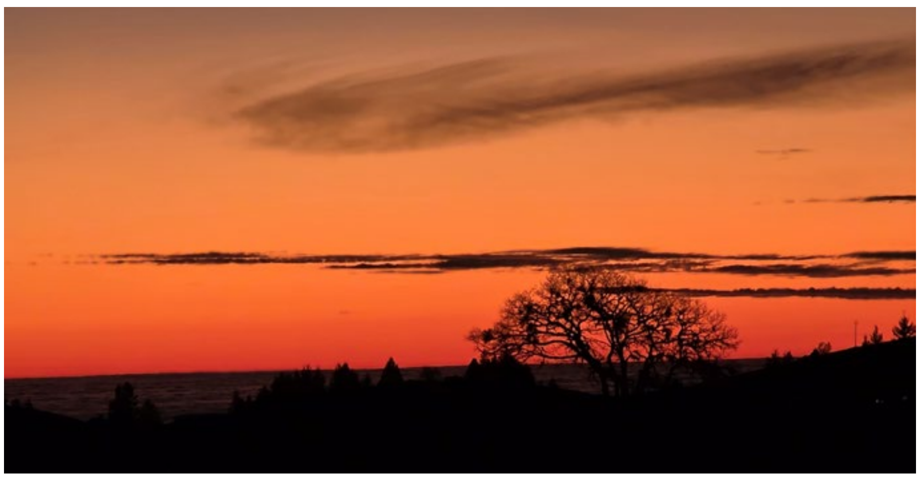
AOH Newsletter

Spring 2026

News and Notes

January at Kneeland

A small group went up to Kneeland in January. We saw the sunset, Jupiter, and a few bright stars. But the hoped-for clearing didn't happen, so we packed up early and called it a night.



Above: Sunset recorded by Nik Kordic.

Left: Jupiter and attendants captured by Catrina Howatt and her Seestar.

Telescope Workshop

We held a telescope workshop at the Eureka Public Library in January. It was advertised for the general public as an opportunity for anyone with a Christmas scope (possibly from Christmases past) to bring it in and learn how to set it up and use it. We had 34 people come in with various scopes; eight AOH members were on hand to assist. We were able to set up, adjust, and give instructions. We and the "customers" and the library staff were quite pleased with the event. See page 6 for information about our next workshop.

Activity at the telescope workshop; photo by Frankie Lujan.

Annual Potluck

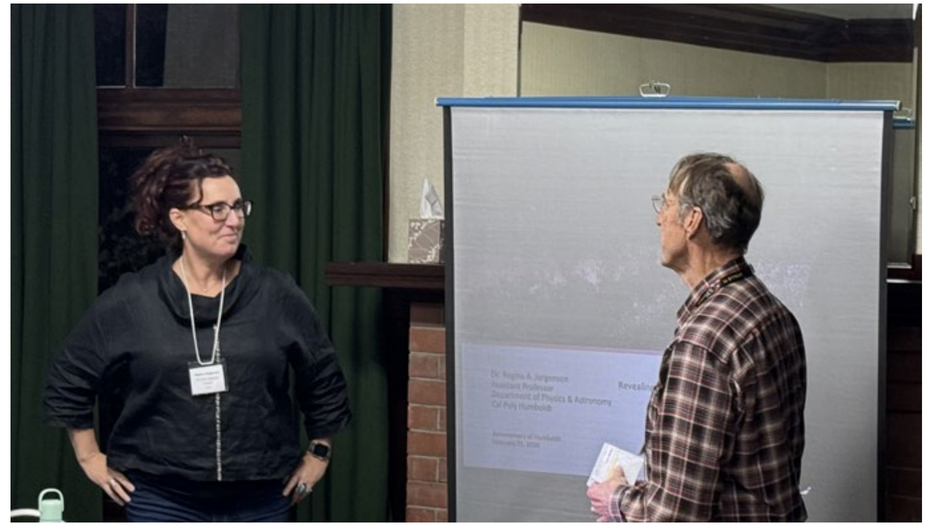
We celebrated the Club's 69th anniversary at our annual potluck at the Eureka Woman's Club on February 21. Our featured speaker was Dr. Regina Jorgenson of the Cal Poly Humboldt Department of Physics and Astronomy. Dr. Jorgenson's talk "Where Did We Come From? Revealing the Mysteries of Galaxy Formation and Evolution" was well received by the AOH members, and we are excited by the prospect of a renewed collaboration between AOH and Cal Poly.

The kitchen was well stocked with mains, sides, and desserts. —Don Wheeler

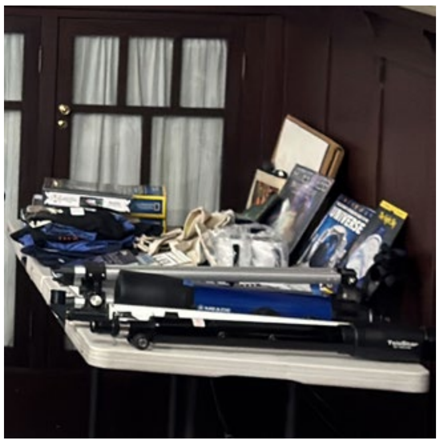
Dr. Jorgenson's presentation on detecting the intergalactic medium was entertaining and educational. —Ken Yanosko

We had a good turnout. —Ken Yanosko.

The audience was attentive. —DW

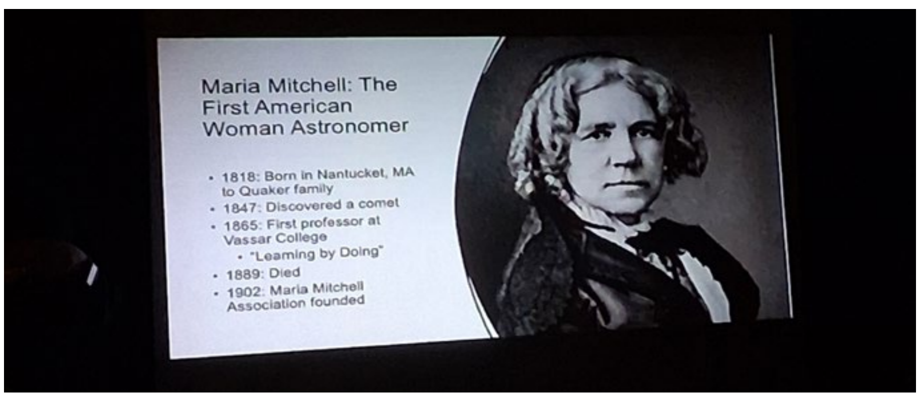


Brent introducing the guest of honor. —DW



The raffle prize table. Everyone was a winner. —DW

Long-time club members Bob Zigler and Jeff and Lisa Schmitt. —DW



The talk included some info about Maria Mitchell. —KY

Grace thanking the speaker with some AOH gifts. —DW

Night Sky Network Stars

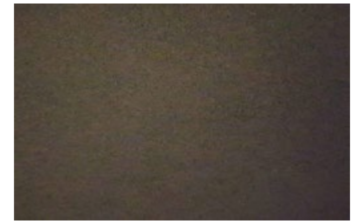
A number of AOH members were recognized at the potluck with certificates and pins issued by the Night Sky Network. They are: Bernie Christen, Susie Christian, Roger Coy, Susan Coy, Gary Creason. Greg Deja, Dan Eaton, Susan Frances, Rick Gustafson, Brent Howatt, Catrina Howatt, Mary Kaufman, Yoon Kim, Russ Owsley, Jeff Schmitt, Lisa Schmitt, Oliver Smith, Susan Terebey, Dave Van Buren, Allison Waltberg, Johann Waltberg, Don Wheeler, Grace Wheeler, Mark Wilson, Ken Yanosko, and Bob Zigler. Thank you all for your contributions to our outreach programs.

Zoomers

Participating in the first Zoom meeting of the year were: Bernie Christen, Roger Coy, Greg Deja, Rick Gustafson, Brent and Catrina Howatt, Mary Kaufman, Ann Kilby, Yoon Kim, Chris McCown, Allison and Johann Waltberg, Grace Wheeler, Ken Yanosko, and Bob Zigler.

Lunar Eclipse, March 3

Arcata was fogged in; so was Kneeland. At right is an "eclipse" photo from my backyard. Below is a screen grab of mid-eclipse from the livestream from Griffith Observatory.



Art Imitating Life, or Vice Versa?

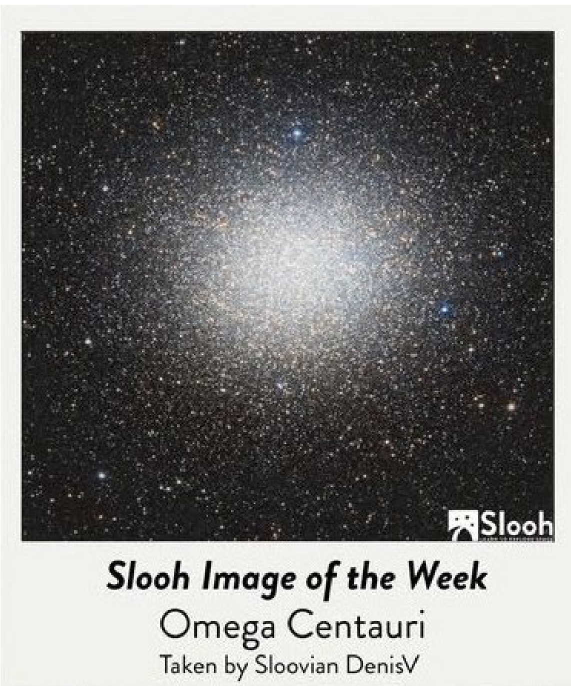
Left: Oliver Smith's FB post from last February.
Right: T-shirt ad on my FB feed last January.
See Oliver's article beginning on page 7. No, I didn't buy the T-shirt.

