The AOH OBSERVER
Fall 2019

The Newsletter of the Astronomers of Humboldt

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The AOH Observer

Grace Wheeler: Editor/Staff Writer

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Fall Events

Saturday October 5. **International Observe the Moon Night and Public Observing at Arts Alive**. International Observe the Moon Night has been observed annually around the world since 2010. AOH will set up scopes at the Gazebo in Eureka for public observing, weather permitting, from 6 to 9 pm. Sunset isn't until 6:52 PDT, but both the third-quarter moon and Jupiter and Saturn will be favorably placed. In the event of overcast skies, this event will be self-canceling.

Friday, October 18, **College of the Redwoods Science Night. from 5:30-8:30 p.m**. https://www.redwoods.edu/Events/ScienceNight. We will be setting up displays in HU125. Look for telescopes outside HU125 if the sky is clear. Volunteers are needed, especially to run the kid's table. Contact grace@astrohum.org if you can help out.

For the dates below, check http://astrohum.org/upcoming.html for updates for time and location.

Saturday October 26. **Regular Monthly Meeting**.

Monday, November 11. **Transit of Mercury**. For our area, the transit will be in progress at sunrise. End of transit is at 10 a.m. http://www.eclipsewise.com/oh/tm2019.html.

November, date and location TBA. **Annual Business Meeting**.

Saturday November 2. **Public Observing at Arts Alive**.

Saturday November 2. **Kneeland School Fall Festival**. The AOH will be there doing astronomy.

Saturday November 23. **Regular Monthly Meeting**.

Saturday December 7. **Public Observing at Arts Alive**.

Friday December 13. **Geminid Meteor Shower**.

Saturday December 28. **Regular Monthly Meeting**.

AOH Public Observing and Outreach Events: Summer 2019

The AOH is grateful to the following volunteers for helping out with our summer outreach events and Kneeland Star Parties:
Jeff Goodman, Tanya Hunter, Mary Kaufman, Greg Deja, Brent and Catrina Howatt, Ken Yanosko, Mark Wilson, Yoon Kim, Mark Mueller, Lisa Hockaday, Becky Chambers, Bea Asmundardottir, Russ Owsley, Joey D'ambra, Dean and Marian Hancock, Don and Grace Wheeler.
Thank you all for sharing your enthusiasm and your knowledge of all things astronomy.

June 22, 2019. Star Party at Humboldt Redwoods State Park. The first star party of the season was at Albee Creek. The excitement before the start of the party was a 5.6 magnitude earthquake (5 miles SW of Petrolia). Our telescopes survived the shaking. The stars came out at about 9:30, and the park visitors were shown some amazing sights through the scopes: double stars (Albireo, Mizar), globular clusters (M5, M13), a galaxy (M82), and a planetary nebula (M27). Jupiter finally cleared the trees at 10:45 p.m. and the visitors saw the bands of Jupiter and the four Galilean moons. There were about 60 attendees in all. The AOH astronomers were Grace, Becky, Bea, Brent, Jeff, and Tanya. The AOH thanks Ranger Mary Kaufman and the staff at HRSP for their help in organizing the star party. (Report and photos by Grace Wheeler)

Brent and Becky were the main presenters at Albee Creek.

Brent and his C-8 aimed at the M13 globular cluster.

Observing the M5 globular cluster through Grace's C-8.

Visitors gathered around Becky's Dob.

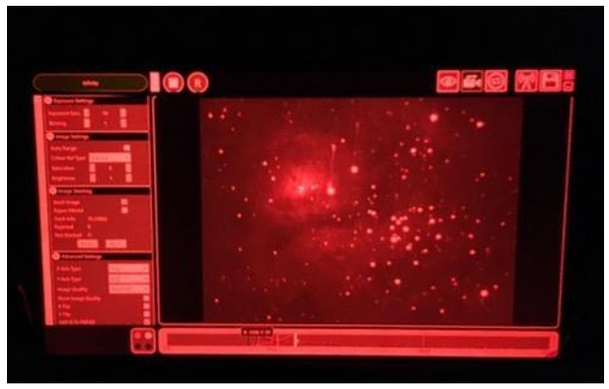
Our newest volunteer Tanya being sworn in as a Junior Ranger by Mary.

The veteran astronomers of Albee Creek were presented the California State Park's "Saber Cat" patches. L-R: Brent, Mary, Bea, Becky, and Jeff.

6/29/2019. Kneeland Airport Public Observing. We had clear skies at Kneeland Airport with chilly but slightly windy conditions. We saw Jupiter, Saturn, a few globular clusters, galaxies, open clusters, and binary systems. Present were Ken, Yoon, Grace, Don, Dean, Brent, Catrina, Frank; former members Shirley and Andrew; and prospective new member Gary. Grace transmitted live images from her telescope with the Atik Infinity Camera. Brent showed off his new AWB OneSky tabletop Dob. Frank demonstrated his new equatorial platform for his Dob. The party broke up around 11:15 p.m. (Report by Ken Yanosko; image credit: Grace Wheeler)

Admiring the AWB OneSky Dob telescope. (L-R) Don, Dean, Ken, Brent, and Yoon

M51, Whirlpool Galaxy in Canes Venatici



M8, Lagoon Nebula in Sagittarius.

7/20/2019. Star Party at Humboldt Redwoods State Park. The AOH (Grace, Mark M, Jeff, and Lisa) along with the staff of HRSP (Mary and the volunteers), commemorated the 50th anniversary of the moon landing with a star party at Burlington Campground. Pre-party activities included a planet walk, gravity well demonstration (which we tied into the moon landing), and lessons on using the Astroscan telescopes (aka "hippie scopes"). It was a fun evening with long lines of stargazers patiently waiting for a turn at the telescopes. Jeff and Grace showed the visitors the double star Albireo, the Hercules globular cluster, and the Ring Nebula. Mark and Lisa had their scopes aimed at Jupiter and its four moons. A shout out to our volunteers who labored under challenging conditions (tall trees, a fog bank, and blustery winds). Thank you to the attendees whose enthusiasm for learning made it an enjoyable evening.

Observing Albireo through the C-8.

Ranger Mary using the gravity well to illustrate the orbit of the planets around the sun.

Visitors learned to aim and focus telescopes.

Lisa and Mark were awarded their Junior Ranger Badges.

July 27. 2019. Get Out and Play Day at Sequoia Park in Eureka. Grace, Mark W, and Ken set up tables and telescopes and interacted with the public. Big hits were the gravity well, NASA and solar system stickers and handouts, and Grace's Lego Sun-Earth-Moon orrery. We also observed the Sun with a Sunspotter Solar Telescope (no spots, though) and the Moon (until the trees got in the way) with binoculars, an Astroscan, and a couple of Galileoscopes. Thanks to Joey, Don, and Sharon for dropping by and helping out. We made contact with a couple hundred kids and adults. (Report by Ken Yanosko; photos by Grace Wheeler)

The Lego Sun-Earth-Moon Orrery

Joey doing a demonstration of the gravity well.

Aiming the Astroscan at the Moon.

Mark Wilson using the Sunspotter to safely observe the sun.

Ken showing visitors the parts of the Astroscan telescope.

Ken explaining the scale of the solar system.

