

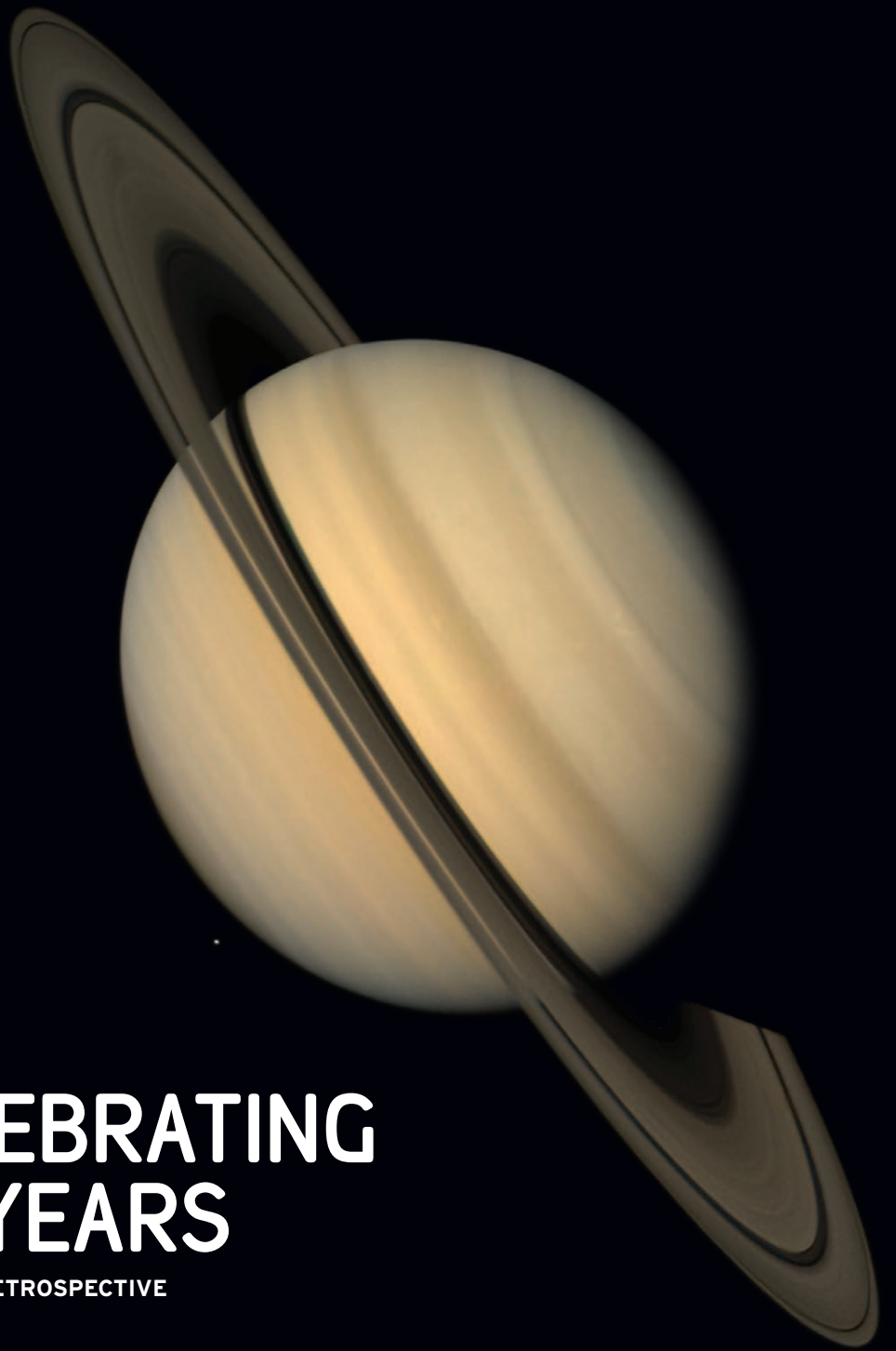


THE PLANETARY REPORT

SEPTEMBER
EQUINOX **2020**

VOLUME 40, NUMBER 3

planetary.org



CELEBRATING 40 YEARS

A SOCIETY RETROSPECTIVE



NASA/BILL INGALLS

Tried-and-True Workhorse

Russian Rocket Continues to Deliver

MOST OF TODAY'S rockets look a lot different from the ones in use when The Planetary Society was founded in 1980. One notable exception is the venerable Russian Soyuz, which has been operating since 1967. Although the launcher has received various upgrades over time, there is little to visually distinguish a modern Soyuz from its predecessors.

Here, a train hauls the Soyuz rocket that launched Russia's Oleg Skripochka, NASA's

Jessica Meir, and the United Arab Emirates' Hazzaa Ali Almansoori to the International Space Station on 25 September 2019. The launch pad, located in Baikonur, Kazakhstan, sits on the same spot where Yuri Gagarin blasted off in 1961 to become the first human in space, and Sputnik 1—Earth's first artificial satellite—was launched. Cold War-era structures loom large over the scene along with rusting rubble near the train tracks. 🚂



NASA/ESA/P. KENNETH SEIDELMANN, KATHY RAGES, AND AMY SIMON/OPAL/JUDY SCHMIDT

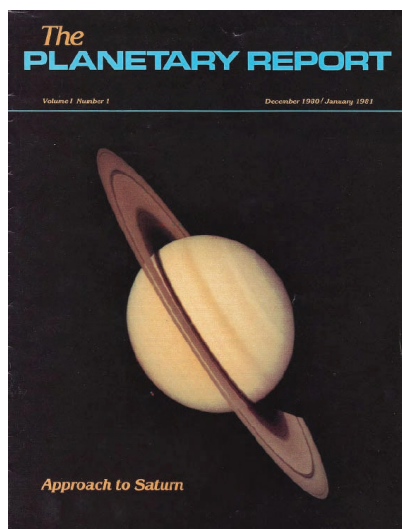
FORTY YEARS is a lot of time here on Earth, but on Uranus, not so much. The ice giant takes 84 Earth years to orbit the Sun, so over the entire course of The Planetary Society’s existence, not even half a Uranian year has passed. Uranus is famously tipped on its side relative to the other planets, but just like Earth, it has seasons, as shown in these 3 images taken by the Hubble Space Telescope in 1995, 2007, and 2019.

In the left image from 1995, Uranus’ south pole is at center-left, and the north pole is hidden. The 2007 image was taken during equinox, when the planet’s rings sat edge-on to Earth, appearing nearly invisible. In the 2019 image at right, the north pole is in view, while the south pole is hidden.

Annual images of the outer planets by Hubble help scientists understand planetary atmospheres. These pictures were processed, colorized, and oriented to look consistent by Judy Schmidt, an amateur astronomer who specializes in archival Hubble image processing. 🪐

SEE MORE AMATEUR-PROCESSED SPACE IMAGES [PLANETARY.ORG/AMATEUR](https://planetary.org/amateur)

SEE MORE EVERY DAY! [PLANETARY.ORG/ARTICLES](https://planetary.org/articles)



ON THE COVER: The first issue of *The Planetary Report* was published in December 1980. For that cover image, our cofounders chose the last picture from Voyager 1’s approach to Saturn in which the entire planet and ring system can be seen in a single frame. For our 40th anniversary issue, Björn Jónsson reprocessed the same Voyager data using modern techniques, revealing stunning new details. Credit: NASA/JPL/Björn Jónsson * *The Planetary Report* (ISSN 0736-3680) is published quarterly at the editorial offices of The Planetary Society, 60 South Los Robles Avenue, Pasadena, CA 91101-2016, 626-793-5100. It is available to members of The Planetary Society. Annual dues are \$50 (U.S. dollars) for members in the United States as well as in Canada and other countries. Printed in USA. Third-class postage at Pasadena, California and at an additional mailing office. Canada Post Agreement Number 87424. * Viewpoints expressed in articles and editorials are those of the authors and do not necessarily represent positions of The Planetary Society, its officers, or its advisers. ©2020 by The Planetary Society. All Rights Reserved. The Planetary Society and *The Planetary Report*: Registered Trademarks ® The Planetary Society. Planetfest™ The Planetary Society.

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The remarkable achievements our members have made over the past 4 decades, alongside other space milestones and events.



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BILL NYE is chief executive officer of The Planetary Society.

Our Past Informs Our Future

Looking Back at Carl Sagan's Founding Essay From December 1980

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YOU AND I have come a long way since Carl Sagan wrote his compelling essay “The Adventure of the Planets” back in the 20th century (see facing page).

Just as he suggested, the very existence of The Planetary Society, today the world’s largest independent space organization, demonstrates that citizens of Earth consider the exploration of planets and other worlds to be a wonderful and worthy use of our human abilities.

Professor Sagan pointed out that we would one day know a great deal more about the cosmos than we did back when he crafted those words 40 years ago—as long as we stayed the course.

He and his cofounders Bruce Murray and Louis Friedman created this organization to petition governments and space agencies, advocating for missions to the planets in our solar system and for instruments to explore objects way out there beyond our Sun.

