THE PLANETARY REPORT

DECEMBER SOLSTICE 2011

VOLUME 31, NUMBER 5

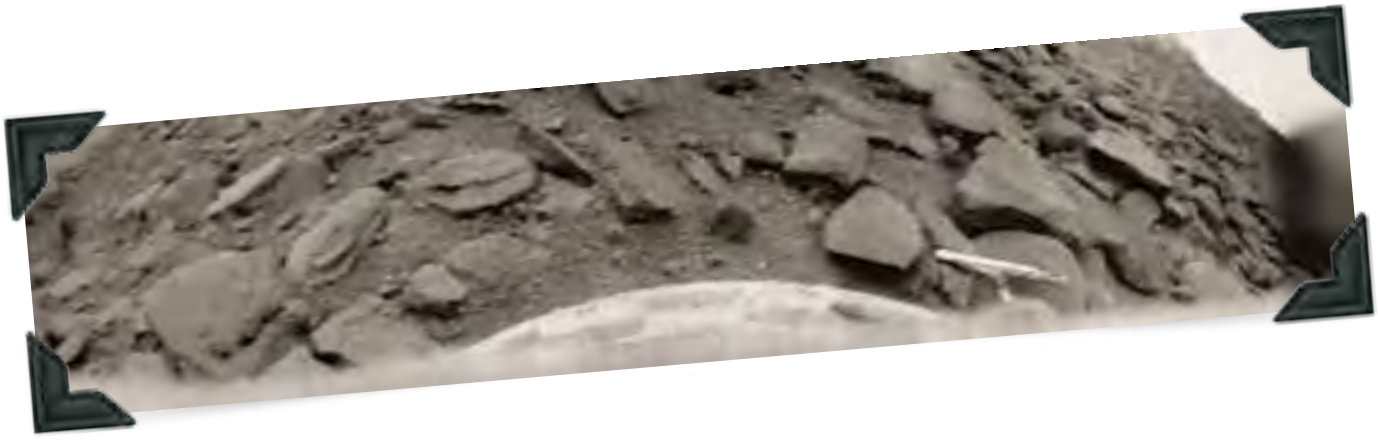
www.planetary.org

REMEMBERING

THE YEAR IN PICTURES

NEW (OLD) VENUS IMAGES ✻ POLITICAL ACTION 2011 UPDATE ✻ SHOEMAKER GRANT RECIPIENTS

EMILY STEWART LAKDAWALLA
blogs at planetary.org/blog.

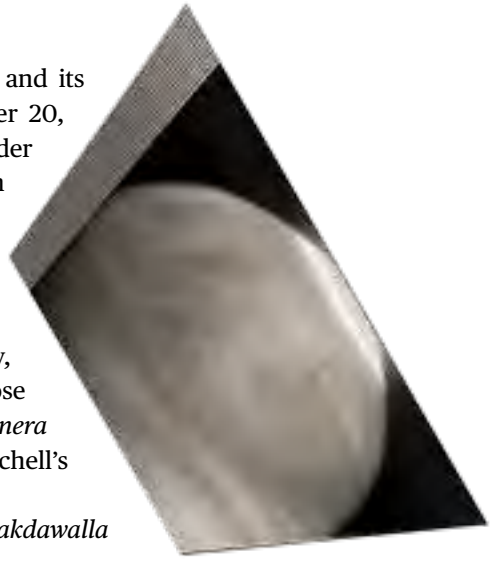


New images, old camera

1975 was a good-looking year for Venus

***VENERA 9* BECAME THE FIRST ARTIFICIAL** satellite of Venus, and its lander was the first to photograph Venus' surface, on October 20, 1975. One of its two cameras, a line-scanner that rotated in order to build a complete image, returned two views of a rock-strewn hillside. The scanner was angled from the spacecraft's body, so this panorama shows the horizon at its edges and the ground in front of the lander at its center. This view was reconstructed by Don Mitchell from data on tapes exchanged between the Soviet Union and Brown University. More recently, digital data have become available online, and Mitchell used those data to reconstruct a view of Venus *(at right)* captured by the *Venera 9* orbiter on December 11, 1975. For more *Venera* photos, visit Mitchell's website at MENTALLANDSCAPE.COM.

–Emily Stewart Lakdawalla



Images: Russian Academy of Sciences/Don Mitchell

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ON THE COVER: After 30 years and 135 flights, the United States' space shuttle program has ended. On July 8, 2011, the last shuttle—*Atlantis*—roared into a blue Florida sky to carry four tons of supplies and spare parts to the International Space Station. With *Atlantis* and its sisters *Discovery* and *Endeavour* now headed for museums, the space station will now depend on Russian, Japanese, and European rockets to deliver supplies, and hope for privately built supply ships to become available soon. *Photo: Ben Cooper/LaunchPhotography.com*

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The Planetary Report (ISSN 0736-3680) is published quarterly at the editorial offices of The Planetary Society, 85 South Grand Avenue, Pasadena, CA 91105-1602, 626-793-5100. It is available to members of The Planetary Society. Annual dues in the United States are $37 (U.S. dollars); in Canada, $40 (Canadian dollars). Dues in other countries are $57 (U.S. dollars). Printed in USA. Third-class postage at Pasadena, California, and at an additional mailing office. Canada Post Agreement Number 87424.

BILL NYE *is executive director of The Planetary Society.*

EVERY 26 MONTHS, a launch window opens up that lets us go to Mars. Such a window opened this year.

I made the trip to Cape Canaveral, Florida to be part of NASA's "Tweetup" for the November 28 launch of *Curiosity*, the next rover on Mars. I've seen a few launches now; each is spectacular in its own way. This one left right on time—to the second. The power, the sound, and the extent of the exhaust flames are all spectacular features of this business. When we stop to consider that this piece of hardware—this spacecraft—is headed to another world and never coming back, it reminds us of just what our humble species can accomplish. In a way, we're in the golden age of planetary exploration. At the same time, we're at a crossroads. Unless we keep our advocacy strong, space programs around the world will founder. Once again, thanks for your support.

As I write, the *Phobos-Grunt* (Soil) spacecraft—and our Phobos LIFE biomodule—have been written off as a loss. Despite focused efforts by Roscosmos, the Russian space agency, and ESA, the European Space Agency, we could not find a way to awaken the spacecraft, fire its engine, and send it on its way to Mars' extraordinary moon. In this issue we share excerpts from a letter written by Lev Zelenyi, director of Russia's Space Research Center, to all participants in the mission. It was a bold undertaking by our colleagues at Roscosmos. Here's hoping the rocket scientists, technicians, and mission planners involved have the courage to try again. Please follow news of the mission on *planetary.org/blog*.

Phobos-Grunt demonstrates once again the tremendous difficulty of space exploration. Although this mission did not succeed, we have the three Earth-control biomodules safely stored, awaiting the resolution and assessment of whatever caused all the trouble. We hope that soon we will have the opportunity to be part of a future mission. No matter what happened or will happen, you are part of another adventure in space. You are a participant.

With your help, we've just about completed our two *LightSail-1*™ spacecraft. These are remarkable machines; with the highest thrust-to-mass ratio of any solar sail, they are the highest-performance solar sail spacecraft ever built, even better than our own earlier *Cosmos-1*. When we get one into space, it will be the most maneuverable solar sail craft to date, able to tack its sails with every orbit around Earth. Twice every 100 minutes or so, the spacecraft will twist, either to present its sails broadside to sunbeams for maximum thrust or to work its way toward the Sun edge-on to minimize what will become the Sun's repelling force. It will also feature amazingly compact accelerometers that will imbue *LightSail-1* with the ability to compute and transmit its own movement. For the first time in the history of solar sailing, ground telemetry will be the secondary source of position data. Frankly, my favorite aspect is that you built this spacecraft. You saw the niche, the opportunity to produce a space vehicle like no other, and you participated and supported us. Thank you.

We very much hope to launch *LightSail-1* before the end of 2012. We await a "ride" to a bit of an unusual altitude; we need to get to a medium Earth orbit (MEO) of about 840 kilometers (450 nautical miles). Some years, space agencies and commercial companies around the world send several rockets to MEOs; other years, not so many. We're hoping that next year, we will launch on one of the few.

Also this year, our staff and Board were recognized for some great work. Our own Mat Kaplan accepted the Parsec Award for the "Best Science Behind the Fiction" at Dragon*Con for his *Planetary Radio* broadcasts (see "*Planetary Radio* Wins Parsec Award" in the September 2011 issue). The science fiction community reminds us that without science, science fiction wouldn't be much fun. Mat makes it factual and fun every week.

