



THE PLANETARY SOCIETY

THE PLANETARY REPORT

DECEMBER
SOLSTICE **2022**

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THE YEAR IN PICTURES

LOOKING BACK –
AND BEYOND

THE COSMOS IS WORTH THE WAIT

Appreciating images that take years (even billions of years) to get to us

by Bill Nye

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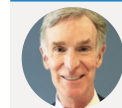
WE'VE BEEN WAITING a long time for images like the one that graces the cover of this issue. If you're young, you've been waiting your whole life. The James Webb Space Telescope (JWST) captured this image shortly after it was launched into deep space and began operations after more than a quarter-century of planning and development. That may have felt like a long time to those of us following and supporting the mission, but it's barely a blip along the breadth of the cosmic timeline. The photons in the cover image came from distant galaxies that traveled 13 billion years to reach the telescope's sensors.

Developing brand-new technologies to do things in space that we've never done before takes time. Guiding a spacecraft millions of kilometers through space takes time ... and patience. That's the easy part. What it really takes is the commitment from governments and space agencies — and from the citizens who put them in place. That's why The Planetary Society is here. Members like you work to make sure that missions like JWST get the funding and support they need to make it to the launch pad. And once those missions are out there enabling exploration and discovery, we're here to make sure people hear about their discoveries and get excited about future missions.

JWST is just getting started, and the returns on this investment are already obvious. Have a look inside this issue. I am confident that you'll find JWST photos in every "Year in Pictures" issue of this magazine for decades to come. Wouldn't it be something if a few of those images prove that planets orbiting other stars show signs of life? It's a discovery that would change the world.

Life is almost certainly out there on other worlds, and with tools like JWST and the many other missions for which we advocate, we are bound to find it. Thank you all for your ongoing support. Please be proud of your contributions. You've enabled missions like JWST to send beautiful and evocative images to us here on Earth. Carl Sagan reminded us that we are the product of stars, the dust of the Cosmos. That means you and I, as space explorers, are a way for the Cosmos to know itself. It fills me with joy and awe. Thank you. 🌌

Bill Nye



BILL NYE is chief executive officer of The Planetary Society.

EDITOR'S NOTE: In our September Equinox 2022 issue, an infographic listed Uranus as the last planet to be discovered in our Solar System. That designation belongs to Neptune. We regret the error.

ON THE COVER: This dazzling, time-traveling deep-field image from JWST was the telescope's first publicly released science image. It is the deepest infrared image of the Universe to date, showing light that has traveled around 13 billion years to reach us. *Image: NASA/ESA/CSA/STScI* * 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 the 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. ©2022 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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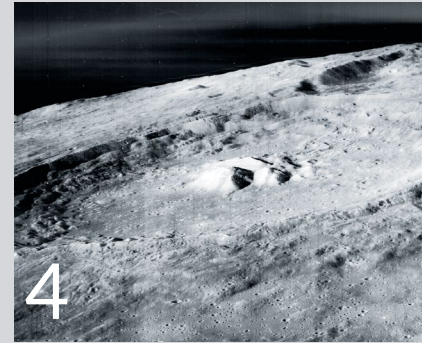
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The Pillars of Creation are set off in a kaleidoscope of color in NASA's James Webb Space Telescope's near-infrared-light view. The pillars look like arches and spires rising out of a desert landscape but are filled with semitransparent gas and dust and are ever changing. This is a region where young stars are forming or have barely burst from their dusty cocoons as they continue to form.

NASA/ESA/CSA/STScI/IMAGE PROCESSING:
JOSEPH DEPASQUALE (STScI)/ANTON M.
KOEKEMOER (STScI)/ALYSSA PAGAN (STScI)

GOING THE DISTANCE TO GET THE SHOT

A brief history of space imaging

by Kate Howells

THESE DAYS, IT'S so quick and easy to take and share photos that we don't even give it a second thought. With a tap of the finger, you can snap a high-resolution picture, send it to a friend, post it online, or even have it printed.

Most of us probably take for granted that spacecraft can send images like the ones featured in this magazine back to Earth just as easily. But space imagery long predates digital photography. So, how did we get photos from space to Earth back then?

The very first photos of Earth from space were taken in 1946 with the same basic technology used by ordinary people at the time: a camera with film. The camera was sent to the edge of space by a group of

The earliest deep-space probes also took photos on film, but because they couldn't return them to Earth for developing, the imaging teams had to use a bit more ingenuity. The NASA lunar orbiters of the 1960s had ingenious equipment on board to take film photos, then develop the negatives, and then mechanically scan them one line at a time to create an electrical signal. The signal strength varied according to how bright each spot on the image was — a process similar to that used in early fax machines. This codified signal could then be transmitted back to Earth via radio for reassembly as an image by the scientists on the ground.

THIS PAGE The Viking lander imaging team members have some fun with its panoramic camera during testing on Earth. Taking advantage of the camera's slow sweep, some members of the team appear multiple times.

NASA/TIM MUTCH



OPPOSITE TOP This image of Theophilus crater on the Moon was captured by the Lunar Orbiter 3 spacecraft in 1967.

NASA

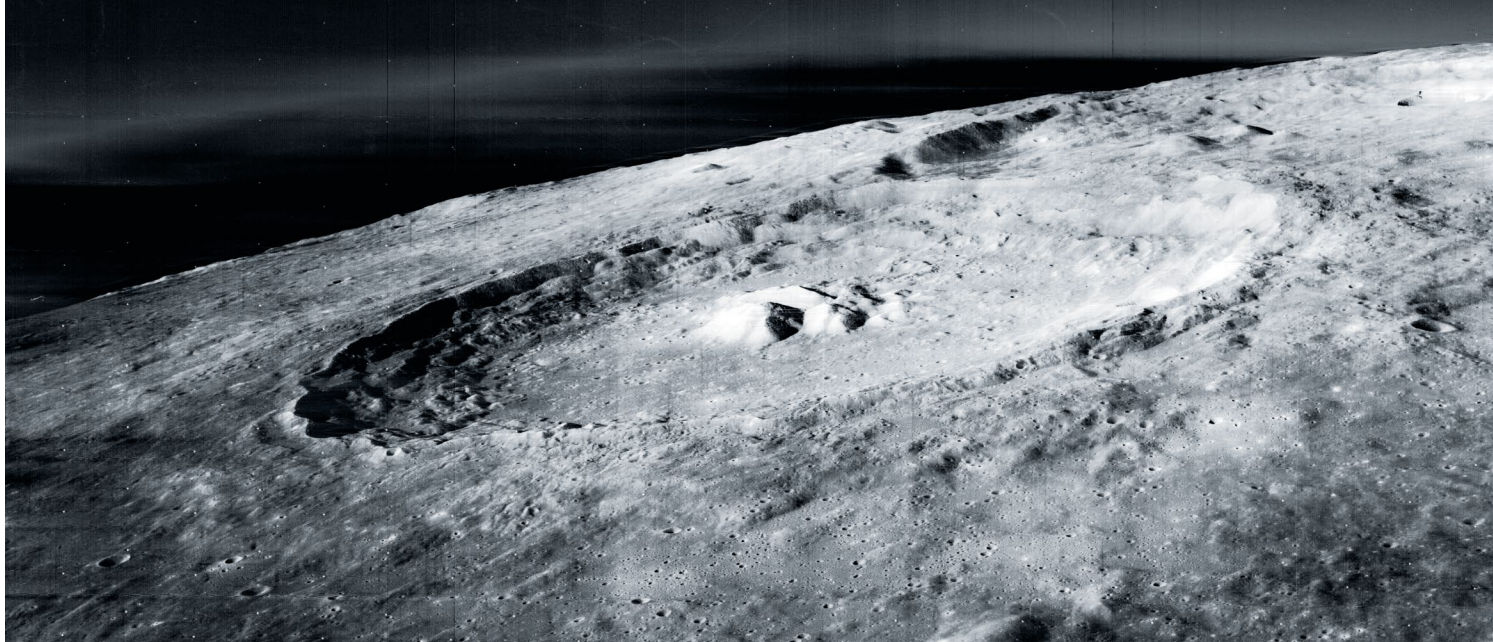
OPPOSITE BOTTOM Earthrise, one of the most iconic images of Earth ever taken from space, was shot by Apollo 8 astronaut William Anders on 70-millimeter color film.

