The PLANETARY REPORT

Volume XXX Number 3 May/June 2010

Why Go Into Space?

From The Editor

This 30th anniversary year has had me looking back to the beginning of The Planetary Society, while our *LightSail* program keeps pulling my thoughts to the future.

In 1980, The Planetary Society launched while Carl Sagan was presenting his personal view of the universe on television screens around the world. There's no question that our organization's success is linked directly to the phenomenon that was *Cosmos*. To honor that connection, in 2005, we created the Cosmos Award for Outstanding Public Presentation of Science. The first recipient was filmmaker James Cameron (who's had a rather big success of his own lately).

This February, we presented The Planetary Society's Cosmos Award to physicist Stephen Hawking. He's probably the most famous scientist alive on Earth today, but we honored him in particular for investing his energy and intellect in bringing science alive for people around the world. We share his remarks about the award with you in this issue.

Meanwhile, we're making steady progress on *LightSail-1*, developing solar sail technology for the future, as you'll also read in these pages. Because we're relying on a piggyback launch on another spacecraft's rocket, we have to wait for the right opportunity, and it looks like that will come no sooner than the second quarter of 2011.

With luck and hard work, next year, as The Planetary Society launches into its fourth decade, you and I will be part of a mission whose ultimate destination is the stars. That's about as far into the future as I'm prepared to look.

—Charlene M. Anderson

On the Cover:

This dazzling, visible-light portrait of the Orion nebula was taken by the European Southern Observatory's new Visible and Infrared Survey Telescope for Astronomy (VISTA). Most of the light from the spectacular clouds comes from hydrogen gas glowing under the fierce ultraviolet glare of the hot young stars at center. The region above Orion's center is obscured by clouds of dust. Image: ESO/J. Emerson/VISTA & R. Gendler, with thanks to the Cambridge Astronomical Survey Unit

Background:

It's easy to forget—as we deal with the day-to-day challenges of life—that we live on a planet whose normal geologic activity can trump our most important plans. Here, lava spews out of a mountain on March 21, 2010, in the region of Iceland's Eyjafjallajökull volcano.

Photo: Fior Kjartansson/AFP/Getty Images

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A PUBLICATION OF THE PLANETARY SOCIETY

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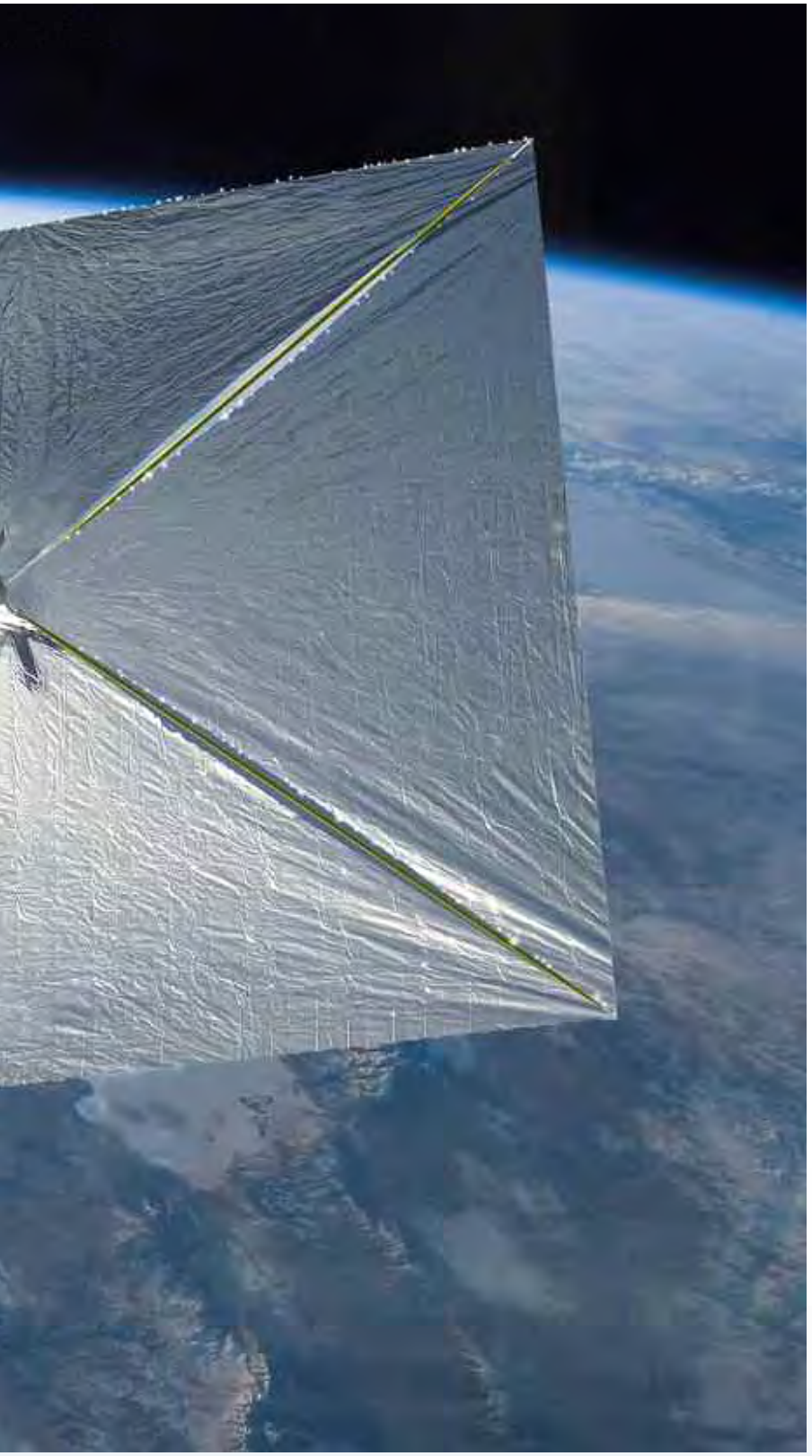
Firming Up the Spacecraft Design

LightSail-1 ***glides along its orbit 800 kilometers (500 miles) above Earth's surface. The only energy source propelling this elegant spacecraft's flight is pressure from the very sunlight that sparkles off its filmy sails.***

Illustration: Rick Sternbach for The Planetary Society

by Louis D. Friedman

The *LightSail-1* spacecraft development is proceeding well. Our engineering team—led by Jim Cantrell—has completed the preliminary design and made critical decisions to select the hardware and subsystem for the final design—crucial milestones to



building the vehicle that will demonstrate the value and potential of using sunlight alone to propel exploratory craft through space.

Thanks to you and your fellow Planetary Society Members, we are well under way with *LightSail-1*, the first of our planned series of three flights. The three missions will be progressively more ambitious, starting in Earth orbit and moving out into the solar system. One anonymous Member got the program off to a flying start with a donation of $1 million. From around the world, other Members have come through with matching donations, ranging from $5 to $100,000, that have allowed us to begin work on this ambitious project.

Design Reviews

In January, we completed the preliminary design review (PDR). A team of aerospace experts—including former Jet Propulsion Laboratory project managers Harris M. (Bud) Schurmeier, Glenn Cunningham, and Donna Shirley, as well as Aerospace Corporation's David Bearden—evaluated progress to date. This review panel went over the development of the *LightSail* program, including mission requirements.

The panel members agreed that our self-imposed requirements might be too ambitious to meet given the available resources and suggested relaxing some capabilities until the second or third *LightSail* mission. After all, plans for our first spacecraft, *LightSail-1*, were pushing the limits of what can be accomplished with a four-kilogram spacecraft while also introducing new capabilities such as an attitude control system, two radios, onboard imaging, a solar pressure sensor, and, of course, the deployable sail.

As you may remember, *LightSail-1* is only the beginning of an innovative program. We will start with a craft launched to an orbit about 800 kilometers (500 miles) above Earth, beyond the first-order effects of the atmosphere, where we can test the sail's performance in space. *LightSail-2* will move

farther away from Earth, and with *LightSail-3* we hope to reach interplanetary space and test how solar sails could be used to monitor solar storms that may threaten technological civilization on Earth.

The project team has thoroughly reviewed the mission requirements and their implications for the spacecraft. As a result of the review, we've simplified several aspects of the design, such as the onboard cameras, going to a single-channel radio from a two-radio system, and reducing the redundancy among orbital velocity measurements. We can rely solely on ground observations for orbit determination, although I remain devoted to the idea of onboard acceleration data if we can accommodate the instrumentation.

The reviewers also suggested that we build more time into the schedule for testing and evaluation. Our 16-month schedule was built around three key elements: a limited budget, getting ready for a launch late in 2010, and using experience in the Cubesat and ground system. We agree that testing is key to a successful mission, and we're committed to ensuring sufficient time in the schedule. The team continues to evaluate our existing mission risks, both to balance risks and to identify those we can reduce or work around.

We've had a stroke of luck on another front: colleagues have a high-sensitivity, commercially developed accelerometer from Lumedyne Technologies they want to test. With *LightSail-1*, we can supply a flight test, they get the data they need, and we get an advanced set of microminiaturized, high-performance accelerometers for our spacecraft. We've just signed an agreement with Millennium Space Systems to that end; the company will provide the software and special processing algorithms to utilize these accelerometers for the *LightSail* mission.

Now we're getting ready for the critical design review (CDR). After that, we'll freeze the design and begin building and testing the spacecraft. Following the review team's recommendations, we decided to hold our CDR in June rather than in April. This will give us more time for the subsystem decisions and enable us to be more specific about our orbit and mission design.

Planning an Uncertain Launch

Our goal was to finish spacecraft development and be ready for launch by the end of 2010. *LightSail-1* can ride on a variety of launch vehicles, but we must piggyback as a secondary payload on an existing mission. To fly completely free of atmospheric drag, *LightSail-1* requires a higher orbit than most secondary payload launches can reach. Opportunities exist, but they're less frequent than other launches to low Earth orbit. It now appears that our earliest opportunity will come no sooner than the second quarter of 2011.

