The PLANETARY REPORT

Volume XXX Number 4 July/August 2010

Hayabusa Returns

From The Editor

As you know, The Planetary Society will soon welcome new leadership, when Bill Nye the Science Guy takes over as executive director in September. To help you get to know him better, in this issue, Bill tells you a little about his multifaceted self—as a working engineer, as a world-renowned performer, and as a soon-to-be executive director.

Bill is a Charter Member, so he knows about both the Society's accomplishments and its potential. He says, "We need to explore. That's what you and I support at The Planetary Society."

With new leadership, the Society's commitment to exploration will progress with programs like the Search for Extraterrestrial Intelligence. The discovery of a technological civilization on another planet would resonate through the ages, and Society Members have supported SETI for most of our history.

In 1982, we began to work with SETI innovator Paul Horowitz. When it comes to building devices to search for signals from across the galaxy, Paul has never stopped advancing. Plus, he has challenged a generation of young scientists to push the boundaries of the possible to detect faint messages from possible alien civilizations, as you can read about in these pages.

The Planetary Society makes it possible for people like you and me to play significant roles in projects like SETI that advance science and exploration. We can make the wonderful possible. As Bill says, "Let's change the world!"

—Charlene M. Anderson

On the Cover:

Top: On June 13, 2010, Japan's *Hayabusa* spacecraft returned home from its seven-year journey to asteroid Itokawa. A team of scientists from the Japan Aerospace Exploration Agency (JAXA), NASA, and other organizations studied the spacecraft's fiery reentry using instruments on board NASA's DC-8 airborne laboratory. The small point of light at the lower right in this still video frame is the precious sample-return capsule. Bottom: *Hayabusa* team members transported the sample-return capsule to Australia's Woomera Test Range Instrumentation Building, where it was held overnight before being returned to Japan.

Images from top: NASA/ARC-SST SETI Institute, Australian Science Media Center

Background:

Hayabusa's sample-return container and its parachute lie on the ground of southern Australia's Woomera Prohibited Area on June 14, 2010. Scientists were surprised to find the outside of the capsule in "good-as-new" condition after surviving the atmospheric reentry that incinerated the main spacecraft.

Photo: JAXA

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A PUBLICATION OF THE PLANETARY SOCIETY

Passing the Torch: The Planetary Society's New Executive Director

*In the few weeks since I announced my transition from the position of executive director of The Planetary Society, I have been inundated—and deeply moved—by encouragement and good wishes from Members and colleagues around the world. That excitement about the future of The Planetary Society—*our *Planetary Society—reflects the confidence that I, too, have in the Society in this 30th anniversary year and in the decades ahead.*

I am excited to share with you my pride in passing the torch of executive director to Bill Nye, internationally recognized science educator and vice president of The Planetary Society. From his education at Cornell University as a student of Planetary Society cofounder Carl Sagan, to his engineering work on Boeing 747s, to his success as Bill Nye the Science Guy, to his decade-plus service on our Board of Directors and as a Charter Member of the Society, Bill brings the acumen, leadership, and passion crucial to guiding The Planetary Society to an even greater future.

I am delighted to turn the leadership of The Planetary Society over to Bill, and I am eager to work with him when he takes on his new position in September. That we have such an active and involved Board helps both me and Bill (we will both remain on the Board) approach this transition with confidence. Thank you for your strong support. I know that with you, he and our Society will thrive.

—Louis D. Friedman, Executive Director

May I Introduce Myself? I'm Bill Nye the Space Science Guy

Greetings, Planetary Society Members and friends. Every moment I spent in Professor Carl Sagan's class had a profound influence on me. As many of you know, he was one of The Planetary Society's founders. As I sat in his classes and symposia, he'd show us pictures from space, fresh from the Jet Propulsion Lab. He'd show us pictures of Mars from the newly landed *Viking* spacecraft. He'd show us meteorites and craters. He'd have us look not only with our eyes but also with our disciplined reasoning—and intuition. We learned how extraordinary our world is and how one might go about discovering life elsewhere. By studying the planets, one senses how remarkable it is that we can understand our place in

At left: On September 7, 2010, Bill Nye will take over the reins as executive director of The Planetary Society.
Photo: Loren Roberts

space. Since then, I've been hooked on the message and purpose of The Planetary Society. We seek to know worlds—those near and far as well as our own.

Now, I find myself closer to this quest than ever before in my life. I am to become the executive director of The Planetary Society.

You and I help explore planets. We help researchers study other worlds. We help people map and study near-Earth objects like asteroids, comets, and odd bits of boulders and bolides hurtling nearby at 11 kilometers (7 miles) per second. We help space agencies understand what you, as a Planetary Society Member, want them to do. We work to answer those two questions: Where did we come from? And, are we alone?

By studying other worlds, you and I will help humankind know more about our own.

Where I Come From

I graduated from Cornell University with a degree in mechanical-aerospace engineering. I worked at the Boeing Company for a few years, characterizing, testing, and designing flight control systems on the 747, with occasional work on other 700-series airplanes. The 787 was a gleam in management's eye at that time. I left there for a brief stint at a shipyard that specialized in oil slick skimming and the seemingly trivial task of separating oil and water in the oil field. As we are all becoming gravely aware, oil and water do mix. Spilling oil is serious, serious business. The environmental effects are miserable, but the technical problem—stopping the flow from the blown-out gusher—will be solved by skilled workers and engineers. I'm proud of my engineering background.

My last full-time engineering job was at Sundstrand Data Control (now Honeywell). We made business jet navigation systems and oil well navigation tools—you do have to steer drill bits. I worked on a very small black box to house ring laser gyros. They have no spinning wheels; they have reflected laser beams instead. Today, that sort of job is handled by global positioning systems. Versions of this inertial navigation system are still around in case something goes very wrong with spacecraft in orbit.

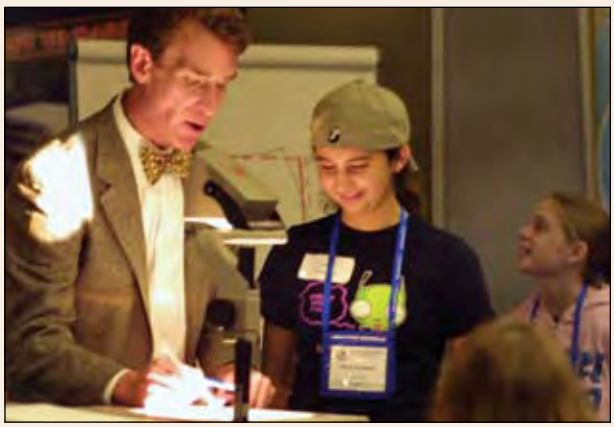
As a restless young man, I started a comedy-writing career. To support myself, I continued to work 20 or so hours a week as an engineer, having made personal contacts in the instrument engineering community.

I had a niche, as a designer. I was one of the last guys who was comfortable with a great big drawing board. My six-foot board was fitted with a right-angle–ensuring *drafting engine*. I had a taboret that carried lead-holders (we don't call them *pencils*), a few dozen plastic drafting templates, and a motor-driven electric eraser. This old-fashioned skill carried me, until the host of the comedy show I was writing for suggested that I could be "Bill Nye the Science Guy." As you might infer, that suggestion changed my life. I often write my sobriquet with the familiar circle R symbol: "The Science Guy®."

My first bit was "Household Uses of Liquid Nitrogen." The premise was that you have liquid nitrogen around anyway . . . hey, who doesn't? So, here are a few tips . . . No really, it was funny. I still can chew "cold-roasted" marshmallows and have steam come out my nose.

By the time 1987 came along, it felt as though U.S. engineering firms were being outperformed by engineers and manufacturers in other countries around the world. Where I was working, managers became focused on making a profit every quarter. That's a hard job when you're building inertial navigation systems from scratch. Frustrated with what I felt was their the-sky-is-falling style, I wanted to work for the future, to influence young people—kids.

By being around the NBC affiliate television station in Seattle, KING TV (in King County), I could explore an idea for a show called *Bill's Basement*. We made a few three-minute segments. The premise was that kids would come by, and we would talk about science. Through a few phone calls, I made arrangements to meet with Professor Sagan, some 10 years after graduation. I talked with him about my television ideas for young people. He reminded me to focus on pure science. Kids, he said, "resonate" with science. Technology changes, but science is our way of seeking the truth about the universe. I embraced that idea.



Bill Nye is dedicated to igniting in others—especially young people—his passion for pure science and for space exploration.
Photo: Courtesy of Bill Nye

Left: Bill was profoundly influenced by his Cornell University professor Carl Sagan, who said "We are all star stuff." Sagan's influence led Bill to the Planetary Society and to its—and his—mission to explore other worlds and to seek life outside the confines of our own home world. This new Hubble Space Telescope image reveals a stellar nursery in the Large Magellanic Cloud—a satellite galaxy near the Milky Way. This area, informally called "N11," is one of the most active star-forming regions in the nearby universe.
Image: NASA/ESA

Above: Bill and Louis Friedman inspect the solar sail after it was deployed by hand (to test packing and folding) at the LightSail System Review Meeting, which was held in San Luis Obispo, California in December 2009.
Photo: The Planetary Society

At KING TV, I met my producer friends Jim McKenna and Erren Gottlieb. We did videos for the Washington State Department of Ecology, and along the way we created *Bill Nye the Science Guy*. The show won 18 Emmys and got some notice.

How I Got Here and Where We're Going

I stayed in touch with Professor Sagan, corresponding with him and his collaborator and wife, Ann Druyan. As most of you know, he died after having fought a very tough fight with myelodysplasia, a rare blood disease. I was invited to speak at Professor Sagan's memorial service in Ithaca, New York.

