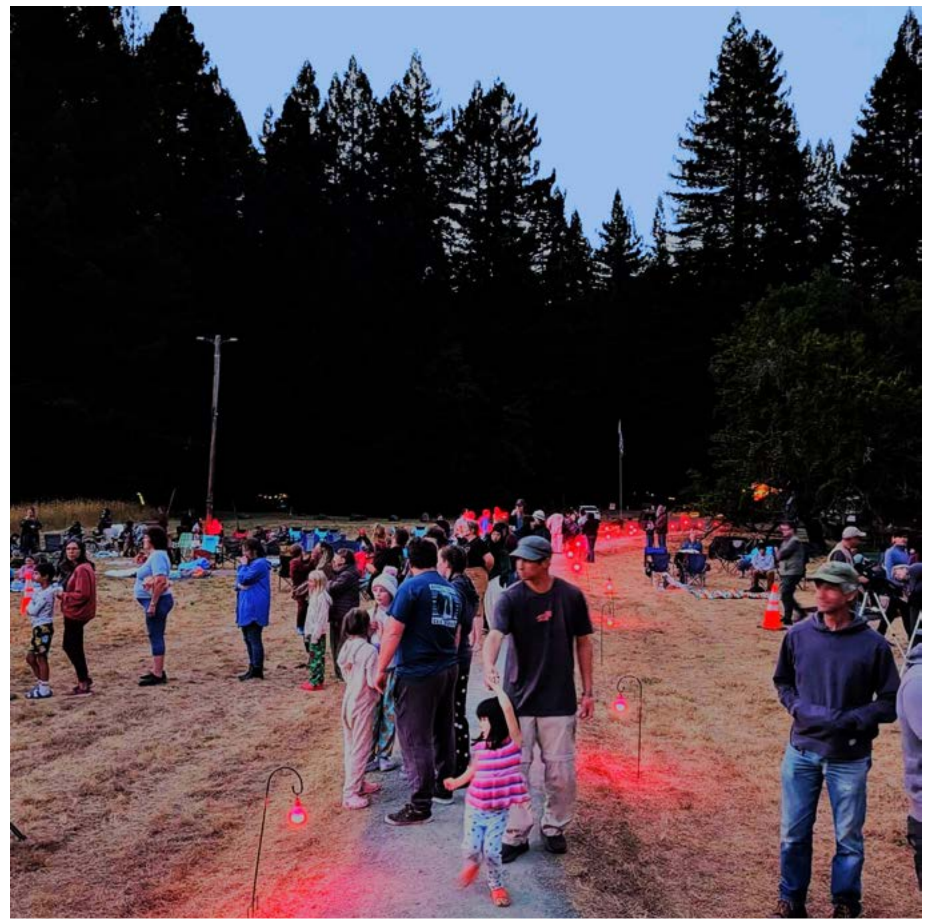
AOH Newsletter

Autumn 2026

News and Notes

Albee Creek Star Parties

Our July and August Star Parties were their usual big hits at Humboldt Redwoods State Park. There were 310 visitors in July and another 200 (despite the threat of clouds) in August.



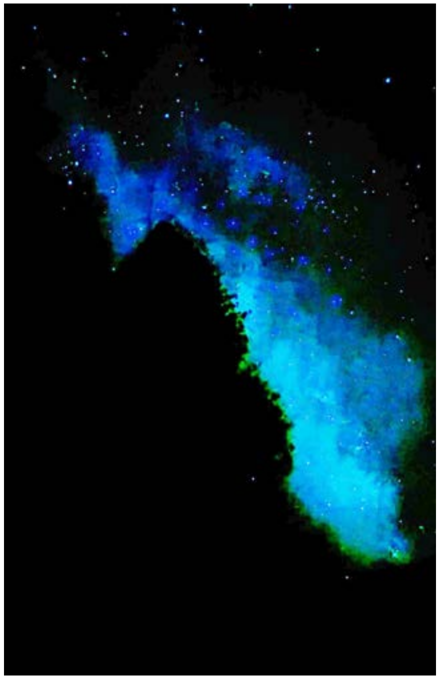
Above: The crescent Moon was the star attraction in the twilight sky.

Right: Part of the crowd gathering in the early evening. —AW, July.

Russ, Brent, Catrina, Chris, Roger, Susan, Mary, Allison, Johann, Shannon, and Sophia. —CH's phone, July.

Above: wildlife appearing before dark.

Right: after dark, the Milky Way outlined by the red-woods. —CH, July.



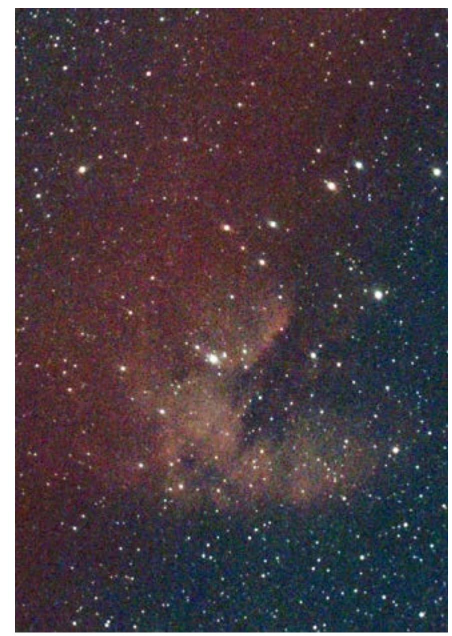
Sophia and Mary from HRIA and Allison and Brent from AOH getting ready to greet the crowd. —JW, July.

Shannon checked out one of the Club's Library Telescopes: an Orion Starblast 4.5. See https://libcat.co.humboldt.ca.us/search~S13/?searchtype=t&searcharg=Telescope+Loan+Program. —AW, July.

HRIA volunteers Hannah, Steff, Olivia, Sophia, Marlon, and Margrete.
—KY, August.

Allison & Johann getting aligned. Is that the same deer as last month?
—KY, August.

Chris and Roger getting set up. —KY, August.



Susan & Seestar —KY, August;
and their Pacman Nebula, NGC 281 —SC, August.

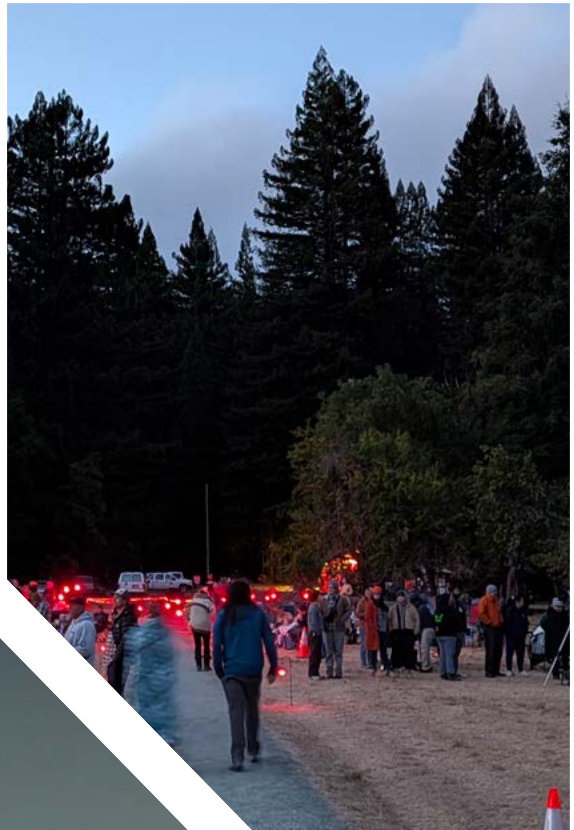
Early in the evening ...

... all eyes were on ...

... the thin crescent Moon ...

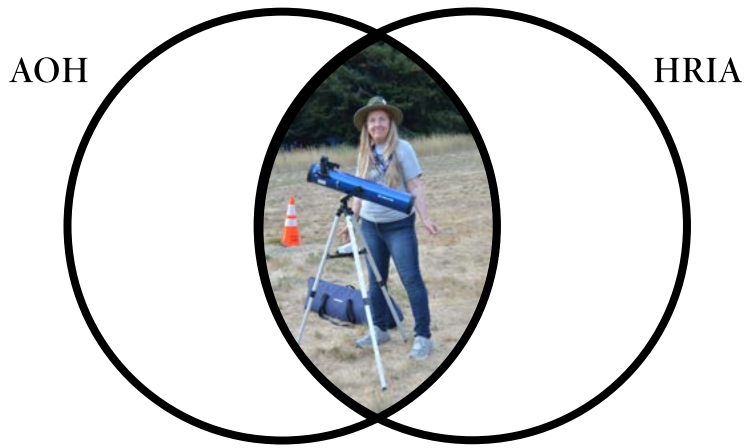
... and the half-disk of Venus. —AW, August.

A few clouds threat-
ened us from the
north
...



...
but it stayed clear
and the stars
appeared right on
schedule.
—AW, August.

Renowned Astronomer Allison gave her excellent constellation talk to the visitors. The visitors, in return, gave Allison a standing ovation.
—JW, August.



And thanks to Mary Kaufman at the intersection of the Astronomers of Humboldt and the Humboldt Redwoods Interpretive Association for bringing it all together.

Cleaning, Eating, and Observing at Kneeland

We held our annual observatory maintenance and cleanup day at Kneeland on August 8. Johann, Allison, Mark, Russ, Susan, Roger, and Ken participated. Afterwards we rewarded ourselves with a picnic dinner and an observing session over at the airport,

Left: Johann removes some rat habitat from the premises. —KY

Below: The picnic. —KY

Russ helping Garth and Elizabeth collimate their Dob. —A&JW

Roger, Mark, and Susan getting set up. —A&JW

Oliver's rig captured a lot of attention. —A&JW

Some of the usual suspects, under the Milky Way, at the airport. —KY

Mark studying his big planisphere. —A&JW

Oliver, in the dark, capturing photons. See Oliver's captured photons from this and many other evenings beginning on page 14. —KY

Susan C. used her Seestar to capture the Whirlpool Galaxy, M51. —SC

Three Rivers School Visit

In June Susan and Roger Coy visited Three Rivers Summer School in Ft. Bragg. They discussed the Solar System, including the rotation and tilt of earth using models, and then did a whole-class demonstration on the size of the planets compared to the Sun. There were about 21 students in attendance. Photos by SC.

Zooms

We held our usual Zoom meetings on June 27 and August 1. Present were Allison & Johann, Bernie, Brent & Catrina, Chris, Corinne, Ken, Mark, Mary, Roger, Russ, and Yoon. We discussed club business, shared astronomical news, and made plans regarding our upcoming events (see below).

Perseid Meteors

Although there was no "official" AOH viewing party for the August 12-13 Perseids, AOH members went to various high spots around the county. Mark Wilson reports that Kneeland Road was parked up with viewers, as was the airport. He saw a few streaks early in the evening before the fog rolled in. Allison and Johann Waltberg attended their neighbor's meteor watch party, where Allison also gave a star talk. Mary Ann Machi viewed from the Horse Mountain Comm Towers. And Barry Evans went to Schoolhouse Peak.

See photos on the following page.

