The PLANETARY REPORT

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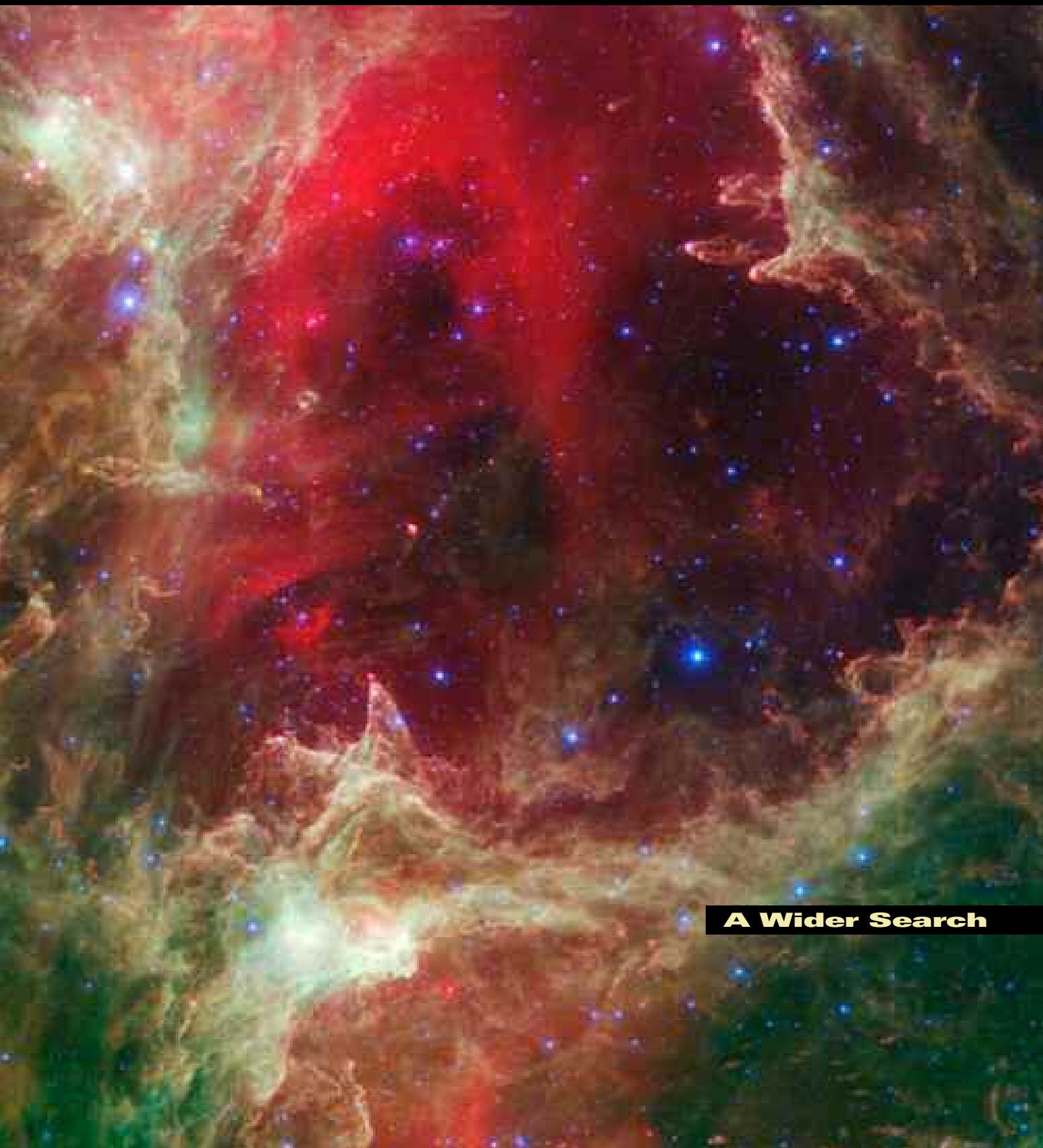

A Wider Search

From The Editor

What will be lost?

How often have you asked yourself that question? Such thinking is not an exercise in nostalgia; the question is fundamentally about the future. The past will survive in memory; what will be lost concerns what will cease to exist in the future—and what will leave an empty space in your heart.

Consider how you feel when old, familiar buildings, perhaps from your childhood, are slated for demolition in the name of progress. Or when a beloved landscape, one that never lost its power to lift your heart, is blighted by thoughtless development or careless utilization. Or when a cherished old tradition vanishes from a culture, never again to bring families together.

I feel such losses more acutely, now that I am a mother, because I know that in my child's life, she will be denied the comfort, peace, or inspiration that I once found in vanished things. It's a soft sorrow, not a piercing grief, but it's a loss all the same.

I ask you now to remember the elation you once felt at seeing the first footsteps placed on the Moon, or watching the first launch of the space shuttle, or holding in your hand the first picture of a distant planet. Remember the vision of *Apollo*, the uplifting belief that our species was destined to travel to other worlds, to build a spacefaring civilization.

Could all that be lost? If we do not commit, during these difficult times, to working together to build that spacefaring civilization, that vision will vanish. The future will be diminished—for you and me, and for our children and their children.

We can preserve that bright, remembered future—if we unite and act together today through The Planetary Society.

—Charlene M. Anderson

On the Cover:

Generations of stars glow in this infrared stellar "family tree" image taken by the Spitzer Space Telescope. This wispy, star-forming region, called W5, is about 6,500 light-years away in the constellation Cassiopeia. Here, the oldest stars are the blue dots in the hollow cavities (other blue dots are background and foreground stars not associated with the region). Younger stars line the cavity rims and show as pink at the ends of the pillars at upper right. White indicates star-forming areas, red shows heated dust that pervades the cavities, and green highlights dense clouds. For an expanded view of this image, visit *http://www.spitzer.caltech.edu/Media/releases/ssc2008-15/ssc2008-15a.shtml.* Image: NASA/JPL-Caltech/L. Allen & X. Koenig (Harvard-Smithsonian Center for Astrophysics)

Background:

This Hubble Space Telescope (HST) image shows the center of a wider view of the edge of the giant, gaseous cavity inside the star-forming region called NGC 3324 in the Carina nebula. The region lies roughly 7,200 light-years away in the southern hemisphere constellation Carina. The glowing nebula has been carved out by intense ultraviolet radiation and stellar winds from several hot young stars. This picture is from the Hubble Heritage Project, a collection of HST images that showcase the artistic beauty of our universe. To see the image in its entirety, go to *heritage.stsci.edu/2008/34/index.html.*

Image: NASA, ESA, and The Hubble Heritage Team (STScI/AURA)

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vvA PUBLICATION OF THE PLANETARY SOCIETY

The Planetary Society's All-Sky Optical

by Paul Horowitz and his research group, Harvard University Optical SETI

Two years ago, we launched a novel and ambitious project—a search of the entire northern sky for nanosecond (billionth-of-a-second) flashes of light, of the sort that we on Earth could now generate with state-of-the-art lasers and that would be easily visible above the glare of our host star (the Sun). Indeed, with current technology, we could outshine the Sun by at least a factor of 10,000, as seen by a distant recipient during the brief and directional laser flash. That's "optical SETI" (the Search for Extraterrestrial Intelligence), a fashionable pursuit of late in the small worldwide SETI community.

All-Sky OSETI

The "all-sky" project follows on the heels of The Planetary Society's targeted Optical SETI at Harvard-Smithsonian's telescope (see the March/April 2000 issue of *The Planetary Report* and *The Astrophysical Journal*, October 1, 2004), during which we made 16,000 observations of some 6,000 likely star sytems in search of the elusive *flash*—a flash that, we are sure, would be heard around the world. The motivation for this grand next step was simple: rather than confine our vision to a soda-straw's view of the sky (the targeted search, which observed about 1/100,000 of the heavens), why not cover the *whole* sky? Simple motivation, but complex task! We needed a large telescope with a wide field, and we needed to replicate the detectors and electronics of our soda straw hundreds of times—and, we hoped, achieve even greater observing fidelity and precision.

With support from The Planetary Society, and with exceptional efforts by students and volunteers, we made it a reality (see the May/June 2006 issue of *The Planetary Report*). In a nutshell, the all-sky observatory houses a unique 72-inch telescope outfitted with a thousand detectors, each of which measures the light falling on it nearly a billion times per second, and which triggers with any brief excess of light that is seen simultaneously by any pair of detectors that are viewing the same spot in the sky. The system is outfitted with an elegant web-based control interface, such that the entire operation is run remotely.

It works splendidly! We've now covered all of the sky that is visible from the observatory (located on a rural Massachusetts hilltop). In fact, we've covered it twice, because we replaced the original "front-end" electronics with an improved version that is five times more sensitive, so that the system's sensitivity is now limited only by telescope size and (sigh) our less-than-ideal weather. We observe every clear night, and you can check out the operation at The Planetary Society's website *planetary.org/programs/projects/seti_optical_searches/*.

During these first years of observations, we've tuned up the software and festooned the observatory with nifty gadgets. For example, we've wired up a rain detector,

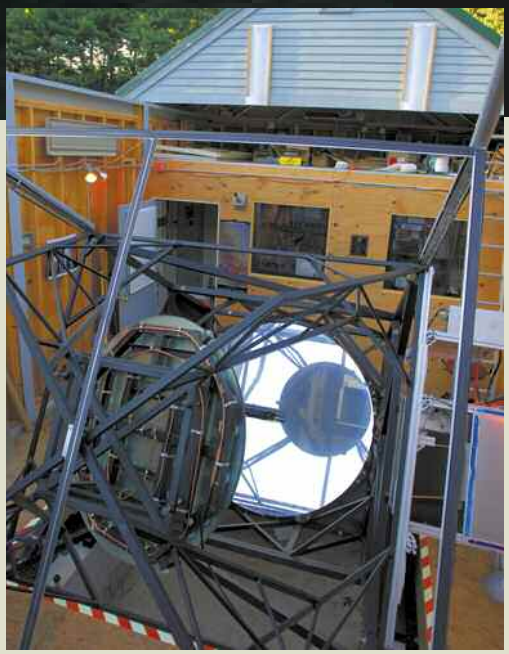
SETI: Where Are We Now?