NASA/WILLIAM ANDERS

soldiers and scientists in a durable steel case aboard a decommissioned missile on a suborbital trajectory. After taking photos, the capsule containing the camera crash-landed back on Earth, and the film was retrieved to be developed in a lab using the chemical process we still use to develop film today.

Likewise, Apollo astronauts used specialized cameras to take photos using traditional film that was developed in labs back on Earth. Even early spy satellites carried enormous spools of specialized Kodak film. When the film was full, the satellite would drop the spool in a heat-shielded reentry capsule equipped with a parachute. A plane would then fly by and scoop up the capsule in midair.

In the 1970s, the imaging team behind the Viking landers developed a technique that didn't require film at all. Light entered the camera through a vertical slit, bouncing off a movable mirror through a set of lenses to 12 diodes that were sensitive to different frequencies of light, including optical and infrared. The diodes translated what they sensed into electronic impulses that were transmitted back to Earth. To take an entire photograph, the camera's mirror would gradually pan from left to right, capturing the entire view in individual vertical strips. This was a slow process; the Viking cameras could only take five vertical line scans per second. A typical 300-degree



panorama consisted of 9,150 such lines, taking about half an hour to capture.

The Viking imaging team had some fun with this slow process while testing the cameras on Earth. While taking a group photo, some of the team members waited until the camera passed them in its slow sweep and then quickly ran around behind it to take their place for a second portrait. In the image at left, Tim Mutch, leader of the Viking lander imaging team, actually appears seven times.

Space missions in the 1970s and '80s generally used some form of direct digital imaging similar to Viking, but many still made use of analog systems in the process. The twin Voyager spacecraft were able to take up to 1,800 images per day but couldn't transmit them back to Earth at that same rate; they had to store image data on eight-track tape recorders that could be rewound and played back to transmit the data later. Modern spacecraft — even as far back as the Hubble Space Telescope, which launched more than 30 years ago — can do all of their imaging entirely digitally and can then transmit data back to Earth via radio signals.

Advances in technology for imaging, data storage, and transmission have worked wonders for space exploration, and today, we're accustomed to enjoying crisp, clear images sent back to Earth without delay. But it's worth remembering how far space imaging has come and what it was able to achieve even in its humble



beginnings. After all, some of the most iconic space images ever taken were captured on good old-fashioned film.

Because of this, the classic image of Earth shown above wasn't published until roughly a week after Apollo 8 had returned to Earth. 🌕



KATE HOWELLS is public education specialist for *The Planetary Society*.

AWE AND AMAZEMENT

WHEN JWST RELEASED its first set of science images, we shared a survey in our weekly Downlink email newsletter asking Planetary Society members to share their reactions. Here is a selection of the many excellent responses we received.

Shock and awe! The images are amazing. They brought tears to my eyes. The accomplishments of our species are grand, and this is proof of what we can do if we work together. I'm so excited to see what new discoveries are to come! [Jaclyn Harder, USA](#)

Absolutely flabbergasted, wow of my life. I always adored the great things coming from Hubble, and Webb takes this so many steps further. What a privilege to be alive in these times! [Mark Silk, Germany](#)

After I marveled at the sublime beauty (as I always do with deep-space images), I couldn't help but imagine how many alien worlds, life forms, and civilizations are in those galaxies today. As far as the overall mission, I am most curious about the study of extra solar planets in our own galaxy. Hopefully, we will soon have confirmation of what we already suspect: that we are not alone. [Derek Wilson, USA](#)

Hubble blew us all away with breathtaking images that we couldn't have dreamed of before. To think that JWST's images will be scaled up to an even higher level of spectacular is just mind-boggling. The first images have already wowed us, and I am very excited to see more and await new discoveries. [Michael Crouch, U.K.](#)

As an artist whose favorite subjects to paint are galaxies and nebulae, this opens up a whole new world for my art. The Hubble images are fantastic, but the rich detail of the Webb telescope images is stunning. I look forward to painting the more detailed subjects and those lovely six-pointed stars. [Alexandria Wagner, USA](#)

JWST is a dream come true after so many years. I am eager to learn about the Universe in a more accurate way — a new window for the future of science and exploration. [Fernando González Valadez, Mexico](#)

I am astonished at everything associated with the JWST, starting with the original idea through all the design, build, and testing (all extremely demanding); the launch; accurately positioning it in space; deployment of the sunshield and the mirror segments; alignment and testing on station (unbelievably complex); and then acquisition of the first images. To be able to see and analyze things so far away and so long ago is simply breathtaking. I can hardly wait to see what revelations will come from it and to hear what experts can deduce from them. Congratulations to everyone involved, which sounds like such a weak thing to say in the face of all that has been achieved, but I've honestly run out of vocabulary to express my admiration. [Alan Turk, U.K.](#)

It was like hearing my child's first word clearly spoken. Certainly wonderful, but the door she just stepped through and the vast potential before her was startling to contemplate. I await the manifestation of that potential. [John Utley, USA](#)



Awe, happiness, and wonder. I was 4 years old when the Hubble Space Telescope was fixed and began its now-famous 30+ year journey to study the Universe. As I grew up, I can recall following along as Hubble released picture after picture cataloging our Universe while helping us understand dark matter, black holes, and the age of the Universe. My children are currently 4 and 6 years old, and I am grateful to know that they will grow up alongside the James Webb Space Telescope. That they will get to experience the wonder and excitement I enjoyed as Webb shares incredible cosmic views and makes discoveries we have yet to realize. [Joshua Harris, USA](#)

ABOVE LEFT *Every eight years, the two stars in this image are brought together by their orbits, creating colliding streams of gas that under the right conditions form a new ring of dust. JWST reveals 15 of the 17 rings seen here for the first time.*