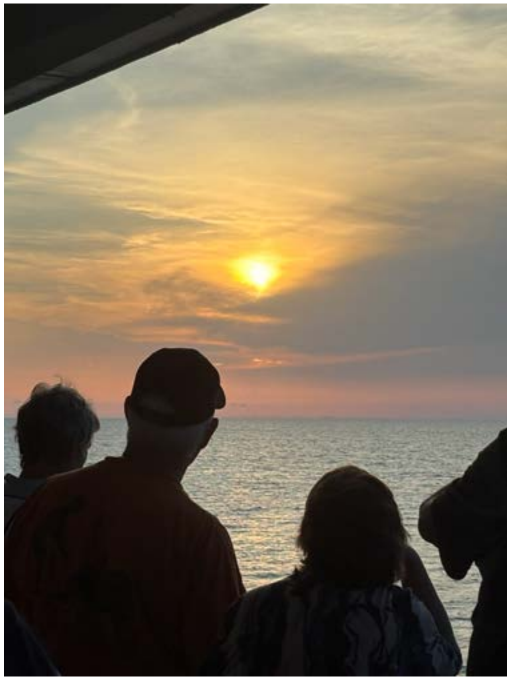
Left, above: "One of the best meteors from the Horse Mtn Comm Towers. Fire burning in the foreground. What a show!!! ... the green tail is astonishing!" —Mary Ann Machi. fb

Left, below: "Caught on my phone camera at Brookey's Perseids party! (Freeze frame from a time lapse video.)" —Allison Waltberg. fb

Below: "At Schoolhouse Peak, a sprinkling of Perseids. But delicious Milky Way and (new for me) Pelican Nebula in Cygnus." —Barry Evans. fb

Eclipses

On August 12 there was a total solar eclipse in the North Atlantic region. Club member Heidi Chien just happened to be at sea off the Spanish coast.



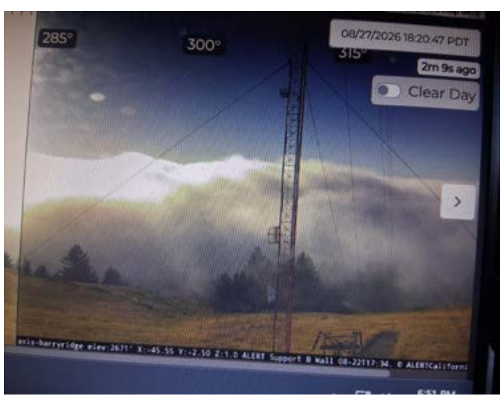
"I was on an eclipse cruise. A lecturer from UC San Diego gave a few cool seminars before the eclipse. My friends who are into the eclipse spent time figuring out the best viewing position and the captain of the ship would announce every turn and adjustment....
We got to see the entire process from 7:30 pm (we were near Spain), then about 8:37, for 1.5 minutes, the total eclipse! Sadly clouds pulled in and we missed the corona. ...
It was fun to watch with lots of people on one side of the deck." —Heidi Chien.

Then on August 27 a near-total lunar eclipse occured. In Humboldt County the partial phase was already underway at moonrise, and the maximum eclipse, with 95% of the Moon obscured, occured just after 9 pm. So we didn't have to travel to see it, except....

As usual the weather was hit or miss in the Arcata-Eureka area. Those who stayed there had mixed luck. The view from Eureka was all fog. In Arcata you could barely make out the uneclipsed sliver of the Moon. But people at the Clam Beach Ovrlook had a clear view.

Mark Wilson and I checked the Barry Ridge webcam to get an idea of what it was like in Kneeland. The fog looked like it was about to cover the camera, and since the camera is only a few miles from Kneeland, we gave up on any thought of going there. It turns out that Kneeland stayed clear, and Allison and Johann got a clear view from their yard in Kneeland. But Mark and Ken drove up to the towers at Horse Mountain, and had a clear view. And Mary Ann went to the Horse Mountain Mine, just down the road from the towers, and likewise had a good view.

"Following the eclipse from our yard in Eureka 🙁 "
—Brent and Catrina Howatt. [fb]



"The fog looked like it was about to swallow the Barry Ridge webcam, and it was moving toward Kneeland, so we decided we didn't want to go there ⚠️"
—Ken Yanosko and Mark Wilson.

"We went to the Horse Mountain Towers. At first we couldn't tell the difference between a partially eclipsed moon and a partly cloudy moon. Then it cleared and it was clear what we were seeing."
—Ken Yanosko and Mark Wilson.

"Drove up to the Horse Mountain area (down the road to the mine).... Cloudy & hazy but managed some eclipse pix."
—Mary Ann Machi. [fb]

"We enjoyed the 96% lunar eclipse from our front yard. Photographing it with phone cameras is a challenge, but we gave it a shot."
—Allison and Johann Waltberg. [fb]

Upcoming Events

Here are some of the fall events on the AOH calendar. Save these dates:

- September 12, October 10, November 7, and December 5. Observing at Kneeland. See https://www.astrohum.org/upcoming.html.
- September 19. International Observe the Moon Night. We will set up observing stations at various places on or around this date. Contact Mark at markw@astrohum.org if you would like to participate.
- October 3. Natural Science Day at the Garberville Town Square from 1 to 5 pm. AOH will set up a table with activities and information. Roger Coy will be the organizer. If you would like to participate contact Roger at roger@astrohum.org.
- October 16. College of the Redwoods Science Night from 5 to 8 pm. AOH will have a classroom with indoor activities and educational displays for families. Weather permitting, we will set up a telescope or two for outdoor observing. If you would like to participate contact Brent at brent@astrohum.org.
- November 7. Kneeland School Fall Festival, starting at 3 pm. We will set up table activities and displays. If you would like to participate contact Brent at brent@astrohum.org.
- November 14. General Membership Meeting and Pizza Party. Location TBA. Watch your inbox for information about nominations of Board members and other agenda items.

In addition, we have three or four possible school visits in the planning stages for this fall. Keep an eye on the Upcoming Events page at https://www.astrohum.org/upcoming.html for more details about these or any other activities that may arise.

Thanks

Allison, Barry, Catrina, Grace, Heidi, Johann, Mark, Mary, Mary Ann, Oliver, Roger, Susan C, and Susan F all helped in putting together this Newsletter. Their contributions are appreciated.

—Ken

The Lunar Occultation of Venus

by Grace Wheeler

On June 17, 2026, there was a lunar occultation of Venus that was visible in Humboldt County. I had been waiting for this event for eleven years, having missed a previous occultation because of weather (December 7, 2015). The lunar occultation of Venus occurs when the Moon moves between the Earth and Venus. Since both are on the ecliptic plane, this occultation occurs about twice a year. However, despite the frequency of this event, it is still a rare observation because of its narrow view path (Figure 1). Because the Moon is closer to the Earth, parallax influences where two observers on Earth will see the apparent position of the Moon in the sky. This parallax can vary up to two degrees if two observers are on opposite sides of the Earth. For the lunar occultation of Venus, observers in the view path will see the Moon move in front of Venus, whereas outside the view path, a close conjunction between the Moon and Venus will be seen (https://in-the-sky.org/news.php?id=20260617_16_100).

For the June 17 occultation, I hedged my bets by driving up to Kneeland, where the NWS forecast had forecasted "some clouds"

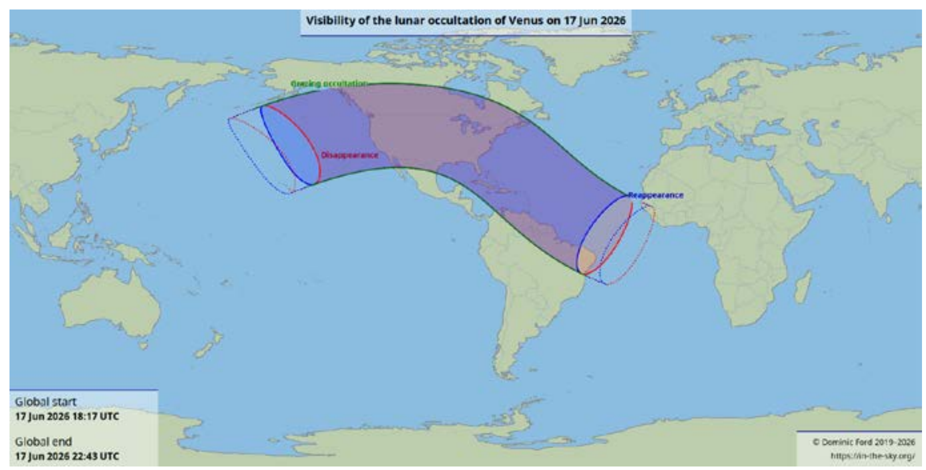


Figure 1. The view path of the June 17, 2026, lunar occultation of Venus.
https://in-the-sky.org/news.php?id=20260617_16_100
Credit: Dominic Ford (copyright holder)

at the airport. In reality, there was a band of broken stratus to the northeast of the airport, right in the area where Venus and the Moon were crossing the sky. Between breaks in the clouds, I was able to set up my telescope and configure tracking for Venus, which was markedly brighter than the 2-day-old crescent Moon. The Starry Night planetarium program showed that Venus would ingress behind the Moon at 11:32 a.m. Because of the clouds, I thought I would miss the occultation altogether, but I was lucky that about ten minutes before the start of the ingress, the clouds thinned out. Although the view was hazy, I could clearly see Venus and the thin crescent Moon through the telescope as shown in Figure 2A. At 11:32, Venus disappeared from view. While I can't be certain if this was due to the clouds or Venus moving behind the Moon, I like to think it was the latter.

According to the Starry Night program, the occultation of Venus would last about one hour and fourteen minutes, with egress starting at 12:46 p.m. While I was waiting for Venus to reappear, the sky cleared up so that at least the second half of the occultation would happen under favorable conditions. Like clockwork, the egress of Venus occurred around 12:46, and I was able to capture Venus rising above the limb of the Moon. Figure 2B is a composite of images taken over five minutes that shows the egress of Venus and its movement away from the Moon.

A timelapse video showing the first three minutes of Venus coming out of occultation can be found here: https://www.youtube.com/watch?v=r0loQK3C1yI.

I feel very lucky to have been able to finally observe a lunar occultation of Venus. Despite the clouds during ingress, I got to see a complete occultation from start to finish. The next occultation of Venus that will be visible in Eureka will be on October 19, 2029, and will occur at sunset. It will be challenging to view as the Moon will be near the horizon.

