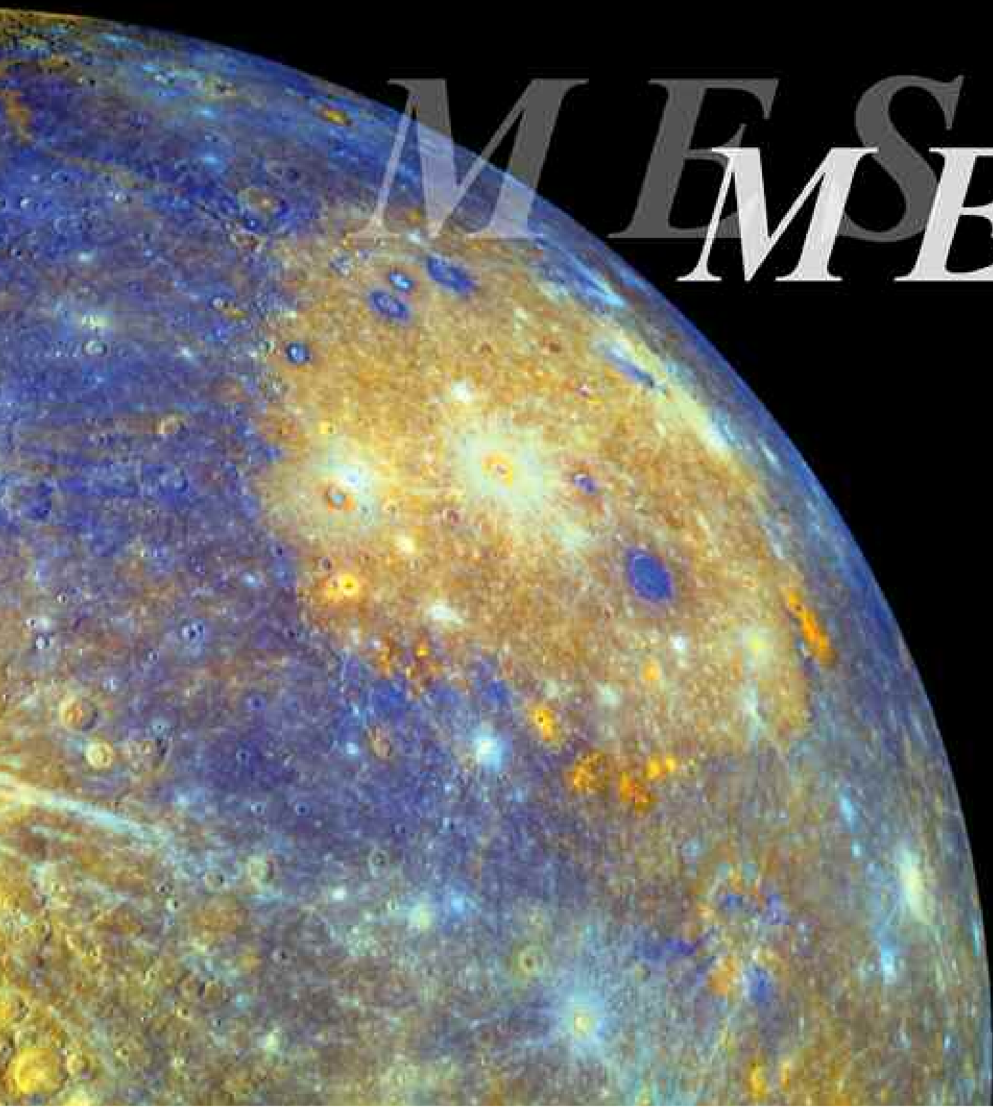
Our last issue of *The Planetary Report* was devoted to the topic of Earth observation. In late June, we unveiled this special issue at a breakfast briefing in the U.S. capitol, with Bill Nye the Science Guy®, our vice president; Charlie Kennel, former director of Scripps Oceanographic Institute and the newly appointed director of the National Academy of Sciences Space Studies Board; Berrien Moore, director of the new think tank Climate Central; and Mary Kicza, assistant administrator for Satellite and Information Services at the National Oceanographic and Atmospheric Agency. The briefing was organized in cooperation with the House Committee on Science and Technology.

Space observations play a critical role in tracking the ongoing changes in our planet's ecosystem. Kennel and Moore described how Earth observation missions have been cut back by NASA and NOAA in recent years and stated that much work needs to be done to ensure that we don't have gaps in data collection.

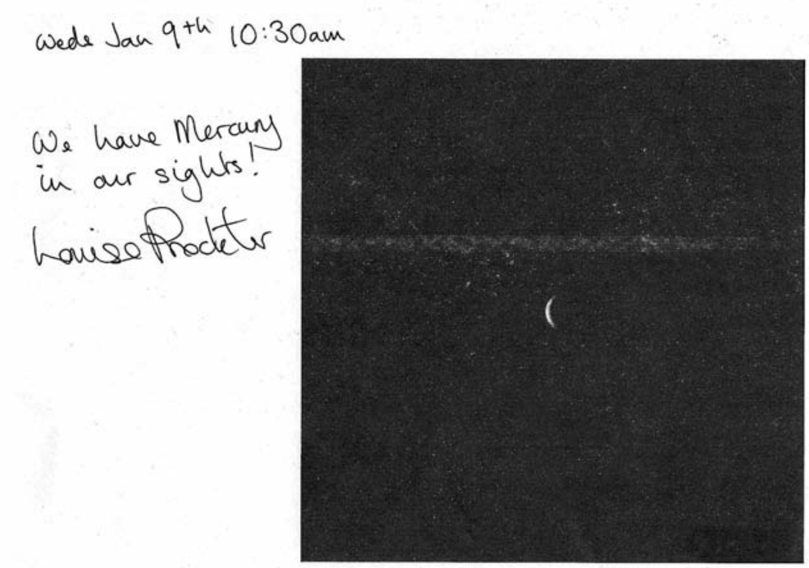
All speakers noted the increasing international activity in Earth monitoring and the importance of international cooperation in the Global Earth Observations System of Systems (GEOSS). The Planetary Society will focus on raising public awareness of GEOSS and of international cooperation in Earth observations.

