# The PLANETARY REPORT

Volume XXV Number 1 January/February 2005

## Nature's Canvas

A PUBLICATION OF THE PLANETARY SOCIETY

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## From The Editor

Carl Sagan, cofounder of The Planetary Society, dated our existence as an organization from the publication of the first *Planetary Report* in December 1980. If you do the math, you'll see that this year marks the silver anniversary of The Planetary Society.

And so . . . it's time to party!

Right now, we are scheduling an array of 25th anniversary events that will take place around the world and will range in size from gatherings in coffeehouses to a gala dinner and beyond. Our goal is to involve every Society member in the celebrations. After all, The Planetary Society is nothing but its members—combined into a strong force to achieve our ultimate goals of exploring other worlds and seeking other life.

We do have a lot to celebrate. From the searching for putative Vulcanoids inside Mercury's orbit to saving a spacecraft bound for Pluto, The Planetary Society has come through time and time again. We've focused our efforts on projects that can make almost unimaginable differences to life on Earth, from seeking possibly life-destroying asteroids to searching for civilizations among the stars. What other group can you think of that has set such lofty goals and achieved so much in pursuing them?

We celebrate each other, joined together, as The Planetary Society. Let's start the party now.

—*Charlene M. Anderson*

### On the Cover:

In a portrait created by light and gravity, lonely Mimas is visible against the cool, blue-streaked backdrop of Saturn's northern hemisphere. Delicate shadows cast by the rings arc gracefully across the planet, fading into darkness on Saturn's night side. Images taken with red, green, and blue filters were combined to create this color view. The images were taken with *Cassini*'s Narrow-Angle Camera on November 7, 2004 from a distance of 3.7 million kilometers (2.3 million miles) from Saturn. The image scale is 22 kilometers (14 miles) per pixel. Image: NASA/JPL/Space Science Institute

## Features



## Departments



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# Members' Dialogue

## More Sound Off

As the debate continues, I would hope that colonization is left out as a reason to send people to other planets. One recent letter cited "massive climate change" as a reason to colonize Mars. A massive disruptive climate change on Earth amounts to a few degrees Celsius, or a latitude shift of a few hundred miles. And to escape that we would make a trip of several months to live in a frozen vacuum with no tolerable climate other than what could be artificially created? It's easier to do that here.

And the arguments that humans must be there to really observe and explore don't wash. Humans are not very good observers. They can't see anything outside their limited visual spectrum, they can't see microscopic items, they can't ascertain chemical composition, and they have no means to make other key observations except with special instruments and tools. These tools can just as well be carried by robots that don't have the weight and maintenance penalties of human caddies.

The International Space Station (ISS) has shown us that many of the technical arguments for the usefulness of a facility with microgravity and a good vacuum just aren't worth the expense. Scientists are scrambling to find something of benefit that can be done there. Meanwhile, support has lagged to the point where most of the work done on the ISS is just plain ISS maintenance.

The benefits to ordinary people from the *Apollo* program have been huge and should be better publicized. More recently, government funding of "Star Wars" military programs has continued to have vast beneficial fallout such as global positioning system navigation, and satellite monitoring of weather and natural resources. So I am in favor of the government supporting an active space program, but let's argue for it from a foundation that makes sense. In the risk-to-reward ratio, [putting] people on Mars is off the charts.

—DAN LeMAY,
*Fallbrook, California*

As a Planetary Society member for several years, I am disturbed by what seems to be a lack of vision (imagination, if you prefer) on the part of some members. Lack of vision in an organization such as The Planetary Society is, indeed, almost chilling.

Of course robotic exploration has to come first and, in some cases, is all that's possible at the moment, as in the New Horizons mission to Pluto and the Kuiper belt—which I fully support. The current robotic missions to Mars are highly worthwhile and necessary. But to suggest that our exploration should be limited to robot probes is to sell the future short. Numbers of studies have indicated that a group of trained men and women could do much more valuable work and do it much faster, for example, on the surface of Mars.

There seems to be some idea that we have all the time in the world to start constructing a spacefaring society, that we can let our grandchildren do it. That is simply not true. As Sir Patrick Moore noted in his recent book *Futures*, there is a window of opportunity for going into space, and that window will not remain open indefinitely. Somewhere along the line, going back to the Moon will become so costly in money and resources that it will become effectively impossible. If and when that day comes, we will have lost the last and greatest frontier and, quite possibly, the future of our civilization as well.

—JAMES S. VELDMAN,
*Joliet, Illinois*

And the debate goes on. It is moot to argue over which is best. In some cases, robotic exploration will seem advantageous for the purpose or place. At other times human expeditions will seem more logical. We can't afford to write off either case. Let's have our logic come into play, but let's not simply take sides for mere opinion's sake.

—MIKE MARTINEZ,
*Lakeland, Minnesota*

## Editors' Note:

*A handful of our members tell us their November/December issues of* The Planetary Report *arrived with pages missing. If your copy is missing pages, please call or e-mail us for a replacement copy at (626) 793-5100, extension 219, or* jennifer.vaughn@planetary.org

*We apologize for the inconvenience.*

*—Jennifer Vaughn,*
*Director of Publications*

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# We Make It Happen!

by Bruce Betts

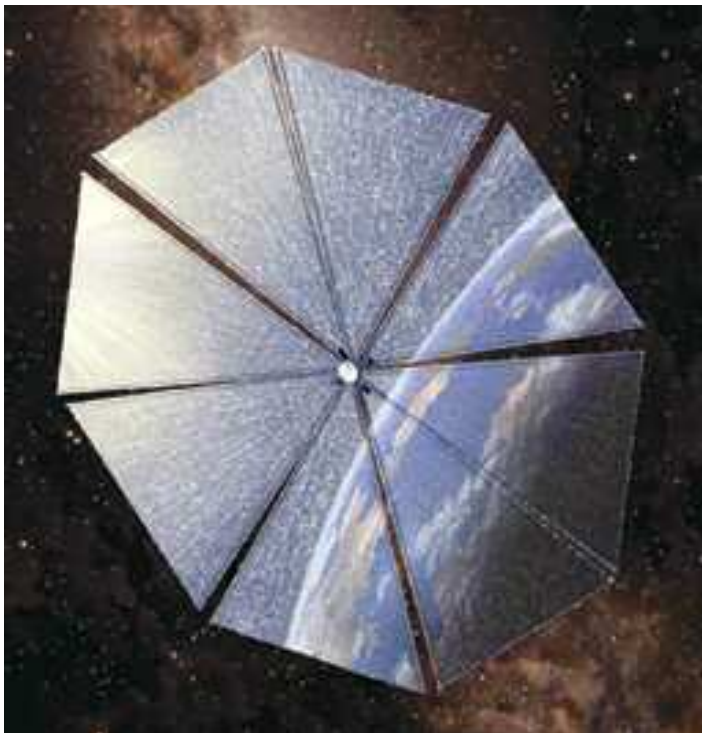
## You Can See the Solar Sail

The Planetary Society's *Cosmos 1* solar sail is now scheduled to launch on March 1, 2005, or within the month or so afterward (see the November/December 2004 issue of *The Planetary Report*). Planetary Society members made this mission happen, and you will be able to follow the progress of the mission on our website and read about it in *The Planetary Report*. You also have a chance to have a more personal experience with the mission—go out and try to see it! Shortly, we'll be debuting our Solar Sail Watch, which will provide information that will allow you to try to see the solar sail in the night sky.

## Look Up in the Sky!

If you haven't ever gone out to see a satellite pass overhead, please do so. It's big fun. Satellites are best seen in the early evening or shortly before dawn—that is, when you are in the dark but the satellite is still in the light. They look like stars moving across the sky, like airplanes without blinking lights.

Until *Cosmos 1* flies, the brightest spacecraft to see is the International Space Station. It is often nearly as bright as the brightest star in the sky. You can also see a variety of other spacecraft, such as the Hubble Space Telescope, and a variety of old rocket bodies and other space "junk." These objects vary in brightness depending on their size, shape, and composition, but many are as bright as moderately bright stars (many around magnitude 3).



***The Planetary Society's* Cosmos 1 *solar sail spacecraft is set to launch in March 2005.*** *Illustration: Rick Sternbach, Space Model Systems*

## It's a Satellite . . . It's a Spacecraft . . .

We'll have an online section at *planetary.org* on how to observe satellites, so check it out. It will also include details on observing *Cosmos 1*. How will you know when and where to look? After all, neither *Cosmos 1* nor any of the other satellites will be visible every evening at a time that works for satellite viewing. You may have to wait a couple of weeks or more to see the spacecraft you're after. You also still need the exact time and direction to look. And, by the way, information on viewing satellites is localized. The satellites typically are only 400 to 800 kilometers (250 to 500 miles) overhead, so just because your buddy a few hundred kilometers away can see it one evening doesn't mean you can.

To solve all this, we are partnering with the website *www.heavens-above.com*, which allows you to determine which satellites are visible from your location, when, and where. You can learn all the details of how to view on our website, then hop on over to theirs for the latest predictions for your area. They will get the latest information on which to base their predictions directly from our project operations.

## It's *Cosmos 1*

The location of *Cosmos 1* at any given time will be well known. What is tougher to predict is its brightness. In the ideal geometry, with the sails fully deployed and acting like mirrors reflecting light to your hometown, *Cosmos 1* could be brighter than the full moon but concentrated in a starlike spot. But edge on, it could be barely visible. More typically, it probably will appear like a bright star.

## Be Clark Kent

If you want to take the next step in your observations, you'll be able to submit them to our website and help us not only with brightness predictions but also with compiling additional data on *Cosmos 1* in general. But don't just tell us about it . . .

We'll be having a photo contest. Go out and try to capture a photo of *Cosmos 1* as it passes overhead. You can catch it as a streak of light passing across the sky with any camera that allows you to leave the shutter open for a few seconds. Those of you with cameras on telescopes may be able to actually take pictures that resolve the spacecraft. This has been achieved with objects like the International Space Station. Either way, take your participation in the mission to yet another level by entering our photo contest.

