THE PLANETARY SOCIETY

THE PLANETARY REPORT

JUNE SOLSTICE 2015

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planetary.org

WE DID IT!

***LIGHTSAIL'S* WILD RIDE**

A NEW SPACE TELESCOPE ✵ SHOEMAKER GRANT WINNERS ✵ A PRACTICAL MARS STRATEGY

DOUG STETSON *managed The Planetary Society's* LightSail *test program.*

A Perfect Launch…

And A Dramatic, Triumphant Finish for *LightSail*'s Test Flight

To read Jason Davis' mission wrap-up, check out **planet.ly/lsreentry**

EXACTLY TWO HOURS after a perfect morning launch on Wednesday, May 20, our *LightSail* test flight spacecraft was released from its carrier into free flight. This moment marked a major milestone for The Planetary Society and made good on the vision shared by our founders and the thousands of Society members who have supported solar sailing for more than a decade.

ABOVE *On the morning of May 20, The Planetary Society's dreams came true when an Atlas V carried our* LightSail *test spacecraft into the blue sky above Cape Canaveral, Florida.*

Things got only better as, about an hour later, the spacecraft deployed its antenna and sent its first radio transmissions, confirming that it was healthy and ready for its mission. As you probably know by now, the mission was not without moments of real concern and uncertainty– but in the end, *LightSail* fulfilled every goal of this test mission and set us firmly on the path toward true solar sailing next year.

PIONEERING SOLAR SAILING

Our first *LightSail* flight may have been "only" a test, but it was a very important test. This brief, low-altitude flight tested the spacecraft's hardware and software and confirmed that the solar sail deployment system can successfully unfurl the 32-square-meter Mylar sail. This mission sets the stage for *LightSail*'s primary flight in September 2016, when it will conduct a full, multimonth demonstration of controlled solar sailing in Earth orbit.

Together, the two *LightSail* flights serve as a critical pathfinder for future solar sail missions to the Moon and other planetary destinations. In fact, NASA is already planning two such missions for later this decade, and other space agencies, as well as private organizations, are eagerly following *LightSail*'s progress.

DRAMA, THEN MISSION SUCCESS!

As is typical of most space missions, the successes of the first few days were followed by moments of question and concern. We lost contact with the spacecraft for several days on two occasions, and in each case it took some creative detective work to understand the situation and re-establish communications. Finally, the command was given to deploy the sail–we tried three times, and on the final attempt, on Sunday, June 7 we saw the motor spin and the sail finally start to deploy. This was confirmed by the beautiful image received on Tuesday, June 9. That "mission success" photo has since been published worldwide, proving that the *LightSail* system is truly ready for prime time next year.

The mission operations team led by professors David Spencer of Georgia Tech and John Bellardo of Cal Poly San Luis Obispo, along with their students and the spacecraft team at Ecliptic Enterprises Corporation in Pasadena, went above and beyond to ensure the success of *LightSail* test flight. Their achievement really belongs to all The Planetary Society members who have been so committed to the vision of solar sailing and its promise of low-cost exploration throughout the solar system.

Photo: United Launch Alliance

ON THE COVER: *LightSail* captured this shimmering self-portrait from Earth orbit on June 8, 2015. In a June 10 press statement, Planetary Society Chief Operations Officer Jennifer Vaughn summed up the project by saying, "This test mission has been a high-intensity, high-profile dress rehearsal. Through the ups and downs of our *LightSail* test flight, our members, backers, and supporters around the world have cheered us on. *LightSail* is a tangible symbol of citizen participation in space exploration. Behind the simple beauty of an image of a shiny sail in space lit by the Sun is the collective effort of tens of thousands of enthusiasts who got this project built, launched, and tested. This successful test flight belongs to all of us." *Image: The Planetary Society*

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BILL NYE *is chief executive officer of The Planetary Society.*

The Big Picture

The Society Takes Small Steps Toward Ambitious Goals

THE STAFF AND I WERE mesmerized at Cape Canaveral in May, overjoyed as we watched the successful launch of our *LightSail* test flight. Four and a half weeks later, I went out onto the roof of my building in New York and stared into the night sky. I oriented my gaze with what apparently is a very accurate compass or azimuth indicator application on my smartphone. I shrugged, because there were a few high cirrus clouds, and the bright lights of the big city made the whole sky glow anyway. I figured I'd be weathered out again—there would be nothing to see.

About 20 seconds after what I believed was the expected first moment, there it was—our *LightSail*, just a pinprick of light in the glowing sky. It was moving pretty fast at this point in the mission. As atmospheric drag started to bring it down closer to Earth, its orbital speed naturally increased. I followed it, transfixed. It was just our spacecraft and me.

It had been a tough few weeks for our team, following a tough few years and a few tough program management decisions. Yet, there it was, right on course. I'd been on the roof a few other times trying to get a glimpse of it. So, when I finally saw it…well, it's a little hard to express how much this test flight has meant to our organization and to me.

A 40-YEAR LEGACY

Ever since I joined the board of directors back in 1997, the Society has been talking about a successful solar sail flight. Although *Cosmos 1*, our first solar sail mission, did not work out, you all stuck with us. So, we stuck with you. We have finally succeeded with the first of two missions to demonstrate the surprisingly difficult business of packing that much sail into that small a spacecraft and deploying it successfully into orbit. We work to advance space science and exploration in the biggest of pictures by taking measured, near-term steps. *LightSail*'s successful test flight reflects our commitment—and yours. Thank you.

To further our progress up there, we created a Kickstarter campaign to fund next year's primary *LightSail* flight. If you followed the test flight, you know there are several key problems to be solved. The Kickstarter campaign will ensure that our engineers have the resources they need to track down these tricky software issues, so that next year's launch aboard a Space-X Falcon Heavy will put us on orbit for a fantastic mission during which we will demonstrate sailing by the pressure of light.

If you've been to our website in the last few months, I hope you noticed the video showing Carl Sagan's 1976 appearance on *The Tonight Show* with Johnny Carson. In it, he's showing Johnny a model of a solar sail that was being proposed to catch up with Comet Halley. The model was square and very shiny, just like *LightSail*. Before cofounding the Society, Bruce Murray and Louis Friedman worked with the team developing this mission at the Jet Propulsion Laboratory. *LightSail* is part of a 40-year legacy. It's an honor to be part of it.

NEW HORIZONS ARRIVES AT PLUTO

Your Society began advocating for this mission way back in the twentieth century. We encouraged our members and supporters to write cards and letters to lawmakers. We visited congressional offices. Many of you (including Neil deGrasse Tyson and me) were at the launch of *New Horizons* in 2006. It still holds the record for the fastest spacecraft ever launched, and it still took 9.5 years with a velocity boost from Jupiter to get to the Plutonian system. On page 6 is Jason Davis's report on the Society's long

history of working to make this summer's Pluto flyby a reality.

HUMANS TO MARS

I've received some thoughtful messages from a few of you expressing concern about wasting resources and intellect on planning human space missions that will never happen. That's why we held our Humans Orbiting Mars workshop in spring. The Planetary Society does not support missions that are unrealistic and very unlikely to be funded. Heretofore, such missions have been promoted by enthusiastic politicians, engineers, and managers from the Apollo era, when the NASA budget peaked at about 4.5 percent of the federal budget. As you may know, NASA's budget is currently 0.4 percent of the federal budget. One may judge this state of affairs as appropriate or inappropriate, but it is the way it is. And, it is the way it will be for any future one may foresee.

With this in mind, The Planetary Society is advocating for an achievable, executable, reasonable human mission to Mars orbit in 2033. Humans can make this trip with existing rockets and other hardware that is already in development. Certain managers at NASA are currently constrained by politics to argue for what they call "mission agnostic" expenditures of funds. We at the Planetary Society feel this approach is wasteful and will lead us nowhere—or at least nowhere new. Initial analysis suggests that this plan and mission architecture could fit within the NASA budget, or "funding profile," for the next two decades. It is a measured, reasoned approach rather than a hopeful, unrealistic proposal. I assert that we can do this, because we work with the best in the business; the men and women who know what it really takes to accomplish things in space. Casey Dreier tells us more in his column on page 22.

It's important to keep in mind that our Mars scientists and engineers estimate that what our very best robots do in a week, a human geologist, for example, could accomplish in less than 15 minutes. If we could get humans there, they would make discoveries at an amazing rate. Furthermore, our experience on the Moon demonstrates the extraordinary value of having humans in situ. When humans land on Mars, it will engage the world's citizens in a way that nothing else has.

2015 SHOEMAKER NEO GRANT WINNERS

In April, we issued our Gene Shoemaker Near-Earth Object (NEO) Grants for 2015. We award funds to investigators and researchers who are doing the vital work of keeping our home world from getting struck by a dangerous incoming asteroid or comet. The seriousness of this business comes home to me every time I see dinosaurs depicted in advertising, or in a new loaded-with-special-effects movie. This year's winners and their prizes are announced in Bruce Betts's column on page 20.

ACCOMPLISHING OUR MISSION TOGETHER

The *LightSail* missions, the Humans Orbiting Mars proposal, the search for near-earth objects, and our successful advocacy work for the *New Horizons* mission are all part of our mission to advance space science and exploration. We take the small near-steps with the decades-long view in our plans. Together we are accomplishing these things. With your strong support, we are all coming to know more about our place in space.

Bill Nye

THIS IS YOUR ORGANIZATION, AND WE WANT TO HEAR FROM YOU.

What do you think about The Planetary Society's mission and vision? What is your opinion of our programs and strategies? How do you feel about being a member? E-mail your thoughts to *planetaryreport@planetary.org* or write to Members' Dialogue, The Planetary Society, 60 S. Los Robles Avenue, Pasadena, CA, 91101.

Thanks!