MESSENGER ARRIVES

BY RALPH L. MCNUTT, JR. AN



The great Caloris impact basin, the orange circular form at upper righ false-color image, is the largest well-preserved impact basin on Merc to date by spacecraft. The contrasting colors in this view reveal that M surface composition is varied, especially between the floor of Caloris the surrounding region (purple). High-resolution images of the bright spots near the outer edge of Caloris show them to be volcanic vents. taken through the 11 color filters on MESSENGER*'s Wide Angle Camer were compiled to make this false-color portrait.* Image: NASA/Johns Hopki Applied Physics Laboratory (APL)/Arizona State University/Carnegie Institution of Washington



The tiny sliver in this raw optical navigation image was the MESSENGER *team's first transmittal from Mercury. The spacecraft returned this image as it closed in on its target on January 9, 2008.* Image: NASA/APL/CIW

"We have Mercury in our sights!"

said Louise Prockter, *MESSENGER*'s instrument scientist for the Mercury Dual Imaging System (MDIS). The raw image from the first optical navigation sequence—blemished with artifacts from both the printer and the system—came down at 10:30 a.m. on January 9, 2008, and its receipt was immensely welcome. It meant that *MESSENGER* was on target for the first spacecraft encounter of Mercury in nearly 33 years.

The moment had been almost 12 years in the making. The *MESSENGER* (an acronym for MErcury Surface, Space ENvironment, GEochemistry, and Ranging) mission to send the first spacecraft to orbit the solar system's innermost planet had been conceived in March 1996, and now all the hard work and planning were coming to fruition—flawlessly.

From the First Flybys to an Orbiter

The only previous spacecraft to visit Mercury was *Mariner 10*, developed and operated by the Jet Propulsion Laboratory (JPL). *Mariner 10* flew by Mercury three times in 1974–1975, imaged about 45 percent of the surface, discovered Mercury's internal magnetic field

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AT MERCURY

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a (WAC)
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Right: This color view, captured as MESSENGER *departed from Mercury, shows about 20 percent of the planet that* Mariner 10 *never saw. The image, made with three of the WAC's color filters, was snapped about 45 minutes after* MESSENGER*'s closest approach to Mercury, on January 14, 2008. Like the portion of Mercury seen by* Mariner 10*, this hemisphere is heavily cratered. At upper right is the giant Caloris basin, including its western portions, which had never before been seen by spacecraft.* Image: NASA/APL/CIW

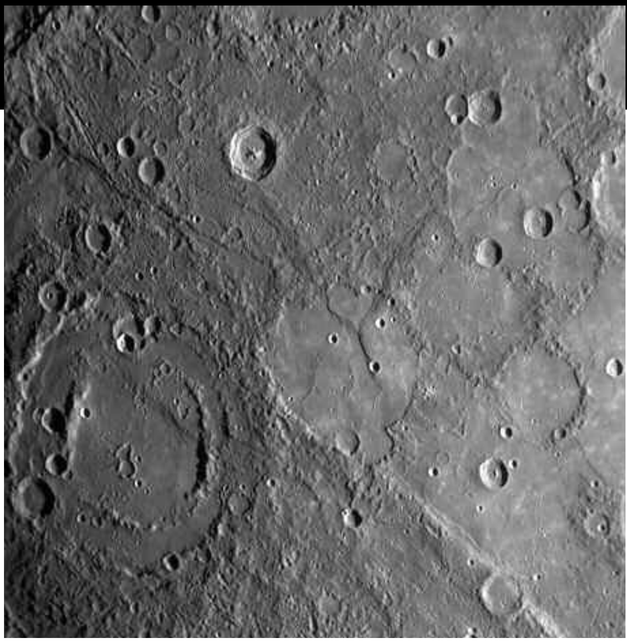
and magnetosphere, and documented that the planet has a tenuous atmosphere.

In the light of *Mariner 10*'s discoveries, the consensus view of the planetary science community was that the next stage of exploration of Mercury should be an orbiter. An orbiter could conduct global high-resolution imaging of the surface, carry out remote geochemical measurements of Mercury's surface composition, map the geometry of Mercury's internal magnetic field, and monitor the structure and composition of Mercury's exosphere and magnetosphere and their changes in response to time of day, solar distance, and solar wind interaction.

In the 1970s, however, it was not known how to insert a spacecraft into orbit about Mercury with a conventional chemical propulsion system. That problem was solved in the mid-1980s by JPL mission design expert Chen-Wan Yen, who discovered trajectories involving multiple gravity assists at Venus and Mercury. A variant of one of these trajectories is employed by *MESSENGER*.

Despite the fact that mission tools were available for a Mercury orbiter, another two decades passed before such a mission could be launched. Mission planners studied several concepts, but they all had price tags too high. The challenges of limited payload mass, large propulsion requirements, and a hazardous thermal environment were finally met by the *MESSENGER* team. They used a combination of scientific focus, miniaturized instrumentation, optimized mission design, and ruthless minimization of spacecraft mass. Only such a holistic approach could address the many cost and technology constraints. Between *Mariner 10* and *MESSENGER*, knowledge of Mercury advanced slowly, even as multiple missions of other types gave us increasingly detailed views of Mars, Venus, and other planets.

In July 1999, *MESSENGER* was selected as the seventh in NASA's Discovery Program series of competed planetary science missions. The mission was confirmed in June 2001. *MESSENGER* was designed, constructed, and tested by the Johns Hopkins University Applied Physics Laboratory (APL), together with several aerospace partners and a science team that is now 46 members strong. APL has operated *MESSENGER* and its payload since launch in August 2004.



Many of the larger impact structures visible here have been filled in, partially to nearly completely, by smooth plains. Several prominent cliffs and ridges mark the locations of faults that formed as a result of horizontal contraction of the crust. This view is approximately 18,000 kilometers (12,000 miles) above the surface and about 500 kilometers (310 miles) across.
Image: NASA/APL/CIW

Craters as small as 400 meters are visible in this image taken from around 5,800 kilometers (3,600 miles) altitude. The dark curved feature running from top left across to bottom center is Beagle Rupes, a shadowed cliff formed by the cooling and contraction of Mercury's crust. The cliff is the surface manifestation of a huge fault: along the fault, the crust to the right has been thrust over the crust to the left by several kilometers. At upper left is part of the elliptical crater Sweinsdóttir, the rim and floor of which have been deformed by Beagle Rupes. Image: NASA/APL/CIW

Water in Mercury's Thin Atmosphere

As *MESSENGER* flew past the night side of Mercury in January, its Fast Imaging Plasma Spectrometer (FIPS) scooped up ions from an atmosphere so tenuous that it's usually called an *exosphere*. FIPS measured the expected amounts of ions such as sodium, potassium, and calcium that previously had been detected as neutral atoms in Mercury's exosphere, but to the science team's great surprise, water also was present—in large amounts.

Mercury has almost no atmosphere because of the planet's close proximity to the Sun; it is continuously blasted by energetic particles from the solar wind, and any significant atmosphere it may ever have formed was eroded away long ago. The particles that *MESSENGER* can find near Mercury got there as a result of the solar wind bombarding Mercury's surface, reacting chemically, and knocking off atoms or molecules, a process called *chemical sputtering*. In a way, then, when FIPS scoops up charged particles from Mercury's atmosphere, it is actually sampling the chemical composition of Mercury's surface.