There I met Louis Friedman and, later, Bruce Murray, our cofounders. Bruce ran the Jet Propulsion Lab during the heyday of the *Voyager* and *Viking* missions. He is the scientist and visionary who pointed out that pictures not only help us see what other worlds might be like, they also have great scientific value. I was familiar with Lou's work, not only from reading *The Planetary Report* but also having read his book on solar sailing, a technology that is being realized at last. At that memorial service, Lou asked me to join the Board of The Planetary Society. I was amazed and honored. I agreed to join at once. Since then, we have kept the founders' dream alive.

The answers to the deep questions about our place in space are continually being refined—through science. We are from and of the cosmos. Our atoms and molecules came into existence in the deep, hot nuclear fusion furnaces of stars. As Carl Sagan observed so eloquently, we are all star stuff. But then, where did the star stuff originate? What, if anything, came before? Of everything that happened here, did or does it happen elsewhere in the universe? To seek these answers, we need to explore. That's what you and I support at The Planetary Society.

After joining the Society as a Charter Member in 1980 and joining the Board in 1997, I now have been elected your executive director, taking the reins from Lou Friedman himself. I will work to promote our mission to explore other worlds and to search for other life.

The Planetary Society will continue to lead space exploration through our projects and grants. We will keep our LightSails flying, so that we can show the world what is possible for the future of space transportation.

As part of our charter, we have to continue our advocacy with space policy makers around the world. NASA is at a crossroads that, to me, is not unlike the turning point it faced in 1980, when our Society started. People are as interested in space exploration as they've ever been, but funding and nationalist concerns often leave lawmakers unwilling to make long-term choices. Time and again, the expertise that The Planetary Society brings to the table helps shape policy. We will continue that work in the years to come.

For The Planetary Society to remain healthy, it has to grow. In the next few years, we will engage young people in the space exploration enterprise. We will reshape *The Planetary Report* and our website just a little, to provide young people with knowledge and understanding of space exploration while keeping our remarkable, authoritative articles for the existing Members.

The coming years are going to be exciting. Together, you and I will continue to seek answers to these deep questions, answers that I claim have the potential to change us—to change the way we feel about the Earth and our place in the universe. I am honored to serve. I look forward to helping you influence space agencies, support space research, and inspire space explorers of all ages everywhere. Let's change the world!

Bill Nye
Executive Director Designate

WE MAKE IT HAPPEN!

Looking for ET Using Laser Light

by Bruce Betts

Many light-years away, on an alien planet, a powerful pulsed laser is hooked to an optical telescope–like system. Brilliant nanosecond (billionth of a second) flashes are directed at the cosmos, including Earth. An intelligent civilization is sending a beacon to announce its presence, to invite communication. For fractions of a second, its laser pulses far outshine its planet's parent star.

Is this just science fiction? We don't know . . . yet. But thanks to Planetary Society Members, we are on the quest to find out. Working with researchers at Harvard University, The Planetary Society is continuing to improve our ability to watch the skies, sifting through more than a terabit of data per second, and there is a big improvement on the horizon to help us sort exotic upper-atmosphere phenomena from extraterrestrial signals and to improve sensitivity.

OSETI: What's Up with That?

Using current Earth technology, we could create a setup like the one described above and outshine Earth's Sun by a factor of more than 10,000 for brief fractions of a second. We've developed this technology within only the last few decades, so imagine how technologically plausible this would be for an advanced alien civilization.

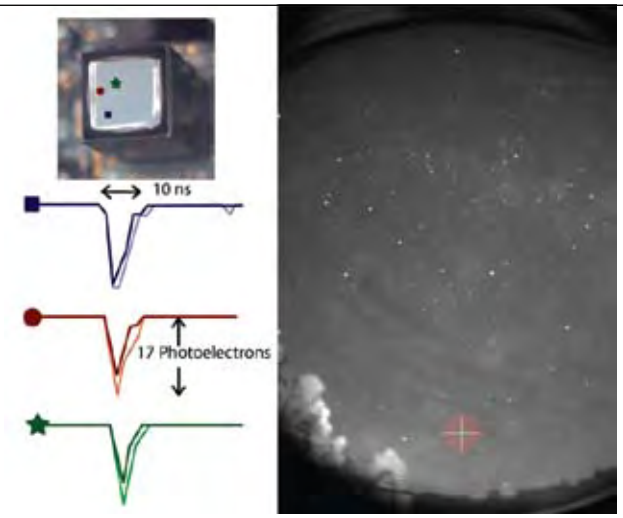
Clearly, we don't know whether alien civilizations exist, or which technology they would use to announce their presence. What we do know is that laser communication, just as it has become prevalent on Earth, has numerous advantages for space communication, including high data rates and more focused beams. But Optical SETI—looking for those signals—is a fairly recent innovation.

A very small number of locations in the world are carrying out targeted Optical SETI, looking for short periods at a limited number of stars. Only one location in the world is looking at the whole sky from its vantage point, and it is doing so every clear night of the year. That location is The Planetary Society's Optical SETI Telescope, operated by Harvard University on a hilltop west of Boston.

Zillions of Observations Made So Far

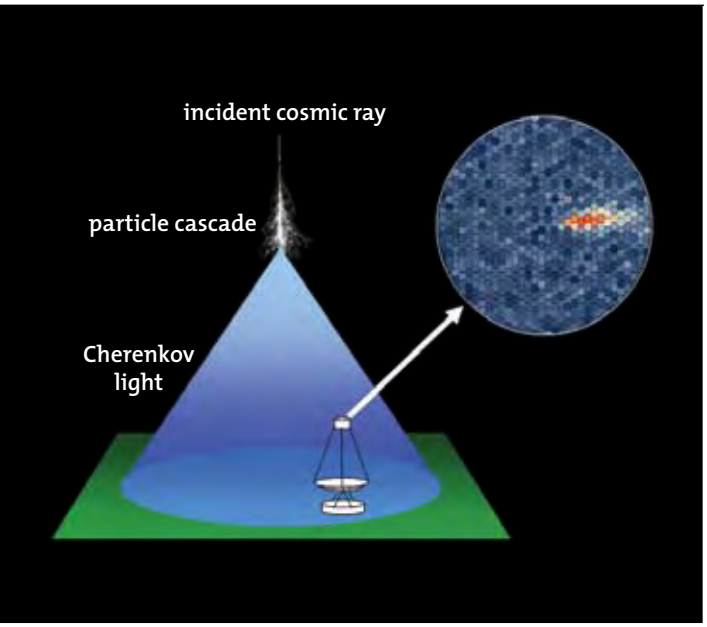
The impressive electronics setup that Paul Horowitz and his students have created processes nearly 2 terabits (trillion bits) of data every second—that's as much as in all the books in print. Perhaps saying "zillions of observations" isn't technically correct, but let me tell you what is. More than three complete scans of the night sky have been completed by doing a million

The Planetary Society's Optical SETI Telescope in Harvard, Massachusetts.
Photo: Al Sliski



In the "event" shown here, three pixels were triggered simultaneously; their positions (square, circle, and star) are overlaid on an image of a photomultiplier tube. A "SkyCam" sky image taken at the instant of the trigger shows a bull's-eye at the telescope pointing direction.
Image: Harvard University

When a cosmic ray hits the upper atmosphere, it slams into atoms, creating a cascading subatomic particle shower and resulting in Cherenkov radiation. In the simulation shown here, the lines represent particle tracks through the atmosphere for a particle shower induced by a 1 TeV proton cosmic ray. (TeV stands for teraelectronvolt, a measure of energy.) The view is from the "side" of the particle shower, with the top of the atmosphere at the top of the image.
Image: F. Schmidt



This diagram shows one of the telescopes in an array in Namibia (High Energy Stereoscopic System) using Cherenkov radiation to study cosmic gamma rays, once again proving that one scientist's signal is another scientist's noise.
Image: H.E.S.S.

billion (10^{15} in science speak) measurements per hour for more than 3,350 hours of observations!

In those zillions of observations, there have been dozens of triggers (spikes in photons detected in two independent detector pixels that are looking at the same point on the sky). None of these triggers has repeated, which is something people look for before they start announcing that they've discovered aliens. Some triggers are well understood. For example, a recently installed sky camera helps to discover triggers caused by those alien craft called airplanes.

The causes of many of the triggers are not understood, but there is a prime suspect: the current arch-enemy of Optical SETI, with roots in outer space, a feisty blue glow, and a penchant for seeming to break the speed limit. Please boo and hiss for Cherenkov radiation! Who?

Save Us from Cherenkov Radiation

Cherenkov radiation is a high-energy particle phenomenon. It gives nuclear reactors a pretty blue color, and it also occurs naturally. It is a bluish light generated as an effect of a particle going faster than the speed of light in a medium. But wait—faster than the speed of light? How is that possible? The universal speed limit is the speed of light in a vacuum, and the speed of light in a medium is slower and not really a speed limit; in fact, it is not even a guideline. For example, the speed of light in water is about three fourths the speed of light in a vacuum. When crazy particles go faster than the speed of light in a medium, then zany effects occur that eventually spit out some blue light. When a cosmic ray (high-energy stuff flying through space, mostly protons) comes slamming into the Earth's upper atmosphere, it starts a chain of particle slamming called a *particle shower* and leads to Cherenkov radiation from particles with a wanton disregard for the speed of light in the atmosphere.

Cherenkov radiation is actually a fascinating physics effect. So why is it the current enemy of our Optical SETI? Because it causes nanosecond-length pulses of light in the atmosphere that can be triggers for our system. That causes wasted effort to be put into follow-ups looking for repeats of the possible alien signal that is really just the result of an upper atmospheric particle party.

