

THE PLANETARY REPORT

MARCH
EQUINOX **2024**

VOLUME 44, NUMBER 1

planetary.org

THE ECLIPSE ISSUE

SCIENCE AND SPLENDOR
UNDER THE SHADOW



EXPERIENCES IN TOTALITY

We're watching for the edge of daylight this year

by Bill Nye

MY LAST TOTAL solar eclipse experience was at Homestead National Historical Park in Beatrice, Nebraska. The year 2017 wasn't long ago, and I've been looking forward to my next eclipse ever since. Thousands of us waited for that moment, and sure enough, on that bright, sunny day, the sky went completely black. I imagine everyone or nearly everyone reading this has a story or has heard stories of a total solar eclipse experience. Well, my friends, it's the real deal.

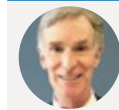
First is the experience itself. Birds sing night songs. Crickets chirp as though the Sun has set; you feel cool or even cold almost instantly. It is amazing. But second, leastways for me, is the realization that humans figured this all out. By all accounts, many cultures attributed the sudden darkness to the wish or whimsy of a god or gods. Indeed, eclipses are moving; they're all that, as the kids say. But just why they occur and exactly when was only known in the last few hundred years.

I've been in a perfect place to experience totality a few times. I found each one to be more moving and extraordinary than the last. This must be because I experienced each event with a deeper understanding of celestial motion, which in turn led me to feel an intimate connection to the Sun and Moon. I guess that's a great deal like a religious experience. I remember Carl Sagan remarking, "Religions would give their eyeteeth for predictions like this." In other words, if you're looking for something to believe in, science is it!

In Washington state in 1979, I was along the side of the path, so I experienced the partial effect. From where I was watching, the

Sun dimmed but did not disappear. When I was in South Africa for a 2002 eclipse, it was quite cloudy up until the very last moment the Moon made its apparent move. It was already overcast. We wondered, "Will it be the same?" It sure was. The world went black. The insects were quite loud in the jungle, and there were a few moments when we wondered what nearby elephants might decide to do when their world went dark. And last time, in Nebraska, I saw something I'd never much thought about until there it was. The national park is on the prairie that locals will proudly remind you is pretty flat. Nevertheless, we were on a small hill, and way, way off in the distance as those minutes of darkness were giving way, one could see the edge of daylight. We were in the darkest part of the shadow, to be sure. But just a few kilometers to the north, the Sun was shining bright as ever.

This April, in Texas, we will see some things we've never seen before. I, for one, will be astonished and filled with joy one more time along with a thousand or so fellow Planetary Society members at our event, Eclipse-O-Rama 2024. We've picked a spot that is very likely to be free from clouds that time of year. If you're in North America, I hope you catch the eclipse this year. I'm looking forward to seeing a great many of you in the sunshine — and in the dark — in Texas! 🌞

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

ON THE COVER: This image of Earth was captured by the NOAA/NASA DSCOVR satellite during a total solar eclipse on Aug. 21, 2017. The Moon's dark shadow is centered on the United States. DSCOVR orbits the Sun–Earth L1 Lagrange point at a distance of about 1.5 million kilometers (1 million miles) from Earth. *Image: NASA DSCOVR EPIC Team* * *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. © 2024 by *The Planetary Society*. All rights reserved. *The Planetary Society* and *The Planetary Report*: Registered Trademarks ® *The Planetary Society*. Planetfest™ *The Planetary Society*.

CONTACT US: *The Planetary Society*, 60 South Los Robles Avenue, Pasadena, CA 91101-2016; General calls: 626-793-5100; Email: tps@planetary.org; Web: planetary.org; Editors **RAE PAOLETTA** and **DANIELLE GUNN**; Contributing Editor **KATE HOWELLS**; Science Editor **BRUCE BETTS**; Copy Editor **NICOLE YUGOVICH**; Art Director **LOREN A. ROBERTS** for **HEARKEN CREATIVE**; Creative Services **ANDREW PAULY**

BILL NYE
Chief Executive Officer

JENNIFER VAUGHN
Chief Operating Officer

CO-FOUNDERS
CARL SAGAN
1934-1996

BRUCE MURRAY
1931-2013

LOUIS D. FRIEDMAN
Executive Director Emeritus

BOARD OF DIRECTORS
Chairman of the Board
DANIEL T. GERACI
CEO and President, FreeFall Aerospace

President
BETHANY EHLMANN
Professor, California Institute of
Technology; Research Scientist,
Jet Propulsion Laboratory

Vice President
HEIDI HAMMEL
Executive Vice President,
Association of Universities for
Research in Astronomy

Secretary
JAMES BELL
Professor, School of Earth
and Space Exploration,
Arizona State University

Treasurer
LON LEVIN
President,
SkySeven Ventures

JOHN GRUNSFELD
President and CEO, Endless
Frontier Associates

BIJAL "BEE" HAYES-THAKORE
Regional Coordinator for Asia Pacific,
Space Generation Advisory Council

JOHN LOGSDON
Professor Emeritus, Space
Policy Institute, The George
Washington University

ROBERT PICARDO
Actor

BRITNEY SCHMIDT
Associate Professor, Astronomy,
Earth, and Atmospheric
Sciences, Cornell University

DIPAK SRINIVASAN
Principal Staff Member,
Johns Hopkins University
Applied Physics Laboratory

LORNE TROTTIER
President and Co-Founder, Matrox

ADVISORY COUNCIL

BUZZ ALDRIN

ROBERT D. BRAUN

DAVID BRIN

NAGIN COX

G. SCOTT HUBBARD

GARRY E. HUNT

MARK HUNTER

RYAN JOHNSON

RYAN KRISER

BEN LAMM

ROSALY LOPES

BRIAN POPE

PETE SLOSBERG

KEVIN STUBE

NEIL DeGRASSE TYSON

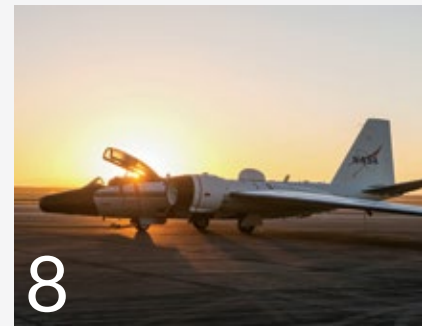
Contents

MARCH EQUINOX 2024

- 2 Your Place in Space**
CEO Bill Nye reminisces about the amazement an eclipse calls forth.
- 4 In Context**
Why our planet's experience of solar eclipses is unique in the Solar System.



- 6 Members on Deck**
We ask our readers, "Have you ever witnessed a solar eclipse?"
- 8 Seizing Upon Syzygy**
Eclipses are not only beautiful events to watch but they also provide rare opportunities for science.



- 17 Your Impact**
Space advocacy ramps up in Washington.
- 20 Get Involved**
Total eclipse viewing, your member community, and more.
- 23 What's Up?**
Planets to look for in the night sky.
- 24 Space Art**
A painting imagining an astronaut's view of a total solar eclipse from the Moon.