Information on all aspects of *Cosmos 1* and our Solar Sail Watch can be found on our website, *planetary.org.*

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*Bruce Betts is director of projects at The Planetary Society*

# What's **Up?**

## In the Sky

All five naked-eye planets will be visible through the first half of January in the predawn sky! Venus will look like the brightest star in the sky before dawn in the east. Mercury will be very close to Venus, looking like a bright star but much dimmer than Venus. Mars will appear dimmer and reddish to the upper right of Venus and Mercury. By mid- to late January, Mercury and Venus will be so low on the horizon at dawn that they no longer will be visible. Jupiter, also bright, will be to Venus' upper right. Saturn will outshine the nearby Gemini "twin" stars Castor and Pollux. Saturn will rise around sunset and set around sunrise, being at opposition (opposite the Sun from the Earth) on January 13. Saturn's rings will be visible in small telescopes. The five planets appear nearly in a line because they all orbit in approximately the same plane.

## Random Space Fact

There are guidelines for feature names on each body in the solar system. For example, almost all features on Venus are named for real or mythological women, features on Uranian satellites are named primarily after Shakespearean characters, and channels on Mars take the name for Mars in various languages.

## Trivia Contest

Our September/October contest winner is Brenda Molnar of Glendale, Arizona. Congratulations!

The Question was: What was the first spacecraft to image the far side of the Moon?

The Answer: The Soviet *Luna 3* spacecraft in October 1959.

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

***To the nearest micron (micrometer, or one millionth of a meter), how thick is the Mylar-like material that makes up the solar sails on The Planetary Society's* Cosmos 1 *spacecraft?***

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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 April 1, 2005. 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*

# Exploring the UNKNOWN: Huygens' Plunge

In many respects, a journey to Saturn is a journey back to the origins of the solar system. Saturn's rings and moons are a model of the archetypal solar system, when fragments of rock and ice collided with one another and melted on a grand scale. Titan, Saturn's most interesting moon, is thought to bear similarities to the primeval Earth in its frozen state. Titan exhibits complex organic chemistry in its atmosphere and on its surface, and the building blocks of life may have been preserved on Titan, though they did not evolve in the moon's cold and hostile environment. The environment certainly is an intriguing place, where time appears to have stood still for billions of years.

*Cassini-Huygens* is one of the most ambitious efforts in planetary space exploration ever mounted. The mission calls for a sophisticated robotic spacecraft to orbit the ringed planet over a 4-year period and for a scientific probe called *Huygens* to be released from the main spacecraft, parachute through Titan's atmosphere, and eventually touch down on its surface. Six instruments on *Huygens* will provide the first direct and detailed sampling of Titan's atmospheric chemistry and the first detailed images of its hidden surface.

## Mysterious Titan

Titan, Saturn's largest moon, truly is a fascinating world. It is freezing cold, with temperatures reaching about –180 degrees Celsius (–290 degrees Fahrenheit), and it

# Through Titan's Atmosphere

by Jean-Pierre Lebreton

***Left:** The date is January 14, 2005, and the place is Saturn's largest and most mysterious moon, Titan.* **Huygens,** *Europe's first spacecraft to land on another world, has just splashed down into a cold hydrocarbon sea and is telling us what it has seen along the way.* **Cassini** *has allowed us to peer at Titan's surface through the heavy curtains of its atmosphere. Now* **Huygens** *will let us step past those curtains and see Titan's surface up close for the first time.* **Xanadu Joyful Day** *was painted by Daniel Chiesa of Montevideo, Uruguay. He is one of the adult first-place winners in The Planetary Society's recent contest "Imagining Titan: Artists Peer Beneath the Veil." To see all the winning entries and to read about their creators, visit* **planetary.org/saturn/artcontest.html**

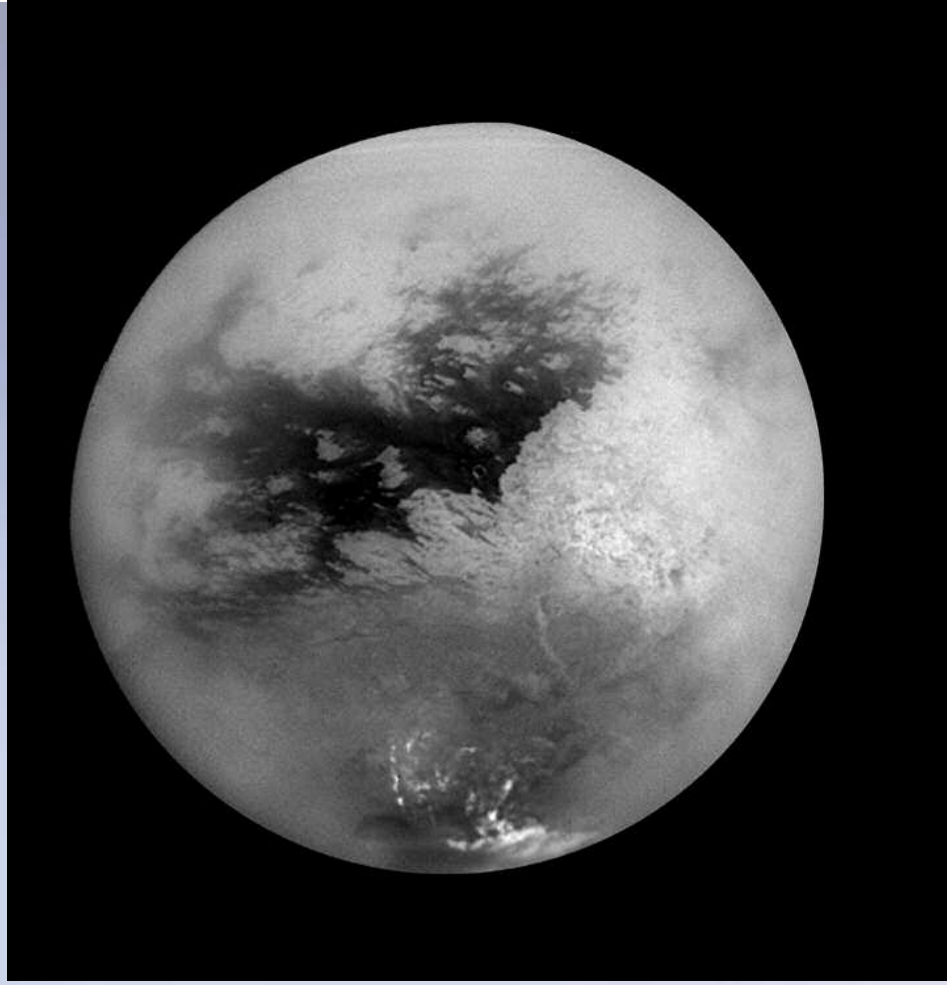
***Right:*** **Cassini** *images have detected a surprising number of haze layers in Titan's upper atmosphere, as revealed in this ultraviolet image of the heavily veiled moon's nightside limb. The many fine haze layers extend several hundred kilometers above the surface—about a dozen distinct haze layers are visible in this image, which has a scale of 0.7 kilometers (0.43 miles) per pixel. Although this is a nightside view, with only a thin crescent receiving direct sunlight, the haze layers are brightened by light scattered through the atmosphere. The image, taken with* **Cassini***'s Narrow-Angle camera, has been colorized to look like true color.*
*Image: NASA/JPL/Space Science Institute*

has a thick atmosphere. Although its origin remains unknown, the atmosphere consists mainly of nitrogen, just like Earth's, and is rich in compounds of carbon and hydrogen that are constantly reacting. In particular, methane ($CH_4$) constitutes a few percent of the atmosphere and is continuously replenished by a mechanism still not understood.

Titan's orange haze and clouds are so opaque that the surface can be seen only when looking through infrared atmospheric "windows." The haze is created by sunlight and cosmic rays breaking down the methane in the moon's atmosphere and producing a range of complex organic compounds that float down to the surface and accumulate over time.