Omega Centauri Season

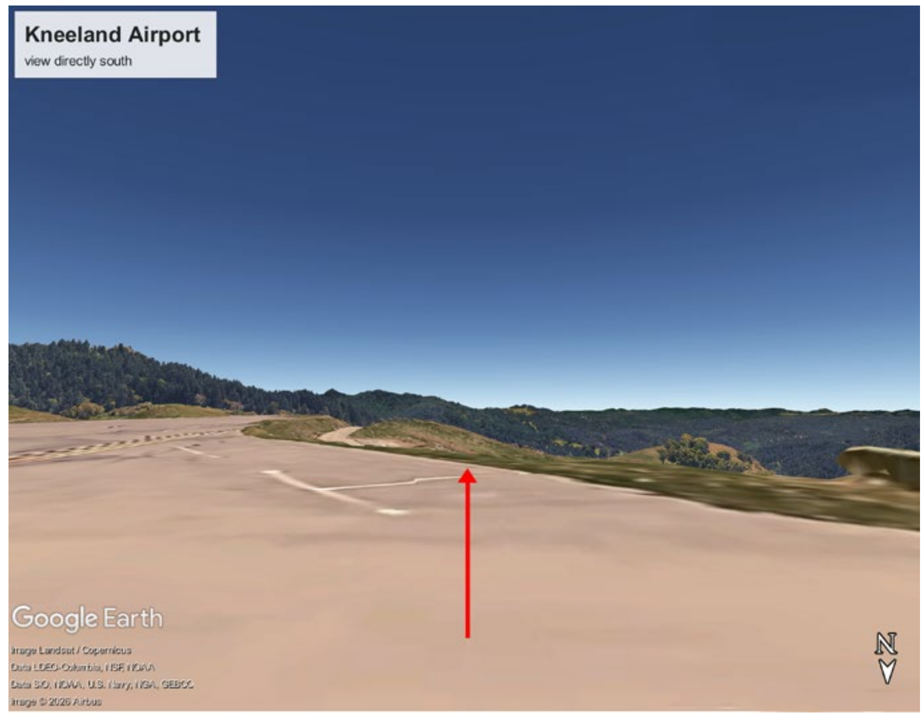
A few years ago Mark Wilson and I saw the globular cluster Omega Centauri from Kneeland, and I wrote about it in the Newsletter (Spring 2022), inviting others to have a look. No one ever responded. So I'm repeating the invitation, this time with a request for a photo or two. With all the Seestars around, it should be easy for someone to get me a picture.

Well, sort of easy. It's true that Omega is the biggest, brightest globular around—its apparent diameter is about a half of a degree, or about the size of the full moon, and its visual magnitude is around 3.8, so it should be visible to the unaided eye. The problem is that it is at declination 47.5 degrees *south*. And here we are (actually, *there* we are when we are observing at Kneeland) at 40.7 degrees *north*. That puts Omega at 90-(47.5+40.7) = 1.8 degrees above the horizon when it is at its highest. And that's a virtual horizon, one that you would see if there weren't any mountains in the way. Like there are at Kneeland.

So here's what you have to do. Go to Kneeland Airport. Set up in our usual spot. Wait until Omega is at its highest, i.e. due south on the meridian. The table here shows what times and dates that happens for this Spring's Saturdays-nearest-the-new-moon. Now, will you see Omega? No. The western shoulder of Gordon Ridge, 3.5 miles due south of the airport, is in the way. Wait a few minutes. The Earth will rotate eastward, carrying the ridge out of the way, and Omega will appear in the gap between this ridge and the next hill over. Send me your photos.



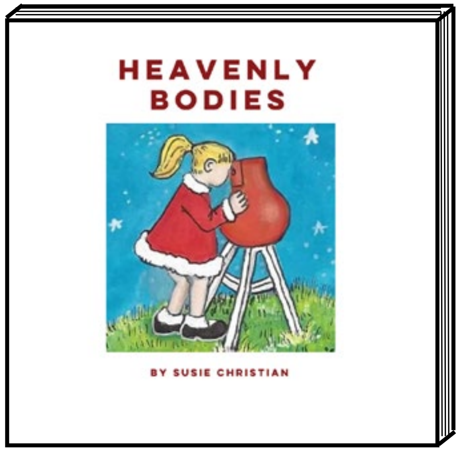
Omega Centauri on the Meridian, Spring 2026, from Kneeland	
Date	Time
March 21-22	02:42
April 18-19	00:51
May 16-17	23:05
June 13*-14	21:15
*On this date astronomical twilights lasts until 22:54.	



Google Earth view from our observing spot at Kneeland Airport. The arrow points due south. At the dates and times listed in the table, Omega Centauri is due south, behind Gordon Ridge, As the Earth rotates, the ridge moves out of our way and lets us see, and hopefully photograph, the cluster.

Susie's Cartoons

For the last 10 years Susie Christian has been painting cartoons for the Newsletter, with the title "Heavenly Bodies." Newsletter editors Grace and Ken gathered up all of these cartoons and presented Susie with a bound collection. An e-version is available in pdf and epub format. Click below to download a copy.



DOWNLOAD PDF   DOWNLOAD EPUB

Library Workshop

AOH and the Eureka Public Library will hold a free workshop for the general public on June 6 from 1 to 3 pm. The topic will be "Observing the Sky—from Astrolabes and Planispheres to Smart Phones and Tablets." We'll need a few AOH members to come out to help (no expertise needed). Contact Ken to volunteer or to get more information.

Albee Creek Star Parties

Save the dates. We have scheduled two star parties at Albee Creek this summer—July 18 and August 15. As usual, the Park has reserved complimentary campsites for AOH volunteers. We have had several hundred visitors attending our events in the past, and so are looking forward to doing it again. And we'd love to have some new AOH participants get involved as well. More information will be in the Summer Newsletter.

Thanks

Nik, Catrina, Frankie, Don, Oliver, Grace, and Susan contributed to this issue of the Newsletter. Thanks to all of you.

Ken

Book Review: Mary Roach, *Packing for Mars*

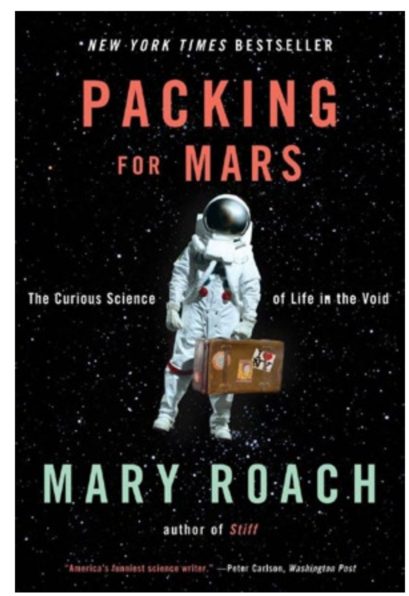
by Ken Yanosko

In 2011, Mary Roach, science writer and humorist, published *Packing for Mars: The Curious Science of Life in the Void*. Although written 15 years ago, before the Artemis Program, it is still remarkably up to date. It's essentially a history of human adaptation to space travel, filled with descriptions and explanations of research programs and space gadgets and training protocols. If you've ever wondered "How do they do __ in space?" this book will probably tell you. The author conducted interviews with astronauts and cosmonauts, scientists and engineers, and volunteers who participated in earth-based simulations of outer-space conditions and environments.

And she became a journalist-participant in many of these programs. She tasted space foods, drank recycled fluids, tried out the space station toilet trainer at the Johnson Space Center, and even got to fly in the zero-g "vomit comet" to experience weightlessness.

The book is scientifically and technically accurate, and highly entertaining as well. Everything is told with a splash of humor, not in the sense of poking fun at the space programs but with an appreciation of how the people involved deal with the discomforts and indignities of being cooped up for days, weeks, and months on an excursion to space.

Whether you're a space travel enthusiast or a feasibility skeptic, I think you'll find this book illuminating and enjoyable.



Mary Roach. Packing for Mars: The Curious Science of Life in the Void. *2011. W. W. Norton & Company.*

A New Beginning

by Oliver Smith

How big is the problem?

So I'm at the beginning of a new discipline of photography, astro imaging! I am not terrific, and I am certainly not ready to teach anybody about anything just yet. But I can certainly encourage you, and share with you about the mistakes that I've made and things that I need to avoid doing in order to walk away with a pretty picture. I'm adding deep space imaging to my 35 year photographic résumé!!

I really enjoy capturing the colors and the finer details of things we cannot see without dedicating several hours to catching photons of light. And I say it like that because I think it's funny, funny in the way of how it was explained to me. Literally when we take a picture of space we are catching tiny little grains (photons) of light in a bucket! These buckets are located on the sensor of your camera and they're called light wells, the more photons caught, the better... I remember laughing when I thought about, "Well, why didn't they just call them light buckets?" I thought about the Walt Disney movie, The Sorcerers Apprentice, and how all the brooms when they were getting chopped up into smaller brooms and still continued on with their buckets, and never stopped marching along! Resilience, I admire that in a broom, I thought to myself.

For me, imaging forces my mind to think more along the lines of a more true perspective. It makes me think about how things might really be. How my patterns of perceived normality, and everything that I might know about this, that, and the other, is actually a survival skill.

When my mind is inside out, thoughts are racing and there are a revolving 104 things that categorize as thoughts, I'm not talking about the 502 bad ideas that are interwoven with the other thoughts. Add adult life, working in the public, being a single parent, and helping my son navigate his path, and 'whats for dinner' is a stress by default, the week can become an uphill muddy battle.