The delay offers one positive aspect for planning: it eases our spacecraft development schedule, giving us more time to analyze options and enhance our test

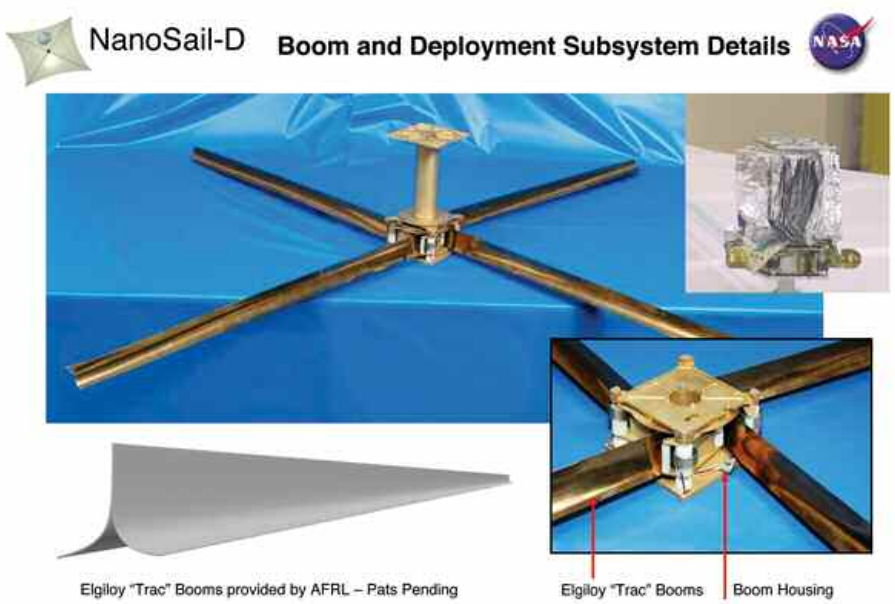
Requirement	Implication	Implementation
Scope and cost fit available budget	Leverage Cubesat program and piggyback launch	Cal Poly 3 Unit Cubesat in P-Pod deployment structure
Demonstrate flight on light (sunlight pressure)	High orbit, above 800 kilometers (500 miles) to negate atmospheric drag Increase acceleration over other efforts	Launch vehicle requirement Mass/area ratio less than 150 grams/m^2 (4.5-kilogram spacecraft, 32-square-meter sail)
Prove successful flight	Image deployed sail with good cameras and sufficient data rate to the ground Measure acceleration or increase in velocity—good orbit determination from several sources	Two cameras, deployment video Two radios: 430, 915 Mhz Worldwide optical observation (Sail Watch + ham radio) NORAD tracking Onboard direct measurement of acceleration or GPS
Control flight	Momentum-based (no fuel, no jets) attitude control	Momentum wheel
Observe solar sail from ground	Ground-based telescopes Public observations	Cooperative arrangements Sail Watch
Public outreach accomodations	Sail Watch Spacecraft Messages from Earth	
Sufficient mission lifetime	Deployment of sail observed and velocity increase measured	Two weeks to one month

program. The bad news is that without a specific launch vehicle agreement, we cannot specify the orbit in which the mission will be conducted. That prevents us from completing the mission design—another reason to stretch out our schedule.

We are working closely with NASA Ames Research Center (through a Space Act Agreement) to identify and arrange launch opportunities. Ames has become a leader in using small satellite launches as secondary payloads. We have identified several good possibilities for launch on U.S. rockets and hope to make launch arrangements soon.

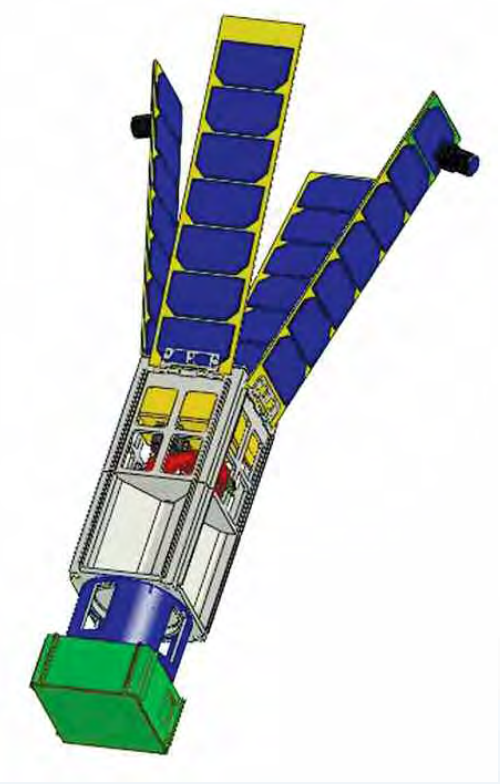
All this means that we're well on our way to making space exploration history with *LightSail*. I will continue to update you on our progress here in *The Planetary Report*. You also can keep up with the *LightSail* program on our website at *planetary.org/programs/projects/solar_sailing/*.

Louis D. Friedman is program director for LightSail-1 *and executive director of The Planetary Society.*

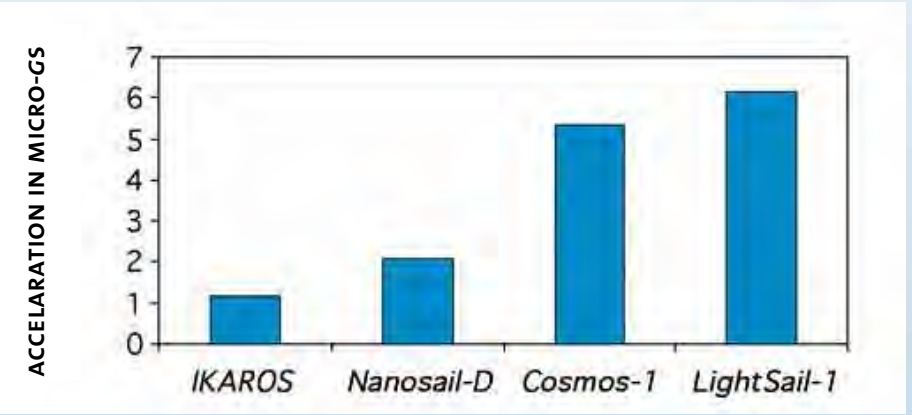


We've experimented with two designs for the sail's booms and their housing. The first, invented by our team at Stellar Exploration, employed a tape-measure approach to deploy the sails. The second, pictured here, is a Triangular Rollable and Collapsible (TRAC) boom system developed by the Air Force Research Laboratory. Because it is stronger and lighter in weight, we've decided to use this latter version.

Photos: Edward E. Montgomery, IV, Marshall Space Flight Center and Charles L. Adams, Jacobs/Gray Research, Incorporated



The basic frame of* LightSail-1*'s spacecraft is shown here. The cameras are the small black units mounted on the solar panels. The topmost Cubesat unit is the spacecraft bus (electronics, batteries, and antennas), and the bottom two Cubesats will house the folded sails and booms. ***Illustration: Chris Biddy, Stellar Exploration***



This chart shows characteristic acceleration for solar sail spacecraft which have been built.* LightSail-1 *will be able to achieve an acceleration greater than that of previous solar sails. The term micro-gs refers to units of acceleration rather than to measures of gravity itself. ***Chart: Louis Friedman***

The New Plan for Human Exploration

by Louis D. Friedman

The Obama administration's new plan for NASA has been met with skepticism and concern that it might never be translated into a vibrant and ambitious space program. The concern is justified: many times, presidential pronouncements about space programs have proven empty. Ronald Reagan in 1984 proposed Space Station Freedom, but nothing happened until the George H. W. Bush and the Clinton administrations changed it to the International Space Station (ISS). George H. W. Bush stated with his Space Exploration Initiative that he was building a program to send humans "back to the Moon and on to Mars," but not much happened with it. George W. Bush pronounced his Vision for Space Exploration but then backed off on funding it.

So what about Barack Obama's plan for NASA? No matter how good many of us believe it is, the proposal still must be acted on by Congress and supported by the public, and the public more than ever is deciding space policy. The Planetary Society is the world's leading space advocacy group, and we have to fight for those space exploration ventures in which we believe. The U.S. Congress, like any political body, is dominated by parochial interests, and its members are concerned about their individual districts' economic rewards and about their financial contributors' contracts. We need to represent the national interest and to invoke international leadership and global cooperation.

Cover of The Planetary Society's* Beyond the Moon: A New Roadmap for Human Space Exploration in the 21st Century, *which we presented to Congress, the administration, and the U.S. Human Space Flight Plans Committee.
Image: The Planetary Society

Why is The Planetary Society leadership so positive about this new plan?

• **It goes faster.** Under Constellation, the Ares I rocket would not have been ready to deliver astronauts to Earth orbit before 2017. Because the existing Atlas and Delta rockets have a good track record, it seems likely that they can be rated for carrying humans sooner. SpaceX, with its Falcon 9, also expects to be ready much sooner.

• **It offers more choices.** With Constellation, all eggs were in the Ares basket, with its rising costs and performance compromises. In the new plan, there will be at least three U.S. launch vehicles to choose from, and competition among them will provide incentives to lower costs.

• **It involves more players.** The new plan encourages more investment from commercial industry because it will have multiple customers, both government and non-government.

• **The ISS remains in Earth orbit.** Under Constellation, the United States would abandon the ISS in 2015, leaving the Ares rocket without a destination. The new plan increases the lifetime and usefulness of the ISS. This alone will encourage international partners and help build teams for future ventures.

• **It goes farther, longer.** U.S. astronauts went to the Moon six times between 1969 and 1972, some 40 years ago. Constellation would not have equaled that accomplishment until 2030. President Obama set a goal of 2015 to begin building a deep-space rocket and 2025 for flying beyond the Moon.

• **It reaches new destinations.** The new plan moves outward to interplanetary space, traveling to asteroids, Lagrangian points, Phobos or Deimos, and Mars itself.

• **It uses international cooperation.** Other nations will go to the Moon, following the path blazed by the United States 40 years ago. The new plan intends to harness international resources for space exploration to improve humanity's reach into the solar system.

• **It advances science and technology.** Constellation was never adequately funded, and it began to eat into NASA's science and technology budgets. Advanced-technology programs were canceled outright. The new

President Barack Obama addressing the audience at the 2010 Space Conference in Florida, April 15, 2010.
Photo: Louis D. Friedman, The Planetary Society

Planetary Society Board members Neil deGrasse Tyson, Bill Nye, Jim Bell, Scott Hubbard, and Louis Friedman at President Obama's Space Conference. *Photo: The Planetary Society*

plan interlinks science, technology, and exploration programs, and it restores robotic precursor and technology demonstration missions.