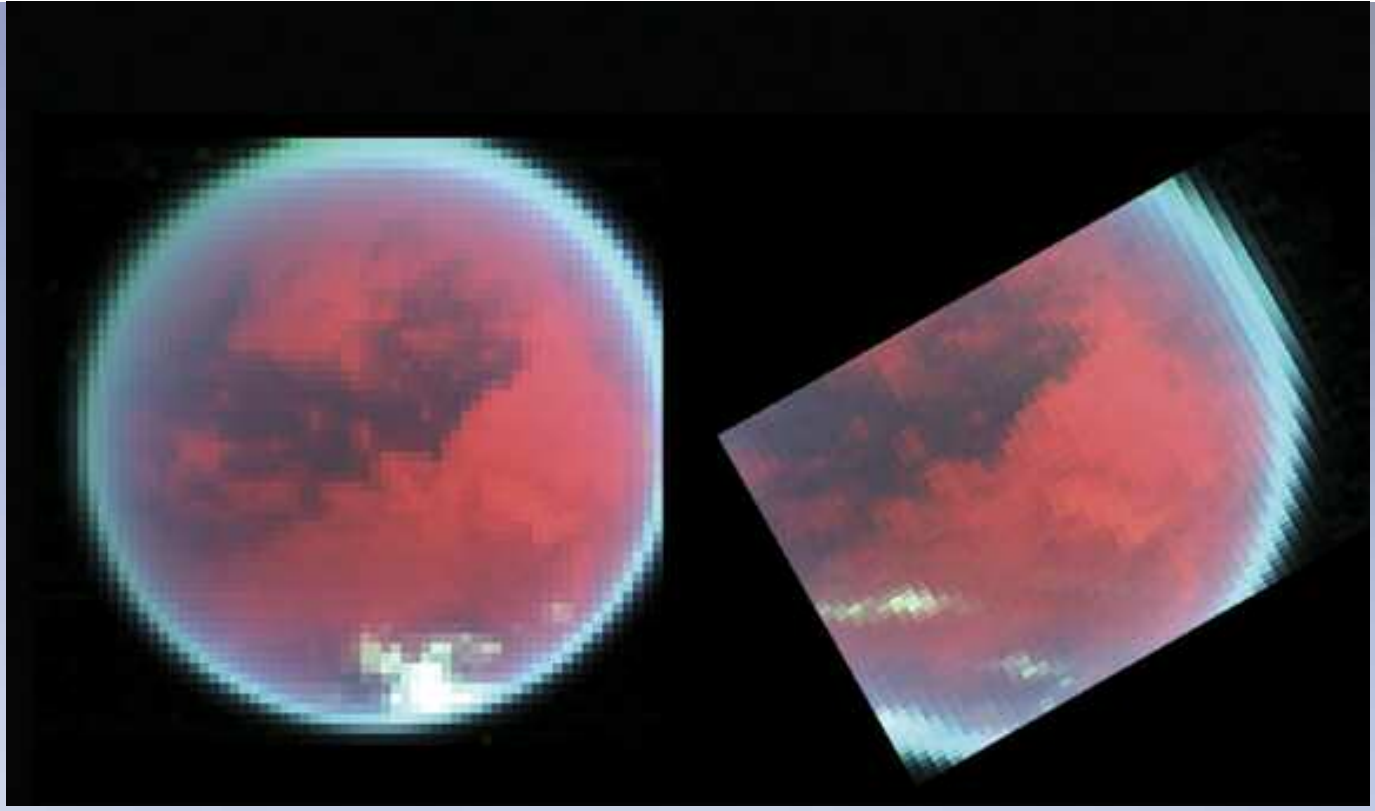
Like Earth, Titan has a greenhouse-warmed climate, but it is sustained by different gases. Volcanoes and impacts shape the surface and perhaps provide energy to make even more complex organic molecules. The surface is far too cold for water to exist for prolonged periods in liquid form; however, it could exist for relatively short periods because of the heat generated by volcanism or asteroid impacts. Very little is known about the moon's surface, and scientists speculate that *Huygens* may find lakes or seas of a mixture of liquid ethane, methane, and nitrogen, or even underground reservoirs. The pressure and temperature on Titan's surface are adequate to liquefy these natural gases.

Both *Cassini* and *Huygens* will look at Titan, and



*This mosaic of nine images captured during* Cassini*'s first very close Titan flyby on October 26, 2004 is the best, most detailed full-disk view we have so far of this haze-covered world. The images that make up this mosaic have been processed to reduce the effects of the atmosphere and to sharpen surface features. The Sun was behind* Cassini *as it captured these images, so nearly the full disk is illuminated. Scales of the composite images vary between 2 and 4 kilometers (1.2 to 2.5 miles) per pixel. The images were taken at distances ranging between 650,000 and 300,000 kilometers (400,000 and 180,000 miles). Surface features are most clearly visible near the center of the disk, where the spacecraft was looking directly downward. Scientists are debating what processes created the bizarre surface brightness patterns seen at the right-side equatorial region here. Although the images hint at a young surface with no obvious craters, the exact nature of the patterns' geologic origin remains unknown.*
*Mosaic: NASA/JPL/Space Science Institute*

*This composite of false-color images was taken by* Cassini*'s Visual and Infrared Mapping Spectrometer (VIMS) less than 2 hours before closest approach on October 26, 2004. The bright white area at bottom is the methane cloud at the south pole, and the inset illuminates and points out the landing site for* Huygens.
*Image: NASA/JPL/Space Science Institute*



***Evidence of Titan's changing weather is visible in these false color VIMS images taken on October 26, 2004 (left) and December 13, 2004 (right). The view at right shows some streaky clouds that appeared at temperate latitudes sometime during the intervening weeks. By tracking these clouds, scientists hope to gain more insight into Titan's global circulation, regional weather patterns, and meteorology. These clouds should not be confused with the methane clouds at the south pole.*** *Images: NASA/JPL/Space Science Institute*

their combined data will greatly improve our understanding of this mysterious moon. They will study its atmospheric chemistry and investigate the energy source that makes it so active. They also will look into Titan's weather, measuring winds and temperatures, monitoring cloud physics and circulation, and observing lightning and seasonal changes as well as possible climate changes.

## Cassini's First Look at Titan

The *Cassini* camera observed Titan over a period of several months while approaching Saturn. It obtained a composite image of Titan's surface that confirmed the main features seen in the Hubble Space Telescope observations in 1994 and later in ground-based adaptive-optics infrared images.

*Cassini* arrived at Saturn on July 1, 2004, and only 31 hours after it went into orbit, *Cassini* observed Titan at a distance of less than 340,000 kilometers (210,000 miles). This observational opportunity, called "Titan-0" or "T0" (revolution 0 is defined as the point *Cassini* entered orbit about Saturn to its farthest point in that first orbit), enabled us to acquire a unique data set of Titan using the four optical remote-sensing instruments aboard *Cassini*, namely the Imaging Science Subsystem (ISS), Visual and Infrared Mapping Spectrometer (VIMS), Composite Infrared Spectrometer (CIRS), and Ultraviolet Imaging Spectrograph (UVIS). Highlights include observations of the methane polar cloud, which seemed to vary over a matter of just a few hours, and VIMS-captured data for a composite map of Titan's surface with approximately 150-kilometer (90-mile) resolution.

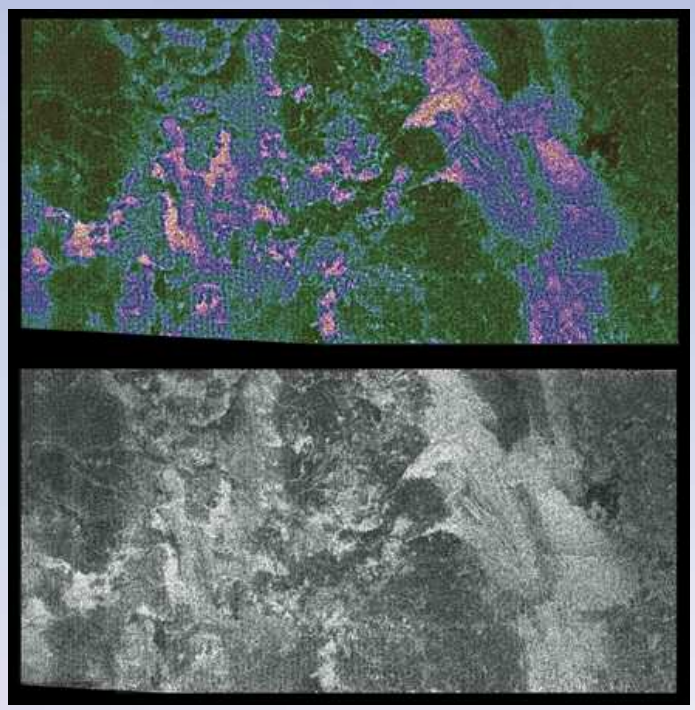
One of the main goals of the T0 observations was to obtain a data set that would confirm the model of Titan's atmosphere that we used to design the *Huygens* probe's entry and descent, especially in the stratosphere—the altitude range between 150 and 400 kilometers (90 and 250 miles)—where the probe would first brake and where its parachutes would be deployed. The new *Cassini* data were analyzed in combination with recent ground-based observations, and they confirmed that the atmosphere at the time of the T0 flyby was similar to the model used for *Huygens*, although it was slightly warmer and denser than our reference model.

*Cassini* completed two low-altitude flybys of Titan at a height of 1,200 kilometers (750 miles) on October 26 and December 13. The data from those flybys were used to further validate the moon's atmospheric model established after T0, both for use by *Huygens* and to confirm the estimated density at 950 kilometers (600 miles) altitude, which *Cassini* is intended to reach during the fifth Titan flyby. The flybys did indeed detect a denser atmosphere at that altitude, so future planned flybys have been raised to 1,025 kilometers (650 miles) to allow more measurements at intermediate altitude before going down to 950 kilometers.

## A Drop into the Unknown

The entire *Huygens* scientific mission was designed to be carried out during just 2.5 hours of exciting descent through Titan's atmosphere and possibly up to a few

*Above: These two views of Titan's haze were taken just before and after* Cassini*'s first close encounter with the smoggy moon. The image at left was taken on October 25, 2004 through an ultraviolet filter sensitive to scattering of sunlight by small haze particles. The scale of this image is 2.8 kilometers (1.7 miles) per pixel. The image at right, taken a day later, shows Titan's night side backlit by the Sun after* Cassini*'s closest approach to the satellite. The pixel scale of this image is 6.6 kilometers (4 miles).* Images: NASA/JPL/Space Science Institute



*This radar image of Titan (shown in both black-and-white and color) was acquired on October 26, 2004, when* Cassini *flew about 1,200 kilometers (750 miles) above the surface. The image reveals a complex surface geology that scientists believe to be composed of icy materials and hydrocarbons. In the color view, brighter areas may correspond to rougher terrains, radar-facing slopes, or different materials. Pink enhances smaller details, while green represents smoother areas. The winding linear features that cut across dark areas may be ridges or channels.* Images: NASA/JPL/Space Science Institute

hours on its surface. The probe was not designed to survive touchdown, so even if *Huygens* does not survive the shock of impact, the mission will be considered a success if it performs well during descent. Despite such a short mission duration, scientists will be able to gather a huge amount of scientific data—the only data of their kind—that will make their enormous efforts over many years worthwhile.

One of the main reasons for sending *Huygens* to Titan is that in some ways, Titan is the closest analog to Earth before life began. Titan's atmosphere and surface may contain many chemicals of the kind that existed on the young Earth and stocked the primeval soup in which the first living organisms appeared. It is known that complex carbon molecules are present in cosmic space. Ultraviolet light from the Sun, cosmic rays, and lightning strikes could also manufacture carbon compounds on planets like Earth.