How could there be water on Mercury? The science team suggests three possibilities, which are not mutually exclusive. First, it has long been theorized (but not yet proved) from Earth-based radar observations that there may be reservoirs of water ice in permanently shadowed crater floors near Mercury's poles. Second, the water could come from comets. Third, the process of chemical sputtering could create water where none existed before, from the ingredients of solar wind and Mercury rock.

—Emily Lakdawalla, Science and Technology Coordinator

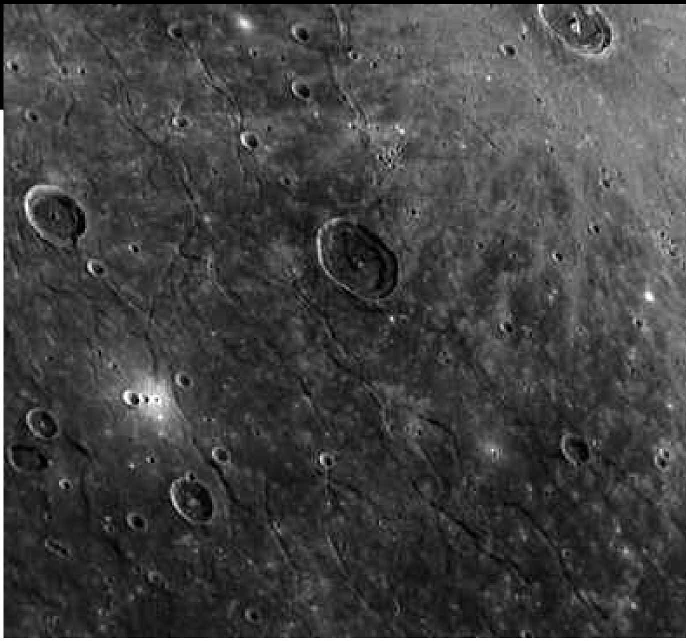
Getting to Mercury

MESSENGER employs a mission design involving six planetary flybys and five major propulsive maneuvers between launch and orbit insertion at Mercury. As of the beginning of 2008, *MESSENGER* had completed a flyby of Earth (August 2005), two flybys of Venus (October 2006 and June 2007), and two of its major propulsive maneuvers.

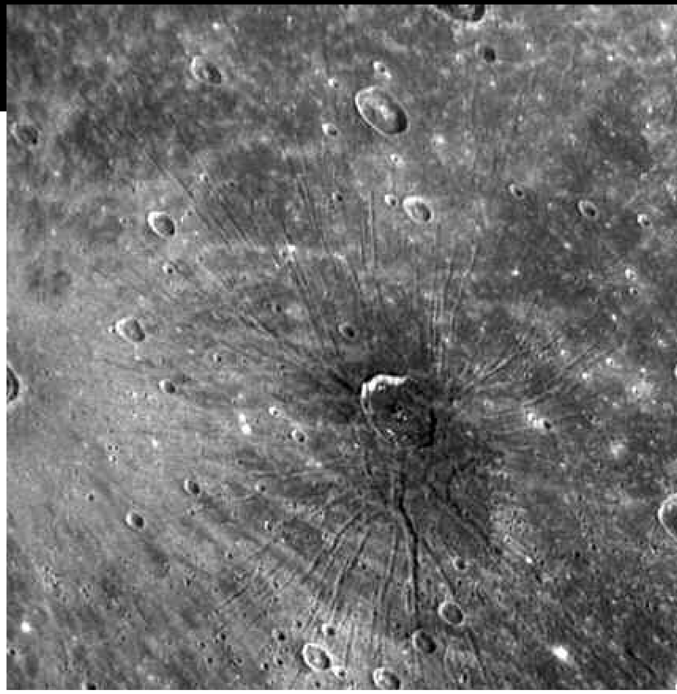
The Mercury flyby planned for January 14, 2008 was the first of three before orbit insertion can be accomplished at the fourth Mercury encounter, in March 2011. Every flyby has to be completed within a small margin of error if the entire mission design—including insertion into the correct orbit about Mercury—is to be accomplished. The January flyby of Mercury therefore not only was the first opportunity for a close-up view of the innermost planet in more than three decades but also was critical to the success of the rest of the mission.

To the delight of the entire *MESSENGER* team, the January 14 flyby was a success on all counts. *MESSENGER* achieved a closest approach altitude of 201.4 kilometers (125.1 miles) at 7:05 p.m. Universal Time (UTC). The encounter sequence of almost 14,000 commands worked nearly flawlessly, with all instruments operating and all guidance and control sequences executed as planned.

Excluding the optical navigation images and frames used to construct approach and departure movies, MDIS returned 1,213 images of Mercury, including some showing 21 percent of the planet's surface never before seen from a spacecraft, as well as new views of areas imaged by *Mariner 10*. *MESSENGER*'s best images from this flyby were at a resolution of about 150 meters.



This is the southwestern section of Caloris basin. The higher reflectance and well-preserved rays of Cunningham crater at top right are evidence that the crater is relatively young. The pattern of troughs visible here is similar to the pattern seen by Mariner 10 *on the eastern side of the basin floor. This image is approximately 280 kilometers (175 miles) across.* Image: NASA/APL/CIW



Originally nicknamed "the spider," this unique feature at the center of Caloris basin is one of the biggest surprises delivered by MESSENGER *so far. At the center of the spokelike pattern of troughs, now formally named Pantheon Fossae, is a crater named Apollodorus, about 40 kilometers (25 miles) across. Whether the crater-forming impact also led to the formation of the spoke-like troughs is still under investigation by the* MESSENGER *team.* Image: NASA/APL/CIW

A Closer Look at Mercury's Surface

MESSENGER's flyby images capture Mercury's surface and geologic history in intricate detail. They show impact features ranging in size from large multi-ring basins to craters as small as several hundred meters in diameter and preserved to varying degrees. The images permit assessments of the relative ages of major geologic features and of the sequence of geologic processes in a given area. They support the inference that many of the smooth plains on Mercury must have been emplaced as volcanic flows rather than as ejecta deposits from large surface impacts. The photos also document the widespread occurrence, first seen in *Mariner 10* images, of large cliffs and ridges that are the surface expressions of thrust faults formed as the entire planet cooled and contracted.

The Caloris basin has its own special geologic history. A number of large impact craters within the basin excavated material substantially darker than and different in color from the comparatively bright plains that fill the basin floor. *Mariner 10* observations of the eastern floor of Caloris showed that the floor displays two sets of tectonic features—an older set of contractional ridges and a younger set of extensional troughs, interpreted to have formed during an early episode of subsidence and a later episode of uplift, respectively. *Mariner 10* did not, however, image the center or the western half of the basin floor. *MESSENGER* has shown that the western basin floor has a deformational history broadly similar to that of the eastern floor.