Harvard's Curtis Mead (left) and Paul Horowitz with a current Optical SETI board.
Photo: Harvard University

How do we sort this out? The key is that Cherenkov radiation will produce some type of shape on the sky. Although details depend on the energy of the impinging cosmic ray, Cherenkov radiation will not be an unresolved point source, which a far-off alien signal would be. To understand the forthcoming upgrade that will save us from Cherenkov radiation, we need to dig a bit more into the details of the current system.

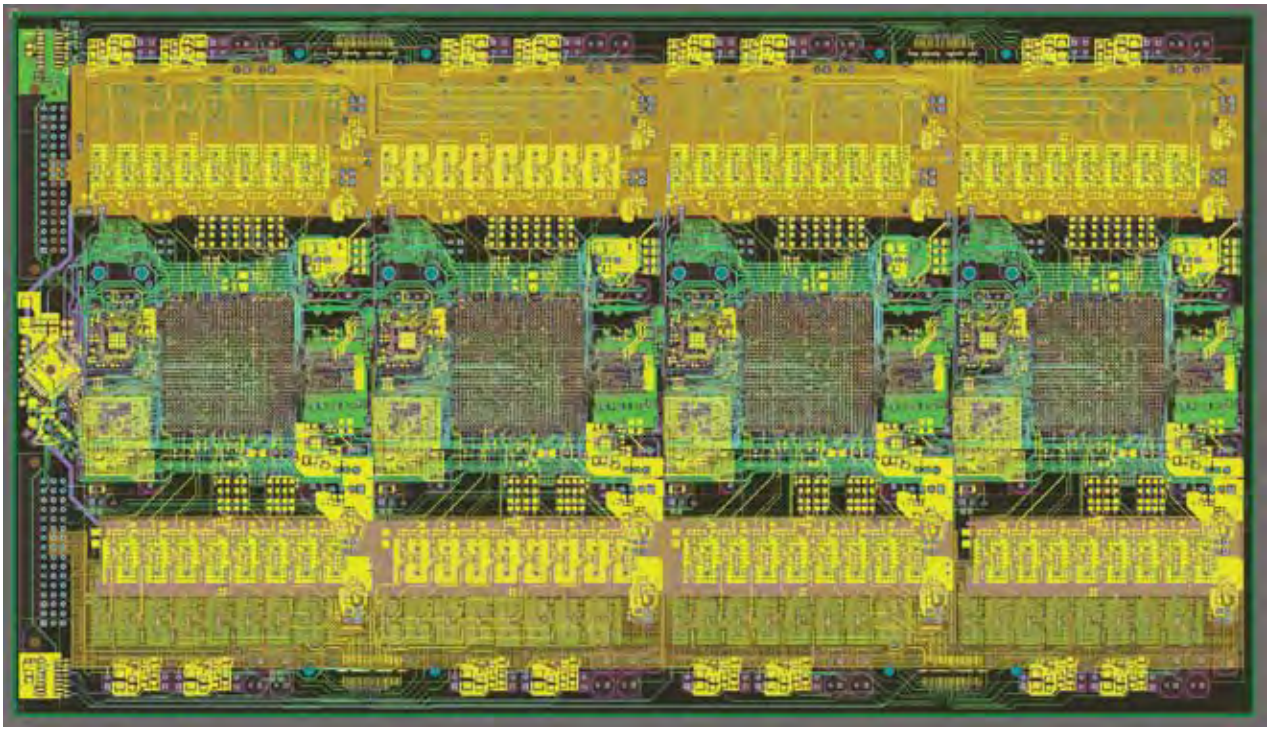
Technology Leaps Forward

Amazing chips were designed by Paul Horowitz's former student (now Dr.) Andrew Howard. They allowed processing of more than 1 terabit per second. The way you do that is to look at all your pixels (two sets of 512) every nanosecond for a spike in photons. If you don't see it, you do not save that result, effectively throwing it away. The only time you save information is when a trigger occurs. Here comes the subtlety. The chips from 2006 have only very limited memory into which to quickly shove information, so the system saves data only for the trigger pixel and 1 out of every 16 of the other pixels. Also, it is limited to only several nanoseconds of data before the trigger, and a few hundred after the trigger. All this means that with the current system, we can't tell Cherenkov radiation from ET.

Enter a whole new spiffy design from Paul's graduate student Curtis Mead, which takes advantage of advances in commercial chips by using them in very clever ways for which they weren't intended. Using commercial, high-performance, field-programmable gate arrays (FPGAs), he's designed a circuit board layout featuring a 12-layer design with hair-thin wiring supporting dense chips with 1,153 tiny contacts each. Mead has tricked them into creating an ultrafast "multichannel flash analog digital converter." (Now would be an appropriate time to make Tim Allen–like grunting noises of approval.)

This will allow for saving data from all pixels when a trigger occurs, as well as saving data for much longer periods before and after the trigger. Cherenkov confusion won't stand a chance. The new board also has other features that will allow greater sensitivity to even weaker ET signals as Optical SETI scans the skies.

A signal from extraterrestrial intelligence is a very small needle in a very large haystack, and to find it,



The Curtis Mead–designed new Optical SETI board showing the 12 layers of electronics.
Photo: Harvard University

Simulated 3–D image of what each new optical SETI board will look like.
Image: Harvard University

we have to search across the dimensions of time, space, and frequency—and we have to do so cleverly. With the Planetary Society Optical SETI telescope, the search continues, even as we strive to make it more efficient and more sensitive. To improve the search, more funding needs to be secured, and Curtis's boards need to be built and tested. If you want to help contribute to these advances, you can donate online at *seti.planetary.org* or use the donation/membership envelope bound into this issue.

The next steps are clear, and we stand on the threshold of more effectiveness, more sensitivity, and more intelligence as we search the skies for extraterrestrial intelligence.

Bruce Betts is director of projects for The Planetary Society.

Explore More

Find out more about our Optical SETI Telescope
planetary.org/programs/projects/seti_optical_searches/

Check out what the Optical SETI Telescope is doing now
planetary.org/special/oseti_telescope/

Help us continue the search
seti.planetary.org

What's **Up?**

In the Sky—August and September

In the first part of August, Venus, Mars, and Saturn are very close together, doing a spectacular dance in the west in the early evening sky. Venus is the extremely bright starlike object, Saturn dimmer and yellowish, and Mars reddish. Mercury is visible during the same period, very low on the horizon to the lower right of the other planets shortly after sunset. On August 12, the crescent Moon joins in just below the three-planet cluster. Meanwhile, very bright Jupiter is rising in the east in the middle of the night and is high up before dawn. The Perseids meteor shower peaks the evening of August 12, but increased activity can be seen from several days before to several days after. The Perseid shower typically is one of the best of the year, with an average of 60 meteors per hour from a dark site.

Random Space Fact

Meteor showers typically are caused by the Earth passing through debris shed by a comet. The Perseid shower is associated with debris from comet Swift-Tuttle.

Trivia Contest

Our March/April contest winner is James Brophy of Tracyton, Washington. Congratulations!

The Question was: As seen from the Earth at visible wavelengths, what is the next-brightest star in the sky after the Sun and Sirius?

The Answer is: Canopus.

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

At what three locations have space shuttles landed after flying in space?

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

Submissions must be received by October 1, 2010. 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*.

Hayabusa Returns!

Looking Back on the Little Spacecraft That Could

by Emily Stewart Lakdawalla

After seven long years and 4 billion kilometers (2.5 billion miles), Japan's* Hayabusa *spacecraft has come home. This daring asteroid sample-return mission has been one of dizzying highs and seemingly impossible-to-overcome lows. In this view,* Hayabusa *has just released its sample-return capsule. The main spacecraft would break up and burn up once it hit Earth's atmosphere.

Illustration: Corby Waste and Tommy Thompson for NASA/JPL

On Sunday, June 13, 2010 at 14:00 UTC, *Hayabusa* burned up in Earth's atmosphere, bringing its dramatic seven-year mission to a fiery end. The moment was both triumphant and sad. Triumph lay in what the spacecraft's return represented—the tremendous human ingenuity to meet seemingly impossible challenges that befell the mission time and again. But one could not help but be sad, too, to watch the demise of this spacecraft that we came to imbue with personality and a will to overcome adversity.

The end of the spacecraft's long and challenging return trip marks just the beginning for the sample-return capsule. As we go to press, we await word from Japan on the tiny capsule's contents. If indeed it contains dust from an asteroid, *Hayabusa* will become the first mission ever to return a sample of material snatched from the surface of a world beyond our Moon. Whatever the case, *Hayabusa* has proven itself to be the "little spacecraft that could."

***Left: Lighting up the sky like a bright meteor,* Hayabusa *burned up over southern Australia on the night of June 13, 2010. This photo appeared in the Japanese newspaper* Yomiuri Shimbun.**
Photo: © The Yomiuri Shimbun, Japanese Daily Newspaper

Right: In this still from the movie Return of the Falcon,* Hayabusa *is shown just before its landing on, and subsequent bounce off of, Itokawa's surface. The red lines are its four laser range finders; its sampling horn points toward the ground.
Image: Copyright © LIVE Company, Ltd.

An Audacious Mission

Hayabusa was conceived as a daring mission that would return a sample from a tiny asteroid, smaller by far than any that had been visited before. The asteroid is so small that its gravity is negligible; instead of entering orbit, *Hayabusa* would match orbits with it and grab a sample in a maneuver that was more similar to docking with another spacecraft than it was to landing on another planet.

The audacious mission required incredibly precise guidance and control of the little spacecraft. The solar-powered craft was fitted with four gimbaled ion engines as its main thrust source, a more traditional chemical thruster system (actually, two separate systems for redundancy) for maneuvering (particularly important for the delicate operation of touching down on the asteroid), and three reaction wheels to control the spacecraft's orientation in space. It had a sampling horn that would contact the asteroid, fire pellets at its surface to knock off asteroid dust, and enclose the flying asteroidal material in a sample-return capsule equipped with a heat shield and parachute.