Left: Sweeping crescent clouds appear to plunge into bright Jupiter and the band of the Milky Way as they light up the night sky. Amateur astronomer Tunç Tezel took this photo last summer while driving up Uludag, a mountain near Bursa, Turkey. The Planetary Society's All-Sky Optical SETI (OSETI) can now search the entire northern sky for that fleeting flash of bright laser light that might signal a transmission from another civilization in our galaxy.

Photo: Tunç Tezel, The World at Night

daylight detector, computer crash detector, and power-fail detector so that the roof closes automatically to protect the good stuff inside. A sensitive sky camera captures pictures of the whole sky during each observation so we can see if there was any cloud cover, or perhaps a flashing object created by terrestrial intelligence! We've installed a pan-tilt-zoom webcam that can see in the faint light of night so we can know that it's OK to open the roof (no hanging icicles), check for unauthorized visitors (two-legged or otherwise), and so on. And we've added a two-axis steerable test flasher that can put a pulse of light onto any detector for calibration and validation.

In parallel with these hardware enhancements, we've also been busy with the software: in an elegant bit of trickery, we exploit the staggered positioning of detectors to get a second, third, and even fourth look when something interesting happens. We do this by tipping the telescope up by just the right amount so the offending spot in the sky has to run a gauntlet of detectors. We've also taught the software to interrupt its routine sky scanning in order to schedule re-observations intelligently, based on the quality of initial events, night sky conditions, and moonlight. We've linked our operations to The Planetary Society's website so members (and nonmembers—you know who you are!) can watch the telescope's nightly duties, see the night sky images, and track the growing sky coverage. Of course, as we have gathered observations, the database has grown nicely, requiring improved analysis tools (and a faster computer).

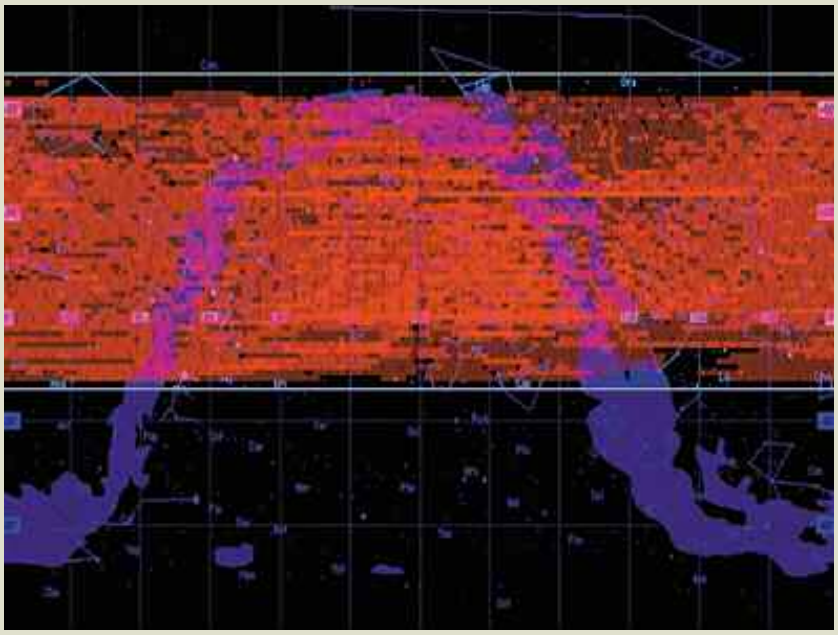


The OSETI observatory, located on a remote Massachusetts hilltop, has a roof that rolls back to reveal the 1.8-meter (72-inch) optical telescope that is the first in the world built exclusively for SETI research. The entire observatory is controlled remotely from the SETI lab in Cambridge.

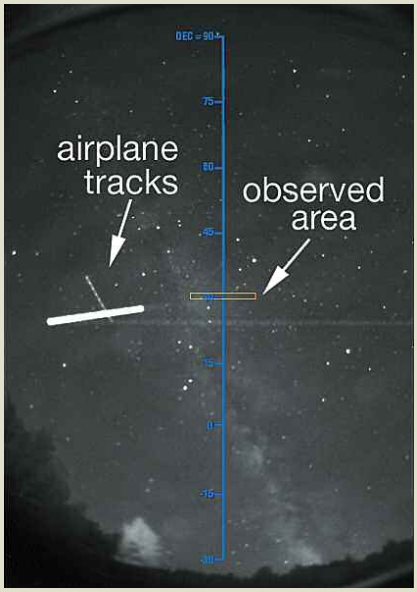
Photo: Stu Rosner, Stu Rosner Photography

Found Anything Yet?

What a question! And the answer is . . . maybe. On an average night, we sometimes see what we call an *event*—that is, the triggering of a pair of detector pixels trained on the same sky location. Over the course of more than two years of observing, we've had a few hundred of these. Some are easily spotted as artifacts—for example, a burst of triggers whose origin is unmasked by the sky camera (see middle photo on page 6). But others are more persuasive, most particularly those that are seen as a compact flash, both in time and in space. We re-observe these candidates—limited, however, by the fact that our telescope operates in *transit*



The new OSETI project works so well that it has already covered the entire sky that is visible from the observatory. This image shows the sky coverage to date. The lighter shade of red indicates parts of the sky that have been re-observed multiple times. *Image: Curtis Mead*



A fish-eye "sky cam" at the observatory allows the OSETI team to see clouds, meteors, and airplanes—one of which is headed directly toward the observation patch of sky here. This particular plane triggered a flurry of false events.
Photo: Curtis Mead

Curtis Mead is shown here running dual OSETI observations from the Smithsonian's Mt. Hopkins Observcatory south of Tucson, Arizona. On the monitor at left he's re-observing the best events locally with their giant, bug-eyed, 10-meter telescope. On his laptop he's running The Planetary Society's all-sky telescope at Harvard via the Internet.
Photo: Curtis Mead

mode and must wait for a desired stellar location to pass through the stationary stripe of sky that we're pointed at. This give us a 1-minute shot once per day.

The ideal solution would be a collocated follow-up telescope that can track the location of a candidate event. With the closure of our targeted instrument, however, we have lost that capability. But there are other telescopes, operated by people who appreciate the significance of OSETI. Most interesting among these are the large optical collectors that are designed to detect powerful gamma rays by their telltale atmospheric signature, a streak of light known as *Cerenkov radiation*. Two such systems are in operation at the Smithsonian's Mt. Hopkins Observatory south of Tucson. We have been lucky enough to establish a partnership with several of their scientists, and we've had a chance to use their tracking 10-meter optical collector as a follow-up to a dozen choice events. The image at the bottom of this page shows what it was like, with our group's Curtis Mead doing re-observations on their telescope while simultaneously operating The Planetary Society all-sky telescope via the Internet. We are exploring this and other second-look techniques, because an event that is not confirmed independently is, well, just an "event."

Next Steps

At least half the enjoyment of any experiment is thinking about the *next* experiment. We've got several ideas right now. One is the business of near-real-time follow-up using a steerable telescope, perhaps outfitted with our first-generation targeted OSETI equipment. Another development, coming along nicely in our lab, is the exploitation of commercial, high-performance, field-programmable gate arrays (FPGAs) as an upgrade to the current custom chips that sit right behind the detectors. This would not increase our sensitivity, but it would enable us to capture 16 times as much information about the spatial pattern of detected light from any event.

In parallel with these ambitious ideas, we are also working on improvements in telescope accuracy, as could be implemented by installing a sensitive digital camera to independently observe star trails across the detector array, and by adding a precision declination readout to the telescope.

Always, though, we must keep our eyes on the real prize: Earth's first detection of a deliberate communication from another civilization. We believe this *will* happen, someday. It will be the most important event in human history. We hope to witness it in our lifetimes, and (dare we hope) it could happen—on any clear night, at The Planetary Society's All-Sky Optical Observatory.

Paul Horowitz is professor of physics and of electrical engineering at Harvard University. The OSETI observatory and equipment were designed and built by students and volunteers at Harvard, including Jason Gallicchio, Andrew and Steve Howard, Chris Laumann, Pratheev Sreetharan, and Al and David Sliski, with cosponsorship by the Bosack and Kruger Charitable Foundation.

Another view of the Milky Way (with Jupiter at top), but this time from the other side of the planet, where Southern SETI searches the skies. The galactic arch appears to emerge from Chile's Cerro Paranal at left and to sink into Antofagasta's bright night lights. Also visible at left are the Magellanic Clouds, and a meteor's trail can be seen at right. Photo: Bruno Gilli, European Southern Observatory

The Planetary Society's Southern SETI

While Paul Horowitz and his crew search the skies for alien light signals, another Planetary Society–supported project listens for extraterrestrial radio transmissions from deep space. Southern SETI has been operating from the Instituto Argentino de Radioastronomia (IAR), south of Buenos Aires, since 1986, using two 30-meter dishes to conduct both sky surveys and targeted SETI searches. Thanks to their southern location, the dishes at IAR can continuously scan the very center of our galaxy, a region that is rarely visible to telescopes located in the northern hemisphere. As a result, whereas nearly all other searches are limited to listening for signals from the periphery of our galaxy, Southern SETI can listen directly for transmissions from the most star-rich region of the Milky Way.

In 1990, with funding from The Planetary Society, Southern SETI team members installed an advanced electronic system built at Harvard by IAR engineers. Known as META II, this SETI back end was a replica of the radio SETI system used by Horowitz at the Oak Ridge Observatory in Massachusetts. It was a highly sensitive system capable of searching for signals with bandwidth as narrow as 0.05 Hertz! Since that time, META II has been the backbone of Southern SETI. A major Society-funded upgrade in 1997 brought the system up to the standards of that time, but 11 years later, the system is aging. A new solution is needed to keep Southern SETI abreast of fast-evolving SETI technology.

These days, thanks once again to a grant from The Planetary Society, Southern SETI is undergoing a complete overhaul. Under the leadership of Principal Investigator Guillermo A. Lemarchand, the project has undertaken to completely replace its aging META II back end with a state-of-the-art SERENDIP V system. The system was designed by Dan Werthimer's team at U.C. Berkeley, which also runs the phenomenally successful SETI@home project.

