The PLANETARY REPORT

Volume XXIX Number 3 May/June 2009

Celebrating Hubble

From The Editor

This issue of *The Planetary Report,* more than any other issue I can recall, reflects the ideas, opinions, and choices of Planetary Society Members. As you page through, you'll see what you and your fellow Members have done and what you've made possible.

You'll see the report on our 2009 Member Survey—an overwhelming success by any measure. Jim Bell, the new Planetary Society president, has heard what you want our organization to do, and, as he promises, we're on it!

We describe progress on our Members' top-rated concern: monitoring potentially dangerous asteroids and comets. The survey results coincided with our selection of winners of the Shoemaker Near Earth Objects Grants, confirming that we were on the right track with our project priorities.

Then, you'll read a feature composed of Members' words and pictures—at least, the pictures you chose as your favorites taken by the Hubble Space Telescope during its first few incarnations. Planetary Society Members can take justifiable pride in the just-completed Hubble repair mission. Three years ago, you campaigned to save the Hubble (and keep NASA from shutting down the *Voyager* spacecraft), so you can rightfully say you played a role in making this mission happen.

And there's so much more we're doing. You can track our actions even more closely if you become a "fan" of The Planetary Society on Facebook. We have a very active community growing there, with daily postings, links to new web features, event announcements, and much more.

So stay in touch! Joined together, Planetary Society Members are a force to be reckoned with. —*Charlene M. Anderson*

On the Cover:

The Cat's Eye nebula (NGC 6543) was one of the first planetary nebulae to be discovered. The Hubble Space Telescope (HST) first revealed, in 1994, its intricate structures, including concentric gas shells, high-speed jets of gas, and unusual shock-induced knots of gas. This portrait of the Cat's Eye nebula, captured in September 2004, was one of our Members' favorite Hubble images. To view more Members' favorites, see page 12.

"One massive star expires in a series of violent explosions, shedding veils of fusion-forged elements that race through the cosmos. When enough of these elements congregate elsewhere, they may eventually produce new stars, planets, or even organisms. We, and everything around us, are formed from the final throes of distant, long-dead stars. In our universe, death is the engine of life."
—Minna Lunney

Image: NASA/ESA/HEIC and the Hubble Heritage Team (STScI/AURA/R. Corradi and Z. Tsvetanov)

Background:

Comet-like filaments are embedded along a portion of the inner rim of the Helix nebula's red and blue gas ring. At a distance of 650 light-years from Earth, the Helix nebula is one of the nearest planetary nebulae to Earth. This composite view, assembled in 2003, is a blend of images from the HST's Advanced Camera for Surveys combined with a wide-view photo from the Mosaic Camera on the National Science Foundation's 0.9-meter telescope at Kitt Peak, Arizona. Image: NASA/NOAO/ESA/the Hubble Helix Nebula Team/M. Meixner (STScI) and T. A. Rector (NRAO)

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A PUBLICATION OF THE PLANETARY SOCIETY

You Spoke Up: The Planetary Society 2009 Member Survey

My first year as President of The Planetary Society has not yet finished, and already I'm overwhelmed with the goodwill and support I've received from our Members.

The enthusiastic response to the 2009 Member Survey is just one way you've shown me how much you care about our organization, and your responses will help me make sure that we are serving your interests and fighting for the programs you feel are important.

It's now time to unveil the results and offer you a few words about what I think they mean. You can either go straight to the numbers and analyze them yourself or read through the following analysis of the 2009 Member Survey—and then go to the numbers if you wish. Here goes:

1 What do you feel should be the focus of space exploration in the immediate future?

Mars is the place you most want to explore immediately, with 62.5% ranking it as "very important" and 33.0% as "important." This response makes me really happy, as I am a member of the Mars Exploration Rovers science team. Destination-wise, the Moon ranks a little lower, with 46.3% voting "very important" and 41.5% "important."

Robotic space exploration is your preferred means to get the job done, with 60.3% ranking it "very important" and 35.4% "important," giving an overall thumbs-up of 95.7%. Keep those rovers coming! The Mars Science Laboratory (*Curiosity*)—a really big rover—is being built for a 2011 launch, and I'm looking forward to seeing what new wonders it will turn up. The Europa Jupiter System Mission (let's hope it gets a better name) will be a NASA-ESA partnership, and we're giving our full support to this flagship mission.

The largest negative vote on this question was something of a surprise to me: 9.3% rated "human space missions" as "not important." Personally, I want to see human explorers follow the rovers to the Red Planet, but I don't see a conflict here with current Planetary Society policy. (A negative vote of less than 10% is, after all, not a terrible result.) Our Roadmap to Space, which we continue to present to policymakers in Washington, D.C. (most recently to the new Augustine review board), calls for robotic missions to Mars blazing a trail for humans to follow. I interpret this survey result as supporting that effort.

2 Which of these Planetary Society projects and activities do you support?

I found a bit of a surprise here, but maybe it's one we should have expected: "Monitoring potentially dangerous near-Earth asteroids and comets" was the most-supported Society project or activity. Near-Earth object (NEO) project supporters may be a quiet bunch (we don't receive a lot of mail cheering on these activities), but their support runs deep, with 88.8% saying to "do more" or "keep it."

We're on it! You should soon be receiving a letter about our NEO program and the ways we're ramping up our efforts in planetary defense through our Shoemaker Near Earth Objects Grants and our Apophis Mission Design Competi-

1

Results shown in percentages:	Very Important	Important	No Opinion	Not Important
Robotic space exploration	60.3	35.4	2.5	0.8
Continued exploration of Mars	62.5	33.0	1.9	1.2
Continued exploration of the Moon	46.3	41.5	5.5	4.9
International cooperative missions	52.1	34.8	6.9	5.0
Human space missions	46.3	37.5	5.4	9.3

2

Results shown in percentages:	Do More	Keep It	It's OK	Drop It
Monitoring potentially dangerous near-Earth asteroids and comets	51.5	37.3	8.7	1.4
Leading space advocacy, including presenting our Roadmap to Space to President Obama	49.9	37.8	8.3	2.3
Solving the *Pioneer* anomaly, which might violate the laws of physics as we know them	28.7	48.3	16.0	4.2
Advocating Earth observations from space to monitor climate change	33.5	38.2	20.2	6.9
Continuing the Search for Extraterrestrial Life through Southern SETI in Argentina and our optical SETI at Harvard	28.0	44.5	19.7	6.6
Launching the world's first solar sail mission	21.8	49.5	22.0	4.8

tions, and in pushing for an answer to the question, "Whose job is it, anyway?" to protect Earth from incoming asteroids.

"Leading space advocacy" came in at a close second to NEOs, with nearly half (49.9%) of respondents urging us to do more. We hear and obey. NASA's fiscal year 2010 budget has just been presented to Congress, Norm Augustine (a former Society board member) is leading a review of the Constellation program, we're banging the drum for the Roadmap to Space, and we're in close contact with space leaders in Europe, Japan, and Russia.

The largest negative response was only 6.9%, for our newest program of advocating Earth observations from space. With a negative response that small, it seems to me that our new Earth program is pretty much on track. We'll be working to turn your responses more positive by better communicating with you about why we feel Earth observations are critically important and what we intend to do.

3 What parts of your Member experience are most valuable to you?

No surprise here: In every survey we've ever done, you've said *The Planetary Report* and our other communications channels are what you value most about your Membership. The next highest in this category was "Being part of the space community," with a total positive rating of 72.4%.

Community-building and social media are the buzzwords of the moment among nonprofit groups like The Planetary Society, and we're jumping on those bandwagons with both feet. Right now, I suggest you visit our new Facebook page and sign up. We'll be posting the latest updates on Society happenings, and you can see what your fellow Members are up to.

Twitter from The Planetary Society will not be far behind (all this social networking takes a lot of work!), and there's more to come. We've just received a grant to run a pilot program for Planetary Citizenship, and that will provide a lot of opportunities for Members to get together and talk about what's important to them.

Our Volunteer Network will be crucial to Planetary Citizenship—as it is to so many of our activities around the world. You can sign up for the network right now at *planetary.org/participate/volunteer/index.html.*

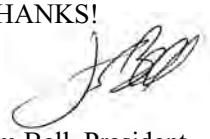
4 What interests you most as we plan for our future in space?

We saw our biggest negative responses in this question: 14.7% voted "Don't try" regarding "Encouraging space tourism." That's still a relatively small number, though, and we noticed a bit of ambivalence about this and other topics that are outside the Society's traditional focus. "Commercializing space activities," "Privatizing launch vehicles," and "Encouraging space tourism" all saw a plurality of Society Members voting that they could go "Either way."

Our traditional focus on "Scientific exploration of the solar system" won this race going away, with 82.8% saying to "Take it on." It looks like most of our Members want to continue to devote our energy and resources to keeping the scientific discoveries coming, and so we will.

I know this is a lot to take in—at least it was for me. I've been talking a lot with the Society's Board of Directors and the staff about where we should go from here, and if we all work together, we can look forward to seeing your wishes become reality.

THANKS!