• **It improves sustainability.** With a flexible path into the solar system, technical progress and available budgets can guide choices of where to go and what to do. This approach is different from deciding now about how we will explore space in two to three decades and then being forced into compromises when the expected budget or technology does not appear.

After the general plan is approved comes the hard work of turning the promise into reality. Critics who say that details are unclear are correct: the details will take time to plan. We expect NASA to convene an "architecture" study soon to consider how to plan missions to the ISS on commercial launch vehicles, how to construct the deep-space rocket, and how to chart the flexible path into the solar system.

Another big question is how to engage the international spacefaring community in the new plan. Space program leaders in Europe, Japan, and Russia have welcomed the new policy. China and India have been talking about human missions to the Moon in the next decade. The ISS partners—the United States, Russia, Europe, Japan, and Canada—have made references to including "nontraditional" partners—a euphemism for China, India, South Korea, and possibly others—in space station operations.

Experts in robotic exploration now recognize that really big missions require international resources. NASA and ESA have already decided that beginning in 2016, Mars landers will be internationally planned and developed. In outer planet exploration, NASA and ESA are jointly planning orbiters of Europa and Ganymede. The proposed boost to exploration has worked its way down to advancing the timetable for Mars Sample Return, a long-sought goal of the science community.

Can the new plan prevail? With public and presidential support joined together, I believe it can. Only once before has a U.S. president gone on the road to campaign for his space policy and budget—John F. Kennedy, in May 1961. On April 15, 2010, Barack Obama went to Florida to do just that.

President Obama firmly rejected critics who claimed that his plan represents the end of America's human spaceflight program, saying, "We will actually reach space faster and more often under this new plan, in ways that will help us improve our technological capacity and lower our costs, which are both essential for the long-term sustainability of spaceflight. In fact, through our plan, we'll be sending many more astronauts to space over the next decade."

For us at The Planetary Society, it was exciting to hear our Roadmap to Space echoed when Obama said, "We will ramp up robotic exploration of the solar system" and "By 2025, we expect new spacecraft designed for long journeys to allow us to begin the first-ever crewed missions beyond the moon into deep space. We'll start by sending astronauts to an asteroid for the first time in history. By the mid-2030s, I believe we can send humans to orbit Mars and return them safely to Earth. And a landing on Mars will follow."

"We stand at a crossroads" is an overused expression, but in this case it rings true. Humanity's future in space may be decided this year as Congress debates the president's proposal. We need to rally public support for this ambitious new plan. I ask Planetary Society members to help make it happen.

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

WE INVITE YOU TO DISCUSS THIS VITAL TOPIC AT

PLANETARY.ORG/PROGRAMS/PROJECTS/SPACE_ADVOCACY.

WHY GO INTO SPACE?

BY STEPHEN HAWKING

From left to right, behind Professor Hawking, are Planetary Society Board members: Bijal (Bee) Thakor, Bill Nye, Jim Bell, Dan Geraci, Ann Druyan, Neil DeGrasse Tyson and Louis Friedman. Photo: Kitty Walker for The Planetary Society

On February 27, 2010, The Planetary Society presented the Cosmos Award for Outstanding Public Presentation of Science to Stephen Hawking in Cambridge, England. Ann Druyan, Carl Sagan's widow and collaborator; Neil deGrasse Tyson; and Louis D. Friedman presented the award, a beautiful glass sculpture of Saturn.

A grant in 2005 from the M. R. & Evelyn Hudson Foundation established the Cosmos Award, which, to date, has been awarded to James Cameron, Paula Apsell, and Dr. Hawking. Funding from the Kenneth T. and Eileen L. Norris Foundation also helped make this latest event possible.

Here, we share the transcript of Dr. Hawking's keynote speech.

I am honored to receive the Cosmos Award, set up in memory of Carl Sagan. I was a great admirer of his television series, *Cosmos*, and so was very pleased when he agreed to write the foreword for my book *A Brief History of Time*. I'm sure that foreword contributed to the success of the book.

Sagan was a great advocate of space travel, and so am I. I will therefore address my remarks to this subject.

Why should we go into space? What is the justification for spending all that effort and money on getting a few lumps of Moon rock? Aren't there better causes here on Earth? In a way, the situation is like that in Europe before 1492. People might well have argued that it was a waste of money to send Columbus on a wild goose chase, yet the discovery of the New World made a profound difference to the old. Without it, we wouldn't have had the Big Mac, or KFC.

Spreading out into space will have an even greater effect. It will completely change the future of the human race, and maybe determine whether we have any future at all. It won't solve any of our immediate problems on planet Earth, but it will give us a new perspective on them and

Left: The recently refurbished Hubble Space Telescope (HST) has uncovered a primordial population of galaxies that never have been seen before. Because light takes billions of years to cross the observable universe, when HST looks deeper into space, it sees farther back in time. This makes it a powerful "time machine" that allows scientists to see galaxies as they were 13 billion years ago, just 600 million to 800 million years after the Big Bang. This new version of the famous "Deep Field" was taken by Hubble's new infrared camera, the Wide Field Camera 3, in August 2009. *Image: NASA, ESA, G. Illingworth and R. Bouwens (University of California, Santa Cruz), and the HUDF09 Team*

Future astronauts explore Mars with the help of a mobile laboratory, which is outfitted with robotic arms for gathering samples. *Illustration: David A. Hardy*

cause us to look outwards rather than inwards. We can hope that it would unite us to face the common challenge. This would be a long-term strategy, and by long-term, I mean hundreds, or even thousands, of years. We could have a base on the Moon within 30 years, reach Mars in 50 years, and explore the moons of the outer planets in 200 years. By "reach," I mean with manned, or should I say "personed," spaceflight. We have already driven rovers on Mars, and we have landed a probe on Titan, a moon of Saturn, but if one is considering the future of the human race, we have to go there ourselves.

Going into space won't be cheap, but it would take only a small proportion of world resources. NASA's budget has remained roughly constant in real terms since the time of the *Apollo* landings, but it has decreased from 0.3 percent of U.S. GDP in 1970 to 0.12 percent now. Even if we were to increase the international [space] budget 20 times, to make a serious effort to go into space, it would be only a small fraction of world GDP.

There will be those who argue that it would be better to spend our money solving the problems of this planet, like climate change and pollution, rather than wasting it on a possibly fruitless search for a new planet. I'm not denying the importance of fighting climate change and global warming, but we can do that and still spare a quarter of a percent of world GDP for space. Isn't our future worth a quarter of a percent?

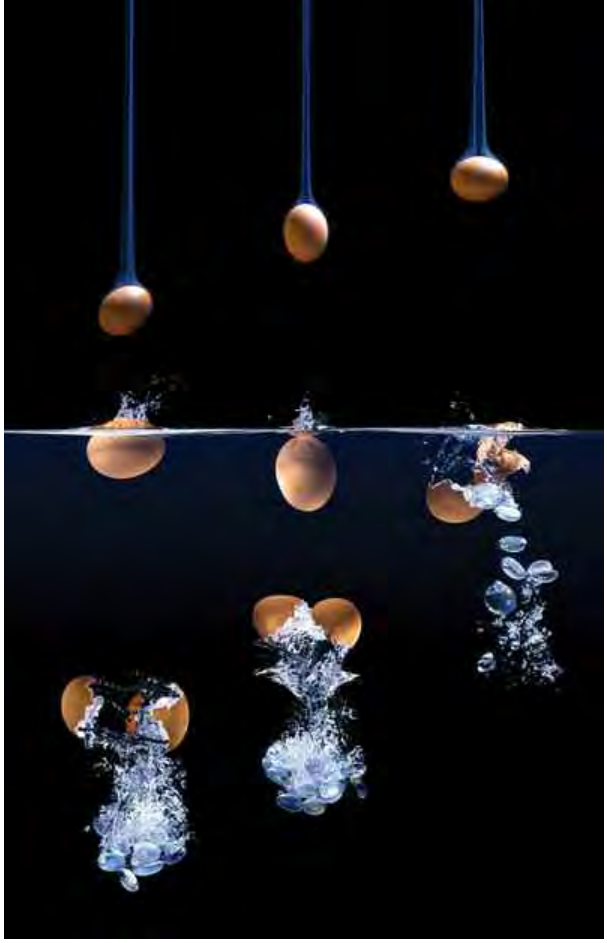
Reviving Interest in Space

We thought space was worth a big effort in the sixties. In 1962, President Kennedy committed the United States to landing a man on the Moon by the end of the decade. This was achieved just in time, by the *Apollo 11* mission in 1969. The space race helped to create a fascination with science and led to great advances in technology, including the first large-scale integrated circuits, which are the basis of all modern computers. However, after the last Moon landing in 1972, with no future plans for further manned spaceflight, public interest in space declined. This went along with a general public swing against science in the West, because although it had brought great benefits, it had not solved the social problems that increasingly occupied public attention.

A new manned spaceflight program would do a lot to restore public enthusiasm for space, and for science generally. Robotic missions are much cheaper, and may provide more scientific information, but they don't catch the public imagination in the same way. And they don't spread the human race into space, which I'm arguing should be our long-term strategy. A goal of a manned

John F. Kennedy, in his historic message to Congress on May 25, 1961, declared, "I believe this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth." Shown in the background are Vice President Lyndon Johnson and Speaker of the House Sam T. Rayburn. *Photo: NASA*

Above: Fossils of algae, about three and a half billion years old, give us one piece of observational evidence of the probability of life appearing in the universe. By comparison, this electron microscope image shows fossilized cyanobacteria (blue-green algae) from the Eocene period that are a youthful 55 to 38 million years old. Photo: Michael Abbey (c) Photo Researchers, Inc. All rights reserved



Right: These eggs breaking and releasing their embryonic contents into water illustrate the concept of panspermia. The theory is that the seeds of life on Earth, such as water and organic matter, arrived here via impacts from comets and asteroids. These impacts then kicked off the process of evolution on our young planet. Photo: John Brackenbury (c) Photo Researchers, Inc. All rights reserved

landing on Mars by 2030 would reignite the space program and give it a sense of purpose, in the same way that President Kennedy's Moon target did in the sixties.

A new interest in space would also increase the public standing of science generally. The low esteem in which science and scientists are held is having serious consequences. We live in a society that is increasingly governed by science and technology, yet fewer and fewer young people want to go into science. A new and ambitious space program would excite the young and stimulate them to go into a wide range of sciences, not just astrophysics and space science. A high proportion of today's scientists say their interest in science was sparked by watching the Moon landings.