August 3, 2019. Regular Monthly Meeting. We had a great evening at Kneeland Airport. There were over 20 people, including new members Neesh, Charles, Alex, and Demi, old members Grace, Don, Ken, Yoon, Joey, Russ, Jeff, Greg, Margaret, Casey, Henry, Mark M, and Lisa, a couple of Boy Scouts and family members (Will, Tim, Ketcher, and Jennifer) from troop 99, and guests from as far away as New York (Karen) and Maryland (Sam). We enjoyed a terrific sky up above the marine layer that socked in the coast. Grace set up a planet walk along the runway. There were seven to eight telescopes that were set up, and we all hopped from eyepiece to eyepiece comparing views of the young moon, Jupiter and Saturn, globular and open clusters, and distant galaxies. The ISS put in an appearance, as did a few early Perseid meteors, and one sporadic south-to-north fireball. (Report by Ken Yanosko; Photos by Grace Wheeler)

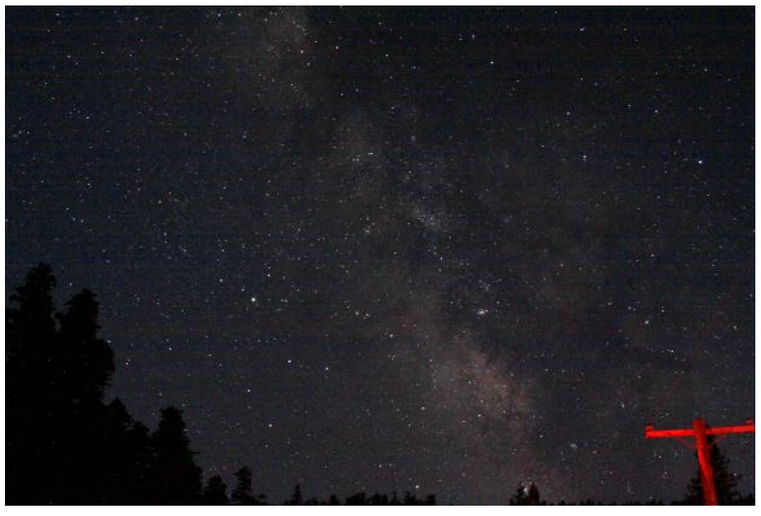
New members Demi, Neesh, Alex, and Charles attending their first star party.

Don setting up the planet walk along the runway.

Yoon observing the moon through the C-8.

Joey's Dob had the best views of Saturn and M13 of the night.

Observing Jupiter at sunset through the C-6.



The Milky Way at Albee Creek (Image credit: Martin Zapata, Yorba Linda, CA).

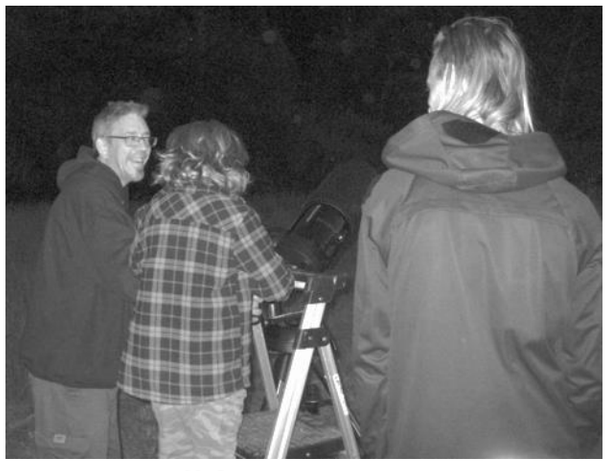
August 17, 2019. HRSP Star Party at Albee Creek. The AOH volunteers were Ken, Mark W, Jeff, Brent, and Grace. The attendance (53) was lighter than usual so we were able to observe and answer questions at a relaxed pace. On the viewing list were Jupiter and the four Galilean moons, Saturn with its rings, globular clusters (M13, M5, M22), the Lagoon Nebula, Bode's Galaxy, the Dumbbell Nebula, and the double-star Mizar. It was an excellent way to spend a late summer evening, and much of the credit goes to our dedicated AOH volunteers. We thank Ranger Mary Kaufman, and the HRSP volunteers for their help in organizing this event. A special thank you goes to visitor Martin Zapata who was kind enough to send us a picture of the Milky Way rising at Albee Creek. (Report by Grace W; Photos by Grace W., unless otherwise stated.)

HRSP Volunteers (Photo credit: Mary Kaufman).

AOH volunteers: Ken, Brent, Mark W, and Jeff.

Viewing M22 through Mark's refractor.

Ken with young astronomer observing Jupiter.



This was Jeff Goodman's third outing to HRSP this summer. Thanks, Jeff!

The AOH gave Mary her very own "Space Ranger" badge at the end of the Night.

Grace with visitor Martin Zapata (Photo Credit: Mary Kaufman).

Mark W and Ken taking the Jr. Ranger Oath from Mary.

August 31, 2019. Regular Monthly Meeting. We met at Kneeland Airport under clear skies. Members present were Grace, Don, Ken, Yoon, Brent, Catrina, Frank, Maggie, Jeff, and Russ. Guests included Albert, Stephanie, Coleton, Serenity, Sarah; cub scouts from Pack 28: Alex, Dexter, Noah, Isaiah, Samuel; and cub parents Ryan, Marissa, Mike, Tom, Megan. We had a variety of scopes on hand: 17.5-inch Dob, 6- and 8-inch SCTs, a couple of Newtonians, and a 4-inch apo-refractor. We also had some "kid friendly" scopes, i.e., an Astroscan and Galileoscopes, that the scouts used to find the moon and Jupiter. The early part of the evening was devoted to viewing the crescent moon, Jupiter, and Saturn. After dark, we turned our attention to globular clusters, galaxies, open clusters, and star-forming regions. Russ gave an excellent tour of the constellations. Balmy temperatures and a transparent sky made it one of the best observing sessions in recent memory. It was the perfect way to celebrate the end of summer.

The Galileoscopes are part of the “AOH Galileoscope Loan Program” which loans telescopes to schools and youth groups. Information about loan program can be found at http://astrohum.org/galileoscopes.html.

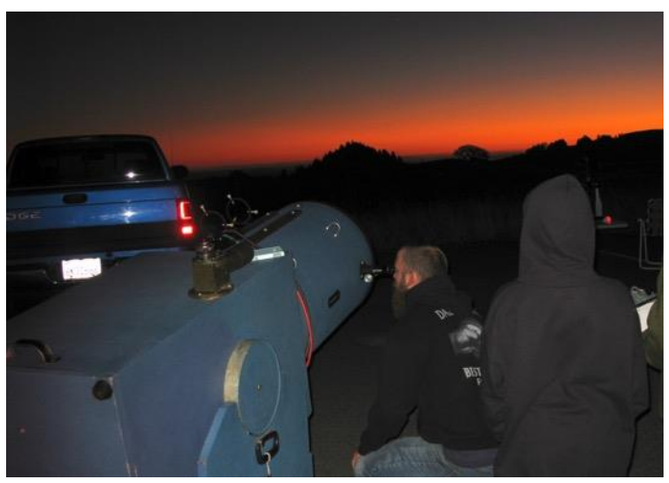
(Report was written by Ken Yanosko and Grace Wheeler;
Photos were taken by Catrina Howatt and Grace Wheeler.)

Yoon aiming the Astroscan at the moon while Noah patiently waits his turn. (Photo credit: Catrina Howatt)

Catrina, Brent, Yoon, and Ken setting up the 17.5 inch Dob. (image credit: GDW)

Maggie, Grace, and Frank with the Clifford Family who brought their Newtonian Telescope for its “first light.” (image credit: Catrina Howatt)

Cub Scouts Dexter, Noah, and Alex and Scout parent Marissa lined up to view Jupiter through Ken’s C-8. (image credit: GDW)



One of the parents viewing the crescent Moon through the 17.5 inch Dob. (Image credit: GDW)

Alex, Isaiah, Dexter, and Noah lined up to use the Galileoscopes to view The moon. (image credit: Catrina Howatt)

Dexter using the controls of the tripod to aim the Galileoscope at the moon. (Photo credit: Grace W.)

The AOH Galileoscope Loan Program

Report and images by Grace Wheeler

The AOH Galileoscope Loan Program was launched in the spring of 2019 with the mission to loan out good quality, simple-to-use telescopes to schools and youth groups. The goal is to introduce astronomy to school-age children, and the Galilescopes enable students to observe the moon, planets, and other bright objects in the sky. For more advanced students, the Galileoscope can be disassembled into components (Fig. 2) and rebuilt. By constructing the Galileoscope from scratch, students learn about light, optics, and how parts of the telescopes work together to gather light and make an image. More teaching resources for the Galileoscope are available on the NOAO "Teaching with Telescopes" website.

The AOH acknowledges these organizations/companies for their help in getting Galileoscope Loan Program off the ground: (1) The Galilsoscopes were a gift from the Astronomical Society of the Pacific; (2) The tripods were funded through a grant of the "Gerald O. and Susan Hansen Family Fund", a fund of the Humboldt Area Foundation; (3) Helio-Pods Sun Finders were provided at a discount from FAR Laboratories.