JASON DAVIS *is a digital editor for The Planetary Society. He reports on space exploration at* planetary.org.

Pushing Back the Frontier

How The Planetary Society Helped Send a Spacecraft to Pluto

ABOVE *People, from scientists to school children, love Pluto. The fact that* New Horizons *has finally reached the Pluto system is testament to our collective unwillingness to let it remain unexplored. The Planetary Society has always been there, helping in the fight to save one proposed Pluto mission after another. In this montage, Pluto is flanked by its large moon, Charon.*

BILL NYE FELT a little uncomfortable.

Maybe his signature bow tie was a little tight that day. Maybe he was still adjusting to regular life following the end of his "Science Guy" television show. Or maybe it was because he was hefting a huge bag of postcards through U.S. Senate offices in Washington, D.C.

It was October 2000. Scientists and space fans had lobbied for more than a decade to send a spacecraft to Pluto, the last unexplored classical planet in our solar system. Each time a proposed mission made it past the drawing board, it was scrapped for political or budgetary reasons. The latest spacecraft proposal, Pluto Kuiper Express, made it all the way to the instrument selection phase. But with costs pushing the $1.1 billion* mark, NASA canceled the Pluto mission–again.

The postcards in Nye's arms came from ten thousand members of The Planetary Society. All urged Congress to overturn NASA's decision. Flanking Nye was The Planetary Society's then-executive director Louis Friedman, who cofounded the space advocacy group with Carl Sagan and Bruce Murray in 1980. Nye was vice president of the board of directors–but he hadn't really signed up for the job. It was more like he was drafted. "This was a job you got when you leave the room when everybody's drinking," he recalled. "You come back, and they say, 'You're the vice president!'"

Nye and Friedman planned to highlight public interest in a Pluto mission by hauling the postcards around Capitol Hill, delivering half to Representative Dana Rohrabacher and half to Senator Bill Frist–both of whom

**All cost figures in this article have been converted to 2014 dollars.*

EDITOR'S NOTE: *Jason Davis posted a version of this article to his blog on July 7, 2015 at* planet.ly/plutofrontier

Montage: NASA/Mark Showalter

chaired powerful space science committees.

The Congressional mail dump was just one salvo in a long, bitter fight over Pluto exploration which culminated with the launch of the *New Horizons* spacecraft in 2006. And though it was an Atlas V rocket that ultimately sent *New Horizons* out of Earth orbit, the mission would not have been possible without the dogged persistence of countless scientists, space fans, and advocacy groups. Among the latter was The Planetary Society, always striving to help NASA to push back our solar system's frontier.

THE LAST UNEXPLORED PLANET

In 1989, *Voyager 2* whizzed past Neptune, skimming the ice giant's atmosphere by just 5,000 kilometers. With that encounter, eight of our nine classical planets had been visited by spacecraft. Two years later, the U.S. Postal Service released ten stamps commemorating the history of planetary exploration. Each planet–along with Earth's moon–got a stamp featuring a spacecraft that visited that world. Pluto's stamp had no spacecraft. Its caption simply read, "Not yet explored."

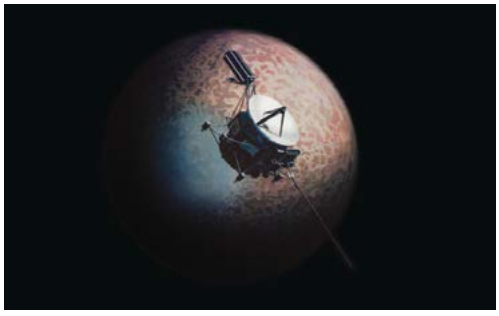
It almost didn't turn out that way. When *Voyagers 1* and *2* were sent on their respective tours of the solar system, NASA considered sending *Voyager 1* to Pluto after the spacecraft's Saturn encounter. But the flyby path that would bend *Voyager*'s trajectory toward Pluto precluded a visit to Saturn's moon, Titan, a tantalizing world in its own right and the only moon in our solar system known to have a stable atmosphere.

"*Voyager*-Pluto was a real possibility," said Jonathan Lunine, a Cornell University astronomer who helped define Pluto mission objectives in the 1990s. Lunine, speaking to reporters at a 2014 *New Horizons* briefing, said the decision to fly past Titan was critical in gaining support for future Saturn missions. "Without the *Voyager*-Titan mission, it would have been very hard to make the case for the *Cassini-Huygens* mission–arguably one of the most successful planetary missions in history," he said.

EARLY MISSION CONCEPTS

By 1990, scientists were starting to float ideas for Pluto missions. An early, audacious concept called for a miniature spacecraft weighing only 40 kilograms, slated for a speedy 5- to 6-year trip. The idea was scrapped when shrinking down a set of usable science instruments for the small craft proved to be unfeasible.

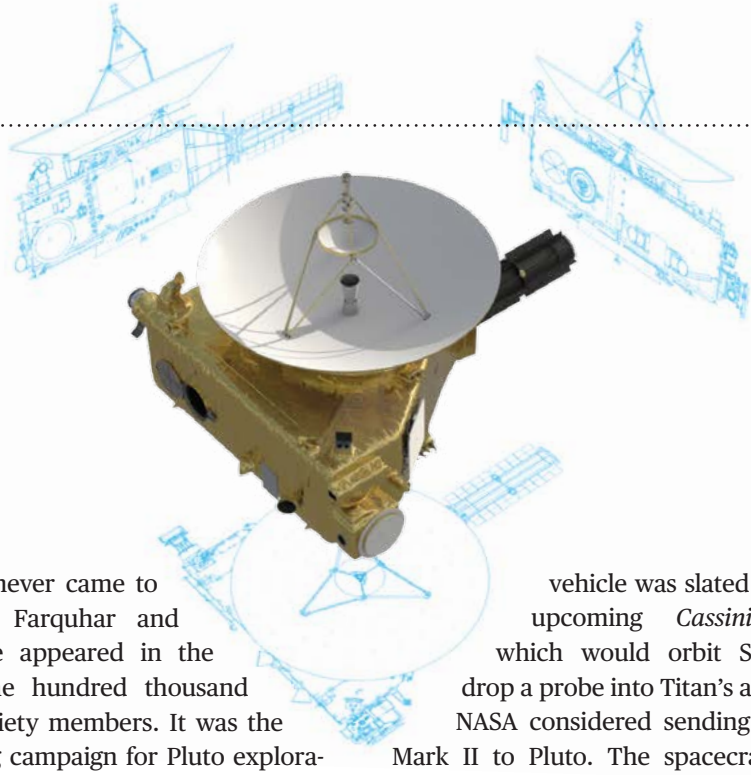
That same year, another Pluto concept appeared in the pages of *The Planetary Report*. The article, "Pushing Back the Frontier: A Mission to the Pluto-Charon System," was co-authored by NASA's Robert Farquhar, and Alan Stern, a planetary scientist from the University of Colorado, Boulder. Stern unveiled a slimmed-down version of *Voyager* with four science instruments and a total weight of 350 kilograms. Bearing a price tag of $543 million, the spacecraft would launch by 2003 and reach Pluto in 14 years. The concept became known as Pluto 350, named after the spacecraft's target weight.



LEFT *Bill Nye and Louis Friedman deliver postcards to Floyd Des Champs of the Senate Committee on Commerce and Science, and staffers, in the office of Senator Bill Frist.*

RIGHT *In 1990, scientists spun a lightweight version of the Voyager spacecraft into a concept called Pluto 350. The craft's name was inspired by its dainty weight of 350 kilograms (770 pounds).*

Photo: The Planetary Society; Illustration: NASA



ABOVE *Space scientist and artist Dan Durda has been a part of* New Horizons *since before it was proposed to NASA. His digital model of the final spacecraft is technically accurate, down to the placement of the screws.*

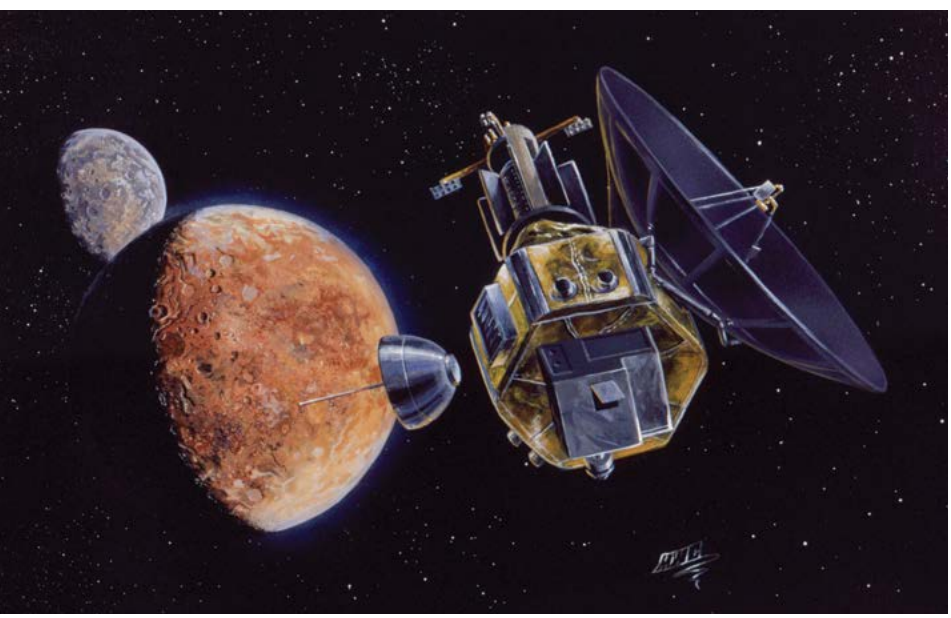
BELOW *In 1992, The Planetary Society lobbied NASA to support a third mission concept called Pluto Fast Flyby. When NASA balked at the cost, the Society looked to Russia for a cheaper launch. The Russians proposed adding a small atmospheric probe. NASA was intrigued, but the loss of* Mars Observer *in 1993 soured them on a Pluto mission.*

Pluto 350 never came to fruition, but Farquhar and Stern's article appeared in the homes of one hundred thousand Planetary Society members. It was the start of a long campaign for Pluto exploration that ultimately culminated with the appointment of Stern as the principal investigator of the *New Horizons* mission.