What Will We Find?

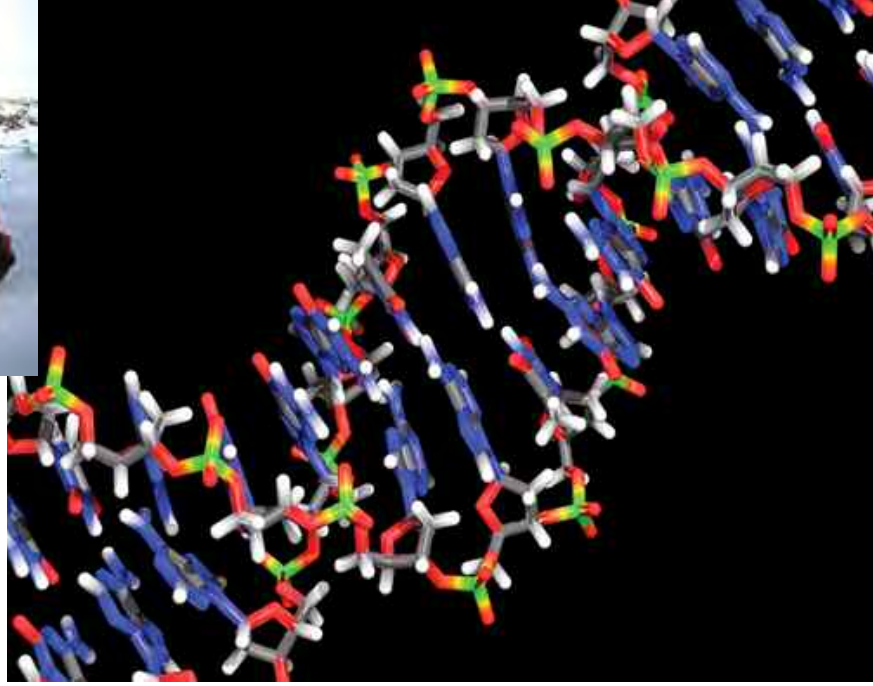
What will we find when we go into space? Is there alien life out there, or are we alone in the universe? We believe that life arose spontaneously on Earth, so it must be possible for life to appear on other suitable planets, of which there seem to be a large number in the galaxy. But we don't know how life first appeared. The probability of something as complicated as a DNA molecule being formed by random collisions of atoms in a primeval ocean is incredibly small. However, there might have been some simpler macro molecule, which then built up to DNA, or some other macro molecule capable of reproducing itself.

Still, even if the probability of life appearing on a suitable planet is very small, since the universe is infinite, life would have appeared somewhere. If the probability is very low, the distance between two independent occurrences of life would be very large. However, there is a possibility, known as *panspermia*, that life could spread from planet to planet, or from stellar system to stellar system, carried on meteoroids. We know that Earth has been hit by meteorites that came from Mars, and others may have come from further afield. We have no evidence that any meteorites carried life, but it remains a possibility. An important feature of life spread by panspermia is that it would have the same basis, which would be DNA, for life in the neighborhood of the Earth. On the other hand, an independent occurrence of life would be extremely unlikely to be DNA-based. So watch out if you meet an alien. You could be infected with a disease against which you have no resistance.

One piece of observational evidence on the probability of life appearing is that we have fossils of algae from 3.5 billion years ago. The Earth was formed 4.6 billion years ago and was probably too hot for about the first half billion years. So life appeared on Earth within half a billion

CALVIN AND HOBBES © 1989 Watterson. Distributed by UNIVER

Earth has been hit countless times by meteorites originating on Mars and, perhaps, many from other cosmic locales. We have no evidence that they've carried life, but it remains a possibility. Here, scientists from the Antarctic Search for Meteorites (ANSMET) search for new finds during the 2006–2007 field season. Photo: Ralph Harvey, ANSMET



This computer model illustrates the complexity of deoxyribonucleic acid (DNA), which carries genetic information. Each strand consists of a sugar-phosphate backbone (red, yellow, green, and white in the model) attached to nucleotide bases (blue and white). There are four different bases: guanine, cytosine, thymine, and adenine. Graphic: Pasieka (c) Photo Researchers, Inc. All rights reserved

years of it being possible, which is short compared to the 10-billion-year lifetime of an Earthlike planet. This would suggest either panspermia or that the probability of life appearing independently is reasonably high. If it was very low, one would have expected it to take most of the 10 billion years available. If it is panspermia, any life in the solar system, or in nearby stellar systems, will also be DNA-based.

While there may be primitive life in our region of the galaxy, there don't seem to be any advanced intelligent beings. We don't appear to have been visited by aliens. I'm discounting reports of UFOs. Why would they appear only to cranks and weirdos? If there is a government conspiracy to suppress the reports, and keep for itself the scientific knowledge the aliens bring, it seems to have been a singularly ineffective policy so far. Furthermore, despite an extensive search by the SETI project, we haven't heard any alien television quiz shows. This probably indicates that there are no alien civilizations at our stage of development within a radius of a few hundred light-years. Issuing an insurance policy against abduction by aliens seems a pretty safe bet.

Why Haven't We Heard from Anyone?

Why haven't we heard from anyone out there? One view is expressed in this Calvin and Hobbes cartoon. The caption reads, "Sometimes I think that the surest sign that intelligent life exists elsewhere in the universe is that none of it has tried to contact us."

More seriously, there are three possible explanations of why we haven't heard from aliens.

First, it may be that the probability of primitive life appearing on a suitable planet is very low.

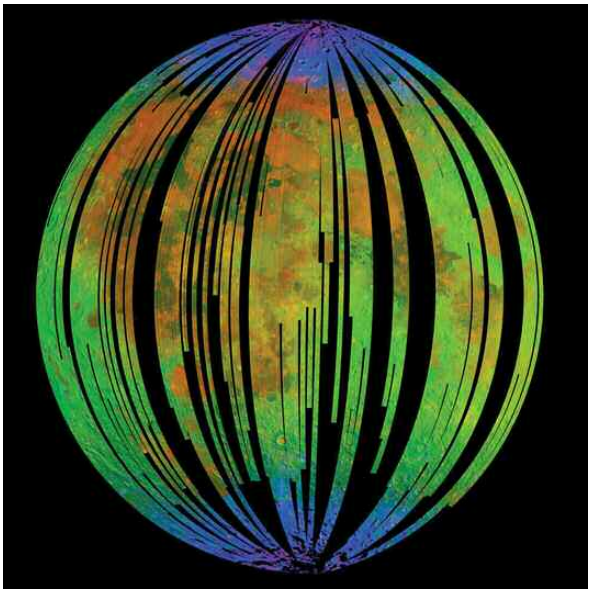
Second, the probability of primitive life appearing may be reasonably high, but the probability of that life developing intelligence like ours may be very low. Just because evolution led to intelligence in our case, we shouldn't assume that intelligence is an inevitable consequence of Darwinian natural selection. It is not clear that intelligence confers a long-term survival advantage. Bacteria and insects will survive quite happily even if our so-called intelligence leads us to destroy ourselves.

This is the third possibility. Life appears, and in some cases, it develops into intelligent beings. But when it reaches the stage of sending radio signals, it will also have the technology to make nuclear bombs and other weapons of mass destruction. It would therefore be in danger of destroying itself before long.

Let's hope this is not the reason we have not heard from anyone. Personally, I favor the second possibility, that primitive life is relatively common, but that intelligent life is very rare. Some would say it has yet to occur on Earth.

Can We Exist Away from Earth?

Can we exist for a long time away from the Earth? Our experience with the ISS, the International Space Station, shows that it is possible for human beings to survive for many months away from planet Earth. However, the zero gravity of orbit causes a number of undesirable physiological changes and weakening of the bones, as well as creating practical problems with liquids, et cetera. One would therefore want any long-term base for human beings to be on a planet or moon. By digging into the surface, one would get thermal insulation and protection from meteorites and cosmic rays. The planet or moon could also serve as a source of the raw materials that



This picture of the Moon was taken by NASA's Moon Mineralogy Mapper on the Indian Space Research Organization's (ISRO)* Chandrayaan-1 *mission. It is a three-color composite of reflected near-infrared radiation from the Sun, and it illustrates the extent to which different materials are mapped across the side of the Moon that faces Earth. Blue shows the signature of water and hydroxyl molecules, green shows the brightness of the surface as measured by reflected infrared radiation from the Sun, and red shows the iron-bearing mineral pyroxene.

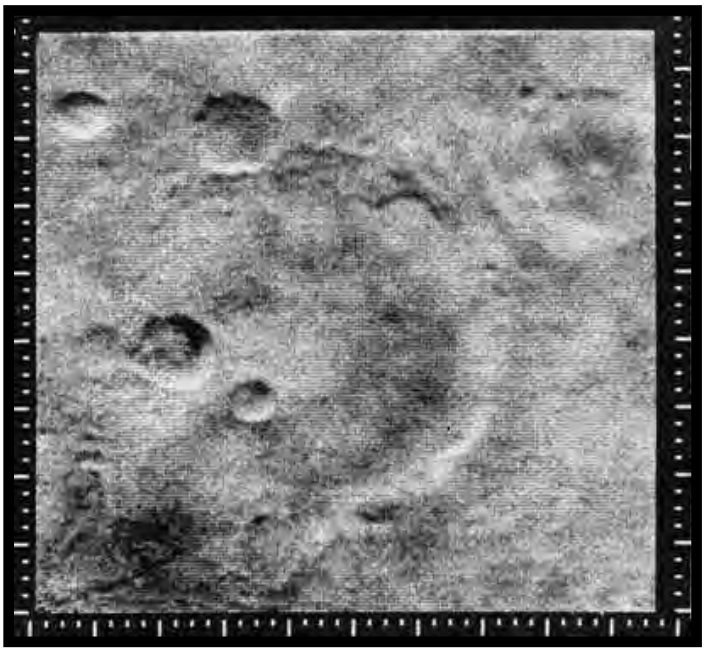
Image: ISRO/NASA/JPL-Caltech/Brown University/USGS

would be needed if the extraterrestrial community was to be self-sustaining, independently of Earth.