On Aug. 21, 2017, a total solar eclipse swept across a narrow portion of the contiguous United States from Lincoln Beach, Oregon, to Charleston, South Carolina. This image was captured from Madras, Oregon.

NASA/AUBREY GEMIGNANI





AN EXQUISITE COSMIC COINCIDENCE

Why eclipses on Earth are unlike anything else in the Solar System

by Kate Howells

ABOVE Planetary Society member Blake Estes captured this image of a total solar eclipse on Aug. 21, 2017, from Douglas, Wyoming. The Sun's corona is visible around the edges of the Moon.

BLAKE ESTES

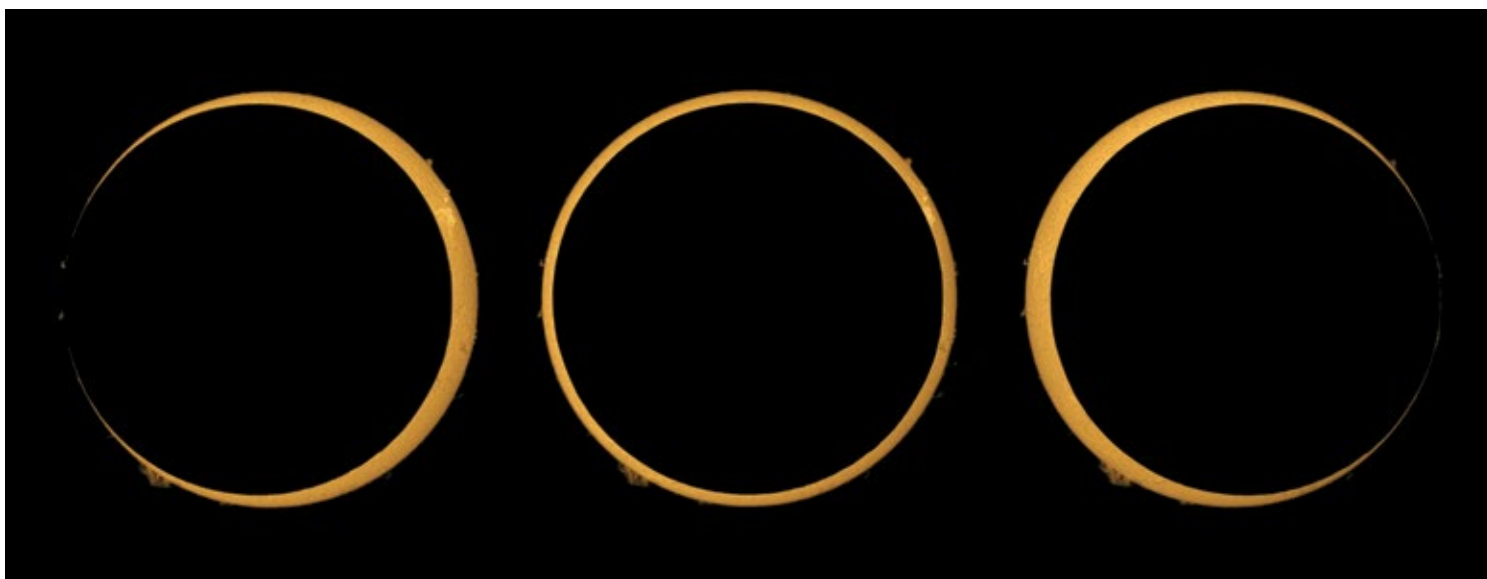
TOTAL SOLAR ECLIPSES are easy to appreciate. For as long as our historical records go back, we know that humans have marveled at them. Many cultures developed mythological explanations for eclipses, believing that only gods could blot out the Sun. Some ancient cultures developed sophisticated astronomical systems that could explain and actually predict eclipses. Today, we understand the motions of celestial objects so well that we can predict the exact minute a solar eclipse will begin at any given location. But the depth of our understanding of the Cosmos doesn't lessen our appreciation of eclipses. In many ways, it enhances it.

Although syzygy (the alignment of celestial objects, like Earth, the Sun, and the Moon) is a completely normal thing in the Solar System, the way it creates eclipses on Earth is unique. This has to do with a wonderful coincidence of size and distance. The Sun is 400 times larger in diameter than the Moon, and the Sun also happens to be 400 times farther away

from Earth than the Moon (most of the time — more on that later). This makes it so that both objects appear to be the same size from the perspective of Earth (in most locations — more on that later too). When syzygy occurs, the Moon can perfectly cover the Sun's face.

Although other planets with moons experience syzygy with the Sun, none also have this coincidence of apparent size. On Mars, for example, syzygy between the planet, its largest moon (Phobos), and the Sun produces a transit, not an eclipse; Phobos is very small, so it just passes in front of the Sun without obscuring it completely.

From the vantage point of the outer planets, like Jupiter or Neptune, the Sun is so distant that syzygy with any large moons would more than obscure the Sun. Only on Earth do we get the perfect eclipse that lets us look at the Sun's corona (the wispy tendrils of its outer atmosphere) and even see prominences (loops of plasma extending from its surface) while its bright light is blocked by the Moon.

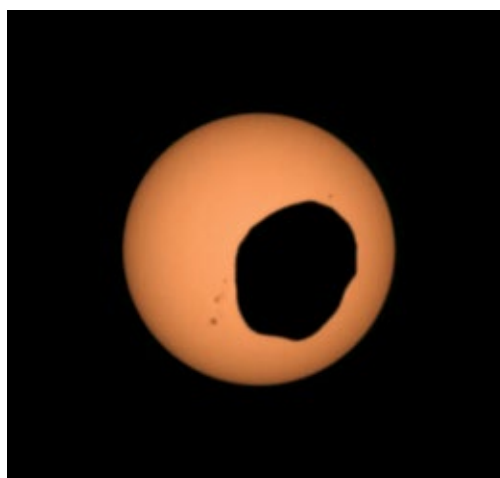


Annular eclipses demonstrate just how perfect the size-distance ratio has to be to produce a total solar eclipse. The Moon's orbit around Earth is elliptical, meaning it comes closer to Earth at certain points in this orbit and farther at others. The difference between the two extremes is about 40,000 kilometers (about 25,000 miles), which creates a change of about 14% in the Moon's apparent size from Earth.

When syzygy coincides with apogee (the point in the Moon's orbit when it's farthest from Earth), the Moon doesn't completely cover the Sun. Instead, a ring of sunlight remains visible around the edges, which is why an annular eclipse is often referred to as a "ring of fire" eclipse.

Locations closer to the poles, such as the Arctic and Antarctic regions, see annular eclipses more often than locations closer to the equator because the Moon is slightly farther away from Earth's poles than from its equatorial regions, making its apparent size in the sky slightly smaller.