Emily Lakdawalla, our wonderful blogger geologist, was awarded the Jonathan Eberhart Planetary Sciences Journalism Award from the American Astronomical Society's Division of Planetary Science (DPS). To engage the international community, that group had its meeting in France this year, and it flew Emily there to receive the award and present a heartfelt and moving acceptance speech.

Our own president, Jim Bell, received the DPS's Carl Sagan Medal for communication of science. He certainly does that extremely well. If you haven't read one of his books, get one and dig in. He's a Mars geologist like no other: he led the team that built the Panoramic Cameras (Pancams) on *Spirit* and *Opportunity* that take the "postcard" pictures on Mars. *Spirit* is stuck in the sand and out of power, but *Opportunity* rolls on, snapping amazing shots along the way.

Along with Heidi Hammel and Scott Hubbard, Jim went to Washington on November 3 to help congressional staffers and reporters understand the importance of planetary exploration and science. Our board members appeared along with Robert Zubrin, president of the Mars Society. Each speaker drove home the idea that we are quite likely on the verge of finding evidence of living things on Mars. This is a pursuit worthy of an investment of our intellect and treasure–a discovery could change the world. The speakers also reminded those in attendance that the James Webb Space Telescope could find another Earth-like world and likely will have the same impact as the Hubble Space Telescope.

Coming up in August 2012, the *Curiosity* rover, the *Mars Science Laboratory (MSL)*, will land near Gale crater on Mars. It carries the third MarsDial we've sent to the Red Planet. The MarsDial bears a message to the future that includes, "To those who visit here, we wish a safe journey and the joy of discovery." We will be watching the landing together with many of you at our *Planetfest*™ activities. The staff and I will be near our headquarters in Pasadena, but we are planning several simultaneous events around the world. *Curiosity* will land on Sunday evening, August 5, or Monday morning, August 6, depending on your time zone. The party will be revving up all weekend beforehand. Make plans; we hope to see you at one of the events somewhere back here on Earth.

Photo: United Launch Alliance

ABOVE *NASA's* Mars Science Laboratory *spacecraft, sealed inside its payload fairing atop an Atlas V rocket, clears the tower at Space Launch Complex 41 on Cape Canaveral Air Force Station in Florida. The mission lifted off at 10:02 a.m. EST, November 26, beginning an eight-month interplanetary cruise to Mars.*

Looking ahead, we continue to create and distribute our kids' section. Everyone who works in space today became inspired to do so when they were kids. We're working to engage the engineers and scientists of the future, so that they will pursue careers to help humankind explore space.

Economically, these are not the best of times, as I suspect you've noticed. Nevertheless, the Society is in good financial shape, and I'm confident that it will become even stronger. We've engaged the Students for the Exploration and Development of Space (SEDS), we've established stronger ties with the International Space University (ISU), and we're increasing our membership for the first time in many years.

At The Planetary Society, discovery is our business. I feel strongly that exploring and coming to know our place in space brings out the best in us. With your help, we will keep looking up.

Bill Nye

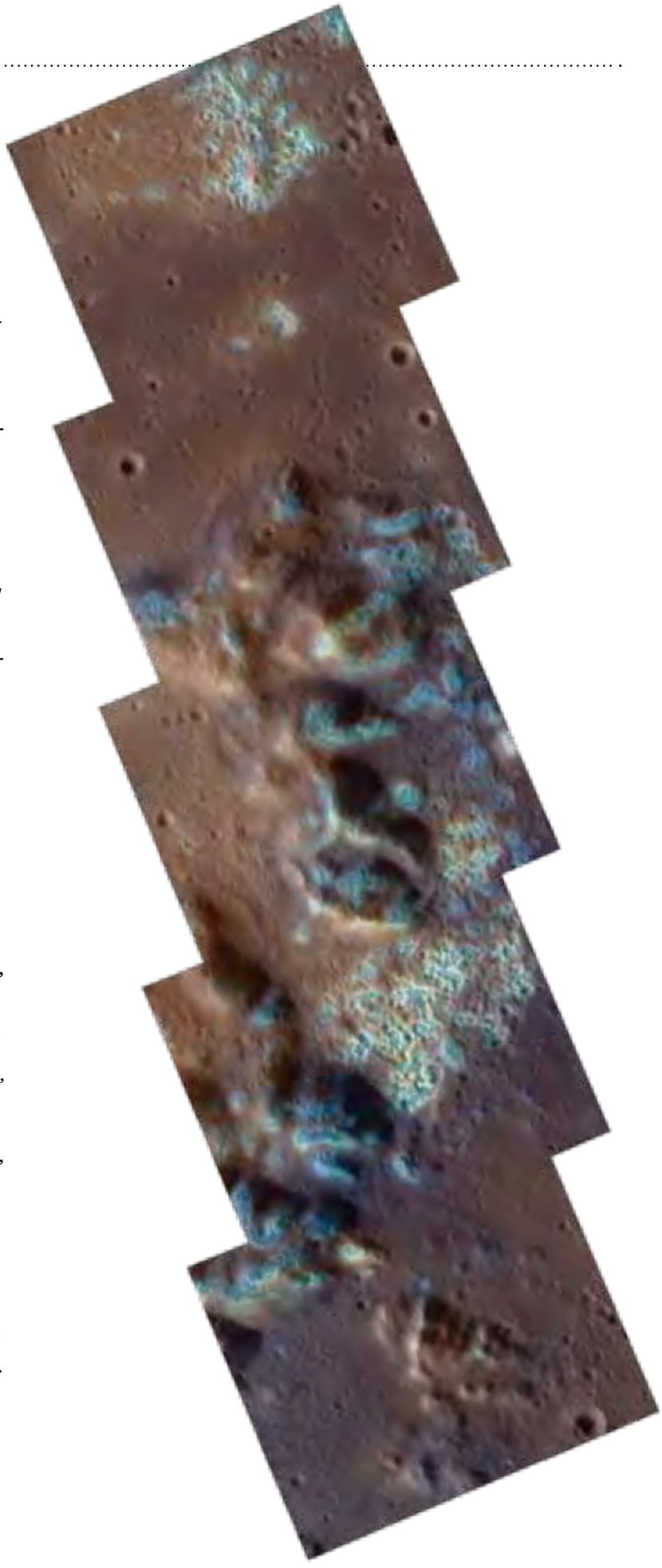
THIS IS YOUR ORGANIZATION, AND I WANT TO HEAR FROM YOU.

E-mail me at *tellbill@planetary.org* or send a letter to Bill Nye at

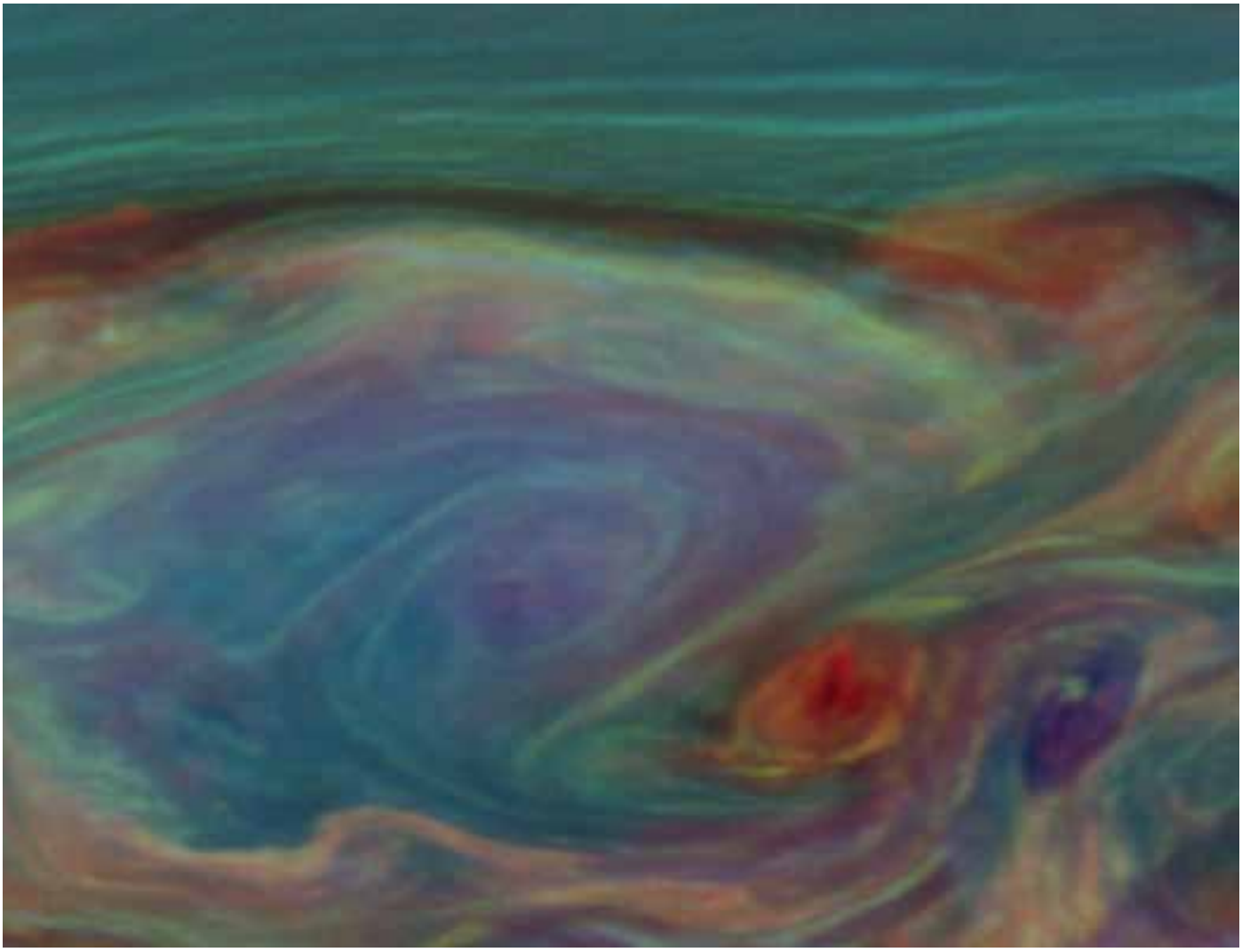
The Planetary Society
85 South Grand Ave.
Pasadena, CA 91105