If I can stop thinking for a moment about what's in front of me, and instead about what's around me, it's a good place to start calming down. I'm on earth but... I'm in space, we all are (right?). Space is a pretty big place, did we ever find out if it's just a ginormous playground and there's walls that we don't know about? Does space thin out and become something alien and unknown, (GASP...) there are aliens floating around with us out here too, you know... in space. (GASP...) I'm one of them, we're all aliens too.

What am I, I'm a man among other men. Where am I, I am on a planet among other planets. These planets revolve around a star, among other stars, in this galaxy among other galaxies, in clouds of dust and gas. The fractal thought expands and eventually I come to realize that 'what's for dinner' just isn't that significant of a problem anymore. It's time for me to break out the gear!

So I begin with Stellarium; this is a FREE app you can download to your phone or your desktop. And it has been, for me, by far, the easiest and most comprehensive night sky chart, not lacking detail and information. Use it as a tool, or to kill some time.

In Stellarium I will find a target that will offer a full evening for imaging, 30 minutes after sunset, 30 minutes before sunrise. I look for what is rising east southeast, maintains over 30° off the horizon for the entire evening. Months ago it was the high point of fall/winter nebulae, including targets like the California, the flaming star, the tadpole nebulae, etc. Now that these targets are starting off at sunset too far into the zenith for me to dedicate a full night on, I keep looking to the east to see what's coming. This time of year we're getting into a higher concentration of star clusters and galaxies. And it will be important to make some small changes to my gear lineup and shooting sequence.

After the shoot I will take all of the exposures from the evening and stack them on top of each other in a program called Deep Sky Stacker. This will develop a stacked image of linear data. Take that image to any processing app like Graxpert, Gimp, or Siril. These are the FREE ones that are popular. Upload the linear data to the app and begin to stretch the photo like pizza dough! Pull tug here, push pull there, and as you do you'll begin to see your target surface from the darkness of its linear state. The idea is simple, the process is not: a lot of study, YouTube, and reaching out to the connections that you've made in your Facebook groups.

It's almost been one year now, for me. I looked at my first image and I'm happy to tell you all—I've gotten a lot better. But I'm still at the very beginning, a very fascinating beginning.

Clear Skies y'all!

Some of the post-processing steps:

a. A linear stack of 200 x 2 min shots (Deep Sky Stacker)

b. Initial image stretch, between 3-6 of these stretches plus texture adjustments (Graxpert & Siril)

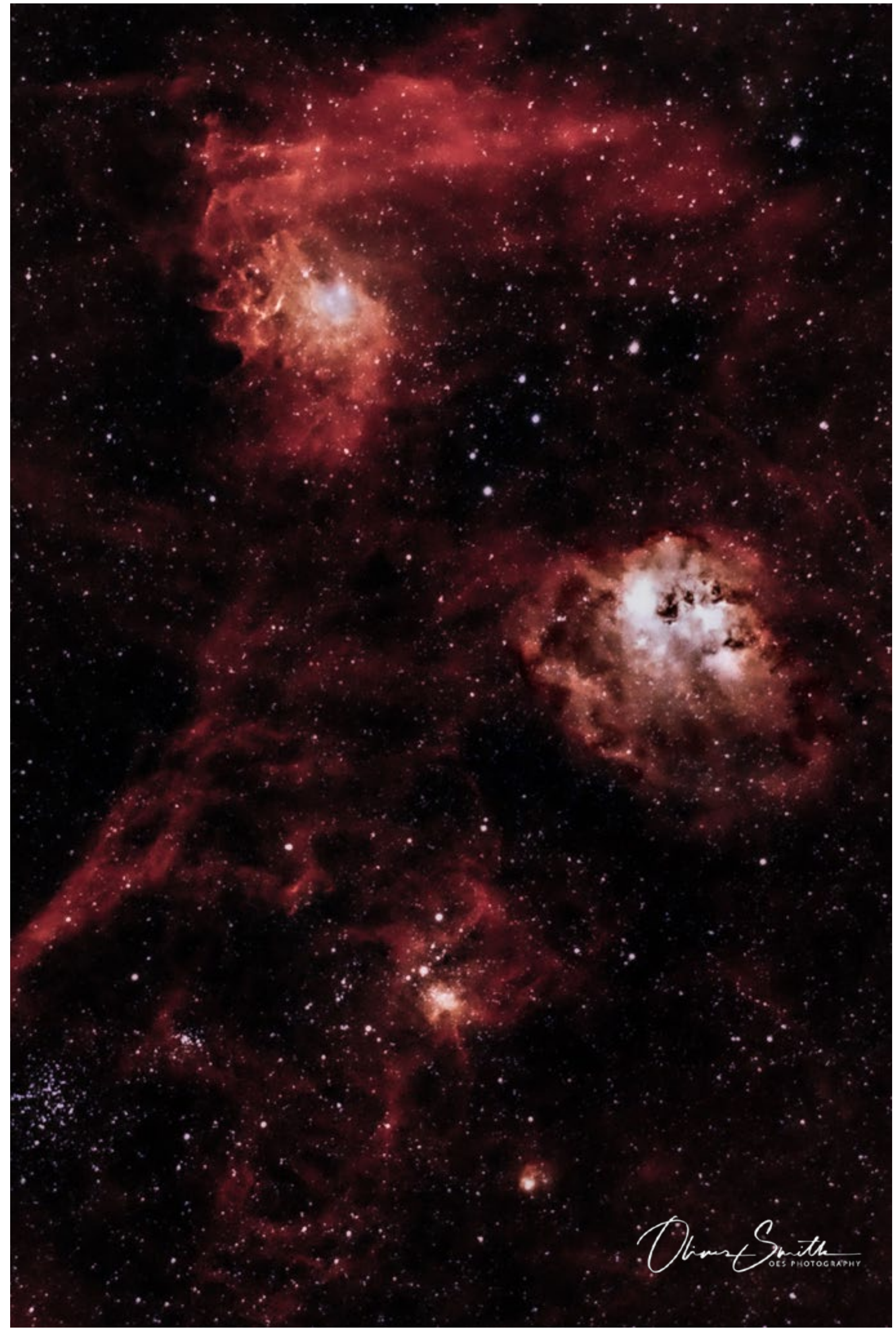
c. Star separation (Starnet++) Nebula edit. On to re-layer stars back in plus color and texture adjustments (Photoshop). Crop, change from TIF to JPEG and send to Grandma (Lightroom)

d. IC405 – The Flaming Star Nebula—Final Image

a

b

c



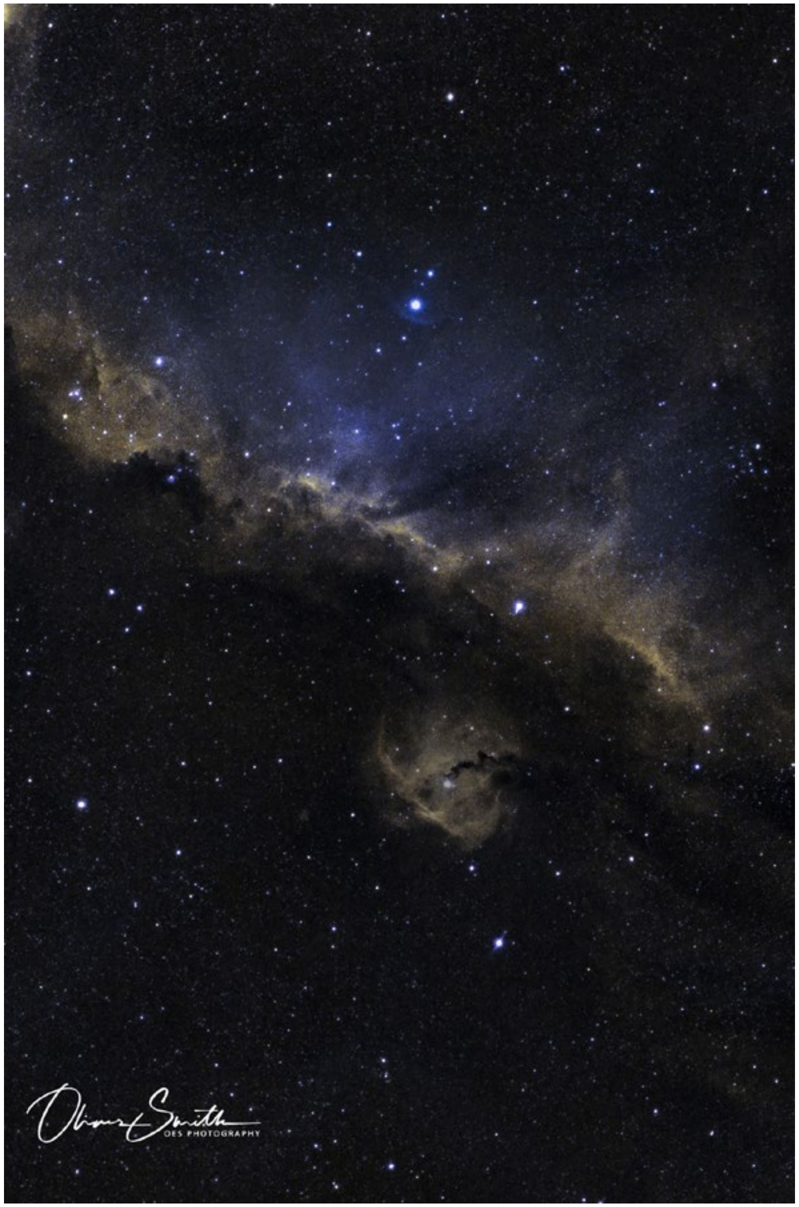
d

NGC 2237 – The Rosette Nebula

sv555 @f/5.0 (54mm/243mm)
sv220 HA/O3 & S2/O3
ASI 183mc pro
ASI 120 mini guide cam
Svbony 40mm guide scope