The spacecraft launched as *MUSES-C* on May 9, 2003 aboard an MV-5 rocket, from the Uchinoura Launch Center at Kagoshima, Kyushu, Japan. After its launch, it was renamed *Hayabusa*, meaning "peregrine falcon."

An Unusual Target

Hayabusa's near-Earth asteroid target was chosen not because of any particularly special qualities of the asteroid itself. Rather, the asteroid was selected on the basis of what *Hayabusa* could reach, given its launch date and the capabilities of its ion-powered engines. In fact, *Hayabusa*'s eventual destination was discovered less than five years before the spacecraft launched toward it.

Hayabusa's target asteroid had been provisionally named 1998 SF36 when it was discovered by the Lincoln Near Earth Asteroid Research (LINEAR) project, and it received the formal numerical designation 25143 shortly after. Following *Hayabusa*'s launch, the asteroid was formally named Itokawa, for Hideo Itokawa, who is regarded as the father of Japanese rocketry and who oversaw the first orbital Japanese launch in 1970.

Discovered only five years before* Hayabusa *launched, Itokawa is the smallest asteroid ever visited by a spacecraft—535 x 294 x 209 meters.* Hayabusa *captured this view in the fall of 2005. *Image: ISAS/JAXA*

Hayabusa *captured this photo of Itokawa as it passed between the Sun and the tiny asteroid on November 10, 2005.* Hayabusa*'s shadow is visible on the surface of the asteroid—a tiny spacecraft causing a tiny solar eclipse on a tiny object.* *Photo: ISAS/JAXA*

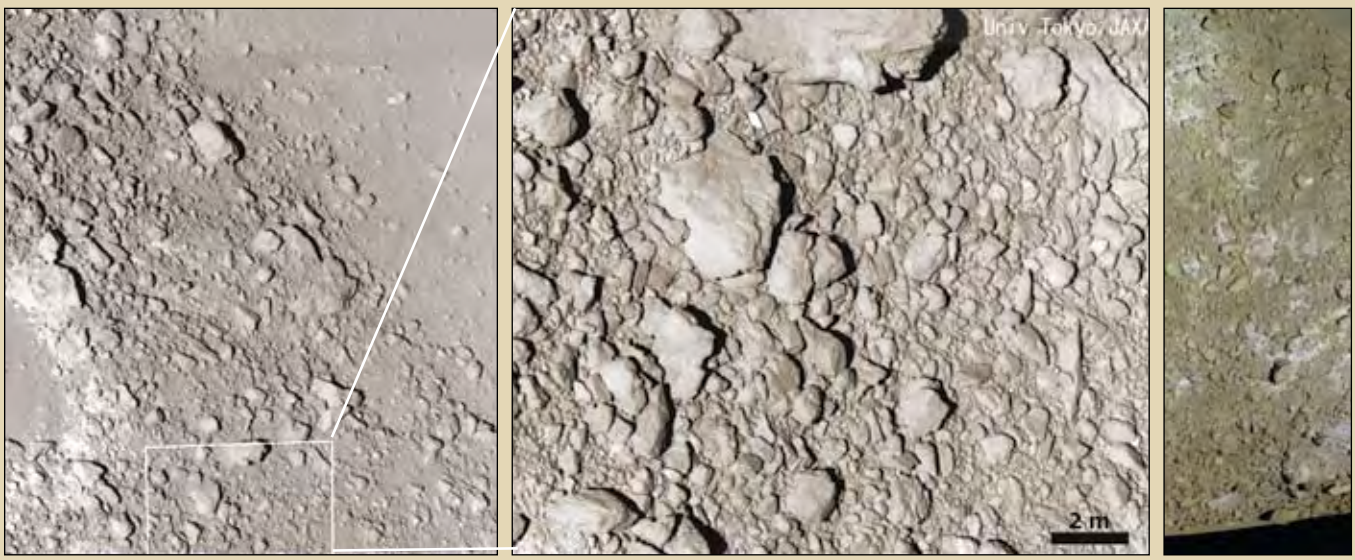
Hayabusa's challenges began in November 2003, when it suffered damage from one of the biggest solar flares in recorded history. The flare reduced the efficiency of the solar cells; this, in turn, reduced the thrusting power of *Hayabusa*'s ion engines, delaying the spacecraft's arrival at Itokawa. Additionally, one of the four ion thrusters, Thruster A, did not function to specifications and was not used, but the mission had been designed to operate on only two thrusters, so this posed no serious problem.

Hayabusa flew on. In May 2004 it became the first spacecraft to perform a gravity-assist flyby (of Earth) using ion engines as the main thrust source. As it approached its target, one of its three reaction wheels (the x-axis wheel) failed, but the remaining two were sufficient to maintain three-axis control of the craft's orientation. *Hayabusa* imaged Itokawa for the first time on September 5, 2004.

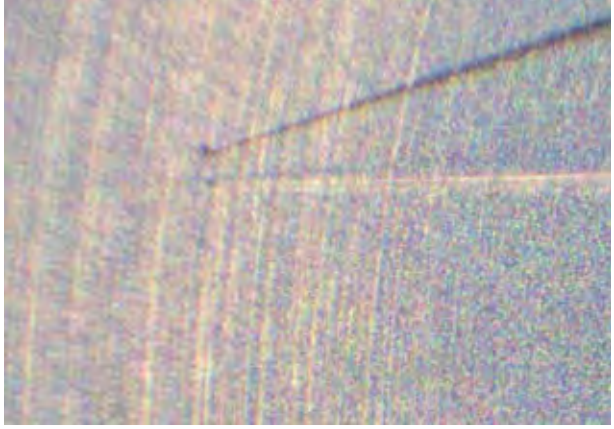
Its approach to Itokawa officially began in September 2005, when the spacecraft's camera first became capable of resolving the asteroid's beanlike shape. The initial rendezvous position, at which *Hayabusa* hovered, was about 20 kilometers (12 miles) above the asteroid. The craft spent about two weeks at this distance (called *Gate Position* by the mission), performing multispectral studies and capturing lengthy movies of the asteroid's rotation. Gate Position was between the Sun and the asteroid, so that the asteroid was almost fully lit by the Sun and the spacecraft's shadow sometimes appeared in its images on the asteroid.

Then *Hayabusa* approached closer, to what was called *Home Position,* a distance of 7 kilometers (4 miles). During the approach, a second reaction wheel (the y-axis wheel) failed. The remaining reaction wheel was not sufficient for control of the spacecraft, so engineers were forced to employ the chemical thruster system to help with attitude control. Still, the Home Position survey continued; the spacecraft toured

Below left:* Hayabusa *captured this view of Itokawa as it slowly approached the asteroid on November 9, 2005. The smooth area to the right is Muses Sea, where the spacecraft eventually would touch down. At left is a circular impact crater called Komaba. Scientists found that the gravel in this image had a preferred orientation, indicating that it had moved over time toward Muses Sea, probably as a result of impact-induced vibrations. The white box indicates the area covered in the closer view at center. Below far right: The images for this color view of Itokawa were taken by* Hayabusa *on November 3, 2005, during the descent phase of the mission. *Images: JAXA/ISAS/University of Tokyo; color by R. Nunes*



Shortly before we went to press, the Japanese released this photo of the inside of the sample-return capsule. It appears pristinely clean—but does contain a few large grains and many small ones. Testing will determine whether they came from Earth or Itokawa. Photo: JAXA/JSPEC



This photo of a manipulating needle pointing at a minute dark particle was taken through a microscope. The shadow is caused by the light source at the bottom of the image. Whether this tiny speck is a part of Itokawa or instead just contamination from Earth remains to be determined. Photo: JAXA/JSPEC

around the asteroid, getting more dramatically side-lit views and imaging both poles.

An Unprecedented Landing

The surveys complete, *Hayabusa* was commanded to approach to within 3 kilometers (2 miles) of Itokawa to prepare for the rendezvous. On November 10, *Hayabusa* released the target marker, a tiny ball designed to aid the spacecraft in ranging to the surface of the asteroid. That target marker also contained nearly a million names collected by JAXA and The Planetary Society and is, presumably, still sitting where it landed on Itokawa. The next day, *Hayabusa* released the mini-lander *MINERVA*. Unfortunately, *MINERVA* missed the asteroid entirely, floating away.

Hayabusa's first attempt to touch down on the surface occurred on November 19, 2005. The first news reports after the descent attempt stated that the spacecraft hovered about 10 meters above the surface for 30 minutes without landing. It later became clear that, in fact, the spacecraft had actually landed and possibly already had some dust within its sample-return capsule.

That was the good news; the bad news was that the spacecraft had not been intended to spend such a long period so close to the Sun-heated surface of the asteroid. *Hayabusa* began to heat up; eventually it went into safe mode, switched from three-axis control to spin stabilization, and autonomously ascended away from the asteroid to a distance of 100 kilometers (60 miles).

Over the next few days, *Hayabusa*'s engineers regained three-axis control and commanded the spacecraft to approach the asteroid for a second landing attempt. At first it seemed that the November 26 landing and sample capture had gone smoothly and that the mission was a triumphant success.

Obstacle After Obstacle

The sense of triumph was premature; *Hayabusa*'s struggles were just beginning. It was discovered that something had gone seriously wrong on November 26. Following the sample-grab attempt, *Hayabusa* ascended from the asteroid under chemical thruster power. During the ascent, there was a leak in the thruster system, and in addition, JAXA lost three-axis control of the spacecraft and even lost contact with it for a few days.