Find more information at *planetary.org/yourplace*

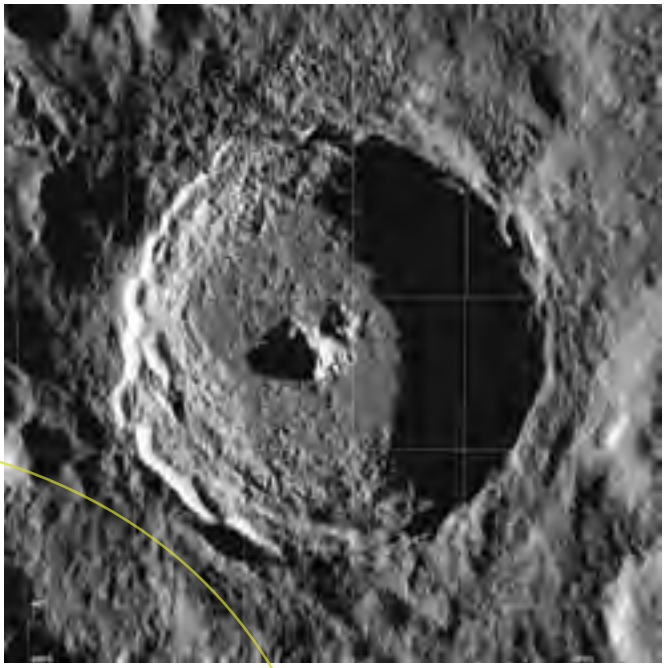
With *Juno* headed for Jupiter, the twin *GRAIL* spacecraft bound for the Moon, and *Curiosity* aiming for Mars, we began four new voyages into space in 2011. Sadly, our Chinese and Russian missions to Mars ended before they even began. We saw momentous arrivals as *Stardust* gave us a second look at comet Tempel 1, *Dawn* spiraled into orbit at main-belt asteroid Vesta, *MESSENGER* became Mercury's first orbiter, and *Opportunity* made landfall at the shore of Endeavour crater. Meanwhile, our corps of active robotic explorers continues to push the boundaries of the unknown, promising more riches in the new year.

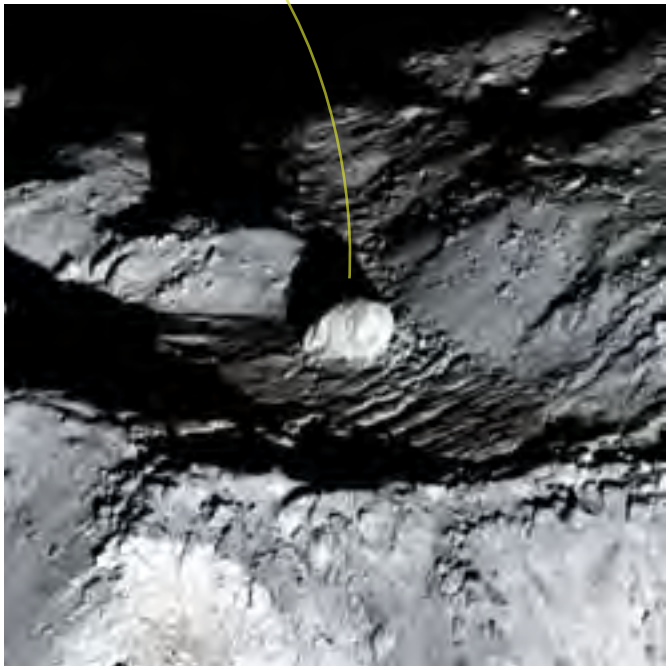


RIGHT *Landscapes, topography, gravity, and surface composition at high resolution. Among* MESSENGER*'s latest discoveries are "hollows," which are shallow, irregularly shaped depressions that sometimes have bright halos, usually found within impact craters, that seem to have formed very recently. It's possible that some material brought from deep below Mercury up to its surface by the impact is slowly disappearing, vaporizing into Mercury's atmosphere.*



THIS PAGE *Late last year, a white spot in Saturn's northern hemisphere blossomed and then spread out into a band of turbulent clouds that wrapped completely around the planet, and then some. The* Cassini *orbiter was in place to take close-up pictures like the false-color view above. The different colors signify clouds at different heights–yellow and white are clouds at high altitude, red and brown are clouds at lower altitude, and the blue color signifies high-altitude hazes. The daily development of the storm was more thoroughly monitored by Earth-based telescopes, most of them operated by amateurs. Larger telescopes also got into the act; Hubble's Wide Field Camera 3 took the photo at left on March 12. The storm finally died out on June 15, after colliding with a particularly turbulent part of its own tail. In the Hubble photo, three of Saturn's midsized moons are visible as tiny dots above the rings: from left to right, they are Dione, Enceladus, and Tethys.*





THIS SPREAD Lunar Reconnaissance Orbiter's *camera can slew sideways to capture dramatic oblique views of the lunar landscape. On June 10, it looked across the Moon to the central peak of Tycho, a relatively young impact crater near the Moon's south pole whose bright rays splash across the near side of the Moon. Perched atop that central peak is a "boulder" that is 120 meters wide and perhaps 80 meters tall. Other large boulders appear in the steep slope of the central peak, which rises about 2,000 meters (6,600 feet) above the crater floor.*