Thanks to you, we’ve stayed the course.

It’s because of the extraordinary feats of exploration that our species has performed during our brief time on Earth that you and I know that we live on a planet with a moon, that the brighter dots in the night sky are other planets, and that every twinkling star is probably the center of its own solar system with its own diverse and intriguing worlds and moons.

Space is hard; exploring it takes time, and it is vital. When scientists decide to take on a project like returning samples from the surface of Mars, it takes decades to accomplish the

project. It requires decades of funding, and year after year, as governments set their nation’s budgets through economic ups and downs, legislators are often tempted to cut costs and cancel programs that may not seem to have immediate payoffs or obvious benefits for their constituents. Meanwhile, these distant worlds cry out for exploration and discovery and speak to us about our own planet. The more we learn about planetary worlds of all kinds, the more we will understand our Earth and how we can ensure a better future for species everywhere, especially our own.

It is as important as ever to speak up as a space advocate. The Planetary Society and our members around the world are here to educate legislators about the value of exploration. We are here to make it known that people—voters, taxpayers, kids (the explorers of tomorrow)—want their governments to keep funding space. We are here to grow a global community of supporters who want ambitious exploration that leads to amazing discoveries and understanding.

I’m proud to see the progress that has been made in space science and exploration since Carl Sagan penned “The Adventure of the Planets.” I hope we all look up and wonder where we’ll be 40 years from now—exploring worlds beyond the sky and learning more about the cosmos and our place within it.

The Adventure of The Planets

by Carl Sagan

For all of human history the planets were wandering lights in the night sky, moving against the background of the more distant constellations in complex, although regular, paths. The planets stirred our ancestors, provoked their curiosity, encouraged mathematics and accurate record keeping. Through the work of Johannes Kepler and Isaac Newton, understanding planetary motion led to the development of modern physics and, in a very real sense, opened the modern age of science and technology. In the last 18 years — ever since the encounter of the *Mariner 2* spacecraft with Venus — every one of those wandering lights has been visited by space vehicles from Earth; every one has revealed itself to be a world in its own right very different from our own. We humans have landed exquisite robot spacecraft on Mars and Venus and orbited both planets. We have flown by Mercury, Jupiter and Saturn. We have discovered the broiling surface of Venus, the windswept valleys of Mars, the sulfur rivers of Io, the great polychrome storm systems of Jupiter. We have discovered new moons, new ring systems, puzzling markings, enigmatic pyramids and have searched for life. Never again will the planets be mere wandering points of light. Because of the effort of the last two decades they will forever after be worlds crying out for exploration and discovery.

And yet the pace of planetary exploration has slackened ominously. After the *Voyager* encounters with the Saturn system in November, 1980 and August, 1981, there will be a period of more than four years in which no new images are returned from the planets by any United States spacecraft. The Soviet Union also shows signs of slowing its once vigorous program of space vehicle exploration of the Moon, Venus and Mars — although it is still spending probably two or three times more per year on such enterprises as the United States. If we back off from the enterprise of the planets, we will be losing on many different levels simultaneously. By examining other worlds — their weather, their climate, their geology, their organic chemistry, the possibility of life — we calibrate our own world. We learn better how to understand and control the Earth. Planetary exploration is an activity involving high technology which has many important applications to the national and global economy — robotics and computer systems being two of many examples. It uses aerospace technology in an enterprise which harms no one, which is a credit to our nation, our species and our epoch. And planetary exploration is an adventure of historic proportions. A thousand years from now, when the causes of contemporary political disputes will be as obscure as the origin of the War of the Austrian Succession is to us now, our age will be remembered because this was the moment when we first set sail for the planets and the stars.

These arguments are widely accepted. And yet when a specific planetary mission is being considered by the Executive Office of the President or by the appropriate Congressional Committees, planetary scientists hear another story. We are told that it is expensive — although a vigorous program of unmanned planetary exploration would cost about a tenth of a percent of the federal budget; the *Voyager* spacecraft, when they are finished with their explorations, will have cost about a penny a world for every inhabitant of the planet Earth. But mainly we are told that, although the arguments for planetary exploration are widely understood in government, they are not supported by the people. We are told that spending money on planetary exploration — on the discovery of where we are, who we are, what our history and fate may be — is unpopular, that it is a political liability to support such ventures. I can remem-



LEFT TO RIGHT: BRUCE MURRAY, CARL SAGAN, LOUIS FRIEDMAN

ber a Congressman telling me that the only letters he had received in support of the *Galileo* exploration of Jupiter were sent by people too young to vote.

And yet there is evidence of enormous support and enthusiasm for the exploration of the planets. We can see it in the popularity of motion pictures and television programs on planetary themes; in the topics discussed in the burgeoning set of science fact magazines, and in the success with which books on this subject have recently been greeted. In puzzling over this apparent paradox, it became clear to me and a number of my colleagues that the solution would be a non-profit, tax-exempt, public membership organization devoted to the exploration of the planets and related themes — particularly the search for planets around other stars and the quest for extraterrestrial intelligence. If such an organization had a substantial membership, its mere existence would counter the argument that planetary exploration is unpopular. And so Dr. Bruce Murray, the director of Caltech's Jet Propulsion Laboratory and I, with a number of colleagues and friends, have established The Planetary Society. The membership of its Advisory Board is not only very distinguished but very broadly based. We believe that many sectors of our society would be willing to support us. We hope to be able to put planetary scientists in touch with their local supporters. With the contributions we have received — some of them anonymous — we have been able to mount a very encouraging sample direct mailing to test the interest of the American public. If we are as successful as at least some experts think we are likely to be, we may be able to accomplish not only our initial goal of demonstrating a base of popular support for planetary exploration; but also to provide some carefully targeted funds for the stimulation of critical activities — for example, in planetary mapping and in the radio search for extraterrestrial intelligence. We can be contacted at P.O. Box 3599, Pasadena, California, 91103. [Like many proposed interstellar radio messages, the Post Office Box number is the product of two prime numbers, 59 and 61.] □

The New and Improved planetary.org

HAVE YOU visited our website lately? We've made some big changes to planetary.org to make it easier for you to find information about missions and worlds, learn about actions you can take to advance exploration, and view reports on program activities enabled by your support. As you take a tour of the site, know that our improved ability to educate the public about space and to rally support for more exploration was made possible by your support as a member.



Advancing Advocacy

THIS YEAR'S effort to raise funds for our space advocacy program was a huge success. With the support of members and donors like you, we were able to raise over \$95,000 to directly aid our critical work in Washington, D.C. to push for NASA funding and

campaign, we also collected signatures on a petition to U.S. President Donald Trump and Democratic candidate Joe Biden asking them to prioritize NASA funding for missions that will advance space science and exploration. One thousand three hundred forty people from around the world signed this petition, showing the strength of public support for space exploration.

Defending Earth Together

EVERY YEAR on 30 June, The Planetary Society teams up with the Asteroid Foundation and its global partners to mark Asteroid Day and raise public awareness of the threat of near-Earth objects that may impact Earth. This year, due to the coronavirus pandemic, Asteroid Day's events were all online. You can check out all the great content from around the world, including a message from our CEO Bill Nye, at asteroidday.org.

Charting the Future of Exploration

THE PLANETARY SCIENCE decadal survey is a consensus document that establishes the scientific priorities for the next 10 years of planetary exploration. This year, The Planetary Society's Space Policy & Advocacy program submitted 2 papers to the decadal committee that would advance the organization's goals of searching for life in the solar system and increasing our commitment to planetary defense. Our staff contributed to 3 additional papers: one focused on our ethical obligation to pursue planetary exploration, another focused on the value of small-cost missions, and a third focused on planetary defense in the upcoming era of advanced telescopic surveys. This is another great example of how The Planetary Society promotes your values in space science and exploration in every step of the process. Find the papers at planetary.org/space-policy.



MEMBER ANTONIO PERONACE FOR THE PLANETARY SOCIETY

to support the national and international campaigns we organize to make sure space exploration gets the political and financial support it needs. Alongside this fundraising

Working for Space for Everyone

IN JUNE, the entire planet saw communities gather to demand an end to police brutality against Black people. As protests spread around the world, more people became aware of the deep systemic roots of the problem. Racism is an issue that affects every facet of society, including humanity's endeavor to explore the cosmos. The Planetary Society is committed to



working against racism. We made public statements in support of the Black Lives Matter movement and the justice it seeks for the murder of citizens like George Floyd and Breonna Taylor. We began engaging in public discussions about racism in space exploration, including a powerful conversation between our CEO, Bill Nye, and retired NASA astronaut Leland Melvin. In August, our staff took part in an intensive training session to confront how racism functions in society, in the space sector, and in even the most well-intentioned individuals. This is ongoing work, and it is every bit as challenging as it is important. We look forward to continuing to update you on our work to ensure an equitable future in space exploration for every human being on Earth.