Even 150 million kilometers (93 million miles) away from the Sun, these small changes in location and lunar distance are enough to make a big difference. In locations experiencing an annular solar eclipse, enough sunlight reaches Earth that people might not even realize that



an eclipse is happening unless they have solar eclipse glasses to look at the Sun and see the "ring of fire."

Learning about how rare and coincidental our planet's experience of solar eclipses is when compared to other worlds really drives home just how special this celestial phenomenon is. If you get a chance to witness a total solar eclipse in your lifetime, let this be another layer to your enjoyment of the experience. 🌑



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

ABOVE Planetary Society member Frank Kraljic captured these images of the 2023 annular eclipse from Ticaboo, Utah.

FRANK KRALJIC

LEFT Phobos passing in front of the Sun, as observed by the Mastcam-Z camera on NASA's Perseverance rover on Apr. 2, 2022.

NASA/JPL-CALTECH/ASU/MSSS/SSI

WITNESSING A SOLAR ECLIPSE

WE ASKED OUR members, “Have you ever witnessed a total solar eclipse? What was the experience like?” Here is a selection of their stories, some of which have been edited for length and clarity. For more, go to community.planetary.org.

Our family saw the 2017 eclipse here in Salem, Oregon, which was the first U.S. landfall. We were right along the centerline, and my grandson used his drone to follow the shadow as it moved across the valley. To say it was stunning [is] an understatement. The Moon truly stole the show. The three-dimensionality of the sphere with reflected earthlight was life-changing. It’s why my wife and I booked Texas as soon as the Society opened up reservations. I can’t wait to see it again. I hope to see a lot of you there!

[Bob Woods](#)

I went down to Easley, South Carolina, to see the total solar eclipse in August 2017. It was a dream come true. I had wanted to see a total eclipse since I witnessed the partial eclipse in 1970 in Vermont. When the Moon took its first bite out of the Sun, I looked at my friends with an expression saying, “It’s really happening!” The sky was clear, and it was a wondrous event. The excitement and joy of that day will stay with me forever.

[Susan Alexander](#)



[The] first total solar eclipse I experienced was at Rexburg, Idaho, and was the most profound experience of my life. Pictured is one of the many images I was able to take of the eclipse.

[David Pinsky](#)

On Aug. 11, 1999, in Penzance, Cornwall, up on the slopes of a grassy hill we waited as the time approached. It had been a really cloudy morning, and hopes of seeing anything spectacular were still gray. But then the weather changed abruptly. It was the weirdest thing. Surreal. The temperature dropped, the wind died down, seabirds were reacting, [and] there were breaks in the clouds just before it got really dark. And then ... we caught glimpses of the total eclipse ... once in a lifetime and last in a century ...

[Robert Johannessen](#)

I saw the 2017 total solar eclipse in Kansas City, Kansas. The clouds rolled in a half hour before totality, meaning I didn’t get to see the eclipse itself, yet the effects of the eclipse were fascinating. The nighttime bugs and birds began to chirp and sing, and the sky took on a green glow that felt like a tornado was near.

[Sean Kane](#)

I lived my young life in Minnesota, so I had to take advantage of the February 1979 eclipse. A friend of mine and I took a road trip to Minot, North Dakota, where the path of totality grazed the very northwest corner of the state before passing into Canada. We were adventurous and on a shoestring budget. We drove to Minot, arriving the night before. We spent that night in the back of the station wagon that served as our accommodations. Like I said, it was February. That morning, I suppose it was like waking up in the morgue. The windows [were] entirely frosted over — on the inside. We drove far north toward Canada before totality to get as close to the centerline as possible. Well, we made it. Needless to say, the eclipse was awesome, seeing the Sun’s corona and the eerie green light all around the horizon over the frozen prairie. It was very surreal. I look forward to a warmer experience this time in Texas!

[Matt Lucking](#)

Yes, in 2017 in Westmoreland, Tennessee. We had traveled there from Louisville, Kentucky, to experience totality. No picture, no video, [and] no written description can come close to capturing or describing the awe and beauty of such an event. Totality was an incredible experience! The wisps of the corona were amazing, the shadow bands rippling across the ground right before totality, the sudden fall of darkness, [and] the drop in temperature all happening within a few minutes is something that everyone should have on their bucket list. I will be in the shadow again wherever clear skies take me [in] April. There is no comparison between a partial and a total eclipse. Don't let the high percentages of coverage at nearby locations fool you. You must see totality to experience perhaps the greatest naked-eye wonder in the sky!

[Robert Massey](#)

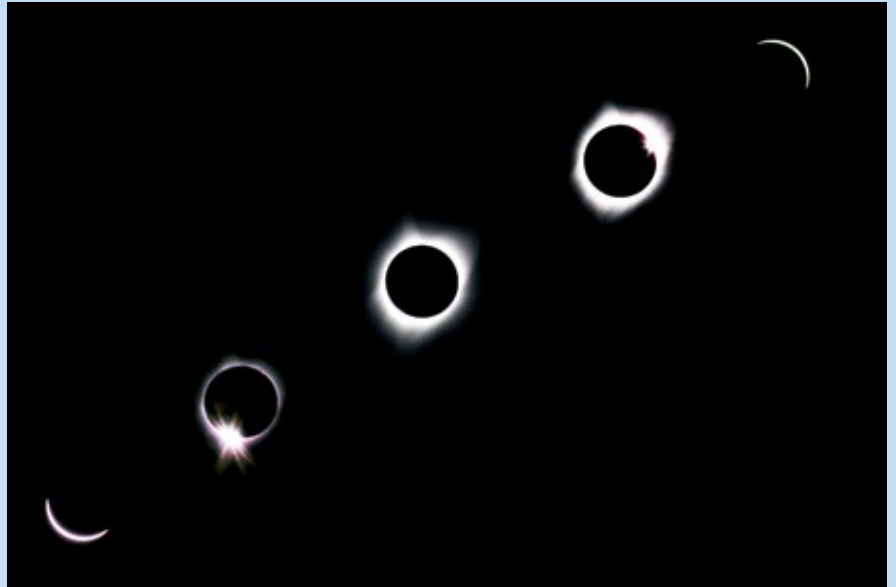
Here are a few haiku inspired by my experience in Missouri during the solar eclipse in 2017:

The eclipse begins
Light does not shine as it should
Dark is my vision

Luna blocks the light
Helios hides behind her
Terra becomes dark

A diamond ring
Then solar totality
Like nothing you've seen

[Suzan Stocker](#)



Solar eclipses give my wife and me reasons to travel to varied locations. We have seen three total solar eclipses and one annular eclipse. Each eclipse-viewing experience was different, but the total eclipses were [all] more dramatic than the annular eclipse. Viewing all of the eclipses was an awesome and emotional experience — the reason we keep going back for more.