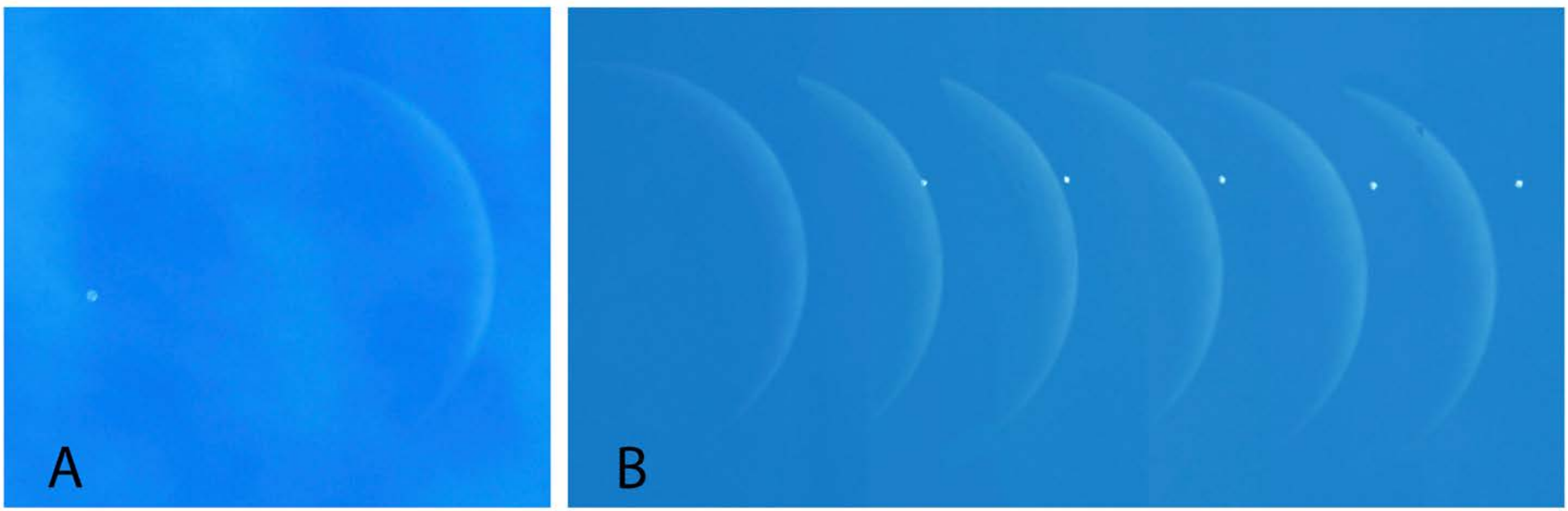


Figure 2AB. (A) The close approach of Venus to the unilluminated side of the 2-day old crescent moon before the start of ingress. (B) Reappearance of Venus from the illuminated side of the crescent moon. This is a composite of images taken between 12:46 to 12:51. Equipment: 81mm William Optics refractor telescope, Zwo MC290 camera. Image credit: GDW.

The Fourth of July Aurora
by Grace Wheeler

A surprise aurora was seen at Kneeland on July 3-4. The aurora was the result of a G2/G3 (moderate to strong) storm that started shortly after sunset local time. I didn't arrive at Kneeland until 10:40 p.m. and I was sure that I had missed most of the event. However, I lucked out and arrived during an intense substorm. There was no need to use a camera to see the aurora: with the unaided eye, I could see the haze from the aurora and a row of bright pillars. The camera was needed, however, to pick up the vivid colors of the aurora which were green, magenta, and purple. The aurora photo shown here was taken at 10:48 p.m. with a 10 second exposure on an iPhone. Since moonrise was at 11:16 p.m., I was lucky that the storm peaked early enough to see the aurora in darkness. The Sun may be past solar maximum, but it's still active enough to send us a spectacular light show for the 4th of July.

Photo by GDW.

I have included a timelapse recording from the Blue Mountain 2 Alert Camera (Modoc County). This webcam not only records in color at night but is also located away from city lights. The clip runs from sunset on July 3rd to sunrise on July 4th: https://www.youtube.com/watch?v=GBlxakPD50g. The most intense part of the auroral storm appeared once twilight deepened around 10 p.m. Even with a gibbous moon overhead later in the night, auroral activity could still be seen on the webcam.

More about the July 3-4 aurora can be found here:

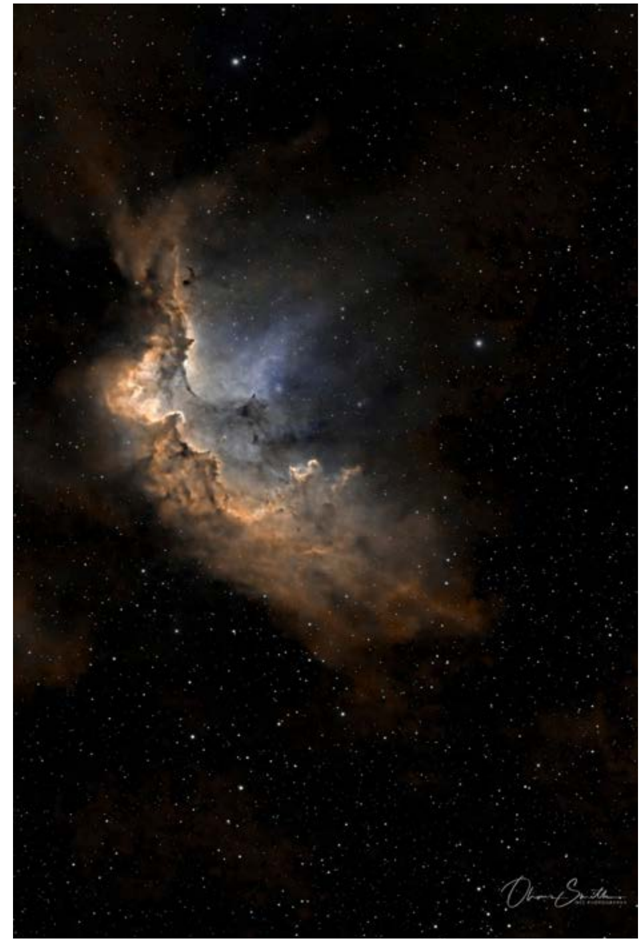
https://watchers.news/2026/07/04/g3-strong-geomagnetic-storm-observed-aurora-as-low-as-new-mexico-after-june-30-cme-impacts-earth/

https://www.msn.com/en-us/science/earth-science/a-g3-solar-storm-lit-up-auroras-over-30-states-beating-forecasts-by-two-levels/ar-AA27tj7N

Grace Wheeler lives in Eureka but will travel to Kneeland, night or day, to intercept any unusual celestial photons.

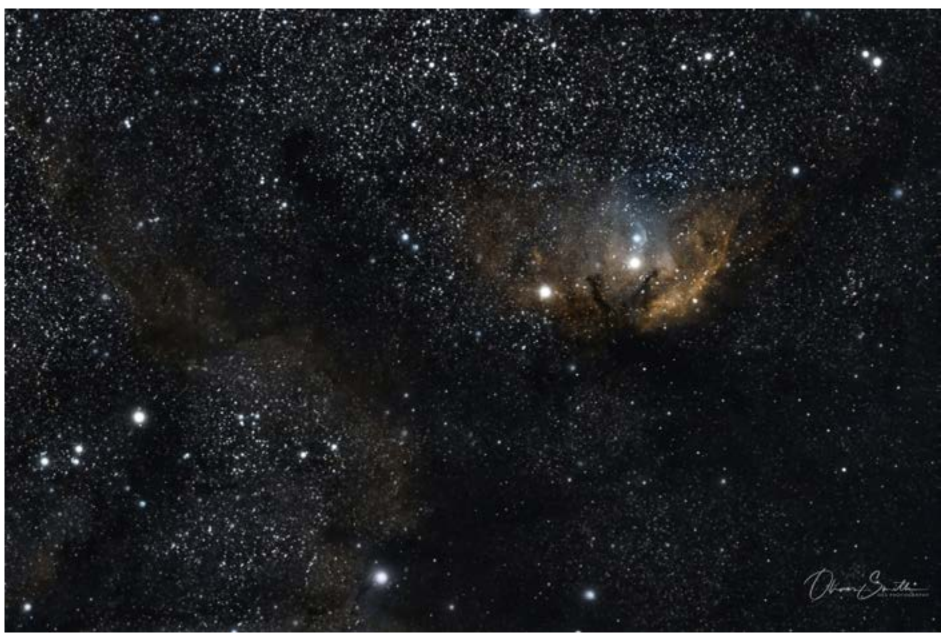
Deep Space Images
by Oliver Smith

Left: Rho Ophiuchi. I think with Rho Ophiuchi you can never get enough, it doesn't matter what focal length you're hitting it with, it doesn't matter how much data you collect, even though more data makes the target stand out with more details. You don't even need a telescope rig, for certain you can get away with using a camera and a modest zoom lens greater than 50 mm.

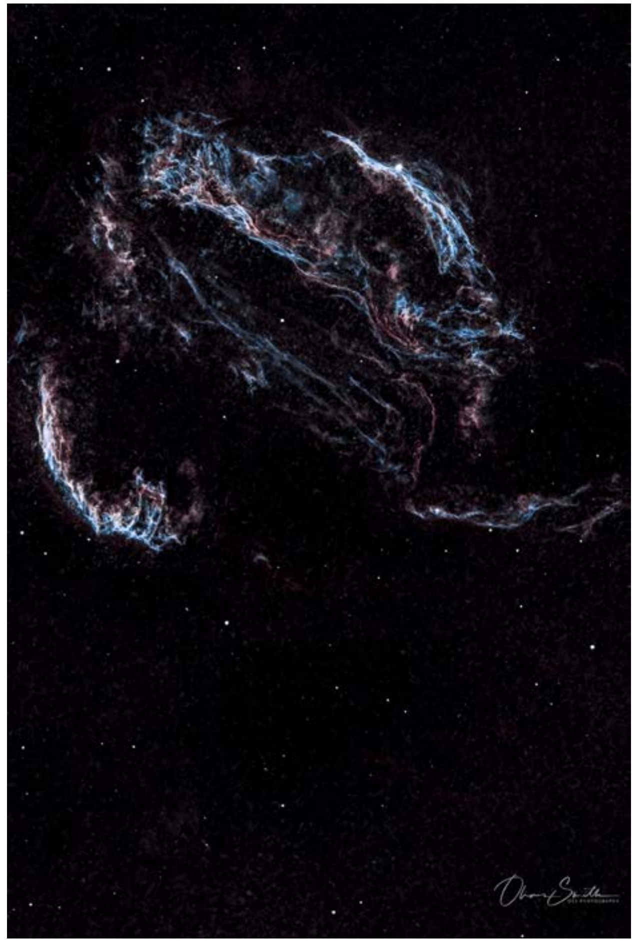


Above: The Wizard Nebula, surrounding developing open star cluster NGC 7380. The Wizard Nebula has to be one of my favorite targets. I keep coming back to it. I think it's the shape; not only does it look like a wizard wearing a wizard hat and extending a hand, the hydrogen and oxygen content of this target is so pronounced. I only wish there were more hours in the evening. Maybe later this season I can devote a few evenings towards collecting more data. This target looks amazing at 20+ hours.

Right: The Tulip Nebula, Sh 2-101. Holy shoot, this was a tough one, but as promised I'm taking you all along for the photo ride from the beginning! ... I will be coming back to this shortly, hopefully this season. Like I said earlier, my mistakes are my teachers. And I'm the kind of student that does not give up easily.



The Cave Nebula, C9.
Sometimes things don't go as planned; it's OK, that's life. Seemed like I had to shift gears to a back-up plan that did not exist. With all my mistakes and feeling steam-rolled by self-disappointment I was able to spend the last 2 hours of the morning on this target and STILL walked away smiling...whispering to myself, "Not too shabby for an unplanned target. Just don't do it again."



The Cygnus Loop, Sh 2-103. (The brightest parts are called The Veil Nebula.)
*Here is about three hours of integration. I had lost 2 hours of data to wind vibration (it's always got to be something, right?) Overall, pretty surprised the image held up ok during the edit. *Lesson learned* When you can't block the wind (or you are falling asleep) reduce the exposure time. I could have kept all the data by reducing the exposure time to 3 minutes instead of 5.*

Cassiopeia's Ghost or "The Misadventures of Astro Ollie" or "Everything in life is a teacher, damn it, everything." Bummed Out!
Bought a new camera, used it, made a few mistakes, and lost all of my shots. None of them are usable. So the next night I went back up on the hill to the same target. I just can't let this get away! Lessons learned: 1. Not all astro cams share the same unity gain. 2. Don't forget to remove your narrow band filter when you are shooting calibration darks.