Finding Earth-Like Exoplanets

EVER SINCE The Planetary Society's founding 40 years ago, members like you have moved planetary science forward by directly funding innovative science and technology projects. This year was no exception. Planetary Society members and donors came together to raise more than \$62,000 for the 100 Earths project to fund the search for Earth-like exoplanets. The science



NASA/AMES RESEARCH CENTER/DANIEL RUTTER

teams, led by Yale University astronomer Debra Fischer, were able to buy a much-needed photonic crystal fiber (PCF), which is an ultra-sensitive cable used to transport light. Fischer's teams are using it to send light from the Lowell Discovery Telescope and Lowell Solar Telescope in Arizona into an advanced spectrometer for exoplanet detection. The crucial concepts used in the spectrometer grew out of technology research that Planetary Society members helped fund between 2009 and 2014. "The contributions that The Planetary Society has made to exoplanets have had a huge impact on the field," said Fischer. "I think that literally I would not be at the place that I'm at now if not for that support." The PCF that members and donors funded will be used as part of a search for Earth-sized exoplanets around nearby stars that could have the potential to host life. 🐾

ABOVE This artist's concept shows what exoplanet Kepler-1649c could look like on its surface. The planet is the closest to Earth in size and temperature found yet in data from the Kepler Space Telescope.

ABOVE LEFT Watch retired astronaut Leland Melvin and Planetary Society CEO Bill Nye's conversation at [planetary.org/video](https://www.planetary.org/video).

Planetary Society members like you make this work possible. *Thank you!*



Discover the Cosmos Right at Home

Whether you have access to a backyard or just your window and are using a telescope or just your eyes, there's a lot to see when you look up at the night sky. Planetary Society members sent us their top tips for enjoying stargazing and planet watching, which we've compiled into an easy beginner's guide. Once you start exploring the night sky, there's no limit to what you'll find. Check out the guide at planet.ly/beginnersastronomy.



Be a Planetary Defender

By the time this magazine reaches you, The Planetary Society will be wrapping up our campaign to raise funds for planetary defense. If you haven't had a chance to make your gift yet, it's not too late to help. Your support will help us pursue a variety of activities to protect Earth from asteroid impacts by finding, tracking, characterizing, and deflecting incoming asteroids and coordinating all these efforts internationally. Learn more and support planetary defense at planet.ly/defendearth.

RIGHT *This ultraviolet-light image of Venus, captured by Japan's Akatsuki spacecraft on 15 January 2017, was processed by Damia Bouic to bring out cloud details that are invisible to the human eye.*

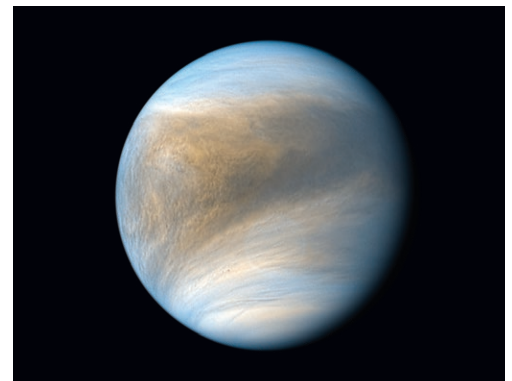
JAXA/ISAS/DARTS/DAMIA BOUIC

Take Action With Us

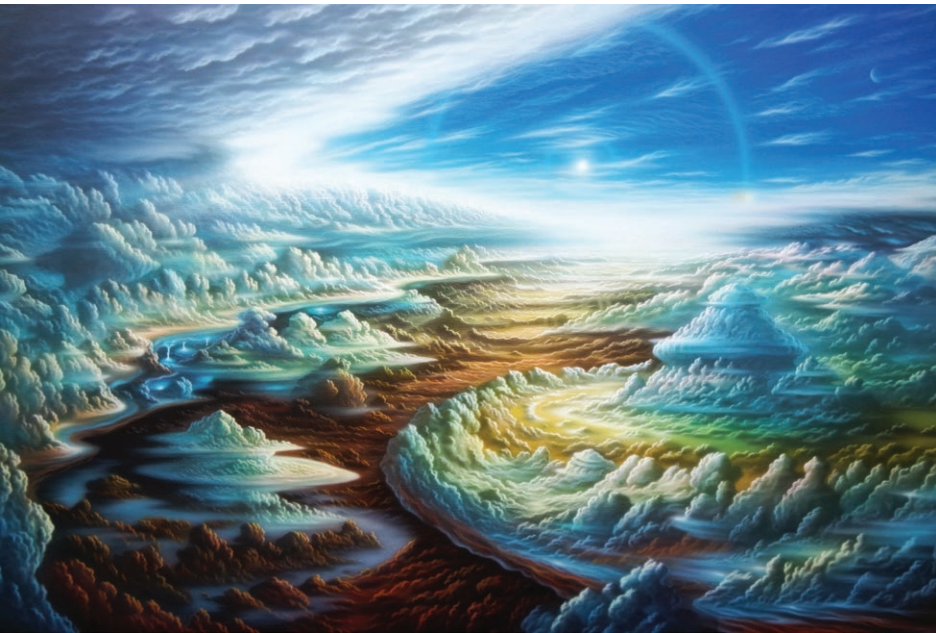
One of the awesome features of our new website is a one-stop-shop action center where you can find ways to make your mark on the future of space exploration. Whether it is teaching someone about the critical importance of planetary defense, signing a petition for NASA funding, or speaking up about timely policy issues, you can make a difference right now by going to planetary.org/action-center.

From Bits to Beautiful

Whenever a spacecraft captures an image of a planet, moon, asteroid, or any other celestial object, it sends that photo back to Earth as raw data. What you may not know is that this raw data is freely accessible to the public. In a new, free online course, Solar System Specialist Emily Lakdawalla shows you how to access this data and process it into stunning images. Not only do you get the satisfaction of discovering what a



spacecraft is seeing but you can also make valuable contributions to space exploration by generating unique space images like the ones featured throughout this magazine (many of which were produced by amateur image processors). Learn how to make your own space images at courses.planetary.org and show off what you make by sending it to us at connect@planetary.org.



ABOVE This painting, titled "Jupiter Storm," was shared by Planetary Society supporter Andrew Stewart.

Calling All Creatives!

Do you create art or maybe music, poetry, sculpture, or fashion to celebrate your love of space? Whatever your creative outlet, we want to hear from you! We're inviting members from around the world to send us your artwork so that we can showcase the amazing variety of creations that space inspires. You can share your creativity with us by emailing connect@planetary.org.



Old School Space Style

Forty years after our founding date, we still love the style of The Planetary Society's original logo. You can get in on this blast from the past with our awesome retro T-shirt. Every purchase supports our mission to advance space science and exploration. Purchase yours today at planetary.org/store.

Planetary Society Member Adventures



We invite you to travel with The Planetary Society to see wonderful eclipses or the aurora borealis in 2020 and 2021!

Travel restrictions during the COVID-19 pandemic are evolving. For updated information, contact Betchart Expeditions Inc. at 800-252-4910 or go to betchartexpeditions.com.

ARGENTINA TOTAL SOLAR ECLIPSE 2020 8-19 DECEMBER 2020

With optional Peru or Easter Island pretrips, 2-8 December 2020

ALASKA AURORA BOREALIS 11-17 MARCH 2021

See the greatest light show on Earth on this ever-popular adventure!

DISCOVER THE GEOMAGNETIC NORTH POLE & WEST GREENLAND ANNULAR ECLIPSE 1-12 JUNE 2021

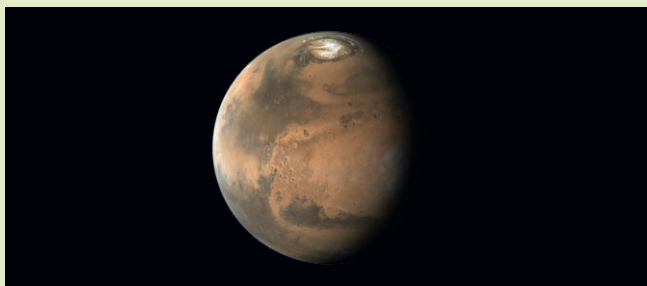
See extraordinary landscapes, sled dogs, glaciers, and the annular eclipse in this land of the midnight sun!

BAFFIN ISLAND, CANADA ANNULAR ECLIPSE 6-12 JUNE 2021

Discover the "ring of fire" in the remote Canadian High Arctic!

ANTARCTICA TOTAL SOLAR ECLIPSE 2021 23 NOVEMBER - 15 DECEMBER 2021

See the total eclipse in one of the most remote places on Earth, plus South Georgia and the Falkland Islands.



ISRO/ISSDC/EMILY LAKDAWALLA

IN THE SKY

There is great sky stuff this quarter! Around the time of its 6 October closest approach, Mars will be 3 times brighter than the brightest star and brighter than Jupiter. Mars' brightness varies considerably as Earth and Mars orbit, and now is a very bright period. Mars won't be any closer until 2035. Very bright Jupiter and yellowish Saturn are in the evening West. On 21 December, they will be extremely close together in the sky. An almost-new Moon will provide dark skies for the Geminids meteor shower, peaking on 13/14 December. The Geminids are usually the best shower of the year with 100+ meteors per hour from a dark site. A total solar eclipse will be visible from portions of Chile and Argentina on 14 December with a partial eclipse visible from much of South America (see planetary.org/eclipse). Super-bright Venus dominates the pre-dawn East.