Once the new system is installed at IAR, the search capabilities of Southern SETI will rise dramatically. Whereas META II listens to 8.4 million different channels simultaneously, SERENDIP V will be able to track 128 million channels at the same time. And whereas currently, Southern SETI can listen to a radio band 420 Kilohertz wide, the new Southern SETI will be able to listen to an 80-Megahertz-wide band instantaneously.

This last feature is particularly significant: not only is it a 50-fold increase over the capabilities of the current system, but it addresses the problem of Doppler drift, which will likely affect any signal coming from the stars. If the instantaneous bandwidth is too narrow, the incoming signal could drift right off the scale and never be detected. But with SERENDIP V's 20-Megahertz band, any transmission from outer space will almost certainly remain within the project's frequency range.

Lemarchand estimates that the SERENDIP V back end will be ready for installation in the spring of 2009. In the meantime, he has been working with international partners to develop the optimal software for operating the new Southern SETI. With partial funding from The Planetary Society, and aided by Argentinian agreements on international cooperation, Lemarchand has joined forces with SETI scientists in Italy and Australia to produce the necessary code. If all goes well, by the summer of 2009, Southern SETI will be scanning the skies 12 hours a day with its new SERENDIP V capabilities in place. If anyone is hailing us from the center of our galaxy, chances are it will be the new Southern SETI that will hear the call.

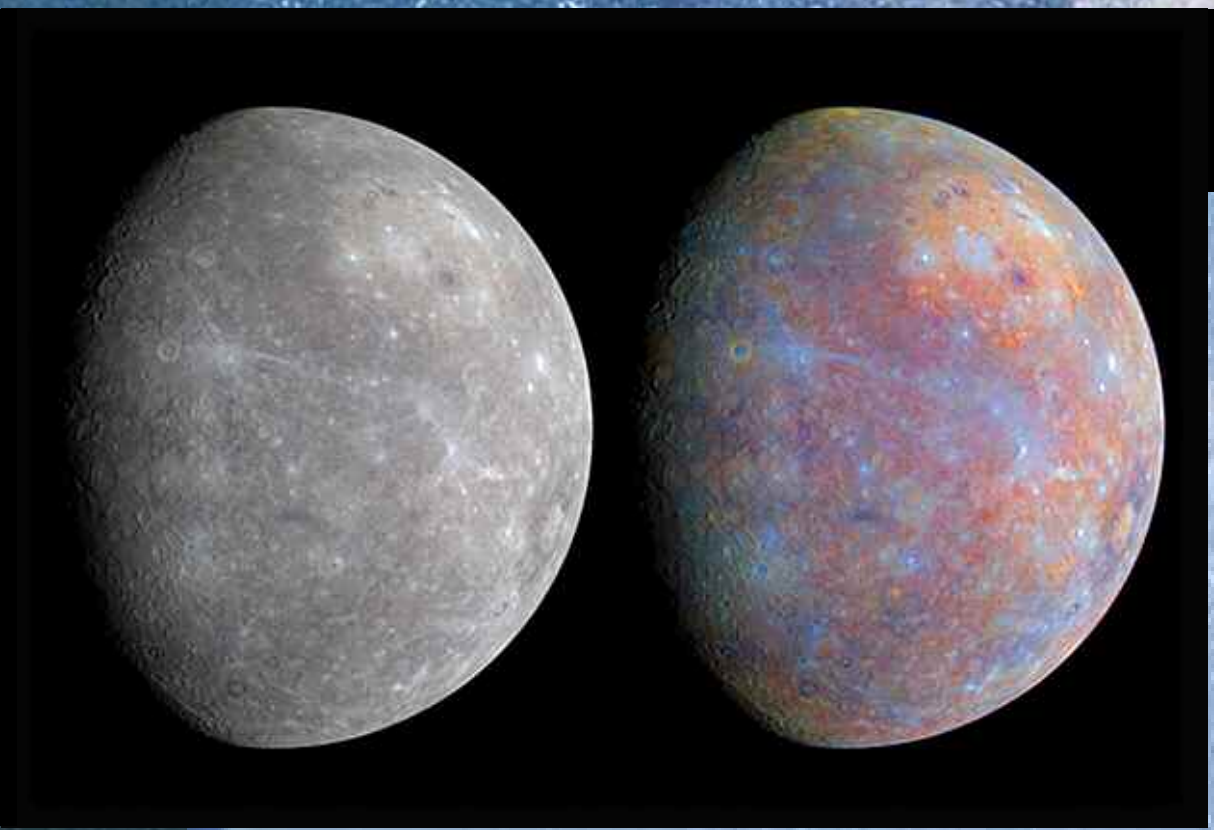
—Amir Alexander, Writer-Editor for The Planetary Society's website, planetary.org.

The two 30-meter dishes at the Instituto Argentino de Radioastronomia (IAR). Photo: Guillermo Lemarchand, IAR

2008—The Ye

The year 2008 was notable for starting out—and ending—with more than 20 missions actively exploring our neighbors in the solar system. Four major events captured the attention of the public. *MESSENGER* began and ended the year with the first two flybys of its target planet, Mercury, finally revealing the half of the planet that had never been seen from a spacecraft. *Cassini* ended its primary mission and began its extended one with a series of close encounters with the geyser moon Enceladus. The first Mars Scout mission, *Phoenix*, landed safely near Mars' north pole and immediately began a race against time to make the most of its mission before the arrival of autumn robbed the solar-powered spacecraft of energy. And ESA's comet-chasing flagship mission, *Rosetta*, had its first science encounter with a tiny, unusual asteroid named Steins.

Throughout the year, less-heralded but still hardworking spacecraft carried on with their science missions. *Venus Express* continued its studies of patterns in Venus' clouds, while *Kaguya* and *Chang'e 1* sent high-resolution photos back from the Moon; those craft were soon joined by India's *Chandrayaan-1*. *Mars Reconnaissance Orbiter*, *Mars Express*, and *Mars Odyssey* continued with their



Mercury as a "Whole New Planet"

After a journey of three and a half years, *MESSENGER* at last gave Earth its first close-up look at Mercury since the final *Mariner 10* flyby in 1975. *MESSENGER* approached a crescent Mercury, viewing part of the hemisphere that *Mariner 10* had already seen. It swung past the night side and captured a departing view of territory new to human eyes, including the entire expanse of the Caloris impact basin, visible in this enhanced-color image as a huge orange splotch at upper right.

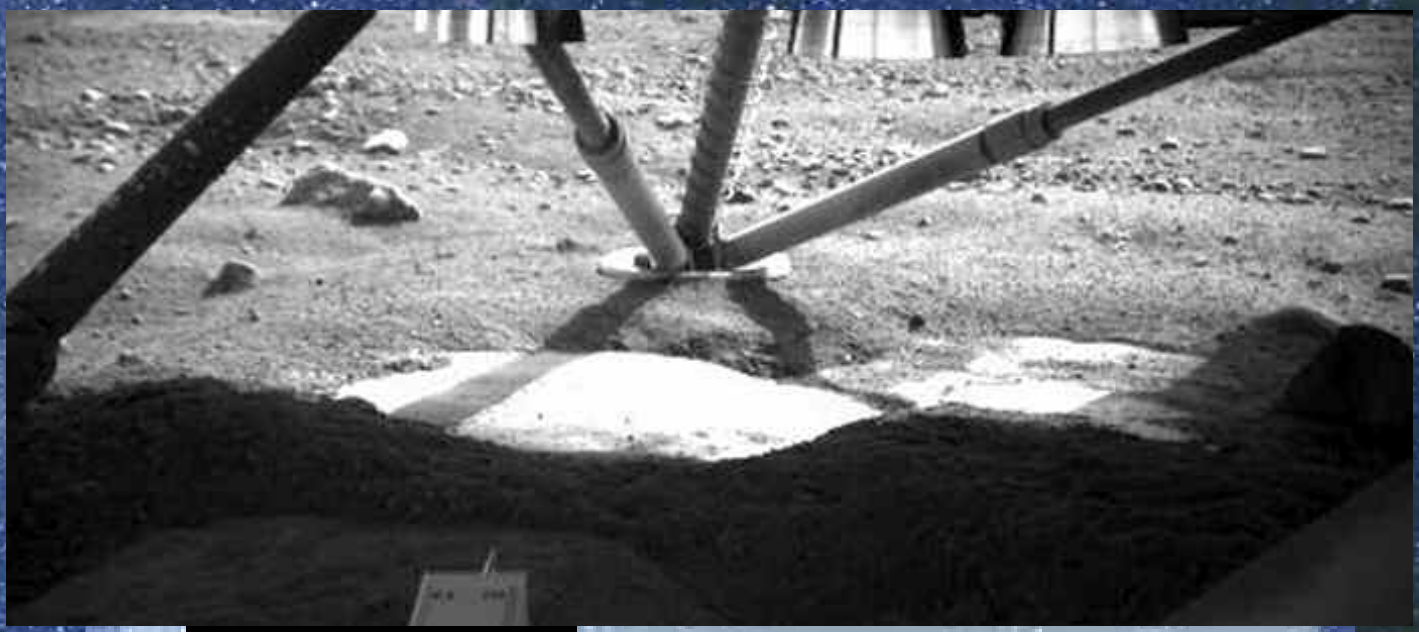
The color information from *MESSENGER*'s camera reveals other oddities. The floor of Caloris is littered with unusual dark-rimmed craters, which appear purple here. Other, fresher, craters have lighter interiors and blue sprays of ejecta. Close examination of the *MESSENGER* images has lent strong support to the notion that Mercury has experienced a lengthy history of geologic activity, including impact cratering, explosive volcanism, effusive lava flows, and a wholesale shrinking of the planet due to the ongoing solidification of a molten metal core. Following this flyby will be two more; the spacecraft will finally enter orbit and begin its primary mission in 2011. Image: NASA/JPL/Carnegie Institute of Washington, enhanced-color version by Emily Stewart Lakdawalla

ar In Pictures

mapping of Mars from orbit as the Mars Exploration Rovers worked steadily through the long winter. *Deep Impact* searched for exoplanets transiting stars in its new extended mission, EPOXI. *New Horizons* crossed Saturn's orbit on its way to Pluto. *Dawn* crossed Mars' orbit and is ready for a Mars gravity assist early next year. *Stardust* and the *Voyagers* are cruising along, periodically communicating with Earth. And, late this year, an old but still-good spacecraft was heard from for the first time since 1999: the *International Cometary Explorer*, one of the fleet of spacecraft that studied Halley's comet in 1986, is on a return trip to Earth; a gravity-assist flyby in 2014 could send it on to another comet.