As totality approaches, you hear the growing sound of viewers' hoots and hollers with a crescendo as totality arrives. The Sun's crescent finally turns into a blazing diamond ring, and then, at the moment of totality, the diamond fades away to a glowing coronal ring around the Sun. The glow is modest at first, [and] then your eyes adjust to the darkened sky, and the intensity of the glow increases to a dazzling bright ring with a blacker-than-black hole in the middle. You feel the winds calm down and the temperature drop noticeably. Animal sounds change, birds stop chirping, and crickets start up. The eclipse appears as a gaping hole in the sky that draws in your gaze — it's hard to look away.

While viewing eclipses, we've met many people who share our love of eclipses. Since there is generally plenty of time before totality, you have the opportunity to get to know fellow eclipse viewers and share experiences with one another. I recall meeting a young woman in her late teens who was with her mom at the 2017 eclipse in Oregon. Although her mom didn't seem to care much about eclipses, the young woman was heavily into astronomy and had been planning to see this eclipse for several years. She was quite knowledgeable about solar eclipses and had prepared herself for what to expect. When totality finally came, she was brought to tears and could no longer speak but just view the event. The eclipse impacted her in a way she did not expect — a state I could appreciate.

This image is from the 2017 solar eclipse in Culver, Oregon.

[Steve Sheridan](#)



Seizing Upon Syzygy

How scientists use total solar eclipses
as opportunities to do solar science

by Jason Davis

IN TERMS OF sheer cosmic spectacle, it's hard to beat a total solar eclipse. Watching the Moon blot out the Sun for a few minutes can be a life-changing experience that prompts you to consider your place in space.

For scientists, it's also a unique opportunity to study the Sun and its effect on our planet. Past eclipses have enabled us to prove Einstein's theory of general relativity, discover the element helium, uncover sun-grazing comets, and more.

During the April 8, 2024 total solar eclipse, the Moon's shadow will cross Mexico, the United States, and Canada. More than 43 million people live within the path of totality, and countless more will travel to see it, including scientists who hope to make the most of the moment. We spoke with three solar scientists to learn about their plans for the big event.

A LUNAR CORONAGRAPH

While telescopes and spacecraft can use coronagraphs to block the Sun and reveal the corona, nothing beats the Moon, said Kevin Reardon, a scientist and astronomer at the National Solar Observatory in Boulder, Colorado.

"The Moon remains the best coronagraph because it's so far away and it's exactly the right size," he said. "It blocks the Sun's light even before it gets to Earth's atmosphere, making the background very dark. That allows us to see the corona both very close to the Sun and for an extended distance away and make some specific measurements that are only possible during an eclipse."



JASON DAVIS is the senior editor for *The Planetary Society*.

Reardon and his colleagues are traveling to Mazatlán, Mexico, for the 2024 eclipse, where the sky will darken for almost four-and-a-half minutes, and chances of clear skies are very high. There, they will set up telescopes equipped with spectrographs that split light into its component wavelengths.



ABOVE Kevin Reardon checks the alignment and tracking of his telescope prior to the 2023 Australian total solar eclipse.

JOHN WILLIAMS/NSO/AURA/NSF

OPPOSITE This incredible image shows a total solar eclipse, on Aug. 21, 2017, in eastern Wyoming, just over 3 kilometers (2 miles) south of the centerline of the eclipse.

GETTY IMAGES

During totality, they will measure the smearing of the solar spectrum caused by the Sun's light scattering off fast-moving electrons in the corona. This process is related to the Doppler effect — the same phenomenon that makes an ambulance's siren change in pitch as it passes by. By connecting the amount of smearing to the velocities of the electrons, they can in turn determine the temperatures in the corona.

A longstanding solar science puzzle is why the Sun's corona is hotter than the surface just a few thousand kilometers below. These temperature



A NASA WB-57F sits at Ellington Field near Houston in 2015.

NASA/JSC/JAMES BLAIR

measurements will be another step toward solving the mystery.

Reardon said that testing and preparing his equipment to make sure everything works properly can be stressful, but he hopes to have time to steal a glance at the eclipse for himself.

“If all goes well, you can press the button and the equipment will run for part or most of the eclipse by itself, acquiring the data,” he said. “There’s always time to look up and take in the whole spectacle.”

CHASING THE SHADOW

While a solar eclipse is a great opportunity for scientists to study the Sun’s corona, ground-based observers still have to

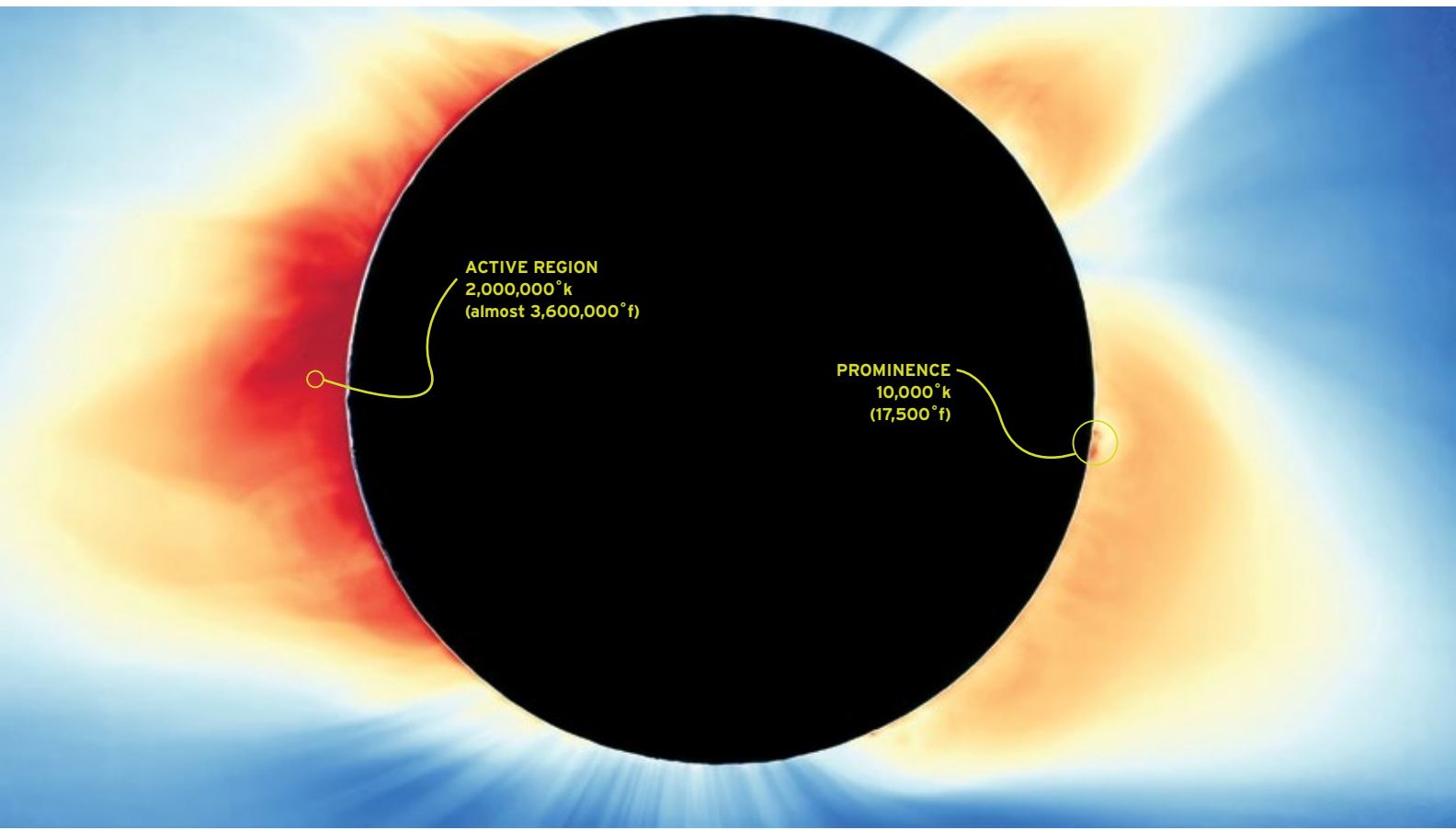
peer through Earth’s atmosphere to make their measurements. Certain studies are difficult or impossible, like observing the Sun in infrared light, since our atmosphere glows at infrared wavelengths.