RANDOM SPACE FACT

On 21 December 2020, Jupiter and Saturn will be closer in the sky than they have appeared in almost 400 years. They will be 7 arc minutes apart or less than 1/4 the width of a full Moon.

TRIVIA CONTEST

Our March equinox contest winner is Jano Mladonicky of The Woodlands, Texas, USA. Congratulations! The question was: **Approximately how many of Earth's Moon would fit inside Earth (assuming no void space, i.e., assuming the volume of Moons smooshes into the volume of Earth)?** The answer: **Approximately 49 Moons would fit inside Earth.**

Try to win a copy of *My First Book of Planets* by Bruce Betts and a *Planetary Radio* T-shirt by answering this question:

In 2020, about how much farther away is the Moon from Earth (average distance) than it was when The Planetary Society was founded in 1980?

Email 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 email 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 1 December 2020. The winner will be chosen in 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.



UNITED LAUNCH ALLIANCE

ABOVE LEFT India's Mangalyaan spacecraft took this image on 22 January 2016, not long after the Martian northern summer solstice. At the top of the view is the permanent northern water ice polar cap.

ABOVE RIGHT NASA's Perseverance rover blasts off for Mars atop an Atlas V rocket on 30 July 2020.

Where We Are

An At-a-Glance Spacecraft Locator

THREE NEW SPACECRAFT are currently cruising to Mars. NASA's Perseverance rover, China's Tianwen-1 orbiter and rover, and the United Arab Emirates' Hope orbiter all launched successfully in July and August and are scheduled to arrive in February 2021.

The European Space Agency's BepiColombo spacecraft will perform its first Venus flyby on 15 October using the planet's gravity to shape the probe's orbit as it journeys to Mercury. Five days later on 20 October, NASA's OSIRIS-REx spacecraft is scheduled to make its first sample collection attempt at asteroid Bennu. OSIRIS-REx will remain at Bennu until 2021 and return its samples to Earth in 2023.

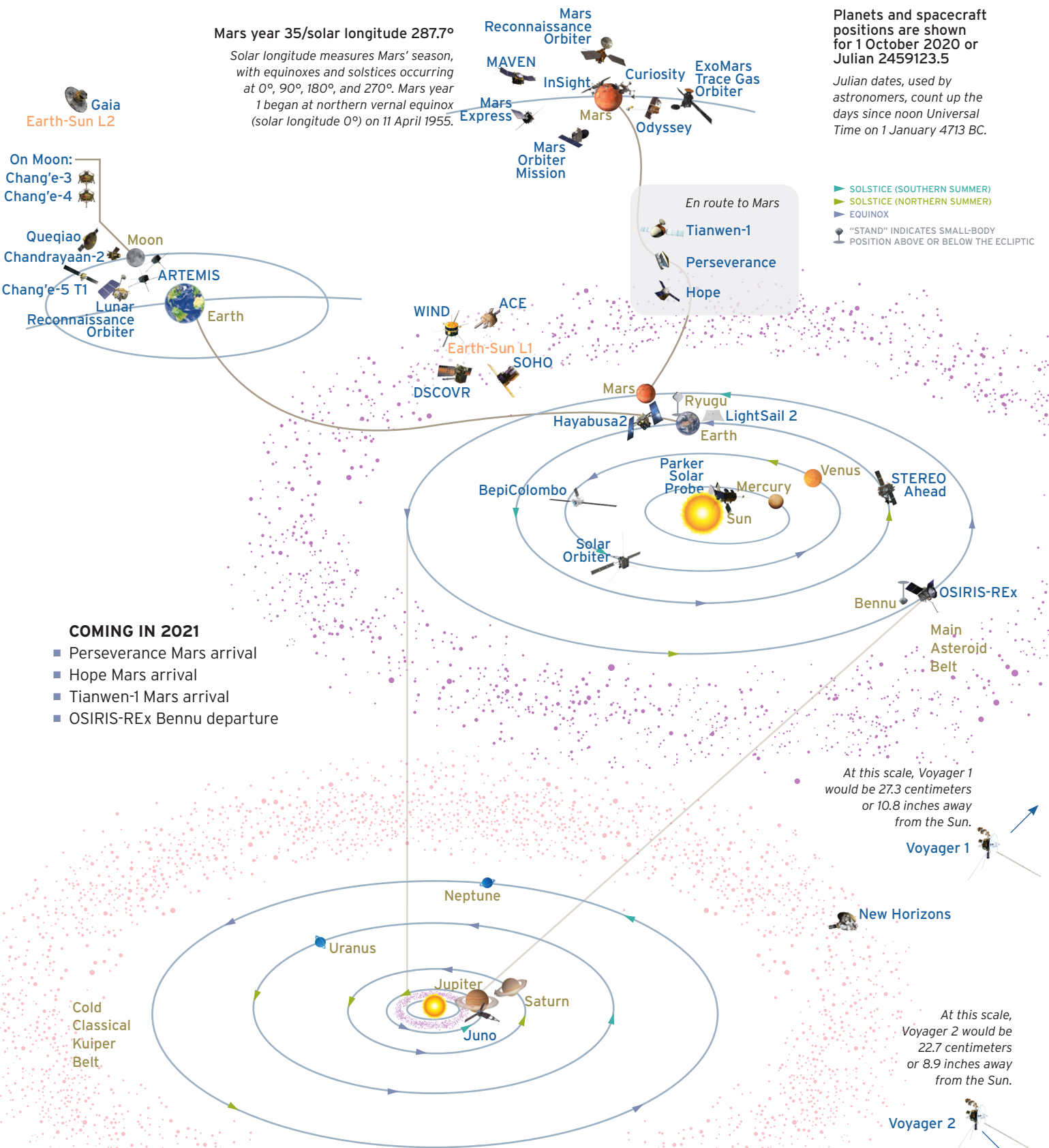
Meanwhile, Japan's Hayabusa2 spacecraft is slowly closing in on Earth, where it will drop off its precious samples from asteroid Ryugu in December. The samples, protected in an atmospheric reentry capsule, will land in Australia while Hayabusa2 cruises onward to possibly visit another asteroid during an extended mission. Also scheduled for December is the launch of China's Chang'e-5 sample return mission to the Moon. 🌕

Mars year 35/solar longitude 287.7°

Solar longitude measures Mars' season, with equinoxes and solstices occurring at 0°, 90°, 180°, and 270°. Mars year 1 began at northern vernal equinox (solar longitude 0°) on 11 April 1955.

Planets and spacecraft positions are shown for 1 October 2020 or Julian 2459123.5

Julian dates, used by astronomers, count up the days since noon Universal Time on 1 January 4713 BC.



En route to Mars

- Tianwen-1
- Perseverance
- Hope

- ▶ SOLSTICE (SOUTHERN SUMMER)
- ▶ SOLSTICE (NORTHERN SUMMER)
- ▶ EQUINOX
- “STAND” INDICATES SMALL-BODY POSITION ABOVE OR BELOW THE ECLIPTIC

COMING IN 2021

- Perseverance Mars arrival
- Hope Mars arrival
- Tianwen-1 Mars arrival
- OSIRIS-REx Bennu departure

At this scale, Voyager 1 would be 27.3 centimeters or 10.8 inches away from the Sun.

Voyager 1

At this scale, Voyager 2 would be 22.7 centimeters or 8.9 inches away from the Sun.

Voyager 2



RIGHT Heidi in her homemade LightSail Halloween costume.

I Am the Cosmos

I WAS BORN at 11:11 p.m. on a starry night with a full Moon, so maybe that’s why the night sky always pulls me. I have loved space from as far back as I can remember.

Being 10 years old, I haven’t been to space yet, but I am always looking up. One crisp September night, my mom and I were walking on the boardwalk when I noticed the Moon, Mars, and Jupiter shining bright over the ocean—a moment I will never forget!

I am always exploring. I love to look for tardigrades in wet moss, flip logs to discover salamanders, and hunt rock piles for fossils. So far, I have found 2 fossils! My life goal is to go to Mars to analyze the rocks there for biosignatures like stromatolites.

In the first 10 years of my life, I have witnessed phenomenal achievements by the science community. We have photographed

black holes, discovered exoplanets, and launched LightSails. However, my generation has also inherited a mass extinction event due to a human-caused climate crisis. I aim to use the same ingenuity that drives space exploration to solve environmental tragedies on our home planet.

I will be 70 years old when The Planetary Society turns 100. Maybe by then we will divert dangerous asteroids, find life on Mars, or reverse climate change!

The fact that we are all made of star stuff tells me that I AM the cosmos, not just an observer. I am as connected to the vastness of space above me as I am to an ant, an oak tree, and my fellow humans all across the globe. It is my hope that together we can sail to the stars while holding dear our connection to each other here on Earth. 🌟



HEIDI JACOBS is a 10-year-old student at Haddonfield Friends School, a Quaker school in New Jersey. She is a proud member of The Planetary Society; in fact, she mows lawns to earn money to donate! When not looking through her telescope, Heidi enjoys horseback riding, swim team, and writing. She loves to travel near or far and is always up for an adventure.