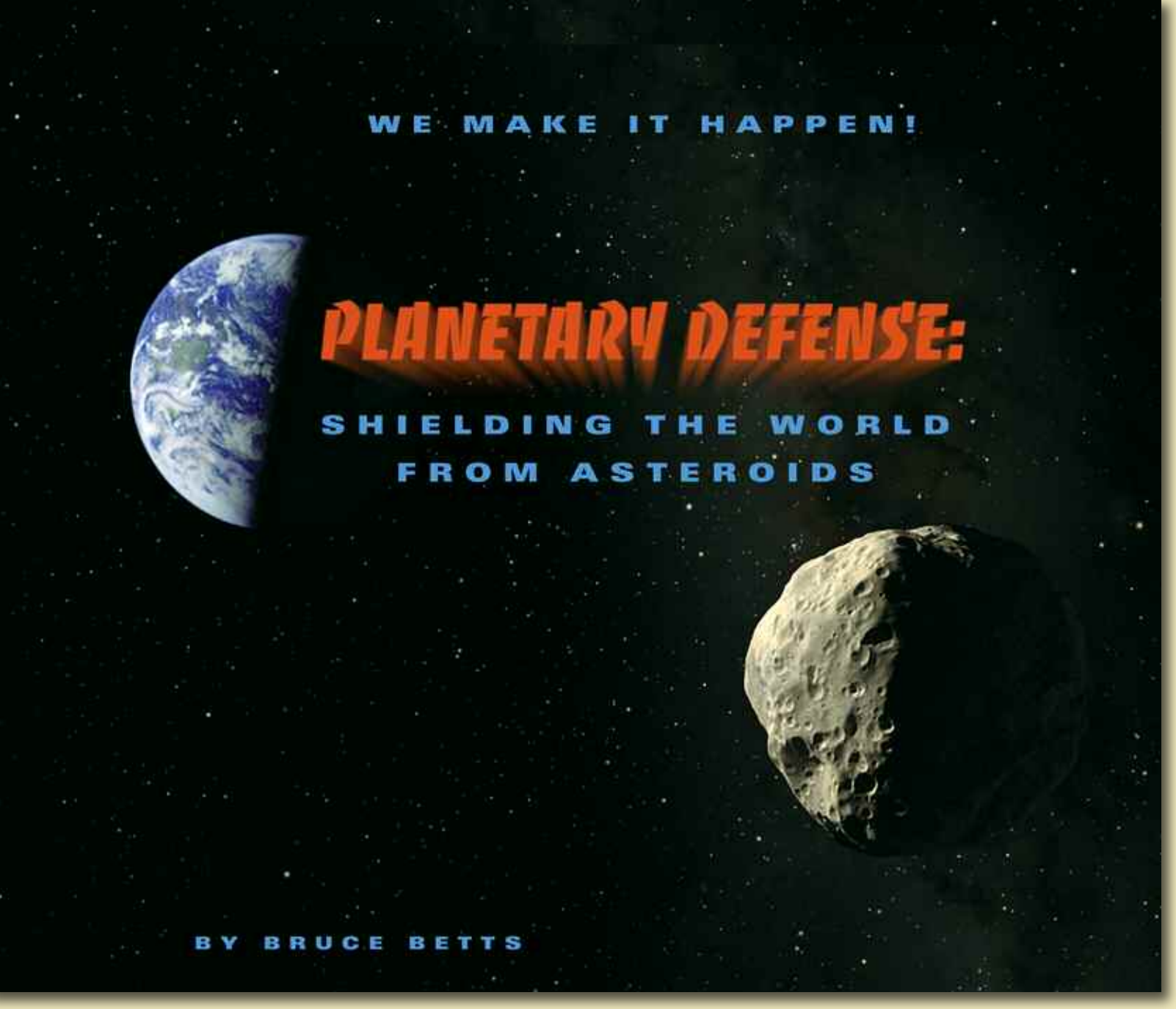
Jim Bell, President

3

Results shown in percentages:	Invaluable	Valuable	It's OK	No Opinion
The Planetary Report, website, and events	36.2	44.1	8.7	1.5
Being part of the space community	30.8	41.6	14.9	3.1
Being part of Planetary Society space projects	25.6	43.5	15.3	5.1
Having my voice heard through Society advocacy work	23.1	41.0	19.2	6.7
Knowing my name rides through space on missions like Phoenix and Stardust	17.0	25.8	34.7	11.4

4

Results shown in percentages:	Take It On	Either Way	Don't Try
Scientific exploration of the solar system	82.8	8.0	0.2
Increased involvement in robotic space missions	67.9	21.5	1.0
The search for extraterrestrial life	57.0	28.5	5.3
Establishing human presence on Mars	55.7	23.9	10.8
Building settlements on the Moon	55.1	27.6	7.5
Mining asteroids for their resources	39.2	37.9	12.5
Commercializing space activities	37.7	41.9	10.1
Privatizing launch vehicles	37.4	43.8	8.3
Encouraging space tourism	31.1	44.2	14.7



I recently returned from the 1st IAA (International Academy of Astronautics) Planetary Defense Conference in Granada, Spain. At the conference, I announced our latest round of Shoemaker Near Earth Objects (NEO) Grant winners, ran into some past Shoemaker grant winners and winners of our Apophis Mission Design Competition, and generally met with a lot of the world's experts in near-Earth objects and planetary defense. In our recent member survey, "monitoring dangerous asteroids and comets" was at the top of your list of things on which we should be working (see article on page 4). We are doing this, and we are ramping up even more as a result of your interest.

Here, I update you on the conference, introduce you to our amazing new Shoemaker grant winners, and tell you what some of our Apophis Mission Design Competition winners are doing.

Protectors of the World

The three-and-a-half-day conference featured numerous presentations and discussions about detecting, tracking, and characterizing NEOs; assessing the threat to Earth; and deflecting a space rock if we find one headed our way. There was also some follow-up on the legal implications and whose job it is to protect us, a topic that was covered much more thoroughly at the Lincoln, Nebraska conference in which Planetary Society Executive Director Louis Friedman participated the week before.

Did you know that you have more chance of dying from an asteroid impact than from a shark attack or botulism? A deadly asteroid impact has a low probability, but not lower than that of some of the other things about which people worry. On any given day, we are all pretty darned safe from asteroids, but without intervention, asteroid impact will happen,

Left: This is how the view from near-Earth asteroid Apophis should look on its April 13, 2029 flyby of Earth. When Dan Durda created this image, he strove to get all details—down to the positions of background stars—astronomically correct. Earth is in the proper orientation and phase as it will appear from the asteroid at the time of closest approach. *Illustration: Dan Durda*

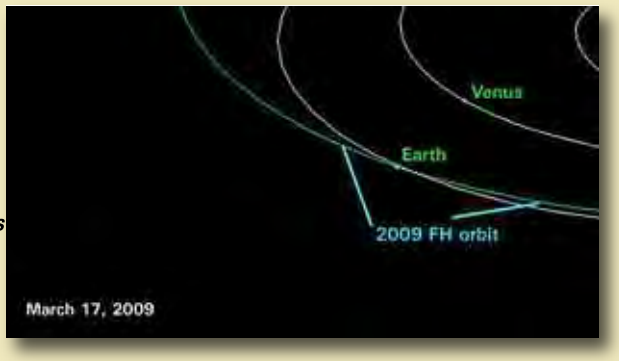
Right: On October 6, 2008, observers using the University of Arizona's Catalina Sky Survey telescope were the first to spot a five-meter, 80-ton asteroid on a collision course with Earth. Within hours, observers all over the world were tracking the object, named 2008 T3. Most important, 2008 T3's size and predicted impact site were quickly deemed to be no threat to Earth's citizens. *Photo: Richard Kowalski*

and it will kill people—it is only a matter of time. That time frame may be tomorrow, though more likely it is measured in decades or centuries. Recall that in 1908, an impactor exploded over Tunguska, Siberia, leveling thousands of square kilometers of forest. If such an impact occurred over a populated location, it could level a city. More likely, it would occur over the ocean and might cause catastrophic tsunamis.

What sets NEOs apart as a natural disaster threat is that they represent the only natural disaster we can actually prevent. Don't we have a responsibility to work to do that?

These points were made during the meeting, in addition to presentations of lots of great science. Check out my blogs from the conference for more information at *planetary.org/programs/projects/neo_grants/*, where you can also find a link to the conference website itself.

In the past few months, Earth's skies have seen their share of NEO traffic. On March 2, asteroid 2009 DD45 buzzed past us only 64,000 kilometers (40,000 miles) above the surface. Two weeks later, a rock called 2009 FH flew by at a distance of 79,000 kilometers (49,000 miles). This diagram shows the intersection of Earth's and 2009 FH's orbits on March 17, 2009. *Diagram: NASA/JPL*



Doing Our Part: Shoemaker NEO Grant Awardees—Past Winners

At the conference, I announced our new winners of Shoemaker Near Earth Objects Grants, named after one of the pioneers of impact science. The Shoemaker NEO grants fill an important niche in planetary defense, providing funding for amateur observers, observers in developing countries, and professional astronomers who, with seed funding, can greatly increase their programs' contributions to NEO research. Grant winners are especially critical for carefully measuring positions of recently discovered NEOs. Once we know a NEO is out there, we need to learn whether or not it will hit Earth. Shoemaker NEO grant winners, past and present, operate many of the most successful asteroid follow-up observatories in the world

Our past winners have been very busy and very successful in discovering, tracking, and characterizing potentially threatening objects. In the last few months, we've had various close flybys of asteroids that our past winners have helped track. For example, the near-Earth object 2009 DD45 swooped within 64,000 kilometers (40,000 miles) of Earth on March 2, and a mere two weeks later, another space rock—2009 FH—passed within 79,000 kilometers (49,000 miles) of our planet's surface. Three past recipients of The Planetary Society's Shoemaker grants helped discover and track 2009 FH, including 2002 recipient Richard Kowalski of the Catalina Sky Survey and 2007 recipients Robert Holmes (also one of this year's winners) of the Astronomical Research Institute in Illinois and James McGaha of the Sabino Canyon Observatory near Tucson, Arizona.