What comes in the Galilesocope Package

The Galileoscope is a 50 mm refractor telescope with a focal length of 500 mm. The lenses in the loan package include a 20 mm Plossl eyepiece which gives a magnification of 25x, a 17x Galilean eyepiece which simulates the view that Galileo had through his original telescope, and a Barlow lens which increases the magnification of the telescope to 50X. The Galileoscope comes with built-in sight posts (Figs. 2, 3a, 4a) which facilitate aiming the telescope during daytime viewing. For night use, a red-dot sight is used to increase the accuracy of pointing the telescope at objects in the night sky. Each loaner telescope comes with an adjustable height tripod which controls the movement of the telescope and is a stable platform for viewing. For more experienced users interested in observing the sun, solar filters and Helio-pod Sun finders are available upon request.

Figure 1. The Galileoscope can be disassembled into components. Shown are the lenses and the components that make up the focuser and body of the telescope.

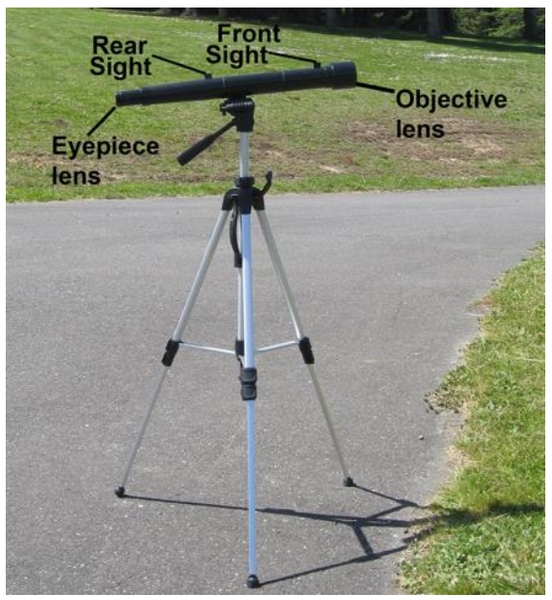


Figure 2. A Galileoscope mounted on a tripod.

Figure 3a. Aiming the Galileoscope at the moon. The moon is lined up with the sight posts.

Figure 3b. View of the moon through the eyepiece.

Figure 4a. Aiming the Galileoscope at a tree using the sight posts.

Figure 4b. View of the tree through the eyepiece.

Viewing Objects at Night with the Galileoscope

For stargazing, we use a red-dot sight on the Galileoscope to aim at specific targets in the night sky. Celestial objects that can be seen with the Galileoscope include the Moon, Venus, Jupiter, Saturn, star nurseries (Lagoon and Orion), globular clusters (M13, M22), open clusters (Pleiades, Double Cluster), and the Andromeda Galaxy.

The images taken below were attained by eyepiece projection with a Pentax Q7 attached to a 25 mm lens. The Galileoscope was attached to a tracking mount to allow for longer exposures. (Image credit: GDW)

Figure 5. Galileoscope with a red-dot sight.

The Moon (1/60 s exp., ASA 100)

Jupiter and Galilean Moons (1/5 s exp., ASA 800)

Saturn (1/40 s exp., ASA 400)

Andromeda Galaxy (25 s exp., ASA 400)

Orion Nebula (20 s exp., ASA 400)

Pleiades (20 s exp., ASA 400)

The Galileoscope Roll-Out

During the spring and summer, the AOH brought the Galileoscopes to outreach events and encouraged the public to test out the scopes. We were keen on finding out how easy or hard it was for school-age children to use the telescopes. With young children (grades 1-5), adult help is needed to operate the scopes. The older children and teens were capable of aiming and focusing the Galileoscopes independently once they received instructions. The majority of the youths were interested in the telescopes and expressed excitement when they were able to aim and focus the telescopes.

We thank the students of Kneeland School and the Scouts of Troop 28 for their help in testing out the Galileoscopes. We also thank the attendees at “Get Out and Play” for visiting our telescope display and using the Galileoscopes.

Transit of Mercury 2019

by Grace Wheeler

Mercury will be transiting the disk of the Sun on November 11th, 2019. From our location, the transit will be in progress at sunrise at which point Mercury will be about half-way across the solar disk. The transit can be viewed safely by correctly outfitting your telescopes with a solar filter, or by using solar projection devices such as a "Sunspotter" or "sun funnel." Never look at the sun without the appropriate protective gear.

The last Mercury transit was on May 9th, 2019 (Fig. 1) and members of the AOH observed this event at Kneeland Airport. While we lucked out in having excellent weather for the May 2016 transit, optimism if low for the upcoming November transit. There is a good chance of overcast skies. As the date of transit draws nearer, check the event page of http://astrohum.org to find out if there are any viewing opportunities either locally or online.

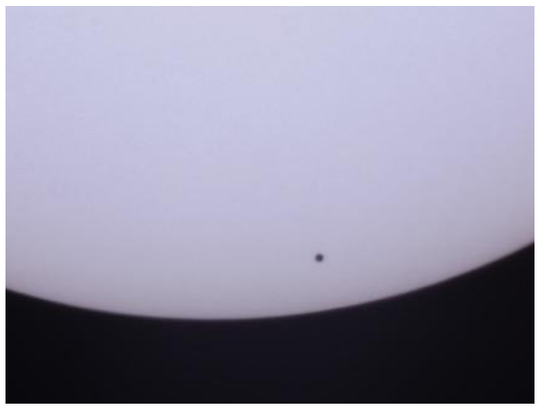


Figure 1. A close up of the Mercury transit on May 9, 2016. This was imaged through a SCT-8, Pentax Q-7. (Photo credit: GDW). A video showing the egress of Mercury can be found here: https://youtu.be/5POGazwf9Ak

The phases of Mercury and why are transits are rare

Mercury is the innermost planet and orbits the sun every 88 days. Earth orbits the sun at a more leisurely pace of 365 days, and about three times a year, Mercury catches up and overtakes Earth. The point at which Mercury catches up to Earth is at inferior solar conjunction when Mercury is directly between the Earth and Sun (Fig. 2A). Inferior solar conjunction occurs every 116 days.

Innermost planets such as Mercury and Venus show phases which as seen from Earth correspond to full, gibbous, quarter (notably occurring at elongation), crescent, and new (Fig. 2A). The phases of inner planets is akin to aspects of the phases of the Moon during the lunar cycle. The new phase of Mercury occurs during inferior solar conjunction, and this is the phase that we see during a transit (Fig. 2A).

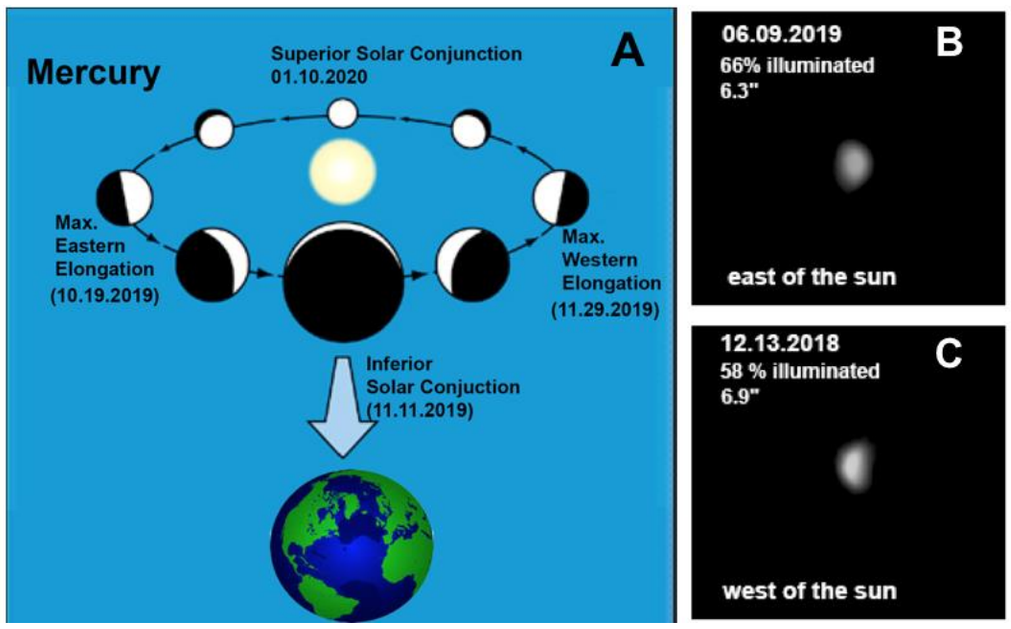


Figure 2. (A) The phases of Mercury and changes in apparent size as seen from the Earth (image modified from ESO). (B) Mercury in waning gibbous phase on 6/9/2019 when it was east of the sun (C) Mercury just past quarter phase when it was west of the sun on 12/13/2109 (image credit: GDW).