WHY I EXPLORE Planetary Society members are explorers. We share this common passion, although we have different stories that drive our passion. We’re curious to know your story. If you’d like to share, we’ve set up a form at planetary.org/whyexplore, where you will also be able to read other “Why I Explore” stories. We’ll also continue to share stories in future issues of The Planetary Report.

Celebrating 40 Years

HOW DO YOU TOP landing humans on the Moon? For NASA, the answer was planetary exploration. Spacecraft built by the agency's Jet Propulsion Laboratory (JPL) in Pasadena, California filled the 1970s with planetary firsts: Mariner 9 orbited Mars, Mariner 10 flew past Mercury, Pioneer 10 visited Jupiter, and Pioneer 11 made it to Saturn. The Viking probes performed the first Mars landing in 1976, and a year later, the dual Voyager probes embarked on a grand tour of the solar system.

Things looked less rosy at the end of the decade. The high-dollar Viking and Voyager programs came at a cost, stifling the development of smaller missions. Meanwhile, the fledgling Space Shuttle program was behind schedule, over budget, and gobbling up more and more of NASA's budget. Policymakers

Congress, as the potential organizer of such an organization. On 30 November 1979, Murray, Sagan, and Friedman formed The Planetary Society. According to its formation documents, The Planetary Society was founded to spread public awareness of planetary exploration and the search for life, share the latest findings from those efforts, and stimulate the development of new science and technology projects.

Forty years later, none of that has changed except the addition of defending Earth from dangerous asteroids. Our members and supporters have delivered hundreds of thousands of petitions to the U.S. Congress and have changed the political fortunes of planetary missions. We have funded groundbreaking technological advancements in solar sailing. We have united researchers

↑ **ABOVE THE TIMELINE:**
Selected milestones in The Planetary Society's history

1975

1976

1977

1978

1979

used a perceived lack of public interest in planetary exploration as an excuse to slash budgets further, and at one point in the early 1980s, NASA seriously considered divesting itself from JPL altogether.

Bruce Murray, a California Institute of Technology planetary scientist who had played key roles in many NASA planetary exploration firsts, took command of JPL in 1976. Murray was alarmed at the situation, as was Carl Sagan, a Cornell University astronomer who was making a name for himself as a public science communicator. Murray and Sagan wanted to build a grassroots advocacy group to prove there was public support for planetary exploration. They identified Louis Friedman, a JPL engineer who was finishing a 1-year fellowship in Washington, D.C. learning the inner workings of

from around the world to work together on asteroid defense. Today, we are the world's largest and most influential independent space-interest organization.

To celebrate The Planetary Society's 40th anniversary, we're looking back at some big moments in planetary exploration during our existence along with our own milestones in helping to advance space science and exploration. While we couldn't possibly list all the amazing accomplishments of the past 4 decades (we know of at least 35 space missions that didn't get a mention), we tried to include major scientific and cultural milestones—moments likely to be remembered by the general public and achievements relevant to our organizational priorities. Here's to the next 40 years. There's so much more to explore. 🚀

↓ **BELOW THE TIMELINE:**
Selected milestones in space history worldwide

ON THE NEXT PAGE: THE 1980s

The 1980s

There was much work to be done after The Planetary Society's formation. Budget cuts, along with an ill-fated U.S. policy to launch all missions on the Space Shuttle, created what is often referred to by planetary scientists as the "lost decade." No new U.S. planetary missions were launched from 1978 to 1989, and only through sustained appeals from organizations like The Planetary Society did NASA's planetary program survive.

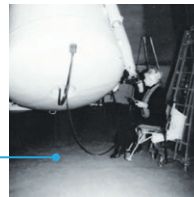
At a time when U.S. government scientists were barred from working with the Soviet Union, The Planetary Society helped bring the 2 superpowers closer together. By the end of the 1980s, things were starting to look up: the Space Shuttle finally launched the long-delayed Magellan and Galileo missions. Brighter days were ahead.

Planetary Society members begin funding efforts for SETI, the Search for Extraterrestrial Intelligence, along with exoplanet research.

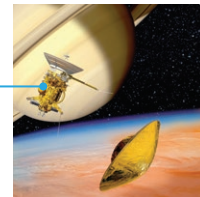
The first issue of our member magazine, *The Planetary Report*, is published.

The Planetary Society launches its first political action campaign, lobbying for a U.S. mission to Halley's comet. Supporters send more than 10,000 letters to the White House, which are in turn forwarded to NASA unopened. Future campaigns would be more effective.

The Planetary Society holds its first Planetfest celebration for Voyager 2's flyby of Saturn. Many more Planetfests have since been held for planetary encounters and landings.



Members begin funding Eleanor "Glo" Helin's near-Earth object research and continue to support her work for more than a decade.

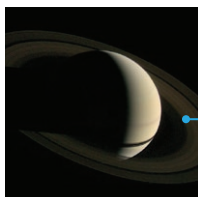


Carl Sagan, writing on behalf of The Planetary Society, urges NASA to send a spacecraft to Saturn and Titan. The eventual mission, Cassini, would launch in 1997. ESA/DAVID DUCROS

The Planetary Society begins advocating for international cooperation in planetary exploration and organizes a meeting between U.S. and Soviet scientists in Graz, Austria.

1980

Arnaldo Tamayo Méndez becomes the first Black astronaut in space, launching aboard the Soviet Union's Soyuz 38 spacecraft.



NASA's Voyager 1 probe flies past Saturn. From there, its trajectory takes it into interstellar space. It is still operating today. NASA/JPL/COLOR COMPOSITE BY GORDAN UGARKOVIC

1981

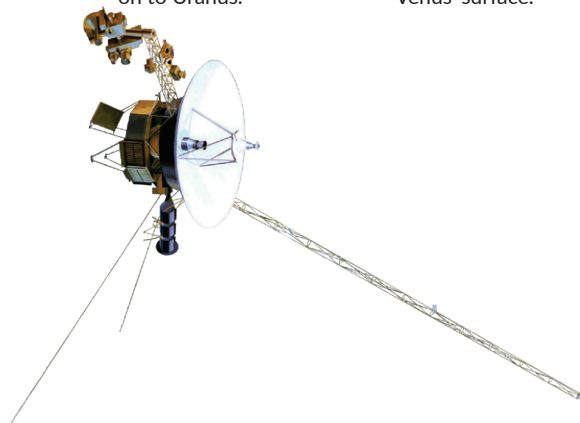
Space Shuttle Columbia launches on the program's first flight.

Cosmos: A Personal Voyage premieres on PBS.

Scientists Walter and Luis Alvarez propose that an asteroid impact caused the extinction event that killed off the dinosaurs.

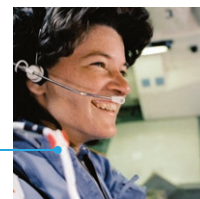
1982

NASA's Voyager 2 spacecraft flies past Saturn and continues on to Uranus.



The Soviet Union's Venera 13 lander captures the first color pictures from Venus' surface.

1983



Sally Ride becomes the first American woman in space.



Guion Bluford becomes the first Black NASA astronaut in space, flying aboard Space Shuttle Challenger.

1984



Paul Horowitz, Carl Sagan, and Steven Spielberg, along with his son, Max, activate project META, a Society-sponsored, radio-signal-based search for extraterrestrial intelligence at Harvard's Oak Ridge Observatory.



Planetary Society members enable Spacebridge, a televised event bringing together American and Soviet space scientists via satellite to advocate for cooperative human and robotic space exploration of Mars.

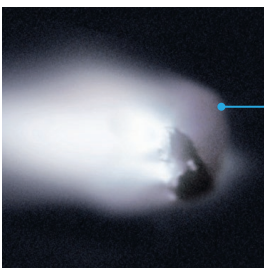


Planetary Society membership reaches an all-time high of 125,000 members in over 80 nations. It was one of the fastest-growing membership organizations of the decade, thus proving strong citizen interest in space exploration.

The Planetary Society celebrates NASA's Voyager 2 Neptune flyby with Planetfest '89—a 5-day event in Pasadena, California that attracts more than 15,000 guests. Legendary rock and roller Chuck Berry serenades the spacecraft as it leaves the solar system with a rendition of "Johnny B. Goode" that includes the lyrics "go, Voyager, go!"

1985

The Soviet Union launches the first piece of the Mir space station.



A fleet of international spacecraft fly by Halley's comet. NASA is not among the participants due to budget cuts and Space Shuttle delays that happened in the late 1970s and early 1980s.
HALLEY MULTICOLOR CAMERA TEAM, GIOTTO PROJECT, ESA

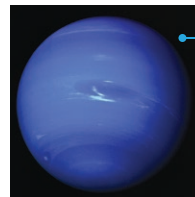
1986



NASA's Voyager 2 spacecraft makes the first (and to date, only) Uranus flyby and heads on to Neptune.
NASA/JPL-CALTECH

Space Shuttle Challenger breaks apart during launch, killing all 7 crew members.