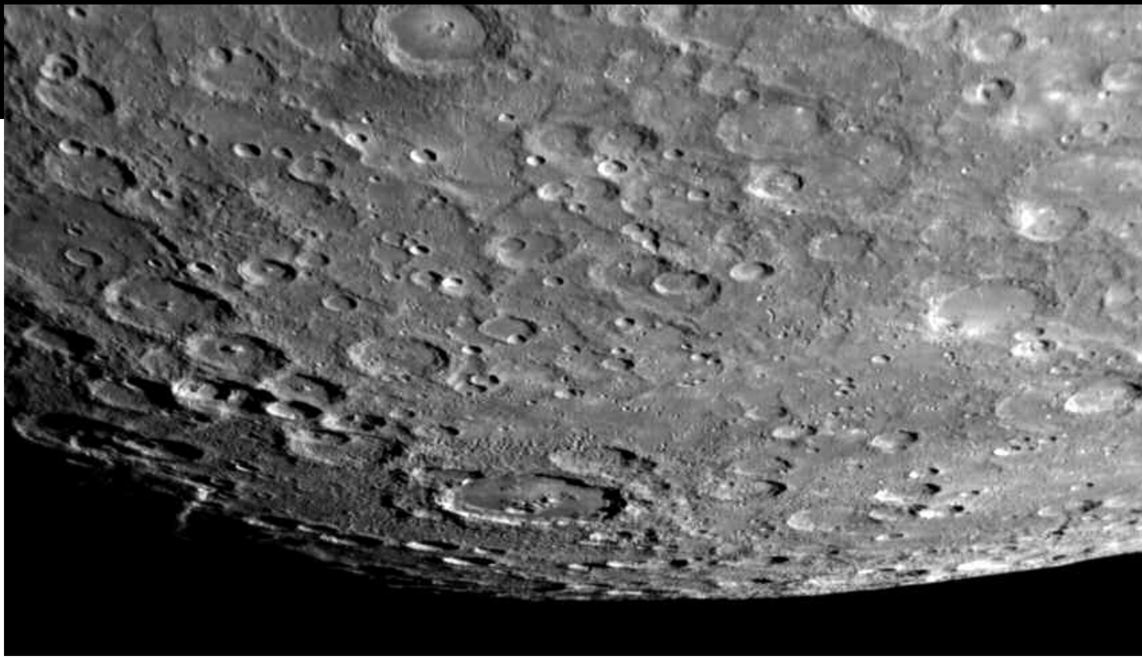
One of the biggest surprises of the *MESSENGER* images is that the center of the Caloris basin floor exhibits a radiating pattern of troughs unlike anything seen elsewhere on Mercury. Near the center of this spokelike pattern of troughs, named Pantheon Fossae, is the crater Apollodorus (named for the reputed architect of the Pantheon in Rome), approximately 40 kilometers (25 miles) in diameter. Whether the impact that formed the crater also led to the formation of the fault-bounded troughs or was simply a coincidental later addition is still under study.

Additional *MESSENGER* images are providing a basis for unraveling the sequence of geologic events on regional scales. Glimpses of the heavily cratered region toward the planet's south pole and the more varied terrain toward the north pole offer hints of what the spacecraft will observe once inserted into a nearly polar orbit about Mercury. Many of the most prominent features imaged for the first time in January 2008 now have new names approved by the International Astronomical Union (IAU), but many more features await future name assignments.

Characterizing the Innermost Planet

MESSENGER's other instruments also returned significant results from the flyby. The magnetometer documented Mercury's internal magnetic field at a closer distance to the planet than was possible with *Mariner 10*. Unlike that earlier spacecraft, *MESSENGER* observed no energetic particles during its flyby, although low solar activity and an unfavorable orientation of the interplanetary magnetic field could have been responsible for that result.

The Mercury Atmospheric and Surface Composition Spectrometer (MASCS) mapped the neutral sodium tail of Mercury for more than 20,000 kilometers (12,500



Glimpses of Mercury's poles offer hints of what MESSENGER *will see once it achieves a nearly polar orbit around the planet. At lower left in this image, looking toward the heavily cratered south pole, a raised crater rim catches sunlight, looking like a wisp of smoke. This region is new to spacecraft "eyes."* Image: NASA/APL/CIW

miles) in the anti-sunward direction, and the Fast Imaging Plasma Spectrometer sensor of the Energetic Particle and Plasma Spectrometer detected a magnetosphere filled with both protons and heavy ions. The heavy ions that originated either from Mercury's surface or by ionization of neutral atoms in the planet's tenuous atmosphere (more properly called an *exosphere*) constitute a remote sampling of Mercury's surface materials (see sidebar on page 14) and provide a measure of the processes that subject those materials to "space weathering."

MESSENGER carried out the first laser ranging to Mercury from a spacecraft and thereby provided the first high-resolution measurements of surface topography. *MESSENGER* was sufficiently close to the surface to obtain ranging results near closest approach only on the night side of the planet, a region not yet imaged by spacecraft. (*MESSENGER* will view this area in sunlight during its second Mercury flyby, in October 2008.) The radar at the Arecibo Observatory captured images of this portion of Mercury's surface, permitting some portions of the altimetric profile to be correlated with craters seen in the radar images, but more confident interpretation of altimetry will be possible once spacecraft ranging and imaging observations can be combined.

MESSENGER also conducted the first reflectance spectroscopy from a spacecraft at wavelengths from the ultraviolet to the near-infrared. Understanding the surface composition and mineralogy of Mercury is an important goal of the *MESSENGER* mission, supported by the Gamma-Ray and Neutron Spectrometer, X-Ray Spectrometer, and MASCS instruments. Both the Visible and Infrared Spectrograph (VIRS) and Ultraviolet and Visible Spectrometer (UVVS) sensors on MASCS were able to view Mercury's surface. The distinct spectral signatures of "mature" and "fresh" material show up clearly. The mission team is continuing its analysis of these spectral data and designing observational campaigns for the next flybys that will elucidate the diversity of terrain types by spectral characteristics.

Whetting Our Appetites for More

Planetary flybys, although short events, require long-term planning. Preparation for the first Mercury flyby began prior to *MESSENGER*'s second Venus flyby in June 2007. That encounter enabled the sequencing team to test much of the software that would be used for the first Mercury flyby. The readiness review for that Mercury flyby was held in October 2007, and final planning continued through the calendar year. By the end of 2007, plans were in place for the science team to gather at APL for the encounter.