Fortunately, there’s a solution: fly high-altitude research planes above most of the atmosphere to get a clearer view.

During the 2017 eclipse, Amir Caspi, a principal scientist at the Southwest Research Institute in Boulder, Colorado, led a team that equipped two of NASA’s WB-57 planes with infrared cameras. The two-seater planes, bearing a pilot and an instrument specialist, flew along the path of totality, chasing the eclipse to give them a few extra minutes in the Moon’s shadow.

This image of the Sun in infrared light was created using data captured by a NASA WB-57 high-altitude research plane during the 2017 total solar eclipse.

SWRI/NASA/DANIEL B. SEATON



ACTIVE REGION
2,000,000 °k
(almost 3,600,000 °f)

PROMINENCE
10,000 °k
(17,500 °f)

The result was the highest-resolution image ever captured of the Sun's corona in medium-wave infrared light. In the image, a solar prominence, a strand of hot gas looping off the Sun's surface, and an "active region," a large concentration of magnetic fields from which solar flares often emerge, showed up at the same intensity of infrared light. This was surprising because active regions are much hotter than prominences.

"The intensity in the active region is about the same as the intensity in the prominence, even though they are two orders of magnitude different in temperature," said Caspi. "So why is that? What is driving the infrared emission for these? That's

what we're hoping to find out in 2024."

For the 2024 eclipse, Caspi's team will once again use a NASA WB-57 that will fly along the eclipse path near Mazatlán, giving them a couple extra minutes in the Moon's shadow. The plane will be outfitted with a small telescope that feeds four science instruments that will image the Sun's corona in three different types of infrared light as well as ultraviolet and visible light.

The results may help them determine what is driving the infrared emission in prominences and the corona. They may also learn how much different wavelengths of light coming from prominences and the corona are reflected from the Sun's surface versus being generated on their own.

Total solar eclipse seen in Chile's Atacama Desert on July 2, 2019, showing the various phases of totality.

GETTY IMAGES







THE POWER TO EDUCATE

A third solar scientist sees the eclipse as a calling to educate and inspire the public.

Maria Kazachenko was a high school student in St. Petersburg, Russia, in 1999. She joined a group of students and teachers for a multiday bus ride across Europe to reach the path of totality for a total solar eclipse crossing Hungary. The experience made a huge impact on her life.

“This experience was so amazing that basically, it was a turning point in my life when I decided to become an astronomer,” she said.

Kazachenko later specialized in solar science. She is now an assistant professor at the Astrophysical & Planetary Science Department at the University of Colorado, Boulder and the National Solar Observatory.

For the 2023 annular eclipse, she traveled to Texas with colleagues for two days of eclipse outreach at local schools and public venues. Her team explained how the Sun works using hands-on experiments and hosted a viewing party for the moment of annularity, where the Moon, slightly too far away from Earth to fully block the Sun, crossed within the Sun’s disk to create a perfect “ring of fire.”

While in her day job as a professor Kazachenko studies solar flares, she has no science scheduled for the 2024 eclipse — instead, she’ll be back in Texas working with the public.

“I feel that going to eclipses and using it as an outreach opportunity is a way for me to give back to the community,” she said. “The experience itself is so amazing that especially if you’re on the path, you cannot miss it.” 🌑

ABOVE Maria Kazachenko helps students visualize magnetism at Sacred Heart Catholic School in Uvalde, Texas.

NSO

WHAT TO WATCH FOR

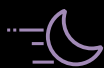
A total solar eclipse only lasts a few minutes depending on your location. There are a lot of things to watch for, which can make the big moment feel overwhelming, particularly for first-time viewers. Here’s a checklist of things you might see during a total solar eclipse. The most important thing you can do is enjoy the show. There’s no need to try to check off every item we list below, but by knowing what to expect ahead of time, you’ll be more prepared to experience this cosmic spectacle.

Go to planetary.org/eclipse to learn more and to see a map that shows the phenomena visible at sites across North America.



Some of these phenomena are visible during both **TOTAL** and **PARTIAL** eclipses.

BEFORE TOTALITY



WATCH THE MOON'S MOVEMENT **TOTAL PARTIAL**

Starting at least an hour before totality (the exact time depends on your location), you can watch a partial eclipse as the Moon slowly crosses in front of the Sun. Always wear certified solar eclipse glasses to view a partial eclipse!



THE QUALITY OF LIGHT **TOTAL PARTIAL**

As more and more of the Sun gets eclipsed, you'll notice some strange lighting effects. Objects aligned to the axis of the Sun's crescent will cast sharper shadows. You may also notice daylight starting to fade. What began as a bright, sunny day may start to appear overcast as the Moon blocks more and more sunlight.



SHADOW BANDS **TOTAL PARTIAL**

A rarer phenomenon to look for near totality is shadow bands. Shadow bands are undulating shadows that are most easily seen on plain surfaces. They are subtle but may appear for a few minutes before and after totality. Scientists are not certain about what causes shadow bands, and their appearance is unpredictable.



THE RACING SHADOW **TOTAL PARTIAL**

If you're watching from a spot where you can see a long way in the direction of the oncoming shadow, you may be able to see it racing toward you on the ground or in the clouds.



BAILY'S BEADS **TOTAL**

As the last of the Sun's rays disappear, you may see what looks like a string of beads along the Moon's limb. These beads are caused by sunlight slipping through lunar valleys — you're actually seeing the Moon's topography!



CHROMOSPHERE AND PROMINENCES **TOTAL**

For a few moments, you may be able to see a red arc along the Moon's edge. This is the Sun's middle atmosphere, known as the chromosphere. You might also see red prominences extending off the surface. These prominences are larger than Earth and consist of electrically charged hydrogen and helium, known as plasma.