The pictures in this article mark some of the exciting events of this year. As 2008 comes to a close, we'll include these and more images from 2008 on our website at *planetary.org/yip*.

Emily Stewart Lakdawalla is science and technology coordinator for The Planetary Society and writes for the Society's blog at *planetary.org/blog*.



Holy Cow, It's Ice!

Among the critical activities during *Phoenix*'s first week on Mars was the imaging of its three footpads to make sure they were resting on solid ground (and not teetering on a rock). Only one footpad could be imaged with the mast-mounted camera; the other two were underneath the lander and could be seen only with the camera mounted on the end of the jointed robotic arm, which first needed to be deployed. So it wasn't until sol 5 that *Phoenix* was able to take a look under the lander at the most distant footpad. Once it did, it saw that the descent thrusters (visible at the top of this image) had blasted away the soil beneath the lander, exposing a smooth, brightly reflective surface buried just centimeters below. The site quickly acquired the name "Holy Cow," after the remark of a science team member seeing the image for the first time. Could this be the ice the spacecraft had been sent to Mars to study? Proof that this material was ice finally came on sol 24, when some of the material, exposed in a trench dug with the robotic arm, disappeared over the course of three sols. Image: NASA/JPL/University of Arizona/Max Planck Institute

Falling Toward Mars

Two feats of spacecraft navigation and control combined to create this awesome action shot of *Phoenix* falling to its landing on Mars. The *Phoenix* polar lander was nearing the end of its 679-million-kilometer (422-million-mile) journey to Mars. It had completed the fiery entry period of its landing, jettisoned its heat shield, and deployed its parachute. At the same time, *Mars Reconnaissance Orbiter* was flying on its own path around Mars. The photo, captured by the High Resolution Imaging Science Experiment (HiRISE) camera, was designed to capture an image of *Phoenix* that might help engineers figure out the cause of a failure of *Phoenix* upon landing, so the orbiter was programmed to spin as the image was taken to compensate for *Phoenix*'s apparent motion and produce a sharp image of the spacecraft. With the fast relative speeds of *Phoenix* along with the orbiter, and the uncertainty in *Phoenix*'s exact position that arose from uncertainties about how long its entry would take, the HiRISE team predicted only a 20 percent chance of successfully capturing an image of *Phoenix* in flight.

Both the imaging attempt and the landing were successful, so the image was not needed for engineering, but it provided an amazing snapshot of a spacecraft in the act of landing on another planet. HiRISE is so sharp an imager that you can even make out the stripes on the parachute and the shroud lines connecting it to the lander. Initially, analysts focused only on *Phoenix*. But upon further investigation of their image, the HiRISE team realized that the background view was impressive, too: a 10-kilometer crater named Heimdall, on whose ejecta blanket *Phoenix* now sits. (Although it appears that *Phoenix* was falling into the crater, that's an optical illusion. The view is oblique, and *Phoenix* was much closer to the orbiter than was the crater.) Later, (althought it is not visible here), the team realized that the blackened heat shield of *Phoenix* is also visible in the image as a black dot falling toward Mars on a trajectory similar to the bright spacecraft. Image: NASA/JPL/University of Arizona

First Triple Near-Earth Asteroid

Astronomers training Puerto Rico's great Arecibo radio telescope on a close-passing asteroid discovered that the small body was actually three. The largest component rotates faster than the smaller ones, spreading it out in this radar image. Although other triple-asteroid systems are known to exist, this is the first near-Earth triple. It is also unusual because of the similar size of the three components—from top to bottom, they are about 0.4, 2.0, and 1.0 kilometers (1,000, 7,000, and 3,000 feet) in diameter. The three objects look dissimilar in size here because the width of an object in a radar image is related to how fast it is rotating, not its actual diameter; faster rotators appears wider. The Arecibo radio telescope is a critical facility for the study of the nature and orbits of near-Earth asteroids and is threatened with closure in 2011 due to a funding standoff between the National Science Foundation and NASA.
Image: Michael Nolan, Arecibo Observatory

An Ice-free Northwest Passage

The search for a northern shipping route around the Americas motivated centuries of expeditions into the Arctic. Many of them ended in disaster and loss of life, including the horrifying end of the Franklin expedition by lead poisoning, botulism, cannibalism, or a combination of the three in 1845. Although some expeditions successfully crossed the Arctic, none led to a viable shipping route. Things have changed. In the last few years, Arctic warming has led to the rapid thinning of the icepack and loss of multiyear ice (ice that usually survives from one year to the next), resulting in a record low summer sea ice extent. Satellite images now suggest that this year the Northwest Passage was free of ice for the first time and may be navigable by ships that are not icebreakers. Shipping companies are already pressing the Canadian and Russian governments for permission to traverse it.

This image is from ESA's *Envisat* radar satellite. The solid line marks the most direct route through the Northwest Passage; the dotted line, called the *Amundsen passage*, is less direct but has been navigable and ice-free for the summer beginning in late July. Image: ESA

Whose Crescent?

In an extreme crescent phase, it is nearly impossible to tell planets with atmospheres apart. Is this *Voyager*'s departing shot of Uranus? *MESSENGER*'s view of a crescent Venus? No, it's a view from the "Mars Webcam," the name that the European Space Agency has given to the newly reawakened Visual Monitoring Camera (VMC) on *Mars Express*. VMC is an engineering camera whose purpose was to monitor the departure of the ill-fated *Beagle 2* lander. It was not used at all from the time of the lander separation in 2003 until the summer of 2007. Although the camera's capabilities are modest, it's in a unique position: it is the only camera in Mars orbit that can take in Mars' whole globe in one frame, and the only one that has ever been able to capture crescent views of the planet on a regular basis. Its images are now being sent to the web within days of acquisition, and ESA has invited the public to process and share VMC images on its website. Image: ESA

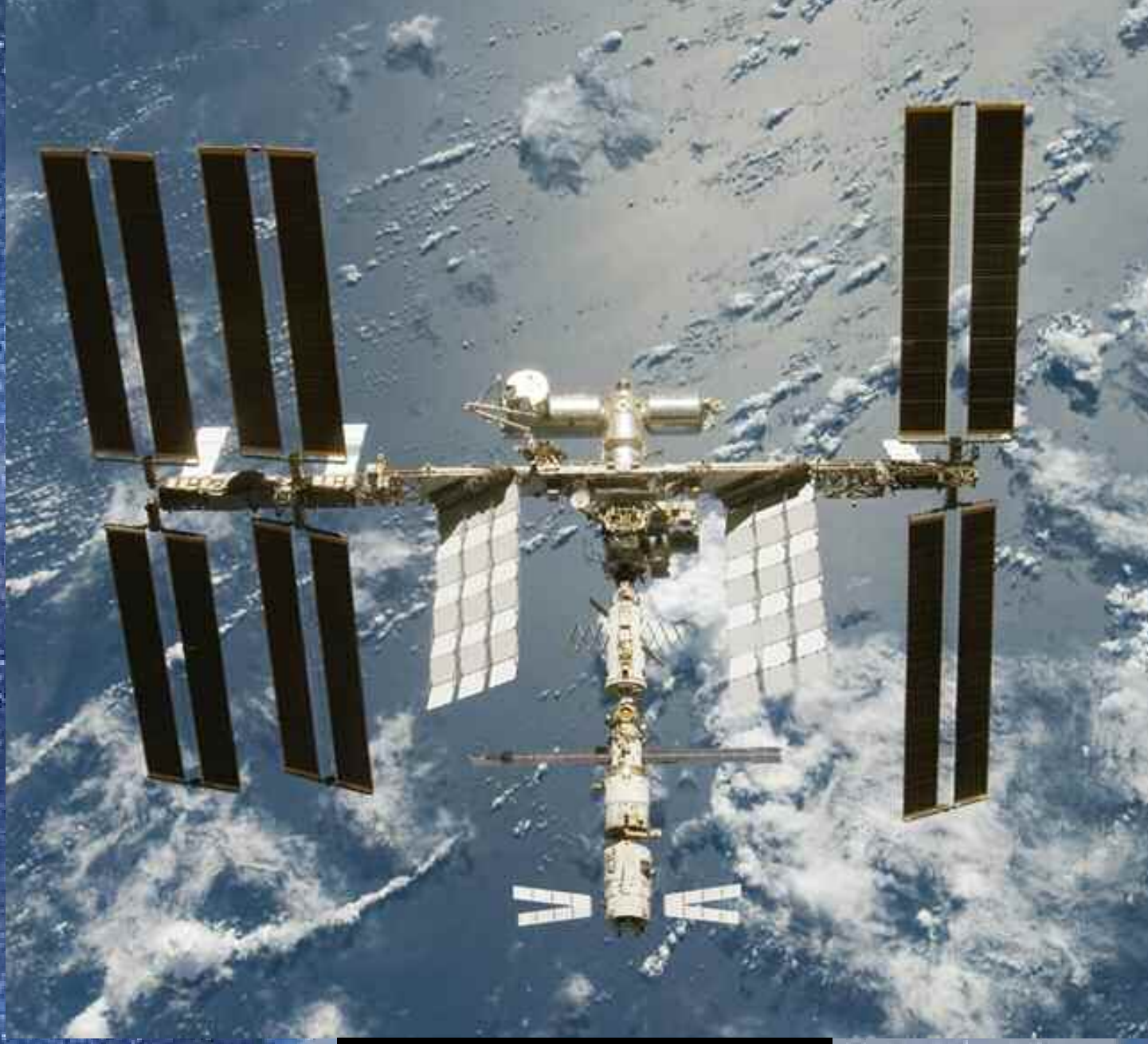
Departing Victoria Station

After spending almost an Earth year inside Victoria crater, *Opportunity* beat a hasty exit. On sol 1,634 of its mission, it again mounted the rim of Duck Bay and sat with six wheels on the flat plains of Terra Meridiani. Its hurry was due to an unexplained "current spike" on one of its wheels, an event that had prefigured the failure of one of *Spirit*'s wheels. Fortunately, it exited without any further wheel problems and is now rolling across the plains for new adventures. Image: NASA/JPL-Caltech

Earth as an Extrasolar Plan

Deep Impact gazed upon its home world 50 million kilometers (about 30 millio the Moon transiting Earth. Although th we see it in our sky, it is in fact much continents of Earth, as this photo mak mission to crash into a comet, *Deep Im* new orders, to use its slightly out-of-f to search for extrasolar planets that tra sequence of Earth and Moon was captu set that can link the variable brightnes point of light from a distant extrasolar structure of oceans, continents, clouds

Image: NASA/JPL-Caltech/GSFC/UMD



Space Station Nears Completion

As the space shuttle *Discovery* departed the International Space Station (ISS), the astronauts photographed their handiwork, which included the addition of the Japanese Kibo experiment module, a tube-shaped element at the top left of the ISS in this image. Earlier in the year, *Atlantis* carried the European Space Agency's Columbus module into orbit. The two modules vastly increase the scientific capability of the station, fulfill important international obligations, and bring the station to a state of near completion. Eight more shuttle missions will be required to complete the ISS.