Team members began arriving at APL on Sunday night, January 13, 2008. Optical navigation images from the previous several days showed a crescent Mercury growing in the field of view.

At 7:56 a.m. local time (Eastern Standard Time, EST) on Monday, January 14, the spacecraft transitioned from high-rate downlink to beacon mode as it was reoriented for radio science and, later, imaging measurements. The majority of the science team was on site by Monday afternoon as *MESSENGER* made its closest approach, just after 2:00 p.m. EST, when the only evident signature of the planet was its occultation of the signal from the spacecraft. The recovery of the signal and the expected Doppler shift in the downlink frequency brought a wave of relief to the entire team. About 22 hours remained before the last elements of the encounter sequence would finish and high-rate data downlink would resume.

The next day, January 15, at 11:30 a.m. EST, the high-rate communication signal from *MESSENGER* was reacquired. Telemetry data indicated that the encounter sequence had executed as planned. That afternoon, images and other data began to flow into the Mission Operations Center (MOC) and the Science Operations Center (SOC) at APL.

With anticipation mounting, the team at the SOC waited for the appearance of the first closeup image—one of the Wide-Angle Camera frames of the full planet. Starting that afternoon, the science team began meeting on a twice-daily basis: at 9:00 a.m. to plan the day and at 4:00 p.m. to discuss the day's results, spacecraft status, and instrument status.

The month of January for *MESSENGER* was marked by 43 website releases, 27 news releases, and a NASA news conference on January 30 (one day before the 50th anniversary of the historic flight of *Explorer 1*). By the end of the month, most science team members had returned to their home institutions. Since that time, the team members have been writing papers and giving presentations at meetings around the world to report the findings from the flyby. Equally important, the *MESSENGER* team has been preparing the command loads for the spacecraft's second Mercury flyby, in October.

What's Next?

We now know that Mercury is a more complex planet than had been appreciated even after *Mariner 10*, and the observations made in January have whetted the planetary science community's appetite for more. *MESSENGER's* October flyby will oblige, because the sunlit side of Mercury will be nearly the opposite of that viewed in January, and another 30 percent of the planet's surface will be seen at close range for the first time.

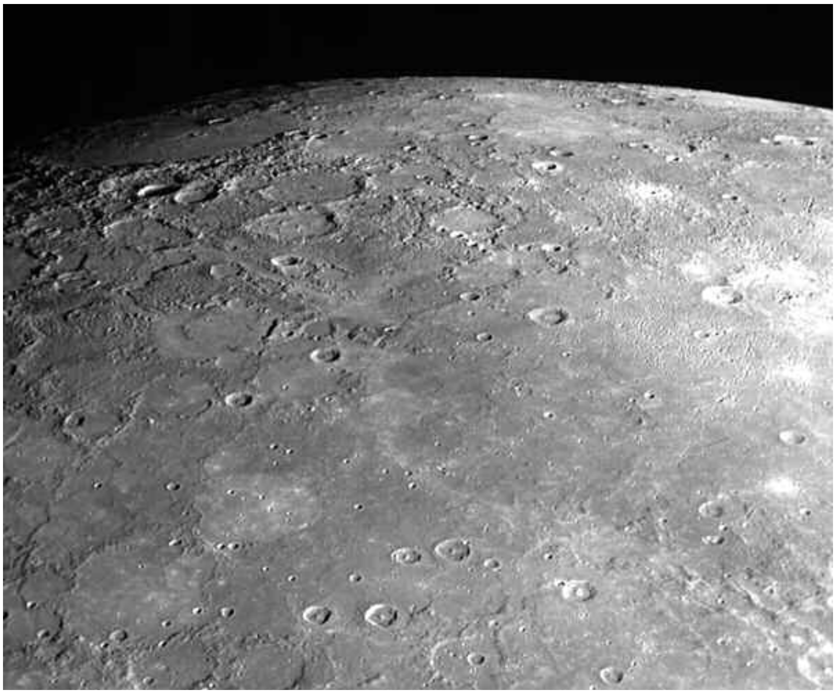
The journey to orbit insertion is barely more than half completed, and two more Mercury flybys promise to return data sets comparable in their impact to what was obtained in January. As of March 2011, *MESSENGER* is slated to be in a 12-hour orbit about Mercury, in effect making a diverse set of observations twice per day that will rival those of the entire January flyby. The innermost planet will be understudied no longer.

Ralph L. McNutt, Jr. is the MESSENGER *project scientist and a co-investigator on the science team; Sean C. Solomon is the* MESSENGER *principal investigator. Both began working on the initial* MESSENGER *concept in the spring of 1996 and have seen the mission through spacecraft and payload development and testing, launch, and—now—the first return of spacecraft observations from Mercury since 1975. McNutt is also a co-investigator on the* New Horizons *and* Voyager *missions and a member of the* Cassini *science team. Solomon is the director of the Department of Terrestrial Magnetism and principal investigator there for the Carnegie Institution's NASA Astrobiology Institute team. A veteran of the* Magellan *and* Mars Global Surveyor *missions, he is also a co-investigator on the lunar* GRAIL *mission, currently under development.*

Where Is MESSENGER Now?

A quick look at the counters on the* MESSENGER *website gives a sense of milestones past and future. As of 6:27 p.m. EDT on July 25, 2008, the mission elapsed time was 1,452 days, 16 hours; the time to the second Mercury flyby was 72 days, 14 hours; the time to Mercury orbit insertion was 965 days, 11 hours; and the distance traveled was 2,674,631,351 miles.

Log on to* messenger.jhuapl.edu *to see where* MESSENGER *is now.



In the more varied terrain toward the north pole, flooding of crater interiors by smooth plains material is visible, as are smaller, younger craters overlying the plains material. The images on these two pages were acquired by* MESSENGER*'s Narrow Angle Camera (NAC) at an outgoing distance of about 32,000 kilometers (20,000 miles). Image: NASA/APL/CIW

Members' Dialogue

The Earth Issue

I just read the July/August 2008 issue of *The Planetary Report*. The Planetary Society is the last place I thought I'd find such a biased treatment of the global warming issue. If you are not aware of the existence of dissenting viewpoints, you are not doing your homework. A growing number of papers do not support global warming, or at the very least, cast doubt on the conclusions of Al Gore and the Intergovernmental Panel on Climate Change (IPCC).

Without going into great detail, interglacial (or "global warming") periods are directly correlated to a number of natural phenomena, including Sun cycles, Earth axis variation, orbital precession variation, orbital eccentricity variation, and yes, CO_2 levels. These processes combine to cause an end to ice ages, usually once every 100,000 years. Most of the causal culprits are never mentioned by the global warming camp.