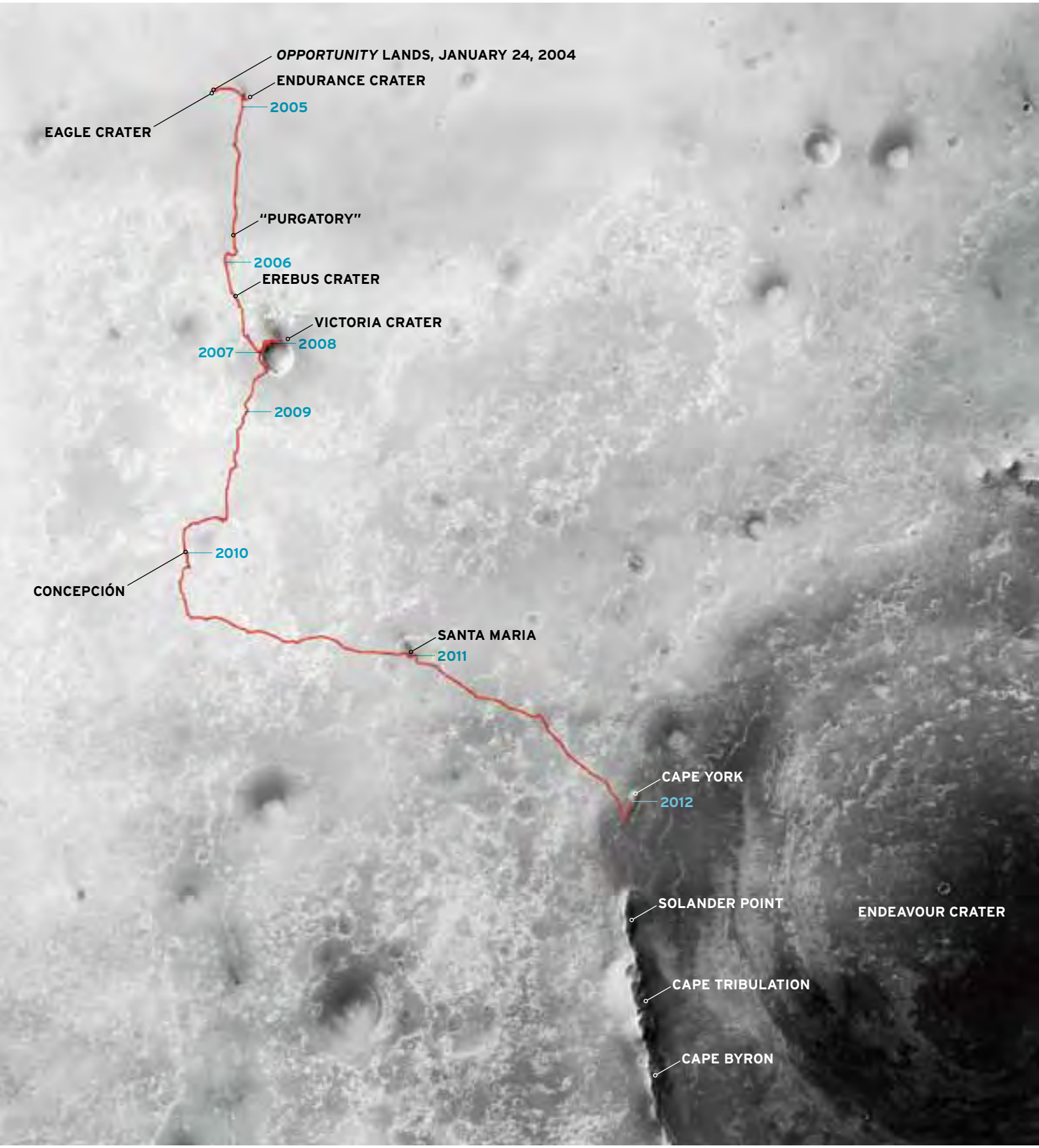
Images: NASA/GSFC/Arizona State University

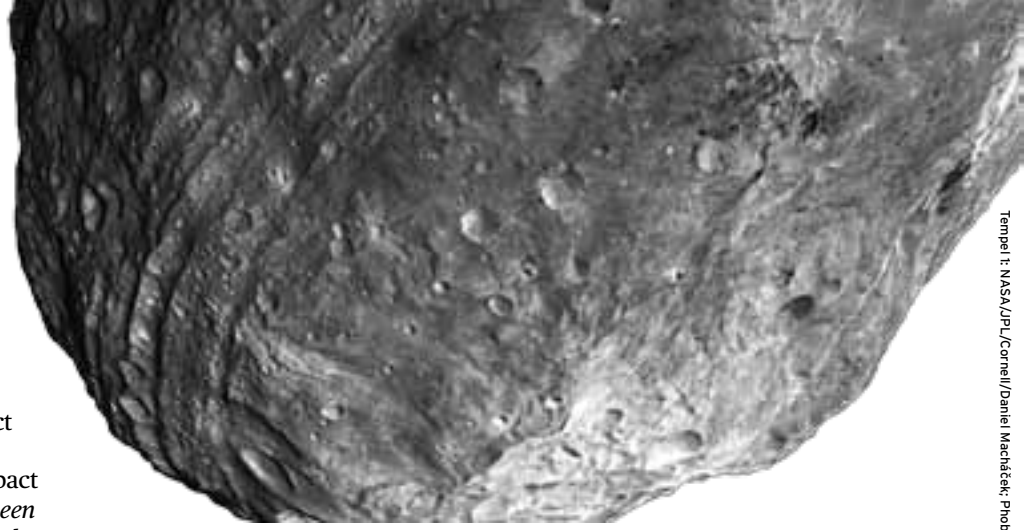
Photo: Ben Cooper, *launchphotography.com*; bottom image: NASA/JPL/UA; opposite page image: NASA/JPL/MSSS/map by Eduardo Tesheiner

ABOVE *Space shuttle* Atlantis *rose on a pillar of fire on July 8 at 11:29 a.m. EDT in front of 750,000 onlookers who had assembled to witness the last launch of the shuttle era. Now* Atlantis *and its sister ships* Endeavour *and* Discovery *are being decommissioned and partially disassembled as they are prepared by NASA to be distributed to their future homes at museums.* Discover *is going to the Smithsonian's Udvar-Hazy Center in Virginia;* Atlantis *is going to Kennedy Space Center, Florida; and* Endeavour *will be at the California Science Center in Los Angeles, not far from The Planetary Society's headquarters.*

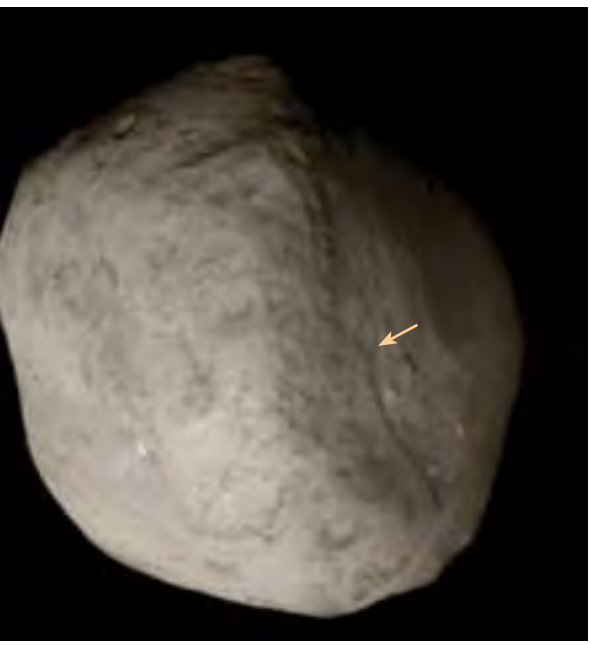
FACING PAGE *The journey has taken more than three years and covered more than 20 kilometers (12 miles). On August 9,* Opportunity *finally rolled onto the rim of* Endeavour *crater. Scientists hope to find rocks much more ancient than the ones* Opportunity *has explored to date, rocks that may represent an earlier, more clement period on Mars.*

RIGHT Mars Reconnaissance Orbiter *snapped a photo of* Opportunity *(arrow) on the southern tip of Cape York, a low hill on Endeavour's rim, on September 10. A bright line of fractured rocks clearly separates the Meridiani plains, at lower left, from* Endeavour *rim rocks, at upper right.*


OPPORTUNITY LANDS, JANUARY 24, 2004
ENDURANCE CRATER
2005
EAGLE CRATER
"PURGATORY"
2006
EREBUS CRATER
VICTORIA CRATER
2007
2008
2009
2010
CONCEPCIÓN
SANTA MARIA
2011
CAPE YORK
2012
SOLANDER POINT
ENDEAVOUR CRATER
CAPE TRIBULATION
CAPE BYRON



BELOW *A small cometary nucleus named Tempel 1 became the first minor planet to be visited by more than one spacecraft when* Stardust *flew past it on February 15. On the right side of the photo is terrain that had been seen previously by* Deep Impact *in 2005 and includes the (very subtle–see the arrow) mark of the crash site of the* Deep Impact *impactor. On the left is terrain that had not been seen before.* Stardust*'s camera did not have color capability; this image has been colorized based upon the color images from the* Deep Impact *photos.* Stardust *spent almost all of its remaining fuel to perform the Tempel 1 flyby. On March 24, it was commanded to spend the last of its fuel and turn off its radio transmitter forever, ending a long, productive mission.*



ABOVE *The ion-powered* Dawn *spacecraft first spotted Vesta, the second-largest object in the asteroid belt, on May 3. As* Dawn *slowly spirals in to closer and closer orbits, its images are revealing a world that is full of surprises. Many of its peculiar features are visible in this global view from July 24: recent impact craters with striped interiors, cratered grooves that girdle its waist, and a south pole that contains one of the deepest impact basins as well as one of the largest mountains in the solar system. Scientists now think that the south pole contains two gigantic overlapping impact basins.* Dawn *will remain at Vesta until July 2012, when it will depart for a nearly three-year cruise to Ceres.*

BELOW Mars Express *has been mapping the sides of Phobos that are never seen by other orbiters that travel closer to Mars. This view shows the south pole, leading hemisphere, and "far side" of Phobos (which always faces away from Mars). Once every five months, the orbits of Phobos and* Mars Express *align in such a way that* Mars Express *gets 10 to 12 reasonably close flybys of the inner and larger of Mars' two moons. The primary goal of the intensive study of Phobos was to prepare for the landing of Russia's* Phobos-Grunt. *Despite the failure of that Russian mission,* Mars Express' *unique views of Phobos are scientifically valuable.*

Tempel 1: NASA/JPL/Cornell/Daniel Machačeк; Phobos: Copyright ESA/DLR/FU Berlin (G. Neukum); Vesta: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA; facing page: Eric Westbrook/Corbis Images

CHARLENE M. ANDERSON
is associate director of The Planetary Society.