Over the next weeks, the situation remained confusing: neither of the redundant thruster systems was working properly, JAXA could not regain three-axis control, and, to make things worse, it seemed increasingly likely that the sample-collection mechanism had failed to operate properly. The struggles to control the spacecraft forced JAXA to delay *Hayabusa*'s departure from the asteroid. As a result, *Hayabusa* missed its Earth return window. It was originally scheduled to depart in December 2005 for a mid-2007 return to Earth, but the unyielding rules of orbital mechanics now dictated that it would not be able to come home until mid-2010.

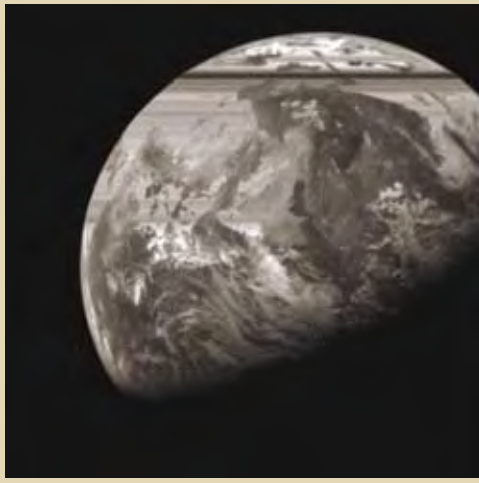
The situation seemed dire. JAXA still had not managed to re-establish three-axis control of the spacecraft, and in fact, it lost contact entirely for several weeks. By March 2006, it had managed, at least, to regain regular contact. The spacecraft had totally lost its chemical thruster system, and four of its eleven battery cells had been damaged.

By early 2007, the mission team had developed solutions to *Hayabusa*'s technical challenges. They nursed a charge into the damaged battery slowly and steadily, finally building up enough current to close the sample-return capsule. They had developed a strategy for three-axis control involving the one surviving reaction wheel and venting puffs of xenon gas from the gimbaled thrusters.

By April 2007, *Hayabusa* was as ready as it could be to begin the return journey to Earth, even though it had just lost the use of ion Thruster B; Thruster A had not functioned since launch, and Thruster C was not being used due to its unstable performance. The team would attempt the return with only a single functioning engine, Thruster D.

The Long Journey Home

The homeward journey began on April 25, 2007. Days later, the science team released *Hayabusa*'s archived



Left: This view of Earth is the last picture* Hayabusa *took, about one hour before the end of the mission. At this point, the sample-return capsule had already been released. The streaks are caused by the brightness of Earth's clouds saturating the camera detector.

Right: This is the same image, "cleaned up" with details enhanced and streaks removed.

Images: JAXA, reprocessing by Gordan Ugarkovic

science data to the world, revealing Itokawa in all its strange glory.

By August, things seemed to be improving. JAXA had restored function in ion Thrusters B and C, though both remained temperamental. JAXA finished the first phase of powered flight in October, returned the spacecraft to spin-stabilization, and let it cruise quietly, though it remained in communication with Earth.

The next phase of the return began on February 4, 2009. JAXA first regained three-axis control of the spacecraft using the one remaining reaction wheel, the gimbaled ion engines, and the force of light pressure off *Hayabusa*'s solar panels—that is, *Hayabusa* was controlled, in part, by solar sailing.

In November, however, *Hayabusa* suffered yet another serious blow. Thruster D—which had operated perfectly throughout the long mission, far beyond its design lifetime—finally failed. Thruster B was no longer functioning either. That again left *Hayabusa* with a single functioning engine, Thruster C. Although one engine was enough for the cruise phase, it would not be enough to accomplish the final trajectory corrections needed to return the sample capsule.

Once again, JAXA's engineers found a solution, one for which plans had been made during design. Each of *Hayabusa*'s engines consists of two main components, an ion beam and a neutralizer. The engineers were able to employ the neutralizer from Thruster A (never used on the mission, because Thruster A's ion beam never functioned properly) to neutralize the ion beam from Thruster B, thus cobbling together the second ion engine necessary to accomplish the return.

Steady work by *Hayabusa*'s ion engines brought the spacecraft's trajectory closer and closer to Earth. In April of this year, *Hayabusa* completed powered flight and began to prepare for the return of the capsule to the Woomera Prohibited Area in Australia. Five trajectory correction maneuvers were required to return the capsule to its targeted location.

The spacecraft aimed squarely for Australia on June 13, 2010. Without chemical thrusters, *Hayabusa* was not able to retarget itself away from Earth. It entered Earth's atmosphere and burned up, creating a brilliant flash of light in the dark sky of southern Australia.

The end of the spacecraft did not mark the end of the story, however. Three hours before atmospheric entry, *Hayabusa* released its sample-return capsule. The capsule, 40 centimeters (16 inches) in diameter, was outfitted with a radio beacon, and its entry was tracked as it streaked across the midnight sky in the remote desert of southern Australia. Just hours after the capsule's release, JAXA announced that it had been recovered and was on its way to the JAXA Sagamihara Campus in Kanagawa, Japan.

We await more news about the capsule's contents. If the tiny particles came from Itokawa, it will be our first sample from the surface of a solar system body other than Earth's Moon. Whether or not the particles are from the asteroid, the *Hayabusa* team and JAXA will have accomplished something amazing.

Emily Stewart Lakdawalla, The Planetary Society's science and technology coordinator, writes for the Society's blog at planetary.org/blog *and is a regular contributor to the weekly radio show* Planetary Radio. *You can follow Emily on Twitter at* twitter.com/elakdawalla.

Explore More

Hayabusa's return to Earth
planetary.org/explore/topics/hayabusa

The Planetary Society's blog
planetary.org/blog

Planetary Radio
planetary.org/radio

World Watch

Washington, D.C.—The U.S. administration's plan to reshape NASA is mired in the Congress, which recessed on June 30 without taking any action on the fiscal year 2011 budget proposal. It looks like there is only one way forward—through compromise. Somewhere between supporters of the administration's "bold new plan" and the opposition seeking to preserve elements (and contracts) of the Constellation program, there must be a space program on which they can agree.

The administration offered the first compromise: the *Orion* crew vehicle, designed for Constellation, would be reworked as a rescue vehicle for the International Space Station. Keeping *Orion* alive helps one of the companies involved, but does it make sense? Although it partially undercuts the administration's goal to shift crew transport to low Earth orbit onto commercial providers, it does preserve part of the investment already made in vehicle development.

But how will NASA pay for the redesigned *Orion*? Perhaps it will take money from the newly proposed advanced technology program or, as in the past, from science programs. Either way, something significant will be lost. New technology development has been sorely neglected for a decade, and its boost was a hallmark of the new plan. NASA's robotic science programs have been extremely successful and are popular with the public.

Another potential compromise is to speed development of a deep-space rocket, or, as NASA calls it, the heavy-lift launch vehicle. It is absolutely necessary if astronauts are to fly anywhere beyond low Earth orbit. The Planetary Society strongly supports building such a deep-space rocket.

However, again there is the thorny question of money. Should NASA get the money now, five years before it's really needed, given that there are no funds yet available to start a mission that could use the rocket? If so, where will the money come from? The administration proposed to fund technology development first, both to lower the cost and to provide more options. Proponents of this compromise believe that if development of the deep-space rocket is not started now, it will be delayed indefinitely.

In the coming weeks, the House Appropriations Subcommittee will be marking up the NASA budget to allocate funds, as will its Senate counterpart. The Authorizing Committees, which set program direction for NASA, are actively engaged in the issues but may not pass a bill in this election year, when everyone is rushing to adjourn and go home to campaign.

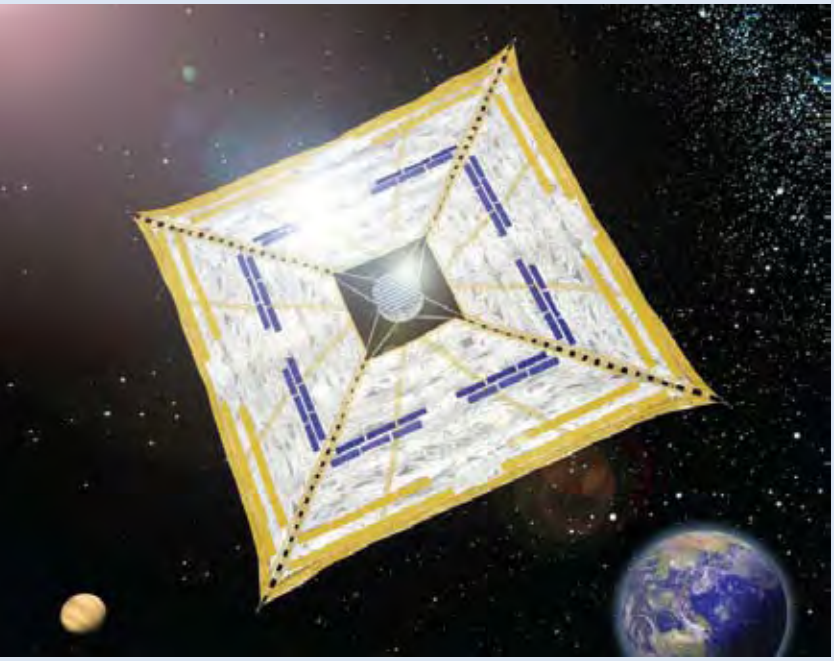
Confused? Join the crowd! The debate over the new plan has been clouded with misunderstandings and wild assertions from all sides. The current administration has been blamed for a decision made six years ago by its predecessor to retire the space shuttle before a new vehicle could be developed. One of the aims of the new NASA plan is to narrow the gap between retirement of the shuttle and completion of a successor vehicle by encouraging commercial competition in the development of launch vehicles. The administration is also being attacked for ending human space exploration, when in fact it is trying to revitalize exploration with more missions to the International Space Station and by taking the first steps into interplanetary space. The attacks based on misinformation highlight the administration's failure to communicate its plans to Congress and the public.