Image: NASA

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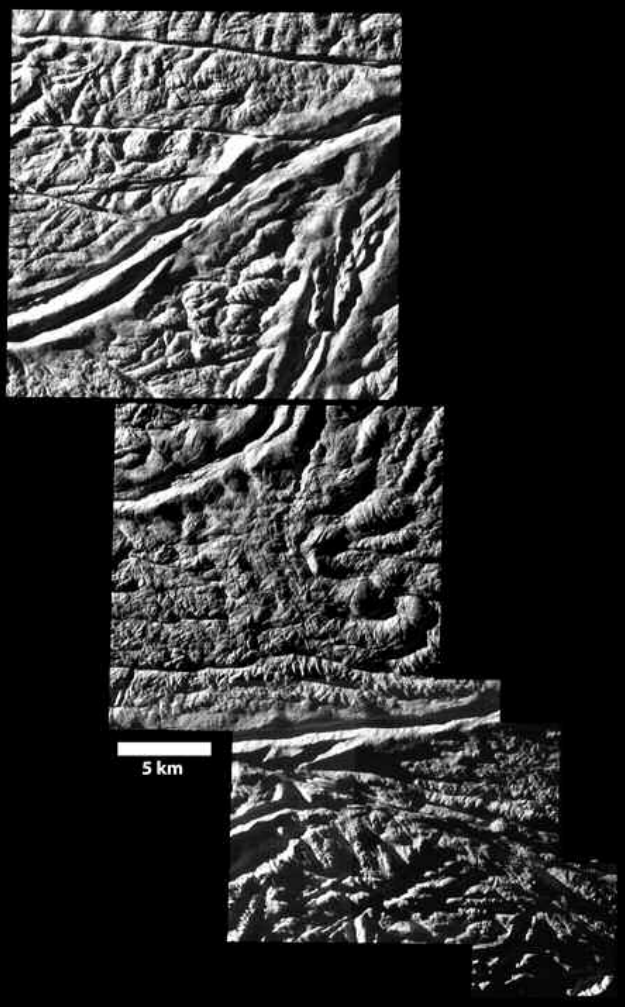
planet to its possible surface
, and potentially even moons.



Cassini Stares Down the Throats of Enceladus' Geysers

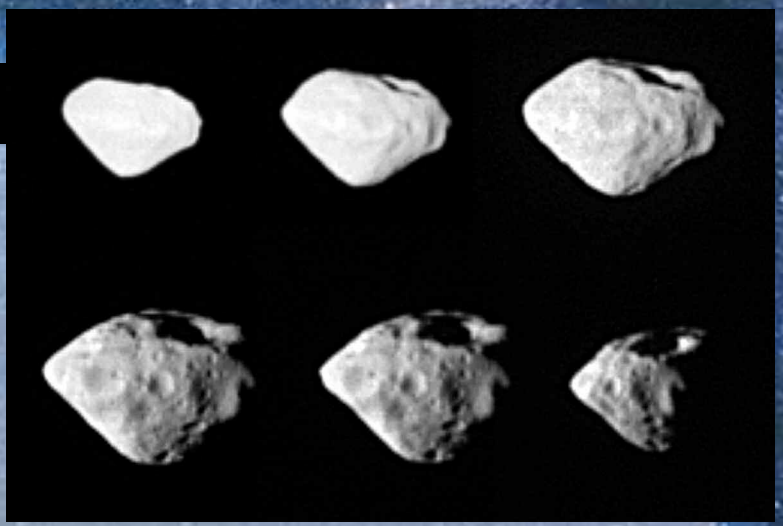
Cassini began its two-year extended mission with a daring flyby of the geyser moon Enceladus, passing within 54 kilometers (34 miles) of its surface. At a relative speed of 18 kilometers per second (40,000 miles per hour), it was impossible for *Cassini* to perform its usual careful targeting of images at closest approach. Instead, the spacecraft spun as quickly as possible to compensate partly for the high speed of Enceladus' motion and repeatedly snapped its shutter, a maneuver that the mission planners dubbed the "Skeet Shoot." Five of the Skeet Shoot images are shown here in a mosaic that crosses two of the south polar vents (also known as "tiger stripes") from which Enceladus' plumes erupt.

The images reveal a landscape that is folded, furrowed, cracked, and mazed with crosscutting tectonic features, all littered with boulders, with not a fresh crater in sight. This is a very young surface, recently renewed by geologic activity. Boulders appear to be more numerous near large vents—were they, in fact, tossed from the vents in explosions? Actual erupting plumes are not visible here, nor were they expected to be, given the lighting conditions.

Cassini's extended mission will include a total of six close Enceladus flybys, all of them focused on the mysterious activity of the south pole of this diminutive moon.

Image: NASA/JPL/Space Science Institute

A Jewel of the Solar System



ESA's comet-chasing flagship mission, *Rosetta*, performed its first science encounter with a flyby of a small asteroid, (2867) Steins. Although its highest-resolution camera shut itself off just nine minutes before the closest approach because of conservatively set safety parameters, *Rosetta* returned data from 15 other instruments, including its wide-angle camera. The first image in the sequence was taken with the Sun almost behind the spacecraft, a point of view that gives the best possible information on the asteroid's color but little topographic information, because there are no shadows. Images from higher sun angles show that the asteroid has been battered by large impacts and is likely entirely fractured inside. The spacecraft used its own cameras to autonomously track the asteroid through the closest approach period, a first for ESA. Image: ESA ©2007 MPS for OSIRIS Team; MPS/UPD/LAM/IAA/RSSD/INTA/UPM/DASP/IDA

HELP US CELEBRATE THE HUBBLE SPACE TELESCOPE

. . . and See Your Words in The Planetary Report

by Neil deGrasse Tyson

This image of the merging Antennae galaxies is Neil deGrasse Tyson's favorite Hubble image. The two spiral galaxies started to interact a few hundred million years ago, making the Antennae galaxies one of the nearest and youngest examples of a pair of colliding galaxies. As the two galaxies smash together, billions of stars are born, mostly in groups and clusters of stars. The brightest and most compact of these are called **super star clusters.**

Image: NASA, ESA, and the Hubble Heritage Team STScI/AURA-ESA/Hubble Collaboration. Acknowledgment: B. Whitmore (Space Telescope Science Institute) and James Long (ESA/Hubble)

I invite you to join me in saluting the Hubble Space Telescope as NASA prepares to launch its next servicing mission to mend and improve this scientific treasure one last time. I ask you because, as a Planetary Society Member, you have helped keep Hubble alive.

Two years ago, Society Members raised their voices to protest NASA's own decision to cancel the Hubble repair mission and let the telescope die in orbit. Our voices were joined by those of people around the world who had come to love this orbiting observatory in a way no one could ever have expected when it was launched in 1990.

Hubble became the people's telescope. It has done more than any other scientific instrument to unlock and share the mysteries of the universe. Recognizing this widespread support, NASA reversed the decision to let it die. We now await the launch of the final repair mission.

To salute Hubble, I ask each Planetary Society Member to choose a favorite image taken by the telescope and tell us, in 75 words or less, why this particular image is important to you. The staff will select 10 images and your accompanying text to include in *The Planetary Report* as the Society's tribute when the repair mission flies.

To choose your favorite Hubble image, it's easiest to go to *hubblesite.org* and browse through the catalog of images you'll find there. Along with your text, please send the URL of that image plus the image title to us at *planetaryreport@planetary.org*.

If you do not have Internet access or an e-mail account, you can still enter the competition. Just mail us the complete title of the image—with a copy, if possible—along with your caption, to Hubble Tribute, The Planetary Society, 65 North Catalina Avenue, Pasadena, CA 91106.