Shoemaker NEO 2007 grant winner Jean-Claude Pelle was located at what was the closest approach point on Earth (Tahiti) for 2009 DD45 and made many observations. Recent recipients have discovered and followed up many other objects, including February's "green comet," comet Lulin, discovered by 2007 winner Quanzhi Ye, who

The nonperiodic comet Lulin made its closest approach to the Sun on January 10, 2009 and then swept past Earth (at 61 million kilometers, or 38 million miles) on February 24, 2009. This unusual comet was co-discovered on July 11, 2007 by Quanzhi Ye (right), a 2007 Shoemaker grant winner. The 19-year-old Ye used his grant money to purchase a laptop and software to run a 16-inch automated telescope. Using his new equipment, he promptly spotted Lulin. Days later, he and fellow 2007 Shoemaker grant recipient Jean-Claude Pelle found another previously unknown NEO that is now called 2007 NL1. ***Photos: (inset) courtesy of Quanzhi Ye; (right) © Philip Jones***

was working in mainland China in collaboration with Lulin Observatory in Taiwan.

While attending the conference, I met one of our former Shoemaker grant winners: Jana Ticha from the KLENOT Project of the Klet Observatory in the Czech Republic, who won a Shoemaker NEO grant in 2000, along with her colleague Milos Tichy. They operate an observatory with a 1.06-meter telescope that has become one of the most prolific observatories on the planet when it comes to follow-up observations of NEOs. Amazingly, they receive no national funding from the Czech Republic, though they do receive some local government funding.

Jana Ticha (left) won a Shoemaker grant in 2000. She and her colleague Milos Tichy are shown in April 2009 during a reception at the Planetary Defense Conference in Granada, Spain. ***Photo: Bruce Betts***

It was a Shoemaker NEO grant from The Planetary Society that kicked off a series of upgrades to their observatory, starting with the optical system our members funded. Ticha and Tichy later upgraded the dome and are now finishing the installation of a new mount for the telescope. This mount will allow them to reach more of the sky with their system. Despite being located in central Europe, they told me their observatory has very dark skies and excellent viewing conditions due to its location, altitude, and local weather patterns. They also operate a planetarium in a city tens of kilometers from the observatory and carry out educational programs at the planetarium.

It was very nice to finally put a face to a person with whom I've been corresponding for many years. This was all the more gratifying when hearing the stories of what Ticha and Tichy have been able to accomplish since the Shoemaker NEO grant several years ago. You can read past updates from Jana Ticha at our 2000 Gene Shoemaker NEO Grant Recipients page at *planetary.org/programs/projects/neo_grants/*.

Doing Our Part: Shoemaker NEO Grant Awardees—New Winners

Our 2009 winners are all established observers with long histories of searching for and tracking NEOs, some of which could one day pose a threat to our planet. The grant recipients and their projects are as follows:

Russell Durkee
Shed of Science Observatory, Minnesota

Durkee is a well-established observer of asteroid lightcurves. He proposed to automate the Shed of Science Observatory to allow him to run more nights and triple the productivity of his NEO photometry program. His award will be used to purchase a computer, a control board and software, and a cloud sensor necessary to fully automate the operations of the observatory.

Robert Holmes
Illinois

Holmes will purchase a new CCD camera to go on one of several telescopes (0.6-meter, 0.8-meter, and 1.2-meters) to be commissioned in 2009. His observing site is one of only a few that can reach to the very faint magnitudes necessary to do follow-up astrometric observations of fainter detections that will come from Pan-STARRS and other deeper NEO surveys in progress. Holmes is The Planetary Society's first repeat Shoemaker grant recipient, having won an award in 2007.

Gary Hug
Sandlot Observatory, Kansas

Hug will purchase a new STL1001 CCD camera from SBIG for a 22-inch telescope that is soon to come on line. Hug has discovered hundreds of main-belt asteroids, an NEO, and three Trojan asteroids, and he was co-discoverer of a comet. He plans to conduct recovery work of semi-lost near-Earth asteroids (NEAs) and follow-up of new discoveries.

For more information on the winners as well as updates on the work of past recipients, visit the Society's website at

The Planetary Society's 2009 Shoemaker NEO grant winners are (left to right) Russell Durkee, Robert Holmes, and Gary Hug.
Photos courtesy of Russell Durkee, Robert Holmes, and Gary Hug

What's **Up?**

In the Sky— June and July 2009

In the pre-dawn east, extremely bright Venus is spectacular. Much dimmer and redder Mars starts June below Venus, grows closer throughout June, and is high above Venus by the end of July. Very bright Jupiter is high in the south before dawn. Saturn, in Leo, moves lower in the western sky after sunset as the weeks go by. On July 22, a total eclipse of the Sun is visible from a small corridor that runs through India, China, Japan, nearby countries, and the western Pacific Ocean. A partial solar eclipse will be visible from most of eastern Asia and the western Pacific.

Random Space Fact

NASA's *Mariner 10* was the first spacecraft to encounter two planets (besides Earth) on one mission. It flew past both Venus and Mercury in the early 1970s.

Trivia Contest

Our November/December contest winner is Dave Whinery of Overland Park, Kansas. Congratulations!

The Question was: 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? *The Answer is:* Earth and Titan.

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

Who was the only astronaut to fly to space on board all five space shuttles?

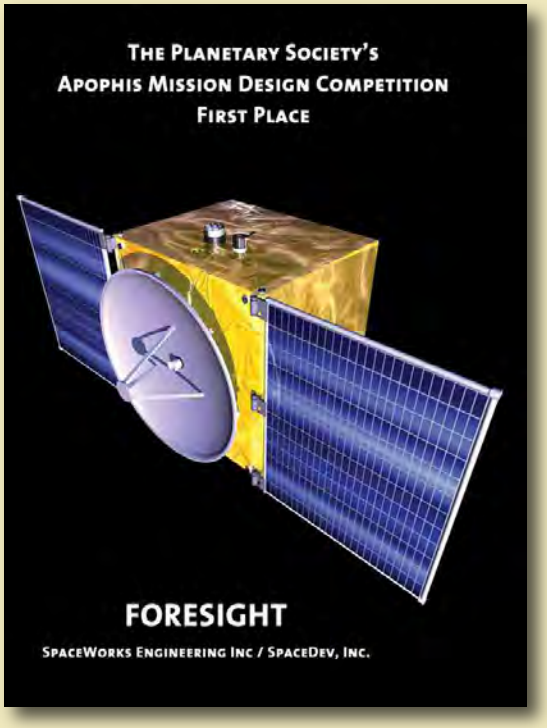
E-mail your answer to *planetaryreport@planetary.org* or mail your answer to *The Planetary Report*, 65 North Catalina Avenue, Pasadena, CA 91106. Make sure you include the answer and your name, mailing address, and e-mail address (if you have one).

Submissions must be received by August 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.*

planetary.org/ programs/projects/neo_grants/ updates.html.

An international advisory group reviews the proposals and recommends candidates to receive the grant awards. We are very thankful for their help. The advisory group for this round was Planetary Society NEO Grant Coordinator Daniel D. Durda of the Southwest Research Institute; Alan Harris, Space Science Institute; Petr Pravec, Ondrejov Observatory, Czech Republic; Tim Spahr, Harvard Smithsonian Center for Astrophysics-Minor Planet Center; and Duncan Steel, QinetiQ, Canberra, Australia.



In 2008, SpaceWorks Engineering won first place in The Planetary Society's Apophis Mission Design Competition with Foresight—a low-cost, conventionally propelled orbiter with only two instruments and a single-band radio tracking system. Foresight would rendezvous with Apophis, survey its shape and surface properties up close, and then place itself in a stable orbit to coordinate radio tracking of the asteroid from Earth.

Illustration: SpaceWorks Engineering

Doing Our Part: Apophis Mission Design Competition Winners

One highlight of the Planetary Defense Conference was the chance to see all of the winning teams from the open category from The Planetary Society's Apophis Mission Design Competition. Not only did they all present at the conference, but also all are continuing work on their mission designs and related studies, as well as presenting their mission designs to space agencies and colleagues.

As a result of The Planetary Society's Apophis Mission Design Competition, in 2008, we awarded $50,000 in prizes to teams that did the best job creating mission designs to tag/track the asteroid Apophis. Apophis is a roughly 300-meter-wide asteroid that will pass closer to Earth in 2029 than our geosynchronous communication satellites. Whether it passes through a "keyhole" a few hundred meters wide at that time will determine whether it ends up hitting Earth and causing a massive catastrophe in 2036. The good news is that right now, this chance is 1 in 50,000 and it may be even lower, according to some presentations given at the conference.