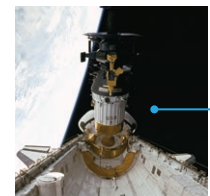
1987



NASA's Voyager 2 spacecraft makes the first (and to date, only) Neptune flyby. From there, its trajectory takes it into interstellar space. It is still operating today.
NASA/JPL-CALTECH

1989

Space Shuttle Atlantis launches the Magellan spacecraft to Venus.



Space Shuttle Atlantis launches the Galileo spacecraft to Jupiter.
NASA/SMITHSONIAN INSTITUTION

The 1990s

In the late 1980s and early 1990s, NASA's budget rose again only to decline once more starting in the mid-1990s. In order to maintain a steady pace of planetary exploration missions, the agency introduced its "Faster, Better, Cheaper" approach to mission design. For the first time in 20 years, Mars became a major focus with the start of a systematic, long-term program to understand the Red Planet.

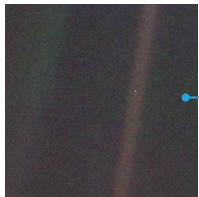
The Planetary Society, which had been advocating for Mars exploration for years, sponsored several related technology-development efforts. Our Mars Balloon was slated to fly on the Soviet Union's Mars '96 mission before the mission was canceled. Society-funded rover tests in Death Valley, California helped pave the way for NASA's Mars Sojourner rover. Our Mars Microphone flew on NASA's Mars Polar Lander in 1999, becoming the first crowdfunded science experiment to fly to another planet. Sadly, Polar Lander crashed on the surface.

Planetary Society members support testing of a Mars Balloon slated to fly on the Soviet Union's Mars '96 mission. Although the mission is canceled, the Mars Balloon effort leads to the Society's role in helping to develop rover technology.

The Planetary Society sponsors Mars rover tests in California's Death Valley.

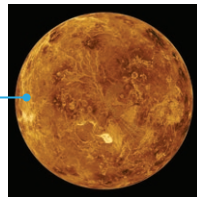


1990



Before permanently powering down its cameras, Voyager 1 turns around and takes a portrait of our solar system, capturing Earth as a pale blue dot scattered in sunlight. Carl Sagan's moving description of the image becomes forever associated with it.

1991



NASA's Magellan spacecraft arrives at Venus to map the surface with radar, revealing the first detailed global look beneath the planet's clouds.
NASA/JPL

1992



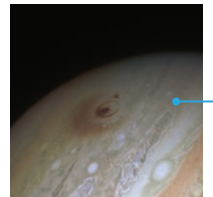
Mae Jemison becomes the first Black woman to travel in space.

1993

Astronauts aboard Space Shuttle Endeavour repair the Hubble Space Telescope.

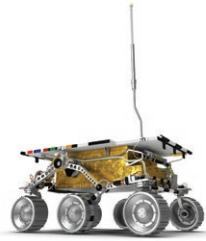
Contact is lost with NASA's Mars Observer spacecraft just before arrival, facilitating the formation of the agency's Mars Exploration program. Decades of successful Mars exploration occur as a result.

1994



Comet Shoemaker-Levy 9 slams into Jupiter, marking the first time humans have watched an object strike another world. The incident provides a sobering reminder that such objects can similarly impact Earth.

DATA: H. HAMMEL, MIT, AND NASA. PROCESSING: JUDY SCHMIDT.

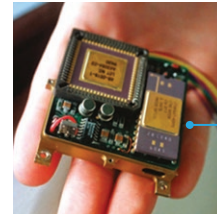


A Society expedition sends members to Belize to search for evidence of the Chixculub asteroid impact that wiped out the dinosaurs.

NASA's Pathfinder spacecraft launches to Mars carrying Sojourner, a rover named through a Planetary Society contest. The Pathfinder lander also contains a "microdot" with the names of 100,000 Planetary Society members.

Planetary Society cofounder Carl Sagan dies at age 62.

Planetary geologist Gene Shoemaker, an early advocate for near-Earth object sky surveys, dies in a car accident. The Planetary Society establishes the Shoemaker Near-Earth Object Grant program in his honor to fund astronomers who discover and characterize asteroids that might threaten Earth. To date, Society members have funded 62 grants totaling \$440,000.



The Mars Microphone, funded entirely by Planetary Society members, launches to Mars aboard NASA's Mars Polar Lander. The spacecraft crashes on arrival.

Seed funding from The Planetary Society helps launch SETI@home, a global program allowing anyone to donate spare computer power to the search for radio signals from intelligent life. Millions of people would participate in the program until its end in 2020.

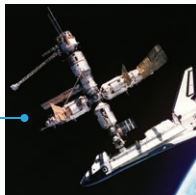
1995

NASA's Galileo spacecraft arrives at Jupiter.

Scientists confirm the first existence of an exoplanet orbiting a Sun-like star.

1996

Russian Valeri Polyakov sets the record for the longest single trip in space: 438 days.



A new era of U.S. and Russian space cooperation begins with the Shuttle-Mir program, for which Russians ride on the Space Shuttle, and the shuttle begins visiting Mir. The program paves the way for the International Space Station.

1997



NASA's Pathfinder spacecraft lands on Mars and successfully deploys the Sojourner rover. It is the first successful U.S. Mars mission in 21 years. NASA names the landing site the Carl Sagan Memorial Station.

NASA/JPL

1998

NASA's Cassini spacecraft launches to Saturn.

Russia launches the first module of the International Space Station, Zarya.

1999

Eileen Collins becomes the first woman to command a Space Shuttle flight.

The 1990s end with Space Shuttle Discovery landing on 28 December 1999, allowing NASA to power off all Space Shuttles before New Year's Eve in case of Y2K software glitches.

The 2000s

The new millennium began with a strong outlook for planetary exploration. Although NASA launched no new high-cost flagship missions, more than 10 spacecraft began journeys to other worlds. Half were Mars-bound. The Spirit and Opportunity rovers, named through a contest implemented by The Planetary Society, would far exceed their design lifetimes on Mars, while New Horizons, the product of a new midcost NASA mission program, blasted off for Pluto. The Planetary Society fought tirelessly to get a Pluto mission to the launch pad. The Society's Red Rover Goes to Mars program

sent 16 students to JPL to work in mission operations for Spirit and Opportunity, while our Visions of Mars project sent a DVD library to Mars aboard NASA's Phoenix lander in 2007. It remains there, waiting for retrieval by future astronauts. We also attempted a space mission of our own in 2005; Cosmos 1 would have been the world's first solar sail spacecraft had the Russian rocket carrying it not failed. The loss of Cosmos 1 led to LightSail, a pair of crowdfunded spacecraft that would demonstrate the power of solar sailing for small, standardized satellites called CubeSats.

Planetary Radio, the Society's weekly radio show hosted by Mat Kaplan, premieres. Episodes from the show's entire history can be found on our website.



The Society provides outreach for NASA's Mars Exploration Rover mission by teaming with LEGO to create the Red Rover Goes to Mars program. Among other accomplishments, the program sends students to work on rover missions at JPL. One student, Abigail Fraeman, ends up becoming the deputy project scientist for the Spirit and Opportunity rovers.

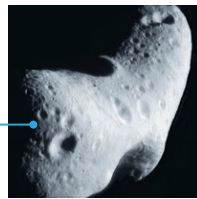
The NASA and European Space Agency (ESA) Cassini-Huygens mission arrives at Saturn, bearing a CD containing handwritten signatures of Planetary Society members and supporters.

2000



Expedition 1, the first long-duration mission to the International Space Station, begins with a joint Russian-American crew. The station has been occupied continuously ever since.

2001



NASA's NEAR spacecraft lands on asteroid Eros.
NASA/JHU-APL

2002

China performs its first human spaceflight as Yang Liwei reaches orbit aboard Shenzhou 5.

Space Shuttle Columbia disintegrates during atmospheric reentry, killing all 7 crew members.

2003

NASA's Spirit and Opportunity rovers land successfully on Mars. They far exceed their 90-day design lifetimes; Spirit's mission formally ends in 2010, while Opportunity's ends in 2019.

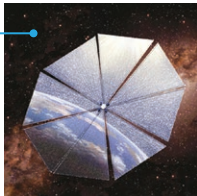
ESA sends its first spacecraft, SMART-1, to lunar orbit.

2004

The joint NASA-ESA Cassini-Huygens mission arrives at Saturn.

SpaceShipOne becomes the first private vehicle to carry humans beyond the boundary of space.

ESA's Rosetta spacecraft launches to comet 67P/Churyumov-Gerasimenko.



Cosmos 1, The Planetary Society's first solar sail mission, launches from a Russian Volna rocket but fails to reach orbit.

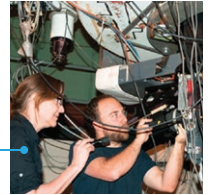
In partnership with Harvard University, The Planetary Society sponsors a new telescope dedicated to an optical SETI search, looking for light signals from intelligent beings.