2011 Advocacy Wrap-Up

Political action advocating for space was a bumpy ride this year

UNCERTAINTY, OUTRAGE, AND FRUSTRATION. ACCOMPLISH-ment, pride, and hope. All these words can describe this past year in space policy—and The Planetary Society's reaction to events that threaten the future of space exploration.

We've witnessed more political turmoil this year than at any other time in the 31-year history of The Planetary Society. If you feel like you've been bombarded with e-mails and letters asking you to take action ... well, you have been. The Planetary Society relies on its Members to demonstrate to politicians that there is a great popular constituency—and lots of voters—who support space exploration.

Turmoil in the world economy is forcing hard choices in government spending, and space endeavors are high-profile targets for budget-cutters. Planetary exploration and the scientific analysis of its discoveries are, for the moment, too expensive for the private sector, so we still must depend on government agencies such as NASA, ESA, JAXA, and Roscosmos.

Most of this year's drama centered on NASA, the U.S. space agency, which remains the largest on the planet. NASA entered 2011 without an approved budget from the U.S. Congress, so there was considerable uncertainty about how to evaluate the administration's proposed budget for 2012, released in early February. All that was certain was that Congress would squeeze, rip, and tangle proposals for all aspects of spaceflight and exploration.

A CONGRESSIONAL DEBACLE

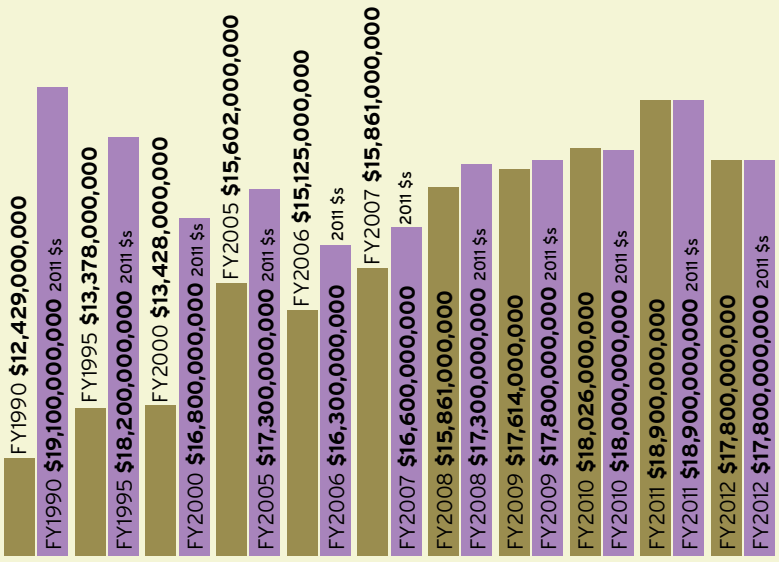
What we witnessed was sometimes appalling. The House Appropriations Committee zeroed out the James Webb Space Telescope (JWST), the successor to the mighty Hubble. Why? To teach NASA a lesson about budget overruns. The committee-passed bill cut a total of $1.9 billion from NASA.

In early March, the National Research Council (NRC) of the National Academy of Sciences released its decadal survey for planetary science for the years 2013–2022. The NRC organizes decadal surveys for NASA's efforts in astronomy and astrophysics, Earth science, solar and space physics, and planetary science in hopes of providing "a science community consensus" that will direct NASA as it chooses which science missions to pursue.

The NRC relies on the community of scientists to set priorities and rank proposed missions for the next 10 years. The missions it recommends are the ones that NASA most likely will undertake—if the U.S. administration proposes and Congress provides the money.

Working with a projected NASA budget range for the next 10 years, the decadal survey recommended two flagship missions—the Mars Astrobiology Explorer Cacher (MAX-C) and a Jupiter Europa Orbiter—if the proposals could be "descoped" so that the ambitious missions could become affordable. For midsized missions, the survey recommended that NASA select two for the New Frontiers program. No specific recommendations were made for small missions, leaving that for NASA to work out.

NASA BUDGETS IN REAL AND 2011 DOLLARS*



*Real numbers obtained from NASA budget requests and Wikipedia. "2011 dollars" was obtained using a GDP deflator, which uses a measure of average prices of goods and services produced in the economy (similar to the Consumer Price Index, but broader).

ABOVE *Although 2012's budget is not as bad as it could have been, it is still a long way from a "vote of confidence" in space science at NASA.*

Even as these planetary recommendations were being released, it was becoming obvious that the money for NASA assumed by the committee would not be provided by the U.S. government. In a sense, the recommendations were dead on arrival.

The Planetary Society immediately started agitating. In a public statement, Executive Director Bill Nye said, "The flow of scientific creativity and technical innovation cannot be turned on and off like a spigot. To make progress, there must be steady support. NASA is charged with exploring and innovating, but the Congress and administration routinely turn the spigot on and off, and then seem outraged when NASA fails to meet their schedules and expectations."

The great flagship missions to Mars and Europa will almost certainly be canceled if this situation does not change. Consider what will be lost, as our former executive director, Lou Friedman, pointed out: "Europa does not care if we arrive there in 2030, 2050, or never, but this generation of children will wonder what was wrong with our generation, if we fail to follow up the discoveries made by *Voyager*, *Galileo*, and *Cassini*, making it impossible for their generation to feel the wonder we enjoyed as those flagships explored strange new worlds."

MEMBERS RALLY TO THE CAUSE

In June, you probably received a letter from The Planetary Society asking you to demonstrate that you support space exploration by signing petitions that we promised to deliver to the House, the Senate, and the administration. Through the summer, your petitions kept rolling in.

It was a hard task to sort and prepare the thousands of petitions for delivery. Post-9/11, the days of grabbing a wheelbarrow, filling it with petitions, and rolling it up to Congress (as we have done in the past) are over. Planetary Society staff and volunteers had to address separate envelopes for each representative and senator, weigh each one and attach accurate postage, leave them unsealed, and prepare them for delivery to the Congressional Acceptance Site, where they would be received and taken to a facility 50 miles away to be irradiated in case of anthrax contamination.

As we worked through the summer, Bill Nye joined Nancy Colleton of the Alliance for Earth Observations to present the Alliance's Leadership Award to Maryland Senator Barbara Mikulski. As chair of the Senate Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies, Mikulski wields considerable power over the budgets of federal agencies such as NASA and NOAA, and has long been a friend of planetary exploration and of observing Earth from space.

In July, The Planetary Society submitted testimony to the House Committee on Science, Space, and Technology of the U.S. House of Representatives for its hearing on NASA's Space Launch System. This proposed rocket, designed by the Senate science committee, is putting budget pressure on other NASA programs, such as JWST and planetary spacecraft. We called on Congress to set priorities and make decisions based on merit and readiness, not protecting jobs in local districts.

As summer drew to a close, we were ready to fire our biggest guns. On September 9, Bill Nye stormed Washington, armed with more than 20,000 signed petitions from you and other Planetary Society supporters from around the world. Bill, braving an insistent rain, personally delivered boxes of envelopes to the Congressional Acceptance Site. For our international supporters, who are not constituents of any U.S members of Congress, Bill Nye delivered their petitions to John Holdren, head of the White House's Office of Science and Technology Policy and the president's science adviser.

"Science has been flat-lined. Planetary Science has been cut. Earth science missions have been delayed–again. Missions to the outer planets won't get off the ground when they're only 'studies.' Mr. Bolden talked about 'hard choices,' but what can he do when NASA has not been given a real budget for this fiscal year? The hard choices are yet to be made."

BILL NYE, SPEAKING IN FEBRUARY 2011 ON THE PROPOSED 2012 BUDGET

Illustration: ESA

ABOVE *ESA's* Mars Trace Gas Orbiter, *one of the many international partnerships that has been damaged by the inaction of the U.S. government on NASA budget issues.*

At lunch that day, Bill hosted a briefing in the House of Representatives for members of Congress and their staffs. Along with Steve Squyres, chair of the NRC's decadal survey, and Jim Green, head of NASA's planetary science division, Bill laid out the reasons that space exploration is important to our future on this planet and why Congress should give it the support it requires.