What was striking to see at the Planetary Defense Conference is the staying power of the competition. We had hoped for this, and we have been working with space agencies, advocating for consideration of the mission designs. Our judges felt all three of the winning mission designs were excellent and deserving of additional pursuit.

At the conference, A. C. Charania represented the SpaceWorks/SpaceDev winning entry. He presented the concept in detail in one of the sessions, along with follow-up studies the team has done (including assessing new launch vehicle options) and future plans. The team has presented its mission concept at other conferences and in front of various space agencies. The members continue to work with spacecraft designers to flesh out options for Apophis missions.

Juan L. Cano from Deimos Space in Spain was the leader of the second prize team and presented at the conference. His team included a variety of organizations from several countries in Europe. The team is now involved with doing detailed Apophis mission studies for ESA, and Cano presented some of the results. He told me the Apophis competition caused them to move forward with designs and plans and has helped lead the team to where it is now.

The third prize team, another large European consortium—in this case, led by a team from Astrium in the United Kingdom—is continuing to pursue related work. I talked with Craig Brown from Astrium, who was not on the proposal team but is working on some of the follow-on activites. He says Astrium continues to be very interested in studying NEO missions. In addition to mission studies, the team has also spun off studies of how to take spacecraft thermal models and apply them to NEOs to study and predict the "Yarkovsky effect," which was discussed widely at this conference. On a rotating asteroid, differential temperatures between its morning and afternoon sides cause changes to the asteroid's orbit. The effect is not well understood yet, but because of its significance for an object like Apophis, lots of people are thinking about it.

You can learn more about each winning Apophis mission design proposal on our website at *planetary.org/programs/projects/apophis_competition/*.

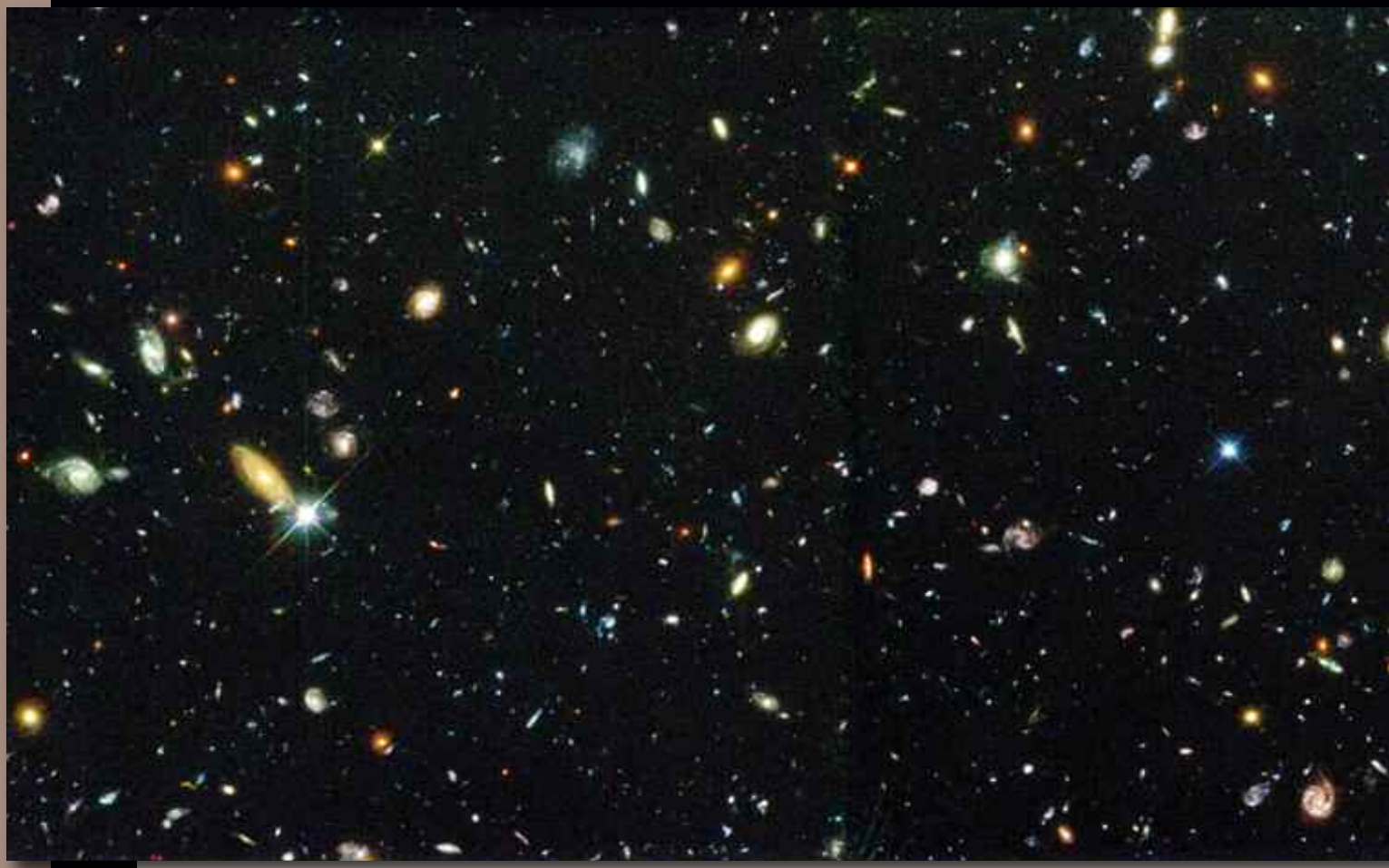
Conclusions

It is fun to work on saving the world, a rather noble goal. A lot of work still needs to be done to make sure we can prevent the only preventable natural disaster, but a lot of progress is being made. Thanks to our members, The Planetary Society really is helping to make it happen.

Bruce Betts is director of projects for The Planetary Society.

All Hail Hubble!

PLANETARY SOCIETY MEMBERS SALUTE THE



On May 11, 2009, space shuttle *Atlantis* blasted off into a clear blue Florida sky. On board, a team of seven astronauts prepared for a daunting task of astronomical proportions. Their mission was to service—for the fifth and final time—the aged and ailing Hubble Space Telescope.

This long-overdue house call repaired and rejuvenated the most beloved observatory in history. In its 19 years of operation, Hubble has given us super-natural vision, bringing the awesome beauty of deep space into our daily lives and even taking us back in time by showing us the cosmos in its childhood.

Over the course of five complex spacewalks, astronauts installed two new instruments, fixed two others, and replaced batteries and other hardware that will greatly enhance Hubble's abilities for another five to seven years. This September, Hubble's new and calibrated instruments should begin to bring us images—more detailed and ever closer to the beginning—of the universe in which we live.

In our November/December 2008 issue, we asked you to help us celebrate this upgrade by choosing your favorite Hubble image and writing a short caption explaining what makes it so special to you. Here are some of your most popular and intriguing responses. To read more about these images, visit *hubblesite.org*.

—*Editors*

HUBBLE SPACE TELESCOPE

Left: Hubble Deep Field Image at Full Resolution

•When I first saw this Hubble image, it filled me with astonishment. Like the first photo of Earth from the Moon, or the "pale blue dot" imaged by *Voyager 1*, it reveals the much grander scale of reality that contains us. Astronomer Edwin Hubble might have marveled that his namesake peered clear to the visible horizon of the universe, seeing the farthest, faintest, most glorious primeval galaxies in the original "Deep Field" image of 1995.
—Laurie A. Carlson

•I remember my exact thoughts the moment I first saw the image: "This, as they say, changes everything." And it did. I'm sure other images ("Pillars of Creation" springs to mind) are more artistically inspiring and awesome, but the "Deep Field" was profound.
—Patricia Ackor

•The "Deep Field" captures, in one image, all the wonders of the universe. Here, in one infinitesimal speck of sky, stand scores of galaxies, trillions of stars, and an innumerable host of planets. Here we see a universe so incomprehensibly vast, so enormously unexplored, that ten billion lifetimes could not exhaust its wonders. What greater thrill or more humbling experience can compare with the grandeur of the universe itself?
—Jason Wallace

•The "Deep Field" image has been my favorite since I first saw it in 1996. I was then, and I am still, amazed today by all the galaxies revealed in such a tiny patch of sky near the Big Dipper, by which I was so mesmerized as a young child. This image is like a window into the universe when it was young, sure to be remembered as one of Hubble's very best.
—Rick Blair

Atlantis *lifts off from NASA's Kennedy Space Center on May 11, 2009.* Photo: NASA