"The Planetary Society gave continued, strong support for a whole variety of Pluto missions that never made it off the drawing board," said Stern. And while everyone from school children to the National Academy of Sciences ended up helping get the spacecraft off the ground, "The Planetary Society was always there—no question."

By 1991, a new spacecraft design called Mariner Mark II was being developed for missions to the outer solar system. The vehicle was slated for NASA's upcoming *Cassini* mission, which would orbit Saturn and drop a probe into Titan's atmosphere. NASA considered sending a Mariner Mark II to Pluto. The spacecraft's probe would separate en route, passing Pluto a little more than three Earth days after the primary vehicle. Since Pluto's rotational period is six and a half days, the planet's previously unlit side would be facing the Sun, allowing Mariner Mark II to map Pluto's entire globe.

In terms of cost and complexity, Mariner Mark II was a drastic departure from Pluto 350. Launching on a mammoth Titan rocket, it weighed two tons and came with a price tag of $3.2 billion. It didn't take long for NASA to realize Pluto mission concepts were headed in the wrong direction.



OUR BOLD HUNT FOR A CHEAPER RIDE

In 1992, a third Pluto mission concept materialized and brought back the ambitious miniature spacecraft from 1990. Dubbed Pluto Fast Flyby, a pair of small, lightweight probes would launch atop two of the beefy Titan rockets proposed for Mariner Mark II. One spacecraft would arrive a year ahead of the other, giving scientists insight into Pluto's seasonal changes.

As it was for Pluto Fast Flyby's miniaturized predecessor, shrinking down the science instruments proved difficult. The two spacecraft gained weight, creeping up to 140 kilograms each. And the cost of the Titan launchers alone was $1.3 billion, giving the mission a total price tag of about $2.1 billion.

While Pluto Fast Flyby was cheaper than Mariner Mark II, it still wasn't cheap enough

Model: Dan Durda, FIAAA; Illustration: Michael Carroll

for NASA Administrator Daniel Goldin. In a 1994 issue of *The Planetary Report*, Louis Friedman reported that Planetary Society officials met directly with Goldin to lobby for the mission. "Dan Goldin expressed great interest in the Pluto proposal," Friedman wrote, "but tempered his enthusiasm with concern that the cost of the mission would prevent it from ever being done."

With the launch vehicle consuming more than half the mission cost, The Planetary Society went looking for cheaper rides. They found one: Russia's Proton rocket, available at the bargain price of just $47 million.

"At the time we floated this proposal," wrote Friedman, "NASA was not permitted to consider joint missions or Proton launches. 'Well,' we thought, 'maybe NASA couldn't consider such things—but The Planetary Society could.'"

By the time the Society approached Russia, the Pluto Fast Flyby concept had been trimmed to a single vehicle. Russia proposed adding a small probe that would plunge through Pluto's tenuous atmosphere before crashing into the surface. On Valentine's Day 1994, the Society delivered the proposal to NASA. Wes Huntress, the head of NASA's space science division, was intrigued. Furthermore, he saw an opportunity to pair Pluto Fast Flyby with another long-delayed spacecraft: Solar Probe.

Solar Probe was a daring mission to capture direct measurements of our Sun's corona. Getting there required a gravity assist at Jupiter, where the spacecraft would whip back toward the inner solar system. Since Pluto Fast Flyby also required a Jupiter gravity assist, Huntress wanted both missions to fly on Proton rockets. The similarities between the two trajectories might ultimately save costs. The project was called "Fire and Ice," a literal description of the probes' destinations and an allusion to thawing relations between Russia and the United States. In a letter to The Planetary Society, Huntress wrote:

"I believe the interest demonstrated by your membership in such a bold venture is shared by the majority of the American public. We believe that too, and if we work with the Russians to lower costs and pool expertise, an exciting program like Fire and Ice could be popular enough to succeed."

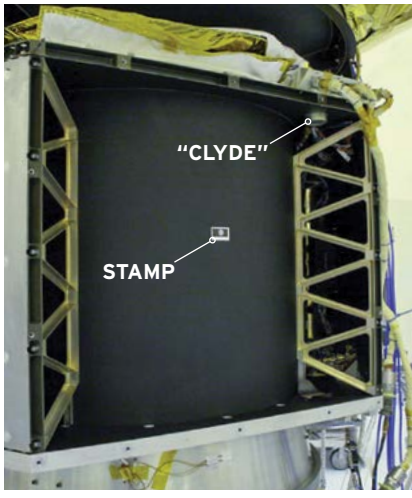
AN EMBARRASSING MISHAP

But at the time Huntress lauded The Planetary Society's initiative, NASA's planetary science program was reeling from an embarrassing mishap. In August 1993, the agency inexplicably lost contact with *Mars Observer*—a Mars-bound probe that was just three days away from entering Martian orbit. Had *Mars Observer* arrived safely, it would have been the first successful spacecraft at Mars since the *Viking* missions in 1976.

Alan Stern, who was making his own push for NASA to team up with the Russians, believes the loss of *Mars Observer* dampened NASA's enthusiasm for a Pluto mission. "These events began to sour then-NASA Administrator Goldin on Pluto Fast Flyby," wrote Stern in a paper summarizing the history of Pluto mission concepts.

PLUTO'S NEIGHBORS HELP OUT

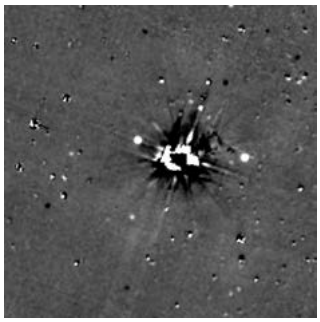
With the project stalled again, fresh support arrived from an unexpected source: Pluto's neighbors. In 1992, astronomers began discovering new worlds beyond Neptune's orbit. The list grew, confirming the existence of the so-called Kuiper Belt, a band of icy objects at the edge of our solar system. Pluto, it

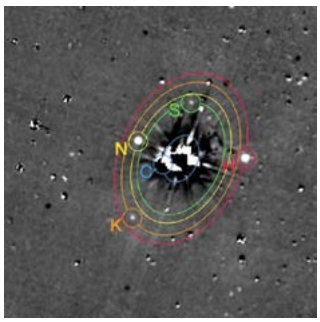


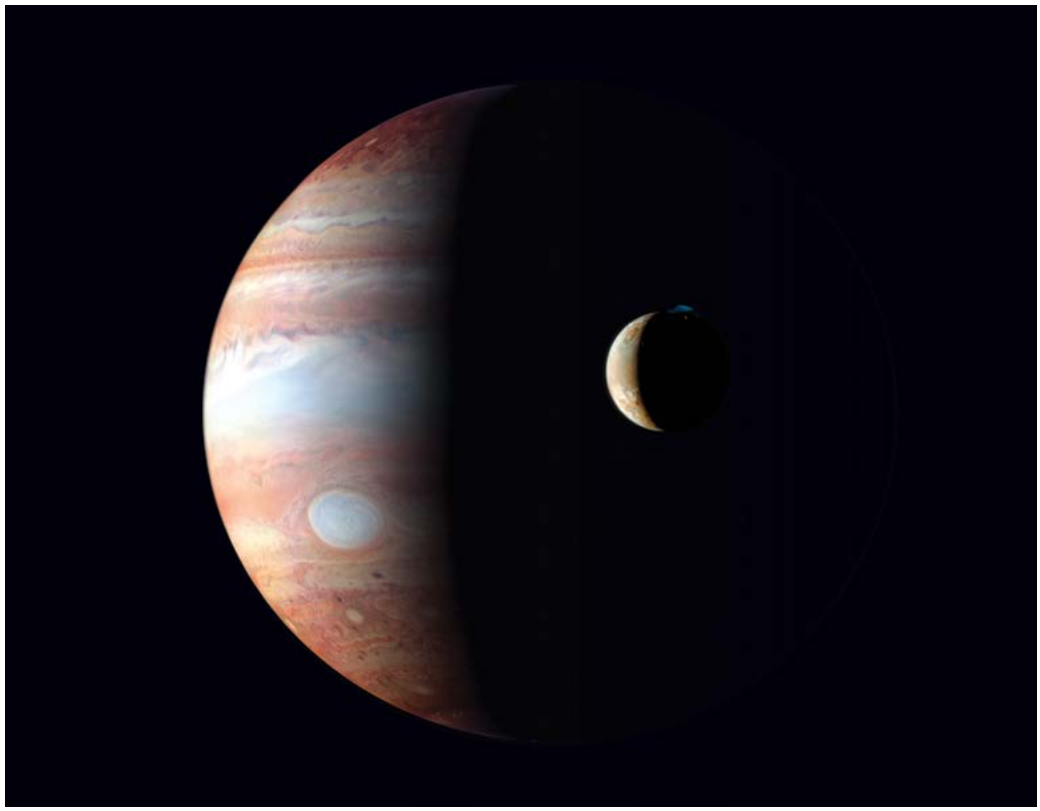
ABOVE *Clyde Tombaugh, Pluto's discoverer, said that if a spacecraft ever made it to Pluto, he'd like his ashes to ride along with it. Alan Stern honored that wish by requesting a small amount of Clyde's ashes from his family. He then affixed those ashes to the bottom of* New Horizons, *along with the 1991 United States postage stamp that said "Pluto: Not Yet Explored."*

Photo: Alan Stern

JASON DAVIS' *interest in spaceflight started early. He recalls watching space shuttle* Discovery*'s 1988 return-to-flight mission following the* Challenger *accident and playing a videocassette of the launch over and over, memorizing countdown and ascent procedures. Jason is now is a digital editor for The Planetary Society. He covers the Society's* LightSail *mission, as well as other science and technology projects, at* planetary.org.