A week later, the U.S. Senate Subcommittee on Science and Space, chaired by space supporter Barbara Mikulski, voted to give JWST $530 million for the year–more than NASA had asked for–and added $1 billion to the House's proposed budget for NASA. As I write, we're waiting to see how this bill will be reconciled with the House's smaller budget for NASA.

A BROKEN PROMISE

In October, The Planetary Society was again roused to action, this time by U.S. government inaction–the seeming refusal of the Office of Management and Budget (OMB) to let NASA send a letter to the European Space Agency (ESA) confirming partnership in the Mars 2016 and 2018 missions.

For the 2016 mission, NASA had promised to provide an Atlas V to launch the *Mars Trace Gas Orbiter*, ESA's spacecraft intended to sniff out the sources of methane on Mars, which might indicate that some sort of life exists today on the Red Planet. ESA needed a letter confirming NASA's partnership to take to its ministerial council. For its side of the bargain, ESA offered 850 million euros–more than $1.1 billion–as its contribution to a joint mission. But the OMB refused to let the letter go.

Outraged, the planetary science community protested, but the OMB did not listen. The science community asked The Planetary Society for help, and we issued a call to action, targeting OSTP head John Holdren and asking him to intervene with the OMB. The OSTP staff returned from the Columbus Day holiday weekend to find more than 1,500 messages from Planetary Society Members waiting for them.

That wasn't enough to shake things loose. With NASA backing out of its promise, ESA announced it was turning to Russia and inviting that country to full partnership in the two Mars missions in return for a 2016 launch. Russian space officials seemed caught by surprise and, as of this writing, have not given ESA a response.

As 2011 draws to a close, The Planetary Society is still agitating for space exploration. Working with the Mars Society, we cosponsored another Capitol Hill lunch, this time sending into action Society President Jim Bell, Vice President Heidi Hammel, and Board Member Scott Hubbard. Less than two weeks later, we submitted testimony supporting science to the Subcommittee on Space and Aeronautics of the Committee on Science, Space, and Technology of the U.S. House of Representatives.

To keep you up on all this activity, we can keep in touch via e-mail–if we have your address. If we don't, please contact us at *planetary.org/emailupdate* to make sure you don't miss any political updates. You also can follow my space politics Twitter page at *@PlanetCharlene*.

Politically speaking, in 2012 space exploration held its own against tremendous budget pressures. Next year, things may change. In early February, the U.S. administration will release its new budget for NASA. Right now, no one is optimistic about what it will contain. You can be sure we will be calling on you–and all Planetary Society Members–to help keep our exploring spacecraft flying. Thanks for everything you've done so far.

Q **What is entailed when a spacecraft is decommissioned?**–*Tony Fisk, Glen Iris, Victoria, Australia*

ABOVE *On September 21, 2003, NASA mission controllers ended* Galileo*'s long, productive life by maneuvering it into Jupiter's crushing atmosphere.* Galileo*'s onboard propellant was nearly depleted, and this controlled destruction prevented an unwanted collision with–and possible contamination of–Europa.*

A When mission planners talk about decommissioning a spacecraft, they first need to consider whether they would like to communicate with it later. If so, the key is to design a hibernation or safe mode that allows the craft to spend long time spans on its own without maintenance from the ground. This requires making sure we always know where it is in its orbit and that its sensor calibration curves are valid for long periods. We also need to make sure the spacecraft's orbit is safe for the time it will be in "storage." Finally, we configure it to receive commands (usually through its Low Gain Antenna, or LGA) with the widest possible pattern. The Low Gain Antennas generally have a wide coverage pattern, while the useful beam of a High Gain Antenna is generally fairly narrow. Configuring the spacecraft to receive commands through its LGA ensures that commands can be received by the spacecraft over a relatively wide range of pointing attitudes, and we turn off the transmitter, allowing mission controllers to wake up the spacecraft for possible future use.

If decommissioning is to be permanent, the craft's trajectory needs to be evaluated for a much longer period. This ensures that the vehicle will not make its way to bodies of interest in the search for life beyond Earth (planetary protection) and will not make its way back to Earth for an unwelcome reentry. Then, depending on the spacecraft's architecture, its transmitter is turned off. We make sure it does not turn back on later, either, by disconnecting the battery from the solar arrays, commanding the spacecraft to an attitude that does not support battery charging, or, as we did with *Stardust NExT*, let the lack of fuel allow the spacecraft to drift so the solar arrays would no longer be pointed at the Sun, which eventually would completely discharge the battery.

Our primary goal is to leave the spacecraft in a known configuration–particularly its radio transmitter. Turning off the transmitter ensures that there will be no unintended radio interference in the future.

At the end of its life, mission controllers plunged *Galileo* into Jupiter to destroy it in a controlled way. Earth-orbiting spacecraft usually are boosted to a long-term parking orbit or deorbited to be broken up on reentry. Spacecraft in interplanetary orbits are evaluated for long-term trajectory safety. *–TIM LARSON, Jet Propulsion Laboratory*

Galileo: David A. Hardy, *astroart.org*; Europa: Britney E. Schmidt and Deadpixel VFX/Jackson School of Geosciences/UTIG/Vetlesen Foundation/NASA; Water Vapor: NASA/JPL-Caltech

Europa Lakes

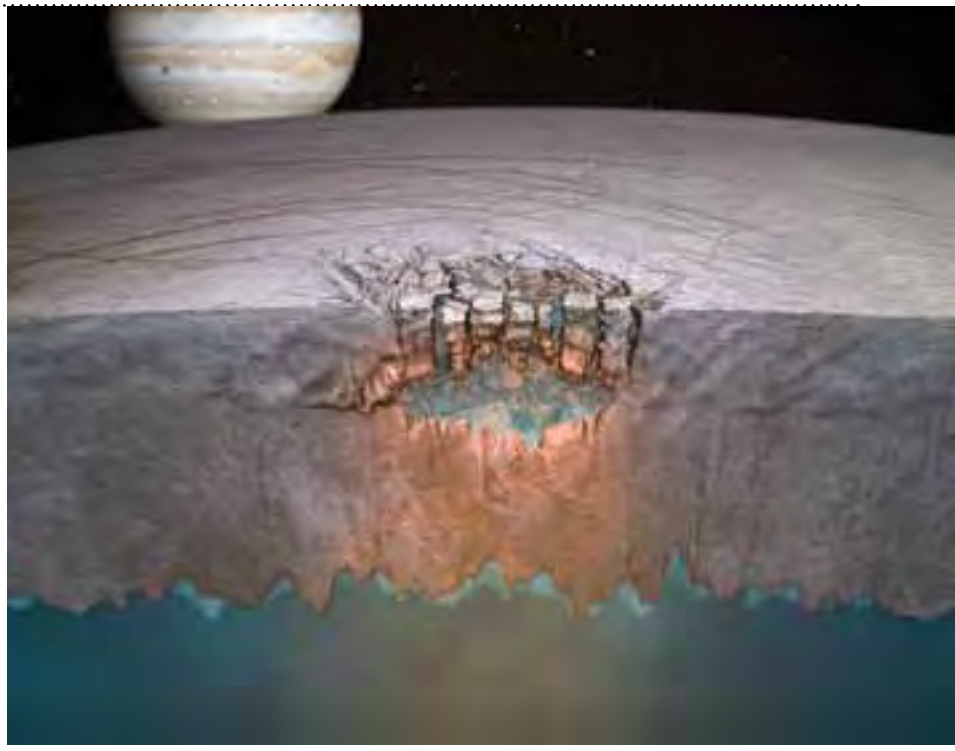
EUROPA'S FROZEN CRUST MAY HAVE enormous cavities of liquid water tucked into the rock-hard ice. One of these lakes, buried a few kilometers below a region called Thera Macula, contains at least as much water as the United States' Great Lakes, scientists reported on November 16, 2011 in *Nature* online.

These hidden reservoirs would explain Europa's jumbled, chaotic surface features, which have puzzled scientists for more than a decade. The existence of such cavities implies vigorous mixing of materials between Europa's frigid surface and the ocean hiding beneath—a tantalizing prospect for scientists considering whether life could evolve on the Jovian moon.

Britney Schmidt, of the University of Texas at Austin, and her colleagues uncovered the lakes while considering how chaotic regions on Europa—such as Conamara Chaos—might form. They compared images of these terrains obtained by *Galileo* with similar landforms on Earth: fractured, collapsing Antarctic ice shelves and icy caps perched atop subglacial Icelandic volcanoes. Water and ice interact to craft these terrestrial jumbles, and similar processes can explain observations on Europa. "Fracturing catastrophically disrupts the ice in the same way that it causes ice shelves to collapse on Earth," Schmidt says.