NASA's Phoenix spacecraft lands on Mars with our archival disc containing names of Planetary Society members and supporters, a library of fiction and nonfiction books, artwork, and essays about Mars.
NASA/JPL/UNIVERSITY OF ARIZONA

On what would have been Carl Sagan's 75th birthday, The Planetary Society announces LightSail, a program to demonstrate the power of solar sailing for small, standardized satellites called CubeSats.

The Planetary Society cosponsors the Planetary Defense Conference in Granada, Spain. To date, we have cosponsored conferences in Romania, Italy, Tokyo, and the U.S.—all in service of defending our planet from dangerous asteroids and comets.



The Society begins funding exoplanet programs led by Yale's Debra Fischer, leading to improvements in the way scientists search for planets around other stars.

2005

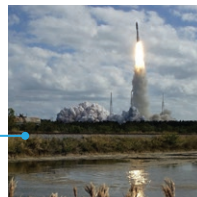
NASA's Deep Impact spacecraft hurls an impactor into comet Tempel 1, ejecting a plume of ice and dust that allows scientists to peer beneath the surface of a comet.



After separating from Cassini, Huygens lands on Saturn's moon Titan and captures the first images from the surface.

NASA/JPL/ESA/UA

2006



NASA's New Horizons spacecraft launches to Pluto with a CD of 430,000 names that includes a Planetary Society member roster.

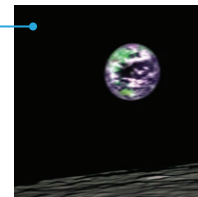
NASA's Stardust mission returns particles from the coma of a comet to Earth. Both the spacecraft and the return capsule contain the names of Planetary Society members.

2007



Chang'e-1 becomes China's first planetary mission beyond Earth orbit.
XINHUA

2008



India's first planetary mission, Chandrayaan-1, arrives in lunar orbit.

2009

NASA's Lunar Reconnaissance Orbiter (LRO) launches to the Moon to collect detailed high-resolution surface images. Its rocket stage and a second spacecraft are intentionally smashed into the Moon, creating a debris plume that allows scientists to look for water.

The 2010s

The 2010s began with a changing of the guard as cofounder Lou Friedman retired and was succeeded by CEO Bill Nye, The Science Guy—a Society charter member who was inspired by Carl Sagan when he took one of Sagan’s astronomy classes at Cornell University. In 2015, The Planetary Society’s LightSail 1 spacecraft successfully tested its solar sail deployment mechanism in space. Four years later, LightSail 2 launched aboard a SpaceX Falcon Heavy rocket and used sunlight alone to change its orbit, demonstrating the feasibility of controlled solar sailing for small spacecraft.

Hastened by the economic crisis of 2008, the 2010s would see NASA’s budget bottom out at lows not seen since shortly after The Planetary Society’s founding. We undertook multiple advocacy campaigns to keep NASA’s planetary exploration program from stalling, including years of advocacy that helped get NASA’s Europa Clipper mission approved in 2015. By the end of the decade, NASA and planetary exploration budgets were once again on the rise.

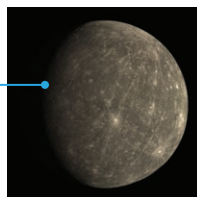
- Planetary Society members begin funding an asteroid deflection technology named Mirror Bees, later to be known as Laser Bees.
- Lou Friedman retires as The Planetary Society’s executive director, and Bill Nye takes the helm as CEO.
- A Planetary Society experiment called LIFE is sent to space and back during Space Shuttle Endeavour’s last flight. LIFE, the Living Interplanetary Flight Experiment, tested the idea that a living organism might survive a journey through space to Earth inside a meteorite.
- Planetary Society funding helps scientists figure out why Pioneer 10 and 11 are slowing down slightly as they head out of the solar system—a phenomenon known as the Pioneer Anomaly.
- Planetary Society cofounder Bruce Murray dies at the age of 81.
- Funding begins for Exoplanet Laser, a cutting-edge calibration system used by telescopes searching for Earth-sized planets around other stars.
- The Planetary Society announces 2 launches for its LightSail program: one in 2015 and another scheduled for 2016.

2010

Space Shuttle Atlantis flies the program’s final mission. No crewed orbital vehicles would launch from the U.S. until 2020—the longest such gap in history.

2011

NASA’s Dawn spacecraft becomes the first orbiter of a main-belt asteroid.



NASA’s MESSENGER probe becomes the first spacecraft to enter orbit at Mercury.
NASA/JHUAPL/CIW/COLOR
MOSAIC BY JASON PERRY

2012

Liu Yang becomes the first Chinese woman to fly in space, launching aboard Shenzhou 9.

NASA’s Curiosity spacecraft lands on Mars using a new entry, descent, and landing sequence that includes a rocket-powered “skycrane” that lowers the rover to the ground via nylon cables.

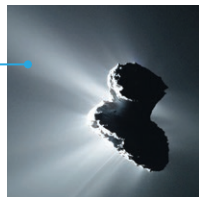
2013

NASA reactivates its WISE spacecraft as NEOWISE and gives it a new mission to detect, track, and characterize moving solar system objects, including potentially dangerous near-Earth asteroids.

Virgin Galactic’s SpaceshipTwo spaceplane breaks apart over California’s Mojave Desert, killing one crew member and injuring the second.

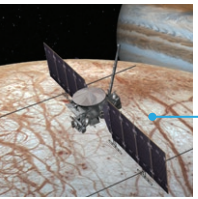
India’s first Mars mission, Mangalyaan, arrives safely in orbit.

2014



ESA’s Rosetta probe becomes the first spacecraft to orbit a comet. Its lander, Philae, unintentionally bounces upon impact and is later found resting in a crevice.

ESA/ROSETTA/MPS FOR OSIRIS TEAM
MPS/UPD/LAM/IAA/
SSO/INTA/UPM/
DASP/IDA/JACINT
ROGER PÉREZ/EMILY
LAKDAWALLA



After years of Planetary Society advocacy, NASA officially commits to a dedicated Europa mission.
NASA/JPL-CALTECH

Planetary Deep Drill, a Society-sponsored technology for collecting samples from deep beneath planetary surfaces, is successfully tested in a California gypsum quarry.

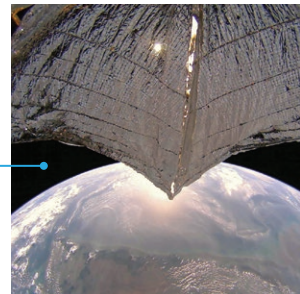
LightSail 1 deploys its solar sail in Earth orbit and completes a successful test flight.



Testing for Honeybee Robotics' PlanetVac, a Society-sponsored sample collection technology, occurs in California's Mojave Desert aboard a Masten Xodiac rocket. NASA has since selected PlanetVac for inclusion on a future lunar mission.

The Society helps form the Planetary Science Caucus, a bipartisan coalition of U.S. congressional members who advocate for NASA's planetary exploration work.

The Planetary Society organizes its first annual Day of Action, which brings nearly 100 members from across the U.S. to Washington, D.C. to speak with their congressional representatives about supporting space exploration.



LightSail 2 becomes the first spacecraft to demonstrate controlled solar sailing in Earth orbit.

2015

2016

2017

2018

2019

NASA astronaut Scott Kelly and Russia's Mikhail Kornienko begin a 1-year mission aboard the International Space Station.

Russia's Gennady Padalka sets the record for the most cumulative time in space at 879 days, accumulating the time during 5 different stays on Mir and the ISS.



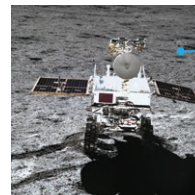
NASA's New Horizons spacecraft flies past Pluto, turning what was before a blurry smudge of light into a complex world with icy dunes, plains, and mountains.

NASA/JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY/SOUTHWEST RESEARCH INSTITUTE/ALEX PARKER

NASA announces that 2 microphones will fly on its Mars Perseverance Rover. The Planetary Society began advocating for and working on early Mars microphones in 1996.

NASA astronaut Peggy Whitson sets the record for the most cumulative time in space—more than 665 days—by an American and by a woman. She racks up the time during 3 stays on the ISS, and during one, she is its first woman commander.

Israel and India attempt robotic lunar landings, but both spacecraft crash during their final descents to the surface.



China's Chang'e-4 spacecraft and Yutu-2 rover complete the first landing on the far side of the Moon.
CHINESE NATIONAL SPACE AGENCY (CNSA) AND CHINESE ACADEMY OF SCIENCES (CAS)

NASA formally establishes a planetary defense program within its planetary science division. The program supports both ground-based near-Earth object detections and missions to test deflection and detection capabilities.

The 2020s



The Planetary Society began the 2020s with an operational spacecraft in orbit. To celebrate LightSail 2's first year in space, we announced an extended mission dedicated to further advancing solar sail technologies. The mission team will continue tuning the spacecraft's performance, will investigate using the solar sail to intentionally generate drag, and will share mission results with the public. Soon, we will begin to accept proposals on our next crowdfunded sci-tech project.