ABOVE *Pluto's four small moons—Nix, Styx, Kerberos, and Hydra—appear in this LORRI image from mid-May. Below, the orbits of all Pluto's moons, including Charon, are overlaid.*

ABOVE RIGHT *This montage of Jupiter and Io is made from images taken by* New Horizons *as it flew by the Jovian system in early 2007. Jupiter is an infrared color composite taken by the spacecraft's Linear Etalon Imaging Spectral Array (LEISHA). Io is an approximately true color composite taken by the Long-Range Reconnaissance Imager (LORRI).*

seemed, was one of the largest members of this new group. Scientists had many questions about these new Kuiper Belt objects—questions that could be answered only by visiting spacecraft.

In 1995, NASA rebranded the languishing Pluto Fast Flyby mission as Pluto Express, and upped the weight allowance to 175 kilograms. The mission's name evolved to Pluto Kuiper Express, reflecting the goal of having the spacecraft visit an additional Kuiper Belt object after the Pluto flyby. "However," wrote Stern, "in late 1996 Pluto Kuiper Express mission studies were drastically cut back by Administrator Goldin and no instrument selection was initiated." In 2000, NASA canceled the mission, which had grown in cost to $1.1 billion.

A CAUSE CÉLÈBRE

It was the fourth time in ten years that a Pluto concept was nixed. The Planetary Society sprang into action, mobilizing the postcard campaign that ultimately sent Bill Nye, Louis Friedman, and a small mountain of mail to Capitol Hill. "The Planetary Society really made a cause célèbre out of it," said Stern.

Congress took notice. Representatives James Walsh and Alan Mollohan, the ranking members of the House Appropriations Committee, sent a letter to Goldin asking why Pluto Kuiper Express had been canceled. The NASA Advisory Council also voiced its support for a Pluto mission. By the end of the year, NASA announced it would accept new Pluto mission proposals.

The tide reversed in early 2001, when the newly inaugurated President George W. Bush's administration released its first budget request. There was no line item for a Pluto mission—effectively canceling it. The Planetary Society called for congressional hearings. The scientific community applied behind-the-scenes pressure. And by September, about $40 million had been added back into the budget for spacecraft development

Images: NASA/JHUAPL/SwRI

and launch vehicle selection, keeping the Pluto campaign alive.

In the meantime, NASA narrowed the number of spacecraft proposals to two. One concept, dubbed *New Horizons*, came from a team led by Alan Stern, now the director of space studies at the Southwest Research Institute in San Antonio, Texas. Mission control would be located at the Johns Hopkins University Applied Physics Laboratory in Baltimore, Maryland.

That November, Stern attended the annual meeting of the Division of Planetary Sciences of the American Astronomical Society, held in his hometown of New Orleans, Louisiana. He received a phone call from NASA informing him that *New Horizons* had been selected for further development. "A win party was held on Bourbon Street that night in the New Orleans French Quarter," wrote Stern, "but the details remain understandably fuzzy."

A FINAL PUSH FOR FUNDING

But the fight still wasn't over. In 2002, the fiscal year 2003 budget request was released. And although Congress had allocated $40 million for Pluto mission studies during the previous year, NASA's new budget showed a zero for Pluto–again.

It wasn't all bad, though. The new budget also announced the creation of a new line of midsize missions called New Frontiers. More expensive than small, Discovery-class missions but cheaper than Flagship programs, a New Frontiers-class spacecraft could cost up to $855 million. New Frontiers missions would be prioritized according to the Decadal Survey, a report outlining the country's top priorities for space science. The Decadal Survey is produced every ten years by the National Research Council, the working group of the U.S. National Academy of Sciences. The next Survey would cover exploration goals from 2003 through 2012.

Early versions of the report were published in 2002. The message was clear: the top priority for NASA's New Frontiers program should be a mission to Pluto. NASA and the Bush administration could no longer oppose the mission. "They couldn't turn down the National Academies," said Stern.

The Planetary Society and other groups lobbied Congress to restore *New Horizons* funding for the fiscal year 2003 budget request. Wesley Huntress, the NASA associate administrator who had supported the Society's 1994 Valentine's Day proposal to fly to Pluto via a Russian rocket, was now the Society's president. Huntress wrote Congress in support of increasing NASA's budget to accommodate the Pluto mission. The Planetary Society followed Huntress's appeal with a petition of ten thousand signatures.

Finally, in 2003, when the 2004 budget request was released, $167 million was allocated to the New Frontiers program. The fate of *New Horizons* was secure. Humanity would get an up-close look at Pluto.

PERSISTENCE PAYS OFF

"Status check."

"Go Atlas."

"Go Centaur."

It was a peaceful January afternoon in 2006 on the Florida coast. An Atlas V rocket sat quietly on the pad at Cape Canaveral Air Force Station Launch Complex 41. Suddenly, a deluge of water flooded the pad's flame trench, and the engine ignition sequence whirred to life.

"Five, four, three, two, one," counted a NASA television commentator. "We have ignition, and liftoff of NASA's *New Horizons* spacecraft on a decade-long voyage to visit the planet Pluto–and then beyond."

Armed with its maximum contingent of five solid rocket boosters, the Atlas V rose quickly. It pierced the clouds within seconds. With the help of an additional third-stage engine, *New Horizons* became the fastest object ever to leave Earth orbit. It arrived at Jupiter just one year later, picking up a gravity assist that put it on course for a July 2015 Pluto flyby.

BELOW/TOP *This preliminary reconstruction of Pluto and Charon, taken by the spacecraft's Ralph color imager, is the first color picture ever made of the Pluto system by an approaching spacecraft.* New Horizons *will eventually return color images that show features as small as a few miles across.*

BELOW/BOTTOM *Pluto comes into focus in this LORRI image taken on July 3, only 11 days before* New Horizons' *closest approach.*

Images: NASA/JHUAPL/SwRI

ABOVE *Once* New Horizons *finishes its pass of the Plutonian system, it will have enough fuel left to travel another billion kilometers to reach Kuiper belt object "Potential Target 1," or PT1, in January 2019.*

FROM A MAILBAG TO LIFTOFF

It has been 25 years since Alan Stern's Pluto 350 mission concept was unveiled in the pages of *The Planetary Report*. From petitions and postcards to engineering design and persistent scientists, it truly took a village to raise a spacecraft.

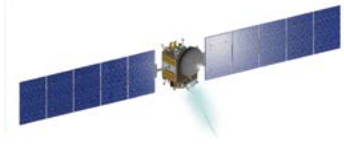
Stern thinks the history of *New Horizons* is an important tale for scientists and space advocates who have eyes on their own ambitious missions. "I think the really interesting human story," he said, "for people who might want to tackle something like getting a spacecraft to Uranus or Neptune, is that you have to really want it. There are many more good ideas than there is money to go around."

For The Planetary Society, *New Horizons* shows that persistence pays off. Never underestimate that a group of dedicated space fans can, as Bill Nye says, "change the world." It's a principle that hearkens back to the Society's origins, he said. "This mission to Pluto is really part of the Carl Sagan legacy–to explore the solar system."

Ceres in View

RECENT *DAWN* IMAGES are giving us a closer look at Ceres' mysterious white spots. A new view of the bright spots, located in a crater about 90 kilometers (56 miles) across, shows even more small spots in the crater than were previously visible. In this image, taken June 9, 2015 from an altitude of 4,400 kilometers (2,734 miles), a cluster of least eight spots can be seen next to the largest bright area, which scientists think is approximately 9 kilometers (5.6 miles) wide. The *Dawn* team believes that a highly reflective material is responsible for these spots–ice and salt are leading contenders–but they are considering other options as well.

–from NASA/JPL



To read more about the bonanza of fascinating Ceres data coming in from *Dawn*, see Emily Lakdawalla's recent blog at planet.ly/ceresfun and Chief Engineer and Mission Director Marc Rayman's *Dawn* Journal at planet.ly/ceresgeology

Illustration: Ron Miller; Ceres image: NASA/JPL/Caltech/UCLA/MPS/DLR/IDA

JASON RHODES *is an observational cosmologist at NASA's Jet Propulsion Laboratory.*

A Wider View

NASA's Wide Field Infrared Survey Telescope

NASA IS HARD AT WORK preparing for the 2018 launch of the James Webb Space Telescope (JWST), successor to the venerated Hubble Space Telescope (HST), which celebrated its 25th birthday in April. Looking beyond JWST, NASA has identified the Wide Field Infrared Survey Telescope (WFIRST) as its next ambitious flagship space telescope.

If approved in 2016, WFIRST could be ready for launch in 2024, on a mission to understand dark energy, perform wide infrared surveys of the galaxy and extragalactic sky, revolutionize our understanding of the demographics of planetary systems, and take a huge step forward in the technology we'll need to find and study another "pale blue dot" planet around a nearby star.