The Planetary Society has always taken a nonpartisan approach to advocating for space exploration. We support the increased budget for NASA included in the new plan, as well as the goal to send humans beyond the Moon. We will not get involved in specifics of industry contracts or the selection of launch vehicles. We support robotic missions to advance deep-space exploration. We urge greater international cooperation to create more affordable and publicly supported space exploration. These are basic principles that the Society has espoused since its founding. Nowadays, with so much rancor and partisanship in the air, it's even more important that we reinforce our basic principles.

I appreciate all the comments I've received from Society Members. They reflect the wide differences in public opinion on this important topic. They all show that Members are passionate about space exploration. In the words of Neil deGrasse Tyson, what a luxury it is to be arguing about how to spend increased funding to explore new worlds. I ask all Society Members to be part of our effort to ensure a path forward for human space exploration. Please join our web discussion and let me know what you think about the new plan for NASA.

Japan—*Hayabusa*'s grand adventure to an asteroid and back ended on June 13, 2010, when it landed in the Woomera desert of Australia (see Emily Lakdawalla's article on page 12). The mission had a dramatic and often tortured history following its launch in 2003. It was often assumed to be dead, owing to one kind of trouble or another. Even after it tried to collect a sample from the asteroid Itokawa, no one knew for certain whether it had succeeded. The sample-return capsule has been opened, and whatever the outcome, the folks at the Japan Space Exploration Center (JSpEC) deserve great praise. This small group handled its mission with outstanding skill and perseverance.

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

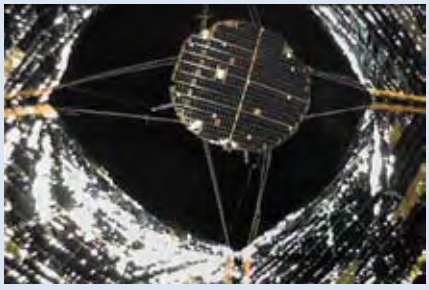


SOLAR SAIL UPDATE

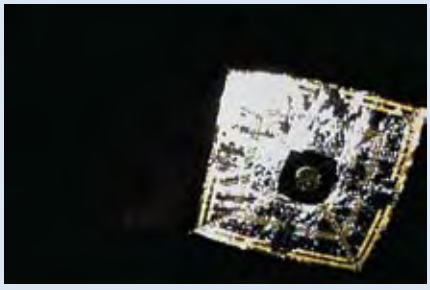
IKAROS Deploys and LightSail Moves Forward

by Louis D. Friedman

***Above:* IKAROS (Interplanetary Kite-craft Accelerated by Radiation Of the Sun) *launched with the Venus Climate Orbiter* Akatsuki *(Planet C) on May 21, 2010.** *Illustration: JAXA*



***DCAM2, a tiny camera deployed by* IKAROS *to photograph its sail after deployment, captured this view after sail deployment was complete, transmitting the images wirelessly to the spacecraft.** *Image: JAXA*



This DCAM2 shot shows the* IKAROS *solar sail fully deployed.
Image: JAXA

***Engineers at JAXA clean the spacecraft's surface in preparation for mounting the DVD carrying the names of Planetary Society members on* IKAROS.**
Photo: JAXA

おめでとうございます (Omedetō gozai masu) to all our friends and colleagues in Japan for the brilliant achievement of hoisting the first solar sail into space. By the time this magazine reaches its readers, Japan may have indeed achieved the first solar sail flight.

The *IKAROS* solar sail was launched as a piggyback on May 21 (Japanese time) on the interplanetary flight of *Akatsuki*—a Venus climate orbiter. *Akatsuki* will reach Venus in December. *IKAROS* was separated on a different trajectory but also is headed roughly toward Venus on its flight.

Within two weeks of launch, mission engineers were ready to attempt the solar sail deployment—achieved by centrifugal force from the spinning spacecraft. The deployment took several days, and engineers checked its progress carefully. The final result was the erection of the 20-by-20-meter sail in space—a sail that includes solar power cells and liquid crystal display (LCD) elements to test a new combined solar power/solar sail concept developed by the Japan Aerospace Exploration Agency (JAXA) for future flights to the outer planets. The LCDs will be used to change reflectivity in different parts of the sail to create unbalanced pressure and thus allow the sail to be turned and controlled. In future flights, the solar power cells will be used to power an electric engine.

Controlling *IKAROS* without engines remains to be done. If the success on the mission to date (as we go to press) is any indication, this will be done well.

IKAROS is a remarkable accomplishment by JAXA and our close friends at the Japan Space Exploration Center (JSpEC), led by Jun Kawaguchi. We appreciate our close ties and their cooperation with us all—our members' names are on this historic spacecraft, and the spacecraft team is cooperating with us concerning technical interchanges on solar sail development. I was invited to the mission operations center for the deployment and acquired a great appreciation for the gutsy way the very young and creative team developed the mission. The very small group was not only operating *IKAROS* but also targeting *Hayabusa* (the asteroid sample-return spacecraft) on its final maneuver back to Earth and beginning the interplanetary flight of *Akatsuki*, all at the same time. 脱帽しました (datsubou shimashita)—hats off!

LightSail-1 has

- 10 solar panels—four deployable arrays with panels on each side plus one panel on the top and one on the bottom of the spacecraft
- Two 2-megapixel cameras mounted at the ends of two of the solar panels (only one camera is visible in the diagram)
- Four Sun sensors mounted at the ends of four of the solar panels
- Six tiny, ultrasensitive accelerometers that will provide a direct measure of the light-force
- A momentum wheel for attitude control (red)
- Three single–axis gyros (yellow)
- Three torque rods (gray)—also part of the attitude control system, and
- A battery that looks like a laptop computer battery (salmon).

Your Name Is in Space!

As members of The Planetary Society, not only are you part of a program that will blaze a path to the stars with LightSail, but you also are a part of the *IKAROS* and *Akatsuki* missions.

Planetary Society Members' names, including yours, are now flying aboard the *IKAROS* solar sailing mission and are on the way to Venus aboard *Akatsuki*.

If you haven't done so already, you can download your official mission participation certificates for *IKAROS* and *Akatsuki* online. Go to *planetary.org/programs/projects/messages/* and follow the instructions to print your numbered certificate.

There's still time to sign up to send your name on *LightSail-1*. As a member, your name will be included on the spacecraft, but you can use the form to add your family members, neighbors, friends, or even pets.

We appreciate all you do to keep this great dream of space exploration alive.

—Monica Bosserman Lopez, Marketing and Interactive Manager

Different Spacecraft, Different Goals

Japan's *IKAROS* is very different from The Planetary Society's LightSail. It is relatively huge: 315 kilograms versus our 4.5-kilogram spacecraft. *IKAROS* has many technological objectives connected with developing hybrid sail/electric engine flight for the future, whereas LightSail is for pure solar sailing and a step toward interstellar flight with small-mass spacecraft. More immediately, we seek to invent the flight system that hovers in interplanetary space to enable solar weather monitoring, a future crucial requirement for our increasingly electronics-dependent civilization.

The biggest difference of all, of course, is that JAXA is a government space agency and The Planetary Society is privately supported by members.

I admire the technology and innovation in the *IKAROS* spacecraft. Our little 4.5-kilogram spacecraft also features a great deal of technological innovation. We are packing into it six accelerometers, two cameras, a radio transceiver, deployable solar arrays, a momentum wheel, and, of course, the four Air Force Research Laboratory (AFRL)-developed Trac booms on novel motorized deployers. The design takes cubesats to a new level of capability, although we have also emphasized simplicity and staying within our budget of less than $2 million.

Our development of the first LightSail is proceeding well. We passed our critical design review in June and are now firmly under way with the building of the hardware and programming of the software. Solar sail material has been ordered. We will complete all of these tasks this year, including all component testing, and be ready for launch by the second quarter of 2011. Several different arrangements for our piggyback launch are being pursued, and we expect to have our final choice defined by September 2010.

Dave Spencer of Georgia Institute of Technology has joined our team as our mission manager. Dave brings rich experience from the Jet Propulsion Laboratory, where he was mission manager for *Mars Odyssey* and deputy project manager for *Phoenix*. Georgia Tech and California Polytechnic University in San Luis Obispo are teaming up for the mission operations. This permits us to bring a number of students into our project in addition to the professional team under Project Manager Jim Cantrell. Stellar Exploration is the lead spacecraft contractor, but now our project includes participation from AFRL, Millennium Space Systems, the Aerospace Corporation, and Nexolve Corporation.

During the critical design review, many of the* LightSail-1 *team gathered for a picture with some of the reviewers. *Photo: Mat Kaplan, The Planetary Society*

It's an exciting time for solar sailing and for The Planetary Society. Together, we're helping to shape the future of spaceflight.

Louis D. Friedman is cofounder of The Planetary Society and program director for LightSail.