Right: *The Cygnus Wall, or what would be the "West coast of Mexico" of the North American Nebula. A lot of cool detail on that wall, I was a little drooly that night!*

Above: The Gecko Nebula, LBN 437: A Lizard (on a Flower) in Lacerta.
The previous evening was so cool that my son Dominic came up to hang out with me and check out all that I was babbling about. I love the company, and the great conversations... even the silences are understood!
One shot after the other all night long, I think I'm proud of this one... yeah, I'm proud of this one.

Left: The Lobster Claw Nebula, Sh 1-109.
Superb conditions offered a spectacularly clear and stable sky. The moon allowed me a few hours to capture SH 1-109 in total darkness, sans starlight. I comfortably slept next to my rig on a camp mat and sleeping bag, faded away while absorbing the stars and lullabied by the crickets and coyotes. Absolutely dreamy.

Left: The Clamshell Nebula, Sh 2-119.

The Kneeland Airport monthly star party. The get-together was great! As usual I'm happy to be off on the far side somewhere sitting and thinking.

There were some new people that had arrived with gear new-to-them, getting all the answers to their questions and getting to use their scope for visuals as well. That was very nice to see.

. . .

We talk about Astronomy, we buy gear to better visualize targets and some up-grade to get better visualization of the targets once they have seen them, some use books, some use cameras...

Is it mere science? Is there a desire to see and share the cosmos to the greatest of ability? Is it love for the understanding of things not seen (easily)? It IS to mere science, says the Scientist. It IS a desire to see and share, says the Teacher. It IS to the love, says the Amateur Astronomer!–

Everyone had left, I said good bye to Ken and Mark and when they rolled out I locked myself back inside (there's a lot of symbolism here 😂), Had a few more ice teas and stared up.

Oh, and I took a picture.

Right: Pickering's Triangle aka Fleming's Triangular Wisp.

Pickering's Triangle is part of the Veil Nebula complex. It was discovered in 1904 on a photographic glass plate by the Scottish born Williamina Fleming while working at the Harvard College Observatory under the direction of Edward Charles Pickering. Fleming was part of a team of skilled and underpaid women known as the Harvard Computers hired to analyze and process data collected by the observatory. Fleming had initially been hired to serve as Pickering's housemaid.

. . .

Fleming became a strong advocate for the advancement of women in the field of astronomy. Accomplishments in her highly successful career included: the discovery of numerous variable stars, novae, and nebulae including the famed Horsehead Nebula in Orion; the development and assessment of a system to classify stars through distinctive features of their spectra; and the publication of scientific articles and reports. In 1906, she was the first American (and Scottish) woman elected to the Royal Astronomical Society of London.

This is my second time to be in the Cygnus Loop; I'm sure I'll have time this season to target the other parts in close-up as well.

Oliver Smith is a retired portrait photographer who now specializes in portraits of celestial beauties. You can find more of his work at his [AstroBin](#) page. Oliver would be happy to share technical details about acquiring and processing these photos. You can contact him by email at oliver@astrohum.org.

Journey to the Bighorn Medicine Wheel

by Mark Wilson

In the Winter 2026 issue of this Newsletter, Allison Waltberg wrote an excellent article on the winter solstice. Her article inspired me to visit the Bighorn Medicine Wheel for the 2026 summer solstice. Every year since 2001 I have traveled to Montana for the Battle of the Little Bighorn anniversary commemorations on June 25. This year was the 150th anniversary. I knew of this ancient stone structure from a visit 25 years ago. I had plenty of time to stop at the Medicine Wheel on the 21st as it is only three hours from the battle site. On this trip to the Wheel, I was much better informed about its origins and use than my prior visit in 2001. In 2025 I became interested in the archeology of prehistoric people. On my return from Montana, I visited several sites and purchased some books on the subject. One of the books was titled *Star Circle: The Bighorn Medicine Wheel*. This book was written by archeoastronomer Ivy Merriot who based her Ph.D. dissertation on a study of the Medicine Wheel.

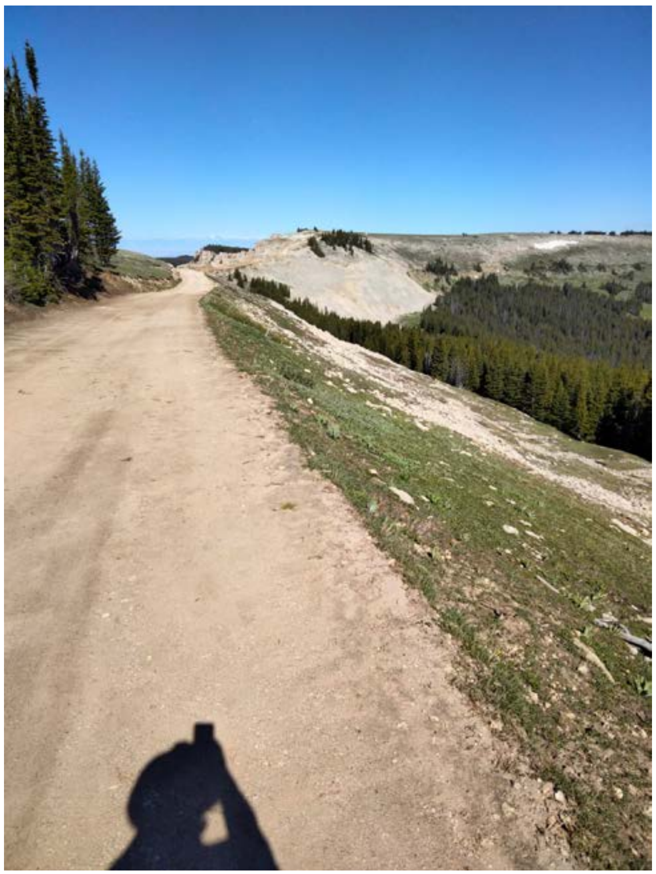


figure 1 —MW

figure 2 — https://www.valleycenter.com/articles/san-diego-archaeological-center-presents-medicine-wheel-astronomy/

The stars were not aligned in my favor. On June 20th, I planned to drive east through Yellowstone Park, across the Bighorn Valley then up the steep west side of the Bighorn Mountains to the Wheel. The day started out overcast and only got worse from there. There was a horrific traffic jam a few miles into the park; so, I decided to go back and head north around the park. The weather turned colder, and it poured rain. I suspected it was snowing up at the Wheel. During my detour it turned dark and was still raining. As the hour was getting late, I decided it was not smart to drive in the dark on wet, probably snowy, unfamiliar mountain roads. I missed the 2026 summer solstice.

On my return journey to McKinleyville I visited the Bighorn Medicine Wheel on June 30. The night before my visit, I camped in my van on Medicine Mountain just below the Wheel site. The next morning brought clear skies and no wind. I drove up a mile or so to the

figure 3 —MW

parking lot, got my hiking gear together along with Dr. Merriot's book and hiked the one and a half miles up the road (closed to vehicles) to the Wheel at about 10,000 feet elevation which is at tree line (figure 1).

Most of the following information about the Wheel is from Dr. Merriot's book. The location of the site is in north central Wyoming just south of the Montana border or more specifically near latitude 45 degrees north and longitude 108 degrees west. The site is a National Historic Landmark administered by the Bighorn National Forest. The Wheel actually looks like a low relief old wagon wheel with 28 spokes radiating out from a central hub or cairn (figure 2). Aside from the central cairn there are six cairns at intervals at or near the outer rim. The cairns have hollow interiors. The construction is 80 feet in diameter and made from local dolomite rocks. It has been altered over the past 150 years due to archaeological studies, efforts to preserve the site, well meaning "repairs", and alterations for use.

There is no definitive date for its construction. It could be a few hundred years old or a couple of thousand. Who built it? No one knows. None of the current indigenous tribes of this region have traditional stories about it or its original intended use. No one claims it; so, current policy is any person or group can use the site for any kind of religious or spiritual purpose. One of the current uses by some native people is for vision quests. One Shoshone woman told of being married there in the late 1800s. Today many people leave offerings of various kinds from animal skulls to cloth tied to the fence around the structure (figure 3). I spread some tobacco and said a short prayer.

So where does astronomy and solstice watching figure into this wheel structure? Dr. Merriot's studies have led her to the conclusion that the wheel is an earthly representation of the sky, kind of like a planisphere. The 28 spokes serve as a grid system for locating sky objects

figure 4 —MW

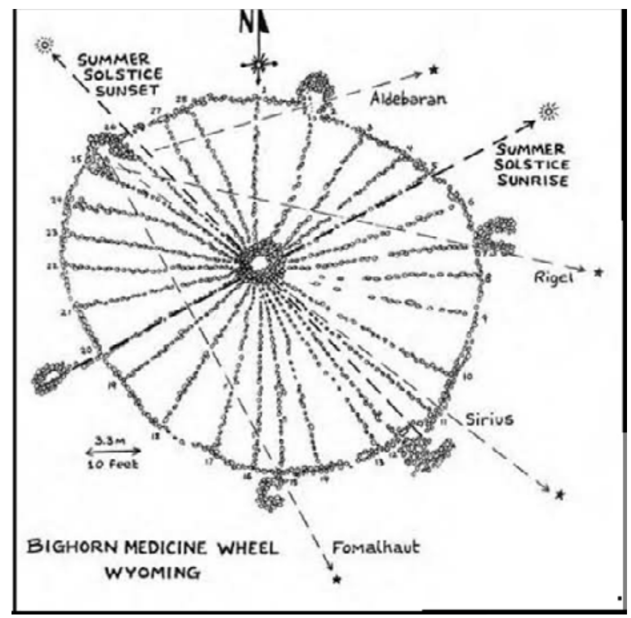


figure 5 — Brad Olsen, Sacred Places Around the World: 108 Destinations*, CCC Publishing, 2004.*

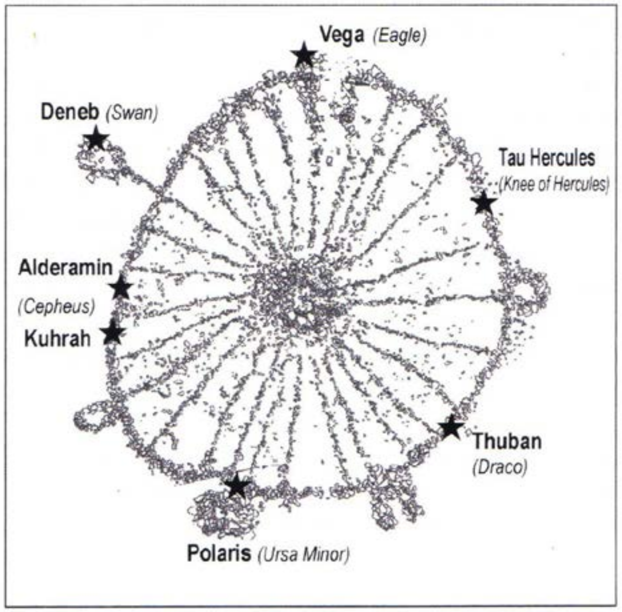


figure 6 —Ivy Merriot, Star Circle: The Bighorn Medicine Wheel, *CreateSpace Independent Publishing Platform, 2017.*

like azimuth and declination are used today on star charts. There are some alignments using the various cairns (figure 4). The summer solstice sunrise and sunset positions are well defined (figure 5). At this latitude and longitude summer solstice sunrise is 4:22 am mountain daylight time. The bright stars that become the north star such as Polaris, Thuban, Vega, et al., over the 24,000 year precessional cycle, are represented by positions on the rim of the wheel (figure 6). How ancient people knew this when they arrived in North America only 14,000 years ago is a mystery to me, but Dr. Merriot makes the point that western science and indigenous science differ. She indicates that the star Capella has a special relation with the wheel because it is the brightest star that remains visible from the wheel year-round as a circumpolar star. The Medicine Wheel mirrors Capella's circumpolar movement. Due to these characteristics, Capella is an excellent star for navigation at this and higher latitudes. In conclusion, Dr. Merriot points out that not every ancient stone circle was built for astronomical purposes. There are 103 known stone circles in the Rocky Mountains (USA and Canada), but only a few are of sufficient size to be astronomical wheels. There are four other known medicine wheels on the tops of other mountains in the Bighorns. I recommend Merriot's book for further investigation; you may borrow mine.