What are the possible sites of a human colony in the solar system? The most obvious is the Moon. It is close by and relatively easy to reach. We have already landed on it and driven across it in a buggy. On the other hand, the Moon is small and without atmosphere or a magnetic field to deflect the solar radiation particles, as on Earth. There is no liquid water, but there may be ice in the craters at the north and south poles. A colony on the Moon could use this as a source of oxygen, with power provided by nuclear energy, or solar panels. The Moon could be a base for travel to the rest of the solar system.

Mars is the obvious next target. It is half as far again as the Earth from the Sun, and so receives half the warmth. It once had a magnetic field, but it decayed 4 billion years ago, leaving Mars without protection from solar radiation. This stripped Mars of most of its atmosphere, leaving it with only 1 percent of the pressure of the Earth's atmosphere. However, the pressure must have been higher in the past, because we see what appear to be runoff channels and dried-up lakes. Liquid water cannot exist on Mars now: it would vaporize in the near vacuum. This suggests that Mars had a warm, wet period, during which life might have appeared, either spontaneously or through panspermia. There is no sign of life on Mars now, but if we found evidence that life had once existed, it would indicate that the probability of life developing on a suitable planet was fairly high. We must be careful, though, that we don't confuse the issue by contaminating the planet with life from Earth. Similarly, we must be very careful not to bring back any life. We would have no resistance to it, and it might wipe out life on Earth.

NASA has sent a large number of spacecraft to Mars, starting with *Mariner 4* in 1964. It has surveyed the planet with a number of orbiters, the latest being *Mars Reconnaissance Orbiter*. These orbiters have revealed deep gulleys and the highest mountains in the solar system. NASA has also landed a number of probes on the surface of Mars, most recently the two Mars rovers. These have sent back pictures of a dry desert landscape. However, there is a large quantity of water, in the form of ice, in the polar regions. A colony on Mars could use this as a source of oxygen. There has been volcanic activity on Mars. This would have brought minerals and metals to the surface, which a colony could use.



Mariner 4 ***took this image of Mars' Mariner crater (which was named after the spacecraft) in July 1965.*** **Mariner 4** ***was the first spacecraft to take a close look at Mars, revealing that the planet has a cratered, rust-colored surface with signs in some parts that liquid water once etched its way into the soil.*** *Image: NASA/JPL*

This close-up view, taken by **Mars Reconnaissance Orbiter's** ***High Resolution Imaging Experiment in October 2008, is a portion of a larger image of a complex crater in Mars' Arabia Terra. The crater lies at the boundary between the planet's southern highlands and northern lowlands and is intersected by one of the putative shorelines of what scientists believe was an ancient northern ocean.*** *Image: NASA/JPL/University of Arizona*

The Moon and Mars are the most suitable sites for space colonies in the solar system. Mercury and Venus are too hot, while Jupiter and Saturn are gas giants, with no solid surface. The moons of Mars are very small and have no advantages over Mars itself. Some of the moons of Jupiter and Saturn might be possible. In particular, Titan, a moon of Saturn, is larger and more massive than our Moon and has a dense atmosphere. The *Cassini-Huygens* mission of NASA and the ESA has landed a probe on Titan, which has sent back pictures of the surface. tHowever, it is very cold, being so far from the Sun, and I wouldn't fancy living next to a lake of liquid methane.

What about beyond the solar system? Our observations indicate that a significant fraction of stars have planets around them. So far, we can detect only giant planets, like Jupiter and Saturn, but it is reasonable to assume that they will be accompanied by smaller, Earth-like planets. Some of these will lie in the "Goldilocks zone," where the distance from the star is in the right range for liquid water to exist on their surface. There are around a thousand stars within 30 light-years of Earth. If 1 percent of these have Earth-sized planets in the Goldilocks zone, we have 10 candidate New Worlds.

We can't envisage visiting them with current technology, but we should make interstellar travel a long-term aim. By long term, I mean over the next 200 to 500 years. The human race has existed as a separate species for about 2 million years. Civilization began about 10,000 years ago, and the rate of development has been steadily increasing. If the human race is to continue for another million years, we will have to boldly go where no one has gone before.

Thank you for listening.

For more than 20 years, physicist Stephen Hawking has engaged the public in some of the most profound questions of existence. His book A Brief History of Time *broke records as a nonfiction best seller and led to a documentary film of the same name. He continued to intrigue the public with his television series,* Stephen Hawking's Universe*, and now reaches an entirely new audience with the children's books he coauthors with his daughter Lucy. Hawking is the most recent recipient of The Planetary Society's Cosmos Award for Outstanding Public Presentation of Science.*

We Make It Happen!

Asteroids, DVDs, and Dust

by Bruce Betts

I have good news from many projects to share with you this time around. We have updates on the great work our Shoemaker NEO grant winners are doing, an announcement that member names are ready to fly on board the Japanese *IKAROS* spacecraft, and news that Stardust@Home may have found an interstellar dust particle.

Shoemaker NEO Grant Updates

We recently announced that applications for our next round of Gene Shoemaker Near Earth Objects (NEO) Grants are due June 10, 2010 (for details, see our website). While we await new proposals, I want to update you on the incredible productivity of some of our past winners. Obviously, I can highlight only a few (we have 31 past winners in 15 countries on 5 continents). Let's take a tour of what a few have been up to in the last year or so.

Robert Holmes of the Astronomical Research Institute (ARI) in Charleston, Illinois—the only Shoemaker NEO grant repeat winner—earned grants in both 2007 and 2009, upgrading cameras on his telescopes. For the 2009 calendar year, the first camera took an astounding 121,097 images of NEOs, and the second camera, which became operational only in December, already has taken 8,542 images. Overall, under Holmes's direction, ARI made the largest number of targeted follow-up observations of faint NEOs (fainter than unfiltered magnitude 22.0) in the world in 2009!

Holmes is also using the grant money to spread the word about NEOs beyond the bounds of the astronomical community. The images taken with the two Planetary Society cameras are uploaded onto the Web and made available for study by high school and college students around the world through the Killer Asteroid Project. Last February, Holmes and his fellows at ARI joined with the Science Museum in Tokyo to present a live NEO show at the museum's planetarium. Live images of NEO 2009 FY4 taken by one of the Planetary Society cameras were projected onto the planetarium's dome, allowing the audience to track its movement through the sky in real time.

Herman Mikuz of the Crni Vrh Observatory in Slovenia received a Shoemaker NEO grant back in 2000 and used it to purchase a 0.60-meter sky survey telescope. Using this equipment, Mikuz and his colleagues discovered four previously unknown NEOs in 2009, designated 2009 CN5, 2009 CT5, 2009 DL1, and 2009 QO. The first of these, 2009 CN5, is particularly significant because its orbit is close enough to Earth's to earn it a place as a PHA—a potentially hazardous asteroid.

Russell Durkee used his 2009 Shoemaker NEO grant to fully automate the NEO observations at his Shed of Science Observatory in Minneapolis. "Installation of the observatory PC, roof control circuitry, cloud sensor, and software began in May of 2009," he wrote to us recently, "and by

late June, the observatory was operating nearly autonomously." Thanks to the automation, Durkee has been able to more than triple the number of observation nights at the Shed of Science Observatory.

The observatory's increased productivity was evident immediately. In late June 2009, Durkee took photometric measurements of asteroid 2001 FE90, which was making a close approach, and was able to measure its 29-minute rotation. He then combined his measurements with data from other observatories to determine the shape of the asteroid. Durkee also joined forces with 2007 Shoemaker NEO grant winners Brian Warner and **Donald Pray** to study binary asteroids—asteroids made up of two space rocks circling each other while orbiting together around the Sun. In particular, the team focused on known binaries 2000 AS152 and 1509 Escalngona, measuring the rotations of each of their two components.

Brian Warner added a 0.36-meter telescope to his Palmer Divide Observatory with the Shoemaker NEO grant he received in 2007. In addition to his collaboration with Durkee and Pray on the binaries study, Warner has been recording the lightcurves of NEOs and objects in the main asteroid belt. The curves help to determine the precise motion of a space rock, whether it is rotating around an axis or tumbling along, and the length of time it takes it to complete each revolution. Of particular interest to Warner are Mars-crossing asteroids, which he refers to as "NEOs in waiting," requiring only a slight nudge to send them into an Earth-crossing orbit.

Finally, a word from our youngest recipient, **Quanzhi Ye** (photo, upper right) of Guangzhou, China. Quanzhi was an 18-year-old college freshman but already the principal investigator of the Lulin Sky Survey in Taiwan when he received a Shoemaker NEO grant in 2007. He needed the money to purchase a laptop that would enable him to conduct his observations via the Internet. Quanzhi discovered and tracked numerous NEOs (and

comet Lulin) with the help of his laptop, but in March 2009, the Lulin Sky Survey ended and, with it, his role as principal investigator. Nevertheless, as he told us in a recent e-mail, his progress in observational astronomy is just beginning.

"I'll graduate in this summer (how time flies! I was a freshman when applying Shoemaker Grant), and I'm now applying for several U.S. grad schools for further study in astronomy, so despite I'm temporarily off on asteroids, I'm still on the way. I'm very happy to say that Shoemaker Grant I received has done a lot on the 'launch' of my Dream! ;-) Please keep up the good work, as the grant has/will help a lot of people."

See *planetary.org/programs/projects/neo_grants/* for more on the Shoemaker NEO grants and our winners' accomplishments.

Members' Names Ready to Fly into Space on *IKAROS*

As part of our Messages from Earth program, Planetary Society member names are once again ready to fly into

A close-up of the final DVD before it was sent to Japan for mounting on the* IKAROS *spacecraft.
Photo: Bruce Betts

The Planetary Society's director of projects Bruce Betts with the final* IKAROS *DVD.
Photo: Donna Stevens, The Planetary Society

What's **Up?**

In the Sky—June and July

Check out Venus, Mars, and Saturn in the evening sky. They'll appear to grow closer over the coming weeks. Venus is the extremely bright starlike object in the west after sunset. To its upper left is Mars, reddish and much dimmer. To Mars' upper left is Saturn, looking yellowish. In early June, Venus appears to be near Gemini stars Castor and Pollux and, in early July, near Leo's bright star Regulus. The crescent Moon will be near Venus on June 14, Mars and Regulus on June 16, and Saturn on June 18. In the predawn sky, extremely bright Jupiter is high in the southeast, and Mercury is visible low in the east in late May and early June. There is a partial eclipse of the Moon (about half-eclipsed) on June 26, visible from most of the Americas, the Pacific Ocean, eastern Asia, and eastern Australia. There is a total solar eclipse on July 11, visible from the southern Pacific Ocean and parts of southern Chile and Argentina.