WFIRST'S GENESIS

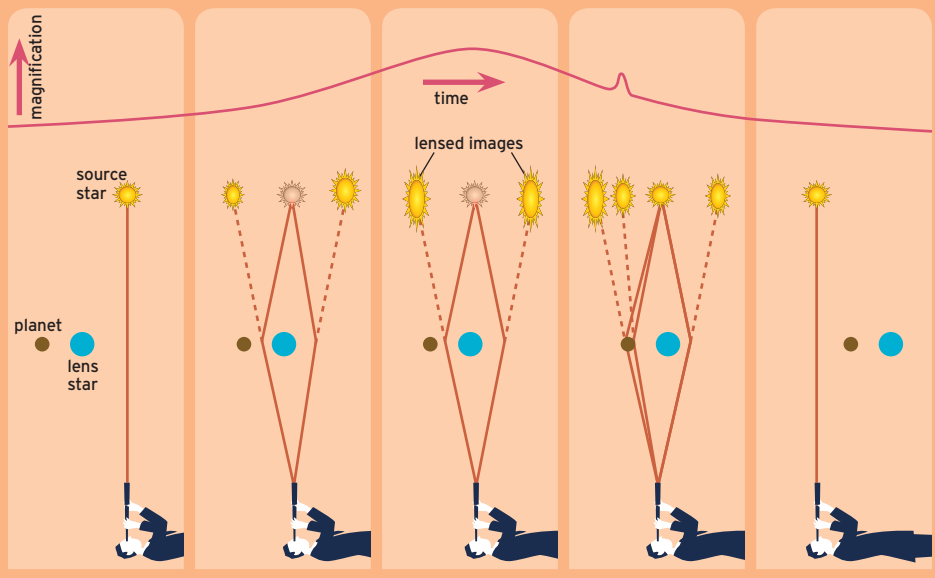
WFIRST was born in the crucible of the 2010 National Research Council Astronomy and Astrophysics Decadal Survey, a once-every-ten-years process in which the U.S. astrophysics community studies mission concepts and key science questions, and then issues recommendations to the government agencies that support astrophysics research (NASA, the National Science Foundation, and the Department of Energy).

Three of the most compelling mission concepts submitted for evaluation had very different science goals, but similarities in their hardware implementations, such as a primary mirror of about 1.3 meters in diameter and a large infrared camera. The Decadal Survey concluded that the science goals of the three mission concepts could be accomplished by a single space telescope. The top recommendation for large (greater than $1 billion) space astronomy projects was that NASA pursue such a mission. By the end of 2010, NASA had assembled a team of scientists and engineers to begin planning for WFIRST.

While the team assembled by NASA was starting to put together a detailed design for WFIRST, negotiations elsewhere within the

ABOVE *From understanding the dark energy driving the expansion of the universe to imaging another "pale blue dot," the advanced capabilities of NASA's proposed Wide Field Infrared Survey Telescope (WFIRST) will broaden our knowledge of the cosmos. Here, the blue sky above an Earth-like planet's equator is bisected by the edge-on view of its thin ring system.*

Illustration: Ron Miller; WFIRST spacecraft illustration: NASA



What is microlensing?

Microlensing takes advantage of the fact that matter bends space and curves the path of light, allowing massive objects to act as magnifying lenses. By taking images of many thousands of stars in the densely populated central bulge of the galaxy, and measuring their brightness, we can wait for a chance superposition of a lens (foreground) star with a source (background) star. The mass of the lens star briefly magnifies the image of the source star as it passes in front of it, just as a glass lens would. When that happens, we measure an apparent brightening of the star. At the same time, two images of the background star appear, although these images are too close together for us to distinguish (even with WFIRST); these images are not key to the detection process.

In some cases, the foreground star will have a planet and that planet will briefly act as another lens to the source star, causing a small, fast blip in the slowly changing "light curve," or measurement, of the total light gathered from the star. This small blip indicates the presence of the planet, and the relative shapes of the blip together with the total microlensing light curve can tell us about the relationship between the masses of the stars and the planet as well as the distance between the lens star and the planet.

RIGHT *As a result of microlensing, the brightness of a distant star measured by a telescope will increase and then decrease with time (shown by the red curve at top), when a star and/or planet passes in front of it.*

agency were taking shape which promised to profoundly change WFIRST's configuration. In early 2011, the National Reconnaissance Office (NRO), a U.S. intelligence agency, donated to NASA two unused space telescopes that had been built a decade earlier, but were never flown. These advanced telescopes have mirrors 2.4-meters across, the same size as HST and nearly twice the diameter initially planned for WFIRST. NASA accepted the telescopes but didn't reveal their existence to the public (or the WFIRST team!) until June 2012.

This high-tech "swords into plowshares" initiative greatly increased the capabilities of WFIRST, giving it four times its previously planned light collecting area and twice the resolution. The first donated NRO telescope was designated the Astrophysics Focused Telescope Asset (AFTA), and the incarnation of WFIRST that uses this welcome gift is often called WFIRST-AFTA. The second telescope will remain in storage until NASA finds another suitable application and the necessary funding to put it to good use.

ONE ADVANCED TELESCOPE, FOUR GOALS

Given HST's 25 years of service, one might wonder what will be the advantage of another space telescope of the same size. The answer lies in WFIRST's incredible field of view, or how much of the sky WFIRST can see at once. At near-infrared wavelengths, which are scientifically interesting but relatively difficult to observe using ground-based telescopes, HST has a 1 megapixel camera, but WFIRST will have an array of sensors with a whop-

Microlensing graphic: David Bennett, University of Notre Dame/Loren A. Roberts

ping 288 megapixels! In its 25 years, HST has surveyed a few tens of square degrees of the sky (out of over 40,000 square degrees of sky). WFIRST, on the other hand, will be able to survey thousands of square degrees per year. While JWST, HST's successor, will have a much bigger (6.5 meters) mirror, its field of view will be similar to HST. WFIRST's amazing field of view will allow it to survey large areas of the sky, a requirement for three of the four WFIRST key science goals.

GOAL 1: UNDERSTANDING DARK ENERGY

In 1998, two teams of astronomers simultaneously discovered that the expansion of the universe is getting faster, rather than slowing down, as previously assumed. The teams' discovery of this accelerating expansion earned them a shared 2011 Nobel Prize in physics. "Dark energy" is the catch-all name scientists give to whatever force or property of space time is causing the expansion to accelerate. While we know very little about this mysterious dark energy, astronomers now believe it to be the dominant component of the total mass/energy of the universe.

WFIRST will use three techniques to study the effects of dark energy. The first is to examine exploding stars, or supernovae, which outshine the roughly 100 billion other stars in their host galaxies for a brief time. By studying these explosions, we can see across great distances, essentially peering back two-thirds of the way back to the Big Bang to see how the universe has expanded under the influence of dark energy. WFIRST will also examine the positions of galaxies in space, as dark energy leaves a telltale signature on the spatial clustering of galaxies. Finally, WFIRST will use weak gravitational lensing, in which the presence of matter bends the path of passing light (much like in microlensing; see sidebar). Weak lensing refers to the small distortions in the measured shapes of distant galaxies caused by mass between us and those galaxies. These distortions tell us about that intervening mass and how it is affected by dark energy.

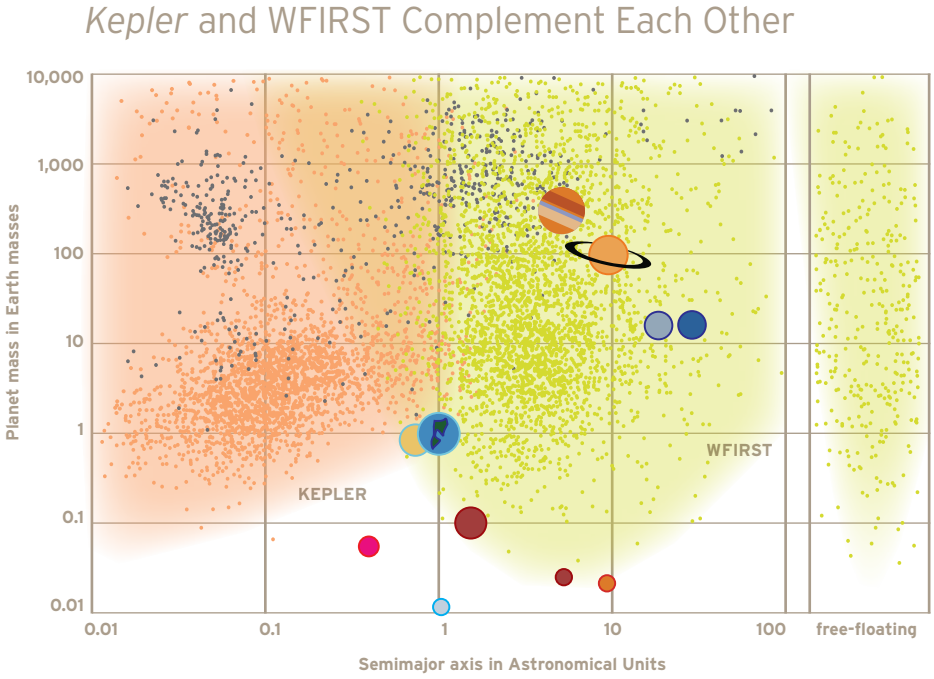


Chart: Matthew Penny, Ohio State University/J.D. Myers at NASA Goddard Spaceflight Center/Loren A. Roberts