*Huygens* was designed to investigate this "home cooking" on Titan and identify the complex molecules by their masses and by their speeds of transit through various gas chromatograph columns. Particles collected from the atmosphere would be vaporized in an oven so they could be identified. By identifying the likely chemical precursors that constituted the primeval soup, *Huygens* would provide fresh information for theories about the origin of life on Earth.

Observing a world where clouds and raindrops are made of methane and nitrogen, meteorologists are fascinated by the parallels and contrasts with the weather on Earth. Winds of 500 kilometers (300 miles) per hour, expected to diminish during the descent, would propel *Huygens* sideways when the main parachute opens. On the way down, the probe would record wind speeds and provide detailed weather information, such as temperature and pressure. It also would measure the electrical properties of the atmosphere and register radio pulses from lightning strikes, if they occur. Additionally, a microphone would listen for sounds, which The Planetary Society will process and post on its website *planetary.org*.

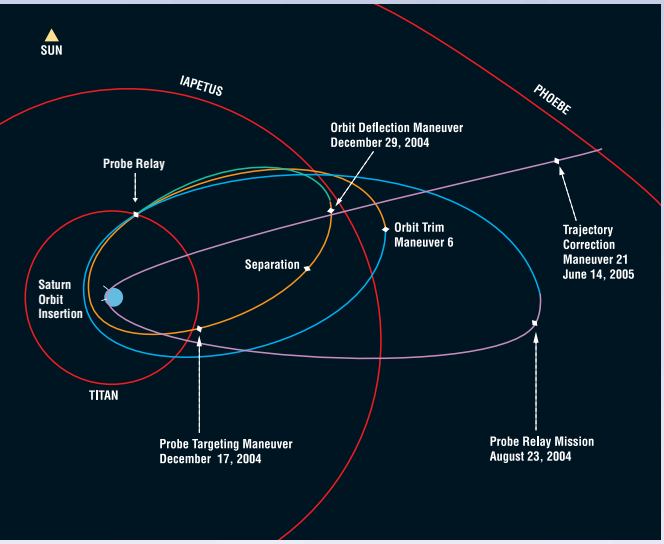
## The Huygens Probe's Arrival

*Huygens* was attached to the *Cassini* orbiter by a separation mechanism that, with the help of three springs, pushed the probe off toward Titan at 2:00 UTC

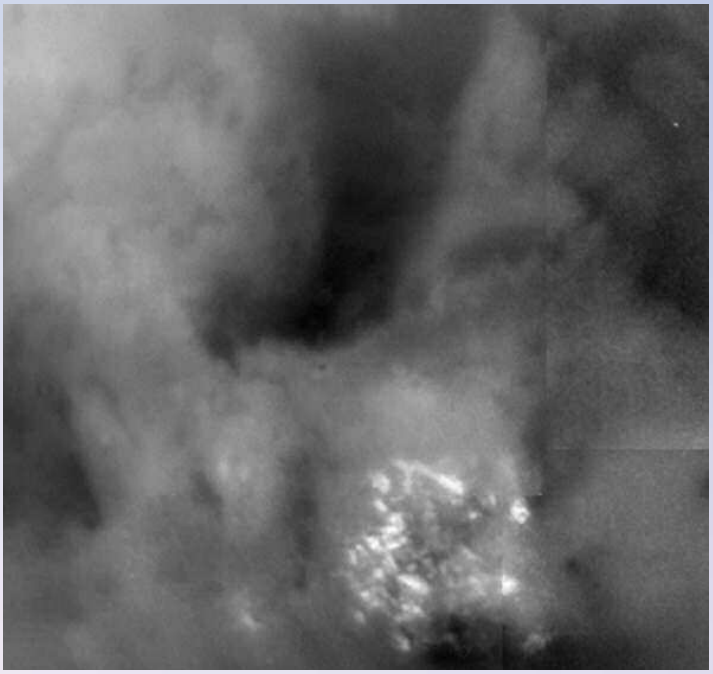
## FOR THE LATEST INFORMATION

about *Huygens*' January 14 descent, visit The Planetary Society's comprehensive *Cassini-Huygens* website at *planetary.org/saturn*

***Right: The* Huygens *probe is carried by parachute to its historic landing on the never-before-seen surface of Titan. Eleven-year-old Antonieta Tavares of Maracaibo, Venezuela, one of the first-place winners in the Youth category of The Planetary Society's Titan art contest, constructed her entry of paint and modeling compound on Masonite. A special feature of Antonieta's entry are the small LED "moons," which are activated by a switch on the back of the piece. To see all the winning entries and to read about their creators, visit*** planetary.org/saturn/artcontest.html




***This diagram shows the path of* Cassini-Huygens, *starting at Saturn Orbit Insertion (SOI) on July 1, 2004 to the separation of* Huygens *and its subsequent landing on Titan.*** *Diagram: Bee Smith*



***One of the highlights of* Cassini*'s first Titan observations upon entering Saturn's orbit was the detection of an Arizona-size cluster of bright methane clouds at the moon's south pole. Features as small as 10 kilometers (6 miles) can be discerned in the rapidly changing field of clouds, which is 450 kilometers (280 miles) across. This image was taken on July 2, 2004.*** *Image: NASA/JPL/Space Science Institute*

on December 25, 2004. During the separation, the spring-loaded mechanism also started the probe rotating, to make sure that it was stabilized during its 3-week coast to Titan to enter the moon's atmosphere with its front shield forward. *Huygens* was built like a shellfish, with a hard shell (carbon-fiber honeycomb covered by silica-fiber tiles) to protect its delicate interior from extreme temperatures (up to 8,000 degrees Celsius or 14,400 degrees Fahrenheit) during the entry into Titan's atmosphere.

The probe itself consisted of two parts: the Entry Assembly Module and the Descent Module. The Entry Assembly Module carried the equipment to control *Huygens* after its separation from *Cassini* and had a front shield that would act both as a brake and as thermal protection. The Descent Module contained the six scientific instruments. The probe used three different parachutes in sequence during its descent.

*Huygens* remained mostly switched off during the 7-year journey, until just before its separation from *Cassini*. Contacts with *Huygens* during the cruise phase were possible only via an umbilical link with *Cassini*. During the long journey, this link has been used to subject the probe to periodic checkouts for health-monitoring and instrument-calibrating purposes. Commands to set the timers to wake up *Huygens* about 4 hours before it

## Huygens Descent Profile


- *Huygens* wakes up by its timers at 03:44 UTC (Universal Time, also known as Greenwich Mean Time). Several Instruments awaken for warming up.
- *Huygens* reaches the upper layer of Titan's atmosphere at 9:07 UTC. The Huygens Atmospheric Structure Instrument measures the low-level atmospheric drag of the probe.
- During the first 3 minutes inside Titan's atmosphere, *Huygens* decelerates from 18,000 to 1,400 kilometers (11,000 to 850 miles) per hour. The temperature of the gas heated by friction with the probe's heat shield may reach 8,000 degrees Celsius (14,400 degrees Fahrenheit).
- When Mach 1.5 (400 meters per second, or 1,440 kilometers/860 miles per hour) is reached, a pilot parachute deploys automatically to pull out the main parachute. Within a minute, the probe's speed falls to less than 300 kilometers (180 miles) per hour.
- 30 seconds later, the shell of the descent module falls away and exposes the scientific instruments to Titan's atmosphere at a height of about 160 kilometers (100 miles). The atmospheric temperature may then be about –120 degrees Celsius (–180 degrees Fahrenheit). All instruments awaken and the radio link is activated about 1 minute later.
- Fifteen minutes later, at about 120 kilometers (70 miles) altitude, the main parachute is cut away and replaced by a smaller one, designed to allow a steady descent at about 20 kilometers (12 miles) per hour at touchdown.
- At about 45 kilometers (30 miles) altitude, *Huygens* goes through the coldest layer of the atmosphere, about –200 degrees Celsius (–330 degrees Fahrenheit).
- A radar altimeter measures the probe's altitude during the last 30 kilometers (18 miles). During *Huygens*' descent, the probe's camera captures images of Titan's cloud deck and surface. Data from *Huygens* are relayed to *Cassini* as it passes overhead, for later playback to Earth.
- At 13:35 UTC, *Cassini* disappears beyond Titan's horizon. A few hours later, it sends the data to Earth.

reaches Titan's atmosphere were the last commands sent to *Huygens* from the ground. After its separation, *Huygens* would have to work autonomously.

*Huygens* rotated as it dropped, and its cameras scanned the surrounding scene through a full 360 degrees, imaging the cloud layers. We knew the view would be very fuzzy, with the Sun plainly visible, but the Sun's halo would allow the probe to measure the size and abundance of the haze particles, while the spectrometers measured the heat flows inward from the Sun and outward from Titan into space. These instruments could tell us about the kinds and numbers of molecules in the atmosphere and analyze aerosol (dust) particles distributed in two layers of Titan's atmosphere (altitude between 150 and 40 kilometers, or 90 and 25 miles, and around 20 kilometers, or 12 miles).

As the probe broke through the haze layers, its camera was programmed to take up to 1,100 pictures of the never-before-seen panorama. Perhaps 50 kilometers (30 miles) above the surface, the haze should clear to give *Huygens* its first glimpse of the moon's surface between fluffy cloudtops. A radar altimeter, whose main function was to measure the probe's altitude, also would help to determine Titan's surface characteristics by listening for echoes. A special lamp, turned on for the final stage of the descent, would measure the colors of the surface to help the probe's spectrographs analyze its composition.

I wrote this before *Huygens* encountered Titan's alien world, and I wondered: will it land in an ocean of methane and ethane, with colored organic icebergs, or on solid land with geysers spouting methane from underground reservoirs? Will it see volcanoes erupting with ammonia and water?