Mercury's orbit is tilted seven degrees to the orbital plane of the Earth. Even though inferior solar conjunctions occur about three times a year, these often happen when Mercury is above or below Earth's line of sight. For transits of Mercury to be visible from Earth, two events must occur: (1) Mercury is in inferior conjunction, and (2) the respective orbital planes of Mercury and Earth intersect. In the case of the latter, Mercury crosses the plane at Earth's orbit twice a year at nodes twice a year (Fig. 3). These nodes are on opposite sides of Earth's orbit and correspond to dates at the beginning of May, and the beginning of November. Inferior solar conjunction of Mercury occurring at or near a node will result in a visible transit of Mercury. Because it is rare that these two events happen together, transits of Mercury occur only 13-14 times in a century, and when it does happen, are in May or November.

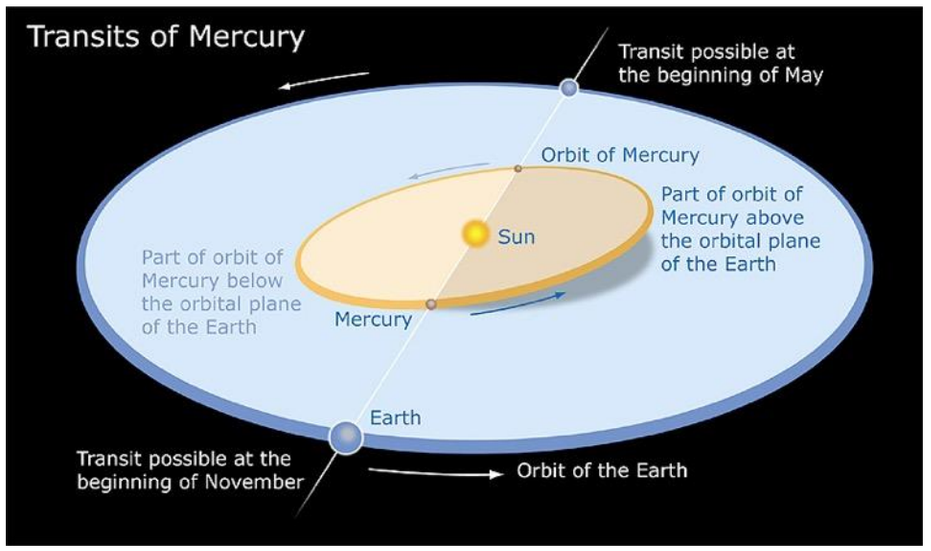


Figure 3. The orbit of Mercury is tilted 7 degrees to the orbital plane of Earth. Shown above are the two nodes (November, May) where the orbit of Mercury intersects that of Earth's. (Image credit: ESO)

The view of the transit from the Eureka

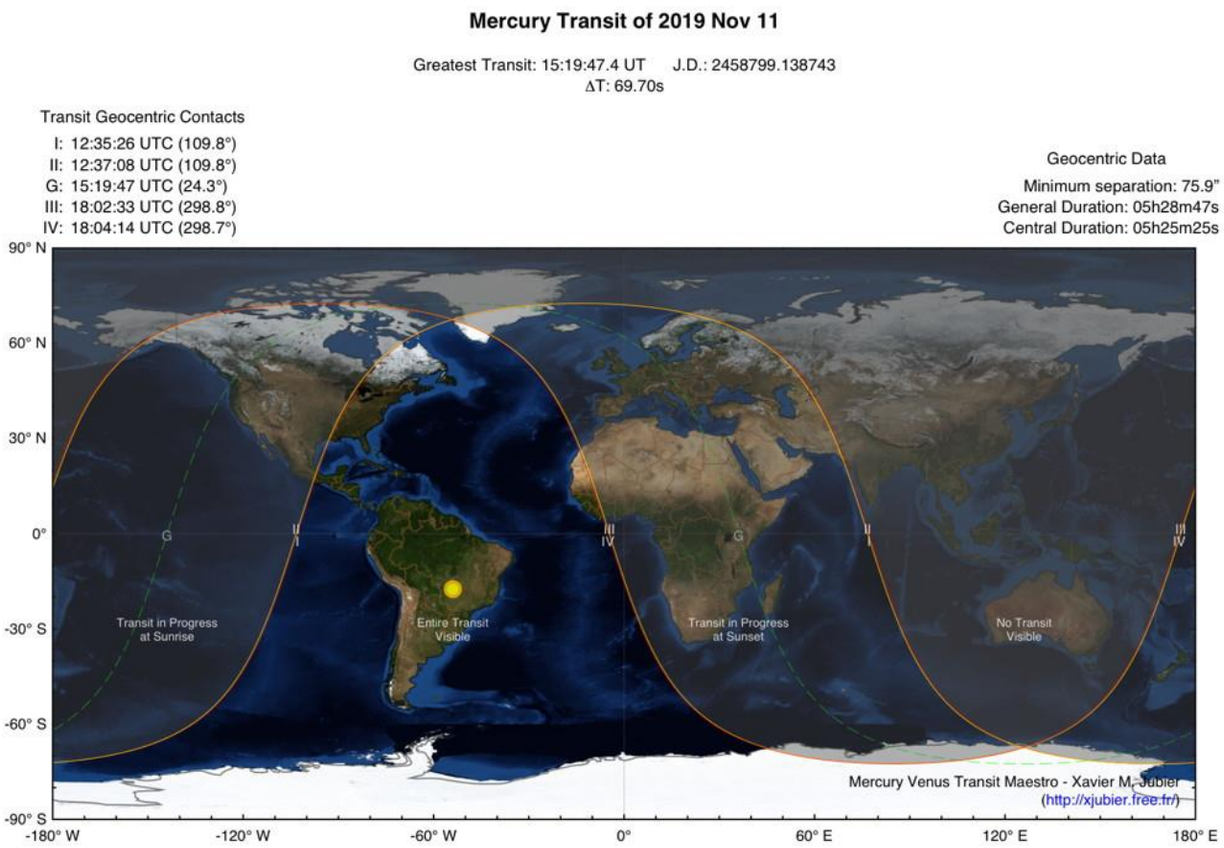


Figure 4. The Global Visibility Map of the 2019 Transit of Mercury showing the locations of where the transit will be visible.

The map is republished with kind permission from Xavier Jubier. More information and interactive tools can be found:
http://xjubier.free.fr/en/site_pages/transits/ToM_2019.html

In the United States, observers on the east coast will be able to view the entire transit of Mercury from ingress occurring at 7:35 a.m. to egress at 1:04 p.m. EST (Fig. 4). On the west coast, specifically Eureka, CA, Mercury will be about half-way through its transit at sunrise (Fig. 5.) The egress of the disc occurs at 10:04 a.m. PST.

A Telescopic view of the Mercury Transit

The sun should never be viewed directly without protective solar filters.

Mercury is the smallest planet in the solar system, and even though it is one of five visible planets in the night sky, its small size and distance from Earth can make it difficult to see without a telescope. For those of us who were fortunate to witness the 2012 transit of Venus, the silhouette of Venus could easily be seen with the unaided eye or binoculars. For the Mercury transit, the disk is minuscule, and even with a telescope, it is tiny dark spot. Because Mercury has no atmosphere, the silhouette is sharp and round and differs from sunspots which tend to be diffuse and irregular in shape. During the May 9, 2016 transit, we were fortunate to observe both the silhouette of Mercury and sunspots (Fig. 6).