The lakes imply that the moon is actively sending materials from the surface—such as oxygen—into its ocean, potentially seeding the depths with compounds needed for life. Study coauthor Don Blankenship, also of UT Austin, explains, "You're taking the surface of Europa, which is plated with whatever the Jupiter system can throw at it, and mixing it catastrophically, then putting it down a few kilometers. It's like a washing machine." For more information, go to HTTP://BIT.LY/TPS03266.

–from Science News



ABOVE *Scientists theorize that lakes like these form when warm, pure ice rises through Europa's crust, eventually reaching a contaminated layer within a few kilometers of the surface. That dirty layer then thaws, forming a lens-shaped lake, and cracks the weakened ice above it. Water pushes up through the cracks and rearranges the surface on top, forming chaos terrain.*

Planet-Making

DATA FROM THE EUROPEAN SPACE Agency's Herschel Space Observatory have revealed cold water vapor enveloping a dusty disk around a young star. The findings suggest that this disk, which is poised to develop into a solar system, contains great quantities of water. Consequently, water-covered planets like Earth may be common in the universe.

Scientists have found warm water vapor in planet-forming disks close to a central star. Evidence for vast quantities of water extending out into the cooler, far reaches of disks where comets take shape had not been seen until now, however. The more water that is available in disks for icy comets to form, the greater are the chances that large amounts eventually will reach new planets through impacts.

"Our observations of this cold vapor indicate enough water exists in the disk to fill thousands of Earth oceans," says Michiel Hogerheijde of the Netherlands' Leiden Observatory. Hogerheijde is the lead author of a paper describing these findings in the October 21, 2011 issue of *Science*.

–from NASA

BELOW *An icy planet-forming disk surrounds TW Hydrae, a young star located in the Hydra—or Sea Serpent—constellation. Scientists using the Herschel Space Observatory have detected water vapor in the star system's outer regions.*

Since you are a valued member of The Planetary Society team that helped launch our Phobos LIFE experiment, I want to share with you excerpts from a letter we just received from our colleagues at the Space Research Institute (IKI) of the Russian Academy of Sciences.

As you'll read, the *Phobos-Grunt* (Soil) spacecraft failed to leave Earth orbit after it was launched last month, carrying our LIFE capsule on what we hoped would be a round trip to Mars' moon Phobos and back.

The letter came from Lev Zelenyi, director of the Space Research Institute. It reads:

As you may already know, the launch of the Phobos-Soil spacecraft was a failure. On November 8, 2011 the spacecraft was put into the near Earth orbit; however, the booster did not turn on, and, therefore, the spacecraft did not manage to change this initial orbit and transfer to the interplanetary trajectory. The reason of this failure has not been determined yet.

Immediately after this unpredictable event all forces of the mission control team were concentrated in order to attempt to establish communication with the spacecraft. Several foreign organizations, in particular, ESOC-ESA, DSN-JPL-NASA, NORAD-STRATCOM, and numerous amateur observers tracked the spacecraft to establish communication with it and determine parameters of the orbit, its orientation and attitude. However, despite people being at work 24/7 since the launch, all these attempts have not yielded any satisfactory results. We are grateful to our foreign colleagues, who provided us with every list of information about the spacecraft which was crucial at the time.

Currently, the spacecraft is rotating at the near Earth orbit, lowering every day, and we expect that it is to enter the atmosphere in several weeks. Lavochkin Association specialists will continue their attempts to establish connection with the spacecraft and send commands until the very end of its existence. We are working nevertheless on the issue of re-entry and probability of where and which fragments may hit the ground (if any).

We would like to express our deep gratitude to you and all the scientists and specialists for collaboration on the Phobos-Soil Mission, preparation of scientific instruments and provision of ground support. We are deeply sorry about the failure of the Phobos-Soil Mission. We hope in future to continue our collaboration on space science projects.

The loss of Phobos LIFE is a blow, but we are already recovering and looking forward to the future. We are even now analyzing the microorganisms that flew with our Shuttle LIFE project on the last flight of *Endeavour*, and we are seeking future exploratory opportunities to share with you.

With your invaluable help and support, we know that together we will make our future in space vibrant, coming ever closer to our shared goals of understanding and appreciating the worlds around us.

Thank you again for all your support.

Sincerely,

Bruce Betts

Bruce Betts,
Phobos LIFE Project Manager

Books for Young People

HELP OUR FUTURE ASTRONAUTS stay on top of their reading with these new offerings! For reviews of these and other books (including links to fare for grown-up explorers), go to HTTP://BIT.LY/TPS03287.

Really, Really Big Questions About Space and Time
$16.99
by Mark Brake, illustrated by Nishant Choksi
Kingfisher, 2010
64 pages, ages 9 and up

Basher Science: Astronomy
$8.99
Created & illustrated by Simon Basher, written by Dan Green
Kingfisher, 2009
128 pages, ages 10 and up

Man on the Moon: How a Photograph Made Anything Seem Possible
$8.95, paperback
by Pamela Jain Dell
Compass Point Books, 2011
64 pages, ages 10 and up

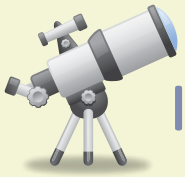
Planetfest2012

August 4-5, 2012, Pasadena Convention Center, CA, USA

Share the excitement!
Make plans to party with The Planetary Society and space enthusiasts around the world next summer as we celebrate the landing of *Curiosity*, the Mars Science Laboratory, on the Red Planet!

As details unfold, we'll keep you updated on *planetary.org*.

WHAT'S UP? *by Bruce Betts*



IN THE SKY

The early evening features a beautiful sight: the two brightest planets in the sky, Venus and Jupiter, approach each other as the weeks progress. The brighter and lower Venus gets higher above the western horizon, and Jupiter lower, until the two nearly meet in mid-March. Mars is at opposition on March 3, meaning that it is at the opposite side of Earth from the Sun, thus rising in the east around sunset and setting in the west around sunrise. By this point, as Mars and Earth have drawn closer in their orbits, Mars has brightened to look like a very bright, reddish star. The Moon is near Jupiter and Venus on February 25 and 26, then again on March 25 and 26. The Moon is near Mars on February 9 and March 7. Yellowish Saturn is high in the sky before dawn, moving westward over time. It is near the similarly bright but bluer star Spica, in Virgo.

RANDOM SPACE FACT

Scale models: If Earth were the size of a baseball, Neptune would be approximately the size of a basketball, and Jupiter the size of an inflatable exercise ball (33 inches, or 83 centimeters).

TRIVIA CONTEST

Our January/February contest winner is Lothar Flathmann of Limburg, Germany. Congratulations! **THE QUESTION WAS**: What is the largest moon of Uranus? **THE ANSWER**: Titania, at 981 miles (1,578 kilometers) in diameter. It is the eighth largest moon in the solar system.

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

What star is commonly known as the dog star?

E-mail your answer to *planetaryreport@planetary.org* or mail your answer to *The Planetary Report*, 85 South Grand Avenue, Pasadena, CA 91105. Make sure you include the answer and your name, mailing address, and e-mail address (if you have one). Submissions must be received by March 1, 2012. 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*.

Protecting Earth from Asteroids

Society funds are put to good use with multiple projects

IT HAS BEEN A BUSY AND productive year for The Planetary Society in the area of planetary defense–protecting Earth from the threat of asteroid or comet impact. Here is a quick update on some of our multiple activities.

ABOVE *The 2011 Planetary Defense Conference was held in the very impressive Romanian Parliament Building, one of the largest buildings in the world.*

RIGHT *Article author Bruce Betts at the Planetary Defense Conference.*

PLANETARY DEFENSE

The Planetary Society cosponsored and served on the organizing committee for the 2011 International Academy of Astronautics Planetary Defense Conference: From Threat to Action, held in Bucharest, Romania. The conference brought together experts in everything from NEO (near-Earth object) observations, to deflection, to emergency management, to the political aspects of the problem. These conferences, usually held every two years, have served to greatly advance the field and to stimulate communication among experts within the field and in related fields.

The Planetary Society is part of Action Team 14. This is not a superhero organization, as it may sound, but is a group working to save the world. AT14 met last in Pasadena, California in August 2011 and is now working on the near-Earth asteroid threat as part of the United Nations Science and Technology Subcommittee of the Committee on Peaceful Uses of Outer Space (COPUOS). AT14 is trying to hammer out not only the technical details but also the perhaps even more challenging details of international cooperation on this global issue.

SHOEMAKER NEO GRANT WINNERS ROCK AT STUDYING ROCKS

About 15 years ago, The Planetary Society established the Shoemaker Near-Earth Objects Grants in honor of Gene Shoemaker, a planetary geologist and studier of near-Earth objects. Our past winners make many tens of thousands of follow-up NEO observations each year that are key to determining NEO orbits, as well as engaging in other studies characterizing NEOs and even making some discoveries. Here is a sampling of what they did over the last year.