The 2020s have the potential to be one of the most exciting decades ever for planetary exploration. NASA's Perseverance rover will directly search for signs of past life on Mars, something the agency has not done since the 1970s Viking missions. NASA's Europa Clipper and ESA's JUperiter ICy moons Explorer (JUICE) missions will explore the habitability of Jupiter's icy moons. NASA and its international partners are planning to return humans to the Moon.

The Planetary Society's latest strategic framework sets ambitious new goals to advance space science and exploration and truly make space for everyone, but our core vision as spelled out by Lou Friedman, Bruce Murray, and Carl Sagan 40 years ago has not changed. We will explore new worlds, search for life, and defend our planet from asteroids. **Let's go!**

2020

NASA's OSIRIS-REx spacecraft collects a sample of asteroid Benu for return to Earth.

China launches its Chang'e-5 lunar sample return mission in December. It is the first mission to return samples from the Moon since the 1970s.

Japan's Hayabusa2 spacecraft returns its samples of asteroid Ryugu to Earth in December.

2021

A fleet of spacecraft launched by the United States, China, and the United Arab Emirates arrive at Mars.

China launches the first module of its new Tianhe space station.

Private company SpaceX launches 2 NASA astronauts to the International Space Station.

2022

NASA's Lucy mission launches on a 12-year journey to visit 8 asteroids.

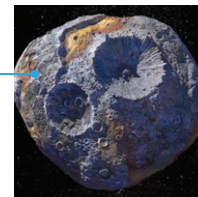
NASA launches the James Webb Space Telescope, a multipurpose observatory that will, among other things, scan the atmospheres of planets orbiting other stars.

NASA's first Space Launch System (SLS) rocket launches, sending the Orion crew capsule to lunar orbit and back. SLS and Orion are cornerstones of the agency's Artemis moon-landing program. One of the mission's secondary payloads is NEA Scout, a solar-sail-propelled spacecraft that will visit a nearby asteroid.

2023

OSIRIS-REx returns to Earth carrying samples of asteroid Benu.

ESA's ExoMars Rosalind Franklin rover launches to Mars.



NASA launches Psyche, a mission to a metal asteroid believed to be the exposed core of a protoplanet.
MAXAR/ASU/P. RUBIN/
NASA/JPL-CALTECH

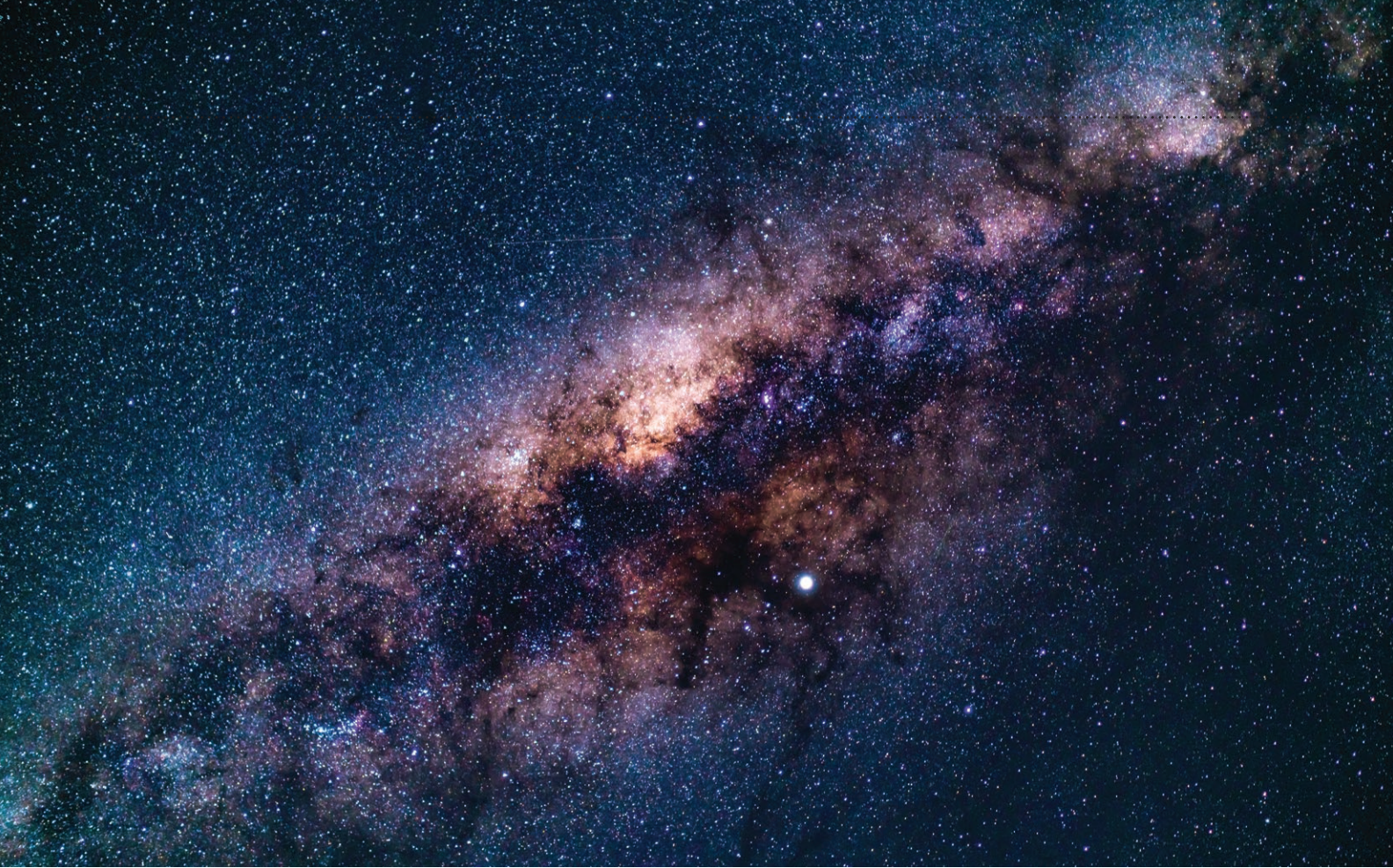
ESA's JUICE spacecraft launches to Jupiter.

2024

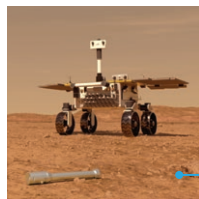
Japan's MMX (Martian Moons Exploration) spacecraft launches to survey Mars' moons and to collect a sample from Phobos.

NASA lands the first woman and next man on the Moon under a 2019 directive from the Trump administration. The highly aspirational date is likely to slip.

NASA launches the Europa Clipper mission in the mid-2020s. The exact date depends on which launch vehicle the agency selects.

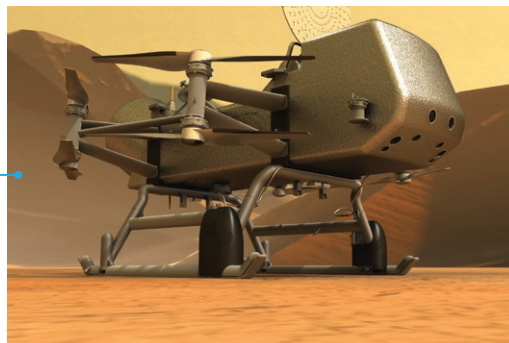


2025



NASA and ESA launch 2 missions to Mars to retrieve the samples collected by NASA's Perseverance rover for return to Earth.
NASA/JPL-CALTECH

2026



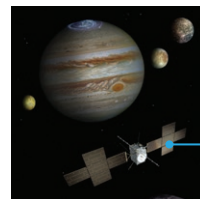
NASA's Dragonfly spacecraft launches on a mission to Saturn's moon Titan. The flying motorcraft will land in 2034.
JOHNS HOPKINS APL

Psyche arrives at its same-named metal asteroid, Psyche.

2027

2028

2029



JUICE arrives at Jupiter to begin a 3-year survey of Ganymede, Callisto, and Europa.
SPACECRAFT: ESA/ATG MEDIALAB; JUPITER: NASA/ESA/J. NICHOLS (UNIVERSITY OF LEICESTER); GANYMEDE: NASA/JPL; IO: NASA/JPL/UNIVERSITY OF ARIZONA; CALLISTO AND EUROPA: NASA/JPL/DLR



Pavel Gabzdyl,
Space Odyssey

In this issue of *The Planetary Report*, we look back over 40 years of exploration and forward to what is to come.

This piece of artwork by Planetary Society member Pavel Gabzdyl, a science communicator from Brno Planetarium in the Czech Republic, gives the feeling of gazing through time and space. From a distance, we look out upon our home planet and beyond.

The overwhelming feeling is one of awe, wonder, and appreciation.

As we look back over our organization's history and forward to the future of exploration, we feel the same. Thank you to all of our members and supporters who have made this possible. We look forward to enjoying the next decades of exploration alongside you.

Do you want to see your artwork here? We love to feature our members throughout this magazine. Send your original, space-related artwork to connect@planetary.org.