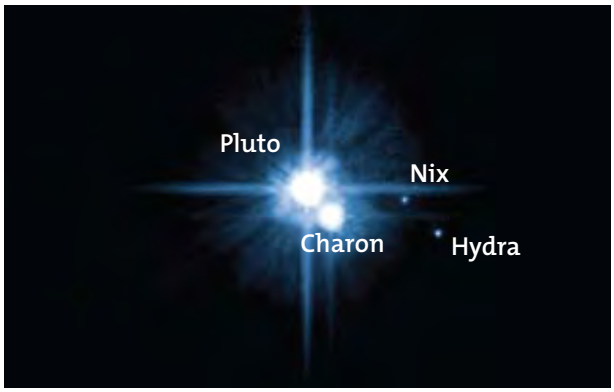
Explore More

Keep up with progress on The Planetary Society's LightSail mission at

planetary.org/programs/projects/solar_sailing

Questions and Answers

Do Nix and Hydra orbit Pluto, or the center of gravity between Pluto and Charon? If they orbit the center of gravity, should they be considered moons of both Pluto and Charon?
—Reid Oreste
Merrick, New York



On February 15, 2006, the Hubble Space Telescope imaged Pluto, Charon, Nix, and Hydra. *Image: NASA, ESA, H. Weaver (JHU/APL), A. Stern (SwRI), and the Hubble Space Telescope Pluto Companion Search Team*

Nix and Hydra orbit the center of gravity of the Pluto system, just as Pluto and Charon do. In fact, all satellites and planets orbit the center of gravity of their systems. However, because Pluto and Charon actually constitute a double planet, with a barycenter (center of gravity or mass) between them—rather than inside Pluto, the primary body—the situation there is different from the case of moons orbiting bodies such as Earth, Mars, and Jupiter. Because of the double-planet nature of Pluto and Charon, I agree with you that Nix and Hydra are moons of Pluto and Charon, rather than just Pluto alone. Despite the fact that it is technically incorrect to say that Nix and Hydra are moons of Pluto alone, however, I suspect that most people and even most scientists will refer to them that way, just as a shorthand expression.
—ALAN STERN,
Southwest Research Institute

I built a one-quarter-scale model of* LightSail-1 *to assist me in creating the illustrations of the spacecraft for The Planetary Society. While I photographed the model outdoors, the Mylar often acted like a solar concentrator and when the angle was just right, I got a nasty blast of heat in the face. I know that some photovoltaic arrays love concentrated light, and the full-size sail (16 times the area of the model) may bounce a lot of light and heat at the nanosat. If the sail does any sort of turn whereby the central cubesats get hit with a double dose of raw sunlight, will that hurt the spacecraft?
—Rick Sternbach
Valley Village, California

There are two kinds of light reflection—specular and diffusive. Specular reflection is just like a mirror, in that photons are reflected at exactly the same angle as they hit the surface. This type of reflection requires a uniquely smooth surface, such as a glass surface that is formed when molten, a polished metal surface, or a flat liquid surface. In the case of a flat reflector, such as an ordinary mirror, the initial image is preserved via the reflection. Besides the image merely reflecting the symmetry of photons, the relationships between individual "bundles" of photons do not change. If the reflector has a parabolic curve, light is focused to a single point in space. This is the method by which solar furnaces and solar thermal electric plants work.

With diffusive reflection, there is no correlation between—or dependence on—the initial striking angle of incoming photons and their departure direction. Any incoming image is not preserved but, rather, is lost because light is diffused. Diffusive reflection is more common. It is a result of reflection from a surface that, instead of being perfectly smooth, has some realistic surface roughness, as is the case with most materials. Diffuse reflection scatters (solar) light in all directions and does not create hot spots the way a specular reflector does.

LightSail is made of such diffuse, light-scattering material. Although its polymer substrate is covered by a thin metallic coating, realistically any surface "smoothness" is lost when the sail is packaged for the launch. Also, it will not be taut or under any real stress during its spaceflight. Thus, the sail's diffuse surface will not create hot spots.

The spacecraft will still feel additional heat, even from the diffuse reflection of the sail, but it will be uniformly distributed across all spacecraft surfaces. We will account for this additional heat in any thermal analyses we perform.
—TOMAS SVITEK,
Stellar Exploration

What, if anything, stands out about meteorites on the surface of Mars? Are they just like those found on Earth?
—K. Milner
Kansas City, Missouri

One of the more surprising finds by the Mars Exploration Rovers has been the discovery of several meteorites. These meteorites seem to be mostly like iron-rich meteorites found on Earth, but they are particularly interesting because they have been found on the surface of another world, where they have interacted with that planet's atmosphere and near-surface environment for potentially long periods.

One particular example of this is the meteorite now named "Block Island." This sample was only recently identified by *Opportunity*. It is the largest iron meteorite found on Mars to date. Scientists estimate that, at the current thickness of the Mars atmosphere, a meteorite this size would have disintegrated into much smaller fragments on impact with the planet's surface. It is likely, therefore, that this meteorite fell in the distant past, when Mars had a significantly thicker atmosphere—thick enough to decelerate the meteorite sufficiently prior to impact.

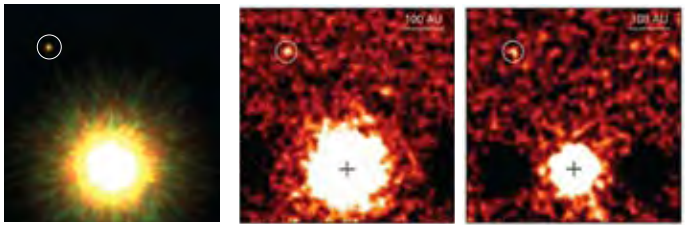
Furthermore, *Opportunity* has observed variations in the chemical composition on different areas of Block Island. These variations may hint at changes resulting from alteration and weathering. Compositional information on this and the other meteorites identified by *Spirit* and *Opportunity* could lead to a better understanding of the type of weathering experienced by these samples. This would then tell us about past Martian climate and, particularly, about the presence of water in near-surface environments on Mars.
—MEENAKSHI WADHWA,
Arizona State University

Factinos

A new analysis of a lunar sample returned by *Apollo 17* reveals that the "Man in the Moon" has "graphite whiskers." Researchers have detected and dated carbon on the Moon in the form of graphite—the sooty stuff of pencil lead—from around 3.8 billion years ago, when the Moon was heavily bombarded by meteorites. Up to now, scientists thought the trace amounts of carbon previously detected on the surface of the Moon came from the solar wind.

Some of the graphite revealed by the new study appeared in a rare rolled form known as "graphite whiskers," which scientists believe formed in the very high-temperature reactions initiated by a meteorite impact. The discovery also means that the Moon potentially holds a record of the carbon input by meteors into the Earth–Moon system when life was just beginning to emerge on our planet.

"Materials that fell on the early Earth fell on the Moon as well, because the two bodies basically share the same gravity well," says Marc Fries, who took part in the research while working at the Jet Propulsion Laboratory and who is now based at the Planetary Science Institute in Tucson. "This sample is like a pristine page from Earth's past, before plate tectonics and other forces erased the history of this ancient carbon material on Earth." A report on these findings appeared in the July 2, 2010 issue of *Science*.
—from the Jet Propulsion Laboratory



At left: This picture, a combination of near-infrared images first released in September 2008, is a Gemini adaptive optics view of the star 1RXS J160929.1-210524 (or 1RXS 1609) and its companion (within the white circle), with a mass approximately eight times that of Jupiter.
Image: Gemini Observatory

Middle and right: These new images of star system 1RXS 1609—taken at 3.05 and 3.8 microns, left and right, respectively—are helping scientists to better estimate the extrasolar planet's mass.
Images: Gemini Observatory/AURA/David Lafrenière, University of Montreal/Ray Jayawardhana and Marten van Kerkwijk, University of Toronto

Scientists have confirmed—and imaged—a planet only about eight times the mass of Jupiter orbiting a Sun-like star more than 300 times farther from its star than Earth is from the Sun (see images at upper right). The newly confirmed planet is the least massive planet known to orbit at such a great distance from its host star.

This new planet was first reported in September 2008 by a team led by David Lafrenière, then at the University of Toronto and now at the University of Montreal and Center for Research in Astrophysics of Quebec. "Back in 2008 what we knew for sure was that there was this young planetary mass object sitting right next to a young Sun-like star," says Lafrenière. The extremely close proximity of the two objects strongly suggested that they were associated with each other, but it was still possible (though unlikely) that they were unrelated and aligned only by chance in the sky. According to Lafrenière, "Our new observations rule out this chance alignment possibility, and thus confirm that the planet and the star are related to each other." Lafrenière and his colleagues used high-resolution adaptive optics technology at the Gemini Observatory to take direct images and spectra of the planet.

The planetary system, known as 1RXS J160929.1-210524 (or 1RXS 1609 for short), provides scientists with a unique specimen that challenges planetary formation theories because of its extreme separation from the star. "The unlikely locale of this alien world could be telling us that nature has more than one way of making planets," says collaborator Ray Jayawardhana of the University of Toronto. "Or, it could be hinting at a violent youth when close encounters between newborn planets hurl some siblings out to the hinterlands," he adds.
—from the Gemini Observatory

Members' **Dialogue**

The Budget Battle

Constellation's *Orion* and Ares programs were abandoned by President Bush when he did not fight for funding. President Obama's NASA budget is right on target, returning NASA to its original purpose of research and development, encouraging and enabling—through technology transfers, licensing agreements, and needed service contracts—America's private enterprise to build a brand new industry of space transport. This would lead, with time, to new sources of energy, such as space-based solar power and materials acquisition from the Moon and asteroids.

We will go to the Moon if it is profitable. We will go to the asteroids and/or Mars, and we will make a profit doing it. That's America's strength. It's what we do best.

President Obama's budget was in the best Kennedy tradition of forward thinking, creating whole new industries where none existed before.
—MICHAEL J. DAVIS,
Scranton, Pennsylvania

The back cover of your May/June 2010 issue features Neil Armstrong. It is a beautiful painting; however, it is ironic that Neil Armstrong is featured in an issue where Obama's slashing of NASA's budgets is supported. Armstrong and several other former astronauts have testified before Congress recently that Obama's space budget is a "pathway to nowhere." It was formulated without consulting leading scientists.

I do not know why *The Planetary Report* has made science a secondary consideration in its articles, but there is no excuse. Please cancel my subscription.
—DAVID EATON,
Salem, Oregon

We honor Neil Armstrong and all the Apollo *astronauts who explored another world. We honor them and what they did, even if we disagree a little now with what they say. Armstrong, like us, is motivated by space exploration.*

One note about your letter: President Obama's budget did not slash NASA's funding—it actually provides a $6 billion increase over the next five years. Another note concerning the consultation with scientists: a dozen science and space organizations, including the largest science organization in the world (the American Association for the Advancement of Science), have come together to support the Obama budget for NASA.