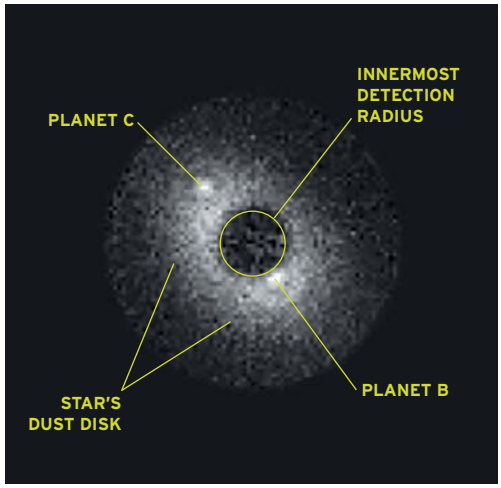
GOAL 2: INFRARED SURVEYS OF THE SKY

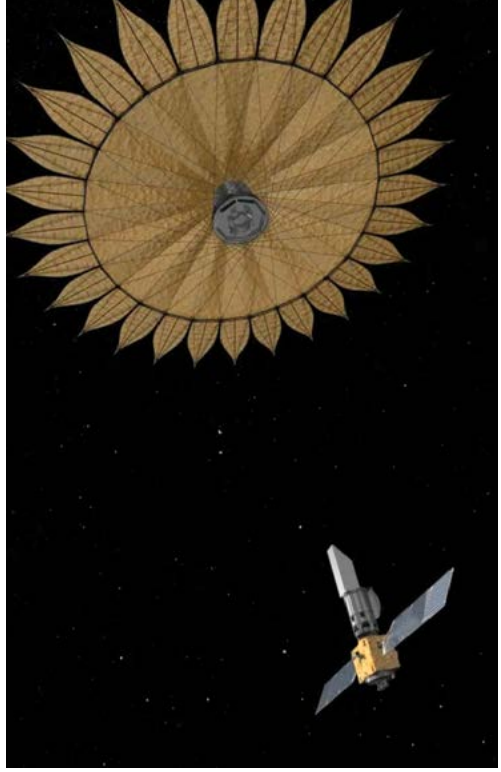
Initial press reports about WFIRST concentrated mainly on dark energy, which, while exciting, is only one of the areas in which WFIRST is expected to make a big impact. WFIRST will set aside 1.5 years of observing time for guest observers. Astronomers from all over the world will be able to compete for time on WFIRST to use its unique infrared capabilities to survey the sky. Experts will review the proposals and assign time to pursue the most scientifically compelling observations. WFIRST is expected to make profound contributions to many areas of astronomy by allowing the best ideas to be implemented.

GOAL 3: SEARCHING FOR EXOPLANETS

The third and fourth facets of WFIRST involve the study of exoplanets. WFIRST's microlensing survey will detect over 2,000 planets, including analogs to all the planets in our solar system except Mercury, which is too close to its star. WFIRST is complementary to NASA's *Kepler* planet-finding mission, in that *Kepler* excelled at finding warm planets (those

ABOVE *Whereas the* Kepler *spacecraft is most sensitive to detecting planets close to their parent stars, WFIRST would be most sensitive to detecting planets far from their stars, as shown in this plot of distance from parent star versus exoplanet mass.* Kepler's *candidate planet detections are shown as orange dots; the green dots are simulations of WFIRST's future detections. WFIRST will also be able to find planets not bound to parent stars. The dark gray dots represent exoplanets not detected by* Kepler. *Just for fun, Earth and other planets have been added.*





LEFT *This simulation of a coronagraph image illustrates how masking out a star's bright light allows observation of the relatively faint light of its two planets. The donation of the Astrophysics Focused Telescope Asset (AFTA) allows a coronagraph to be added to WFIRST, enabling scientists to look for exoplanets from space.*

TOP RIGHT *A coronagraph is not the only way to block a star's light to allow direct imaging of an exoplanet. NASA has been studying concepts for an external option such as a "starshade." This free-flying spacecraft could be maneuvered precisely into place to let the light from a planet shine past its outer edge while the inner part blocks the star's light. The starshade's "petals" create a softer edge that would result in less bending of light. To watch an animation of the starshade (illustrated here) being deployed, as well as a video of this starshade prototype's deployment test at JPL, go to* planet.ly/starshade

OPPOSITE PAGE *To watch a brief animation of WFIRST in space, go to* planet.ly/wfirst

near their parent stars), and WFIRST excels at finding cool planets (those farther from their stars) and even free floating planets not orbiting a star. Thus, WFIRST will complete the demographic survey of planets in our galaxy begun by *Kepler* and tell us how common various planet are across a full range of sizes, temperatures, and distances to the host star. This plays into NASA's long-term goal of understanding the frequency of planets in the habitable zone, the region around a star that allows for liquid water. Scientists believe an Earth-size planet in the habitable zone is our best bet for finding life outside our solar system.

GOAL 4: USING A CORONAGRAPH TO LOOK AT EXOPLANETS

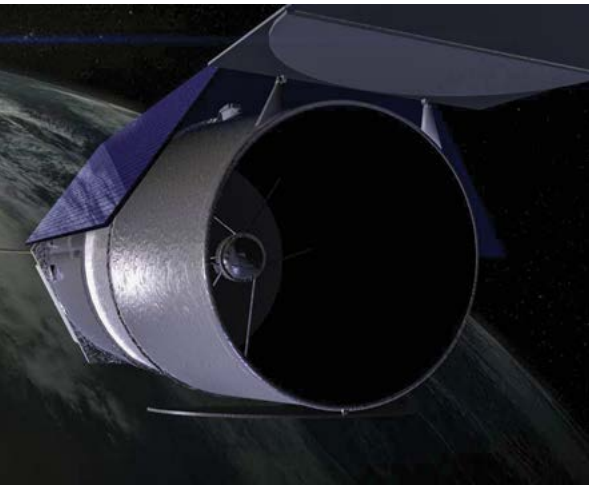
Microlensing, which allows us to detect exoplanets but not see them directly, was the extent of WFIRST's expected exoplanet capabilities as envisioned by the Decadal Survey in 2010. While that's exciting, scientists would also like to be able to directly image exoplanets to study them in greater detail. With the donation of the AFTA hardware, this has become a possibility. The larger AFTA telescope allowed NASA to add a coronagraph to WFIRST to enable direct imaging of nearby exoplanets, which is technically challenging because they are very close to stars (by astronomical scales) and much fainter than their host stars. Thus, a coronagraph has to block out as much light as possible from the central star so that instruments can capture the relatively feeble light from the planet.

The Decadal Survey put the development of technology for imaging exoplanets at the

JASON RHODES *is an observational cosmologist at NASA's Jet Propulsion Laboratory. He is working toward understanding the mysteries of dark matter and dark energy using space telescopes like WFIRST and European Space Agency's Euclid mission. When not developing space missions he enjoys running and spending time with his wife Alina, a fellow cosmologist at JPL.*

Coronagraph image: Tom Green, NASA/Ames Research Center; starshade illustration and photo: NASA/JPL

RICHARD CHUTE *is The Planetary Society's director of development.*



Animation: NASA Goddard Space Flight Center Conceptual Image Lab

top of its priority list for "medium size" (hundreds of millions of dollars) investments in space astronomy. The addition of a coronagraph to WFIRST will allow this recommendation to be met, not only by developing the technology in the laboratory but also through flying it in space. The expected contrast ratio of the WFIRST coronagraph will be a thousand times better than anything that has been accomplished–and great progress toward this goal has already been made in the past two years in laboratory tests. If we are successful, we will be able to directly detect planets the size of Neptune and larger with WFIRST.

IMAGING ANOTHER PALE BLUE DOT

The WFIRST coronagraph is but a stepping stone to an even more exciting mission in the future. If we can successfully demonstrate the use of a coronagraph on WFIRST for imaging exoplanets, we will open the door for a subsequent mission with a larger telescope and more powerful coronagraph. Such a mission would be able to take images (and spectra) of Earth-size planets in the habitable zones of nearby stars. This would allow us to look for the presence of both water and oxygen–possible signs of life–in the atmospheres of these planets. WFIRST thus will be an important step on the way to finding another pale blue dot and understanding the prevalence of life in the universe.

Crowdfunding Success

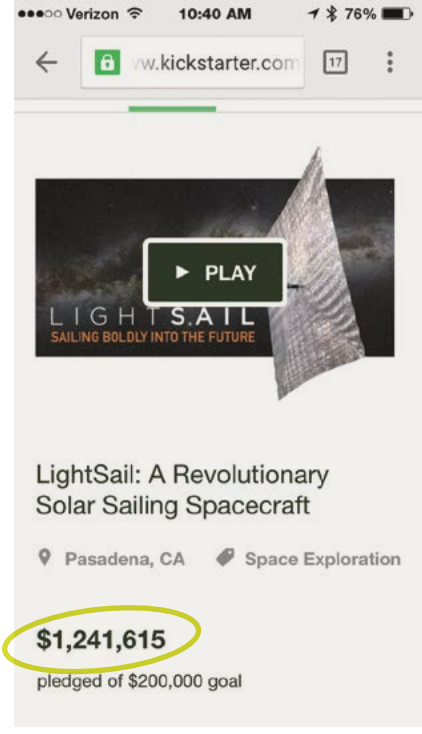
THIS SPRING WE JUMPED into the crowdfunding scene in a big way by putting our *LightSail* project on the fundraising website **kickstarter.com**. Our results have wildly exceeded expectations, with more than $1 million raised and more than 23,000 donors at the time of this writing.

While this is great news for *LightSail*, there are other reasons crowdfunding is an even bigger deal for The Planetary Society. Our science and technology program has long served as an incubator for new technologies, and the crowdfunding community is an ideal place to find people who love to back this kind of innovation. We plan to work with our Science and Technology Director Bruce Betts to develop Kickstarter campaigns for projects like the Planetary Deep Drill, which is underway this year.

Just as importantly, the Kickstarter campaign has connected us with tens of thousands of new members and supporters. We expect that many will become new loyal members of The Planetary Society and supporters of our mission to advance space science and exploration.

One of the most exciting aspects of the campaign was the way in which it became a story in its own right. The public response to the *LightSail* project became the subject of many news reports on TV, radio, Web, and in print. In fact, the donations came in so fast and furiously that Kickstarter made the *LightSail* campaign their home page for a day. The outpouring of support raises the profile of space exploration with our elected leaders, ultimately helping us achieve our awareness and advocacy goals.

In the coming year, we will launch one or more new Kickstarter campaigns. We hope you will watch for them and participate!