NASA/ESA/CSA/STScI/JPL-CALTECH

It's amazing. Not just the "deep field," with those warped images from distant and ancient galaxies, but also the spectra of the exoplanet. And the nebulae. And they colored the infrared images, making them astonishingly beautiful. I hope that the discoveries of the James Webb Space Telescope will bring us a great deal of knowledge about the vast Universe and the stars and planets that inhabit it. [Marcelo Machado de Oliveira, Brazil](#)

ABOVE RIGHT *A pair of entwined galaxies are colliding together 270 million light-years away, creating new stars at a rate of more than 20 times that of our Milky Way. JWST's latest image shines a new light on these interacting galaxies.*

ESA/WEBB/NASA & CSA/L. ARMUS & A. EVANS

In light of current geo-political events, it is good to know that humans can still work together to accomplish great things. These images remind us of how small we are. They remind us that the Universe is a beautiful place. We have only dipped our toes into the Cosmos. What wonders have yet to be discovered? [Terry Lee Steffen, USA](#)

The Year in Pictures

by Rae Paoletta



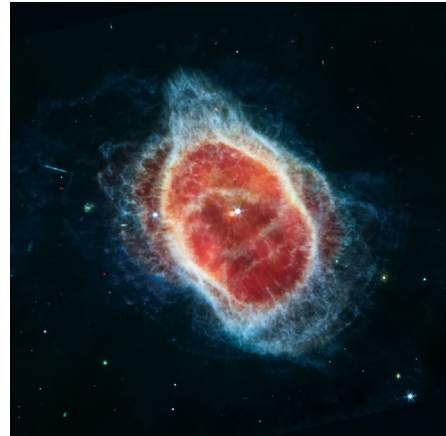
OPPOSITE JWST's Near-Infrared Camera (NIRCam) captured this image of Jupiter. Since infrared light is invisible to the human eye, the light has been mapped onto the visible spectrum. Scientists collaborated with citizen scientist Judy Schmidt to translate the telescope's data into images like this one.

NASA/ESA/CSA/JUPITER ERS TEAM/
IMAGE PROCESSING BY JUDY SCHMIDT



THIS PAGE The Southern Ring, or “Eight-Burst,” nebula is a planetary nebula located about 2,000 light-years from Earth. These side-by-side images show a star’s death — gas emanating from a dying star. Both images were taken by JWST in near-infrared light (left) and mid-infrared light (right).

NASA/ESA/CSA/STScI



SPACECRAFT, TELESCOPES, and rovers are our eyes throughout the Solar System. Thanks to them, the Cosmos has never felt closer.

In 2022, we revisited familiar vistas with a new lens and spotted phenomena previously considered science fiction. This year, the James Webb Space Telescope (JWST) began to “unfold the Universe” as promised, peering billions of years back into the heart of distant galaxies. Juno, Perseverance, BepiColombo, and other missions continued to beam back images of the worlds within our cosmic neighborhood, sparking new ideas and questions about them.

NASA's DART mission was a first-of-its-kind planetary defense effort that ground- and space-

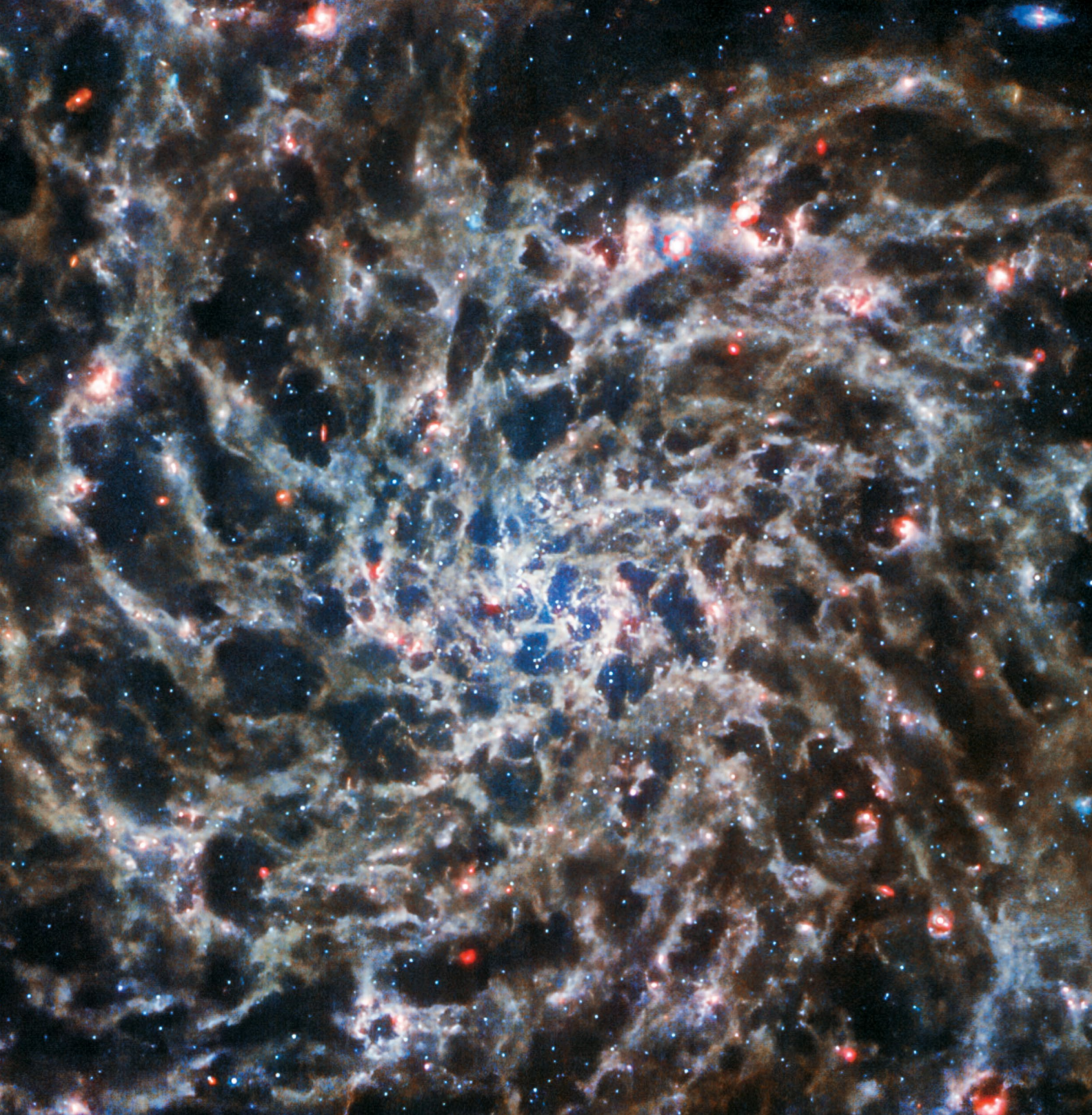
based telescopes — as well as a lone CubeSat — were able to capture in stunning detail. These pictures allow us to preserve that historic moment in which a spacecraft intentionally collided with an asteroid’s moon.