Random Space Fact

In scale models, if Earth is the size of a professional soccer ball, Jupiter's diameter is approximately the height of a professional soccer goal.

Trivia Contest

Our November/December contest winner is Andy Fleming of County Durham, United Kingdom. Congratulations!

The Question was: How many engines did the first stage of the Saturn V rocket have?

The Answer is: Five

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

Where in the solar system (on what planet or moon) is Alpha Regio?

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 August 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.*

the solar system, this time on board the Japanese Space Agency's (JAXA) *IKAROS* spacecraft. *IKAROS* (Interplanetary Kite-craft Accelerated by Radiation Of the Sun) is a solar sail that will gather sunlight as propulsion by means of a large sail. This solar-powered sail craft will employ both photon propulsion and thin-film solar power generation during its interplanetary cruise. *IKAROS* will be launched together with the Venus Climate Orbiter, *Akatsuki*, in mid-May 2010 by JAXA. The Planetary Society is partnering with JAXA not only on flying names but also on solar sailing in general, in connection with our *LightSail* program.

Names and messages were collected by both JAXA and The Planetary Society (about 34,000 names each). All Planetary Society members' names also were added. The data were recorded onto a silica glass mini-DVD and delivered to JAXA by The Planetary Society.

The data writing of the silica mini-DVD was generously provided by Plasmon OMS, our longtime partner for providing archival glass mini-DVDs. Plasmon also provided the mini-DVDs that flew on board both Mars Exploration Rovers and *Phoenix*. Data on these discs have an expected lifetime of many hundreds of years, even in the environment of space.

You can print a certificate commemorating your name's flight on *IKAROS* from our Messages from Earth website at *planetary.org/messages*. You also can go there to sign up additional names to fly on The Planetary Society's solar sail spacecraft *LightSail-1*.

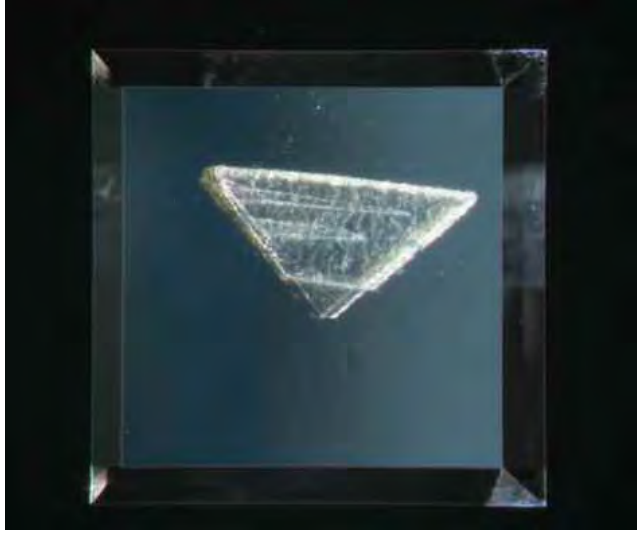
Possible Interstellar Dust Particle from Stardust@Home

There is tantalizing news from the UC Berkeley Stardust@Home project, in which The Planetary Society is an official collaborator. Stardust@Home is using volunteers to analyze movies of aerogel returned by NASA's Stardust spacecraft to try to find interstellar dust particles. Stardust@Home Director Andrew Westphal has reported that the project has found by far the most promising interstellar dust candidate to date. He says, "We emphasize that we do not yet know whether or not it is actually interstellar—this may take years to determine definitively. Nevertheless, we are cautiously optimistic that it is in fact a tiny piece of matter from outside our solar system."

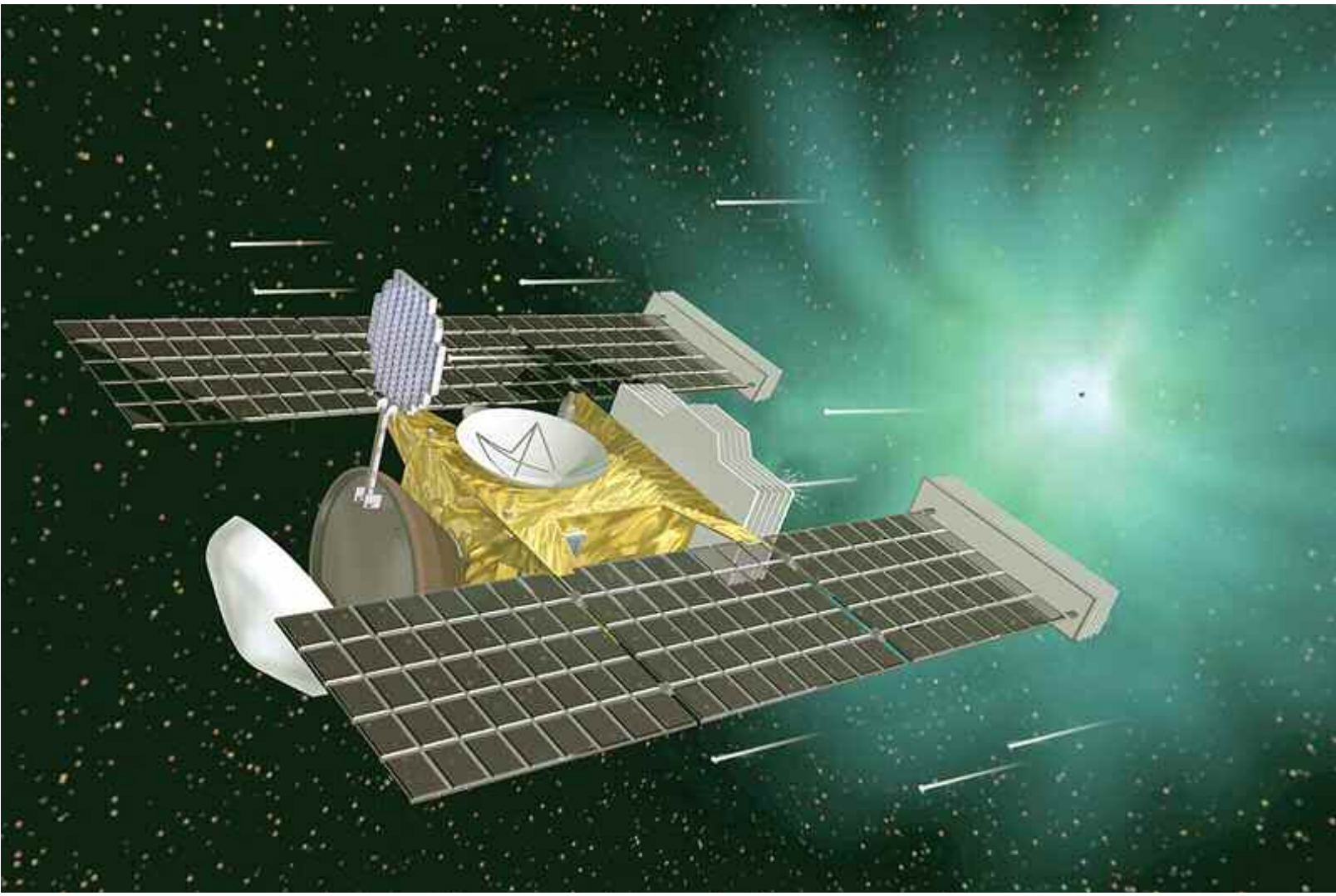
Nicknamed Orion, this particle is in a so-called midnight track because of the angle of its direction on entry into the collector, and its track looks quite different from original expectations of what an interstellar dust track might look like. The project attributes success in finding this and other particles in large part to the power of the human brain to analyze the data.

Orion has gone through various analyses so far. It shows composition consistent with cosmic abun-

First detected and named by Stardust@Home volunteer Bruce Hudson, Orion is known as a midnight particle because of the trajectory of its track. Here it is shown embedded in an aerogel picokeystone that was extracted from Stardust collector tile 43.
Image: NASA/Stardust@Home



After a process of trial and error, the Stardust@Home team settled on this window as the optimal way to mount the pieces of the aerogel for study. In this configuration the "keystone" containing a candidate track is sandwiched between two silicon nitride windows, each only 70 nanometers in thickness.
Image: Regents of the University of California, Stardust@Home



This artist's rendition of the* Stardust *spacecraft approaching comet Wild 2 shows the spacecraft in the process of collecting particles from the comet's coma by extending its paddle-shaped particle collector composed of ultralight aerogel. Using the reverse side of the collector throughout the spacecraft's 195-day journey to Wild 2,* Stardust *attempted to capture rare particles of interstellar dust. Orion may be prove to be such a particle. *Image: NASA/JPL*

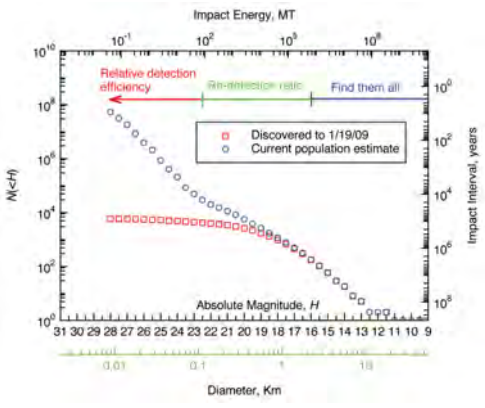
dances, and it is quite complex. Analyses are ongoing. Meanwhile, Stardust@Home, using what has been learned from the discovery of this particle, is moving into a new phase—Phase 3—that will focus on finding more of the midnight tracks. Learn more about the story of Orion on our website at *planetary.org/programs/projects/stardustathome/*.

Bruce Betts is director of projects for The Planetary Society.