Mount – ZWO AM3 on AVX
Bortle 5 in the back yard

60 x 300sec. Temp -10. Gain 111
Graxpert, Siril, PS/LR
Cropped for stacking artifacts



IC 2177 – The Seagull Nebula

sv555 @f/5.0 (54mm/243mm)
sv220 HA/O3 & S2/O3
ASI 183mc pro
ASI 120 mini guide cam
Svbony 40mm guide scope

Mount – ZWO AM3 on AVX
Bortle 2-3 Kneeland

95 x 120 sec. Temp -10. Gain 111
Graxpert, Siril, PS/LR
Cropped for stacking artifacts

Below:
IC 434 – The Horsehead Nebula

Scope. sv555 @f/5.0 (54mm/243mm)
Filters. sv220 HA/O3 & S2/O3
Camera. ASI 183mc pro
Guide Camera. ASI 120 mini
Guide Scope. Svbony 40mm
Mount. ZWO AM3 on AVX
Sky. Bortle 5-6 Backyard

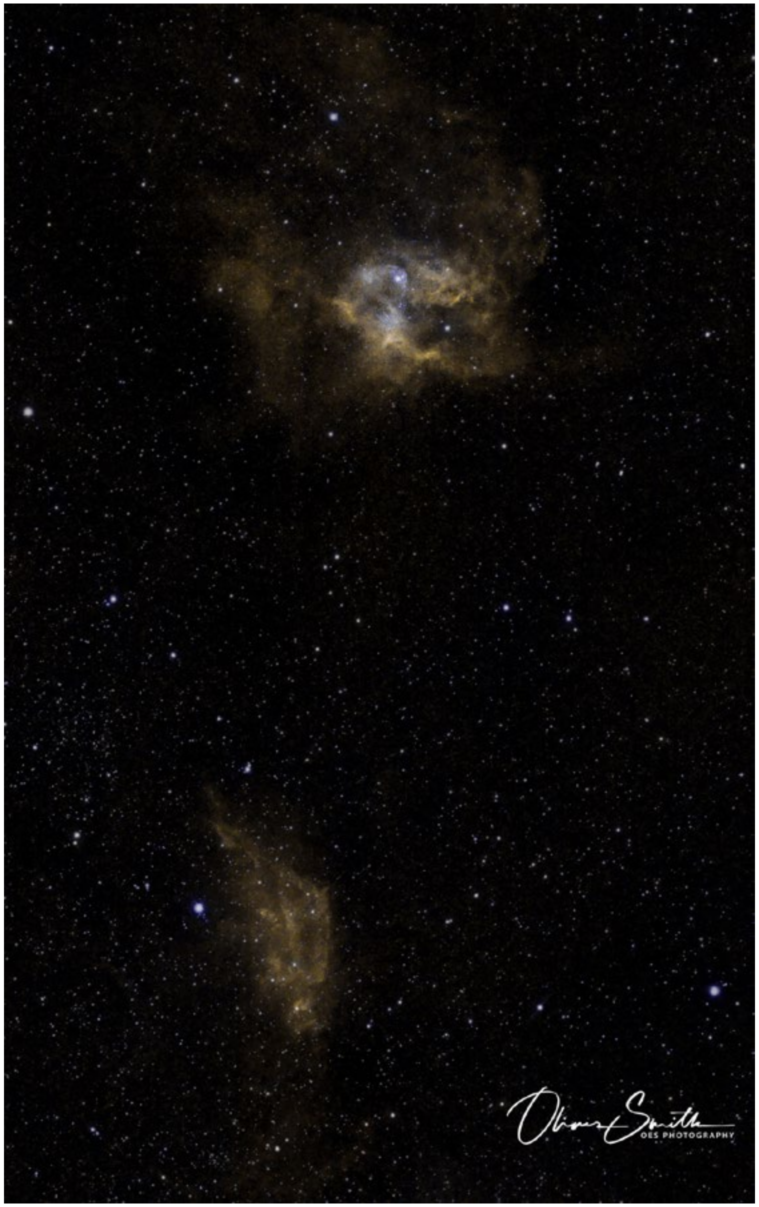
80 x 120 sec. HA/o3
80 x 120 sec. S2/o3
Temp -10. Gain 111
Graxpert, Siril, PS/LR
Cropped for stacking artifacts

Above:
NGC 2359 – Thor's Helmet

Scope- Svbony sv503 70mm ED
Field Flattener/Reducer - Svbony 0.8 for sv503 80mm ED
Filter - Svbony sv220 HA/o3 7nm Duo-Band
Drawer - SV226
Camera - ZWO ASI183mc PRO
Mount - ZWO AM3
Guide Scope - Svbony 40mm
Guide Cam - ASI 120 mini
Distribution/control - ASIair mini
Tripod - Celestron AVX

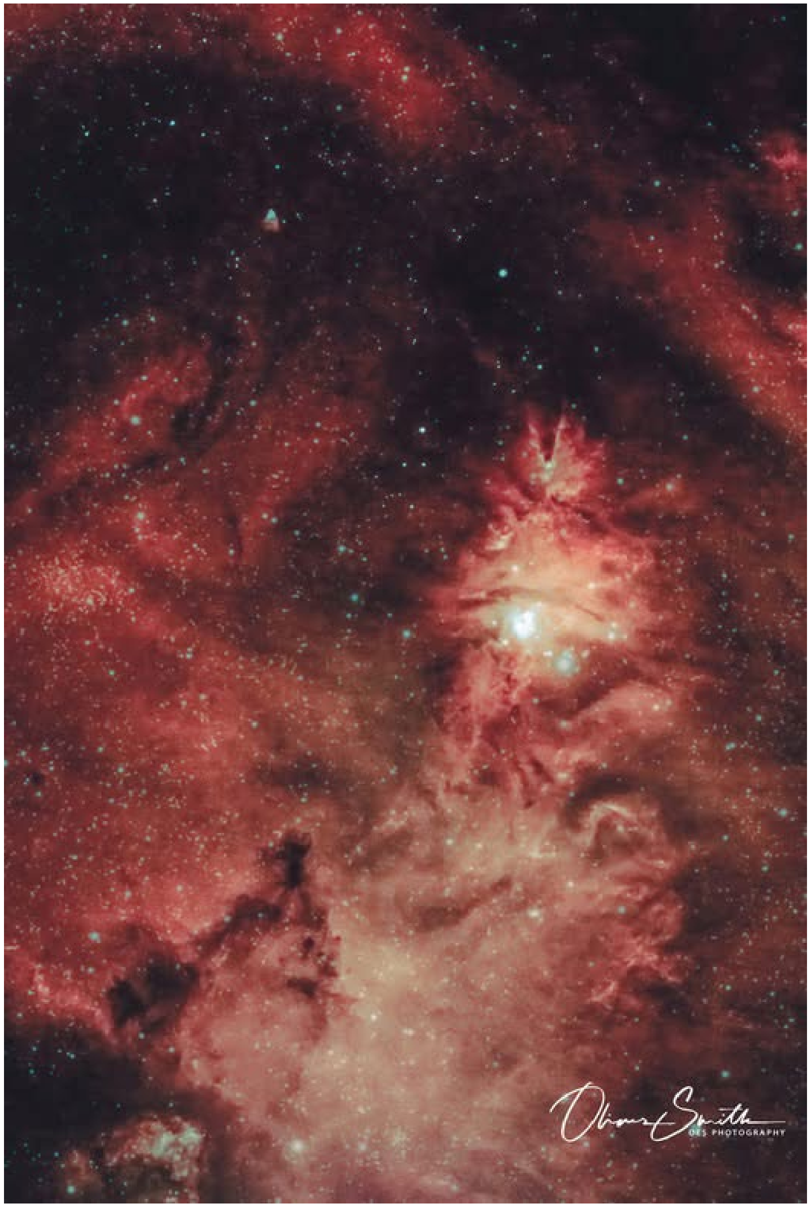
15 x 300sec. Tracking error <0.90"
30 Dark. 20 Flat. 0 Bias. 0 Dark flat.
Bortle 2 sky

DSS, Graxpert, Siril, PS/LR



Sh2 280 & Sh2 282 – Lower's Nebula

I was able to get about 4 hours for this shot. I LOVE that blue "bow shock" (the seagull nebula has one too!)



NGC 2264 – The Cone Nebula & Christmas Tree Nebula

Oliver Smith is an old dog eagerly learning new tricks.

Jupiter at Opposition and the Transit of Callisto

by Grace Wheeler

On January 10, 2026, two noteworthy Jovian events coincided: Jupiter reached opposition, and the Galilean moon Callisto transited the planet's disk. Transits of Callisto are infrequent, occurring only during a three-year window centered around Jupiter's equinoxes. During these periods, the Earth and the Sun are nearly aligned with the Jovian equator, allowing observers to see Callisto and its shadow pass directly in front of the planet. Outside of this window, near the Jovian solstices, Callisto's expansive and slightly inclined orbit results in a large vertical displacement; this causes Callisto to pass above or below Jupiter from our perspective and miss the disk entirely.

Observing the Callisto Transit

The transit of Callisto (Figure 1) was observed starting at 10:50 p.m. on January 9 and ending in the early morning hours of January 10 at 2:30 a.m. Figure 1. illustrates the event in three stages: Callisto before its ingress onto the Jovian disk (A), at mid-transit (B), and near the end of the transit (C). Throughout the event, video was recorded at 10-minute intervals to create detailed images of Callisto's crossing. A timelapse of the full transit can be viewed here: https://youtube.com/shorts/pwi8KmfeUN4.