Though there are so many remarkable space images from which to choose this year, we've selected a few of our very favorites. They are so much more than pretty pictures; they are a testament to what is possible when people work to realize a dream together — a steadfast reminder of what Carl Sagan called the “star stuff” that binds us to one another. 🌌



RAE PAOLETTA is the director of content and engagement for The Planetary Society.





OPPOSITE TOP JWST's Near-Infrared Camera (NIRCam) captured this stunning view of the Carina nebula, located about 7,500 light-years from Earth. Nicknamed the "cosmic cliffs," it is essentially a nursery for young stars, some of them several times larger than our own Sun.

NASA/ESA/CSA/STScI

OPPOSITE BOTTOM No need to be afraid of this spider! This star-forming region called the Tarantula nebula is located about 161,000 light-years away in the Large Magellanic Cloud Galaxy. JWST created this mosaic, which extends about 340 light-years across, using its high-resolution infrared images.

NASA/ESA/CSA/STScI/WEBB ERO PRODUCTION TEAM

ABOVE This image of galaxy IC 5332 as taken by the Webb telescope's Mid-Infrared Instrument (MIRI) resembles gray cobwebs in the shape of a spiral. These "cobwebs" are actually patterns of gas spread throughout the galaxy.

ESA/WEBB/NASA & CSA/J. LEE AND THE PHANGS-JWST AND PHANGS-HST TEAMS



TOP This image from the James Webb Space Telescope shows the heart of M74, otherwise known as the Phantom Galaxy. JWST's sharp vision has revealed delicate filaments of gas and dust in the grandiose spiral arms that wind outward from the center of this image. A lack of gas in the nuclear region also provides an unobscured view of the nuclear star cluster at the galaxy's center.

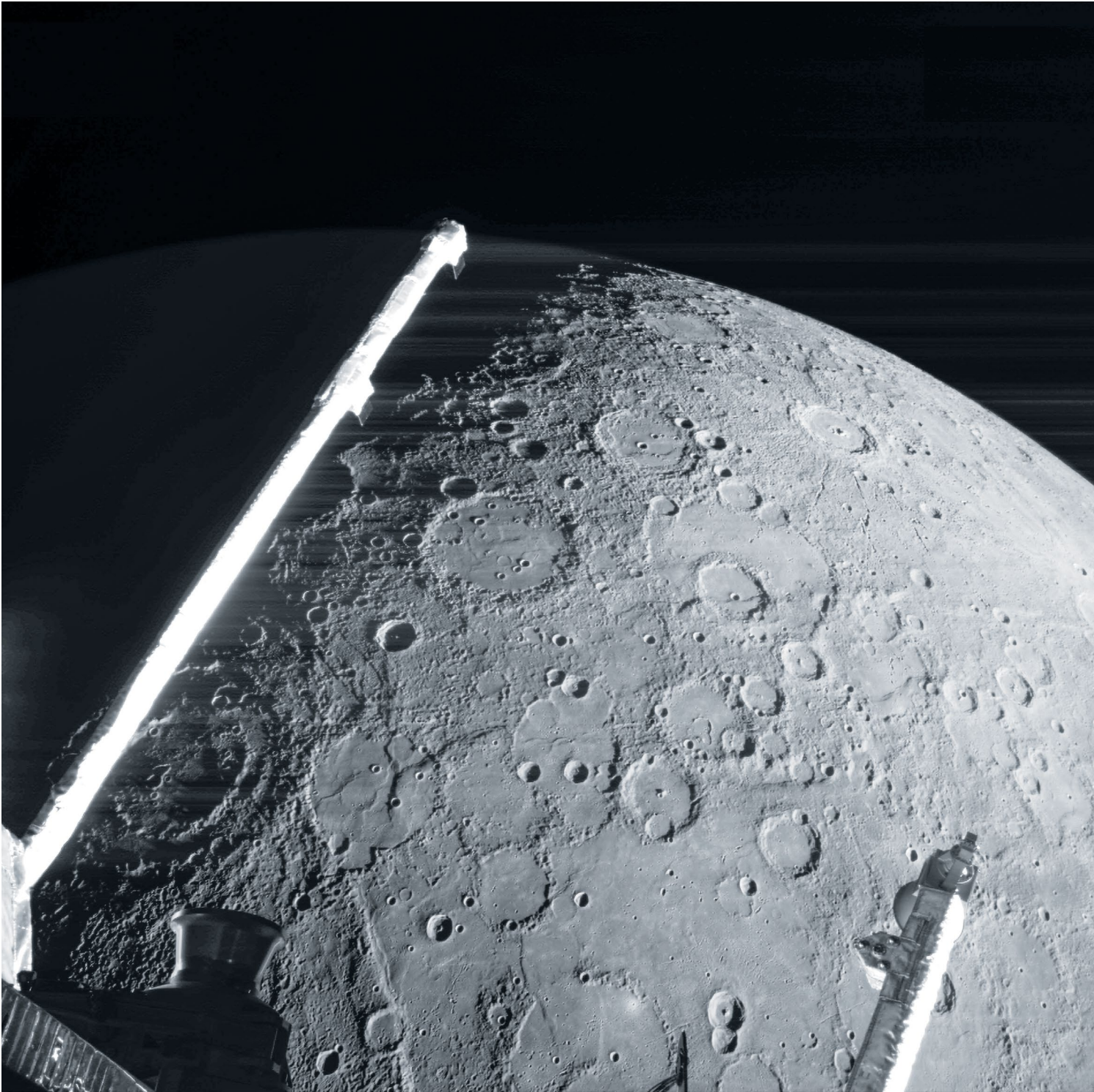
ESA/WEBB/NASA & CSA/J. LEE AND THE PHANGS-JWST TEAM/ACKNOWLEDGEMENT: J. SCHMIDT

LEFT This image of the Cartwheel Galaxy and its companion galaxies is a composite from JWST's Near-Infrared Camera (NIRCam) and Mid-Infrared Instrument (MIRI). NASA released the image on Aug. 2, 2022. The Cartwheel Galaxy formed after a high-speed collision between a large spiral galaxy and a smaller galaxy not visible in this image.