Questions and Answers

In the March/April 2009 issue of* The Planetary Report, *I read that the "goal of the [Spaceguard] survey was to discover 90 percent of NEOs larger than 1 kilometer in diameter within 10 years" but that only about 80 percent actually were found in that time. I am puzzled about how anyone can be sure what actual percentage has been achieved if nobody knows how many near-Earth asteroids there are in total. If they haven't been found, how can we know how many of them there are?
—Alan Turk
Wilts, United Kingdom

Indeed, we do need to observe a significant number of near-Earth asteroids to be able to estimate the total number out there. We make the estimate in three parts. After surveying and cataloging for some time, we begin to notice that we aren't discovering any new objects of the largest sizes—we just keep seeing the same big ones every time they come around. At some point, we are justified in saying we have found them all. In the figure (shown below), this is quite likely true for NEAs larger than 3 or 4 kilometers (about 2 miles) in diameter: there are fewer than 100 of them known, and we have not discovered a new one that large for years, despite seeing the known ones over and over again. As we progress down to the smaller sizes, we start discovering new asteroids as well as redetecting ones already known. Going down to about 1 kilometer in diameter, about 90 percent of the objects that size currently being detected by the surveys are already known; only about 10 percent are new discoveries.



This figure is a plot of the cumulative number, N(< H), of NEAs larger than a given size versus size. Three size scales are given. The fundamental one is the absolute magnitude H (brightness) of the object—this is what is actually measured by the surveys. Below that is a scale in kilometers, corresponding to the H magnitudes, assuming an average albedo (reflectivity) of NEAs of around 15 percent. The third scale, across the top, is the impact energy an object of that size would have if it entered Earth's atmosphere at the average speed of impacting NEAs, around 20 kilometers (about 12 miles) per second. Finally, along the right side of the plot is the "impact interval," or average time between impacts, of objects corresponding in numbers to N(< H). That is, for any single object, the expected time to impact is around half a billion years. If there are 1,000 objects, for example, then the expected interval between impacts is half a million years. Two sets of data are plotted. Red squares show the total number versus size of currently detected objects. Blue circles are the total population, estimated as described in the text. In both cases, the numbers plotted are the cumulative number brighter (larger) than the given value of H (or equivalently, diameter).

If all asteroids were equally discoverable, like picking colored marbles out of a jar, we would declare that the surveys are currently 90 percent complete. Unlike marbles in a jar, however, not all NEAs are equally easy to find, if for no other reason than that some are in orbits with longer periods and don't come around as often. Once we know something about the distribution of orbits of the NEA "swarm," we can model which ones are easier to find and correct for the fact that we are re-seeing the ones that are easier to find. This allows us to "bias-correct" our estimate and conclude that, currently, surveys have found around 85 percent, rather than 90 percent, of NEAs larger than 1 kilometer in diameter. We can continue applying this technique down to NEAs as small as 100–200 meters in diameter. This process doesn't work for smaller asteroids because we don't see enough of them a second time to compute an accurate redetection ratio. There are still plenty of discoveries to get an idea of the population but not enough redetections of known objects to apply the redetection ratio method.

The same computer models that allow us to estimate the bias correction to redetections allow us to estimate, in a relative sense, the depth of a survey as a function of size of objects. That is, if a given survey has found 50 percent of objects 300 meters in diameter, the models tell us that the same set of observations should yield about 25 percent of objects 200 meters in diameter, 10 percent of objects 100 meters in diameter, and so forth. If we know that a given survey has achieved 50 percent completeness at 300 meters in diameter (that's about the status of current surveys), we can estimate the population of objects 200 meters in diameters by multiplying the total number of objects that size discovered by 4, and for 100 meters, the total number discovered by 10, and so on down to still smaller sizes. Using this "bootstrapping" method, we can obtain at least a rough estimate all the way down to the smallest objects detected by the current surveys, around 10 meters in diameter.
—ALAN HARRIS,
Space Science Institute

I've not been able to find any indication as to how many stars we've actually been looking at in the search for extrasolar planets. I'd be interested to know what percentage of stars have planets, accepting that this is likely to be a crude estimate.
—Andy Chappell
Bristol, United Kingdom

On the date that I am composing this reply, April 7, 2010, the unofficial exoplanet (extrasolar planet, or ESP) count stands at 443 planets outside our solar system. This number changes on an almost daily basis, so if you want a completely up-to-date count, you will need to go to Jean Schneider's website,The Extrasolar Planet Encyclopedia, located at *exoplanet.eu/*. The International Astronomical Union no longer tries to keep up with the exoplanets that meet its definition of "what is a planet." As a result, Schneider's website has become the de facto worldwide authority on the exoplanet total.

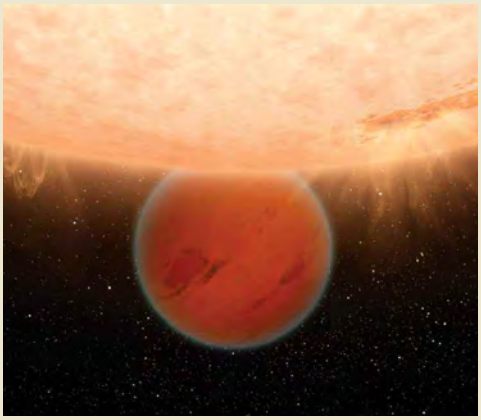
Thousands of stars have been monitored by the dozens of ground-based exoplanet searches, and more than 100,000 are being searched for transits in space by *CoRoT* and *Kepler*. The best statistics to date on the frequency of planets come from the Doppler and gravitational microlensing surveys. The Doppler surveys have shown that hot Jupiters (gas giants with masses similar to, or greater than, Jupiter's, with orbits much closer to their parent stars than any planets in our solar system) occur around a few percent of Sun-like stars, while warm and cold Jupiters, with orbital periods as long as about five years, orbit about 10 percent of Sun-like stars. The Doppler estimates are that gas giant planets may orbit within 20 AU of as many as 20 percent of Sun-like stars.

For lower-mass, M dwarf stars, the Doppler surveys imply a much lower frequency of gas giants, only a few percent. Microlensing surveys, however, indicate that the frequency of gas giants around M dwarfs is much higher, perhaps 35 percent. Both Doppler and microlensing show that lower-mass planets, the super-Earths with masses up to about 10 Earth masses, appear to be incredibly commonplace, orbiting about 35 percent of Sun-like stars. The implications for the prevalence of life in the universe are proportionately high, given the expected high frequency of habitable worlds.

—ALAN BOSS,
Carnegie Institution of Washington

Factinos

NASA's Spitzer Space Telescope has detected something odd about a distant extrasolar planet—it lacks methane, an ingredient common to many of the planets in our solar system. "It's a big puzzle," said Kevin Stevenson of the University of Central Florida in Orlando. "Models tell us that the carbon in this planet should be in the form of methane. Theorists are going to be quite busy trying to figure this one out."



NASA's Spitzer Space Telescope has found evidence that a hot, Neptune-sized extrasolar planet lacks methane—an ingredient common to many planets in our own solar system. In this view, the unusual, methane-free world, called GJ 436b, is partially eclipsed by its parent star. *Illustration: NASA/JPL-Caltech/R. Hurt*

The methane-free planet, called GJ 436b, is about the size of Neptune, making it the smallest distant planet that any telescope has successfully "tasted," or analyzed. Eventually, a larger space telescope could use the same kind of technique to search smaller, Earth-like worlds for methane and other chemical signs of life, such as water, oxygen, and carbon dioxide.

"In this case, we expected to find methane not because of the presence of life, but because of the planet's chemistry," said Joseph Harrington, also from the University of Central Florida. "This type of planet should have cooked up methane. It's like dipping bread into beaten eggs, frying it, and getting oatmeal in the end."

GJ 436b is located 33 light-years away in the constellation Leo. It rides in a tight, 2.64-day orbit around its small star, an M dwarf much cooler than our sun. The planet transits, or crosses in front of, its star as viewed from Earth. Harrington and his team reported their findings in the April 22, 2010 issue of *Nature*.

—from NASA/JPL/Spitzer Science Center

A team of European scientists has announced the discovery of nine new transiting extrasolar planets (ESPs). What is surprising is that when they combined their new results with earlier observations of transiting ESPs, they found that 6 (out of a larger sample of 27) have retrograde orbits—they circle their stars in the "wrong direction."

The new discoveries provide an unexpected and serious challenge to current theories of planet formation. They also suggest that systems with exoplanets of the type known as "hot Jupiters" are unlikely to contain Earth-like planets. After the initial detection of the nine new exoplanets with the Wide Angle Search for Planets (WASP), the team of astronomers used the HARPS spectrograph on the 3.6-meter ESO telescope at the La Silla observatory in Chile, along with data from the Swiss Euler telescope, also at La Silla, and data from other telescopes to confirm the discoveries and characterize the transiting exoplanets found in both the new and older surveys.

"The new results really challenge the conventional wisdom that planets should always orbit in the same direction as their stars spin," says team member Andrew Cameron of Scotland's University of St Andrews. The group presented its discovery at the Royal Astronomical Society's National Astronomy Meeting in Glasgow on April 14, 2010.

—from the European Southern Observatory

Members' **Dialogue**

NASA's Budget

Neil Armstrong had it right when he called President Obama's NASA budget "devastating." By abandoning Constellation, $10 billion of our taxes has been wasted. We will now depend on Russia, a rival in space that is not well-disposed to us in Iran and other crucial flashpoints, for access to low Earth orbit. By abandoning a firm goal to even return to the Moon—much less to land humans on Mars—by a fixed date, Obama's plan ensures that travel by humans to other planets will not happen in my lifetime, nor in that of most Planetary Society members.

Even the milestones Obama has set, such as sending humans to a near-Earth asteroid, are hollow. He is scrapping the launch vehicle (Ares 5) and the crew capsule (Orion) that could have gotten us there. Imagine if President Kennedy had announced that he would slightly increase NASA's budget and then task NASA with developing new technologies to allow more efficient space travel without setting the Moon as a goal. Does anyone seriously believe Neil Armstrong and Buzz Aldrin would have landed on the Moon in 1969, 1979, or even 1989 with such an approach?

This is the first time in my over two-decade-long membership in The Planetary Society that I am dismayed at the Society's leadership, which has chosen to obsequiously applaud the president's plan to gut the human space exploration program instead of standing up and speaking out and fighting for it.

—KAJ AHLBURG,
Port Angeles, Washington

Take Care of Earth

This dialogue on manned, robotic, and Earth science missions is healthy. Appreciating perspectives from Ferko, Smith, and others, let me clarify that a (my) call for more of a focus on Earth now is actually a way to reaffirm our commitment to land people on other worlds. Whether or not you personally believe in climate change, for the Society to acknowledge the critical nature of the science question, and to call for using space to study the climate and oceans while preparing for the next manned missions, says that we are science-driven as well as adventure-driven as we advocate space exploration.