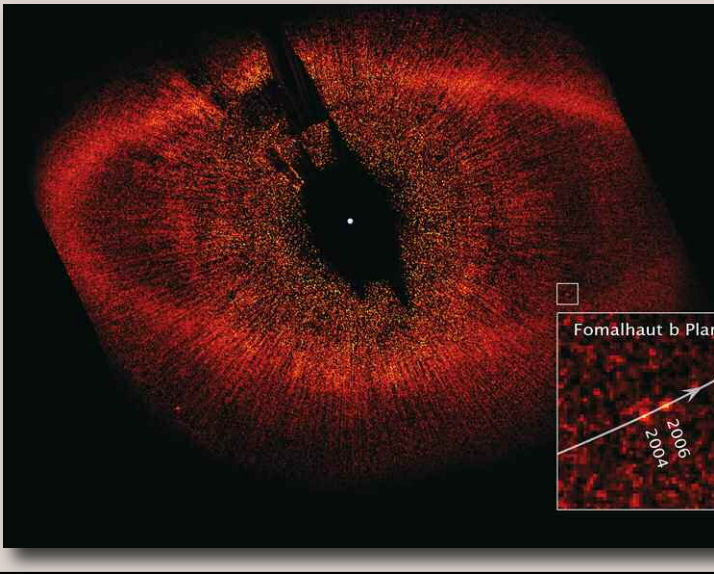
Below: The Heart of the Whirlpool Galaxy

To pick one image was very difficult, because there are so many beautiful pictures in the gallery. However, I chose "The Heart of the Whirlpool Galaxy" because it is such an incredible swirl of colorful stars. I'd like to think that it's how our galaxy would appear, if viewed from afar. This may be how our home, the Milky Way Galaxy, looks from on high.
—Donald Stewart

Out with the Old: Replacing the High-Resolution Spectrograph

This is my favorite because it shows humans servicing the telescope. Being able to do this is one of the first steps toward humans living in space and on other planets. The team of designers, builders, testers, trainers, ground controllers, and astronauts makes it look easy, but it's not. At age 64, I will probably never have the opportunity to go into space, but I enjoy these photos of other people out there.

—Nickie Nelson

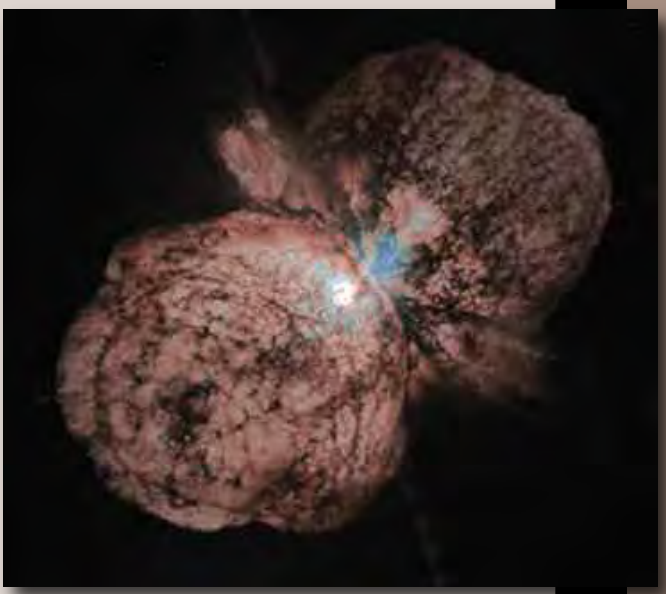


"Light Echo" Illuminates Dust Around Supergiant Star V838 Monocerotis

"Light Echo" is my favorite Hubble image because it perfectly captures a poem I wrote as a young astronomer, many years ago (50 to be exact):

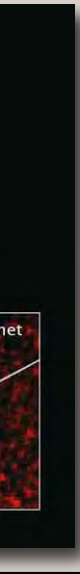
Light Echo

As a secret child, did
I hunger for the stars,
spinning through
a bowl of clouds. I knew the stars
and softly called
their secret names:
Thuban! Mizar! Tarazed! I knew the stars
while my brothers
all around me
Stared at the street lights.
—Elaine Lovitt



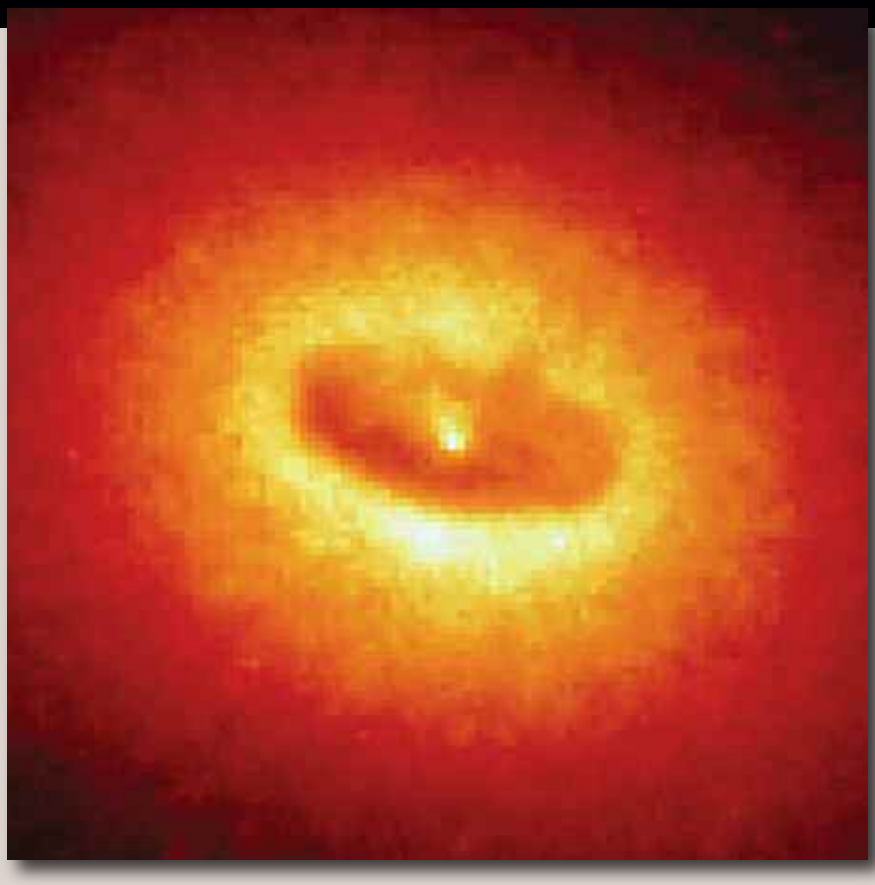
The Doomed Star Eta Carinae

This composite image superbly captures the extreme forces and violent dynamics of an exploding star. It has a three-dimensional quality and feeling of the roiling masses of hot gas and dust. Beneath its magnificence one senses the death and birth processes occurring here. Nuclear processes, electromagnetic forces, plasmas, and jets are captured with an elegant beauty.
—Clinton Brooks



HST Image of Fomalhaut and Fomalhaut b

This photograph of a visible planet orbiting its parent star along with a huge circular disk of stellar material magnificently illustrates the apparent readiness of star systems to produce solar systems similar to our own. This propensity, combined with the relative abundance of organic molecules and water discovered in our own solar system and galaxy, increases the prospects for the existence of other life in the universe to breath-taking new levels.
—Michael L. Turney

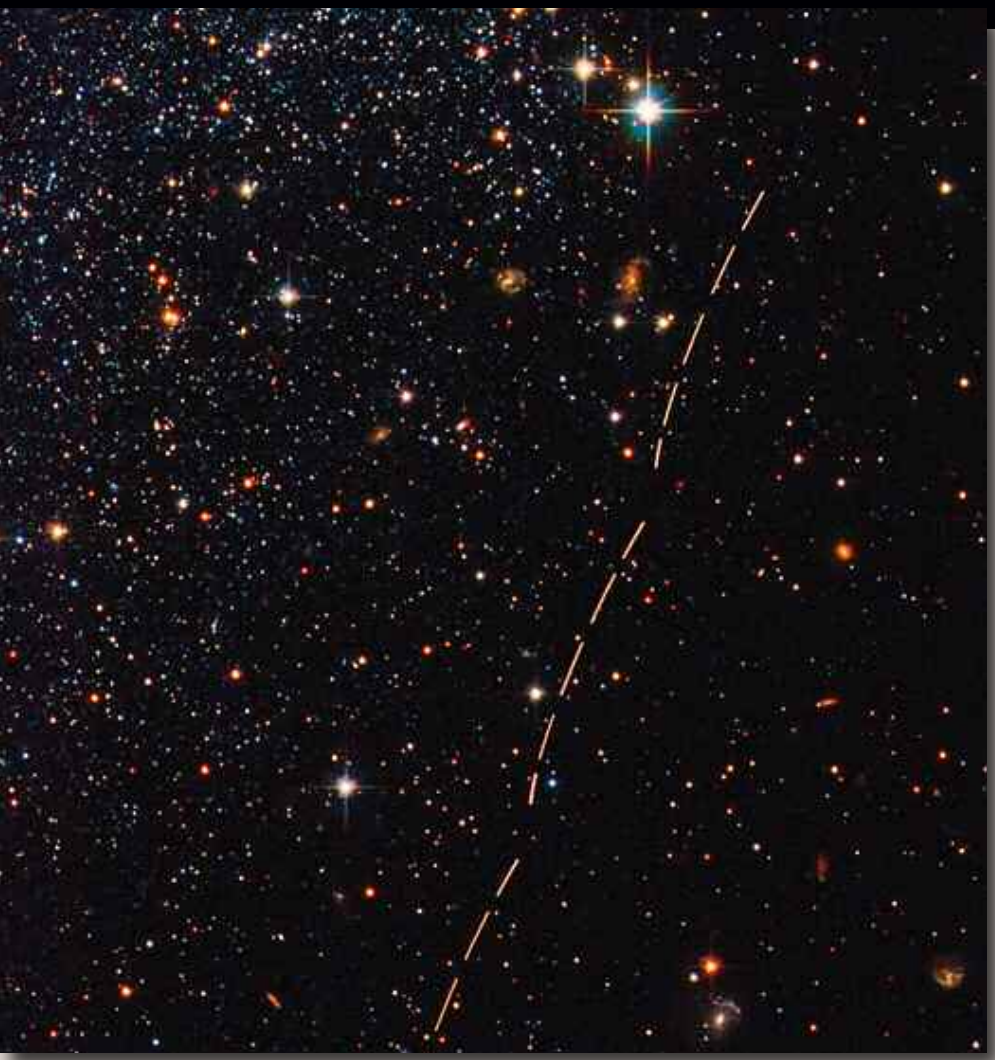


Giant Disk of Cold Gas and Dust Fuels Possible Black Hole at the Core of NGC 4261