Science is not secondary to us, or to NASA. I hope you will reconsider and continue your support for space exploration with The Planetary Society.
—LOUIS D. FRIEDMAN,
Executive Director

SETI

In his inspiring acceptance speech for the Cosmos Award, printed in your May/June 2010 issue, Stephen Hawking lists three possible explanations for why we haven't heard from aliens: the probability of primitive life is low, the probability of intelligent life is low, or the probability that intelligent life usually destroys itself when it reaches the technological level of sending radio signals is high.

Hawking leaves out a fourth possibility: the probability is high that interstellar civilizations far surpass us in communications technology. Simply because humans have manipulated the frequency and amplitude of the electromagnetic spectrum to communicate over the past 100 years does not mean this is the way intelligent life-forms will communicate across interstellar space after their technologies have evolved for thousands, millions, or hundreds of millions of years.

Even 150 years ago, the fastest way to communicate between St. Joseph, Missouri and Sacramento, California was via the Pony Express. Just a few centuries ago, the concepts of radio, TV, and the Internet were beyond our comprehension, let alone our capability. It is a bit presumptuous and temporocentric to assume that because we recently discovered some ways to use radio waves to communicate, these must be the way all civilizations will communicate across vast distances. Just because we can't imagine other communication modalities yet doesn't mean they don't exist.

Perhaps we are sitting in the midst of a cacophony of interstellar conversations, oblivious to them as we look far and wide for the Pony Express.
—TIM McAFEE,
Edmonds, Washington

Please send your letters to
Members' Dialogue
The Planetary Society
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Pasadena, CA 91105
or e-mail: *tps.des@planetary.org*

Society **News**

A Shout Out to Our Discovery Team Members!

The Planetary Society's Discovery Team Members truly are a force in planetary exploration. Each has signed on to make a donation to the Society every month. That donation might be just $15 a month, a cost to them of only cents a day that adds up to a tremendous gift for The Planetary Society.

Discovery Team Members choose the amount of their monthly gift and know that with it, they are providing the crucial funding needed to advocate for new missions of discovery, conduct valuable scientific experiments, and develop and launch our series of LightSail space missions.

Ensuring our future in space—exploring other worlds, understanding our own, and seeking life elsewhere—is a long-term and innovative process. To be successful, we rely on steady, predictable funding from passionate space explorers like our Discovery Team Members.

Plus, when you make a monthly donation as a Discovery Team member, you help The Planetary Society reduce fund-raising expenses by eliminating renewal notices (your membership automatically renews) and you take us a step further in "going green" as we eliminate more paper from our day-to-day operations. It's a winning proposition.

If you already are a member of the Discovery Team, thank you! If you'd like to join the Discovery Team, you can do so simply and securely online at *discoveryteam.planetary.org* or call us at (626) 793-5100.

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

—Andrea Carroll,
Director of Development

Planned Giving: Your Legacy for Tomorrow

One of our Charter Members recently asked me about whether a planned gift really could make a difference to The Planetary Society. My answer? Absolutely!

Your gift to The Planetary Society through a will or estate plan, also known as a *planned gift*, is a terrific way for you to make a significant contribution toward space exploration tomorrow.

Over the past 30 years, we've received many planned gifts from Members the world over. They've come to us as gifts of cash, transfers of real estate, and payments as the beneficiary of insurance policies.

The common denominator for any planned gift to the Society is that it mirrors what you value deeply. It is a way to extend your commitment to The Planetary Society into the future and to leave your legacy.

A planned gift helps ensure the long-term success of our projects, whether searching for life and other worlds, embarking on innovative missions like LightSail, understanding and protecting our pale blue dot of a planet, or advocating for a strong and effective space program.

As someone who cares about our planet and those beyond, you can make a bequest to The Planetary Society that will help ensure that we can meet new challenges and opportunities.

Your planned gift really will make a difference!

From all of us at The Planetary Society, thank you to all of you who have already named The Planetary Society in your will or estate plan.

Please call me, Andrea Carroll, at (626) 793-5100, extension 214, or e-mail me at *andrea.carroll@planetary.org* if you would like information about including The Planetary Society in your will or estate plan.

—AC

Photo: Courtesy of Micky Cook

Travel with The Planetary Society

Join us on one of these great adventures!

- Discover HAWAII
  October 2–9, 2010
- Visit ANTARCTICA!
  December 9–21, 2010
- Explore ARECIBO and the Lesser Antilles
  January 21–29, 2011
- See ALASKA'S Aurora Borealis
  March 10–26, 2011

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

Whichever destination you choose, you will be traveling with fellow Members, like-minded individuals who appreciate scientific exploration and understand the lure of the unknown. You also will be supporting The Planetary Society's programs because the Society receives a portion of the monies collected for every tour.

What are you waiting for? Join us in Hawaii, Antarctica, Puerto Rico and the Lesser Antilles, or Alaska!

To find out more about any of these exciting adventures, contact Betchart Expeditions at (408) 252-4910 or *info@betchartexpeditions.com.*

—Susan Lendroth,
Events and Communications Manager

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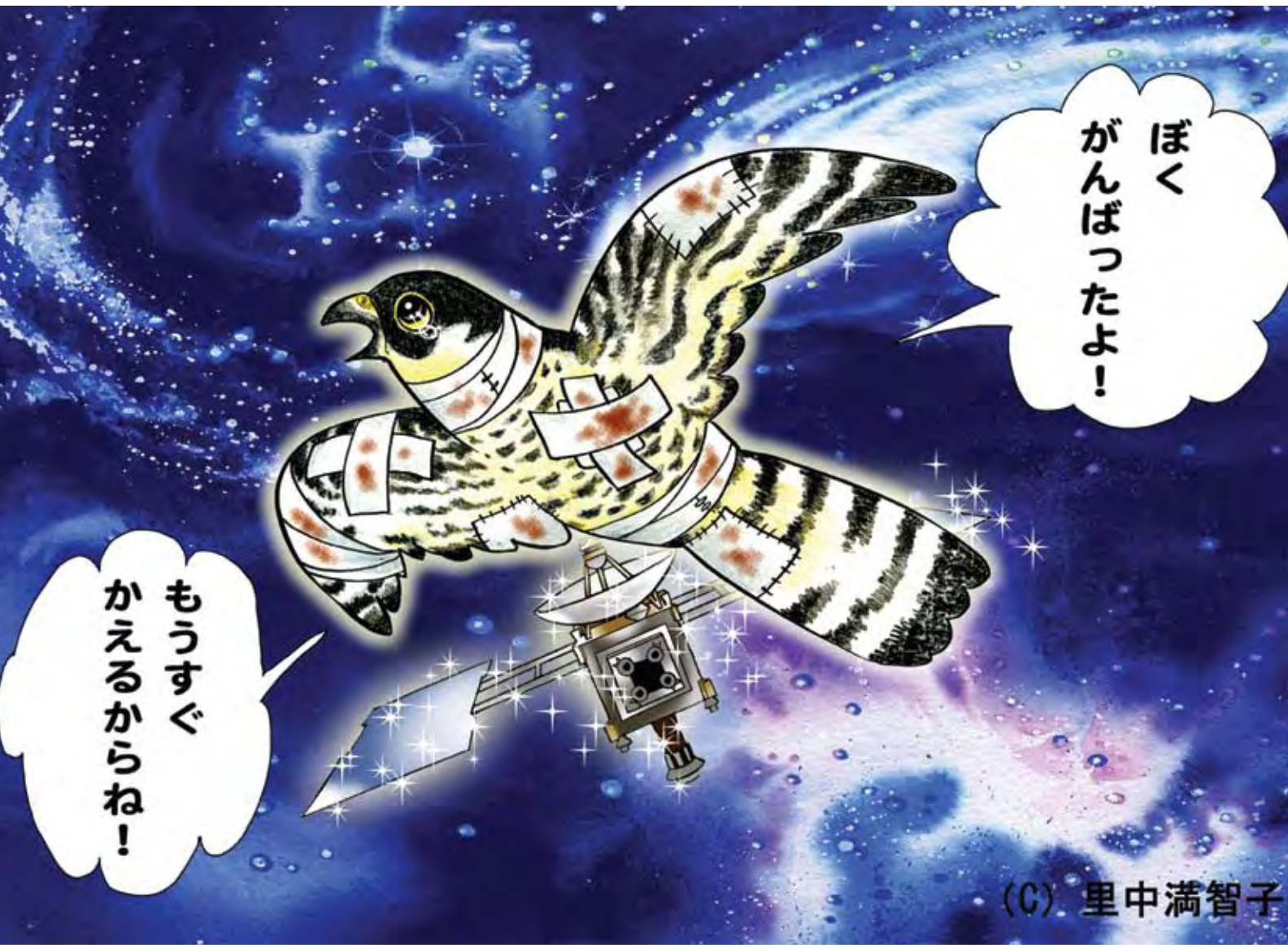

The trials, tribulations, and ultimate triumph that *Hayabusa* experienced during its voyage to Itokawa turned the spacecraft into a national hero and its mission into a "never-say-die" tale of bravery and adventure that captured the hearts of Japanese citizens. Machiko Satonaka depicts *Hayabusa* (which translates as "peregrine falcon") as a battle-scarred victor in this cartoon. The balloon at right translates as "I did my best," and the one at left as "I'll be back."

Machiko Satonaka is one of Japan's renowned manga (cartoon) artists. An artist with a long career, Satonaka also is a space enthusiast, a member of the council on future Japanese lunar exploration, and an adviser to space organizations, including the Japan Space Forum.