While this will not satisfy members who would be happy only with an immediate, full-throttle push to the Moon and/or Mars, I suggest the smartest policy strategically, politically, and evolutionarily is to 1. build a space platform for comprehensive climate and ocean observation; 2. research next-generation propulsion; and 3. go for NEOs and Mars.

A stable Earth climate enabling a robust economy is the best support for space exploration and, eventually, an off-planet colony. Personally, I think we can do better than today's chemical rockets.

This approach aligns with The Planetary Society's mission: "To inspire the people of Earth to explore other worlds, understand our own, and seek life elsewhere." It supports the Society's space exploration roadmap, which includes "accelerating research into global climate change through more comprehensive Earth observations."

Would the Society open a Web discussion forum and work toward ratifying a Member's Proclamation? My suggestion would be for it to highlight Earth for this decade while researching and reaffirming Mars for the next.

—RAND WROBEL,
Alameda, California

A hearty thanks to Louis Friedman as he steps down after 30 years of outstanding service to The Planetary Society and to every person who looks up at the universe with wonder.

The cover of *The Planetary Report* for March/April 2010 speaks volumes for focusing on robotic exploration of the Moon, Mars, and other destinations. The determined exploration of Mars by the *Spirit* and *Opportunity* rovers shows how we can get substantial scientific information from such robots. The bottom line is that robotic exploration is not only more affordable, but also much safer.

The need to establish human outposts well beyond Earth to preserve the species is not compelling. Let's take really good care of our home planet. I've had dreams of traveling to Mars for decades but am now very excited about improved robots spreading out to Pluto and well beyond.

—EARL FINKLER,
Medford, Wisconsin

Please send your letters to
Members' Dialogue
The Planetary Society
85 South Grand Avenue
Pasadena, CA 91105-1602
or e-mail: *tps.des@planetary.org*

Society News

Our New Headquarters!

After 25 years in our historic Greene and Greene headquarters in Pasadena, California, The Planetary Society has moved . . . but not far!

Our new headquarters is located at **85 South Grand Avenue, Pasadena, CA 91105**.

Twenty-five years ago, we purchased the Sanborn House in Pasadena with the help of you, our Members. We are eternally grateful to all of you who supported this effort and helped us to purchase the property, which has been our home and has served as the birthplace of many of our most exciting projects.

As we have packed up the offices in preparation for the move and have sorted through our bookshelves, files, photos, and memorabilia, we have been amazed by the many projects and activities you made possible. It's inspiring to see what we have been able to accomplish together.

We wish the new owners—an architecture firm—great success. They have terrific plans for restoring the 100-year-old house to its original glory. Although we are a little sad at leaving our beautiful old house, we are excited about our new headquarters and the opportunities it affords.

This year, we will celebrate our organization's 30th anniversary, and we're thrilled as we look forward to continuing this adventure with you. It is going to be a tremendously exciting new era for us.

Thanks for being along for the ride.
—The Planetary Society Staff

Thank You, Dave!

When the Planetary Society held its first official volunteer meeting in January 1981, Dave Hagie was there. Over the years, he has cheerfully performed many tasks, from stuffing letters into envelopes to working security at several Planetfests.

Dave took on a monumental task when he offered to oversee our move. We had been in the same location for 25 years, a location that included not only two buildings but also a basement, a huge attic, and two storage sheds. Every nook and cranny was chock full of posters, brochures, research reports, financial records, event flyers, paper, paper, and more paper. Some of the stuff was important or memorabilia, and lots just trash. Somehow Dave sorted through everything and determined whether it would make the move, go into storage, or be trashed, while allowing the staff to continue their daily work.

It took several months, but he did it! Thanks, Dave!
—The Planetary Society Staff

2010 Cosmos Award Ceremony

Each year, The Society's Cosmos Award for Outstanding Public Presentation of Science gains in prestige. This February's award and the ceremony honoring Dr. Stephen Hawking proved no exception.

From the M. R. & Evelyn Hudson Foundation, whose grant in 2005 established the Cosmos Award, to the Kenneth T. and Eileen L. Norris Foundation, which helped fund this year's event, to the Members who traveled from near and far to attend and to those who attended in spirit, to Planetary Society U.K. volunteer Andy Lound and his team—thank you!

If you have not already, I hope that you will read the transcript of Dr. Hawking's remarks in this issue. Like I did, I imagine that you will take great pride upon reading his remarks about the award, The Society, and the rich legacy that you and I continue as Planetary Society Members—engaging citizens around the world in the excitement of exploring our world and worlds beyond.
—Louis Friedman,
Executive Director

Travel with The Planetary Society

Join us on one of these great adventures!

- TAHITI Total Solar Eclipse 2010 (a few spots still available!)
  July 4–12, 2010
- Discover HAWAII
  October 2–9, 2010
- ANTARCTICA!
  December 9–21, 2010
- 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 received for every tour.

What are you waiting for? Join us in Tahiti, Hawaii, Antarctica, or Alaska!

Contact Betchart Expeditions—*info@betchartexpeditions.com*— or phone (408) 252-4910 for more information on any of these trips.

THE PLANETARY SOCIETY
85 South Grand Avenue
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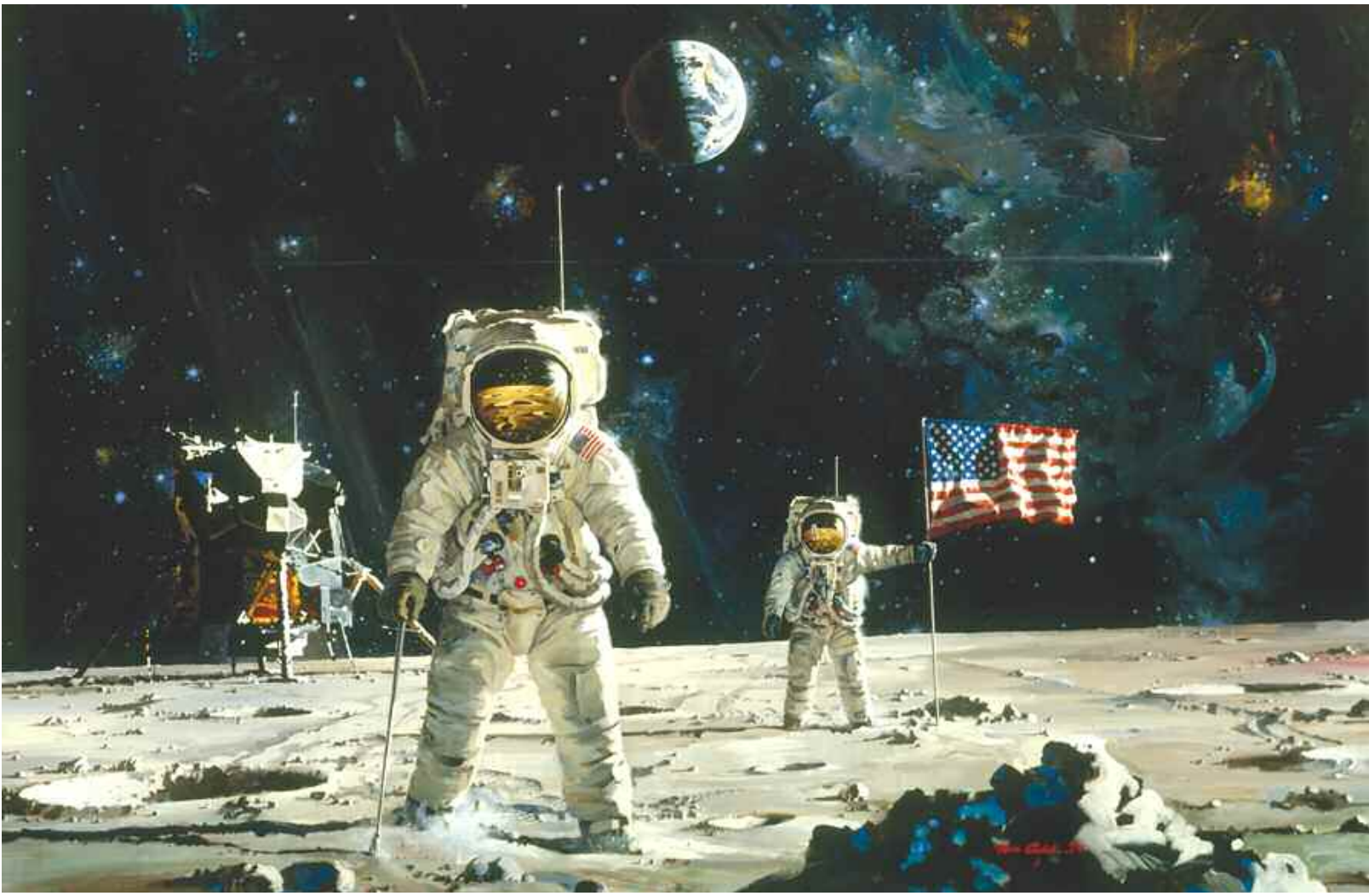

First Men on the Moon, by Robert T. McCall, depicts that beautiful moment in Earth's history when two of our citizens—Neil Armstrong and Buzz Aldrin—first set foot on another world.

Robert McCall died on February 26, 2010 in Scottsdale, Arizona. Since the birth of the space age, Bob had been illustrating our visions of the future and chronicling our efforts to get there. He was one of the first artists invited by NASA to be a part of its Fine Arts Program. Alongside such diverse artists as Andy Warhol and Norman Rockwell, he documented the many stages of our journeys off Earth. The public was introduced to Bob's work when he illustrated *LIFE* magazine's 1960s series on the future of space exploration. In 1968, Stanley Kubrick asked him to illustrate the posters for his seminal film *2001: A Space Odyssey.*

Bob designed postage stamps and NASA mission patches, and he served as art director on Paramount's 1979 film *Star Trek: The Motion Picture.* His murals adorn the walls of NASA's Johnson Space Flight Center and Dryden Flight Research Center. The most famous of these works is the six-story *The Space Mural—A Cosmic View.* This 1976 piece, depicting space history from the beginning of the universe to the days when humans walked on the Moon, is seen by about 10 million visitors a year to the Smithsonian Institution's National Air and Space Museum.

Bob gave his time and talent to the creation of Arizona's Challenger Space Center, and he was always gracious and generous in his dealings with The Planetary Society. His multitude of paintings, awards, acknowledgments, and charitable works are too many to mention here; nevertheless, they light our path to the stars.