If the probe survived the touchdown, the Surface Science Package would come into its own for the last phase of the mission. It contained a sonar and an array of "simple" sensors for measuring the physical properties of the surface material. Using these instruments, it would be able to tell whether the surface is liquid and, if so, what the chemical composition of that liquid is. It could even detect

waves and measure the depth. It would be able to deduce the ratio of methane to ethane in the liquid, which will give an indication of how long Titan has spent converting one into the other. Scientists should then be able to judge whether the ocean is as old as Titan or is a later addition. If the probe landed on a dry surface, *Huygens* would be able to measure its hardness and whether the surface is level.

Whatever *Huygens* found on January 14, just flying this spacecraft was a remarkable accomplishment in an attempt to get our first glimpse of a truly alien environment.

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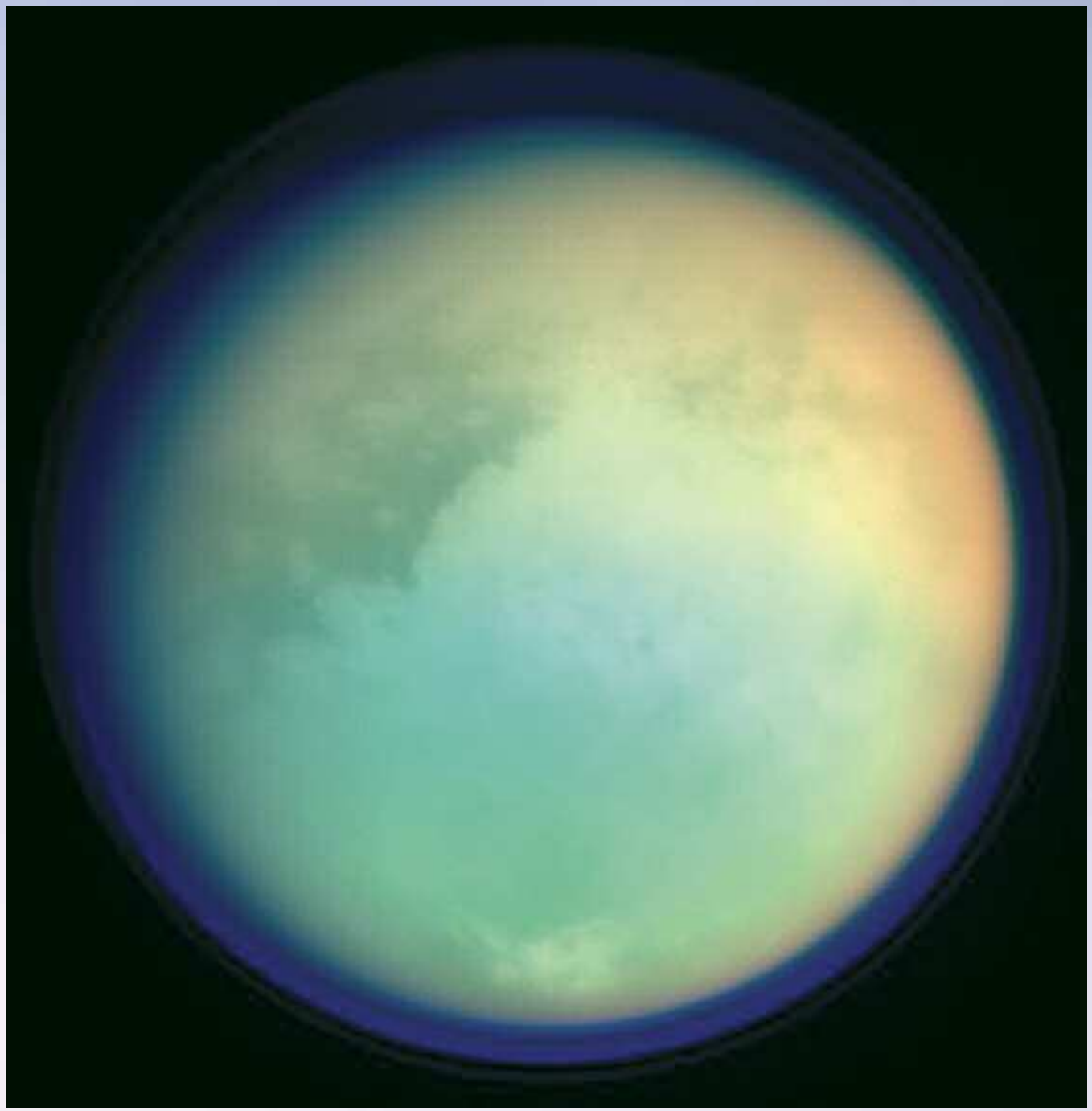
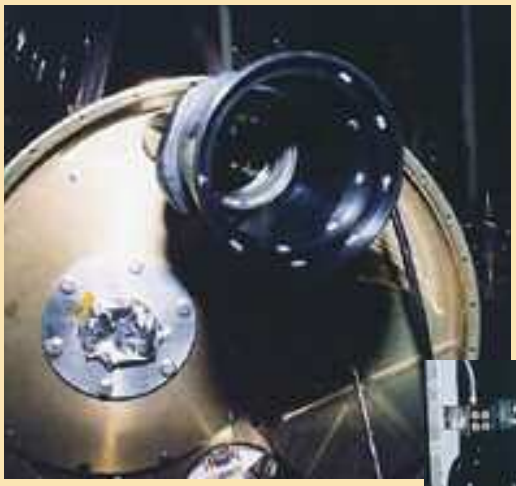
*Jean-Pierre Lebreton is mission manager and project scientist for the European Space Agency's* Huygens *mission. Lebreton works at ESA's Space Research and Technology Center in Noordwijk, the Netherlands and has been involved with the mission since 1984.*



***Four images taken through different color filters on* Cassini*'s Imaging Science Subsystem (ISS) on October 26, 2004 were combined to produce this view of Titan. Red and green represent infrared wavelengths and show areas where atmospheric methane absorbs light. These colors reveal a brighter (redder) northern hemisphere. Blue represents ultraviolet wavelengths and shows Titan's high atmosphere and detached hazes. The scale of this picture is 6.4 kilometers (4 miles) per pixel.*** *Image: NASA/JPL/Space Science Institute*

# A Suborbital Sear

The world of observational and experimental astronomy is rewarding almost beyond words, but it can be fraught with difficulties as well. Thus has it been with the ongoing search for Vulcanoids. Tight schedules, finite budgets, and all the constraints imposed by the real-world engineering and physics involved with real space-qualified hardware make for demanding operations. Like the search for the first asteroid or the long hunt for asteroid moons, the search for Vulcanoids is a challenging quest with an uncertain outcome. The following article describes the latest, and ultimately unsuccessful, chapter in a bid for the first detection of this potential new population of small asteroids near the Sun.



*Left: A close-up of VULCAM's lens and the ultraviolet spectrometer's entrance aperture.*

*Below: The Big Dog payload as it sat ready for transport from the vehicle assembly building to the launch site 1 mile away. The camera lens at top belongs to VULCAM, and the entrance aperture to the Ultraviolet Spectrometer is visible just below it. The red cap at bottom belongs to the Fine Guidance camera, which is used to steer Big Dog during flight.* *Photos: Southwest Research Institute*

*Left: In the region between Mercury and the Sun, there may orbit a population of small rocky bodies called Vulcanoids. Although the Sun's glare has prevented human observation of these small asteroids, circumstantial evidence says that they do exist. In this artist's conception, a single Vulcanoid orbits close to the Sun and the planet Mercury glows in the distance.*
*Painting: Daniel D. Durda*

# ch for Vulcanoids

## by Daniel D. Durda

AT T– 40 SECONDS, I stripped the headphones from my ears and ran out of the control room to watch the launch with my own eyes. I knew I probably wouldn't see much, though—the early morning air was dewy with a pea-soup fog. That's not unheard of in the New Mexico desert in January, but we would have preferred a clear, starry morning just for the beauty of it. I couldn't even see the bright floodlights that were illuminating our rocket as it sat poised on the desert launch rail a mile away. As I listened to the countdown over the loudspeaker reach "3-2-1-launch!" a brilliant flash of light penetrated the fog and unmistakably signaled the start of the Big Dog's suborbital flight to 275 kilometers (170 miles) and back.

That's about where the story left off several months ago. In an update on The Planetary Society's website (*planetary.org/news/2004/vulcanoids.html*), I described the mission of the Big Dog Planetary Rocket (BDPR), a NASA planetary science sounding rocket mission. Its goal was to obtain the first ultraviolet spectrum of the planet Mercury, and, with help from The Planetary Society, to conduct a search for an elusive population of small asteroids called Vulcanoids that might orbit very near the Sun.

A special niche function of sounding rocket astronomical observations is to allow planetary scientists to look at objects that are close to the Sun in the viewer's field of vision, an area difficult to see for ground-based telescopes that are blinded by twilight glare or hazy and turbulent thick air near the horizon, and a dangerous place for sensitive space telescopes like Hubble. BDPR mission Principal Investigator Alan Stern and Project Manager Dave Slater of the Southwest Research Institute led the development of BDPR's large new ultraviolet (UV) spectrometer that can be used to examine

***The Black Brant rocket carrying the Big Dog payload sits on the launch pad in White Sands, New Mexico, waiting for its predawn blast-off on January 16, 2004.*** *Photo: Southwest Research Institute*

the composition of a variety of solar system bodies, from Mercury to comets to the Moon.

Tagging along on the flight with the primary BDPR payload was an astronomical imaging device called VULCAM. Alan Stern and I have been interested for some time in solving, once and for all, a long-standing planetary detective story involving the Vulcanoids. In the July/August 2003 issue of *The Planetary Report*, I described the history of that search, from the quest a century ago for a putative inter-Mercurial planet named Vulcan, to the realization that at best a belt of small "Vulcanoids" might inhabit that region.

Most recently, Alan and I have conducted searches with image data from the space-based SOHO solar observatory and aboard high-flying NASA F/A-18B jets with a cousin of VULCAM. But this is a tough observational problem owing to the fact that one has to contend with the nearby Sun, and we've been challenged every step of the way—we've either had instruments located in the ideal environment in space but not designed for a search for these faint, starlike objects, or we've had a very sensitive instrument easily capable of seeing faint Vulcanoids but have struggled to fly it high enough to avoid contending with the bright twilight sky.