Jan Hattenbach from Sky and Telescope described this transit as a rare event because it coincided with Jupiter's opposition. According to Hattenbach, during this brief period, the Sun, Earth, Callisto, and Jupiter lay in a nearly straight line spanning roughly 780 million kilometers. At opposition, Callisto and its shadow crossed the disk in tandem; the shadow remained hidden because Callisto was superimposed directly over it (Figure 1B, C). In effect, Callisto was occulting its own shadow.

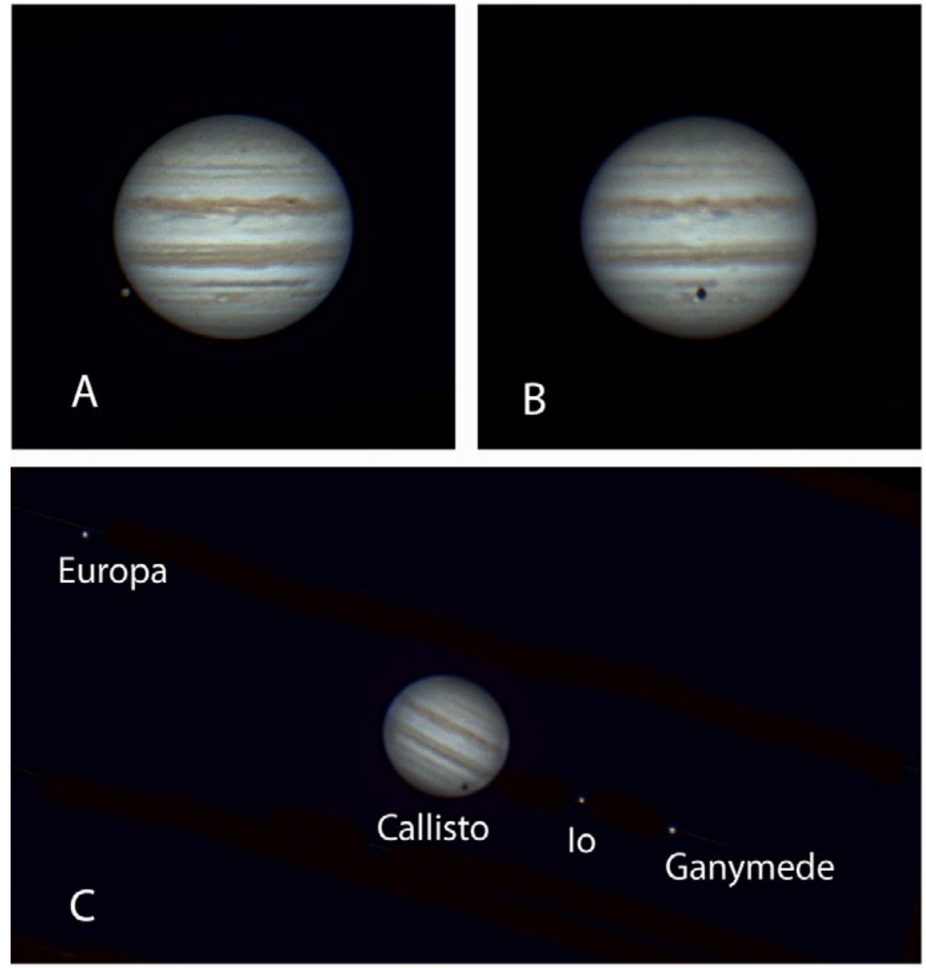


Figure 1. The transit of Callisto on January 9-10, 2026.

(A) Callisto is shown to the east of the limb at 10:50 p.m. This is just before the start of the transit.

(B) Mid-transit of Callisto at 1:00 a.m.

(C) A "family" portrait of Jupiter and the Galilean moons at 2:30 a.m. This was taken as Callisto was nearing the end of its transit.

Images were captured with an 8-inch Schmidt-Cassegrain telescope, a 2.5X Televue Powermate, and a Zwo 294MC planetary camera.

2026 Transit Season of Callisto

The Callisto transit season began in early 2025 and will continue through late 2027. In 2026, three transits are visible from the West Coast: January 10, January 26, and December 27. The January 10 transit occurred during opposition, with the moon and its shadow simultaneously crossing the Jovian disk (Figure 1.) The January 26 transit occurred 16 days post-opposition; in that instance, the moon transited before the shadow. Because Callisto crossed the disk during the afternoon, the moon itself was not viewable from our location, though the latter half of the shadow transit was visible once night fell (Figure 2).

The final Callisto transit of 2026 will occur on December 27. This will be a pre-opposition event, with the shadow transit preceding the moon. It is unlikely that the shadow transit will be visible, as most of it will be completed by the time Jupiter rises at 9:45 p.m. However, the good news for observers is that the entire transit of Callisto itself will be visible in the early morning hours of December 28, lasting from 2:16 a.m. to 6:54 a.m.

Jupiter's Springtime Apparition

At the time of this publication in mid-March, Jupiter continues to be a bright "evening star". It can be seen high in the constellation Gemini after nightfall and does not set until after 4:00 a.m. local time. Even though transits of Callisto will not be in the offing for the remainder of Jupiter's springtime apparition, the other three Galilean moons—Io, Europa, and Ganymede—can be seen transiting the Jovian disk much more frequently. For a list of these transit events, as well as eclipses and occultations, visit https://www.projectpluto.com/jevent.htm.

Note that the times on this site are given in UTC, and not all listed events will be viewable from our specific location. Happy hunting!

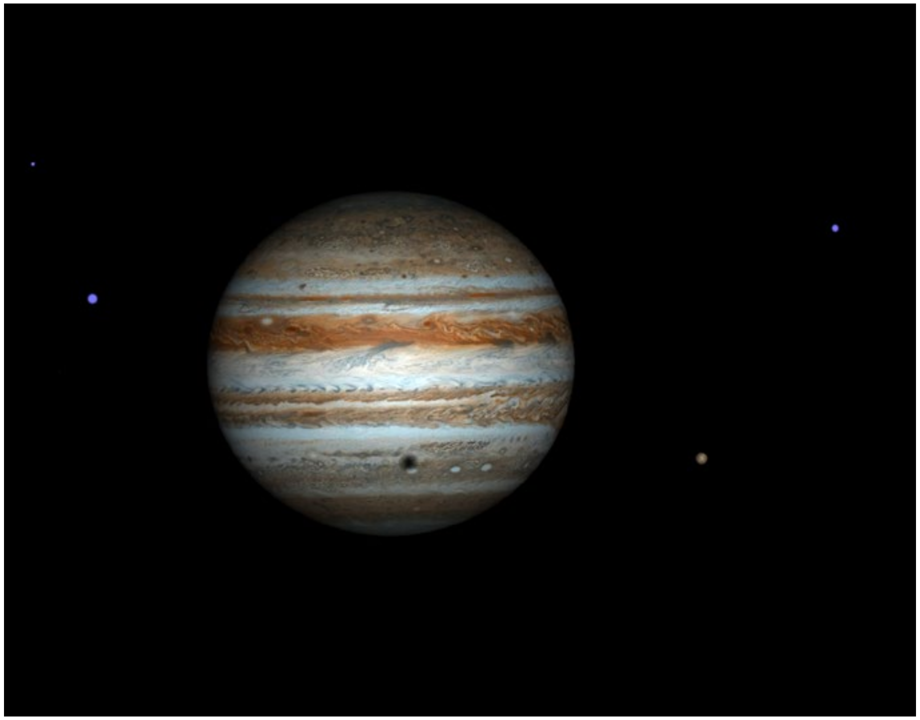


Figure 2. Simulation of the shadow transit of Callisto on January 26 at 7:00 p.m. PST. The shadow is shown on the Jovian disk. The moon Callisto had crossed several hours earlier and is shown to the right of Jupiter. The image is from Starry Night Planetarium program.

References

Hattenbach, Jan. "An Extremely Rare Callisto Event on January 10." Sky and Telescope, 8 January 2026. https://skyandtelescope.org/astronomy-news/an-extremely-rare-callisto-event-on-january-10th/

McClure, Bruce. "Jupiter Equinox and Mutual Events of its Four Major Moons." EarthSky, 31 March 2021. https://earthsky.org/astronomy-essentials/jupiter-equinox-mutual-events-moon-2021/

Grace Wheeler is Director of the AOH Transit Authority.