NASA/ESA/CSA/STScI/WEBB
ERO PRODUCTION TEAM

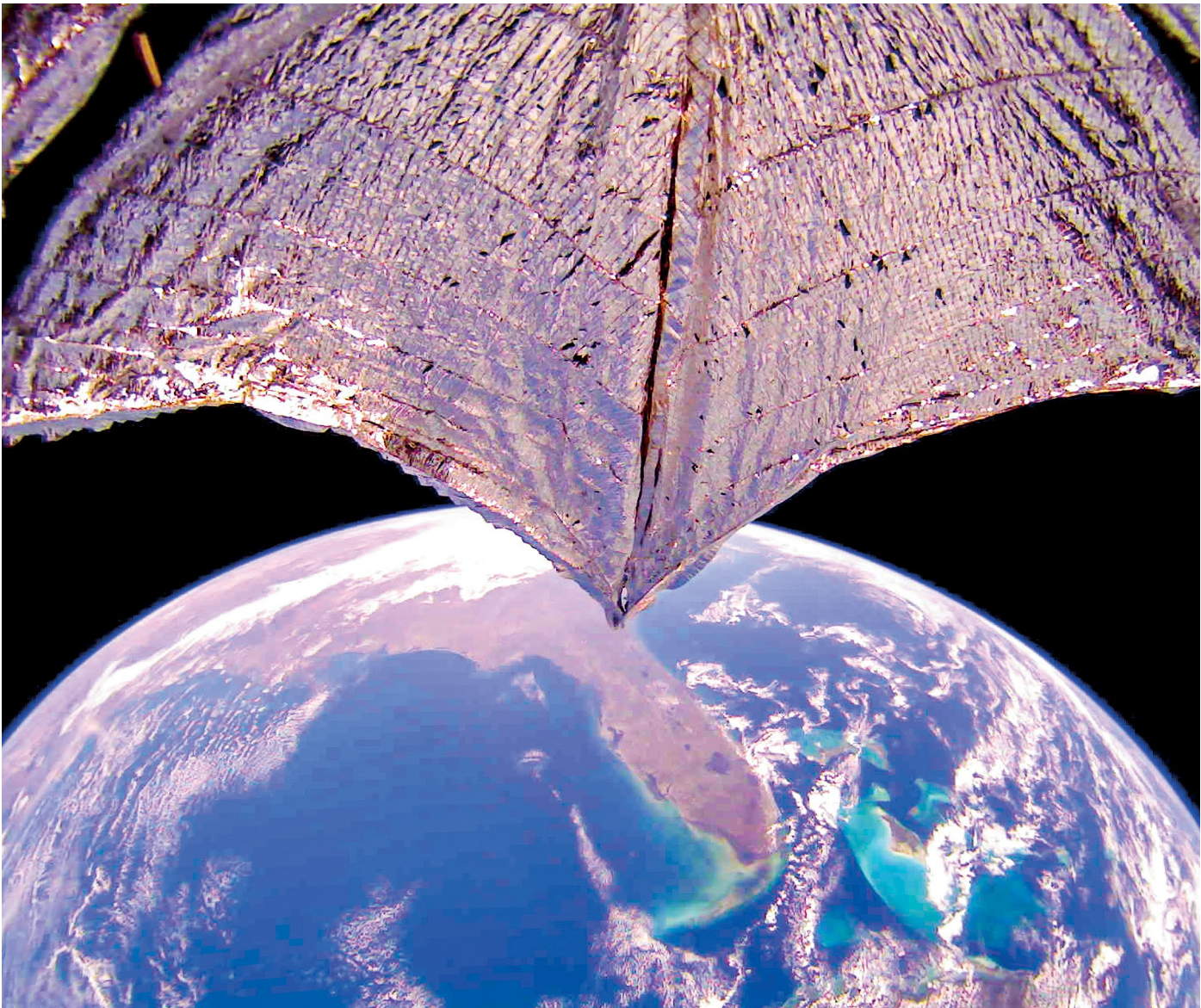
RIGHT Stephan's Quintet is the name given to a visual grouping of five galaxies located about 290 million light-years away in the constellation Pegasus. JWST was able to show shock waves, tidal tails, and more astonishing details about these distant galaxies.

NASA/ESA/CSA/STScI



ABOVE The ESA/JAXA BepiColombo mission captured this image of Mercury during its second flyby of the planet on June 23, 2022. The spacecraft was 920 kilometers (570 miles) from the surface of Mercury when the picture was taken. Parts of the spacecraft are visible in the foreground, including the mission's magnetometer boom on the left.

ESA/BEPICOLOMBO/MTM



OPPOSITE TOP Astrophysicist and rock ‘n’ roll legend Brian May used two slightly different images from JAXA’s Hayabusa2 spacecraft to create this 3D stereoscopic image of asteroid Ryugu. This image is correctly viewed when cross-eyed.

JAXA/UNIVERSITY OF TOKYO/KOCHI UNIVERSITY/RIKKYO UNIVERSITY/NAGOYA UNIVERSITY/CHIBA INSTITUTE OF TECHNOLOGY/MELJI UNIVERSITY/UNIVERSITY OF AIZU/AIST./STEREOSCOPIC CREDIT: CLAUDIA MANZONI, BRIAN MAY

OPPOSITE BOTTOM This image taken by The Planetary Society’s LightSail 2 spacecraft on Dec. 24, 2021 shows Florida and the beautiful waters of the Bahamas. North is approximately at top left. The image has been color-adjusted, and some distortion from the camera’s 180-degree fisheye lens has been removed. Though technically not an image from 2022, we couldn’t help but to include it.