Dance with the Druids—or Winter Solstice in McKinleyville

by Mark Wilson

Allison Waltberg wrote an excellent article in the Winter 2026 issue of our Newsletter on the winter solstice. She discovered that in Humboldt County we have a human-made winter solstice sunrise alignment monument. You may recall from her article that our modern monument was not intended to be a solstice marker, but it works. It is a segment of highway 101 just north of the Mad River bridge. If you extend a line along this segment of highway to the southeast, it points directly toward the solstice sunrise point.

But if you extend this line back to the northwest you end up at Baduwa't Park on the bluff overlooking the Mad River at the west end of School Road, at Ocean Drive, in McKinleyville. With that in mind, I invite all of you, your family, and friends, to join me there for the solstice sunrise. The date is Monday, December 21. The sunrise time on that day in McKinleyville is 7:37 am PST. I shall provide coffee, hot chocolate, and pastries of some kind.

On the other hand, sunset on the solstice was also important to ancient people. So, if you have to work in the morning or like to sleep in, you can instead celebrate the sunset, which occurs at 4:52 pm PST. I recommend the vista point on 101 west of the airport. Alternatively, Kneeland might be better for fog avoidance.

Mark Wilson lives in McKinleyville. He is the AOH Vice-President and Equipment Manager. With this event, he will also be assuming the position of AOH Breakfast Chef.

This article appeared in two parts in the North Coast Journal on July 3 and July 10, 2026. It is reprinted here with the permission of the author.

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Saturnian Drone: Dragonfly at Titan
by Barry Evans

"[On early Earth] you need to have gone from simple to complex chemistry before jumping to biology, but we don't know all the steps. Titan allows us to uncover some of them."
— Zibi Turtle, Dragonfly principal investigator

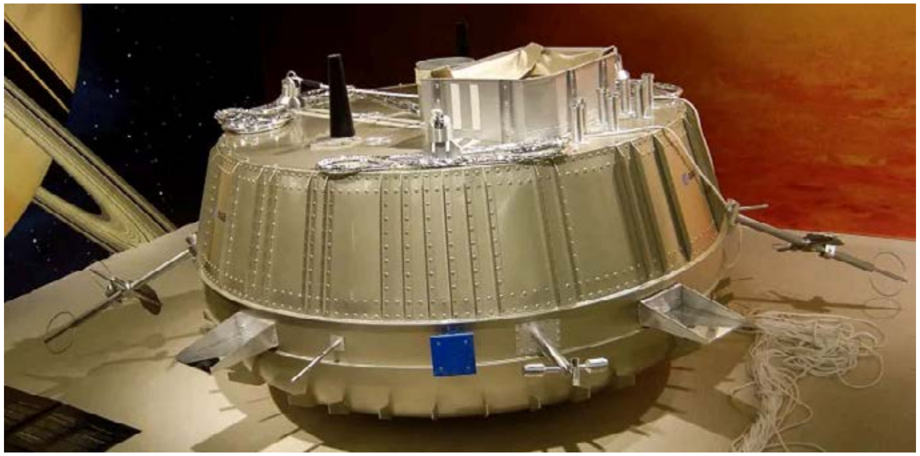
"A bizarre Earth" is how one investigator describes icy Titan, Saturn's largest moon, and the target of NASA's most ambitious robotic mission to date. Titan has long been the darling of exobiologists (biologists whose interest is extraterrestrial life) who, I'm told, are practically salivating in anticipation of Dragonfly — essentially a large drone — slated to arrive at Titan in 2034.

Titan, more than any other body in our solar system, bears a strong resemblance to early Earth, with the three essentials for life as we know it: an energy source (the Sun), organics (carbon-based molecules, building blocks for amino acids and proteins) and liquid water (solvent). Some 4 billion years ago, scientists believe organic compounds here on Earth enriched themselves in a "primeval soup," becoming more and more complex until — after perhaps several millions of years — nature stumbled upon a self-replicating molecule, aka "life."

That "prebiotic" process, from simple to complex chemistry, has all but been obliterated here by the very life it spawned. Titan, however, holds the promise of a virgin laboratory, where it might be possible to view the complexification as it happens. Like early Earth, Titan's hazy skies are mostly composed of methane that, when bombarded with UV rays from the sun, forms organic molecules that fall as rain onto the moon's surface. And it's Titan's surface, comprised of deep-frozen water ice and longitudinal dunes similar to those seen in Namibia's ancient coastal desert (with hydrocarbons instead of silica sand) that's the main target of NASA's Dragonfly mission.

In astronomical terms, Titan is an "ocean world," the term given to a planet or satellite that, scientists suspect, contain a substantial amount of oceanic water. Earth, of course, is an ocean world, as are Jupiter's moons Europa and Ganymede and Saturn's Titan and Enceladus, although the others are subsurface. In Titan's case, we're pretty sure that some 100 miles below the frozen surface, there's a vast water ocean, kept liquid by both heat from the moon's core and salt and/or ammonia dissolved in the water. No conceivable future mission will be able to directly sample Titan's ocean, which, with all sorts of caveats, may harbor primitive life. However, the Dragonfly mission is designed to sample sites where liquid water may have once existed on the surface. Which is why Dragonfly will be landing in, or close to, Selk impact crater, where liquid water may once have mixed with surface organics, since an impact from a comet or meteorite may have melted otherwise deep-frozen ice, perhaps briefly creating conditions similar to those on early Earth.

Dragonfly will be landing near the equator, nowhere near another area of interest to exobiologists, Titan's polar methane lakes.



Replica of Dragonfly's predecessor, the 4-foot-diameter Huygens lander. Credit: Photo by David Monniaux, GNU Free Documentation License

The moon's frigid temperature, about 90 degrees Kelvin (minus 300 Fahrenheit), precludes any liquid water currently, but that's just fine for liquid methane and ethane. NASA's Cassini mission, in orbit around Saturn from 2004 to 2017, discovered these lakes from radar reflections. They are huge, one comparable in size to the Caspian Sea, although they were probably once much larger, perhaps covering the entire surface.

Dragonfly won't be the first craft to land on Titan. That honor goes to a remarkable little probe named Huygens (after the discoverer of Titan in 1655) that hitchhiked on Cassini. Built by the European Space Agency, Huygens was deployed from Cassini in January of 2005. It operated for four hours, including 90 minutes on the surface following it's descent by parachute, before its batteries died. Most of what we currently know about Titan comes from the 100 MB of data transmitted back to Earth (via Cassini) from that vanguard mission.

. . .

Titan's surface is a tapestry of abundant carbon-rich chemistry, a delicious target for curious Earthlings to explore. The challenges are immense, including temperatures that make Minnesotan winters look positively tropical, a 90-minute-long communication gap with Earth, sand-like dunes ready to bog down wheeled vehicles and surface sunlight one thousandth the strength of what we receive here on Earth.

In the early stages of designing a suitable vehicle to explore Titan's surface, engineers considered deploying a Montgolfière Balloon, that is, a hot-air balloon designed to descend from an orbiter and float 6 miles above the surface for several months. That was before the rapid development of drone technology, which led to the design of the Dragonfly mission, NASA's most exciting attempt to date to explore the far reaches of our solar system.

My recreation drone and Dragonfly have rotors at each of their four corners, but there the resemblance ends. Dragonfly is an octocopter sporting eight 52-inch-long aluminum propellers with titanium leading edges, two at each corner rotating in opposite directions. [See a picture in the Summer Newsletter.] With 1/7 Earth's gravity and a thick atmosphere (characterized by the Huygens lander), Titan is a perfect environment for a drone. On Titan, a drone flies with 40 times the efficiency of one on Earth, which also makes landing on Titan a breeze compared to, say, Mars. Six years after launch, Dragonfly will hit Titan's thick atmosphere at 16,000 mph, then rapidly decelerate, first using its aeroshell, followed by two parachutes before flying under its own power to autonomously scan the surface for a safe landing site. The whole procedure will take about two hours.

Although it's easy to think of Dragonfly as a drone, its actual flying time is minimal. Rather, it's a mobile lander, able to hop from one site of interest to another, each flight taking 20-30 minutes with a 16 Earth-day hiatus between flights. (That's the length of a day on Titan.) One the ground, two drills, one on each landing skid, will send samples of surface material to a mass spectrometer via a "Dyson vacuum" type suction system. Particularly interesting samples — hopefully, those relevant to biological processes — will then be vaporized for fine (atomic scale) analysis. A Japanese-built seismometer will measure any Titanquakes, giving information on Titan's subsurface ocean, while other instruments will measure the wind and composition of the atmosphere.

Solar panels are useless far from the sun under a hazy atmosphere, so Dragonfly will rely on a radioisotope thermoelectric generator, using the natural decay of plutonium 238 (half-life 84 years) to produce heat which will generate about 100 watts of electricity. Lithium ion batteries, recharged during the 16-day gap between flights, will power Dragonfly's eight rotors.

A priority target for Dragonfly will be the inside of the Selk crater, an environment in which carbon-rich material and liquid water may have mixed for an extended period following the impact that created the crater. If (big if) hydrocarbon-based life once arose there, Dragonfly's exquisitely sensitive on-board "chemistry lab" should be able to detect that. I can't wait!

Barry Evans (he/him, barryevans9@yahoo.com) has a new book out,
Amazon to Zodiac: 101 Scientific Curiosities across Time and Space.
Available in your favorite bookstore or direct from the author.