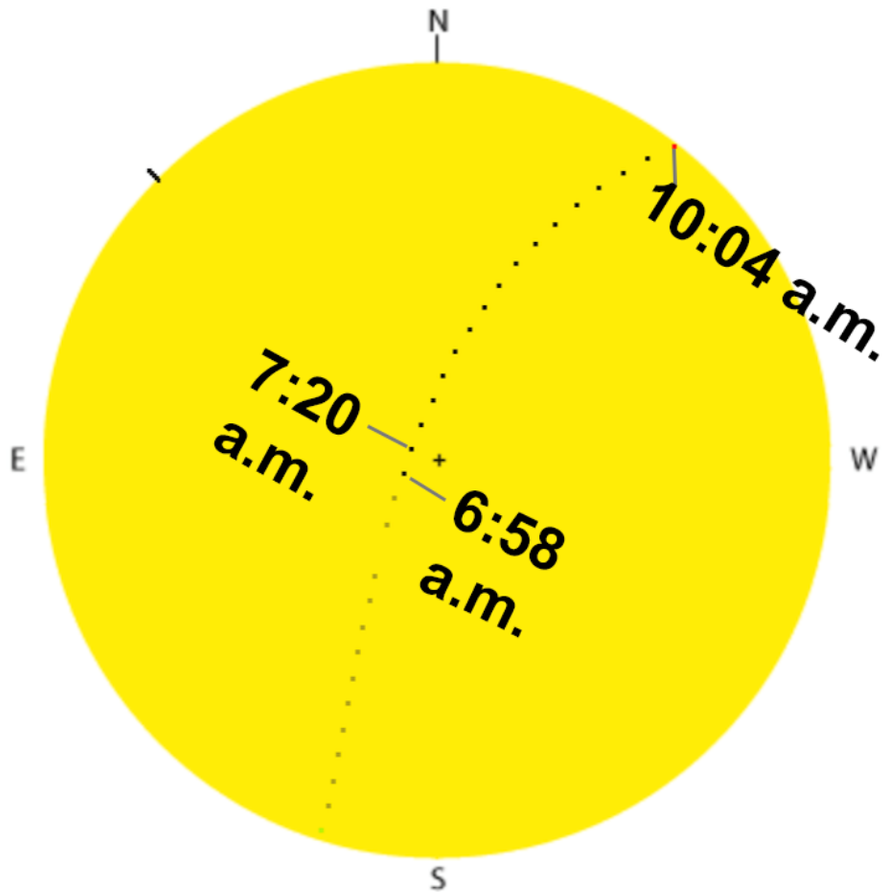


Figure 5. The transit path of Mercury as seen from Eureka, CA (PST). The transit will be visible at sunrise (6:58 a.m.) The midpoint of the transit (the greatest instant) is at 7:20 a.m. Egress of Mercury is at 10:04 a.m. The path was generated the Xavier Jubier's Transit Map Calculator. The image was modified show the part of the transit that will be visible from Eureka.

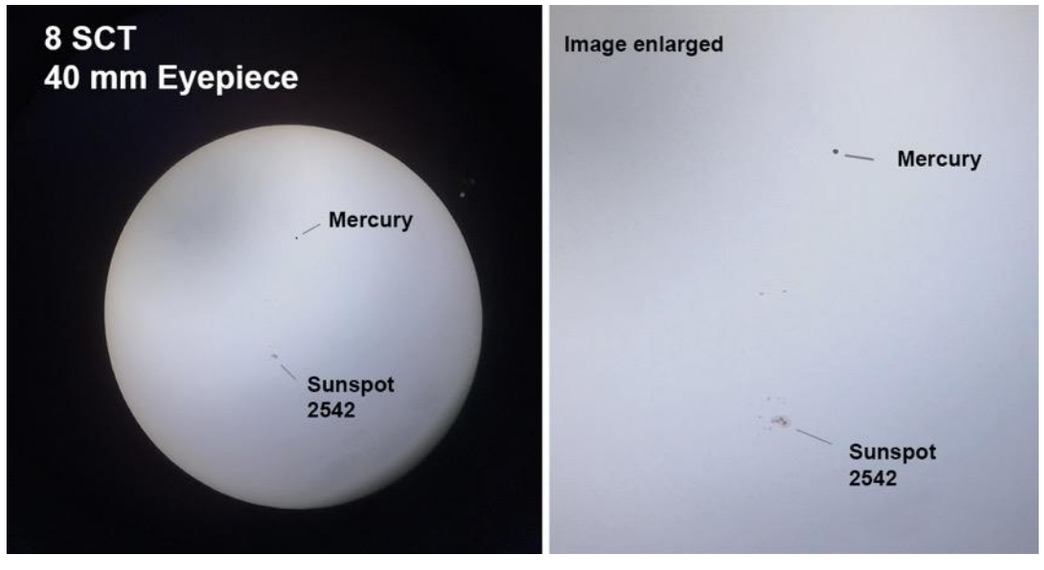


Figure 6. The view of the transit of Mercury (May 9, 2016) through an 8 inch SCT with a 40 mm eyepiece. (Image credit: GDW)

Tips for viewing the Mercury Transit

An unobstructed view of the southeastern horizon is needed to view the November transit of Mercury. The sun will have a low altitude, and even at 9 a.m., the sun will only be 18 degrees above the horizon. Kneeland Airport is an ideal location, but keep in mind, permission is needed from the County to set up a telescope at the airport, especially during the daytime.

As mentioned in the previous section, a telescope or high powered binoculars are required to observe the Mercury transit. The solar filter should cover the front end of the telescope or binoculars. Do NOT use solar filters that attach to the eyepiece. Check the solar filter for damage before using it. Be sure to cover the finder scope on the telescope.

The safest way of viewing the Sun is to use solar projection. For the 2016 transit of Mercury, we used a Solarscope (Fig. 7) and a sun funnel attached to a 4-inch refractor telescope (Fig. 8) to project the sun. Both devices provided enough magnification to see the transit of Mercury. An added benefit is that many people can view the transit at the same time.

Figure 7. AOH members Dan and Ken, and guest Craig at the May 9, 2016 transit of Mercury. Both Ken and Craig have solar filters on the front end of their telescopes. Dan set up the Solarscope to project the sun

Figure 8. Sun funnel inserted into the diagonal of a 4-inch GoTo refractor telescope. (Image credit: GDW)

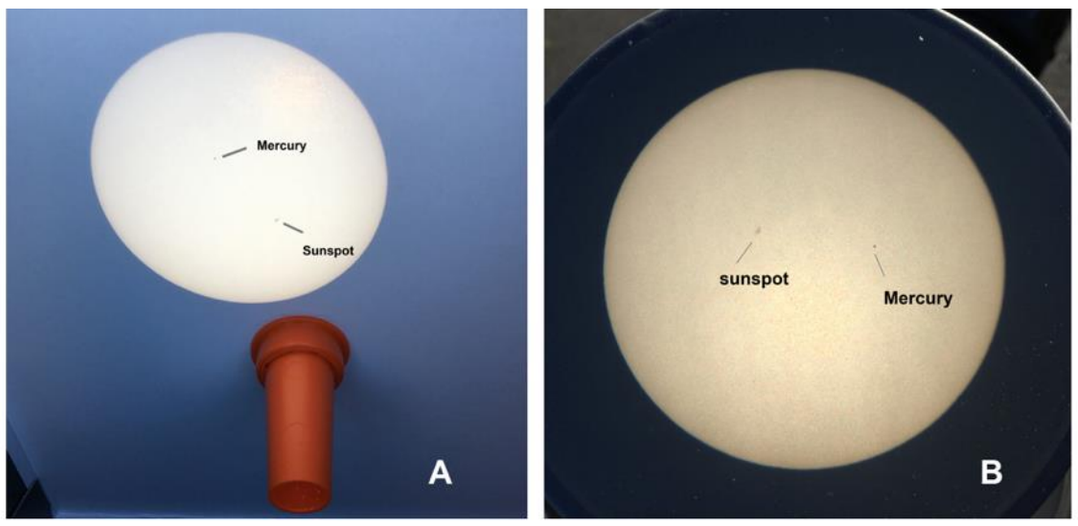


Figure 9. Mercury transit viewed on (A) Solarscope and (B) sun funnel.

Why we should care about the Mercury Transit of 2019

Historically, the transits of Venus, and to a lesser extent, Mercury, were instrumental in determining the distance between the Earth and the sun by use of the solar parallax method. The 1761 and 1769 transits of Venus gave the first concrete value to the sun's distance from the Earth, and the scale of the solar system. Today, we use transits to detect exoplanets, i.e., planets outside of our solar system that are orbiting other stars. In transit photometry, the dimming of a star assumes the passage of an extrasolar planet between Earth and the star. The degree that a star dims, and duration of dimming, is used to infer the size of the exoplanet and orbital period, respectively. Because some starlight will pass through the atmosphere of an exoplanet as it transits, spectroscopy can be used to study their atmospheric composition. Astronomers have used the transits of Venus and Mercury to practice and refine their methods for studying extrasolar planetary transits.