ABOVE *Our initial goal was $200,000. As shown by this screen capture of our Kickstarter page, the campaign finished at $1,241,615!*

KATE HOWELLS *is The Planetary Society's Volunteer Network Manager.*

Total Solar Eclipse: Bali and Sulawesi, Indonesia

FEBRUARY 26–MARCH 10, 2016

Join us in Indonesia to see the Total Solar Eclipse on March 9, 2016! The trip will conclude in legendary Bali, where we will learn about the Balinese culture, see the monkey forest, visit historic temples, and celebrate our adventure! You'll also visit the world's finest orangutan reserve for close looks at these magnificent primates, along with proboscis monkeys, gibbons, and more! The trip includes an optional extension to Kadidiri Island, situated in the Togian Islands, Indonesia's finest marine reserve. There we will snorkel, kayak, and explore its underwater wonderland.

$5,895 + AIRFARE

Alaska Aurora Borealis Adventure

MARCH 3–9, 2016

Experience the Northern Lights in the snowy wonderland that is Alaska in winter. We will ride by train to Fairbanks, passing awesome Mt. McKinley, North America's highest peak. In Fairbanks we'll attend the yearly World Ice Art Festival and learn about the Aurora Borealis at the University of Alaska's Geophysical Institute. At night, we'll watch the Northern Lights from three of Alaska's best viewing locations, including the Alpencrest Observatory. Plus, we'll see sled dogs and learn about mushing, visit the local curling club, watch Alaskan wildlife, and much more!

$2,795 + AIRFARE

To get started on your adventure, go to **planetary.org/expedition** to download more information.

You can also contact Taunya at Betchart Expeditions to learn more:
Taunya@betchartexpeditions.com
408-252-4910 (International)
800-252-4910 (USA only)
408-252-1444 (Fax)

Betchart Expeditions
17050 Montebello Rd., Cupertino, CA 95014 USA
info@betchartexpeditions.com
betchartexpeditions.com

Mexico City Outreach Coordinator Celso Mosqueira and friends

Volunteers Working Around the World

THE PLANETARY SOCIETY'S volunteers continue to do fantastic outreach work around the world, sharing the joy of discovery with people in their communities.

During the weekend of March 21 and 22, the Society's outreach coordinator for Mexico City, Celso Mosqueira, gathered a group of space enthusiasts (and enthusiasts in the making) to participate in a local astronomy society's Messier Marathon. Amateur astronomers all over the planet regularly take on this challenge, aiming their telescopes at the skies for one night to try to spot the 110 Messier objects–bright galaxies, nebulae, and star clusters catalogued by 18th century astronomer Charles Messier.

Celso and his son Diego brought their team of stargazers together to learn about astronomy and observing techniques before turning to their telescopes to search for as many of Messier's famous objects as possible. There were clouds, an astronomer's worst enemy, but Celso and his team were able to spot galaxies, star clusters, nebulae, and the planets Jupiter and Saturn–sights that invariably amaze and inspire.

Celso and outreach coordinator Jose Costa of Natal, Brazil, also spearheaded our first major translation project, coordinating the Society's global volunteer network to create subtitles in the world's most common languages for the Society's *Random Space Fact* videos.

Thanks to our extraordinary team of volunteers, we can connect more than ever with people around the planet. To check out what our volunteers are up to and learn how you can get involved, go to **planetary.org/volunteer**.

Photo: Courtesy of Celso Mosqueira

HAPPENING ON
PLANETARY RADIO
planetary.org/radio

LANDING ON MARS
The bigger you are, the harder it gets. *Curiosity's* Chief Engineer Rob Manning returns to tell us about one of NASA's best hopes for getting spacecraft—that may one day carry humans—onto the planet's surface. **planet.ly/manning**

THE PLANETARY DEFENSE CONFERENCE — *PLANETARY RADIO LIVE!*
Planetary Radio Live was the only public event at the just-completed Planetary Defense Conference in Italy. Hear from William Ailor, Fabrizio Bernardi, Paul Chodas, and more! **planet.ly/prpdc15**

THE RISE OF PLUTO
The science and images have already started to flow from *New Horizons*, according to the mission's Principal Investigator Alan Stern. **planet.ly/stern**

SPIRALING CLOSER TO CERES
It's the biggest dwarf planet between here and Pluto, and it has a new permanent resident, named *Dawn*. We spend time with Chief Engineer Marc Rayman. **planet.ly/rayman**

AN UPDATE ON *CASSINI*
Our most frequent guest, *Cassini* Project Scientist Linda Spilker, returns with another update on the magnificent mission at Saturn, including evidence for hydrothermal vents in the oceans of Enceladus! **planet.ly/spilker**

Find these shows and our entire archive of *Planetary Radio* at planetary.org/radio!

ON *PLANETARY.ORG*

EXITING SPACECRAFT

SAYING GOODBYE TO *MESSENGER*
Worldwide, people said farewell to *Messenger* as it crashed into Mercury. **planet.ly/farewell**

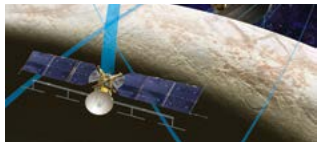
ASTROBIOLOGY

THE SWEET MYSTERY OF LIFE
Jason Dworkin examines how *OSIRIS-REx* might answer big questions. **planet.ly/sweetlife**

PRETTY PICTURES

ENOUGH ROCK LAYERS?
Emily Lakdawalla finds even more layers of rock while sifting through *Curiosity* images. **planet.ly/rocklayers**

REAL-TIME SUNSET ON MARS
Glen Nagle created a 6-minute "simulation" based on *Curiosity*'s sol 956 sunset images. **planet.ly/sunset**



AFFORDABLE MISSIONS

EUROPA
Van Kane explores JPL's newest plans for getting to Europa. **planet.ly/goeuropa**

AMAZING PHOTOGRAPHY

SPACE IMAGES
Astrophotographer Adam Block shows some incredible photos, and explains what makes them unique and impressive. **planet.ly/adamblock**

ROSETTA NEWS

PHILAE AWAKENS!
Emily reported on up-to-the-minute changes in Philae's status as it came back online. **planet.ly/philaeawake**

RETOOLING NASA'S SPACEPORT
Kennedy Space Center prepares for the first flight of the Space Launch System in 2018. **planet.ly/newrocket**

BRUCE BETTS *is director of science and technology for The Planetary Society.*

Protecting Our World

Highlights from This Year's Planetary Defense Conference

ABOVE *In this artist's view, two asteroids speed past Earth by a hair-raisingly close margin. Since its earliest days, The Planetary Society has been working to make sure these rocky marauders continue to pass us by.*

PLANETARY DEFENSE has been a fundamental focus of The Planetary Society since shortly after its founding 35 years ago. This year, in mid-April, The Planetary Society was a primary sponsor of the 2015 International Academy of Astronautics' Planetary Defense Conference (PDC) at European Space Research Institute (ESRIN), a European Space Agency facility in Frascati, Italy, outside of Rome. The PDC is held every two years and brings together the world's experts on all aspects of the asteroid threat to Earth. I also served on the organizing committee, and it was nice to see it all come to fruition.

I like to describe that there are five issues we need to address to prevent asteroid impact, and all five were covered at the PDC: find, track, characterize, deflect, and internationally coordinate and educate. The Planetary Society is active in each of these steps.

Particularly relevant to tracking and characterizing, we announced our new Shoemaker NEO Grant winners (details below) at a public *Planetary Radio* live event at the Italian Space Agency (ASI). At that event, hosted by Mat Kaplan, we had a panel of experts talk about the near-Earth object (NEO) threat. Listen to the event on *Planetary Radio* at **planet.ly/prpdc15**.

I presented a conference paper about the Shoemaker NEO Grants and, along with our director of communications Erin Greeson, presented a paper about our broader NEO-related public education and communication efforts. Media Producer Merc Boyan and his partner CaLisa Lee shot video at the conference, and we filmed several *Random Space Fact* videos, including some NEO-related and some Roman-related, on site in Rome. Watch them at **planetary.org/rsf**. Planetary Society Volunteer Network Manager Kate Howells and coauthors Jim Burke, Madhu Thangavelu, and Clemens Rumpf presented a poster entitled, "International NEO Education and Public Outreach."

You'll find much more about the conference at **planet.ly/5steps**.

2015 SHOEMAKER NEO GRANT WINNERS

Over 18 years, The Planetary Society has awarded 49 Shoemaker NEO Grants, totaling about $323,000, to 39 awardees from 16 different countries on five continents. We announced the very impressive winners of the 2015 grants at the

Thanks! Planetary Society members have helped make these grants—and many other projects—possible! Thank you.

Illustration: European Space Agency/P. Carril

PDC. They are:

LUCA BUZZI, who operates the G. V. Schiaparelli Observatory near Varese in northern Italy. His observatory focuses on NEO astrometric (sky position) follow-up. His grant will enable the purchase of a CCD camera for the observatory's new 0.84-meter-diameter telescope.

MAURICE CLARK was given a grant to assist with moving a telescope from Texas to the western Australian town of Koorda, an extraordinarily good observing site that also provides good geographic coverage. The funds will assist with construction of an observatory at the site.

DANIEL COLEY, who specializes in determining rotation periods for NEOs, as well as the Hungaria and Jupiter Trojan minor planets. His grant will purchase a new CCD camera to replace a failing instrument at the Center for Solar System Studies (CS3) in Landers, California.

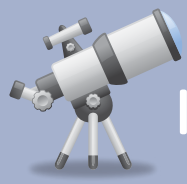
ROBERT HOLMES at the Astronomical Research Institute (ARI) in Westfield, Illinois, is among the world's most prolific follow-up observers of NEOs. His grant is for a new, more sensitive CCD for the institute's 1.3-meter-diameter telescope.