The Aurora of January 19-20, 2026

by Grace Wheeler

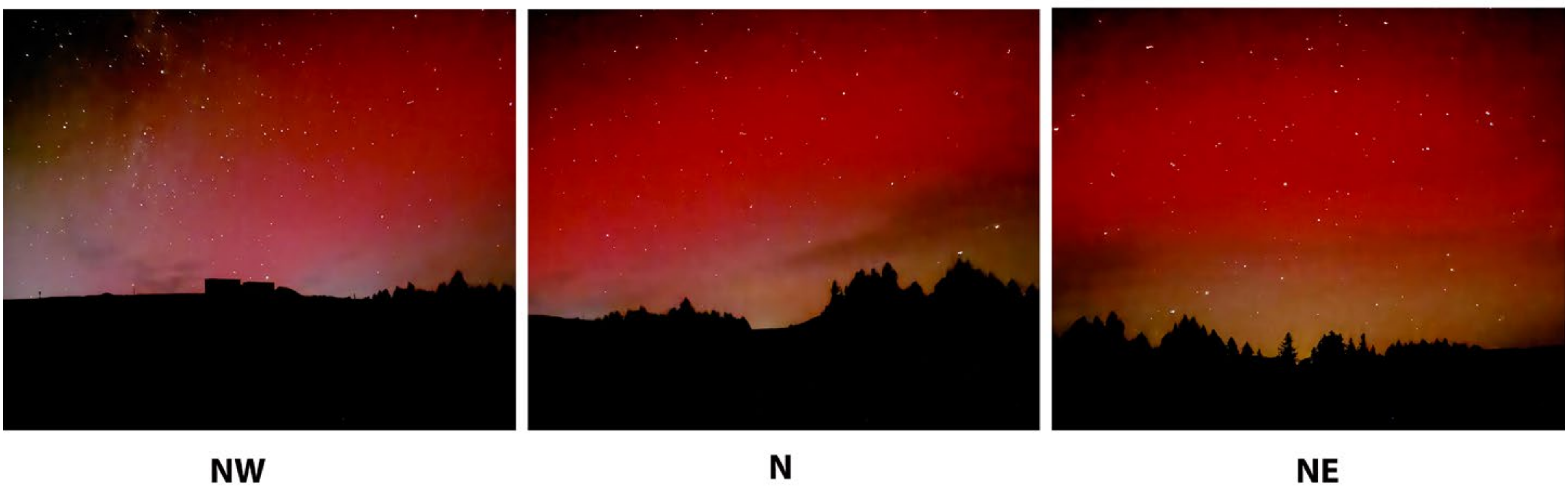
The aurora of January 19, 2026, was caused by an X1.9 flare that erupted on January 18. The resulting coronal mass ejection (CME) moved at an impressive speed, arriving on January 19—a day earlier than the original forecast. Preceding the CME impact was a severe (S4) radiation storm, the strongest since the 2003 "Halloween" solar storms. Solar radiation storms occur when solar energetic particles (SEPs), primarily protons, are accelerated from the sun during CMEs. While the Earth's magnetic shield protects us from most of these SEPs, they can still affect satellites and aircraft flying over polar regions. Although SEPs are not responsible for geomagnetic events, the intensity of this radiation storm signaled that the incoming CME would be highly impactful.

The CME arrived at 11:30 a.m. EST on January 19. A combination of high solar wind speeds, a strong Bt (the total strength of the interplanetary magnetic field), and an impressively negative Bz (the north-south field orientation) of -58 nT resulted in a severe G4 geomagnetic storm. The negative Bz is crucial, as it facilitates the entry of solar wind particles through the poles. During the G4 storm, strong auroral substorms were visible across mid-latitude Europe (Aurorasaurus.org). While internet news sites speculated that an extreme G5 storm was imminent, the Bz turned positive around 1:30 p.m. EST, causing the geomagnetic activity to wane.

Observing at Kneeland on January 19

Despite the weakening conditions at nightfall in the U.S., there were sightings of auroras as far south as Alabama. This prompted me to head to Kneeland to search for the lights. When I arrived after sunset, the airport was quiet, save for Jack Hopkins, who had set up astrophotography gear in the parking lot. Jack was skeptical of my chances and concerned that an aurora would ruin his deep-sky

Figure 1. The aurora at Kneeland Airport on January 19, 2026. These images were taken at around 7:00 p.m. with an iphone camera on night mode, 10s exposure. The compass reading for the center of each image is as follows: NW (330 degrees), N (0 degrees), and NE (30 degrees).



images; I promised to show him my photos if I saw anything. He did eventually see my aurora photos before leaving and was mildly impressed.

The sky was mostly clear with thin clouds to the northeast. I used my cell phone camera in night mode with a 10-second exposure to capture the aurora (Figure 1). The lights were not visible to the naked eye, but I could see them through the phone screen. It was a diffuse red glow without any pillars, stretching from the northwest (330 degrees) to the northeast (030 degrees). It remained mostly stationary for over two hours.

Brent and Catrina joined me around 8:30 p.m., but the aurora had weakened by then (the red seemed less intense in my images). Interestingly, Catrina's camera captured the red hues much more effectively than mine (Figure 2).

The Return of G4 Storming on January 20

Upon returning to Eureka, I monitored the space weather conditions for several hours. At 11:00 p.m. local time, the Bz was once again turning negative; geomagnetic activity bumped up to a moderate G2 storm. Just after midnight on January 20, a G4 warning

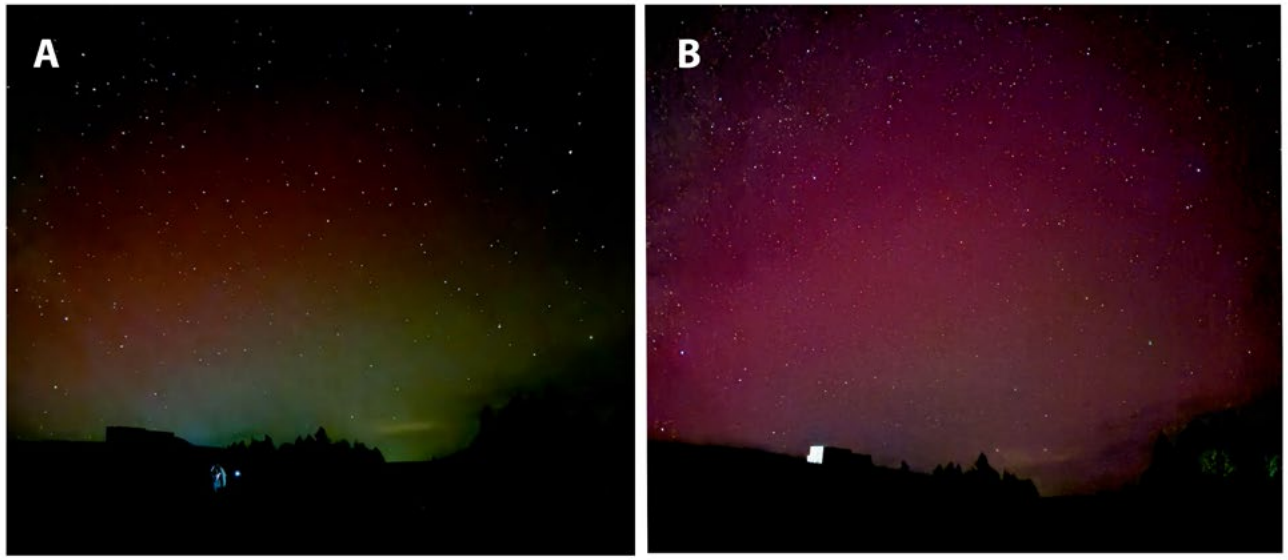


Figure 2. View of the aurora to the north. Images were taken between 8:30 and 9:00 p.m. (A) The image taken by my camera showed less red in the aurora which I took as a sign of weakening. (B) Catrina's camera seemed to be more effective at picking up red hues of the aurora.

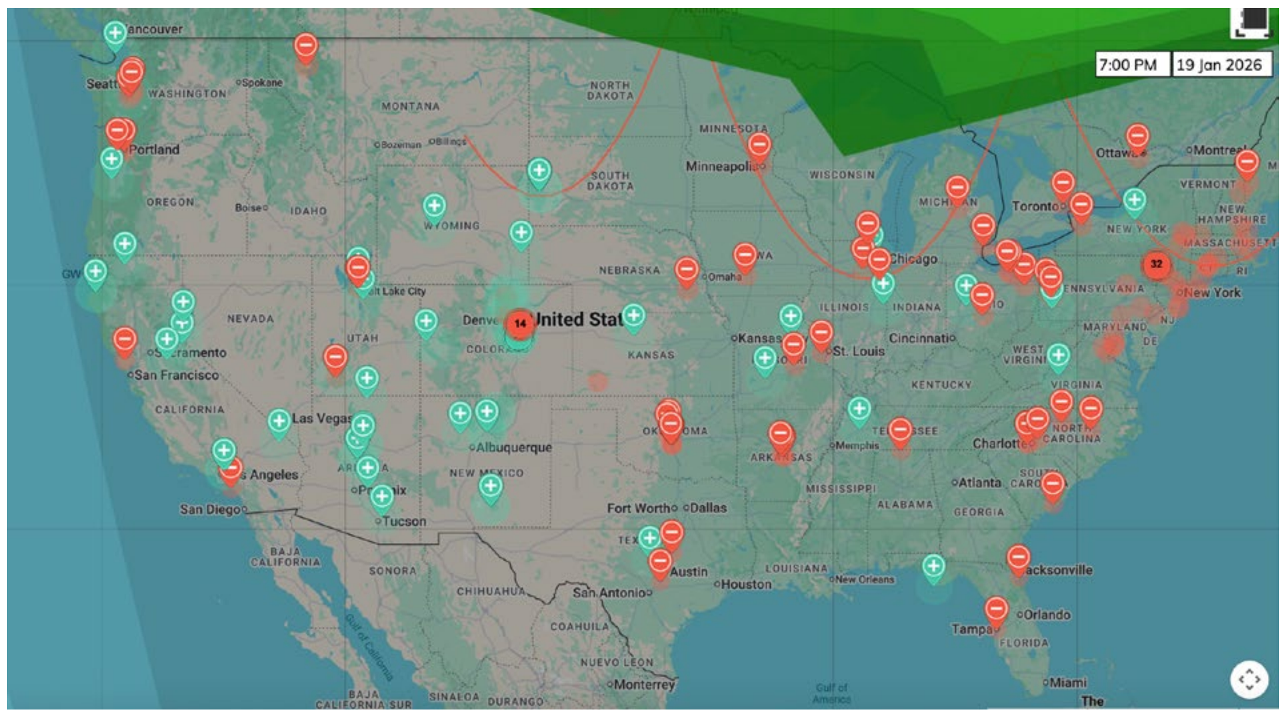


Figure 3. The Aurorasaurus map of reported aurora sighting throughout the U.S. on January 19 at 7:00 p.m. PST. (The GW on the Calif. north coast is my report.)