DIAMOND RING **TOTAL**

As the Baily's beads wink out, only one will remain, shining bright like a diamond set into a glowing ring. Get ready for totality!

DURING TOTALITY



TWILIGHT AND SUNSET **TOTAL**

The diamond ring disappears as the sky plunges into twilight, marking the start of totality. It is now safe to view the Sun with your unaided eye. The horizon all around you glows orange like at sunset.



THE SOLAR CORONA **TOTAL**

With the Sun completely eclipsed, the corona emerges. The corona is the Sun's outer atmosphere, visible as a wispy white expanse billowing out from the Sun.



STARS AND PLANETS **TOTAL**

As the sky darkens, bright stars and planets may emerge. Generally speaking, look for Venus to the Sun's right or bottom right. Jupiter should be to the Sun's left or upper left.



TEMPERATURE DROP **TOTAL**

With the Sun temporarily hidden by the Moon, temperatures on the ground will fall.



ANIMAL BEHAVIOR **TOTAL**

Unlike you, animals haven't been warned ahead of time that a major cosmic event is about to happen. As the sky fades into twilight, some diurnal animals may engage in their bedtime rituals, while nocturnal animals may wake up and become active.

AFTER TOTALITY

All of the events that preceded totality will now occur in reverse. The diamond ring will reemerge. The chromosphere and prominences may appear as the Moon slides off the Sun's disk. Baily's beads will blink on. And then the glare of the Sun's surface will reappear.

Look for shadow bands again, along with the Moon's shadow racing away from your location. Temperatures will rise. Shadows will remain sharp along the Sun's crescent axis. And finally, as seen through eclipse glasses or a solar filter, the Moon's bite out of the Sun will decrease until it disappears.

It's important to note again that the most important thing you can do during the eclipse is enjoy the show. It may not be possible to see every eclipse phenomenon, even if you're trying really hard. But by knowing what to expect ahead of time, you'll be better prepared to have a memorable experience.

ECLIPSE GLOSSARY

ANNULUS

The ring of light that is seen around the Moon during an annular solar eclipse.

CORONA

The outermost layer of the Sun's atmosphere, which is visible during a total solar eclipse as a halo of faint light.

PROMINENCE

Gaseous eruptions or loops of plasma that can be seen along the edges of the Sun during a total solar eclipse.

RING OF FIRE

Another term for annulus.

SYZYG

The technical term for when three objects in space (like the Sun, Earth, and the Moon) line up. (Pronunciation of this term is tricky. It sounds like "si-zuh-jee.")

TOTALITY

The period when the Sun is completely obscured by the Moon.



ABOVE To be eclipsed is something that not only the Sun experiences. Metaphorically, the word “eclipse” also means to deprive someone or something of significance, power, or prominence. The dual definitions were playfully used in this satirical print from 1829, which uses eclipse imagery to comment on the political dynamic between the Duke of Wellington (depicted as the Moon) and the monarch George IV (the Sun being eclipsed). This artwork also shows how cultural perceptions of eclipses were shifting at the time. In 17th century Europe and earlier, artistic depictions of eclipses were almost always used in religious contexts. As the scientific understanding of eclipses became more sophisticated, Western cultures began to think of eclipses less as mysterious and ominous events and more as interesting but otherwise normal phenomena – even suitable for joking.

THE TRUSTEES OF THE BRITISH MUSEUM

ANNOUNCING THE FIRST C. WALLACE HOOSER AWARD FOR VISIONARY PHILANTHROPY

Dan Geraci, Board of Directors

The Planetary Society is pleased to announce the C. Wallace Hooser Award for Visionary Philanthropy and its first recipient, Mark Gelfand.

The award is named in memory of longtime board member and friend Wally Hooser, who believed that The Planetary Society represented a long-term investment in humanity. Wally felt that it was vital to explore the Cosmos and realize our place in space while also protecting our species from tangible threats, like hazardous asteroids and comets.

A decade ago, Wally challenged the board and staff to build a more fiscally sustainable Planetary Society. He infused the organization with self-confidence that helped it grow into what it is today.

As Wally was battling the illness that would eventually take him, we established the C. Wallace Hooser Award for Visionary Philanthropy in his name. Award candidates must have a track record of exceptional generosity and commitment to the promotion of space science, exploration, and education. They must demonstrate outstanding civic responsibility and encourage others to take philanthropic leadership roles. Finally, they must share their time, talent, and treasure in a manner consistent with the example set forth by Wally Hooser.

Wally passed away in 2021. We miss him dearly, yet his legacy with The Planetary Society lives on thanks to his generosity, his kind spirit, and this new award to honor those who follow in his footsteps.

We are pleased to announce that Mark Gelfand is the first recipient of the C. Wallace Hooser Award for Visionary Philanthropy. Inspired by the space race of the 1960s, Mark has always been interested in technology and how things work. He received a degree in physics and went on to work in finance, awed by the mathematical similarities between thermodynamics and financial markets.

Mark joined The Planetary Society in 1998. He has given generously to the organization over the years, supporting ambitious technology projects such as solar sailing and a mission to send microorganisms on a round-trip mission to the Martian moon Phobos.

“The Planetary Society deals with things that are accessible, if not today, soon — within a decade or two,” he said.

Mark is passionate about the power of STEM (science, technology, engineering, and math) education. He is the founder and president of STEMpower, an organization that has established more than 110 STEM centers across sub-Saharan Africa. The organization provides enrichment centers and hands-on labs that encourage pre-university students to pursue STEM careers.



It's challenging work, and Mark said that STEMpower's track record of getting things done is similar to that of The Planetary Society. “We do what is practical and doable,” he said. “We don't dream of things; we do things.”

With his trademark humility, Mark said that he was honored to receive the award and noted that much of the credit goes to his STEMpower staff. “It's all a wonderful honor. I'm glad people are realizing that they see some value in this and what we're doing,” he said.

The Planetary Society sees great value in how Mark is changing the world, and we're pleased to bestow this honor. Wally would be proud.

Planetary Society Board Chairman Dan Geraci (right) presenting Mark Gelfand with the C. Wallace Hooser Award for Visionary Philanthropy.

THE PLANETARY SOCIETY



FUNDRAISING SUCCESS

Planetary Society members rallied together to support several important campaigns in late 2023.

Last autumn, members raised over \$80,000 for the LightSail program's ongoing work. These funds will allow The Planetary Society to broaden the possibilities of solar sailing by sharing the remarkable story of LightSail with scientists, engineers, and space enthusiasts around the world. This includes publishing a book about the program; disseminating our findings in scientific journals and at conferences; and building a master archive of all the mission data to share with engineers, scientists, and future missions.

And in our annual year-end fundraising drive, members came together to raise over \$200,000, unlocking an additional \$20,000 in matching funds from generous members of our board of directors on #GivingTuesday. Plus, we unlocked \$100,000 in additional matching funds thanks to a generous Society member. These funds will help us continue all of our work through 2024 and beyond.