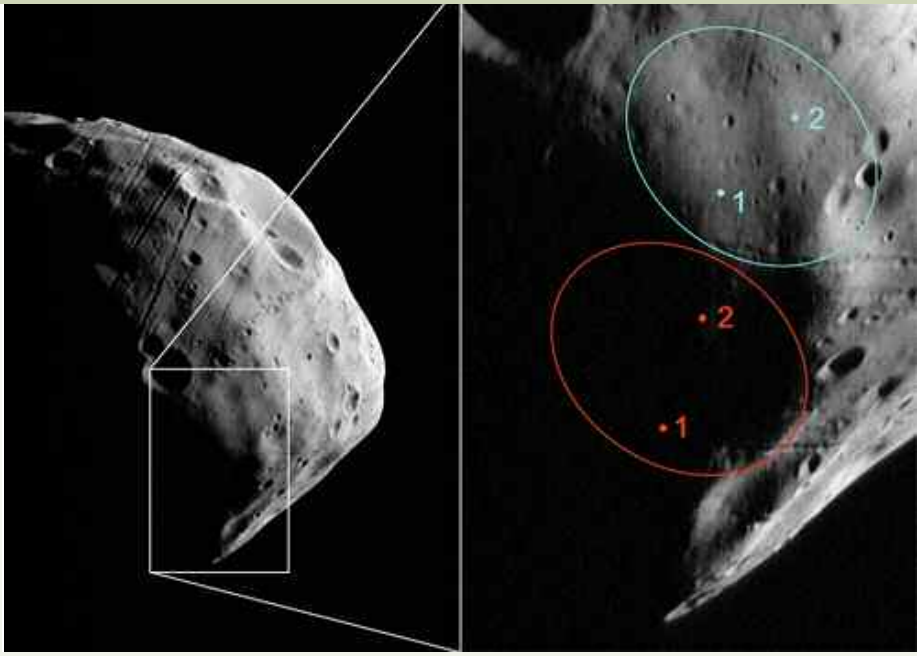
Send us your image by Monday, March 2, 2009. This is your chance to see your words in *The Planetary Report*, alongside your favorite Hubble Space Telescope image. I hope to hear from you.

Neil deGrasse Tyson is the former president of The Planetary Society and director of New York's Hayden Planetarium.

Our **Phobos LIFE Biomodule** Passes Tests

We Make It Happen!

by Bruce Betts



The European Space Agency's* Mars Express *took a close look at Mars' moon Phobos. Based on* Mars Express*' images of Phobos, the Russian sample return mission,* Phobos Grunt*, has shifted the leading landing site candidates from the original locations, in the red ellipse, to safer new locations, in the blue ellipse.
Image: ESA/DLR/FU Berlin (G. N eukum)

Far left: This projectile was fired from an air cannon to simulate potential impact during Earth landing. The Phobos LIFE biomodule is the cylindrical titanium object on the left end of the projectile.

Left: The LIFE module, which contains 30 sample tubes and 1 colony sample, is just 57 millimeters in length and fits comfortably in the palm of one hand. *Photos: Bruce Betts*

With new partnerships and the successful completion of tests, The Planetary Society's Living Interplanetary Flight Experiment (LIFE) is moving toward delivery for an October 2009 launch on board the *Phobos Grunt* (Soil) spacecraft. Phobos LIFE will send a collection of living organisms on a three-year trip to the Martian moon Phobos and back to Earth inside a simulated meteoroid. (See the May/June 2008 issue of *The Planetary Report*.)

LIFE will be a unique test of one aspect of the transpermia hypothesis: the possibility that life can move between the planets inside rocks blasted off one planetary surface by impact, to land on another planetary surface. This type of experiment—with the combination of multiyear periods and exposure beyond the protection of Earth's magnetosphere—has not been done before.

Getting Slammed and Shaken

Before any hardware flies in space, it must be subjected to a series of experiments to ensure it will survive the rigors of space and, in this case, return to Earth. Phobos LIFE is no exception. It was designed to survive the shaking of launch and the big impact upon Earth return, which could be as high as 4,000 *g*s.

But one can't be sure that a design really will work until it is tested. So we've carried out a variety of tests on our biomodule at the facilities of our engineering contractor, Stellar Explorations, Inc., and at the nearby California Polytechnic State University, San Luis Obispo.

Each of the 30 sample tubes and 1 colony sample tube were filled with a fluorescent liquid. (The actual flight samples will be dry, but we used liquid for the test to make sure we could identify any leaks.) The entire biomodule was sealed, as the flight biomodule will be for spaceflight. Then we slammed it, shook it, and checked the results.

Vibration, or "shake," tests are designed to simulate the shaking that occurs during launch. We used shake tables at Cal Poly San Luis Obispo for the vibration simulation, and the biomodule and all its components worked perfectly with no leaks, despite being subjected to vibrations far beyond those that will be encountered during launch.

For the impact test, Stellar Exploration's engineers designed an air gun that launched the test biomodule into foam at high speed. Speeds and impact materials were adjusted to simulate, and exceed, the worst-case scenario parameters for a rough landing. The first time the test was performed, 3 of the 30 capsules leaked fluid; however, all other seals retained complete integrity. The cause of the three leaks was found to be uneven seals on the capsules. Engineer Bud Fraze, who created the clever design of the entire multisealed biomodule, designed a device that can create uniform seals every time on the sample tubes. The tests were then repeated, and nothing leaked.

You can read more about the final impact and vibration tests in an article by Planetary Society Member Mark Gelfand at *planetary.org/programs/projects/life/*.

Collaborations with ATCC and DLR

A few months ago, the American Type Culture Collection, known as the ATCC, agreed to contribute its resources and expertise to the experiment. The nonprofit ATCC is the organization charged with storing and characterizing microorganisms for scientific uses in the United States, and it is where researchers go to obtain microorganisms for study. ATCC scientists are the experts at handling microbial samples as well as drying them for storage.

Having ATCC on board is a terrific boon to the LIFE experiment. ATCC will provide many of the microorganisms for the experiment and characterize them before and after the flight to determine how they were affected by exposure to deep-space conditions. ATCC will also load most of the samples into the individual sample tubes.

David Warmflash, our science principal investigator, Bud Fraze, and I visited the excellent facilities at ATCC in October, working out procedures for the upcoming tests and loading of biomodules (flight model, spare, and experimental controls to be kept on Earth).

We have also begun collaborations with a highly experienced team of scientists in Germany. Researchers from the German space agency, known as the DLR, have been flying bacteria on space missions for decades. The group, led by Petra Rettberg, has agreed to provide our experiment with two strains of bacteria that previously have flown in space in a near-Earth environment. Comparing them with the identical strains that have spent years in interplanetary space will be interesting additional science for the Phobos LIFE experiment.

Moving Toward Launch

Passing these crucial tests of the integrity of our experiment is quite a relief, and adding new collaborations to our team will enable the best possible experiment. The focus now is on testing the drying and loading procedures for the organisms. After that, we will load and seal the biomodule and deliver the organisms in their biomodule for their long cosmic round trip.

Stay up to date on our LIFE project at *planetary.org*.

Bruce Betts is director of projects for The Planetary Society.

What's **Up?**

In the Sky—December and January

Early in December, Venus and Jupiter—the two brightest planets—will appear close together in the sky in the west after sunset. Venus is the brighter of the two and gets higher in the sky, but Jupiter gets lower and harder to see throughout December. Saturn is high in the sky before dawn and will rise before midnight in the east by January. The Geminids meteor shower, often the best of the year, peaks on December 13; however, the almost full Moon will drown out the dimmer meteors. The Quadrantids peak on January 3 with less interference from the Moon but fewer meteors per hour. An annular solar eclipse occurs on January 26. At least a partial eclipse will be visible throughout most of southern Africa, southeastern Asia, and western Australia.

Random Space Fact

If you were holding a scale model Sun whose diameter was the size of this page (height, to be specific), Earth would be about the size of this letter "O" and would be located about 29 meters away.

Trivia Contest

Our May/June contest winner is George Myers of Bronx, New York. Congratulations!

The Question was: Which astronauts have flown in space on seven separate flights?

The Answer is: Franklin Chang-Diaz and Jerry L. Ross.

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

Which two worlds in our solar system have significant atmospheres (with a surface pressure greater than 0.5 of Earth's surface pressure) that are mostly composed of nitrogen?

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 March 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*.

Members' **Dialogue**

Global Climate Change

Your lukewarm editorial response to the two climate change deniers in the September/October 2008 issue was disappointing, especially from a publication that consistently fills its pages with the pursuit of good science. In fact, the evidence for anthropogenic climate change is both wide and deep. Our scientific theory, observations, and modeling together produce a coherent and compelling case that our climate is changing (e.g., rising temperatures and sea level, retreating sea ice and glaciers, changing ecosystems) as a result of increasing concentrations of greenhouse gases generated by human activities (e.g., fossil fuel combustion and deforestation) and that these changes will grow in the future.

Natural processes and variability have been exhaustively examined and ruled out as the major causes of these changes. This case ultimately rests not on Mr. Gore's lectures or the IPCC's synthesis reports but, rather, on the accumulated results of decades of peer-reviewed research by thousands of scientists around the world, confirmed by their national academies and professional scientific societies. The only remaining scientific "controversy" is that perpetuated by those with either economic or political motivations or a poor understanding of the subject.

Ongoing research continues to illuminate the details of climate change and its impacts, but the real debate has shifted to the search for effective policy responses, for both mitigation and adaptation. And while no one is accusing humankind of "evil" intent for our past actions, history will surely judge us harshly if we refuse to act to correct our mistake.

—TIM BENNER,
Silver Spring, Maryland

Achieving The Dream

I am a new member of The Planetary Society. I joined because I saw it as one way not only to participate in, contribute to, and advocate the advancement of our knowledge of the universe we live in but also to get us closer to achieving the dream of space travel.

When I read the Members' Dialogue section of my first two issues of *The Planetary Report* (March/April and May/June 2008), I was shocked and concerned over the attitudes of some other members: a position they hold that human spaceflight is wholly unimportant and that only robotic space exploration holds any value. I would like to think that members of The Planetary Society were moved, like myself, to become members through a shared passion and vision for the future of humanity, which surely must extend beyond our small, lonely planet. If even such people do not advocate spending time, money, and effort on the truly noble and ultimate goals of human space travel and extraterrestrial colonization, what message does that send to others who do not share the same level of passion and vision?

I do understand that most members are citizens of the United States and that Americans do not, nor should they, want to carry the burden alone for the future of all of humanity. My own country's spending on space programs is dismally low in comparison. While I sincerely hope that will change—and I encourage all Canadians to push for increased spending on space programs—the truth is that Canada, like many other countries, does not have the same level of leadership or historical achievement in space exploration as the United States. Instead, we make modest contributions via NASA, which is seen by many throughout the world as the leader, or at least the coordinator and facilitator, of international programs. Decreased funding to NASA is just the excuse short-sighted politicians in other countries need to likewise decrease their already modest spending. If, however, Americans were to signal an increased interest in space programs and encourage international funding and cooperation, I believe that most other nations would follow and participate.