Figure 4. Image of pillars from an auroral substorm recorded on the Horse Mountain 2 (Humboldt) camera on January 20, 2026 at 1:57 p.m. Image courtesy of ALERTCalifornia (UC San Diego).

Figure 5. Image of pillars from an auroral substorm recorded on the Blue Mountain Modoc 2 camera on January 20, at 2:45 a.m. The lights were so bright that it activated the daytime color mode. Image courtesy of ALERTCalifornia (UC San Diego).

was issued as the Bz dropped further into negative territory. I was able to view the resulting aurora substorms on the ALERTCalifornia fire cameras: Barry Ridge, Horse Mountain 2, Big Valley 2, and Blue Mountain Modoc 2. For the first time all evening, I saw the distinct pillars of an aurora (Figures 4 and 5).

The storm intensified between 2:00 a.m. and dawn, with the appearance of wave after wave of pillars. The aurora was so bright that it triggered the "daytime mode" on some cameras, allowing them to record the substorms in full color (Figure 5). The video links for the auroras recorded at Big Valley 2 and Blue Mountain Modoc 2 are included below.

https://www.youtube.com/watch?v=VSvsSFMO1XQ
https://www.youtube.com/watch?v=nYa6BxSfVsw

As more data trickles in regarding the January 19–20 event, it appears to be the third-largest geomagnetic storm of Solar Cycle 25. It displaces the G4 storm of November 11, 2025, which I previously covered in the Winter 2025 AOH Newsletter. The historic G5 storms of May 11, 2024, and October 11, 2024, continue to hold the first and second positions, respectively.

Acknowledgment: Thank you to Catrina for sending me her photos of the aurora.

Additional Readings and References

https://www.ncei.noaa.gov/news/great-halloween-solar-storm-2003
https://www.aurorasaurus.org
https://www.spaceweatherlive.com
https://www.facebook.com/SolarHam

Grace Wheeler is Chair of the AOH Aurorophile Committee.

NASA's Pandora telescope will study stars in detail to learn about the exoplanets orbiting them

by Daniel Apai

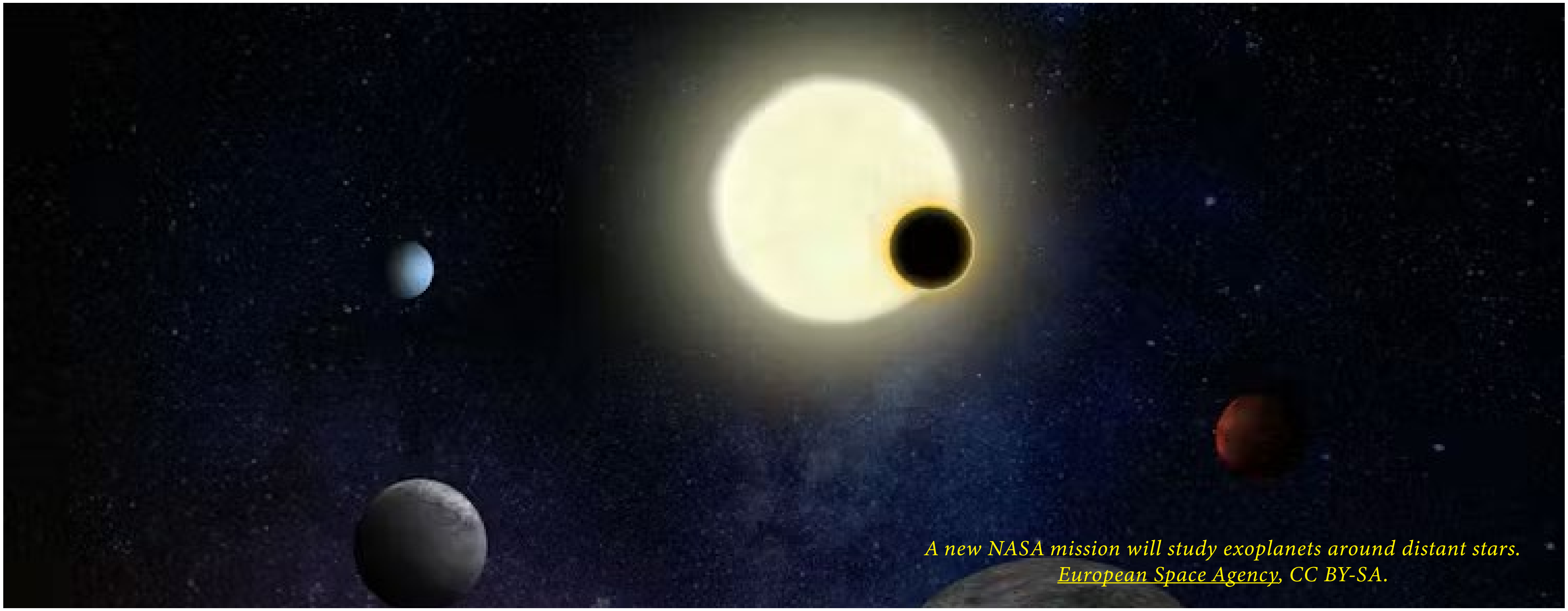
On Jan. 11, 2026, I watched anxiously at the tightly controlled Vandenberg Space Force Base in California as an awe-inspiring SpaceX Falcon 9 rocket carried NASA's new exoplanet telescope, Pandora, into orbit.

Exoplanets are worlds that orbit other stars. They are very difficult to observe because – seen from Earth – they appear as extremely faint dots right next to their host stars, which are millions to billions of times brighter and drown out the light reflected by the planets. The Pandora telescope will join and complement NASA's James Webb Space Telescope in studying these faraway planets and the stars they orbit.

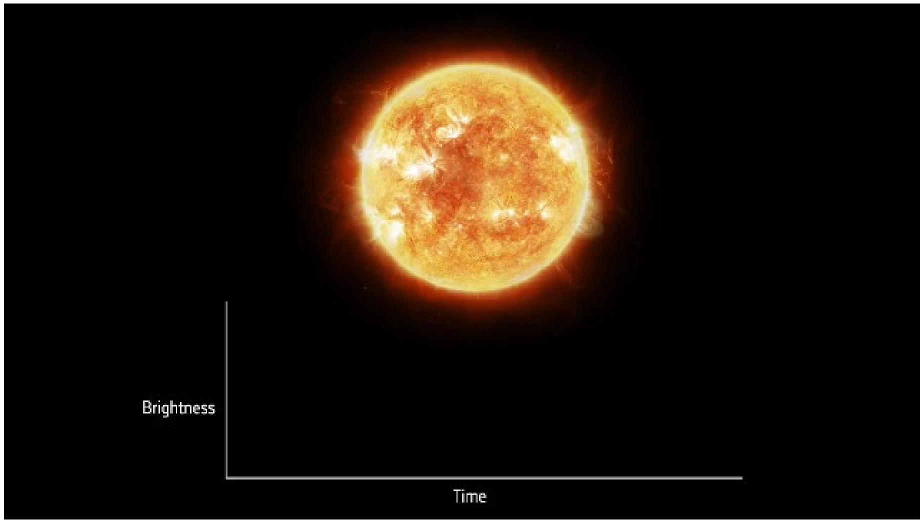
I am an astronomy professor at the University of Arizona who specializes in studies of planets around other stars and astrobiology. I am a co-investigator of Pandora and leading its exoplanet science working group. We built Pandora to shatter a barrier – to understand and remove a source of noise in the data – that limits our ability to study small exoplanets in detail and search for life on them.

Observing exoplanets

Astronomers have a trick to study exoplanet atmospheres. By observing the planets as they orbit in front of their host stars, we can study starlight that filters through their atmospheres.



A new NASA mission will study exoplanets around distant stars. European Space Agency, CC BY-SA.



When a planet passes in front of its star, astronomers can measure the dip in brightness, and see how the light filtering through the planet's atmosphere changes. Click on the picture for animation. If your pdf viewer does not display the animation, click here instead.

These planetary transit observations are similar to holding a glass of red wine up to a candle: The light filtering through will show fine details that reveal the quality of the wine. By analyzing starlight filtered through the planets' atmospheres, astronomers can find evidence for water vapor, hydrogen, clouds and even search for evidence of life. Researchers improved transit observations in 2002, opening an exciting window to new worlds.

For a while, it seemed to work perfectly. But, starting from 2007, astronomers noted that starspots – cooler, active regions on the stars – may disturb the transit measurements.

In 2018 and 2019, then-Ph.D. student Benjamin V. Rackham, astrophysicist Mark Giampapa and I published a series of studies showing how darker starspots and brighter, magnetically active stellar regions can seriously mislead exoplanets measurements. We dubbed this problem "the transit light source effect."

Most stars are spotted, active and change continuously. Ben, Mark and I showed that these changes alter the signals from exoplanets. To make things worse, some stars also have water vapor in their upper layers – often more prominent in starspots than outside of them. That and other gases can confuse astronomers, who may think that they found water vapor in the planet.

In our papers – published three years before the 2021 launch of the James Webb Space Telescope – we predicted that the Webb cannot reach its full potential. We sounded the alarm bell. Astronomers realized that we were trying to judge our wine in light of flickering, unstable candles.