Thank you for your support!



THE PLANETARY CAUCUS IS BACK

Following a two-year hiatus, the Congressional Planetary Science Caucus has officially been rechartered in the 118th Congress thanks to the leadership of the caucus co-chairs: Reps. Don Bacon (R-Nebraska) and Judy Chu (D-California). This bipartisan effort will offer a venue for members of Congress to rally in support of space science, research, and exploration.

The Congressional Planetary Science Caucus was originally founded in 2018 and existed through the end of the 116th Congress (January 2021). The Planetary Society worked closely with Reps. Bacon and Chu to reorganize the caucus for the 118th Congress.

According to the caucus's official charter, its goals are to:

- Support government agencies, commercial partners, academic institutions, and nonprofits in the research and exploration of space.
- Bolster efforts by space organizations to find, track, characterize, and mitigate the threat of potentially hazardous near-Earth objects.
- Facilitate the search for life in our Solar System and beyond, answering the fundamental question, "Are we alone in the Universe?"
- Raise awareness of the economic benefits of federal investments in space science, technology development, and STEM education.

Thanks to strong financial support from our members and thousands of small donors, the Society's Space Policy & Advocacy program has grown in size and capability over the past few years. We used this expanded in-house expertise to work closely with a bipartisan group of lawmakers to assist them in putting together the caucus, and we will provide ongoing support and outreach to the public and the scientific community.



LEFT The brine pools of Last Chance Lake in central British Columbia are a sodium carbonate-rich system. This provides an analog for closed basin paleolake environments on Mars, and the lake geochemistry may mirror that of ocean worlds like Enceladus (where the Cassini spacecraft found carbonates in the moon's south polar plumes). In the foreground, Emmy Hughes, a graduate student from Georgia Tech and a co-investigator on the project, takes spectral measurements of the lake's salt deposits to help us better characterize these systems using instrumentation available to orbiter and lander missions.

JACOB BUFFO

STEP GRANT UPDATE: STUDYING SALTY LAKES AS PLANETARY ANALOGS

One of the winning projects from the 2023 round of STEP (Science and Technology Empowered by the Public) Grants is a multiyear study of salty lakes on Earth that share characteristics with the past and present oceans of other planets and moons. Dr. Jacob Buffo of Dartmouth College, who is leading the project, gave us an update on the first field trip his team took to British Columbia's Cariboo Plateau in Canada to study small, extremely salty lakes there. This trip was made possible thanks to the support of The Planetary Society's member-funded STEP Grants.

"One of the highlights of the trip was getting to work with such a multidisciplinary group of scientists up there," said Buffo, "and for them to get to meet each other and try to figure out all the puzzling aspects of these lake systems together." Buffo's team is very diverse, including specializations

in remote sensing, geochemistry, astrobiology, planetary analog systems, biogeochemistry, geobiology, planetary science, and geophysics.

Another exciting outcome of the trip was gaining experience collaborating with drone operators from the University of New Hampshire who were doing complementary work gathering hyperspectral drone imagery of the lake sites. Buffo's team will now match what they see in the aerial drone data with the biochemical and geochemical data they're collecting on the ground. This could test strategies for using planetary exploration drones, like Ingenuity, to scope out landscapes on other worlds to select targets for astrobiological study by rovers or even human explorers.

"These lakes continue to surprise us each time we go up there," said Buffo. The STEP Grant funds will support several more field trips for Buffo and his team, helping to advance this exciting field of planetary analog research.



READ OUR FULL ANNUAL IMPACT REPORT

Learn more about the important work your membership made possible in 2023 by reading our annual impact report. You can find it at planetary.org/2023impact.

YOUR PICKS FOR THE BEST OF 2023

The Planetary Society's global community members did the seemingly impossible in November 2023 — they chose favorites from among all the amazing things that happened in space exploration last year! Here are some of the top results. You can see the rest at planetary.org/best-of-2023.

BEST SOLAR SYSTEM IMAGE

The Japanese ispace Hakuto-R spacecraft captured this image of a total solar eclipse from lunar orbit on April 20, 2023.



ISPACE

MOST EXCITING MOMENT IN PLANETARY SCIENCE

NASA's OSIRIS-REx spacecraft successfully returned a sample of asteroid Benu to Earth in September, completing a seven-year mission that spanned 7.1 billion kilometers (4.4 billion miles).



NASA/KEEGAN BARBER

BEST "FACT WORTH SHARING" FROM OUR WEEKLY DOWNLINK NEWSLETTER

With trillions of galaxies in the Universe, each containing hundreds of billions of stars, most of which are likely to host planets and many of which host moons, the number of worlds out there is staggering — as is the likelihood that life exists beyond Earth.

BEST MARS IMAGE

Through the lens of NASA's Curiosity Mars rover's black-and-white navigation camera, the red planet robotic explorer captured breathtaking panoramas of the Marker Band Valley at two different times on April 8, 2023. The photos were subsequently merged and enhanced with color, infusing an artistic touch into the scene. The morning panorama was adorned with vibrant yellow hues while the afternoon panorama embraced soothing blues.



NASA/JPL-CALTECH

THE BEST PLANETARY SOCIETY ACCOMPLISHMENT THANKS TO THE SUPPORT OF OUR MEMBERS

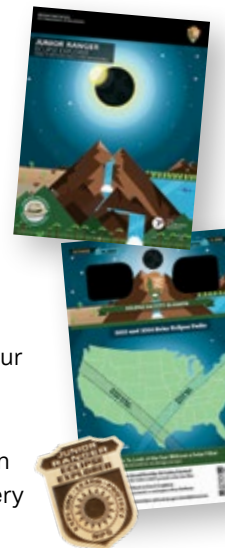
The Planetary Society coordinated a series of advocacy actions throughout the year to get funding for the VERITAS mission to Venus, the Mars Sample Return program, and the NEO Surveyor asteroid-hunting space telescope.

THE GREAT NORTH AMERICAN ECLIPSE IS JUST WEEKS AWAY. ARE YOU READY?

Here are some tips for enjoying the April 8, 2024 total eclipse experience whether or not you're in the path of totality.

1. Watch the eclipse with us. If you live in North America, use the map we made with The Eclipse Company to find the exact timing of the eclipse in your location, see how much of the Sun will be covered, and get an idea of the phenomena you might witness at your location. If you're elsewhere, you can watch a live stream of our Eclipse-O-Rama 2024 event, hosted by YouTuber Everyday Astronaut and our CEO, Bill Nye.
2. Make sure you're prepared for safe viewing! If you don't already have eclipse safety glasses, you can buy a Planetary Society-approved pair. Go to planetary.org/eclipse to find the link to our partner's online store and order yours today!
3. Check out all our latest eclipse content:
 - [A GUIDE TO SHARING ECLIPSES WITH KIDS](#)
 - [TIPS ON HOSTING AN ECLIPSE PARTY](#)
 - [HOW SONIFICATION TECHNIQUES CAN ALLOW YOU TO HEAR A SOLAR ECLIPSE](#)
4. If you have kids and will be in the United States, check out our partnership with the National Park Service's Junior Ranger program. Kids can complete an activity worksheet to earn a very cool eclipse explorer badge.
5. Take our free online course that's all about eclipses. Learn everything you need to know to truly appreciate and share the wonder of solar and lunar eclipses.