## A New Opportunity

As BDPR was coming together, Alan realized that we had a spare data downlink channel available and perhaps some spare room to fly one of our very sensitive video rate CCD (charge-coupled device) cameras to look for Vulcanoids. The rocket already would be looking at Mercury and pointing near the Sun anyway—why not use another camera with a wide-field lens to see if we might use a sounding rocket platform to beat all the classic problems associated with the atmosphere when looking near the Sun?

With the generous support of The Planetary Society and its members, we set about readying VULCAM for flight aboard BDPR. Dave Slater found the space within BDPR and installed the camera for us, along with a makeshift baffle to help reduce stray light. The baffle would function much like using your hand over your eyebrows to shade the glare of the noonday Sun, with the dark interior of the baffle blocking most of the light from the bright twilight limb of the Earth from entering the VULCAM lens. We would have loved to have installed a very long baffle, a foot or two long, but with the 58-foot-tall Terrier-Black Brant rocket already nearing the limits of flight stability due to length (there's a reason we named our payload the Big Dog Planetary Rocket!), the best we could do was to add a roughly 5-inch lens shade to VULCAM.

At 5:28:55 MST on January 16, 2004, the 220-kilogram (490-pound) BDPR payload, along with 500 more pounds of NASA-supplied pointing, telemetry, and recovery systems, roared off the launch rail atop a NASA Terrier-Black Brant sounding rocket. After 44 seconds, powered flight was over, and the vehicle continued on its arcing trajectory over the New Mexico desert, coasting upward in zero *g* at almost 7,000 feet per second!

With the light show over, we quickly returned to our stations in the control room just 35 feet away. VULCAM powered on with no problem 65 seconds after launch as the payload coasted upward through an altitude of 85 kilometers (50 miles). Fifteen seconds later, at an altitude of 112 kilometers (70

*Left: In this example of how the scattered light from Earth's limb makes it hard to see the background sky, note the faintness of the two stars.*

*Below: To determine how faint an object VULCAM could detect under ideal conditions with no scattered light, the team focused on a particular star in a field far from the Sun. The result was a pleasingly faint 11th magnitude.*

*Images: Southwest Research Institute*


miles), the payload shutter door opened and the first image data from the VULCAM became visible on the downlink channel in the control room. The very first images I saw as the shutter door opened were of sparks and flame. I was worried for a moment, but then I realized everything was okay—it was just the spent booster falling from the payload, its last gasps of exhaust sputtering away below.

Within seconds, as the payload aligned itself with known stars, I could see beautifully focused images of many faint stars. All was well. After pointing to two different guide stars to realign the payload's guidance system and gather calibration data for the UV spectrograph, Alan commanded the rocket to point to Mercury, and the VULCAM began gathering our Vulcanoid search data.

I could see the background brightness of the downlinked VULCAM image increase quite a bit as its view neared the Earth's limb. Would there be too much scattered light again? This is what we worried about preflight because we knew the VULCAM experiment was a risky one given how it was only hitchhiking aboard the larger BDPR. The payload reached its apogee of 274 kilometers (about 160 miles) 269 seconds after launch. After the UV spectrograph pointed quickly at the Moon for some bonus data, the shutter door closed 460 seconds after launch at an altitude of 109 kilometers (68 miles) as the payload fell back to Earth for a soft parachute landing 77 kilometers (48 miles) downrange.

BDPR performed flawlessly all through the flight, and VULCAM downlinked video with more than 50,000 images of the sky in the Vulcanoid region. That's a lot of data to pore through, and we were fortunate to welcome Sara Magrin to our team after the mission had been completed. Sara is finishing her Ph.D. in near-Earth object (NEO) studies at the University of Padua in Italy, and her advisor, our colleague Cesare Barbieri, thought that analysis of our Vulcanoid search images would nicely complement her other NEO studies. From late January through early March, Sara processed the VULCAM images, establishing the performance characteristics of the camera and working to extract all we could from the Vulcanoid search field.

## The VULCAM Images

The VULCAM camera is a video rate CCD imager, producing 60 images every second. Of course, the exposure for each individual image is very short, but if we add together many images, all of which are aligned so that the patterns of stars in each image overlap, we can increase the ratio of useful "signal" to electronic

## The Planetary Society and the Search for Vulcanoids

***When Alan Stern and Dan Durda were looking for sponsors for their search for Vulcanoids, they naturally turned to us at The Planetary Society. We are proud to say that we did not fail them. Our members responded generously to a request for support we sent out, and Society member Mark Gelfand followed the appeal with a generous challenge grant on our website. It was our members' commitment to exploring the frontiers of space science that made the flight of the Black Brant possible.***

"noise" in the resulting final image. This image coadding technique allows us to create the equivalent of a long time exposure from a moving platform (like a jet aircraft or a sounding rocket) that would otherwise cause significant image smearing if made with a conventional CCD imager.

To characterize how faint an object VULCAM could detect under ideal conditions with no scattered light, we focused on one of the star fields VULCAM stared at while the UV spectrometer gathered calibration data. As Sara describes, "We did the procedure on a star field far away from the Sun. We summed some hundreds of images referring to a particular star in the field, and we found we could reach eleventh magnitude." That's pretty faint. If we could complete a search for Vulcanoids to that limit, we would make a major contribution.

"Unfortunately," Sara reported, "in approaching the Vulcanoid observation field, the background scattered light became so bright that the gain of the VULCAM camera automatically closed a bit. This meant that most of the fainter light sources (stars and any candidate Vulcanoids) could not be detectable over the background light." After processing the coadded image to remove some of the effects of the residual twilight brightness near the limb of the Earth, we were unable to detect faint stars at all.

Any Vulcanoids that may wander the inner frontier of the solar system elude us still. It's clear that future Vulcanoid searches using the Earth's limb to block the Sun will have to pay close attention to beating the problem of scattered light from the twilight limb. We won't be throwing in the towel on the search for Vulcanoids anytime soon. This is a challenging observational problem we want to solve, and knowing once and for all whether any Vulcanoids exist today—and what their properties are—is important to planetary science.

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*Dan Durda is a planetary scientist at the Southwest Research Institute in Boulder, Colorado, where he studies the collisional and dynamical evolution of asteroids and the effects of their impacts on Earth. A pilot, cave diver, author, and space artist, Durda is also coordinator for the Society's Gene Shoemaker Near-Earth Object Grant Program*

***The Southwest Research Institute's Big Dog team stands near the assembled Black Brant rocket. From right to left are Cesare Barbieri, University of Padua; Dan Durda, principal investigator; Mike Davis, payload scientist; Dave Slater, project manager; Alan Stern, principal investigator; Norm Peltier, systems technician; and Mark Gelfand, donor and guest.***

***Photo: Southwest Research Institute***

# World Watch

by Louis D. Friedman

**Washington, DC**—In a stunning last-minute maneuver, literally at midnight, the US Congress approved full funding for NASA for the fiscal year 2005 (October 2004–September 2005). Full funding means that essentially all money and program support requested by NASA and the Bush administration is now included in the operating budget for this year. This includes the shuttle's return to flight, continuing space station support, and initiation of the programs in the Moon-to-Mars human space exploration policy proposed in January 2004.

The maneuver was led by House Majority Leader Tom DeLay (R-TX), who overrode limits on the funding in the House and Senate appropriations bills and who worked with the administration to threaten a veto of the appropriations bill if the new exploration policy was not supported.

Initiation of the new exploration policy is a great victory for the space-interest groups that had campaigned for the shift away from the shuttle and space station to human exploration beyond Earth orbit. (The Planetary Society was a leader in this campaign, and members who participated in the Aim for Mars! effort should be proud of their role.) Work on the new Crew Exploration Vehicle, to replace the shuttle, and on a robotic lunar mission to prepare for Moon-to-Mars human exploration is expected to begin immediately.

The budget passage was also remarkable in that most of the program constraints (often called firewalls) that Congress imposes on NASA concerning funding were removed. This gives NASA greater freedom in constructing the new exploration program. Many in the science community are concerned that this could lead to "raids" on science programs to fund expensive human spaceflight programs.

The exploration policy includes strong support for robotic planetary missions and space science. But there will be budget pressures, and vigilance and support will be needed for the crucial robotic missions that not only prepare the way for human exploration of the solar system but also make remarkable discoveries and create great adventures in their own right.

**Washington, DC**—Just about the same time as the final budget passage, NASA hosted a meeting of 19 space agencies from around the world to consider how to make the human Moon-to-Mars exploration program international. Included were the major International Space Station partners, who are worried about their investments in the still-uncompleted station; China, now the third nation to launch humans into space; and India, which, like China, Europe, and Japan, is conducting its own robotic mission to the Moon.

The meeting appears to have been successful in opening new doors to international cooperation on space exploration ventures. Inclusion of China was particularly noteworthy because it reversed a several-year policy of snubbing Chinese space contacts. Two weeks after this meeting, Chinese space agency Administrator Sun Laiyan paid a visit to NASA Administrator Sean O'Keefe in Washington.

NASA plans to follow up the international Moon-to-Mars exploration meeting with an international cooperation science meeting along with the space agencies in March 2005.

**Udaipur, India**—Dovetailing nicely with the international cooperation meeting cited above, an international lunar conference and meeting of the space agencies' International Lunar Exploration Working Group were held here, also in mid-November.

A wide range of lunar science papers was presented, including Planetary Society proposals for cooperation on upcoming orbiter missions and for developing an International Lunar Way-Station. The meeting participants issued a statement endorsing and urging more cooperation by the space agencies in planning lunar missions.

**Noordwijk, Netherlands**—One lunar mission being conducted is *SMART-1*. The European Space Agency ion-propulsion technology mission reached the Moon in November. *SMART-1* took some 16 months to get to the Moon using low-thrust acceleration to spiral slowly away from low Earth orbit. It will conduct a range of scientific measurements at the Moon, ones that organizers hope will shed new light on the possibility of measurable amounts of water in the lunar polar regions.