When I was a kid I always dreamed about what a black hole would really look like, if it existed. It was but a dream and a theory then. Hubble filled in the blanks. It painted it yellow, orange, red, and black and made the most destructive force in the universe also a thing of beauty. It made a theory a reality, and it made me believe in fantasy again.
—Robert Mera

A Giant Hubble Mosaic of the Crab Nebula

Choosing one image was difficult because they are all so captivating and informative, and undoubtedly show the priceless value of the Hubble telescope. I chose the Crab nebula because the colors and shape also resemble the sea—a crashing wave. I saw in this image a metaphor for the universe itself as a sea of life, of infinite beginnings and possibilities of which we are a part. *—Yawaridi Southerland*

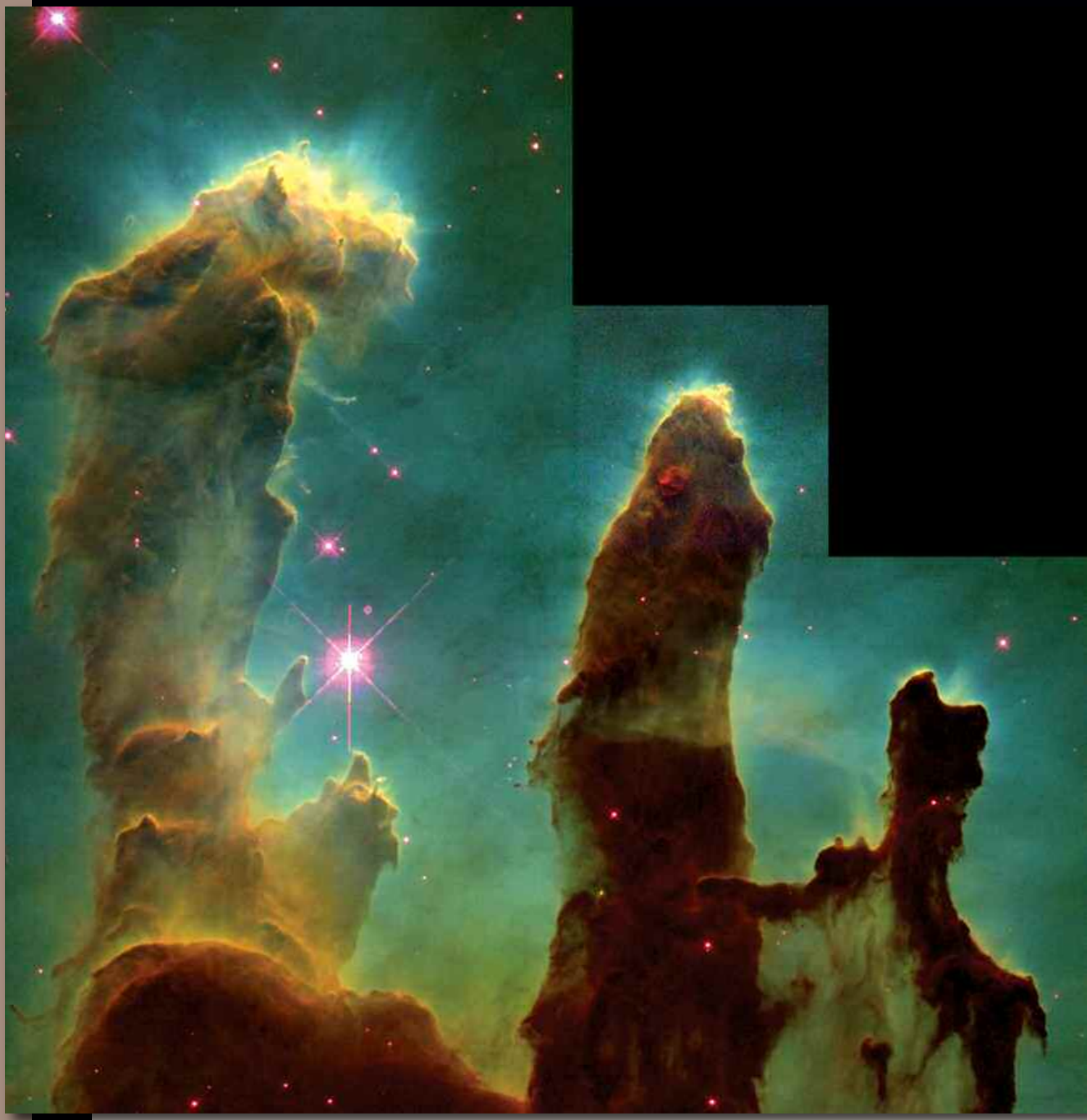


Sagittarius Dwarf Irregular Galaxy with Asteroid

For me, Hubble's greatest gift is offering perspective through juxtaposition. That is why I am enchanted by this image of an asteroid meandering before a grand backdrop. The scope of the universe comes into focus. Initially, I was moved by the idea of a solitary pilgrim on a long, cosmic journey. But I also find comedy. It's as if this audacious little fellow is crashing Hubble's quest for yet another grand panorama.
—Jake Christensen

Jupiter's Galilean Satellites

When viewing Jupiter's four Galilean moons, the possibility of new discoveries excites my imagination. Europa may give us an ocean of water and extra-terrestrial life. Callisto may also have an ocean, or perhaps the geologically active Io or the magnetosphere of Ganymede will surprise us with a new understanding. These images remain important 400 years after Galileo first saw them, opening a new world of discovery and understanding then and possibly now.
—Philip Lehpamer



Pillars of Creation in a Star-Forming Region

•This particular image is important to me because it looks like "fingers of God" reaching out to create new stars and solar systems and represents just how small humans are on the grand scale of the universe. Images from the Hubble really bring this point home and should humble all of us. For us to appreciate just how important and knowledge-expanding space exploration and space astronomy is, the Hubble Space Telescope has provided many vivid images.
—Glenn G. Whiteside

•When the strange and beautiful image of the gas pillars in the Eagle nebula (M16), "Pillars of Creation in a Star-Forming Region," first appeared in 1995, I struggled then to put my feelings of awe and wonder into a poem titled "Random Glory," including these lines: "I have never seen so close or clear/ The common miracle of heavens straining bloom/ Of stars cast to contradict the night/ And we past seven thousand years of gloom/ Can now see their first morning's glory bright . . ."
—Gerry L. Sperry

World Watch

Washington, D.C.—What will the Obama administration do with President Bush's proposed Vision for Space Exploration? Will they keep the 2020 target date for America's next landing on the Moon? Will they really retire the space shuttle by the end of 2010? Will they continue with the Ares/Orion rocket and new crew vehicle despite criticism? Are they going to live with the "gap"—the planned four-year period in which the United States will have to rely on Russia for access to the International Space Station (ISS)? Will the United States completely abandon the ISS after 2015?

All of these questions were supposed to be answered—or at least addressed—in the administration's first NASA budget proposal, but they were not. Instead, the White House announced that a blue-ribbon independent review panel will conduct an estimated three-month inquiry into Constellation—NASA's program for human spaceflight in the next decade. The review will be chaired by well-known aerospace leader Norm Augustine, the former chairman of Martin Marietta Corp. (now Lockheed Martin). Augustine was also a member of The Planetary Society's Board of Directors.

The Planetary Society welcomes the review. We hope that it not only affirms the goals of human exploration into the solar system but also creates a greater public consensus for its achievement. Our recommendations for human exploration (and its synergy with robotic exploration) have been presented to the new administration in our "roadmap" to space, *Beyond the Moon* (for more on the roadmap, see the January/February 2009 issue of *The Planetary Report*).

For the time being, the proposed budget keeps NASA on track for shuttle retirement and Ares/Orion development. The plan supports a schedule of nine more shuttle missions, including an ambitious six in 2010.

The uncertainty in the human program was not mirrored in other parts of NASA. The budget calls for the funding of several new Earth science missions and an overall increase in the Earth science budget. Aeronautics and other technology also received a boost. The budget for planetary exploration and other parts of space science is relatively flat for the next several years—although there is strong support for the big-ticket items: Mars Science Laboratory (MSL), the James Webb Space Telescope, and the *National Polar-Orbiting Operational Environmental Satellite System*. The new Europa flagship mission, to be done jointly with Europe, also received a strong endorsement, although it won't need a large budget for a few years.