All of these great resources can be found at planetary.org/eclipse.




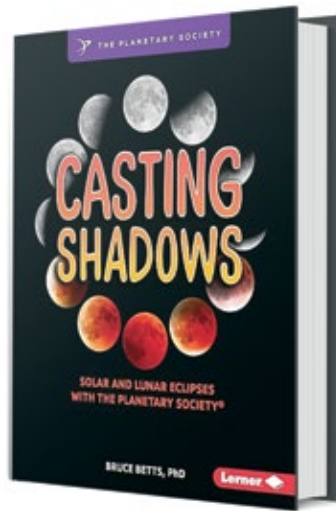
BELOW An example of some of the discussion topics available in the member community.

 ART, CULTURE, & FUN
Random
A space for whatever else you want to share and discuss!

 COMMUNITY LEARNING
Missions and Worlds
A space to share content on planets, moons, asteroids, and the missions to explore them

 GET ACTIVE
Look Up!
Share your skywatching stories, astrophotography work, telescope tips, and more!

 HOME
Announcements
The latest on the work your membership makes possible



A NEW PLANETARY ACADEMY BOOK SERIES

If you know kids who would love to learn more about eclipses, check out “Casting Shadows: Solar and Lunar Eclipses with The Planetary Society,” the first in a new series of kids’ books from The Planetary Society in partnership with Lerner Publishing. The entire series will include 15 Planetary Academy kids’ books on space and science that will be made available to school libraries across the United States.

YOUR MEMBER COMMUNITY

It has been a year since we launched The Planetary Society’s online member community. This is a space where members can learn more about space science and exploration, discuss their passions and interests, share their creative work, and have fun getting to know each other. Since its launch in March 2022, over 9,500 members have joined this virtual community.

The community also includes recurring events like our very popular monthly book club, where members can discuss a space-related book with the author. You can also take part in a weekly trivia contest, share and read scientific papers on space topics, and take online courses. There are so many ways to engage with awesome space content and even more amazing people to connect with. Find it all at community.planetary.org or on the Planetary Society app.

CALENDAR OF EVENTS

MARCH 19

March equinox

MARCH 25

Penumbral lunar eclipse (visible throughout all of North America, Mexico, Central America, and South America)

APRIL 8

Total solar eclipse (visible as a partial or total eclipse across North America)

APRIL 22-23

Lyrid meteor shower

MAY 6-7

Eta Aquarid meteor shower

JUNE 20

June solstice



LET'S GO BEYOND THE HORIZON

With the help of our members and donors like you, The Planetary Society seeks to connect everyone with the beauty, adventure, and promise of space exploration.

With a transformative goal of \$40 million, the **Beyond the Horizon: Creating Space for Everyone** campaign will grow and strengthen the Society and fuel our efforts to explore worlds, search for life, and defend Earth. And we need your support to get us there and help everyone come to know the Cosmos and our place within it.

Learn more and make your gift today at planetary.org/horizon



BELOW There are eight bodies in the Solar System that are between 2,500 and 5,300 kilometers (1,500 and 3,300 miles) in diameter. From left to right: Mercury, the Moon, Io, Europa, Ganymede, Callisto, Titan, and Triton.

NASA/JPL/TED STRYK/ALFREDO BALREIRA/SSI/EMILY LAKDAWALLA



IN THE SKY

Bright Jupiter is low in the early evening west through April, getting closer to the horizon as days pass. Reddish Mars is near yellowish Saturn in the predawn east in April, after which they get farther apart in the sky while both get higher as weeks pass. Mercury is low in the west soon after sunset in late March. On April 8, there will be a total solar eclipse visible in North America. The path of totality will begin in the Pacific Ocean, making landfall around Mazatlán in Mexico and will then cross Mexico into Texas and move across the U.S. to Canada, eventually reaching Nova Scotia. A partial eclipse can be seen from a much broader area including much of Mexico, the U.S., Canada, and Central America. More information can be found throughout this magazine and at planetary.org/eclipse. For more night sky tips, you can always check out planetary.org/night-sky.

RANDOM SPACE FACT

The last total solar eclipse visible in the contiguous United States occurred in 2017, and the next one will occur in 2045.

TRIVIA CONTEST

Our September equinox contest winner is Maya Wotjan of Klosterneuberg, Austria. Congratulations! The question was: **In our Solar System, how many moons are larger than Earth's Moon?** The answer: **Four. Ganymede, Titan, Callisto, and Io.**

Try to win a copy of the new book "Casting Shadows: Solar and Lunar Eclipses with The Planetary Society" by Bruce Betts and a Planetary Radio T-shirt by answering this question:

Besides the United States and Russia, what country has had the most people go to the International Space Station?

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 June 1, 2024. One entry per person. The winner will be chosen in a random drawing from among all the correct entries received.



IGUAZU FALLS IN THE ARGENTINIAN NATIONAL PARK

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!

ARGENTINA ANNULAR SOLAR ECLIPSE SEPT. 26 - OCT. 7, 2024

Discover the magnificence of Argentina, from Buenos Aires to thundering Iguazu Falls, including the "ring of fire" eclipse in historic coastal San Julian. Optional Easter Island pre-trip September 18 – 26, 2024

ALASKA AURORA BOREALIS FEB. 27 - MARCH 5, 2025

Come see the greatest light show on Earth! Explore the Kenai, take the train to Fairbanks, and delight in the ice festival and aurora in the night sky!

TAHITI TOTAL LUNAR ECLIPSE MARCH 6-16, 2025

A breathtaking opportunity to see the total lunar eclipse in this South Pacific paradise! Explore Tahiti and Moorea and then fly to legendary Bora Bora for the lunar eclipse. You have the option of staying in overwater bungalows in our lagoon-side hotel!

TANZANIA SAFARI & LUNAR ECLIPSE SEPT. 3-14, 2025

See the finest wildlife reserves in East Africa and the Total Lunar Eclipse! This is a tremendous experience for travelers to view the Milky Way over spectacular Ngorongoro Crater and the Serengeti.



PAT RAWLINGS

Eclipse from the Moon

Pat Rawlings

In this painting from artist Pat Rawlings, an astronaut peers through binoculars at a solar eclipse taking place on Earth. The scene is illuminated by earthshine, the Sun's light reflecting off our planet. Spacecraft have witnessed this view on behalf of humanity, capturing images like the one on the cover of this issue. To see it for yourself would be quite another experience. Pat Rawlings is a member of The Planetary Society and 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.