I hope that The Planetary Society and its members continue to inspire the people of Earth not only to explore other worlds but to go to other worlds and make homes there, carrying the dreams and stories of our collective whole with them for all time.

—PHILIP HACHEY,
*Ottawa, Ontario, Canada*a

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

World Watch

United States—The United States has elected a new president. Barack Obama will be coming into office with a mandate for change and a host of urgent economic priorities separate from the space program. We have been pleased with Obama's comments about space exploration and the importance of the U.S. space program. NASA occupies just 7 percent of the U.S. federal budget, but the public interest in new discoveries and achievements is immense.

Space has largely been a nonpartisan issue in U.S. politics. In late September, the Congress gave its bipartisan support to a NASA authorization bill that endorsed both a budget increase for NASA and a strong science and exploration program. It also directed new focus on Earth observation satellites that are necessary to understand and deal with global climate change. The Congress also gave bipartisan support to the international arrangements that will permit U.S. astronauts to fly on the Soyuz to the International Space Station after the retirement of the space shuttle and before the new Ares rocket is operational.

The additional budget support was in the congressional authorization bill, which does not actually *appropriate* funds to NASA. The real spending money comes in the appropriations bill, which actually gave NASA less money than was requested in the administration budget. Appropriations were part of a continuing resolution from Congress that set the spending level for fiscal year 2009 at the same level as 2008.

Most observers expected more money would be made available by the new Congress, which reconvenes in January, but that was before the economic crisis that has now gripped the world. Budget pressures will be enormous as other priorities dominate the political agenda, and there is a real chance that plans for future space exploration will be set back. Now, more than ever, The Planetary Society will need all of our members to support continued space exploration in the coming year.

***Cover of* Beyond the Moon: A New Roadmap for Human Space Exploration in the 21st Century.**

The Society released its plan for the U.S. space program, *Beyond the Moon: A New Roadmap for Human Space Exploration in the 21st Century*, for consideration by the new administration and Congress. We have asked Planetary Society members and supporters to endorse the principles of our Roadmap to Space. You can find the roadmap online at *planetary.org/roadmap*, where you can also endorse our plan. With your help, we can provide the strongest possible testimony to government decision makers (in the United States and around the world) on behalf of a vital and worthy new age of exploration of the solar system.

Glasgow, Scotland—Planetary Society Vice President Bill Nye the Science Guy® and I went to the International Astronautical Federation (IAF) Congress in Glasgow, Scotland. Nye moderated two plenary panels—one on the International Space Station and one on the future of human space exploration. I presented a paper, coauthored with Jacques Blamont of France, about a new paradigm for international cooperation in space. Blamont, a member of the Society's Advisory Council, also presented a paper advocating an International Lunar Base.

Scott Hubbard, a member of our board of directors, spoke at the conference about the workshop the Society organized with Stanford University titled "Examining the Vision for Space Exploration." His paper about the workshop results and the paper by Blamont and me can all be found on the Space Advocacy section of the Society's website at *planetary.org/programs/ projects/ space_advocacy/*.

Current events loomed large while we were in Glasgow. The Chinese completed their third human space flight, this one with an extravehicular activity (EVA). Li Ming presented pictures and movies from the flight. The European *Jules Verne* space station supply vehicle re-entered the Earth just as predicted, during the opening event at the conference. Also exhibited at the conference were the high-definition movies of the Moon taken by the Japanese *Kaguya* spacecraft.

While in Glascow, Nye and I met with young professionals from the Space Generation Advisory Council and with the Students for Exploration and Development of Space. We also conducted a Town Hall meeting—the fourth in our series of such public meetings—to learn about public attitudes toward space policy, human and robotic spaceflight, and government and private space ventures.

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

Questions and Answers

Do we know if the rust-colored iron oxide on Mars is just a surface phenomenon, or does it extend through the planet's crust? If it is just on the surface, does that suggest the past presence of an atmosphere rich in oxygen in which the organisms or other processes creating the oxygen ceased to function and the free oxygen in the atmosphere oxidized the soil and rock of Mars? Or is the concentration of surface oxides nothing special and explained by the natural ratios of elements in the planet's surface?
—Andy Majot
Sellersburg, Indiana

Planetary scientists are working at understanding the amount of iron on the surface and in the interior of Mars, as well as its oxidation state.

We know that Mars has a significant amount of iron in its interior because the planet's density is significantly higher than that in average silicon-bearing rocks. It also appears that Mars once had a strong magnetic field, which was likely formed from a spinning, partially molten, iron-rich core early in its history.

Based on laboratory studies of rocks and minerals at high pressures and temperatures, most of the iron in the mantle and core of Mars probably has not oxidized very much, if at all. Rather, it likely occurs as either *native* iron or *ferrous* iron bound into silicate minerals such as olivine, which is common on all the terrestrial planets. Ferrous iron oxides like that are not rust-colored.

Rust-colored iron oxides contain *ferric* iron, which forms when native iron or ferrous iron minerals are oxidized. The oxidation can easily occur by chemical reactions involving free oxygen in an atmosphere, but ferric iron also can be created using oxygen liberated from water during weathering or generated by ultraviolet light breakdown of minerals or atmospheric gases such as carbon dioxide (which is abundant on Mars). The important point is that an atmosphere rich in oxygen is not necessarily required to explain the presence of iron oxides.

The action of water and ultraviolet light does not extend very far into the interior of Mars, so ferric iron on the planet is probably mostly a surface and shallow crustal phenomenon. For example, the famous Martian dust contains some ferric iron. Some scientists think that the dust is just tiny

Factlets

The* Mars Reconnaissance Orbiter *has detected rocks containing a hydrated mineral similar to opal on the surface of the Red Planet. The relatively young rocks—shown here as the light-colored strip moving down the center of this false-colored image—indicate that liquid water existed on Mars' surface as recently as two billion years ago. *Image: NASA/JPL/University of Arizona*

The *Mars Reconnaissance Orbiter* (*MRO*) has observed a new category of minerals spread across large regions of Mars—opals. This discovery suggests that liquid water stayed on the planet's surface a billion years later than scientists previously believed.

Data from the orbiter's Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) show evidence of hydrated silica, commonly known as opal. The hydrated, or water-containing, mineral deposits are telltale signs of where and when water was present on ancient Mars.

"This is an exciting discovery because it extends the time range for liquid water on Mars, and the places where it might have supported life," said *MRO* team member Scott Murchie of Johns Hopkins University's Applied Physics Laboratory. "The identification of opaline silica tells us that water may have existed as recently as 2 billion years ago."

Until now, only two major groups of hydrated minerals, phyllosilicates and hydrated sulfates, have been observed on Mars. The newly discovered opaline silicates are the youngest of the three types of hydrated minerals. They formed where liquid water altered materials created by volcanic activity or meteorite impacts on the Martian surface.

"We see numerous outcrops of opal-like minerals [see image at left], commonly in thin layers extending for very long distances around the rim of Valles Marineris and sometimes within the canyon system itself," said Ralph Milliken of the Jet Propulsion Laboratory. Milliken is lead author of an article detailing the discovery in the November 2008 issue of *Geology*. The study reveals that the minerals, which also were found recently by *Spirit* in Gusev crater, are widespread and occur in relatively young terrains.
—from the Jet Propulsion Laboratory

flakes of what was only a thin, mildly oxidized surface coating on volcanic rock surfaces; others think that the dust is the worn-down and weathered remains of extensively oxidized ancient crustal rocks.

The debate goes on, with new results on the planet's chemistry and mineralogy arriving (literally) daily from the fleet of orbiters, rovers, and landers now studying the Red Planet.
—JIM BELL,
Cornell University

My question regards* Voyager 2*'s crossing of the termination shock at the outer edge of our solar system, where the solar wind slows down to subsonic speed. But doesn't the speed of sound depend upon the temperature and pressure of the medium through which it travels? Isn't this area of space pretty much a vacuum? How do scientists calculate subsonic speed in a vacuum? Also, what is the sound speed out there?
—Dave Hall
Laurel, Maryland

This can be confusing, and for that reason, the discussion is often simplified by using the familiar term *supersonic*, which means the wind speed is faster than the speed of sound waves. If a wind is moving away supersonically, a sound wave is carried outward faster that it can travel inward.

There are actually two kinds of waves that propagate in the solar wind: sound waves and Alfven waves. The latter are waves that travel along magnetic field lines much like waves traveling along a string that has been plucked. The sound waves are also affected by the magnetic field and are referred to as *magnetosonic* waves. The solar wind is faster than both kinds of waves, so it is both *supermagnetosonic*— that is, it is both supersonic and super Alfvenic—and is often informally described as supersonic.

Although the vacuum of space is deeper than any vacuum found on Earth, it is actually filled with a very dilute plasma of solar wind ions, so there are incredibly weak sound waves there. At about 80 astronomical units (AU, the distance between Earth and the Sun, which is 150 million kilometers or 93 million miles), the temperature of the solar wind plasma is roughly 10,000 kelvins (about 9,700 degrees Celsius or 17,500 degrees Fahrenheit) and the sound speed is about 10 kilometers (6 miles) per second. The speed of Alfven waves is approximately 40 kilometers (25 miles) per second. So, at 300 to 400 kilometers (about 190 to 245 miles) per second, the solar wind is indeed faster than the waves.