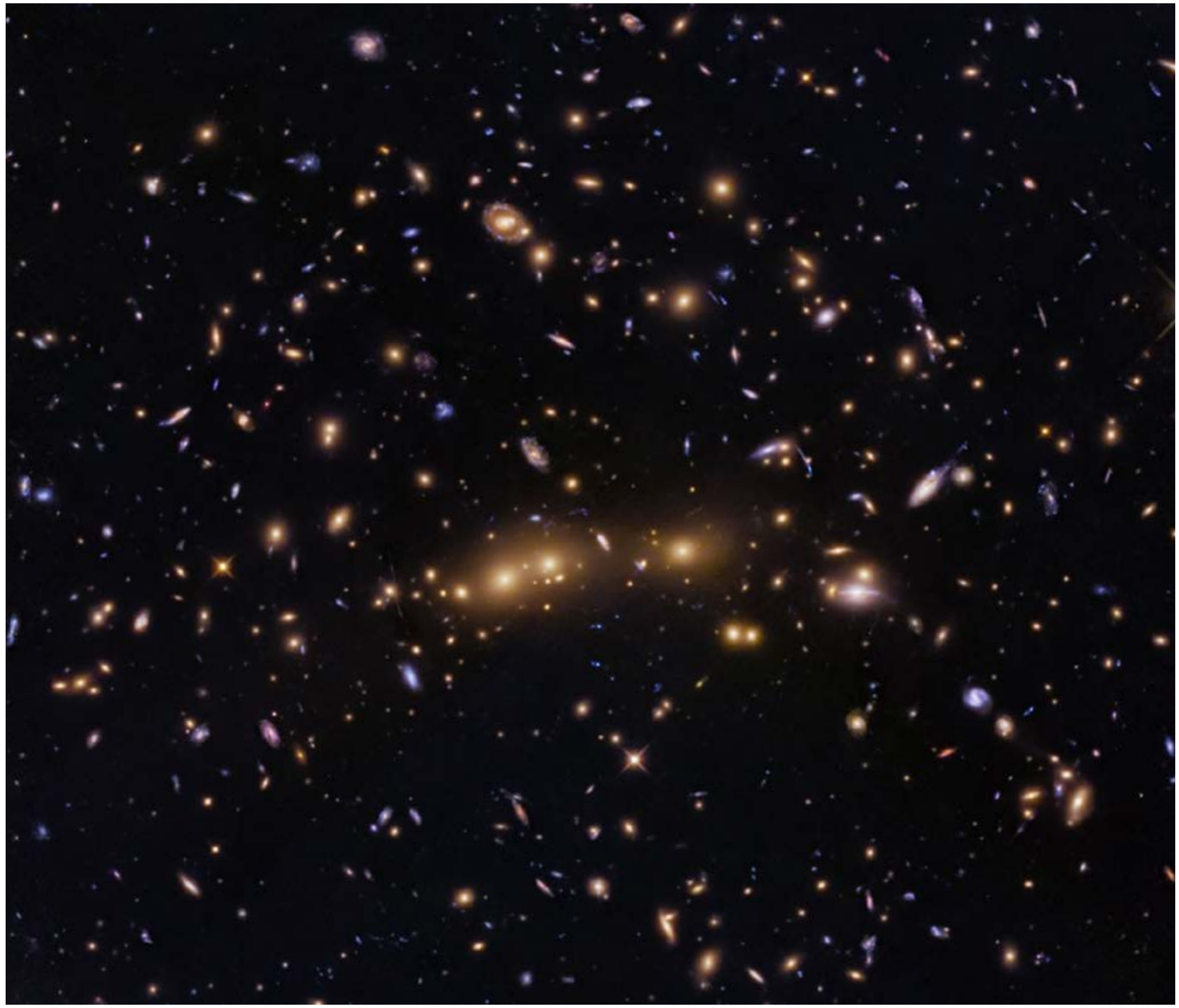
Hubble Glimpses Merging Galaxy Clusters

This NASA Hubble Space Telescope image features a galaxy cluster, called CL0016+1609 or MACS J0018.5+1626, that is very bright at X-ray wavelengths and is one of the most extensively studied clusters at X-ray and radio wavelengths. The X-ray observations of this cluster revealed that it is two clusters merging along our line of sight.

Researchers requested time to observe CL0016+1609 with Hubble's Advanced Camera for Surveys because that data would help them accurately measure the cluster's dark-matter distribution, which helps them study the merger and the role of CL0016+1609 in the large-scale structure of the universe. Hubble can't directly see dark matter, but its infrared and visible light observations can detect dark matter's gravitational lensing effects on the normal matter Hubble observes.

The data in this image also includes observations with Hubble's Wide Field Camera 3 taken as part of an observing program that obtained the first Hubble infrared images of 46 massive galaxy clusters and looked for distant galaxies gravitationally lensed by these clusters. Called RELICS (Reionization Lensing Cluster Survey), this survey found some 300 high-redshift candidate galaxies lensed by these clusters.

You can see the faint vertical arc of one of these distant galaxies in the image [below]. Look for it just to the left of the large elliptical galaxies in the center of the image. Another brighter, though shorter arc is visible just above and to the right of the large elliptical galaxies in the center of the image.



This NASA Hubble Space Telescope image features a swarm of galaxies in the galaxy cluster called CL0016+1609 or MACS J0018.5+1626.

This article is distributed by the NASA Night Sky Network, a coalition of hundreds of astronomy clubs across the US dedicated to astronomy outreach.

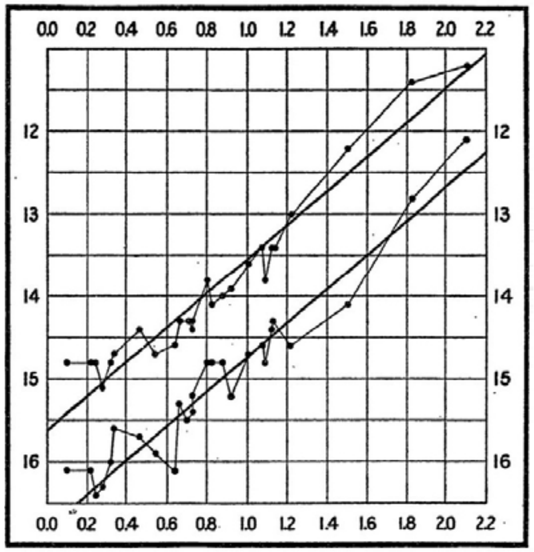
Cepheus: A House Fit for a King
by David Prosper

Sometimes constellations look like their namesake, and sometimes these starry patterns look like something else entirely. That's the case for many stargazers upon identifying the constellation of Cepheus for the first time. These stars represent Cepheus, the King of Ethiopia, sitting on his throne. However, many present-day observers see the outline of a simple house, complete with peaked roof, instead—quite a difference! Astronomers have another association with this northern constellation; inside its borders lies the namesake of one of the most important types of stars in modern astronomy: Delta Cephei, the original Cepheid Variable.

The stars of Cepheus are visible all year round for many in the Northern Hemisphere, but fall months offer some of the best views of this circumpolar constellation to warmly-dressed observers. Just look northwards! Image created with assistance from **Stellarium**.

Cepheus is a circumpolar constellation for most observers located in mid-northern latitudes and above, meaning it does not set, or dip below the horizon. This means Cepheus is visible all night long and can be observed to swing around the northern celestial pole, anchored by Polaris, the current North Star. Other circumpolar constellations include Cassiopeia, Ursa Major, Ursa Minor, Draco, and Camelopardalis. Its all-night position for many stargazers brings with it some interesting objects to observe. Among them: the "Garnet Star" Mu Cephei, a supergiant star with an especially deep red hue; several binary stars; several nebulae, including the notable reflection nebula NGC 7023; and the "Fireworks Galaxy" NGC 6946, known for a surprising amount of supernovae.

Perhaps the most famous, and certainly the most notable object in Cepheus, is the star Delta Cephei. Its variable nature was first discovered by John Goodricke, whose observations of the star began in October 1784. Slightly more than a century later, Henrietta Leavitt studied the variable stars found in the Magellanic Clouds in 1908 and discovered that the type of variable stars represented by Delta Cephei possessed very consistent relationships between their luminosity (total amount of light emitted), and their pulsation period (generally, the length of time in which the star goes through a cycle of where it dims and then brightens). Once the period for a Cepheid Variable (or Cepheid) is known, its luminosity can be calculated by using the scale originally developed by Henrietta Leavitt, now called "Leavitt's Law." So, if a star is found to be a Cepheid, its actual brightness can be calculated versus its observed brightness. From that difference, the Cepheid's distance can then be estimated with a great deal of precision. This revolutionary discovery unlocked a key to measuring vast distances across the cosmos, and in 1924 observations of Cepheids by Edwin Hubble in what was then called the



This historical diagram from Henrietta Leavitt's revolutionary publication shows the luminosity of a selection of Cepheid Variables on the vertical axis, and the log of their periods on the horizontal axis. The line drawn through these points shows how tight that relationship is between all the stars in the series. From Henrietta Leavitt and Edward Pickering's 1912 paper, "Periods of 25 Variable Stars in the Small Magellanic Cloud," a copy of which can be found at: https://ui.adsabs.harvard.edu/scan/manifest/1912HarCi.173....1 .

Andromeda Nebula proved that this "nebula" was actually another galaxy outside of our own Milky Way! You may now know this object as the "Andromeda Galaxy" or M31. Further observations of Cepheids in other galaxies gave rise to another astounding discovery: that our universe is not static, but expanding!

Because of their importance as a "standard candle" in measuring cosmic distances, astronomers continue to study the nature of Cepheids. Their studies revealed that there are two distinct types of Cepheids: Classical and Type II. Delta Cephei is the second closest Cepheid to Earth after Polaris, and was even studied in detail by Edwin Hubble's namesake telescope, NASA's Hubble Space Telescope, in 2008. These studies, along with others performed by the ESA's Hipparcos mission and other observatories, help to further refine the accuracy of distance measurements derived from observations of Cepheids. What will further observations of Delta Cephei and other Cepheids reveal about our universe? Follow NASA's latest observations of stars and galaxies across our universe at nasa.gov.

David Prosper is an astronomy educator who has written for the Night Sky Network **News & Resources** *and the Astronomical League* **Reflector.**

THE CONVERSATION

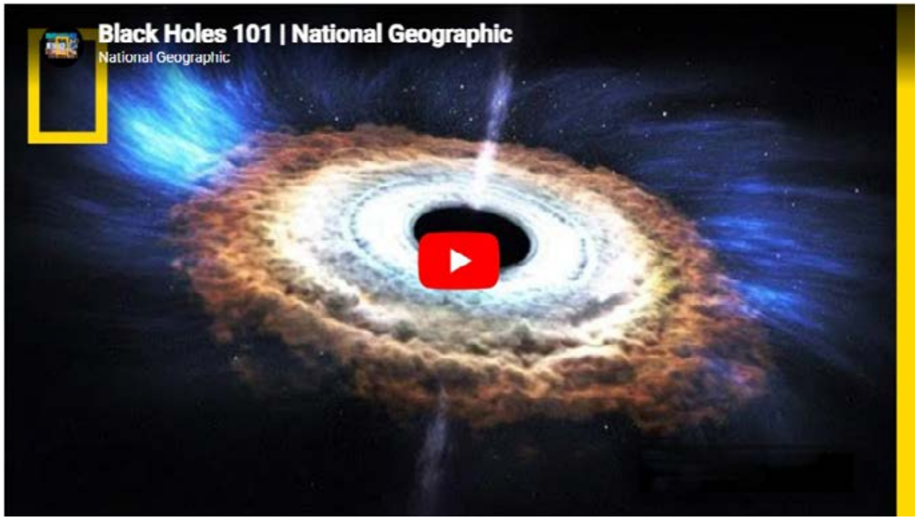
What are supermassive black holes? Everything you need to know – and what astronomers are still learning – about these mysterious objects

by Mary Ogborn

Nearly every massive galaxy observed hosts a supermassive black hole at its center. NASA's James Webb Space Telescope has discovered that some of these supermassive black holes may even be too big for the galaxy they're found in, challenging astronomers' understanding of these objects and prompting questions about their growth in the early universe. Astronomers are still investigating many key questions about these mysterious and powerful objects, and studying them can help researchers understand how galaxies form and grow.