Summary of the Science Budget Request

The science totals increase about $200—$300 million per year in fiscal years 2011 to 2014 from the 2009 budget request, with all of the increase in Earth science.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**4,733.2**	**4,903.0**	**4,477.2**	**4,747.4**	**4,890.9**	**5,069.0**	**5,185.4**
Earth Science	1,237.4	1,704.6	1,405.0	1,500.0	1,550.0	1,600.0	1,650.0
Planetary Science	1,312.6	1,325.6	1,346.2	1,500.6	1,577.7	1,600.0	1,633.2
Astrophysics	1,395.6	1,281.2	1,120.9	1,074.1	1,042.7	1,126.3	1,139.6
Heliophysics	787.6	591.6	605.0	672.6	720.5	742.7	762.6

Summary of the Human Exploration Budget Request

The asterisks acknowledge that the administration will submit a revised request after the blue-ribbon panel finishes its review. Currently, the request for 2011 to 2014 is less than was proposed last year for the Constellation program.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010*	FY 2011*	FY 2012*	FY 2013*	FY 2014*
FY 2010 President's Budget Request	**3,299.4**	**3,905.5**	**3,963.1**	**6,076.6**	**6,028.5**	**5,966.5**	**6,195.3**
Constellation Systems	2,675.9	3,433.2	3,505.4	5,543.3	5,472.0	5,407.6	5,602.6
Advanced Capabilities	623.5	472.3	457.7	533.3	556.5	558.9	592.7

The Planetary Society's biggest concern is the future of Mars exploration after the *MSL* mission in 2011. Are we to take the road to Mars all the way to a Mars sample return mission and then on to a human destination? The Mars planning has been virtually cut out of Constellation, and the robotic program for Mars exploration has had cuts of more than half a billion dollars in the past several years. We are further from humans landing on Mars that at any time in the history of the space program. The same is true for robotic sample return.

In late May, the Society convened a group of Mars experts and leaders to examine the rationale and principles for Mars exploration for the next several decades. Results will be used for the Society's political advocacy and public information efforts.

The strong support for NASA and the budget increase for the agency are notable at this time, when there are so many other extraordinary national and global economic priorities. NASA is a vital part of the administration's desire to invest in science and technology, although much of the funding for NASA is nondefense, discretionary spending and hence always at risk.

Despite the strong support, many in the space community are worried about the uncertainty in the human exploration program and the possibility that the Augustine-led review will come up with major changes. In addition, it is important to remember that this is only a budget request to the U.S. Congress. Over the next many months, there will be a lot of back and forth as the House and Senate negotiate the 2010 budget.

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

Questions and Answers

When the* Cosmos 1 *team was designing the mission, what potential problems did they work to avoid? Other than the blades not unfurling in orbit, what else did they try to guard against?

Launch vehicle issues aside, did* Cosmos 1 *reveal new things to look out for in future solar sail missions?

—Kirby Milner
Topeka, Kansas

When one designs a spacecraft system and mission, all problems are of concern because one minor error can destroy a mission. The most critical issue is always the interaction of subsystems. In solar sailing, the biggest technical uncertainty is in the dynamics of the sail. That cannot be fully simulated, and how the sail will flutter or resonate while it is being deployed and when it is moved is a concern.

Cosmos 1 was the first fully developed, tested, flight-qualified solar sail spacecraft ever built. The achievement of that goal revealed many of the subsystem interactions and system design issues I cited above, and it also proved that a low-cost spacecraft approach for new technology was possible.

Delivering the spacecraft to the launch vehicle was a major accomplishment. Unfortunately, *Cosmos 1* also confirmed that nothing has changed in 30 years of solar sailing studies. Getting a spacecraft into space reliably and affordably is still our biggest challenge. There are no free launches.

—LOUIS FRIEDMAN,
Executive Director

Is there, or was there ever, any risk of a spark (ignition source) from a probe like* Cassini/Huygens *on Titan causing a fire with methane, ethane, et cetera, as a fuel? Are there any oxidizers such as nitrogen or chlorine present on Titan for such a reaction to occur? If there is no risk, why not?

—Pat Foster
Aioi Hyogo, Japan

Oxygen is extremely rare in Titan's atmosphere, and it exists not in the "free" (molecular oxygen) form that we breathe but primarily in carbon monoxide. Nitrogen is present as molecular nitrogen—like that in our atmosphere—but it is extremely stable chemically. Some nitrogen participates in methane chemistry to make hydrogen cyanide (HCN) or cyanogens (CN compounds), but nothing that would burn in Titan's atmosphere. It is so cold on Titan that chlorine—if it exists—should not be in the atmosphere; indeed, it has not been detected.

Nonetheless, sources of chemical energy, such as acetylene, are made from methane in Titan's atmosphere. In Earth's oxygen-rich atmosphere, acetylene explodes, but on Titan it gently polymerizes to make benzene or longer-chain polymers, a process involving the release of small amounts of energy. This could be a source of energy for chemistry—or even a kind of exotic biochemistry—on the surface of Titan.

Huygens carried no rocket engines (it was pushed off *Cassini* by springs), and it parachuted to the surface using no propulsion. Any future vehicles carrying oxygen or other oxidizers—and, of course, spacesuits with oxygen tanks—would need to be engineered carefully with the methane-rich atmosphere in mind.

—JONATHAN LUNINE,
University of Arizona

How about not just deflecting but, rather, capturing a near-Earth asteroid (NEA)? What sort of velocity changes would be necessary to put one into orbit in the Earth-Moon system? With enough time, could a gravity tug do that? It is so expensive to lift stuff from Earth. We might be talking about very long time frames here that challenge the time versus value-of-money theory.

—Charles B. Warren
San Francisco, California

The change in orbital speed needed to capture an NEA into orbit around our planet is far, far greater than that necessary to merely nudge it off course to prevent an impact. For example, let's use everyone's favorite NEA "poster child" of late, the roughly 300-meter-diameter Apophis. This asteroid has a mass of a couple dozen million tons. A gravity tractor spacecraft with a mass comparable to that of a communications satellite (a ton or two) would change the orbital speed of the asteroid by about 0.03 millimeters per second for every year that the spacecraft hovered near the asteroid. If you want to prevent a future impact by keeping Apophis from passing through a small orbital "keyhole," you need to change the asteroid's motion by only a few microns per second. We can do the job with a gravity tractor in a few months of hover time.

On the other hand, to put the asteroid into orbit around Earth, we'd have to change its speed by an amount comparable to the difference between its encounter speed past Earth and its new orbital speed around our planet. In the case of Apophis, that's on the order of a few kilometers per second, depending on where you would want it to end up orbiting in the Earth-Moon system. To do the job, our gravity tractor would have to hover near the asteroid for a hundred million years or so!

It's far more cost-effective (and calendar-effective) to simply use the NEA's resources where they are: in near-Earth space. If you really want, or need, to use the resources near Earth, it would be better to take your resource processing system to the NEO and bring the processed goods back home.

—DAN DURDA,
Southwest Research Institute

Factinos

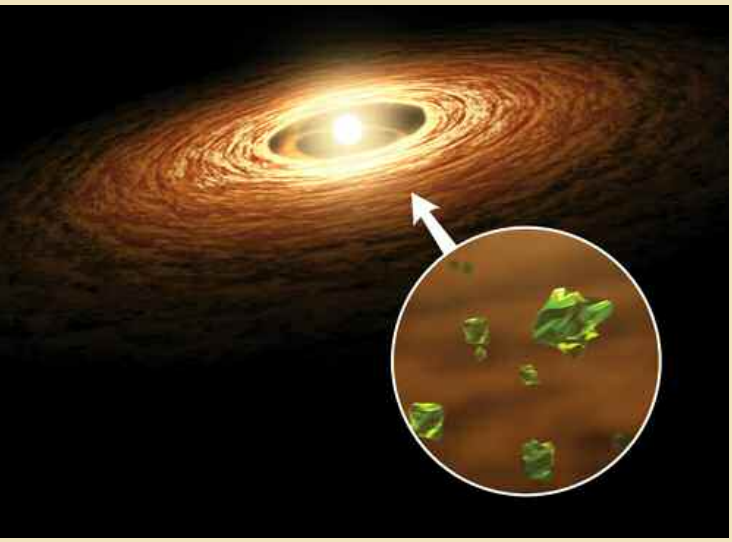
Scientists may have figured out how tiny silicate crystals, which need very high heat to form, end up in the icy comets that come from the deep freeze of our solar system's outer edges. The crystals would have started as non-crystallized silicate particles, part of the gas and dust from which the solar system developed.

Researchers using NASA's Spitzer Space Telescope to observe a young, Sun-like star believe they've found a new explanation for where and how these crystals may have been created. Their study, which appeared in the May 14, 2009 issue of *Nature*, provides new insight into the formation of planets and comets.

The team found that silicate appears to form into crystals after an outburst from a star. They detected the infrared signature of silicate crystals on the disk of dust and gas surrounding the star EX Lupi during one of its frequent flare-ups, or outbursts, which was seen by Spitzer in April 2008. These crystals were not present in Spitzer's previous observations of the star's disk during one of its quiet periods.