As it happens, *Voyager* found that the story is more interesting and more complicated than what I have described. In addition to the dilute plasma of solar wind ions that can propagate sound waves, there is also a dilute plasma of interstellar ions that is "hotter" and has a higher sound speed. Even so, the solar wind is faster than all these waves upstream of the shock (supersonic) and slower than the fastest waves downstream (subsonic), where plasma is hotter. As a result, waves can propagate upstream in the heliosheath (the outer edge of the heliosphere, the area under the Sun's influence) but not in the solar wind.
—ED STONE,
California Institute of Technology

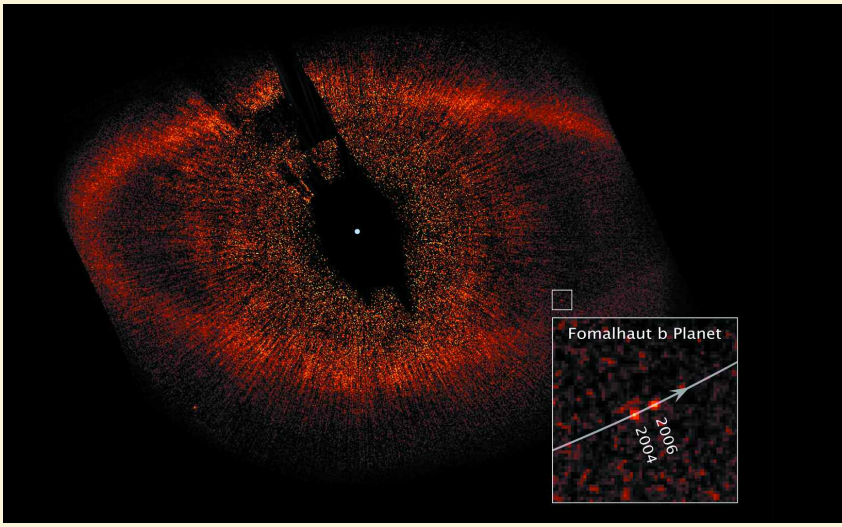
The Hubble Space Telescope (HST) has given us the first visible-light picture of a planet around another star (see image at right). The planet, which scientists estimate to be no more than three Jupiters in mass, is called Fomalhaut b. It orbits the bright southern star Fomalhaut, located 25 light-years away in the constellation Piscis Australis (the Southern Fish).

In 2004, Paul Kalas of the University of Berkeley and his team used HST to produce the first-ever resolved visible-light image of a large dust belt—a ring of protoplanetary debris with a sharp inner edge—around Fomalhaut. The ring is about 35 billion kilometers (about 22 billion miles) across and is similar to our own Kuiper belt in that it contains icy bodies ranging in size from dust grains to dwarf planets such as Pluto.

In 2005, the researchers proposed that the ring was being gravitationally modified by a planet lying between the star and the ring's inner edge. Now they have used HST to photograph a point source of light lying 2.9 billion kilometers (1.8 billion miles) inside that inner edge.

"Our Hubble observations were incredibly demanding. Fomalhaut b is one billion times fainter than the star. We began this program in 2001, and our persistence finally paid off," Kalas says.

For more details on this story, visit *planetary.org/news/2008/ 1114_ Scientists_Lay_Eyes_on_Distant_Planets.html*.
—from HubbleSite



The Hubble Space Telescope has captured the first visible-light image of an extrasolar planet. The white dot at the center of this image is Fomalhaut, a young southern star 25 light-years away. The small white box at lower right shows the position of the planet, Fomalhaut b, in relation to its parent star. The larger white box surrounds a composite image showing Fomalhaut b's position in Hubble observations from 2004 and 2006.

Image: NASA, ESA, P. Kalas, J. Graham, E. Chiang, E. Kite (University of California, Berkeley); M. Clampin (Goddard Space Flight Center); M. Fitzgerald (Lawrence Livermore National Laboratory); and K. Stapelfeldt and J. Krist (Jet Propulsion Laboratory)

Society News

End-of-Year Giving: Your Way to Win

A gift to The Planetary Society does double duty: you support the Society, and you invest in the future of space exploration. The Planetary Society offers you various gift-giving options and, for those of you in the United States, potential tax savings.

Unrestricted gifts are always welcome. We'll put your generous contribution to work where it's most needed.

Have a special interest in one of our projects? Your donation—large or small—will make a difference. Choose the project or program area that intrigues you.

A tribute gift is a terrific way to congratulate a colleague, honor a friend, or celebrate the memory of a loved one.

• *Your gift of cash*—by credit card or check—will support our search for other life and other worlds and our quest to better understand our planet.

• *You might also consider donating your appreciated stock*—just let us know you are making the transfer—and know that you are investing in future space science and exploration.

• *If your employer offers a matching gift program*, please multiply the impact of your gift by having your gift matched.

You can donate securely online with a click of the button at *planetary.org/join/donate.html*, or you can mail your gift to The Planetary Society headquarters at 65 N. Catalina Ave., Pasadena, CA 91106-2301 USA.

Please call me at (626) 793-5100, extension 214, or e-mail me at *andrea.carroll@ planetary.org* if you have questions.

No matter the size, your gift makes a difference. Together, we are shaping space exploration.

Thank you, and best wishes from all of us for the coming year!
—Andrea Carroll,
Director of Development

A Fitting Gift: A Gift of Membership

Not quite sure if your friend or nephew wears a size medium or large? But sure that he or she is wild about space?

A Planetary Society gift membership will fit perfectly!

It's the perfect way to wrap up a year's worth of space exploration, advocacy, and discovery.

Your fellow space explorer will receive a personalized gift card with your special note, and we'll follow that with a welcome packet, a personalized membership card, and our acclaimed magazine, *The Planetary Report*.

You can make your gift securely online at *planetary.org/join/ membership/gift.html*, or you can e-mail us at *tps@planetary.org* or call us at (626) 793-5100 to make your membership gift.

This is one gift that is sure to fit, and one that you'll feel good about giving. *—AC*

Special Discount Offer—Save Money While Supporting The Planetary Society

Phlare, Inc.—producers of educational space science products—is offering a 15 percent discount to Planetary Society members who purchase their products. In addition, Phlare will donate 15 percent of the purchase price to The Planetary Society to support Society programs.

Phlare produces beautiful educational products that cover the Moon, Mars, the solar system, and beyond. Products include a Mars map and information sheet and question-and-answer cards about the solar system, the Moon, and the discoveries of the Hubble telescope. Phlare also has a line of note cards that showcase imagery from Hubble, *Cassini*, and the Mars Exploration Rovers.

To receive the discount, and to ensure the donation goes to The Planetary Society, place your order at *www.phlare.com* and use the code **PlanSociety** during checkout. (The code goes in the text field under Gift Vouchers/Discount Coupons.) You will see 15 percent deducted from your total price, and The Planetary Society will receive 15 percent of the nondiscounted price.

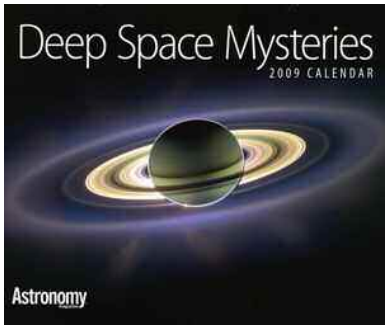
Unique gift ideas

Pale Blue Dot Poster
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**

Surf Titan T-Shirt
A Planetary Society classic—we 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**
Regular price: $22.22 **Member price: $20.00**

Target Earth T-Shirt
We live in a busy solar system! The dangers our planet faces from near-Earth objects (NEOs) are the focus of The Planetary Society's Target Earth program. From our Apophis Mission Design Competition and our campaign to save the Arecibo telescope's radar tracking of NEOs to the Society's ongoing Gene Shoemaker Near-Earth Object Grants, we're helping to prepare Earth to avoid disaster from the skies. Adult sizes: S, M, L, XL, XXL 1 lb. **#598**
Regular price: $22.17 **Member price: $19.95**

Deep Space Mysteries: 2009 Wall Calendar
Each month, enjoy awe-inspiring, full-color images from deep space. This 2009 wall calendar is produced by the creators of *Astronomy* magazine.
2 lbs. **#520**
Regular price: $12.50
Member price: $11.25



An Explorer's Guide to Mars Poster
24" x 37" 1 lb. **#505**
Regular price: $16.95 **Member price: $15.25**

"Is Anybody Out There?" Poster
39" x 16" 1 lb. **#320**
Regular price: $15.00 **Member price: $13.50**

Nebula Poster
22" x 34" 1 lb. **#315**
Regular price: $15.00 **Member price: $13.50**

Set Sail for the Stars! Poster
22" x 34" 1 lb. **#571**
Regular price: $15.00 **Member price: $13.50**

"Dusters" Stardust@home T-Shirt
Adult sizes: S, M, L, XL, XXL 1 lb. **#585**
Regular price: $22.22 **Member price: $20.00**

"Is Anyone Out There?" T-Shirt
Adult sizes: S, M, L, XL, XXL 1 lb. **#586**
Regular price: $22.17 **Member price: $19.95**

SETI@home Mug
2 lbs. **#550**
Regular price: $11.11 **Member price: $10.00**

Planetary Society Cap
1 lb. **#673**
Regular price: $15.00 **Member price: $13.50**

Planetary Society Key Ring Medallion
1 lb. **#677**
Regular price: $17.78 **Member price: $16.00**

Planetary Society Lapel Pin
1 lb. **#680**
Regular price: $3.33 **Member price: $3.00**

We're Saving Space for You! Bumpersticker
1 lb. **#695**
Regular price: $3.33 **Member price: $3.00**

***Planetary Report* Binder**
Each hardcover binder will hold two years worth of issues. 2 lbs. **#545**
Regular price: $16.11 **Member price: $14.50**

***Special Value*—order two binders for $25.00**
($27.78 for nonmembers)!

Spacecraft Science Kits
Build your own spacecraft and learn how it works. All models are accurate representations of the robots now exploring the universe. Intricate, laser-precut paper elements make these models highly detailed yet easy to assemble. All models contain details such as trusses, baffles, and even movable scan platforms and are accompanied by fact sheets giving the particulars of the mission. Each sold separately. 1 lb.
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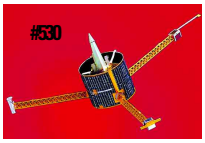
#525 Hubble Space Telescope
#530 ***Lunar Prospector***
#560 ***Voyager***



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Attention, teachers—submit your order on your school letterhead and receive a 20% discount.

Perhaps, as we plan our next ventures off Earth and into the near solar system, astronauts from another world in our galaxy are just starting to explore their planetary neighborhood. In *The Biggest Step*, these alien explorers have set foot for the first time on the rocky, frozen terrain of their home world's nearest satellite.

Frank Hettick has been creating visions of space since 1952 in oils, acrylics, and, more recently, digital format. He is a member of the International Association of Astronomical Artists and is the owner of Sky-High Galleries near Bend, Oregon.

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