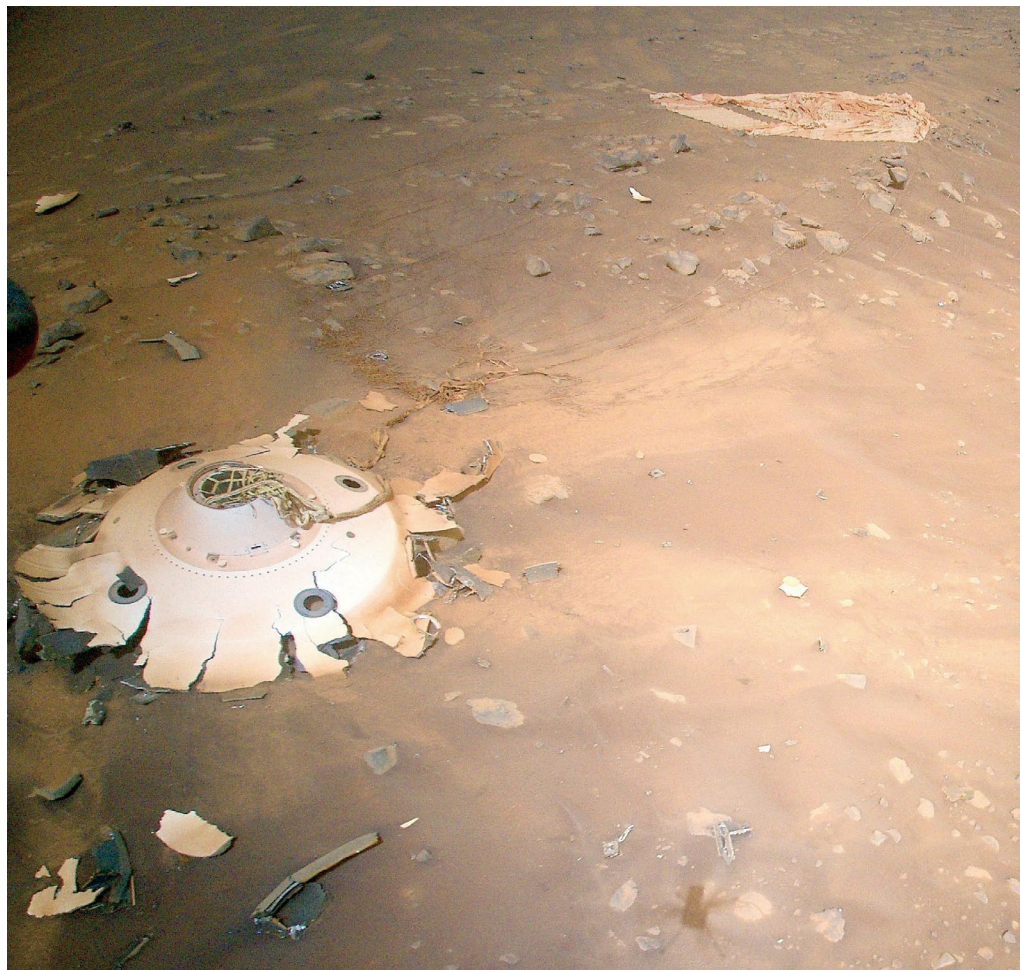
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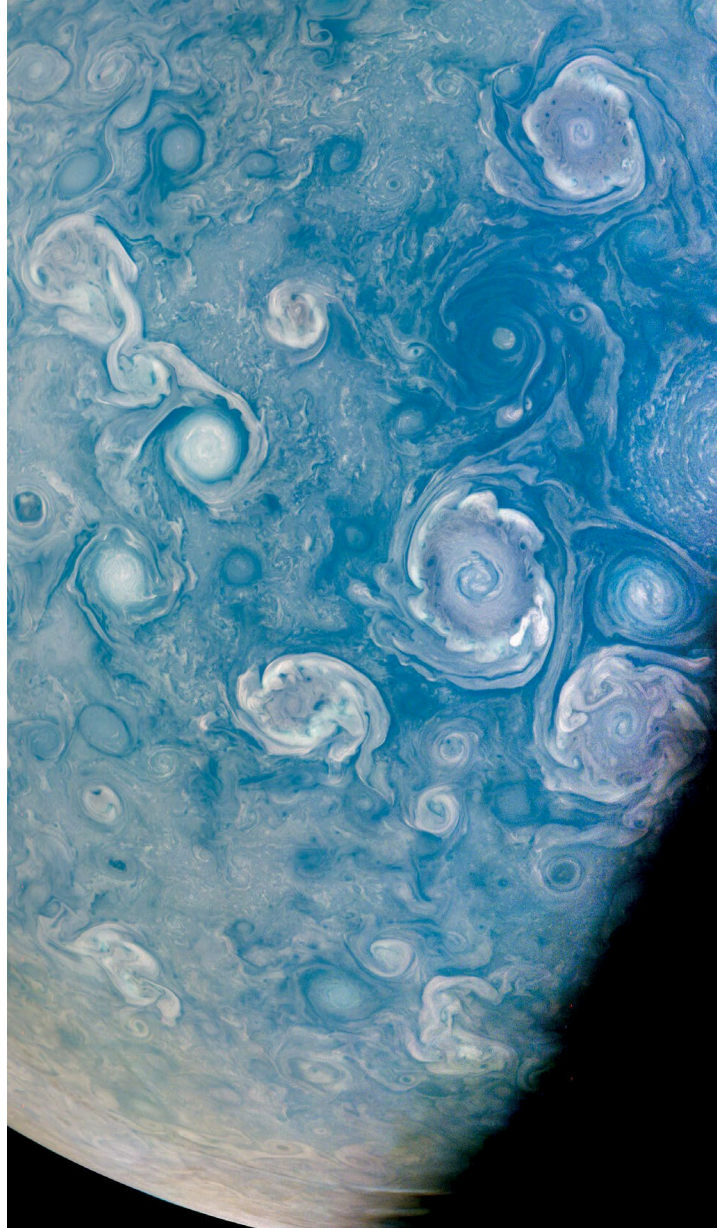
ABOVE RIGHT NASA’s Perseverance rover captured this image of a shiny object that appears alien to Mars. The mission team thinks it’s a piece of thermal shielding that separated from the spacecraft’s rocket-powered, jet-pack-style descent stage, landing about 2 kilometers (1.2 miles) away.

NASA/JPL-CALTECH

BELOW RIGHT During its 26th flight, the Ingenuity Mars helicopter captured this aerial view of the landing gear that safely delivered NASA’s Perseverance rover to the surface of Mars. Mission engineers requested this and other images of the smashed backshell and parachute to learn more about the landing system’s performance to help improve the design for future missions.

NASA/JPL-CALTECH





TOP LEFT In a thrilling moment, DART captured this view of Dimorphos just as it was about to crash into the asteroid moonlet. The transmission ended shortly thereafter.

NASA/JOHNS HOPKINS APL

TOP RIGHT NASA's Juno spacecraft took this image on July 5, 2022 during its 43rd flyby of Jupiter. Its JunoCam instrument saw these vortices near the gas giant's north pole. These vortices appear to be spiraling wind storms.

NASA/JPL-CALTECH/SwRI/MSSS; IMAGE PROCESSING BY BRIAN SWIFT

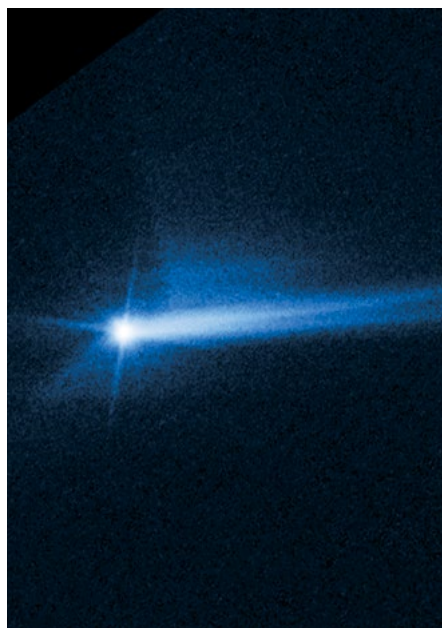
BOTTOM NASA's Juno spacecraft took this image of Europa's icy surface on Sept. 29, 2022 during its flyby of the Jovian moon. This marked the third-ever close pass of Europa and the closest approach since NASA's Galileo in 2000. According to NASA, Juno was about 352 kilometers (219 miles) from Europa at its closest.

NASA/JPL-CALTECH/SwRI/MSSS



KICKSTARTING A NEW ADVENTURE

Thanks to the overwhelming support of our members and backers, we were able to raise just over \$115,000 on Kickstarter to get our brand-new kids' membership program, Planetary Academy, off to a stellar start, with more than 800 new members joining the program! Our team has dreamed about launching a member program designed just for kids for many years, and we've been hard at work to make it happen this year. Thanks to you, this dream is now a full reality, and Planetary Academy is available to all. Turn to page 22 to learn more about this program and our mission to spark a lifelong passion for space exploration in generations to come.



DART IMPACT MISSION SUCCESS!

On Sept. 26, NASA successfully slammed the DART spacecraft (Double Asteroid Redirection Test) into Dimorphos, a moonlet of the asteroid Didymos. Planetary Society CEO Bill Nye was there to celebrate at Johns Hopkins Applied Physics Laboratory, helping pump up the crowd at the official watch party with former astronaut and Society friend Leland Melvin. Now comes the work of studying the impact, including ensuring the European Space Agency's (ESA's) HERA mission launches in 2024 to study the effect of DART's impact up close. In 2019, Planetary Society members wrote to ESA to show their support for HERA, which was subsequently funded by ESA's member countries.