An artist's impression of the black hole in the M87 galaxy and its powerful jet. S. Dagnello (NRAO/AUI/NSF), CC BY-NC-SA

I'm an astronomer who studies supermassive black holes in other galaxies. These fascinating astronomical objects can tell researchers about how matter gets consumed or expelled from the center of the galaxy and how that may affect other processes in the galaxy.



Black holes are numerous in the universe, but scientists still have many unanswered questions about how they work.

What are supermassive black holes?

Supermassive black holes are the largest class of black holes.

Black holes are regions in space in which gravity has become such a predominant force that nothing, not even light, can escape. These black holes range from hundreds of thousands to millions or billions of times more massive than our Sun.

Studies suggest that nearly every massive galaxy astronomers have observed has a supermassive black hole at the center. However, galaxies are so large that these black holes occupy only a small part, and they're outweighed by gas, dust and stars.

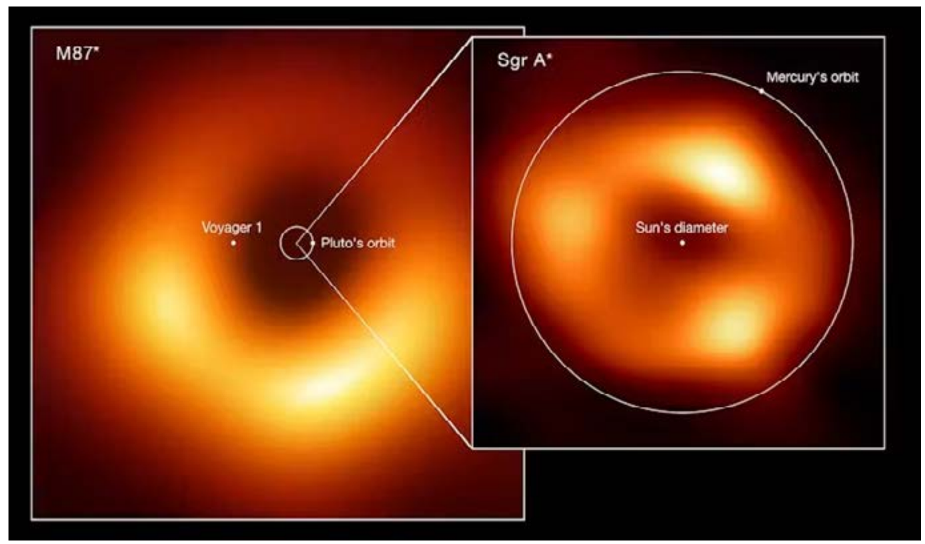
A supermassive black hole is enclosed by its event horizon, or the point of no return. Any object that crosses the horizon would have to be traveling faster than the speed of light to escape the black hole, which is not physically possible.

If you were to place the supermassive black hole in the center of our galaxy, named Sagittarius A*, where the Sun would be, its event horizon and surrounding gas would fit within the orbit of Mercury. However, for a more massive supermassive black hole, such as M87*, the entirety of the solar system would fit within the event horizon.

How do scientists study them?

Observationally, supermassive black holes are hard to catch.

Even though many are millions of times larger than our Sun, they occupy only a small part of a galaxy, which can be further enshrouded by stars and dust. To date, only two "images" have been taken of supermassive black holes, both by the Event Horizon Telescope Collaboration.

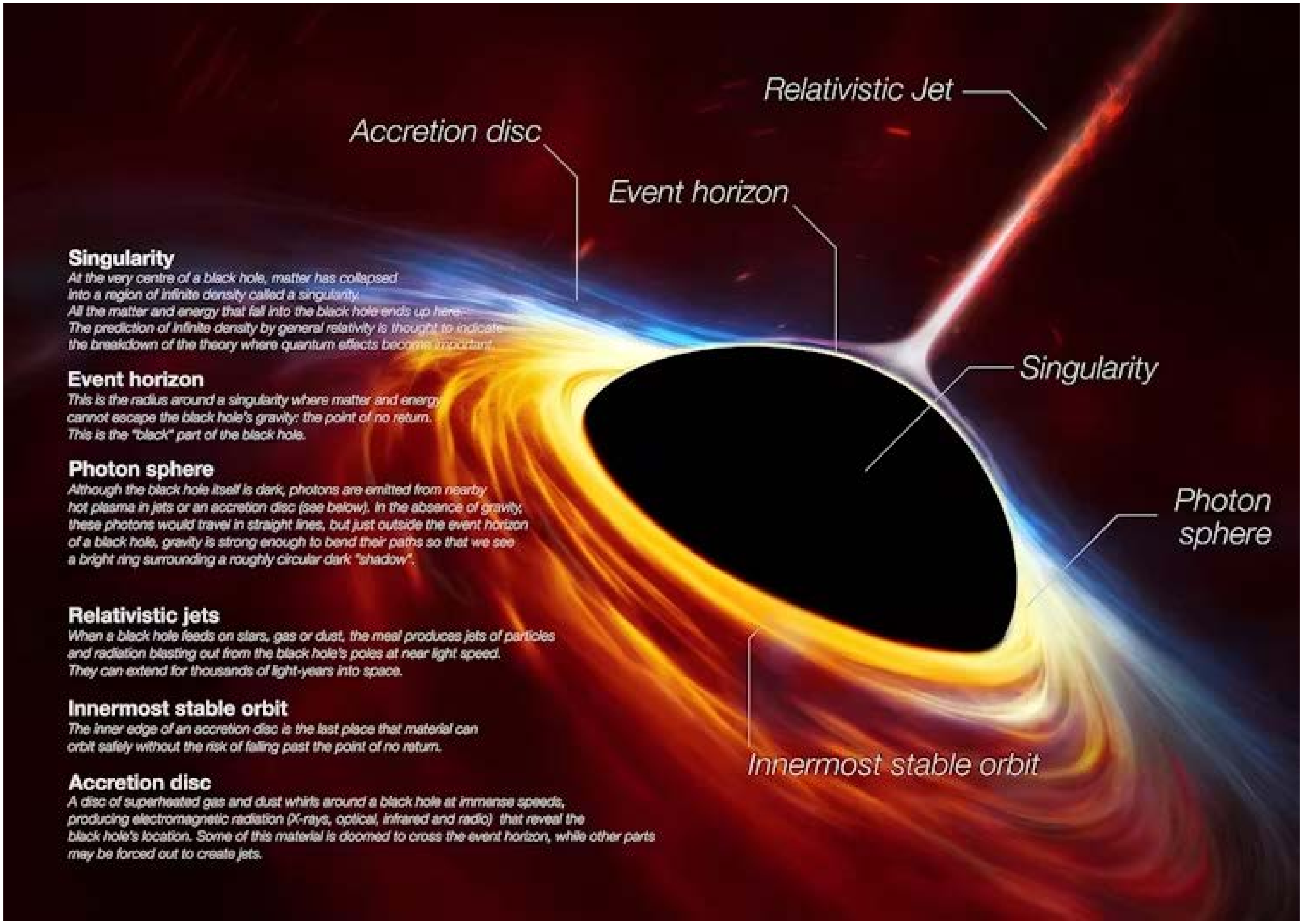


The only two images taken of black holes as of 2026, captured in millimeter wavelengths. On the left is the supermassive black hole M87, located at the center of the galaxy Messier 87, with a drawing overlaying the orbit of Pluto and the location of the Voyager 1 probe, which is off in interstellar space. On the right is the supermassive black hole located at the center of the Milky Way as an inset of the left, with a drawing overlaying the location of Mercury's orbit, and the Sun's diameter. Credit: [EHT collaboration (acknowledgment: Lia Medeiros, xkcd)]., CC BY*

Because it is very difficult to take pictures directly, astronomers have to use indirect methods to learn about supermassive black holes and their properties.

To figure out the mass of a supermassive black hole, astronomers can look at its surrounding host galaxy and calculate the mass needed to exert that gravitational force on the components of the galaxy. Supermassive black holes that are consuming matter are categorized as active, whereas supermassive black holes that do not consume matter are known as inactive or quiescent.

For galaxies with a quiescent supermassive black hole, astronomers measure how quickly the stars tightly packed near the center of the galaxy are traveling. They take the average of all these speeds



Active black holes are surrounded by accretion discs. These rotating discs are made up of superheated gas and dust. [ESO, ESA/Hubble, M. Kornmesser/N. Bartmann](), *CC BY-NC* and use a relation known as the M-sigma relation to get a mass that matches with the average measured speed.

For galaxies with an active supermassive black hole, astronomers look at the light the gas around the event horizon emits. If scientists make the assumption that the gas is moving in an orbit around the supermassive black hole, the width of the surrounding gas corresponds to the central mass, and that can provide another way to estimate mass.

Astronomers can also get a sense of how much mass is falling into an active black hole by measuring the luminosity, or observed power, of the gas before it crosses the event horizon.

What don't we know about these objects?

Astronomers are also interested in figuring out how supermassive black holes form. While they already know how smaller black holes, called stellar mass black holes, form, supermassive black holes are too big to form in the same way.

Stellar mass black holes form when a massive star runs out of fuel. Gravity causes its core to collapse, which sends out a shock wave that destroys the star and can leave behind a black hole. However, the stars that form these stellar mass black holes are not large enough to form supermassive black holes.

Scientists have two hypotheses for the formation of supermassive black hole seeds. The seeds are the initial black holes that gain mass over time until they turn into the supermassive black holes that we observe today.

One hypothesis is that they are the results of massive, young stars in the early universe, known as Population III stars, dying. The other hypothesis theorizes supermassive black hole seeds came from a large gas cloud collapsing, due to its large mass and strong gravity, into a black hole.

Neither hypothesis currently has direct observational evidence supporting it, but results from the James Webb Space Telescope hope to answer these questions.

Another major question that has not been answered is when these supermassive black holes form.

This question becomes a bit of a chicken-or-the-egg problem: Did the supermassive black hole seeds form first, then gradually attract the matter that eventually formed the galaxy around it? Or did a galaxy start to coalesce first, and stars and gas clouds inside it collapsed into the supermassive black hole seeds?

Preliminary results and observations suggest the former is more likely, but if that's the case, it raises the question: How could the rest of the galaxy form and evolve with the supermassive black hole inside it?

Why is it important to study them?

Supermassive black holes affect their host galaxies. As the supermassive black hole grows, astronomers see an increase in the speed of the stars located in the central cluster of the galaxy. This pattern suggests a link between the supermassive black hole and the other components of the galaxy, such as stars, gas and dust.

Often, scientists observe matter falling inward, toward the black hole. But before it's sucked in, some of it gets blown back by winds created by the black hole's intense pressure and friction. This matter blown away from the vicinity of the supermassive black hole may either heat up gas and prevent stars from forming or compress gas and cause shock waves within the galaxy.

Though a supermassive black hole can affect its host galaxy, Earth is in no danger of being sucked up or taken into the black hole at the Milky Way's center. In most galaxies, the supermassive black hole simply acts as a gravitational force that keeps objects in the galaxy in orbit.

However, it is important for scientists to understand how supermassive black holes affect their host galaxies, and how they can shape our observations of the universe.

Mary Ogborn is a PhD Candidate in Astrophysics at Penn State.