For many of us, the 2019 transit of Mercury will the last time for us to easily see such an event. Although there is are transits of Mercury in 2032 and in 2037, neither of those are visible in the U.S. The next transit of Mercury that will be visible in the U.S. will not occur until 2049. Whether you are watching the 2019 transit of Mercury live or online, I hope you will appreciate the awesomeness of it.

Find Strange Uranus in Aries

David Prosper

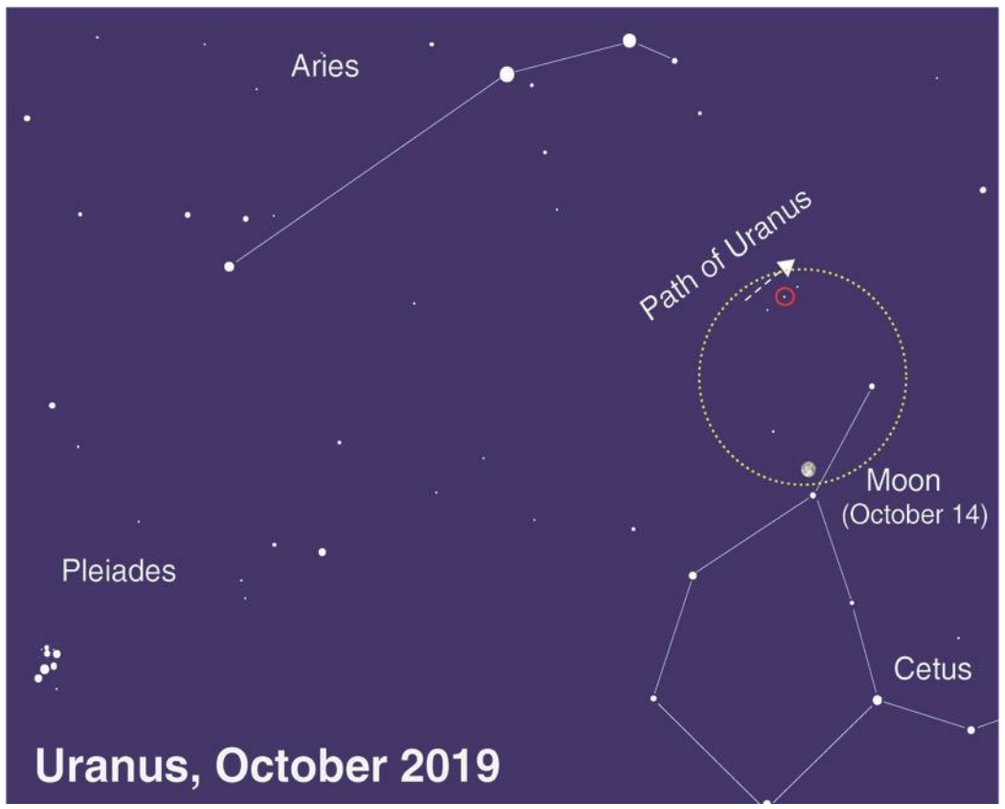
Most of the planets in our solar system are bright and easily spotted in our night skies. The exceptions are the ice giant planets: Uranus and Neptune. These worlds are so distant and dim that binoculars or telescopes are almost always needed to see them. A great time to search for Uranus is during its opposition on October 28, since the planet is up almost the entire night and at its brightest for the year.

Search for Uranus in the space beneath the stars of Aries the Ram and above Cetus the Whale. These constellations are found west of more prominent Taurus the Bull and Pleiades star cluster. You can also use the Moon as a guide! Uranus will be just a few degrees north of the Moon the night of October 14, close enough to fit both objects into the same binocular field of view. However, it will be much easier to see dim Uranus by moving the bright Moon just out of sight. If you're using a telescope, zoom in as much as possible once you find Uranus; 100x magnification and greater will reveal its small greenish disc, while background stars will remain points.

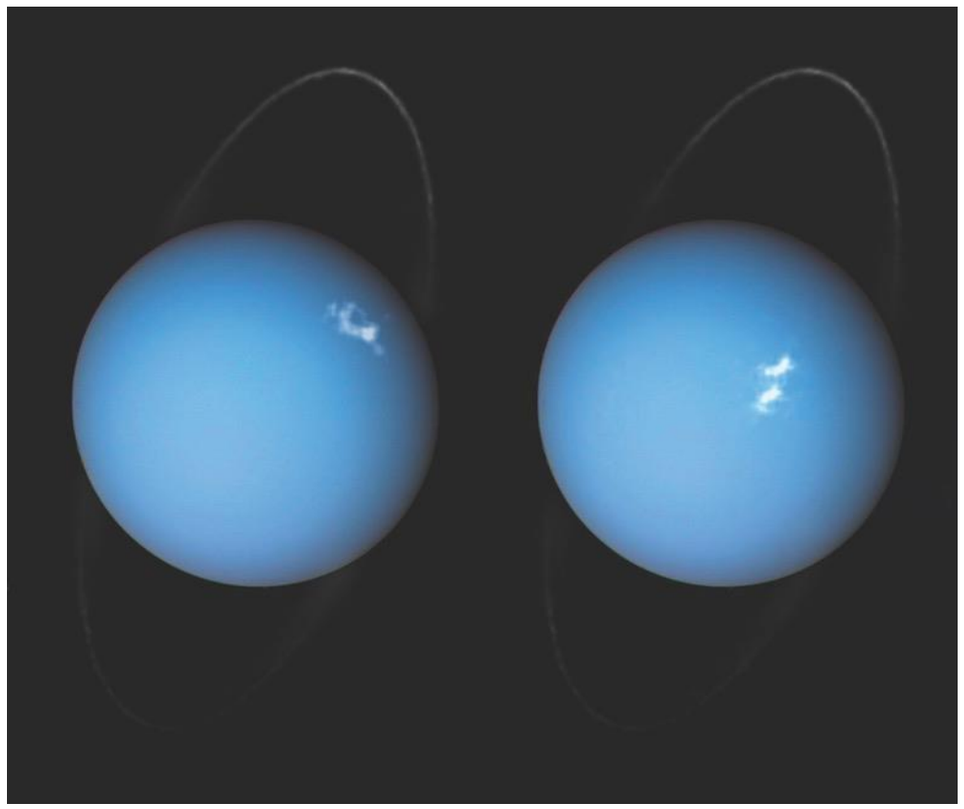
Try this observing trick from a dark sky location. Find Uranus with your telescope or binoculars, then look with your unaided eyes at the patch of sky where your equipment is aimed. Do you see a faint star where Uranus should be? That's not a star; you're actually seeing Uranus with your naked eye! The ice giant is just bright enough near opposition - magnitude 5.7 - to be visible to observers under clear dark skies. It's easier to see this ghostly planet unaided after first using an instrument to spot it, sort of like "training wheels" for your eyes. Try this technique with other objects as you observe, and you'll be amazed at what your eyes can pick out.

By the way, you've spotted the first planet discovered in the modern era! William Herschel discovered Uranus via telescope in 1781, and Johan Bode confirmed its status as a planet two years later. NASA's Voyager 2 is the only spacecraft to visit this strange world, with a brief flyby in 1986. It revealed a strange, severely tilted planetary system possessing faint dark rings, dozens of moons, and eerily featureless cloud tops. Subsequent observations of Uranus from powerful telescopes like Hubble and Keck showed its blank face was temporary, as powerful storms were spotted, caused by dramatic seasonal changes during its 84-year orbit. Uranus's wildly variable seasons result from a massive collision billions of years ago that tipped the planet to its side.

Discover more about NASA's current and future missions of exploration of the distant solar system and beyond at nasa.gov.



Caption: The path of Uranus in October is indicated by an arrow; its position on October 14 is circled. The wide dashed circle approximates the field of view from binoculars or a finderscope. Image created with assistance from Stellarium.



Caption: Composite images taken of Uranus in 2012 and 2014 by the Hubble Space Telescope, showcasing its rings and auroras. More at bit.ly/uranusauroras Credit: ESA/Hubble & NASA, L. Lamy / Observatoire de Paris

Extreme Life and Where to Find It

By Kimberly M. S. Cartier

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Life finds a way in the most extreme environments on Earth and sparks the imagination about far-off places where we may yet find it.