"We believe that we have observed, for the first time, ongoing crystal formation," said Attila Juhasz of the Max Planck Institute for Astronomy in Heidelberg, Germany. "We think that the crystals were formed by thermal annealing of small particles on the surface layer of the star's inner disk by heat from the outburst. This is a completely new scenario about how this material could be created."

—from NASA/JPL-Caltech



This illustration shows a young Sun-like star encircled by its planet-forming disk of gas and dust. Streams of material spiral inward from the disk and into the star, increasing its mass and causing it to brighten and heat up dramatically. This outburst of heat makes temperatures rise in the star's surrounding disk, causing the amorphous silicate particles there to melt and then cool into forsterite (inset), a type of silicate crystal often found in our solar system's comets.

Illustration: NASA/JPL-Caltech/T. Pyle

An international team of scientists has found that giant exoplanets orbiting very close to their stars could lose a quarter of their mass during their lifetime. The team found that planets that orbit closer than two percent of an astronomical unit (AU, or the distance between Earth and the Sun) may lose their atmospheres completely, leaving just their core.

The group, led by Helmut Lammer of the Space Research Institute of the Austrian Academy of Sciences, believes that the recently discovered CoRoT-7b "Super Earth," which has less than twice the mass of Earth, could be the stripped-down core of a Neptune-sized planet.

Lammer's team used computer models to study the possible atmospheric mass loss over a stellar life-cycle for exoplanets at orbiting distances of less than 0.06 AU. The 49 planets they studied included hot gas giants (planets with masses similar to or greater than that of Saturn and Jupiter) and hot ice giants (planets comparable to Uranus and Neptune).

The team found that gas giants could evaporate down to their core size if they orbit closer than 0.015 AU. Lower-density ice giants could completely lose their hydrogen envelope at 0.045 AU. Gas giants orbiting at more than 0.02 AU lost five to seven percent of their mass. Other exoplanets lost less than two percent.

—Adapted from *ScienceDaily.com*

The Sun has entered its weakest cycle of magnetic activity since 1928, meaning fewer solar flares and coronal mass ejections, reports a panel of solar scientists assembled by the National Oceanic and Atmospheric Administration's (NOAA) Space Weather Prediction Center. The cycle—which scientists believe began in December 2008—will peak in May 2013.

Storms of solar magnetic activity cause flares and ejections that can spit X-rays, ultraviolet light, and billions of tons of charged particles into space and toward Earth. These outbursts can make Earth's upper atmosphere expand, potentially knocking out electrical grids and disrupting satellite communications—and can harm spacewalking astronauts.

"It's fair to say we probably won't see a whole lot of solar storms from this cycle," said Douglas Biesecker of NOAA's Space Weather Prediction Center in Boulder, Colorado. "But a weaker cycle won't lessen the intensity of the storms, just the number of them."

—Adapted from *ScienceNews.com*

Members' Dialogue

Check the Map

I was deeply disappointed and somewhat disgusted after reading "Beyond the Moon: A New Roadmap for Human Space Exploration in the 21st Century" in *The Planetary Report* of January/February 2009. While I fully support the notion that space exploration is an inspiration for the human race and a great opportunity to unify the world and to engage the younger generation, I found nothing "forward-looking" in the Roadmap proposed by the Planetary Society. No, this Roadmap for human space exploration is backward-looking, just like the Vision for Space Exploration proposed by President Bush was—but on a more grandiose scale. If the Vision for Space Exploration is expected to be a failure, then the Roadmap will, most likely, be a grandiose failure.

Contrary to what the Roadmap claims, the competition between human spaceflight and robotic science missions is not just "perceived"; it is real—real because human spaceflight is so outrageously expensive that it inevitably drains the lifeblood from many Earth and space science initiatives. Since the end of the *Apollo* era, we have spent 100 billion dollars on human spaceflight—with absolutely nothing to show for it. By contrast, "cheap" robotic missions have returned a wealth of scientific knowledge—though, unfortunately, many have been canceled or curtailed because NASA needed money for its human spaceflight programs.

The Roadmap mentions "synergies" between human spaceflight and robotic exploration. In truth, there are no such synergies. All human spaceflight will do is drain resources that could more efficiently be infused directly into robotic space missions. I am not asking to replace humans with robots. All space exploration is "human" space exploration. But humans can stay here on Earth while robots do the dirty work out there. Yes, the Roadmap asks for both human spaceflight and robotic exploration, but considering NASA's usual budget constraints, it is nothing less than utopian to think we can develop interplanetary human spaceflight capabilities and at the same time strengthen robotic science initiatives.

I know that sending robots into space would probably not be considered a "cultural milestone" or an "adventure woven into the fabric of humanity." But is fulfilling romantic dreams really worth hundreds of billions of dollars and possibly sacrificing robotic missions that would actually return scientific knowledge? The imperative for humans is to "understand" our planetary neighborhood, not to "experience" it. To ask that humans experience our planetary neighborhood seems a bit silly. Robotic space probes—remotely controlled by humans—are perfectly capable of providing the understanding without the experience.

To put it in a nutshell: We have to stop running space exploration like a Boy Scout camp and start running it like a business. Adventure and excitement have no place in today's space exploration programs. For every dollar we invest in space exploration, we need a dollar's worth of returns in terms of scientific knowledge, Otherwise, the dollar is not a dollar spent, but a dollar wasted.

The world has changed since the 1960s and 1970s, and so has space technology. Instead of ignoring those changes, we should take advantage of them. The Planetary Society needs to promote programs that obviate the need for humans in space—not cling to the thrills of a bygone era.

—HANS K. BUHRER
Smithsburg, Maryland

Thank you for your thoughtful letter. You raise many good points—points that we are considering. Briefly, let me try to defend our Roadmap as forward-looking because it makes proposals that at least the policymakers are considering bold: (1) moving out into interplanetary space with new distances and flight duration accomplishments for humans, (2) a human mission to a near-Earth asteroid, (3) synergy between robotic and human programs for Mars sample return and other preparations for human to Mars, and (4) delay of the United States' return to the Moon until the interplanetary transportation steps are developed and until it can be done internationally.

The debate over the conflict between human and robot science mission budgets is as old as the space program. One recent proof that human exploration goals are good for science is the current interest in lunar science missions. For more than three decades, there was no such interest, and there were no robotic mission plans until the Vision for Space Exploration proposed a human mission to the Moon.

I agree that the cost of missions must be justified—but not by science alone. Space ventures, especially those involving humans, have other important political and geopolitical goals besides just science.

All of the questions you raise do require further discussion and consideration, something that we are encouraging among all space-faring nations and that we encourage within our membership. Thanks again for your views.
—LOUIS D. FRIEDMAN
Executive Director

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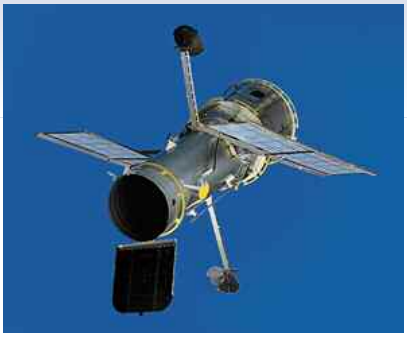
Pasadena, CA 91106-2301
or e-mail: *tps.des@planetary.org*

Discovering Our Place in the Universe!



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.

Regular price: $17.50 **Member price: $15.75**

#525 Hubble Space Telescope (pictured)
#560 *Voyager*

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 Shoemaker Near Earth Objects 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**

Nebula Poster

This awe-inspiring image from NASA's orbital Spitzer Space Telescope shows a false-color infrared view of nebula RCW 49—a birthplace for many hundreds of new stars and likely many thousands of planets.This stunning poster features one of Carl Sagan's poignant statements: "If we crave some cosmic purpose, then let us find ourselves a worthy goal." 22" x 34" 1 lb. **#315**

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"Dusters" Stardust@home T-Shirt

Adult sizes: S, M, L, XL, XXL 1 lb. **#585**

Regular price: $22.22 **Member price: $20.00**

Surf Titan T-Shirt

Adult sizes: S, M, L, XL, XXL 1 lb. **#593**

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**

We're Saving Space for You! Bumper sticker

1 lb. **#695**

Regular price: $3.33 **Member price: $3.00**

Planetary Society Key Ring Medallion

1 lb. **#677**

Regular price: $17.78 **Member price: $16.00**

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In *Jupiter's Stormy Sunset*, lightning flickers in the lower levels of a huge storm system lit by the setting Sun. A giant cumulus cloud of ammonium hydrosulphides (colored in yellows and oranges by other compounds) boils upward in the giant planet's troposphere. At this level, Jupiter's atmospheric pressure is about twice the atmospheric pressure at sea level on Earth. Io and Ganymede are visible through high layers of haze, while a meteor begins breaking up as it plunges toward the Jovian clouds.

Marilynn Flynn is a space artist who grew up with the space program. Although she hasn't had a chance to go into space herself (yet), one of her paintings orbited Earth for several months on board *Mir*. Her gallery of space art can be seen online at *www.tharsisartworks.com*.