Book Review: *110 Things to See with a Telescope*

by Ken Yanosko

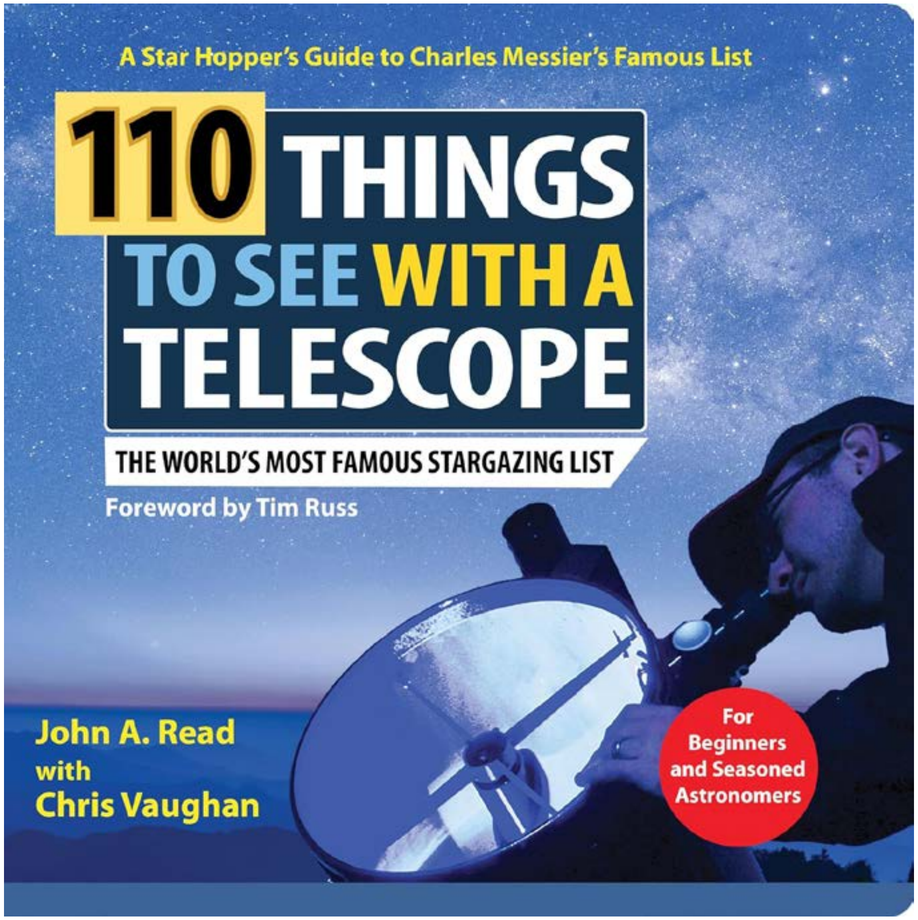
The number 110 in the title of this book is a dead giveaway: this is a book about (but not limited to) the Messier objects. It is written by a couple of amateur astronomers, John A. Read and Chris Vaughan, with a forward by another amateur astronomer, Tim Russ, and is intended for amateurs. It is useful for beginners and old-timers (like me). Its 25-page introduction begins with the usual story behind Messier's list, with a photo of Messier's Gregorian Reflector, and goes on with a discussion of basic observing techniques.

Although the book isn't specifically organized for a Messier Marathon, since the objects are organized by season rather than by a single night's endeavor, it can be used for a marathon, since in either case one is searching roughly by right ascension. For the Autumn targets they tell you which are evening marathon objects and which you look for just before dawn. And they even tell you when you can squeeze in a nap during a marathon: after the Virgo and Coma galaxy fields and before the Sagittarius/Scorpius Milky Way objects.

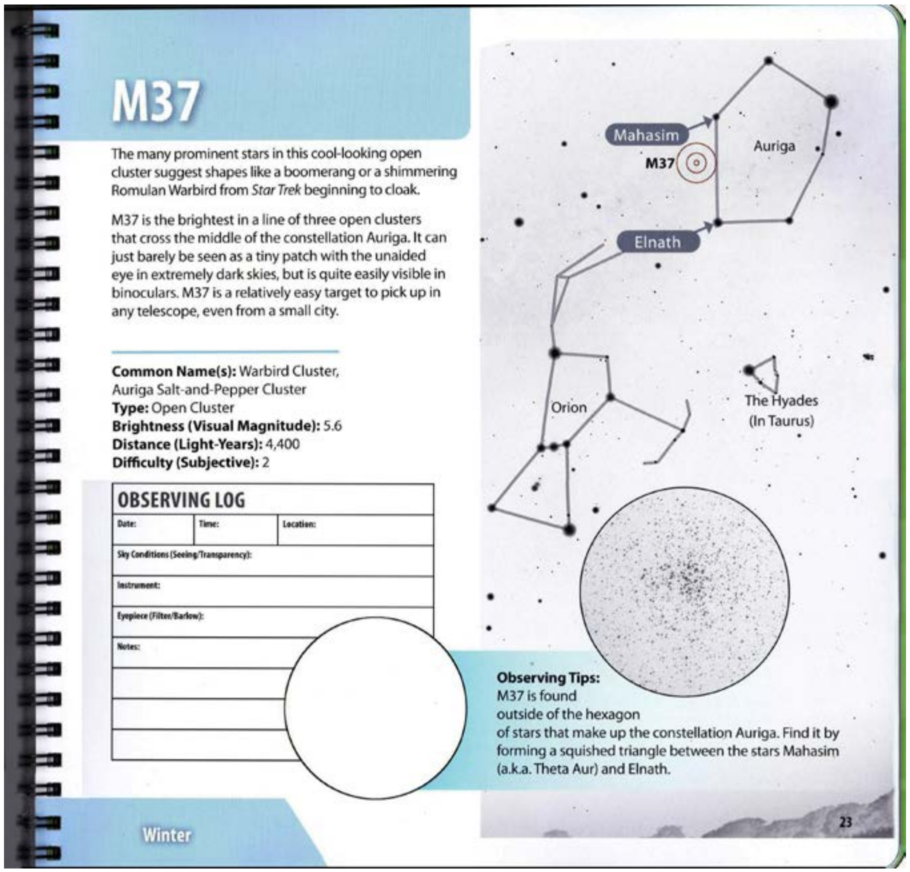
Each page is dedicated to one of the 110 objects (a few pages have two or more closely spaced items) and has a large-field map showing the object's location inside a set of Telrad rings and relative to one or more constellations. Then it has a close-up eyepiece view (as seen by an amateur scope, in grayscale) and a verbal description and data table and a place for the users to add their own data and even draw their own sketch. Finally there are "Observing Tips" to aid in starhopping to the object. And if there are non-Messier objects of interest nearby, the authors will mention those, too, and put them on the locator map. And here and there they include a full-page map of things like the Leo cluster and the Sagittarius star clouds.

I was amused by some of the modern nicknames given to some of the objects: M29 is the "Cooling Tower," M103 is the "Traffic Light Cluster," M11 is the "Borg Cube," and M37 is the "Warbird Cluster." These latter two are no surprise, given that the forward-writer, Tim Russ, used to have a day job playing Lt. Commander Tuvok on *Star Trek: Voyager.*

If you've seen me pushing around my orange-tube C8 or my SkyQuest XT8 you know I'm a "hunt and peek" observer. I can believe this book was written expressly for me. I have Telrad bases on both tubes, and put my Telrad on whichever scope I'm using for the night. I have printed out Telrad-based Messier maps (see https://www.astrohum.org/tumol.pdf), and I have a first edition of our former colleague Lenore Freeman's book *A Starhopper's Guide to Messier Objects* (now out of print). Each of these is useful but is not nearly as



110 Things to See with a Telescope.
John A. Read and Chris Vaughn.
Sourcebooks. Naperville, Illinois. 2024.


M37

The many prominent stars in this cool-looking open cluster suggest shapes like a boomerang or a shimmering Romulan Warbird from *Star Trek* beginning to cloak.

M37 is the brightest in a line of three open clusters that cross the middle of the constellation Auriga. It can just barely be seen as a tiny patch with the unaided eye in extremely dark skies, but is quite easily visible in binoculars. M37 is a relatively easy target to pick up in any telescope, even from a small city.

Common Name(s): Warbird Cluster, Auriga Salt-and-Pepper Cluster
Type: Open Cluster
Brightness (Visual Magnitude): 5.6
Distance (Light-Years): 4,400
Difficulty (Subjective): 2

OBSERVING LOG
Date: Time: Location:
Sky Conditions (Seeing/Transparency):
Instrument:
Eyepiece (Filter/Barlow):
Notes:

Observing Tips: M37 is found outside of the hexagon of stars that make up the constellation Auriga. Find it by forming a squished triangle between the stars Mahasim (a.k.a. Theta Aur) and Elnath.

Winter 23

A typical page for one of the 110 things.

complete as this book. I think *110 Things* will become my primary how-to-find-it resource.

Even if you're a "Go-To" user, and are expert at setting up your AI-controlled rig, I think you'll enjoy this book, and I'll bet you'll learn a few things. Which Messier object is closest to the center of our galaxy? (Page 75.) What was Messier thinking when he put a binary star on his list? (Page 37.) What's the next thing to try when averted vision just won't bring a dim object into view? (Page xv.)

This book is worth a look. It is available in hardcover, paper-back, and a most-useful (and least expensive) spiral-bound "field edition."

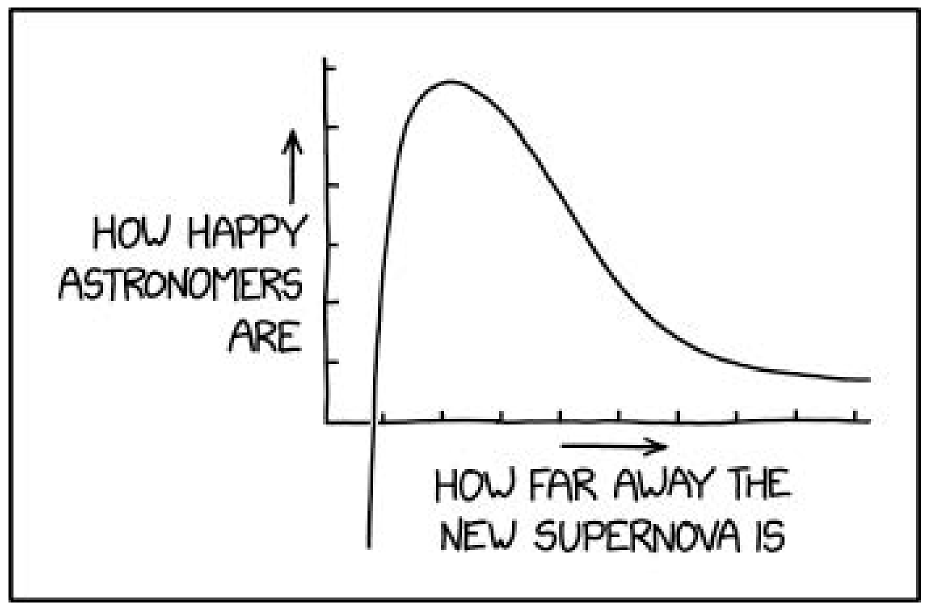
After Words

"We find them smaller and fainter, in constantly increasing numbers, and we know that we are reaching into space, farther and farther, until, with the faintest nebulae that can be detected with the greatest telescopes, we arrive at the frontier of the known universe."

Edwin Hubble
The Realm of the Nebulæ
1936

"We have peered into a new world and have seen that it is more mysterious and more complex than we had imagined. Still more mysteries of the universe remain hidden. Their discovery awaits the adventurous scientists of the future. I like it this way."

Vera Rubin
Bright Galaxies, Dark Matters
1997



Randall Munroe
xkcd, Creative Commons