MAKING AN IMPACT FOR PLANETARY DEFENSE IN PARIS

In September, the world's leaders in planetary defense came together at the 2022 International Astronautical Congress in Paris, France for a panel called "Defending Earth: The International Effort to Protect Us From Asteroids and Comets." Moderated by Planetary Society board member Dipak Srinivasan, the panel featured DART Mechanical Lead Engineer Betsy Congdon; NASA Associate Administrator for Technology, Policy, and Strategy Bhavya Lal; HERA mission Principal Investigator Patrick Michel; ESA Head of Planetary Defence Office Richard Moissl; and our own CEO Bill Nye, who shared ideas for how to get the public more fully engaged in planetary defense.



ABOVE Planetary Society staff and members at a meetup in Cape Canaveral, Florida.

SARAH AL-AHMED/THE PLANETARY SOCIETY

CELEBRATING SPACE AROUND THE PLANET

Space exploration is an international endeavor, and the things that we discover about the Cosmos and our place in it are meant to be enjoyed and appreciated by the whole world. That's why The Planetary Society partners with global organizations and events that share space with people all around our planet. In October 2022, we invited our members and supporters to join us in celebrating World Space Week, for which this year's theme was "Space and Sustainability." We joined with thousands of participants in over 90 countries for a series of virtual and in-person events highlighting the role that space plays in sustainable development on Earth and how space exploration itself can be done in sustainable ways. That same month, we joined NASA in promoting International Observe the Moon Night. This event invites people around the world to look up at the Moon, learn about our planet's natural satellite, and share the adventure of lunar science and exploration with others.



World Space Week OCTOBER 4-10



MEMBERS CAME OUT IN SUPPORT OF ARTEMIS

Artemis I may not have launched as expected in August 2022, but that didn't stop us from celebrating! Planetary Society members who traveled to Kennedy Space Center to see the launch gathered together, making the trip worthwhile despite the rocket not taking off the next day. Every time members are together in person, it's a wonderful reminder of the sense of community we've built around our shared passion for space science and exploration. We look forward to more in-person events in the months and years ahead.

MAINTAINING LEADERSHIP IN SPACE POLICY

In response to Planetary Society advocacy, both houses of Congress have proposed NASA budgets that restore tens of millions of dollars to this mission, which was to suffer a 75% cut. At the time of publication, the Senate had proposed to restore \$40 million to the program and the House, \$55 million. Additional legislation passed into law directs NASA to avoid cutting NEO Surveyor in the future, even when facing overruns in other planetary science missions.

RIGHT Pictured from left to right are Danielle Gunn, chief communications officer of The Planetary Society; Professor Masaki Fujimoto, deputy director-general of JAXA; Dr. Bethany Ehlmann, president of The Planetary Society; Dr. Kate Kitagawa, director of space education at JAXA; and Bill Nye, chief executive officer of The Planetary Society.

THE PLANETARY SOCIETY

THE PLANETARY SOCIETY AND JAXA TEAM UP

In August, Planetary Society leadership welcomed education outreach leaders from Japan Aerospace Exploration Agency (JAXA) to Society headquarters in Pasadena, California to explore ideas for collaboration on education and public outreach initiatives.



DEIA AT THE PLANETARY SOCIETY

Over the last two-and-a-half years, The Planetary Society has been working to integrate diversity, equity, inclusion, and accessibility (DEIA) best practices into all of our work. Thanks to the support of members like you, we have been able to make some major, long-term changes to improve how we engage with our staff, members, volunteers, board of directors, and audiences.

DEIA has been woven into our day-to-day operations thanks to the creation of a working group within our staff and a committee on our board. We have conducted training sessions for all of our staff as well as our board to learn more about DEIA and to dig into how we can improve what we do

here at the Society. We brought on a consultant, Chino Nnadi-Bridger of Consult x Chino, to work more closely with our staff to examine hiring practices, train supervisors on identifying and eliminating bias, and implement other DEIA best practices.

We also participated in the Zed Factor Fellowship program for the second time this year. This program empowers aspiring aerospace professionals from underrepresented backgrounds to explore the aerospace industry through internship placements. This year, we worked with Zed Factor Fellow Melody Miguel, an undergraduate student from the University of Central Florida.

Our DEIA goals for the coming years start with internal work: committing time and funding for consultants, trainings, workshops, and other learning opportunities; improving our hiring, onboarding, and HR policies; ensuring our staff has a safe and empowering work environment; and continuing to learn and grow together as an organization. From this work, we already see a change in how we communicate with and engage our communities, from members to volunteers to audiences. Our ultimate goal is to be a force for change in the space community as a whole, bringing greater diversity, equity, inclusion, and accessibility to the worldwide effort to explore space. Thank you for your ongoing support as we do this important work.

BOOST YOUR IMPACT ON OUR FUTURE IN SPACE

It is you, as a member of The Planetary Society, who powers our mission to increase discoveries in our Solar System and beyond, elevate the search for life beyond our planet, and decrease the risk of Earth being hit by an asteroid. We rely on your support to fund advocacy, education outreach, scientific innovation, and global collaboration in support of these endeavors. **That's why your year-end gift is so important.**

Scan below or visit **planetary.org/planetaryfund** to make a gift today. Plus, when you give by Dec. 31, your contribution will be doubled up to \$100,000 thanks to a generous fellow member. Thank you!



MEET THE NEW HOST OF PLANETARY RADIO

AFTER 20 YEARS at the helm, our friend and colleague Mat Kaplan is retiring as the host of Planetary Radio — a show he started from scratch that now reaches more than 2.5 million listeners each year in more than 40 countries.

It is a bittersweet moment. The good news is our show will be in excellent hands after Mat's departure. We're



ABOVE On Jan. 4, 2023, Sarah Al-Ahmed will become the new host of Planetary Radio, The Planetary Society's renowned weekly space podcast and radio program.

THE PLANETARY SOCIETY

delighted to announce that Planetary Radio's new host is Sarah Al-Ahmed.

Sarah is a talented science communicator informed by a professional background in astronomy and a degree in astrophysics from the University of California, Berkeley. In 2015, she started working at Griffith Observatory in Los Angeles, giving science lectures, guiding school field trips, and writing for its magazine. She became a show producer for Griffith's monthly show and webcast "All Space Considered," where she eventually served as its citizen science correspondent.

Eventually, Sarah applied to work at The Planetary Society, where she was hired as our digital community manager. For the last two years, she's brought science to the public as the lead voice of our social media channels and has developed new ways to engage with our members.

When Mat announced his retirement from the show earlier this year, The

Planetary Society set out on an extensive search for a new host. Hundreds of people applied. Sarah's gift for finding and communicating the most compelling stories and insights from the space community to the public made her the clear choice. She is very excited to get to know you all, and we are excited for you to get to know her. Sarah will debut as the new host on Jan. 4, 2023.