For more information about *SMART-1* and other current missions, visit the Society's website at *planetary.org*.

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

# Questions and Answers

***What percentage of near-Earth asteroids have been discovered and tracked, as compared with estimates? At present viewing rates, how many more years will it take to view more than 90 percent of these asteroids? What telescopes are watching in the Southern Hemisphere? Finally, how is funding secured for these searches?***
**—Douglas Kaupa**
**Fairchild, Washington**

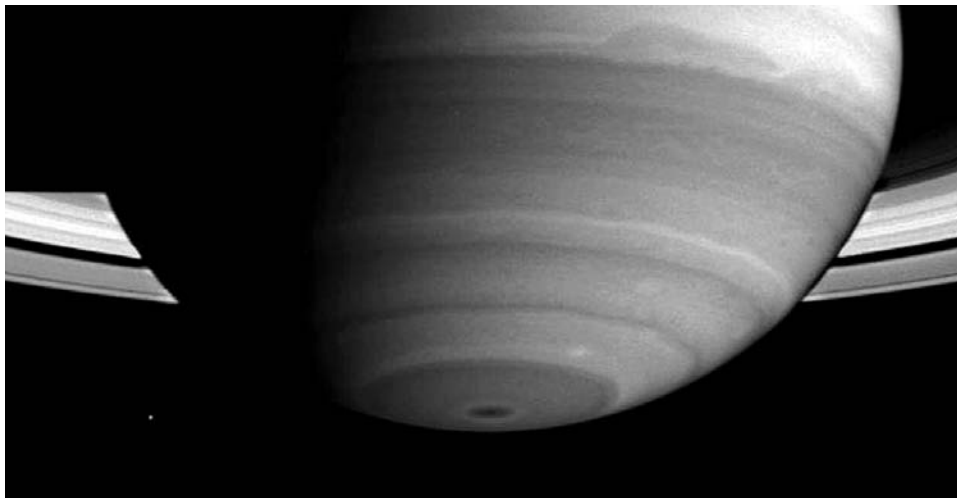
The most recently published estimate of the number of 1-kilometer (0.6-mile) and larger near-Earth asteroids (NEAs) is by Scott Stuart and Rick Binzel of the Massachusetts Institute of Technology. They estimate the total population of objects larger than 1 kilometer to be 1,090, plus or minus 180. As of June 2004, the various asteroid surveys around the world had tallied up about 611 NEAs larger than 1 kilometer across, or about 56 percent of the estimated total population. If we want to meet the Spaceguard Goal of finding 90 percent of the kilometer-and-larger NEAs by 2008, we'll need to find another 370 large NEAs over the next few years.

But Al Harris of the Jet Propulsion Laboratory carefully tracks the status of the search, and he points out that the story may not be that simple. "Here's the kicker," says Harris, who is also on the selection committee for The Planetary Society's Shoemaker Near-Earth Object (NEO) Grant program. "Because the population is uncertain by plus or minus 180, the total population is in the range from 910 to 1,270. Ninety percent of those numbers is 819 to 1,143. Subtracting 611 from those two numbers leaves the range of numbers needing to be discovered to reach the goal at 208 to 532 more objects. That's a factor of 2.5 uncertainty in how many more need to be found before we are 'done.' That, in turn, translates to close to a factor of 3 in the uncertainty in how long it will take to find them at the current rate. If the population is at the lower end of the possible range, it will take only about 4 years to find the remaining 208 asteroids, and we'll meet the Spaceguard Goal.

"On the other hand, if the total population is closer to the upper end of the range and we need to find about 530 more asteroids, it may take more than a decade from now to find that many."

Shoemaker NEO Grant selection committee member Brian Marsden, who serves as the world's clearinghouse of near-Earth object observations, provided the following information on Southern Hemisphere search and follow-up. Rob McNaught and Gordon Garradd at Siding Spring in Australia are back in business after a several-year hiatus, conducting an NEO search with a CCD (charge-coupled device) on the 0.5-meter Uppsala Schmidt telescope, along with help from Steve Larson and other members of the Catalina Sky Survey program in Tucson, Arizona. Alan Gilmore and Pam Kilmartin provide very helpful professional-level follow-up observations with the 1.0-meter and 0.6-meter reflectors at Mount John Observatory on New Zealand's South Island. Grant Christie and colleagues at the Auckland Observatory (using the 0.35-meter Schmidt-Casselgrain) and Jamie Biggs and colleagues at the Perth Observatory (using the 0.25-meter reflector) contribute helpful observations as well. There is also some amateur follow-up in Australia, Brazil, and Argentina, which is partially funded through the Society's Shoemaker NEO Grant program.
—DANIEL D. DURDA,
*Southwest Research Institute*

***The picture of Saturn on the cover of the May/June 2004 issue of* The Planetary Report *shows a dark feature in the atmosphere over the south pole. Does anyone know what it is? Will* Cassini *be taking a closer look at it?***
**—Lee Bishop**
**Santa Monica, California**



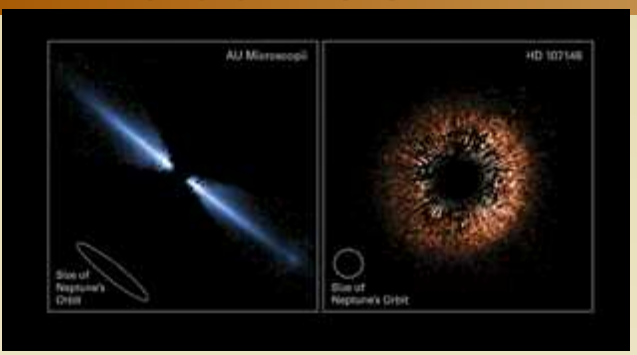
***Saturn's haze layer is less dense at the south pole, which allows light to penetrate deeper into the atmosphere.*** *Image: NASA/JPL/Space Science Institute*

The small dark spot centered on the south pole in the image (page 20) is a place where Saturn's haze layer is not as dense as it is at other latitudes. We know this because methane absorbs light and this feature is especially dark when seen through *Cassini*'s Imaging Science Subsystem filters, which sample methane absorption bands. In these relatively clear regions, light can penetrate deeper into Saturn's atmosphere, and there more of it is absorbed by methane gas.

We do not understand why Saturn has such a nice compact region right at the pole. None of the other giant planets has this feature. We can infer, however, that the planet's atmospheric circulation is downward in this region because downwelling of dry air from higher altitudes promotes clearing.

—ROBERT A. WEST,
*Jet Propulsion Laboratory*

# Factinos




***The Hubble Space Telescope has captured images of two planet-forming disks around young stars. At left, the disk around newborn AU Microscopii is seen edge-on. The disk at right surrounds HD 107146. Both disks have inner gaps where planets may have swept up dust and cleared a path.***

*Image: Space Telescope Science Institute*

The Spitzer and Hubble (HST) Space Telescopes have given us an unprecedented look at disks of planetary debris around stars the size of our Sun (see images above). Spitzer has discovered, for the first time, dusty disks around mature, Sun-like stars known to have planets, while HST took the most detailed picture ever of a brighter disk circling a much younger Sun-like star. These images offer us snapshots of the process by which our own solar system evolved.

"Young stars have huge reservoirs of planet-building materials, while older ones have only leftover piles of rubble. Hubble saw the reservoirs and Spitzer, the rubble," said Charles Beichman of the Jet Propulsion Laboratory and lead of the Spitzer study.

The young star HST observed, HD 107146, is between 50 and 250 million years old, which is old enough to theoretically have gas planets but young enough that rocky worlds like Earth might still be forming. An even younger star, 12 million-year-old AU Microscopii, was also imaged by HST. The six older stars studied by Spitzer average 4 billion years in age, nearly the same age as our Sun. They are known to have gas giant planets and may also have rocky ones.

Prior to these findings, planetary debris disks around stars the size of the Sun had been seen only rarely because they are fainter and harder to see than those around more massive stars.

—from the Space Telescope Science Institute

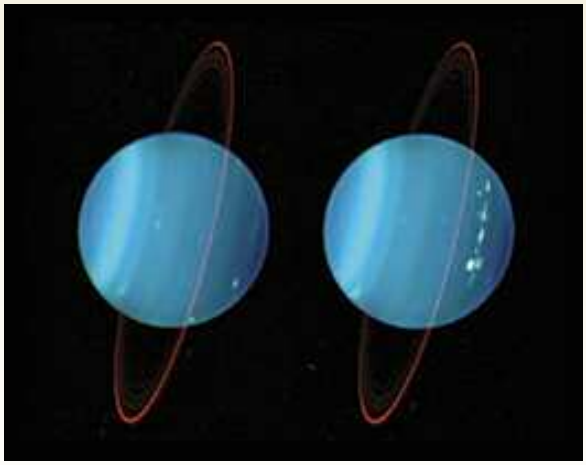
Recent near-infrared images (below) from the 10-meter Keck II telescope on Hawaii are changing our view of Uranus as the solar system's biggest bore. The images, taken in 2003 and 2004 with adaptive optics to counter atmospheric blurring, revealed discrete clouds by the dozens, which is more than the total of all observations of the planet combined up to the year 2000. The clouds vary in size, brightness, and longevity, showing that Uranus has a dynamic and complex atmosphere after all.

In the northern hemisphere, the largest group of atmospheric features ever observed on Uranus—a narrow, 29,000-kilometer (18,000-mile) cloud complex — disappeared in only one month. Teams led by Lawrence A. Sromovsky of the University of Wisconsin and Heidi B. Hammel of the Space Science Institute have documented wind speeds exceeding 225 meters per second (about 500 miles per hour)—the fastest yet recorded on Uranus. "Records are breaking as fast as we can take the data," says Hammel.