It was only as recently as the 1970s when the CO_2 levels deviated significantly from the global temperatures, and the headlines read: "Global Cooling!" The fact is that we have not been making (reliable) measurements long enough to even predict tomorrow's weather. This interglacial period will end—as have those before it—we just do not know when.

Richard C.J. Somerville states, "In fact, about 125,000 years ago the sea level was some 4 to 6 meters higher than today, but relatively high temperatures were sustained for centuries." What goes unsaid is the fact that CO_2 levels were also higher, and there were no significant contributions from humans (who were obviously pre-industrial).

If you wish to continue publishing global warming articles, please do so in an unbiased fashion, befitting the long history of The Planetary Society. Better yet, stick with the topics that have led to your loyal readership.
—WARREN MILLER,
Portland, Oregon

I will not go into all the reasons why your most recent issue is bad science. Earth has been warming ever since the ice age and it is not all the result of human activity. It is going to continue to warm up, no matter what is done. Learn to live with it. Just do not continue to scare our young people with unproven unscientific facts that make mankind the evil culprit.
—PHIL PICKERING,
Edmonds, Washington

Earth's climate has changed throughout its history, and this change will continue until the planet dies. The difference is that billions of people live on Earth today, have an effect on its atmosphere, and will be affected by it. Understanding and getting data to monitor our climate is something the space program can—and should—do.

A recent survey of our members showed that, three to one, they think it is important to use space observations to monitor and understand global climate change. The Society takes no stance on the political issues surrounding that topic, except to strongly support data gathering from space to understand the processes involved. You can read more about the Society's advocacy for space-based observations of Earth on our website at http://www.planetary.org/about/executive_director/20080709.html.

More information about global warming is available at these government websites:
http://climate.jpl.nasa.gov/evidence/#no3 *and*
http://www.ncdc.noaa.gov/oa/climate/research/2008/mar/global.html#tem
—Louis D. Friedman,
Executive Director

The Planetary Society is to be highly praised for dedicating the July/August 2008 issue of *The Planetary Report* to planet Earth. The importance of Earth as our only current home and the vital need to monitor its health from space must be constantly reinforced.

The *Apollo* program's widely publicized photographs of Earth from space jolted the human psyche into realizing not only the fragility of our home planet but also that as human beings we truly are all in this together. I wonder, however, if these early realizations could use constant reinforcement.

What if we were to transmit from space live images of dynamic Earth on a continual basis and include the display of these images on huge monitors in population centers around the world? Might this constant reminder reinforce our personal commitment and responsibility to planet Earth as well as to each other as fellow passengers? Would not a dramatic continuous view of Earth suspended in space also reinforce the reality that we are a spacefaring people? And might this, in turn, help foster the necessary international cooperation ideally suited for world endeavors including space travel, exploration, and colonization?
—MICHAEL L. TURNEY,
Placerville, California

Please send your letters to
Members' Dialogue
The Planetary Society
65 North Catalina Avenue
Pasadena, CA 91106-2301
or e-mail: *tps.des@planetary.org*

Society News

Wedding Bells Are Ringing

When Planetary Society members Nancy Pinard and Byron Roberts married this past spring, they exchanged more than wedding rings. In lieu of wedding favors, they shared their passion for planetary rings—and all things space—with their guests.

Byron explained, "Instead of spending money on wedding favors that people would probably just throw away or never use, we decided to take that same money and contribute it to The Planetary Society. But so the guests would have some sort of keepsake from the reception, we made up cards (containing information about The Planetary Society and your Web address) and gave those to each guest, explaining what we were doing. People seemed to think it was a great idea, too!"

Do you want to celebrate a special event or honor someone?

You can make a tribute gift by going to the Society's website at *planetary.org/join/giving* or by sending your tribute donation to us at The Planetary Society, 65 N. Catalina Ave., Pasadena, CA 91106-2301.

Be sure to let us know the name and address of the person you are honoring, and/or tell us what the special occasion is, so we can send a note about your gift.

Questions? Please contact me at *andrea.carroll@planetary.org* or (626) 793-5100, extension 214.
—Andrea Carroll, Director of Development

Planetary Society of Japan's New President

We are pleased to announce that Hitoshi Mizutani assumed the position of president of The Planetary Society of Japan as of June 2008. Mizutani succeeds Tamiya Nomura, The Planetary Society of Japan's first president.

Mizutani is a well-respected lunar scientist who led the planetary science division of the Institute of Space and Astronautical Science (now the Space Science Division of JAXA) until he retired from the institute in March 2005. He also has served as editor-in-chief of *Newton*, a Japanese monthly science publication with a circulation of more than 120,000.

Mizutani is a longtime friend of The Planetary Society, and we are pleased that he is stepping in to lead The Planetary Society of Japan.
—Louis D. Friedman, Executive Director

The World's First Solar Sailing Video Game . . . for Kids!

The Planetary Society wants to inspire kids with the potential for solar sailing, so we recently advised the people who make award-winning Cogno science games in their creation of the world's first "solar sailing" video game for kids.

The game, called LightRider, is available free online once you sign up as a Cogno agent (also free). A kid-friendly Q&A explains the fascinating science behind solar sailing.

Go to *www.cogno.com/#/games* and click LightRider to find out more and to play the game.
—LDF

Planetary Society's P.O. Box

We have closed The Planetary Society's P.O. Box 61270, and the Post Office's forwarding service will expire in January 2009. Please send all future correspondence to Planetary Society headquarters: The Planetary Society, 65 N. Catalina Ave., Pasadena, CA 91106-2301.

Thank you! We appreciate your support.
—Melanie Lam, Membership Manager

Questions and Answers

The painting showing magma on the young Moon in your May/June 2008 issue got me thinking about our satellite's lack of an atmosphere. I know its gravity is too weak to hold onto gases for a long time, but during the early life of the Moon, did abundant volcanism replenish gases quickly enough to create an atmosphere with a density comparable to that of Earth's atmosphere?
—Ted Toal
Nevada City, California

It seems unlikely that the Moon could have attained an atmosphere as dense as Earth's because its gravity is just too low to hold onto most gases for very long. A detailed answer is more complicated and would factor in the rate of gas release or replenishment from the inside of the early molten Moon versus the loss rate due to low gravity, as you suggest.

The release of gas from inside the newly formed Moon probably was very slight. The reason for this is that scientists think our satellite formed during a mighty collision between Earth and a large planetesimal. The hot gases released in the explosion would have tended to blow off into space instead of condensing into the solid material that formed the Moon. The young Moon, therefore, probably had very little volatile material (material easily driven off as gas when heated). The virtual absence of volatiles in any of the *Apollo* lunar samples supports this theory.