On Earth, creatures like this sea spider survive in the deep ocean without ever seeing daylight. Studying how life survives in the deep, dark ocean could give us insight into the underground oceans of Europa, Calisto, Ganymede, Enceladus, Titan, and Triton. Credit: Scott C. France, Bahamas Deep-Sea Corals 2009 Exploration, NOAA-OER, CC BY-SA 2.0

When scientists talk about the search for life in the cosmos, they often leave out a few key words: life *as we know it on Earth*. That usually means three things: liquid water, complex chemistry, and an energy source. It's not a perfect definition of what's required for life, but it's as good a starting point as any.

But life *as we know it on Earth* can get pretty darn weird. Extremophiles can thrive in the most inhospitable places and make our planet seem less like a documentary and more like an episode of *The X-Files*—the X-philes, perhaps. We haven't found any life beyond Earth yet, but here are five extreme environments on Earth in which life has managed to find a way and the distant worlds where we might look for their cosmic cousins.

A Martian Desert in Chile

The Atacama Desert's rocky terrain, dried salt lake beds, and hyperarid climate make it challenging for life to gain a foothold. And yet the Atacama is home to insects, reptiles, occasional fields of flowering plants, and a few mammal species adapted to live in its extreme ecosystem.

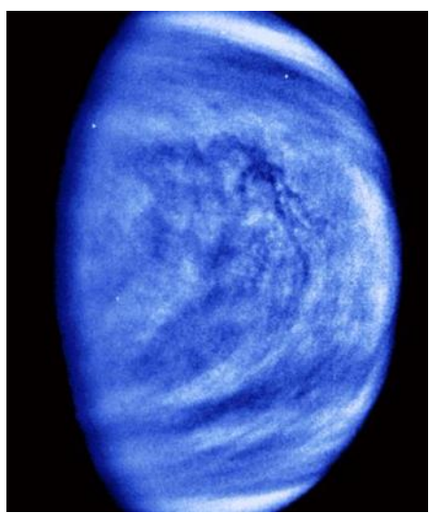
On the basis of its looks, the Atacama has often stood in for Mars in movies and TV shows, but portions of it are actually a good scientific analogue for Mars's soil and climate, too. Oxalate minerals, found in both places, break down through biological Processes and play a role in the carbon cycle of the Atacama. Scientists think the minerals could also do the same on Mars and serve as a potential biosignature for the dry limit of life. .

The hyperarid Atacama Desert can bloom with flowers. Credit: Javier Rubilar, CC BY-SA 2.0

Venusian Clouds in Earth's Atmosphere

Life on Earth doesn't live just on the surface and in the oceans. It also floats in the clouds. Microbes including bacteria, mold spores, pollen, and algae have all been detected in various regions of Earth's atmosphere, lofted by storms and impacts and dispersed by the wind to other locations.

The same might be true of Venus's lower atmosphere, where conditions are much more temperate than on its surface. "Among the plausible niches for extraterrestrial life in our solar system, the clouds of Venus are among the most accessible and among the least well explored," planetary scientist David Grinspoon said at a forum in May 2018. A study last year explored the idea that sulfur-eating, acid-resistant, and UV-absorbing bacteria similar to those found on Earth could thrive in Venus's atmosphere.



Viewing Venus in visible and ultraviolet light reveals dark streaks from an unknown UV absorber. Credit: JPL/NASA

Otherworldly Ice Blades in the Andes

Sharp blades of ice carved by sunlight cling to the sides of Andean slopes. Scientists recently discovered that these penitentes are home to microbial life that survives the intense sunlight, dry air, and icy surface. “I think it’s the first discovery of microbes on penitentes,” microbial ecologist Steve Schmidt told *Eos* earlier this year. “Nobody ever thought to look for them.”

Penitentes, like these in the Atacama Desert, have been detected elsewhere in the solar system. Credit: European Southern Observatory, CC BY 4.0

Beyond Earth, penitentes have been detected on Pluto and are suspected to exist on Jupiter’s moon Europa. Studying these snow algae on Earth could give clues to how much aridity, ultraviolet radiation, and altitude life can withstand.

Titan’s Chemical Cocktail in Arctic Lakes

Titan is always near the top of the list of places to search for life beyond Earth because of its abundant surface liquid and exotic chemical composition ideal for chemotrophs to munch on. The discovery of vinyl cyanide in the moon’s atmosphere was particularly exciting for astrobiologists, as the molecules could theoretically combine with methane in Titan’s lakes to make the compounds that form cell walls.

Methane lakes on Earth are hard to find but are becoming more common in the Arctic as permafrost thaws. For the past decade, scientists have been monitoring how Arctic lakes are responding to global warming. As the permafrost melts, it releases methane gas created by biological processes and trapped in ice. Although the Arctic lakes are still composed primarily of water—something frozen rock-solid on Titan—studying their ecosystems as they become more methane rich can give insight into not only our own planet’s future but also the potential for life on Titan.

Methane bubbles up from thawed permafrost in an Arctic lake. Credit: NASA, Katey Walter Anthony/ /University of Alaska Fairbanks

Irradiated Mold on the ISS

As far back as the Soviet space station Mir in the 1980s, scientists have known that mold is a big problem for spacecraft. Recent research has shown that some mold spores that have been found on the International Space Station (ISS) can survive X-ray exposure 200 times the dose that would kill a human. “We now know that [fungal spores] resist radiation much more than we thought they would,” microbiologist Marta Cortesão said about her team’s discovery.

Mold grows on an interior panel of the International Space Station. Credit: NASA

This resilience might be relevant for planets orbiting stars smaller than the Sun. Many red dwarf stars have strong flares that expose nearby planets to punishing doses of X-rays and ultraviolet light. But the ISS molds hint that such stars might not be so poisonous after all—at least not to mold.

As we explore the limits of life *as we know it on Earth*, we begin to understand that the potential for life beyond our X-philes planet is much bigger than we had imagined—the truth is, in fact, out there.

The Living Landscape: Serpentine in Lake County and beyond

KATHLEEN SCAVONE

The original article appeared in the Lake County News on March 9, 2014. This is being republished with kind permission from Kathleen Scavone.

Serpentine rock samples with lichen (bright orange patch near center) on a weathered travertine ($CaCO_3$) deposit. The travertine minerals result from the reaction of atmospheric CO_2 with high pH, calcium-rich water escaping from subsurface serpentinites. In terms of its mineralogy, this travertine deposit is an analog for deep sea white smoker vents and also several terrains mapped on Mars. Photo by Kathleen Scavone.

LAKE COUNTY, Calif. – Serpentine, California's state rock, can be found in abundance in Lake County.

Although beautiful to gaze upon, the soils it forms makes for poor gardening conditions.

It is recommended that when selecting plants for landscaping, you should select species native to these soils, such as those recommended by the California Native Plant Society.

Serpentine is actually a mineral, and comes in an array of colors. It can vary from yellow to black, but is often green in color here in Lake County.

A rock made up primarily of serpentine minerals is also known as serpentinite. It's not truly a single mineral, but instead, an assemblage of related minerals such as antigorite and chrysotile. Chrysotile's fibrous form is a type of asbestos.

Serpentine has a silky smooth, wax-like feel to it. Outcrops of our state rock can be found over 2,200 square miles in California, and other exotic places on earth related to tectonic plate convergence, such as the Philippines.

According to local geologist, Dean Enderlin, “The formation of serpentinite is a very complex process. Much has been (and is being) written about it in geology journals. Serpentine minerals form when unstable ultramafic minerals in the deeper parts of an ophiolite complex chemically react with sea water (they hydrate).”

To put this in layman's terms, millions of years ago Lake County was under the ocean – up to about the Sierra Nevada foothills. The land below this ocean underwent a great collision of earth's tectonic plates.

This particular under-ocean movement, called subduction, caused the floor which was west of us to move toward us, and under us. This complex process created our unique serpentine-rich geology.

Enderlin said, “Lake County geology can be divided into two assemblages of rocks: 1) The basement rocks, which go back to a time when our area was in the deep ocean; 2) The overlying rocks, which include volcanic deposits and lake beds, which are much younger than the basement.”

Dr. Dawn Caradace calibrating a pH and temperature probe to collect data on waters seeping from travertine atop serpentine at McLaughlin Natural Reserve, 2009. Photo by Kathleen Scavone.