The major reason for Uranus' newfound dynamism probably is its bizarre seasonal cycle. Uranus is the solar system's only planet whose rotation axis is tipped over nearly in its orbital plane.

"Twenty years ago we simply couldn't see details in the outer solar system the way we can today with large, ground-based telescopes like Keck. These images actually reveal many more cloud features than the *Voyager* spacecraft found after traveling all the way to Uranus," says Sromovsky.

—from *skyandtelescope.com* and the Keck Observatory



***Recent observations of Uranus taken with the adaptive optics system on Hawaii's Keck II telescope were formed into a composite image in which the highest clouds appear white, midlevel clouds look bright green, and lower clouds appear dark blue. The color balance used to reveal the cloud structure in this infrared view makes the ring system appear red and is an artifact of the process. Uranus' north pole is at 4 o'clock.***

*Image: Lawrence Sromovsky, University of Wisconsin/W. M. Keck Observatory*

# Society News

## The Mars Watch Art Contest Winner!

*The grand prize winner of The Planetary Society's Mars Watch International Art Contest is Michael Z. Tyree of Sedona, Arizona. His painting, titled* Spirit of Mars, *depicts Spirit, the first child born on the Red Planet, on January 4, 2062. We see Spirit's reflection as she looks out at her namesake under a Martian night sky.*

## Planetary Society Board Elects New Officers

The Society welcomed the new year with two new officers and one new member on the Board of Directors. Neil deGrasse Tyson is the new chairman of the board and Bill Nye the new vice president. Tyson, an astrophysicist and director of New York's Hayden Planetarium, succeeds Bruce Murray, who will remain on the board after stepping down as its chairman. Nye, known to millions of kids as Bill Nye the Science Guy, is stepping into the vice president's position, formerly filled by Tyson. Laurie Leshin joins the board as its newest member.

Tyson recently hosted the four-part series *Origins* on PBS and has written numerous books on the universe and humanity's place within it. In 2004, Tyson was appointed by President George W. Bush to serve on the commission to implement the United States space exploration policy, dubbed the "Moon, Mars, and Beyond" commission. The members held several forums around the country to assess the opinions of the American public about the space program and to make recommendations about the direction the program should take in the coming decades.

Bill Nye introduced millions of kids to the "way-cool wonders of science" with his television series, *Bill Nye the Science Guy*. Nye earned a degree in mechanical engineering and spent several years working as an engineer before combining his dual loves of science and comedy into the Science Guy. His most recent TV program, *100 Greatest Discoveries*, aired on the Science Channel.

Laurie Leshin is the Dee and John Whiteman Dean's Distinguished Professor of Geological Sciences and director of the Center for Meteorite Studies at Arizona State University. She graduated from the California Institute of Technology with a Ph.D. in geochemistry and oversees the world's largest university-based collection of meteorites at Arizona State University. Leshin served on the nine-member "Moon, Mars, and Beyond" commission with Tyson.

*—Susan Lendroth, Manager of Events and Communications*

## 25 Years—Let's Celebrate!

We're in the dawn of a new year, the 25th since our founding by Carl Sagan, Bruce Murray, and Louis Friedman. For 25 years, it has been you—Planetary Society Members in more than 125 countries—who have made into reality the dream with which we were founded: to explore other worlds and seek other life.

Your support—we don't take any government money—enables the Society to advocate internationally for robust space programs; fund innovative studies, projects, and missions; and directly engage the world's public in the exciting adventure of space exploration.

In our 25th year, please help celebrate this anniversary in a special way:

- Give a gift—of cash or stock—and multiply it through your employer's matching gift program.
- Leave your legacy—include the Society in your will or living trust.
- Give the gift of membership—to family, friends, colleagues, a classroom, or your library.
- Craft an endowment, fund a special project, or make a Society "wish" come true.

Call me at 626-793-5100, extension 214, or e-mail me at *andrea.carroll@planetary.org* if you have any questions about making a gift to The Planetary Society.

Thank you, Members!

*—Andrea Carroll, Director of Development*

## Annual Audit Completed

The firm of Hensiek & Caron has completed its yearly audit of The Planetary Society. The firm determined that the Society's 2004 financial statement was in conformity with generally accepted accounting principles.

Copies of the financial statement are available upon request.

*—Lu Coffing, Financial Manager*

# Celebrate a New Year of Exploration!

### *Cosmos 1* T-Shirt

The Planetary Society's *Cosmos 1*, the first-ever solar sail, will take off into orbit this year. This commemorative T-shirt is a Society exclusive. Long-sleeved, with glow-in-the-dark ink, it's perfect for dark nights of solar sail watching.
Adult sizes: S, M, L, XL, XXL 1 lb. **#570 $25.00**

### *Cosmos 1* Crystal Cube

Commemorate *Cosmos 1*'s historic first flight with this stunning laser-etched crystal cube. Our elegant eight-bladed spacecraft floats inside double-beveled leaded crystal with the title "*Cosmos 1*, The First Solar Sail." Each 2"cube comes with a satin-lined gift box.
2 lb. **#577 $49.00**


### 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 $20.00**

### Nebula Poster

This stunning poster of nebula RCW 49 features one of Carl Sagan's poignant statements: "If we crave some cosmic purpose, then let us find ourselves a worthy goal."
22" x 34" 1 lb. **#315 $13.50**

### "Is Anybody Out There?" Poster

This astounding image, obtained by the Two Micron All Sky Survey, reveals some of the 400 billion stars in our own Milky Way galaxy. 39" x 16" 1 lb. **#320 $13.50**

### *Spirit*'s View at Bonneville Crater Poster

Sixty-seven days after landing, *Spirit* reached the raised rim of Bonneville and used its panoramic camera to capture this 360-degree view of its new surroundings.
10" x 39" 1 lb. **#350 $13.50**

### Mars in 3-D Poster

Put on your red/blue glasses and step onto the Martian surface, where *Mars Pathfinder* still rests today. Red/blue glasses included. 12" x 39" 1 lb. **#306 $13.50**

### Pale Blue Dot Poster

This 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 $10.00**

### An Explorer's Guide to Mars Poster

Images from *Mars Global Surveyor*, speculative paintings of the Red Planet's past and future, informative captions and charts, and images of Mars' surface from the *Pathfinder* and *Viking* spacecraft enhance a detailed US Geological Survey map. 24" x 37" 1 lb. **#505 $15.25**

### Explore the Planets Poster

This poster is full of fascinating facts about our planetary neighbors. 34" x 22" 1 lb. **#310 $11.50**

### *Pathfinder* Images of Mars

20 slides. 1 lb. **#215 $7.50**

### *Craters!* A Multi-Science Approach to Cratering and Impacts

By William K. Hartmann with Joe Cain. For grades 9–12. 224 pages (softcover). 2 lb. **#109 $24.95**

### "Top Three Reasons I Want to Move to Mars" Mug

This humorous mug featuring an image of *Spirit*'s landing site suggests three added benefits of life on the Red Planet. 2 lb **#610 $16.00**

### Future Martian T-Shirt

Child sizes: S, M, L 1 lb. **#565 $13.50**

### *Cosmos 1* T-Shirt

Adult sizes: S, M, L, XL, XXL 1 lb. **#570 $25.00**

### *Cosmos 1* Team Jacket

Adult sizes: M, L, XL 1 lb. **#573 $60.00**

### "Is Anyone Out There?" T-Shirt

Adult sizes: S, M, L, XL, XXL 1 lb. **#586 $19.95**

### SETI@home Mug

Our new 11-ounce mug features a wraparound image of the SETI@home screen saver. 2 lb. **#550 $10.00**

### *Cosmos 1* Thermal Mug

Stainless steel 16-ounce thermal mug.
2 lb. **#575 $18.00**

### Spacecraft Science Kits

Build your own spacecraft and learn how it works. Each sold separately. 1 lb. **$15.75**

**#524 *Galileo***
**#525 Hubble Space Telescope**
**#529 Keck Telescope**
**#530 *Lunar Prospector***
**#531 *Mars Global Surveyor***
**#538 *Magellan***
**#560 *Voyager***

### *Winds of Mars* and the Music of Johann Sebastian Bach

This audio CD features digitally simulated sounds of the winds of Mars heard between 17 of Bach's finest compositions, played on piano. Liner notes explain the production of the Martian sounds and offer a general history of Mars exploration. 1 lb. **#785 $15.00**

### Mini Mars Polar Lander Science Kit

1 lb. **#778 $3.00**

### "We're Saving Space for You!" Bumper Sticker

1 lb. **#695 $3.00**

### Planetary Society Key Chain

1 lb. **#677 $16.00**

### Planetary Society License Plate Holder

1 lb. **#675 $5.25**

### Planetary Society Lapel Pin

This striking pin is approximately 1 1/4 inches long, with a vibrant blue background and gold lettering.
1 lb. **#680 $3.00**

### Planetary Society Cap

The royal blue cap features our logo on the front and *planetary.org* on the back. 1 lb. **#660 $13.50**

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All nine planets are featured on full-color, 8" x 10" mini-posters. Each includes detailed information and a scientific description of the planet. 1 lb. **#336 $11.25**

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When Europe's *Huygens* touches down on Titan, it will be the first spacecraft in history to land on an outer planetary body. It will give us our first look at one of the solar system's last great mysteries. Titan, a planet-sized moon with a thick atmosphere and frozen surface, may be hiding the same chemistry that, on the young Earth, gave rise to life.

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Chelsey Tyler's oil pastel *Chaos Beneath the Veil* is the grand prize winner of The Planetary Society's art contest "Imagining Titan: Artists Peer Beneath the Veil." Fifteen-year-old Chelsey's art will be displayed, along with the other winning entries, at the European Space Agency's Operations Center in Darmstadt, Germany during the *Huygens* landing. As grand prize winner, Chelsey will be there herself, a guest of the *Huygens* team and The Planetary Society, to witness the landing. To see all the art contest's winning entries and to read about their creators, visit *planetary.org/saturn/artcontest.html*

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