An exciting recent discovery is relevant, however. A scientific team has found trace amounts of water molecules—no more than 46 parts per million—in the famous "orange soil" that astronauts found during the *Apollo 17* mission in 1972. (The researchers reported on their discovery in the July 10, 2008 issue of *Nature*.) The orange soil turned out to be composed of volcanic glass beads. Even in the 1970s, scientists suggested that such soil was formed by exposure to steam during a volcanic eruption—a view that now seems confirmed. It means that the Moon's original interior did have traces of water, and if it did form by a giant impact, not all the water and other volatile gases escaped during the explosion.The Moon's gravity is so low, however, and the amounts of water there—even in the orange glass—are so small that our satellite probably never accumulated an Earth-like or Mars-like atmosphere.
—WILLIAM K. HARTMANN,
Planetary Science Institute

These orange glass spheres and fragments (now known to be volcanic in origin) are the finest particles ever brought back from the Moon. Tiny traces of water in these particles seem to have originated as steam from an ancient volcanic explosion. Ranging in size from 20 to 45 microns (about 1/1,000 of an inch), the glass beads are magnified 160 times in this photomicrograph. *Image: NASA/JSC*

I am excited by the* Phoenix *mission and the* Phoenix *DVD. The DVD allows me to connect more closely to the exploration.

The disc appears to sit on the top of the lander, exposed to the elements. How will it last hundreds to thousands of years if it is exposed in that manner? Is the readable side the one that's not exposed to dust collection? Will Mars' temperature variations have an effect on the disc over that extended time period? Is the expectation that a future human, Martian, or other being will have a disc reader handy, or is there a reader for the disk on the lander?
—Rick Bowman
Dayton, Ohio

Thanks to you and to everyone else who sent their names and names of additional family to Mars on our *Phoenix* DVD. You can find updates about the DVD and *Phoenix* in this issue on pages 4–7.

We do believe the *Phoenix* DVD will last many hundreds of years. The disc is not an off-the-shelf plastic DVD but instead is made of a very tough, fused silica glass. The collection of data is etched directly into the glass, and it is also protected by the label.

Not only is the glass very robust, but the Martian environment also is generally much less erosive than Earth's environment. There is no liquid water and, as a result, physical and chemical weathering are greatly lessened. Also, Mars' atmosphere is much thinner than Earth's, lessening the impact from wind-related phenomena. In addition, the *Phoenix* disc is highly resistant to radiation and to temperature fluctuations. Having the DVD sit on the deck of the lander not only allows those who sent their names to see the disc on the surface but also makes it much more likely that future explorers will retrieve it.

Regarding the reading of the disc, we don't know if it will

be recovered in 50 years or 500 years, so clearly we cannot assume that a DVD player will be handy. It is likely, nevertheless, that access to the data encoding standards will still exist. Even if the intended, usual type of access is not possible, the "bits" of encoded information on the disc can be read using a microscope or other device. When a civilization demonstrates the knowledge needed to make it to Mars and recover the disc, we're betting that it also will be clever enough to figure out how to both read and decode the data on it, even without reference to the DVD standards of 2007. To try to make their job easier, we've placed technical information on the label in the "fine print."
—BRUCE BETTS,
Director of Projects

The recent 100th anniversary of the Tunguska impact has me wondering: What is the minimum size for an incoming object to survive a direct (nonoblique) pass through Earth's atmosphere and reach the surface? What is the minimum size for an object to produce a crater on our planet? (I imagine that composition is an important factor.)
—J. Franconi
Columbus, Ohio

The so-called conventional wisdom on this topic has been that stony asteroids smaller than about 40 meters in diameter don't make it to the ground but explode in the atmosphere, so they don't cause significant damage. This conventional wisdom was challenged on September 15, 2007 when a stony meteorite—a class H4-5 ordinary chondrite about one meter in diameter—crashed in Peru near the village of Caracas, not far from Lake Titicaca, leaving a crater with a diameter of 13 meters. Objects this size enter the atmosphere about 10 times a year. Obviously, most of these do not make it to the ground, but this singular event demonstrates that under the right entry conditions, and for a sufficiently hard stone, it is possible.

In addition, we believe that iron meteorites as small as a few meters in diameter are capable of making it to the surface. It is hard to place a firm limit on the smallest size of a body that can hit the ground and leave a crater, but it seems likely that most meteoroids smaller than 30 meters in diameter do not make it to the ground; otherwise, we would see the craters.
—ALAN W. HARRIS,
Space Science Institute

Factinos

At least one of the large lakes observed on Titan contains liquid hydrocarbons. *Cassini* scientists have positively identified liquid ethane in a solution with methane, other hydrocarbons, and nitrogen. This makes the Saturnian moon the only known solar system body besides Earth to have liquid on its surface.

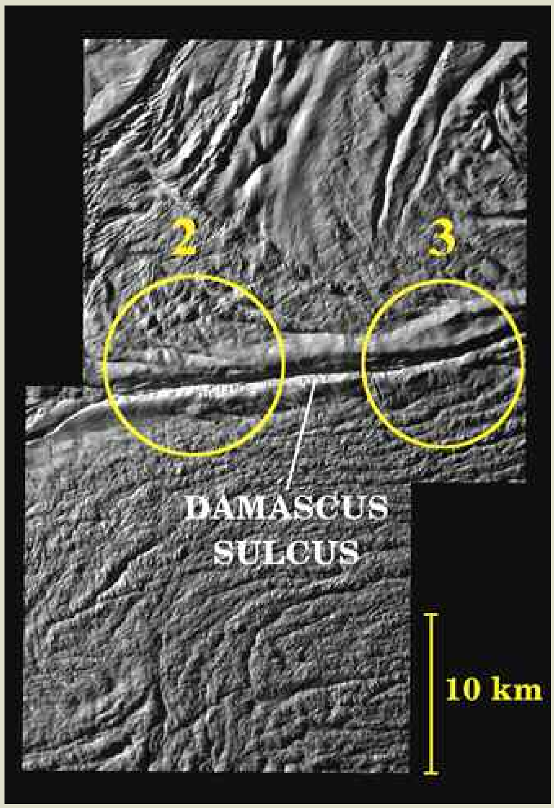
The researchers made their discovery using data from *Cassini*'s Visual and Infrared Mapping Spectrometer (VIMS). It identified chemically different materials based on the way they absorb and reflect infrared light. The VIMS observed a lake, Ontario Lacus, near Titan's south pole during a close *Cassini* flyby in December 2007. The lake is roughly 20,000 square kilometers (7,800 square miles) in area, slightly larger than North America's Lake Ontario.