JULIAN OEY, the director of Blue Mountains Observatory in New South Wales in Australia, received a grant to obtain a CCD for the observatory's largest (24 inches diameter) telescope.

DONALD PRAY specializes in determining light curves for binary asteroids at Sugarloaf Mountain Observatory in Massachusetts. Donald's grant will help purchase a new CCD camera to replace an old, failing camera.

The Planetary Society thanks our expert advisory/review panel: Planetary Society NEO Grant Coordinator Timothy Spahr, Alan Harris of MoreData!, and Carl Hergenrother of the University of Arizona. We also gratefully thank you, our members, who make these grants possible. More information on the Shoemaker NEO Grants and grant winners can be found at planetary.org/neogrants.

WHAT'S UP? *by Bruce Betts*



IN THE SKY

The Perseid meteor shower peaks August 12-13, with increased activity several days before and after the peak. With little interference from moonlight this year, the Perseids should yield 60 to 80 meteors per hour, visible from a dark site. A total lunar eclipse is visible September 27-28 throughout most of North and South America, Europe, Africa, and western Asia. Very bright Venus and Jupiter join Mars for a busy predawn East by late summer. Saturn is in the evening South, then West throughout the summer.

RANDOM SPACE FACT

The force of sunlight pushing on the 32-square-meter sail of the *LightSail* spacecraft is about the same as the downward force of a housefly sitting on your hand. The advantage for spacecraft propulsion is that the force is constant and just keeps pushing, unlike the large but brief forces of chemical rockets.

TRIVIA CONTEST

Our December Solstice contest winner is Douglas F. Crane of Mount Pleasant, South Carolina. Congratulations! **THE QUESTION WAS:** In November 2014, ESA's *Rosetta Philae* lander became the first to soft-land on a comet. On what spacecraft mission did a human-made object slam into a comet in 2005? **THE ANSWER:** NASA's Deep Impact mission slammed a 370-kilogram copper impactor into a comet at 37,000 kilometers per hour (23,000 mph) and watched the impact that resulted.

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

What five spacecraft are on escape trajectories from our solar system, i.e., they will leave and never return?

E-mail your answer to *planetaryreport@planetary.org* or mail your answer to *The Planetary Report*, 60 S. Los Robles Ave., Pasadena, CA 91101. Make sure you include the answer and your name, mailing address, and e-mail address (if you have one). By entering this contest, you are authorizing *The Planetary Report* to publish your name and hometown. Submissions must be received by September 1, 2015. 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*.

CASEY DREIER *is director of advocacy for The Planetary Society.*

Humans Orbiting Mars

Looking at a Realistic Plan

THE STREETS ARE quiet. The attention of the world is, briefly, on four people very far away: an international crew of astronauts nearing the Red Planet. The world is waiting to hear if the crew successfully entered Martian orbit after nearly eight months traveling in interplanetary space. Everyone on Earth is quietly committing the time to memory: 2033, the year we made it to Mars.

But not land on it. Not yet.

The crew makes a successful entry into Mars orbit, and stays there. Soon after arrival, they dock with Phobos. They spend nearly a year with the Martian moon, collecting samples, exploring its craters, and seeking to understand its odd history.

On Mars itself, multiple rovers scout out future landing sites and explore the terrain. The astronauts on Phobos control them in near-real time. Without the 15-minute lag of the communications signal from Mars to Earth, the astronauts operate the rovers much faster than the science teams back home.

After more than a year in orbit, the astronauts return home. The next crew, the crew that will land on Mars, has been busy studying the experiences of those who orbited first. The spacecraft hardware, now checked out for use in the Mars system, can now be focused on getting people to the surface. The orbit-first mission has whetted public appetite for the adventure of Mars–everyone is eager for the next step. In the late 2030s, humans go for landing.

HUMANS ORBITING MARS

This was the scenario presented to an invitation-only workshop hosted by The Planetary Society in Washington, D.C. in March. We called it the "Humans Orbiting Mars" workshop. In attendance were distinguished representatives of the aerospace industry, scientific community, policy world, and NASA itself. Society board members Scott Hubbard and John Logsdon chaired the meeting. Hubbard is the former director of NASA's Ames Research Center and the first "Mars Czar" at NASA. Logsdon founded the Space Policy Institute at George Washington University and served as its director for more than 30 years.

Inspired by last year's report by the National Academies–which declared that current budgets and plans for human spaceflight are completely unrealistic–our goal was to explore a sustainable, executable, and affordable plan for NASA to get humans to Mars.

NEW HARDWARE AND NEW ACCESS

We are in a time of great change in NASA's human spaceflight program. For the first time in forty years, there is new hardware–notably the Space Launch System, Orion Crew Capsule, and a growing capability by the commercial launch sector–that provides access to new destinations beyond Earth for humans. So the question is, how can we build a true program of Mars exploration that is sustainable over the decades?

The centerpiece of our workshop was a Mars program architecture concept developed by a study team at the Jet Propulsion Laboratory (JPL) that aimed to do just that. Their goal was to reduce the number of "miracles" needed for a successful program by embracing as much existing technology as possible. This lowers risk, which lowers

For a list of the consensus points reached by attendees of The Planetary Society's Humans Orbiting Mars workshop, go to **planet.ly/homresults**

To learn more about the plan presented by JPL at the Humans to Mars Summit in May 2015, go to **planet.ly/exploremars**

cost. It means utilizing solar electric propulsion (currently under development for the Asteroid Redirect Mission), the Space Launch System (ready in 2018), and the Orion crew capsule (ditto). The only new piece of hardware necessary is a long-duration human habitation module, which is already in early concept studies. Their concept has hardware shakedown missions near the Moon throughout the 2020s, followed by an orbit-first mission in 2033, and then, beginning in 2039, an extended series of landings that increase in complexity.

Does this concept save money? Well, according to the Aerospace Corporation, which provided the cost estimates for last year's National Academies report, it appears that an orbit-first plan could fit within the current human spaceflight budget if it grows with inflation and NASA ends its primary role in the International Space Station (ISS) as planned in 2024.

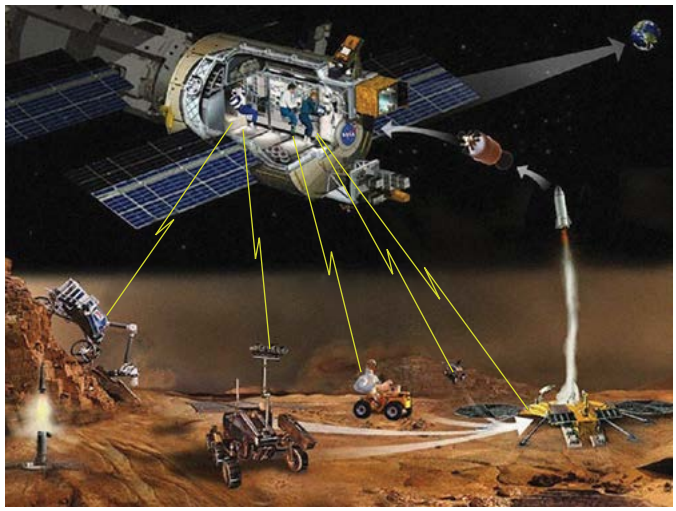
A SUSTAINABLE, EXECUTABLE, AFFORDABLE PLAN

At the workshop we took a hard look at this concept. We discussed the potential science return from an orbit-first mission, its public engagement potential, and the funding reality that NASA faces in the coming decades. The initial results from the workshop were very encouraging; the consensus was that JPL had developed a credible framework for getting humans to Mars, affordably.

While much will change as we go forward, the Society believes this orbit-first approach to the human exploration of Mars is extremely promising. NASA needs to commit to Mars soon. There will still be new hardware needed, new procedures, techniques, and abilities to develop and test on the ISS and near the Moon. And there will be problems, surely, that will have to be overcome. But the sooner we commit to a real Mars strategy, the stronger our chances for success.

The workshop and its consensus points will form the basis of a longer report we'll release later this year. This report will help inform the Society's future advocacy work in the realm of human spaceflight. But I'm also asking for feedback from our most important constituency: you, our members.

What do you think? Should humans orbit first? What's the right balance between a practical and ambitious program of human exploration? E-mail me at *casey.dreier@planetary.org*. You may also send letters to *planetaryreport@planetary.org* for possible inclusion in a future issue of *The Planetary Report*.



LEFT *A variety of robotic explorers swiftly transmit data to a crew of astronauts in Mars orbit. The Planetary Society's Humans Orbiting Mars workshop brought leaders in space exploration together to study a plan which looks at a realistic, affordable strategy for getting humans to the Mars system in 2033.*

Illustration: NASA

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Celebrate Our History—and Our New Home

It's hard to believe our organization is old enough to have history, but it's true! The Planetary Society has definitely come of age and is now marking 35 years of promoting space science and exploration.

In other words, it's time to celebrate!

This fall we will host a public celebration on Saturday, October 24 to commemorate our history and to dedicate our new headquarters. In addition, we will honor a very special group of supporters, our charter members, with a reception to be held on Friday evening, October 23.

More details will be forthcoming soon, but you will definitely want to mark your calendars and plan to join us for this magnificent occasion.

And for those who have participated in our Buy-A-Brick fundraising campaign (there's a little time left before our August 1 deadline—for more information, visit **planetary.org/bricks**), you'll be able to drop by and see your brick installed just outside our entry.

It will be a great day for The Planetary Society as we hearken back to the vision of our founders, Carl Sagan, Bruce Murray, and Louis Friedman, and look forward to a stellar future.

Join us!

Regards,

Richard

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Image: NASA, ESA, the Hubble Heritage Team (STScI/AURA), A. Nota (ESA/STScI), and the Westerlund 2 Science Team