Mat, who will remain with The Planetary Society in a new role after he hangs up his headphones on Dec. 30, couldn't be happier for Sarah or the show.

"The loyal Planetary Radio audience is about to discover someone who loves to share the PB&J of space — the passion, beauty, and joy — as much as I do," he said. "I can't wait to see where she and our colleagues take us in this new era."

JOIN YOUR NEW DIGITAL MEMBER COMMUNITY!

BEING A PLANETARY Society member means you are part of a global community of people who share a passion for space and who want to help make more exploration happen. Soon, you will be able to connect with your fellow members like never before.

In early 2023, we will launch a brand-new digital community just for Planetary Society members. In this online space, you'll be able to join like-minded people to learn, chat, collaborate, and share your love of space.

Here are a few things you'll be able to do in this member community:

- Connect with members who are geographically close to you
- Join discussion groups interested in specific topics, like astrophotography or advocacy
- Chat about the latest Planetary Society articles, videos, and podcast episodes
- Participate in virtual events
- Take free online space courses and engage with others as you learn
- Ask questions and share your thoughts with the community
- Connect directly with The Planetary Society staff, board, and advisers
- And so much more!

This member community has been in the works for a long time, and we've been working hard to build a fantastic, engaging online platform for you. To celebrate its launch, we're inviting all our members to a special virtual launch event. This virtual event will take place within the digital community, introducing members to the platform and showcasing its great features. You'll hear from space experts and meet and mingle with your fellow members.

Keep an eye on your email inbox for announcements with more details about this exciting launch event!

GIVE THE GIFT OF SPACE

It's not too late to give the perfect holiday space gift to your loved one — or add it to your own list! Here are a few out-of-this-world ideas:



PLANETARY ACADEMY

Open up the Cosmos for your kid! Kids can make a real impact on space exploration and support our mission by joining Planetary Academy, a membership designed for kids age 5 to 9. As a member, your young explorer will receive four adventure packs per year developed by the educational experts at The Planetary Society. The first adventure pack includes a personalized welcome letter from Bill Nye, CEO of The Planetary Society; an official membership card to Planetary Academy; an activity book; stickers; trading cards; games; and surprises. Memberships take three to four weeks to fulfill, but you can print a PDF certificate on demand after you check out so you can wrap it up for your young explorer right away. planetary.org/planetary-academy



GIFT MEMBERSHIPS

As a proud Planetary Society member, you know that your love of space is even more meaningful when paired with action. Spread the excitement to a loved one who cares about space but hasn't yet become a member by getting them a gift membership to The Planetary Society this year. You'll be able to print a PDF certificate on demand after purchasing so you have something to give them right away while their member benefits, like their official member T-shirt (pictured) and The Planetary Report magazine, arrive in the mail. planetary.org/gift



PLANETARY SOCIETY GEAR

Shop to support our mission by visiting the official Planetary Society store. From stunning posters to clothes to stickers, our store helps you (or the fellow space nerd in your life) show off your love of space in style. planetary.org/shop



YEAR-END FINANCES

A year-end donation to The Planetary Society's Planetary Fund is a powerful way to make an impact on our shared mission to advance space science and exploration. Make your gift today!

planetary.org/planetaryfund

For U.S. tax purposes, gifts must be received on or before the last day of the year. Here are some common methods of making a gift and their associated deadlines.

- Online credit card gifts: transaction completed by 11:59 p.m. EST (8:59 p.m. PST), Dec. 31, 2022.
- Checks sent via U.S. mail: postmarked on or before Dec. 31, 2022. Checks sent via third-party shipping (such as FedEx or UPS): delivered on or before Dec. 31, 2022.
- Credit card gifts via U.S. mail: received and processed on or before Dec. 31, 2022.
- Stock transfer: broker-to-broker instructions issued in time for completed transfer on or before Dec. 31, 2022.



JWST before it launched. NASA/CHRIS GUNN

PLANETS ABOVE!

IN THE SKY

There is a planet party in the evening sky. January begins with yellowish Saturn low in the west after sunset with very bright Jupiter above it. If you follow an approximate line through Saturn to Jupiter and take it high in the sky, you'll find very bright reddish Mars. During January, Saturn drops lower, and super-bright Venus rises up from below the horizon as the days pass. They are close together but very low to the horizon on Jan. 22. As the weeks progress, Saturn drops out of sight while Venus keeps rising. Very bright Jupiter drops lower until it makes a spectacular close pairing with super-bright Venus on March 1. Mars stays high in the evening sky, gradually dimming as Earth and Mars move farther from each other in their orbits. The Quadrantids meteor shower peaks the night of Jan. 3/4. The Quadrantids can be an above-average shower, but the Moon will be nearly full, washing out dimmer meteors this year. For more night sky tips, you can always check out planetary.org/night-sky.

RANDOM SPACE FACT

About 48.25 grams of gold coat the JWST mirrors. That is about equal to the mass of a golf ball. Why gold? Gold is very reflective in the infrared, and JWST observes primarily in the infrared.

TRIVIA CONTEST

Our June solstice contest winner is Justin Eckoff of Bethel Park, Pennsylvania, USA. Congratulations! The question was: ***What single space mission returned the highest mass of samples from a body other than Earth?*** The answer: ***Apollo 17. It returned 111 kilograms (245 pounds on Earth) of material from the Moon.***

Try to win a copy of the new book "Solar System Reference for Teens" by Bruce Betts and a Planetary Radio T-shirt by answering this question: ***How many hexagonal segments make up the JWST primary mirror?***

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 Mar. 1, 2023. One entry per person. 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.

KOMODO DRAGONS ON FLORES



Please contact Terri or Taunya at Betchart Expeditions for brochures and updated information on COVID and travel. Call 1-800-252-4910 or go to betchartexpeditions.com.

We invite you to join other members of The Planetary Society to discover the world on Betchart Adventures!

BALI AND EAST TIMOR TOTAL SOLAR ECLIPSE APRIL 14-28, 2023

Including the Komodo dragons on Flores!

WESTERN AUSTRALIA TOTAL SOLAR ECLIPSE APRIL 13-24, 2023

Delight in the magnificent natural world of Western Australia and snorkel in the Indian Ocean.

NEW MEXICO ANNULAR ECLIPSE OCT. 10-17, 2023

See the International Balloon Fiesta, the ancient Indian pueblos at Chaco Canyon and Mesa Verde, and the annular eclipse.

ALASKA AURORA BOREALIS MARCH 7-13, 2024

Discover magnificent Denali and the northern lights in the pristine splendor of Alaska in winter.



Kara Szathmáry: *Jupiter: NASA's Lucy mission to the Trojan asteroids*

This issue of The Planetary Report looks back at images from a tremendously exciting year of space exploration, but there's even more to look forward to in the years to come. This painting from artist Kara Szathmáry depicts the Lucy spacecraft at the Jupiter Trojan asteroids with the giant planet seen in the distance. Lucy is already on its way to the Jupiter Trojan system and will arrive at its first Trojan asteroid target in 2027. Kara is a longtime member of The Planetary Society as well as the International Association of Astronomical Artists.

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.