The science team published its results in the July 31, 2008 issue of *Nature*.
—from the Jet Propulsion Laboratory

Cassini has identified some precise points where icy jets of water vapor and trace organics erupt from Saturn's geologically active moon Enceladus (see image at right). The new images show exquisite details in the moon's south polar "tiger stripe" fractures from which the jets emanate. The fractures are about 300 meters deep, with V-shaped inner walls. Some of the fractures have extensive deposits of fine material surrounding them, as well as blocks of ice the size of a small house or even up to tens of meters on a side.

Cassini took the images during an August 11, 2008 flyby of Enceladus. A special technique, developed by imaging team member Paul Helfenstein of Cornell University, canceled out the high speed of the moon relative to the spacecraft to obtain the high-resolution views. This new information, coupled with observations by *Cassini*'s other instruments, may answer the question of whether reservoirs of liquid water exist beneath the satellite's surface.
—from the Space Science Institute, Boulder, Colorado

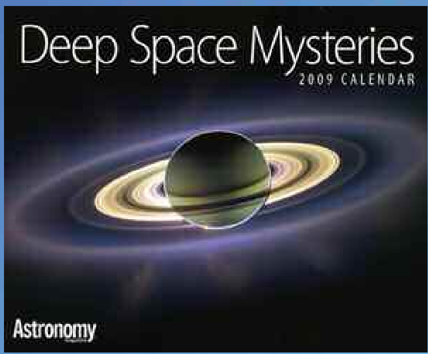
For more detail on these stories, visit *planetary.org*.



On August 11, 2008, Cassini *acquired a set of seven high-resolution images targeting known jet source locations on Enceladus' "tiger stripe" fractures, or* sulci. *In this mosaic, images 2 and 3 from that set are circled in yellow.*

Features on Enceladus are named for characters and places from The Arabian Nights, *with the four most prominent sulci named Alexandria, Cairo, Baghdad, and Damascus. Here, Damascus sulcus runs across the center from left to right.* Mosaic: NASA/JPL/Space Science Institute

The Planetary 20



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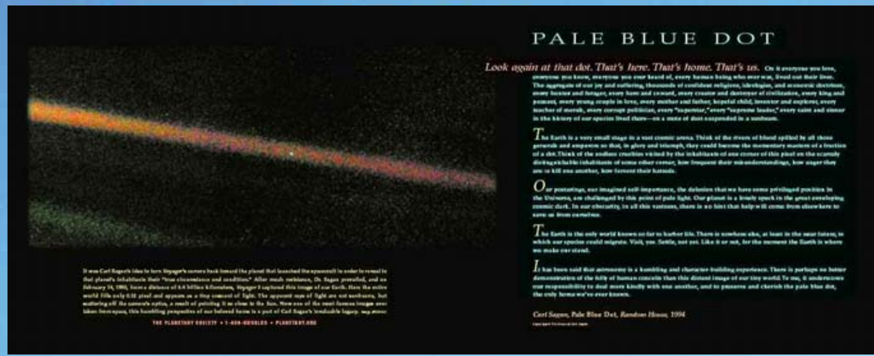

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In February 1990, *Voyager 1* looked back at its home planet for the first time. The image of Earth as a tiny bluish dot inspired Carl Sagan to write one of his best-known essays, which starts off his book *Pale Blue Dot*. The poster features Carl's timeless words and the full frame of the profound image captured by *Voyager 1*. 12" x 30" 1 lb. **#326** **Regular price: $11.11** **Member price: $10.00**

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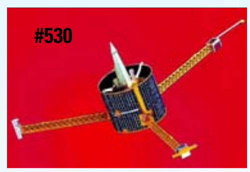

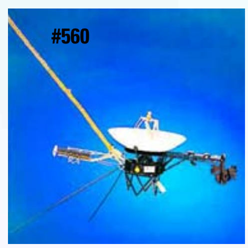

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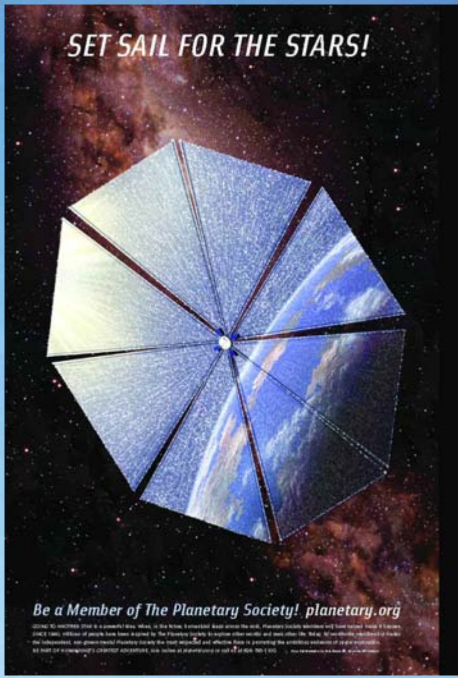

"Dusters" Stardust@home T-Shirt
Show that you're part of the Stardust@home team of volunteer investigators with our exclusive Dusters shirt. In 2006, the *Stardust* spacecraft captured the first particles from distant stars and brought them back to Earth. But before scientists can study these precious samples from the faraway Sun, they will first have to find them. Stardust@home turned to tens of thousands of "dusters" who have been volunteering time and energy searching for evidence of these tiny pieces of star stuff. Are you a duster? Do you want to be? We have more online at *planetary.org/stardustathome/*. Adult sizes: S, M, L, XL, XXL
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Nebula Poster
This awe-inspiring image from NASA's orbital Spitzer Space Telescope shows a false-color infrared view of nebula RCW 49—a birth-place for many hundreds of new stars and likely many thousands of planets. This stunning poster features one of Carl Sagan's poignant statements: "If we crave some cosmic purpose, then let us find ourselves a worthy goal."
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Regular price: $15.00
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Surf Titan T-Shirt
A Planetary Society classic—we first introduced this shirt after *Voyager* passed by Titan, revealing hints of a methane ocean. Now that *Cassini-Huygens* has arrived for a closer look at the mysterious moon, we decided to bring this old favorite out of retirement. This shirt is long-sleeved with "The Planetary Society" printed on the left sleeve. Adult sizes: S, M, L, XL, XXL 1 lb. **#593**
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Mounting evidence indicates that Mars, now freeze-dried and apparently lifeless, once had liquid water on its surface. In *Blue Mars IV*, we see the Red Planet as it may look again—if humans colonize and terraform it, creating vast seas and a much thicker atmosphere. On the planet's night side, city lights glow as Deimos orbits in the foreground.

Mark Garlick, an astrophysicist by training, is also a freelance illustrator and author specializing in Earth and space sciences, technology, and science fiction. A Fellow of the International Association of Astronomical Artists (IAAA), he lives and works in the United Kingdom.

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