RUSSELL I. DURKEE is at the Shed of Science Observatory in Minneapolis, Minnesota. His upgraded camera, made possible by a Shoemaker NEO Grant, facilitated identification of two new binary asteroids and follow-up observations for others. The camera also enabled the observatory to collaborate with other observatories on especially challenging objects, such as the very slowly rotating asteroid 2675 Tolkien, which was found to rotate only once in 44 days.

Thanks! Planetary Society Members made the Shoemaker Grants and more possible with their generous donations.

Photos, opposite page: The Planetary Society; this page: Robert E. Holmes, Anthony Wesley, and Jaime Nomen.

ABOVE *2011 Shoemaker NEO Grant recipients are, from left, Robert E. Holmes, Anthony Wesley, and Jaime Nomen (center), with colleagues Miguel Hurtado and Jaime Andreu.*

DAVID HIGGINS operates Hunters Hill Observatory (HHO), located in Canberra, Australia. His 2010 Shoemaker Grant camera allows him to study fainter objects and download images faster, enabling the tracking of fast-moving NEOs. He has discovered the binary nature of more than a dozen asteroids and assisted with the discovery of and follow-up on a dozen more, resulting in new insights into the formation of small binary systems and their dynamics.

Using multiple telescopes, **ROBERT E. HOLMES JR.** in Ashmore, Illinois is currently ranked second in the world in measuring the largest quantity of NEOs, exceeded only by a professional survey. In the past 12 months alone, his observatory made and submitted a total of 11,651 NEO measures. Although the focus is follow-up observations, in the past year there were two NEO discoveries. To date, nearly a million images have been exposed using Shoemaker Grant cameras. Through Holmes' Killer Asteroid Project, many of those images enhance educational opportunities in the classroom for more than 300 schools in 40 countries.

GARY HUG at the Sandlot Observatory in Scranton, Kansas increased the number of NEO observations he has submitted by a factor of six over the last two years. He also recovered several more comets, becoming the third most productive active observer of such objects. He said, "I attribute the increases largely to the new imaging camera made available by the 2009 Shoemaker NEO Grant."

JAIME NOMEN used his 2010 grant to purchase a new camera for the La Sagra Observatory on the Spanish island of Mallorca. With the new camera, Nomen and his colleagues have already discovered 10 NEOs, including two that are potentially hazardous to Earth.

JEAN-CLAUDE PELLE from Tahiti, a 2008 Shoemaker NEO Grant winner, acquired images of NEO 2010 AL30 while it was only 0.5 Lunar Distance (LD) from Earth. His team has also discovered its 500th asteroid.

ANTHONY WESLEY in Canberra, Australia used his 2010 Shoemaker NEO Grant to significantly improve his overall ability to image planets such as Jupiter and Saturn at high resolution. This represents a new direction in NEO research: observation of giant planets, looking for impacts that help us better understand asteroid flux in the solar system.

For more information and updates on the Shoemaker NEO Grant program, see HTTP://BIT.LY/TPSNEOGRANTS.

In future issues, look for exciting, informative updates on Planetary Society-sponsored projects involving lab studies of a new asteroid deflection method and studies about finding impact scars on Earth.

SOCIETY TRAVEL

SPOTLIGHT ON:

Arecibo & the Lesser Antilles

January 26–February 4, 2012

The Planetary Society is calling explorers to travel with us to remote, beautiful, and even alien regions on planet Earth to witness some of our world's most breathtaking wonders. Escorted by knowledgeable guides, the tours we offer through Betchart Expeditions span the globe.

Join us for ARECIBO & the Lesser Antilles, January 26–February 4, 2012, or join us on one of these other great adventures!

For more information or to sign up for any of these incredible trips, visit *betchartexpeditions.com* or contact:

Betchart Expeditions
17050 Montebello Road, Cupertino, CA 95014-5435
Tel.: (800) 252-4910 or (408) 252-4910
Fax: (408) 252-1444; E-mail: *info@betchartexpeditions.com*

COMING UP:

ANTARCTICA
December 30, 2011–January 11, 2012

ALASKA's Aurora Borealis
March 15–21, 2012

The GRAND CANYON and the 2010 Annular Solar Eclipse
May 14–21, 2012

SIBERIA & LAKE BAIKAL for the Transit of Venus
June 1–12, 2012

Discover HAWAII and the Transit of Venus
June 4–12, 2012

VOLUNTEER OPPORTUNITIES

THE GLOBAL VOLUNTEER NETWORK is one of the cornerstones of The Planetary Society. Volunteers have turned their talents to a wide variety of projects, including:

- building scale models of the *LightSail*,
- creating animation for the website,
- writing for the blog, and
- archiving the history of the organization.

In addition, Volunteers organize events, introduce students to planetary exploration, and inform their local communities about the latest Planetary Society projects and programs. As a volunteer, you can help The Planetary Society continue to grow.

You can take an active role with The Planetary Society by joining our Global Volunteer Network. Just send our Global Volunteer Coordinator, Tom Kemp, your name and e-mail address, and get started!

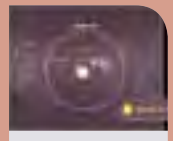
If you've missed *Planetary Radio* lately, here are some recent highlights:

Building a Better Galaxy with Javiera Guedes

New book *The Art of Space* with Don Dixon and Jon Ramer

All-star Caltech panel discussion

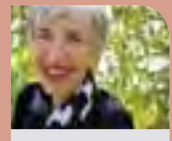
***Cassini* Mission Update with Linda Spilker, Mission Project Scientist**



Laurance Doyle and one planet with two suns

Touring the National Solar Observatory

The First International Planetary Caves Workshop



Author Dava Sobel & "A More Perfect Heaven—How Copernicus Revolutionized the Cosmos."

Find these shows and our entire archive of *Planetary Radio* at *planetary.org/radio*!

Planetary Society members are united in their love of space exploration—which has its origins in Earth's skies. Thank you for sharing your views with us! To see more, go to HTTP://MYSKY.PLANETARY.ORG.

The partial solar eclipse of January 4, 2011 as it looked over Uppsala, Sweden.—*Björn Johannson*

This view of the Moon's southern hemisphere shows the area around Tycho and Clavius. It was taken on October 10, 2011 from Tucson, Arizona with an 8-inch Orion Cassegrain telescope using a small Sony digital camera.—*Jerry Petrey*

I just finished the June Solstice issue—great redesign. I'll be sending the kids' section out to my niece and nephew! The MySky blurb on the back cover leads me to make the attached offering. This is the Harvest Moon—looking almost like a mini-Sun itself—taken with my cell phone from my front porch on October 22, 2010 here in Catawba, North Carolina. A wondrous sight! Thanks for the opportunity to contribute!—*James T. Haney*

WANT TO SHARE YOUR SPACE IMAGE? Send us an e-mail with a jpeg (less than 5 MB) attachment of your image to *planetaryreport@planetary.org*. Please use the subject line "MySky" and include a short caption (such as where you took the image and, if appropriate, with what equipment) and credit line for the image. Please include just one MySky image per submission. Also be sure to include your name, contact information, and membership number (it's on your membership card and on the mailing label of your magazine). We'd also love to receive a picture of you and to learn more about what is most important to you about being a Planetary Society Member. Questions? E-mail *andrea.carroll@planetary.org* or call (626) 793-5100, extension 214.

The Planetary Society
85 SOUTH GRAND AVENUE
PASADENA CA 91105-1602 USA

A Letter to You from
Bill Nye
Planetary Society Executive Director

Dear Fellow Explorer,

Do you know how big an impact you have had on space science and exploration this year?

You have been part of historic and crucial initiatives, programs that will literally advance space exploration.

Just consider the following–together, you and I

- Flew the inspiring Shuttle LIFE Experiment aboard the last flight of *Endeavour*.
- Launched a search for planets around stars whose broad spectral lines couldn't be resolved without the Society's member-funded FINDS Exo-Earth optical system.
- Made modest grants to amateur astronomers who discovered 10 near-Earth asteroids, including two that are potentially Earth threatening. Talk about an incredible return on investment.
- Plus, just weeks ago, I presented literally tens of thousands of petitions from Planetary Society Members around the world. We made the case for a revitalized space program to the U.S. Congress and White House.

You can imagine my pride in you and your fellow Members. Thank you!

I hope that you will bask in the glow of our progress this year. You are vital to the success of The Planetary Society.

My very best wishes to you for a joyous 2012.

Sincerely,

Bill Nye
Executive Director

P.S. Together, you and I can advance exploration even more. Please give generously at *advance.planetary.org*.