He continued, “ The process rarely fully converts the original minerals, so geologists often say that a rock is 'serpentinized' or 'partially serpentinized.' In our area the most commonly serpentinized rock is peridotite. Each mineral within the original peridotite will undergo a different chemistry (there are over 20 serpentine minerals). To complicate life, most serpentine minerals can only be identified using a petrographic microscope and other lab equipment.”

Lake County's serpentine outcrops are so special, that the University of California has been studying them at McLaughlin Natural Reserve, located at the confluence of Lake, Napa and Yolo Counties, where the old Homestake Mine once operated.

Along with university scientists, NASA scientists, like Dr. Jen Blank, PhD, Space Sciences & Astrobiology Division at NASA Ames Research Center, and Dr. Dawn Cardace, also affiliated with the NASA Ames Team through her postdoctoral fellowship (2007-2010), now on the faculty at the University of Rhode Island in the Department of Geosciences.

Blank, a scientist on the Mars Science Laboratory team which operates the Curiosity Rover on Mars, believes our Lake County area has some unique serpentine forms which are used as an analog to formations on Mars.

“Some of the heat from the Geysers near you comes from hydrothermal circulation through ultramafic rocks,” said Blank.

She said that serpentine is formed from the “reaction of warm water with ultramafic minerals such as olivine and pyroxene that are rich in iron and magnesium. The conversion of ultramafic minerals into serpentine has some interesting consequences. You're going from denser material to less-dense, less-ordered material- and this expansion produces cracks in the rocks, allowing more fluids to percolate through them and promoting additional chemical reactions.

“By-products of the serpentinization reaction include reduced gases such as methane and hydrogen- these can be used as energy/food by chemotrophic bacteria,” Blank said. “Methanogens and sulfur reducing bacteria able to thrive on these gases can support other microbes in a subsurface environment – which may be a place to look for life on Mars.”

She added, “On Mars, we think we see evidence of hydrothermal alteration as a result of impact craters- rather than tectonic activity.”

Dr. Dawn Cardace conducted research on Lake County's serpentine at McLaughlin Natural Reserve as part of a consortium of scientists who are looking at “life in hostile places.”

Dr. Dawn Cardace conducts an acid test on travertine deposit associated with serpentine at Mclaughlin Natural Reserve, 2009. The acid fizzed readily, identifying carbonate minerals in the travertine deposit. Photo by Kathleen Scavone.

“They have drilled numerous wells on the Reserve which they use to 'observe' microbial life in the nasty high pH waters deep within the serpentinized areas,” said McLaughlin Natural Reserve's co-director, Cathy Koehler

They call their project “CROMO,” which stands for Coast Range Ophiolite Microbial Observatory.”

“The reaction of water with minerals from Earth’s mantle transforms large swaths of the planetary subsurface over geologic time,” said Cardace. “As the minerals, olivine and serpentine react, they liberate hydrogen: this is an excellent source of energy for microbes living beyond the reach of our Sun. As yet uncharted deep habitat exists in Earth and many planetary bodies, and may host amazing life. This work underscores the scholarly importance of these sites in geobiology.”

NASA astrobiologist, Dr. Chris McKay suggests viewing the video below, which gives further information on serpentinization, and discusses studies at McLaughlin Reserve.

Serpentinization, chemistry, and life at the Coast Range Ophiolite Microbial Observatory
https://youtu.be/ZWsYd1kTFzA

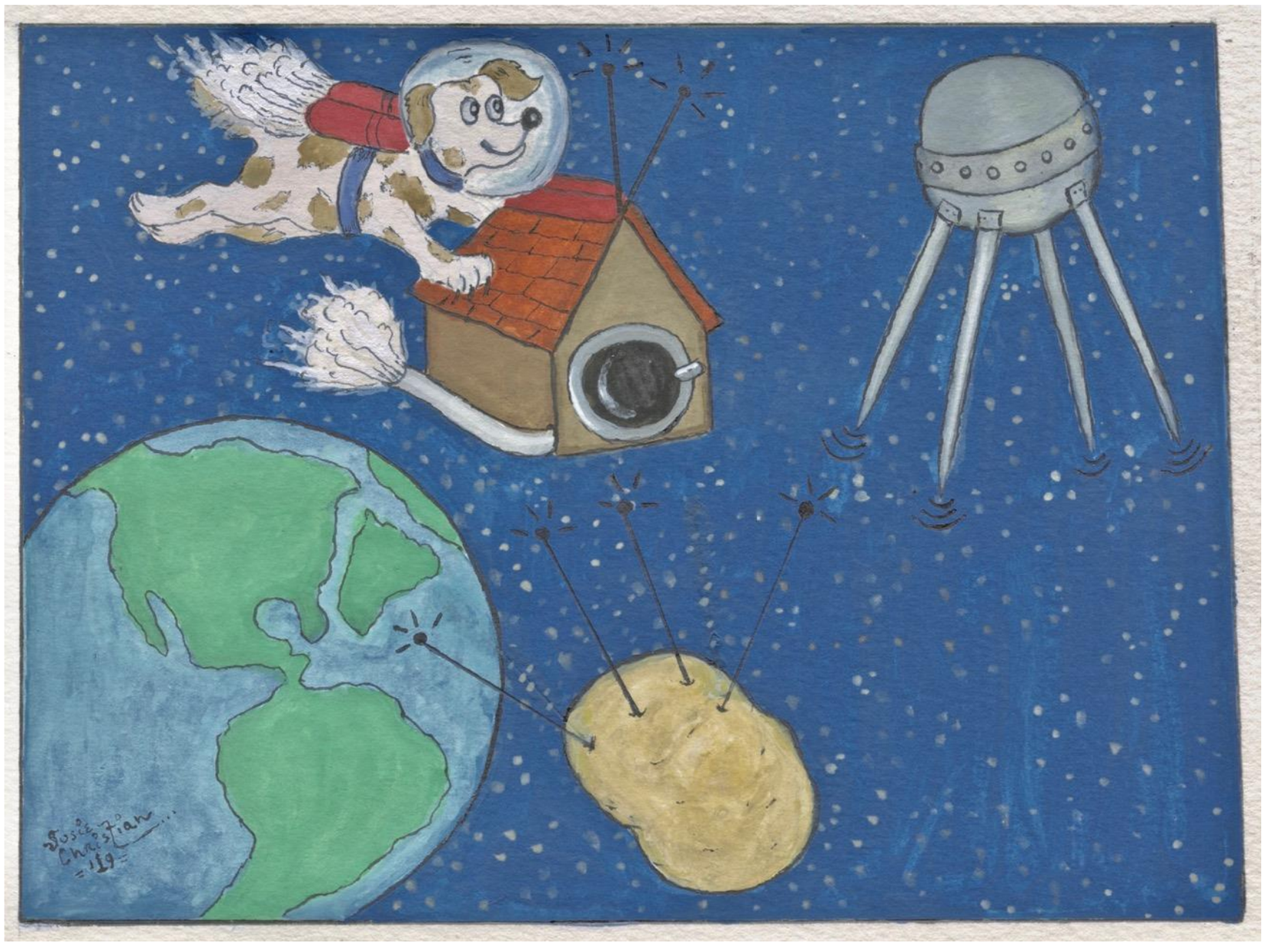
Kathleen Scavone, M.A., is an educator, potter, writer and author of “Anderson Marsh State Historic Park: A Walking History, Prehistory, Flora, and Fauna Tour of a California State Park” and “Native Americans of Lake County.” She also writes for NASA and JPL as one of their “Solar System Ambassadors.” She was selected “Lake County Teacher of the Year, 1998-99” by the Lake County Office of Education, and chosen as one of 10 state finalists the same year by the California Department of Education.

Editor's Note: As we remember the 50th Anniversary of the Apollo 11 moon landing, we give a nod to the little Soviet satellite that started it all.

What Sputnik Began

Russia's, and the world's, first space satellite was, of course, named Sputnik. And when the Soviets promptly followed with a satellite carrying a dog, Americans dubbed it "Muttnik." And what was the nickname given to a U.S. satellite that carried a scientific experiment involving potato growth? That's right—"Spudnik."

Excerpted from : ***A Funny Thing Happened on the Way to the Moon***
by Bob Ward



Heavenly Bodies

By Susie Christian