The birth of Pandora

For me, Pandora began with an intriguing email from NASA in 2018. Two prominent scientists from NASA's Goddard Space Flight Center, Elisa Quintana and Tom Barclay, asked to chat. They had an unusual plan: They wanted to build a space telescope very quickly to help tackle stellar contamination – in time to assist Webb. This was

Members of the Pandora SmallSat team with the completed satellite in Blue Canyon Technologies' cleanroom in Boulder, Colorado, before Pandora was shipped to California for integration into the SpaceX Falcon 9 rocket. Blue Canyon Technologies.

Artist's concept of NASA's Pandora Space Telescope.
NASA's Goddard Space Flight Center/Conceptual Image Lab, CC BY.

an exciting idea, but also very challenging. Space telescopes are very complex, and not something that you would normally want to put together in a rush.

Pandora breaks with NASA's conventional model. We proposed and built Pandora faster and at a significantly lower cost than is typical for NASA missions. Our approach meant keeping the mission simple and accepting somewhat higher risks.

What makes Pandora special?

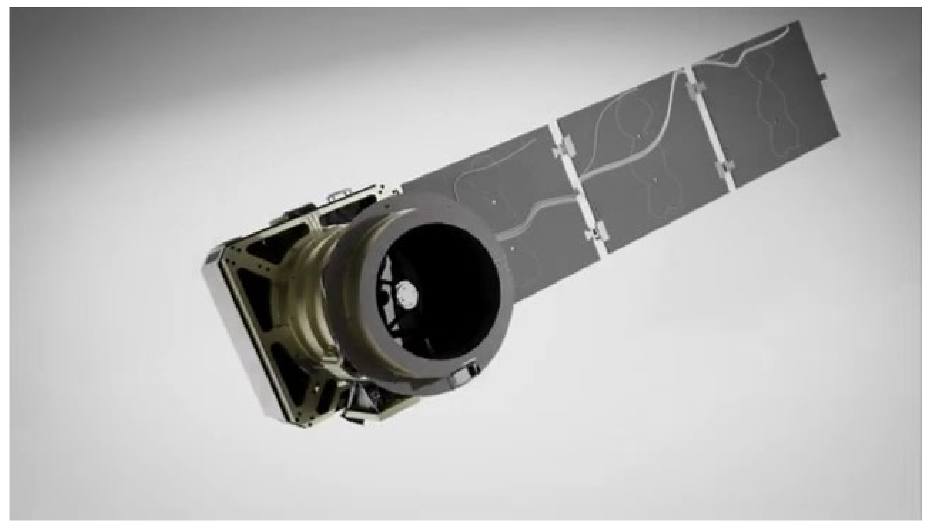
Pandora is smaller and cannot collect as much light as its bigger brother Webb. But Pandora will do what Webb cannot: It will be able to patiently observe stars to understand how their complex atmospheres change.

By staring at a star for 24 hours with visible and infrared cameras, it will measure subtle changes in the star's brightness and colors. When active regions in the star rotate in and out of view, and starspots form, evolve and dissipate, Pandora will record them. While Webb very rarely returns to the same planet in the same instrument configuration and almost never monitors their host stars, Pandora will revisit its target stars 10 times over a year, spending over 200 hours on each of them.

With that information, our Pandora team will be able to figure out how the changes in the stars affect the observed planetary transits. Like Webb, Pandora will observe the planetary transit events, too. By combining data from Pandora and Webb, our team will be able to understand what exoplanet atmospheres are made of in more detail than ever before.

After the successful launch, Pandora is now circling Earth about every 90 minutes. Pandora's systems and functions [have been] tested thoroughly by Blue Canyon Technologies, Pandora's primary builder.

About a week after launch, control of the spacecraft [transitioned] to the University of Arizona's Multi-Mission Operation Center in Tucson, Arizona. [Now] the work of our science teams begins in earnest and we will begin capturing starlight filtered through the atmospheres of other worlds – and see them with a new, steady eye.



NASA's Pandora mission will revolutionize the study of exoplanet atmospheres. Click on the picture for animation. If your pdf viewer does not display the animation, click here instead.

Daniel Apai is a Professor of Astronomy, Planetary Sciences, and Optical Sciences at The University of Arizona.

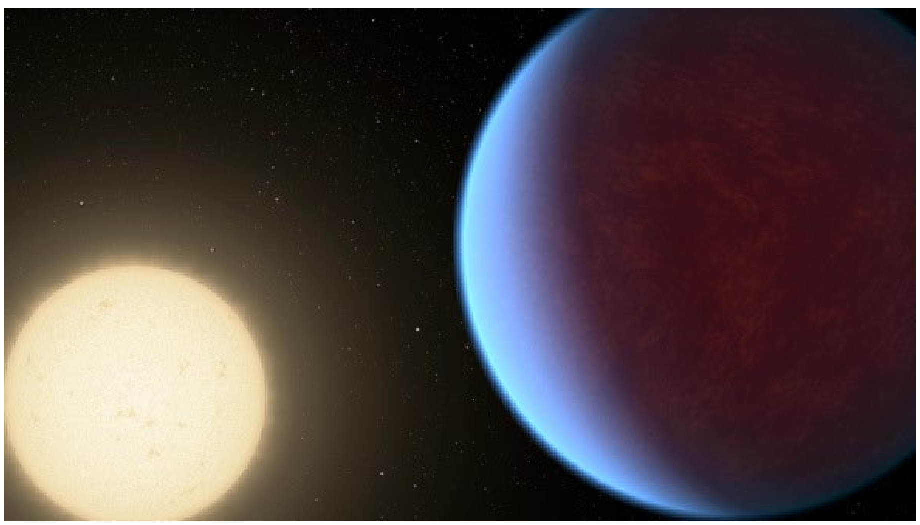
This article is distributed by the [NASA Night Sky Network](), a coalition of hundreds of astronomy clubs across the US dedicated to astronomy outreach.

Dim Delights in Cancer

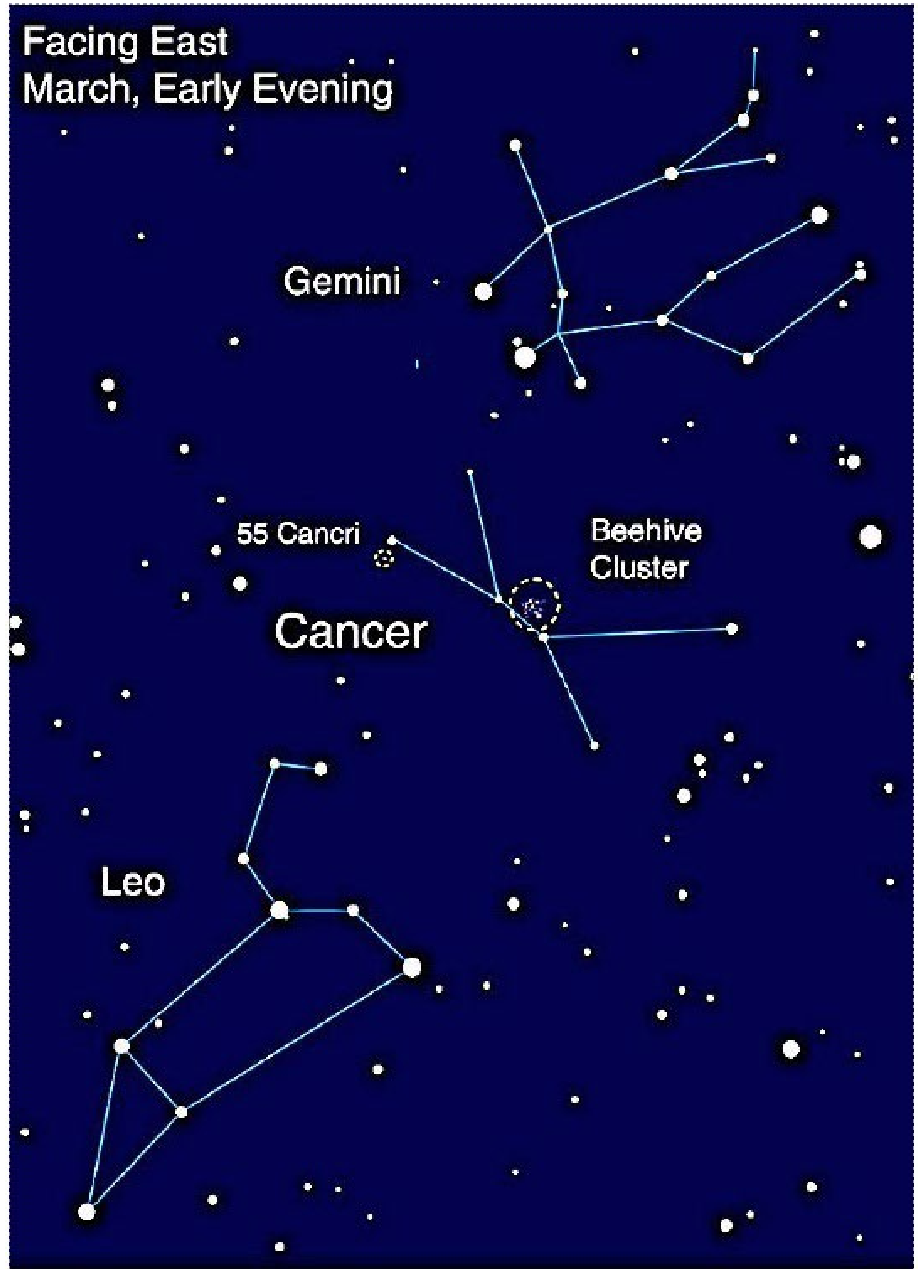
by David Prosper

Cancer the Crab is a dim constellation, yet it contains one of the most beautiful and easy-to-spot star clusters in our sky: the Beehive Cluster. Cancer also possesses one of the most studied exoplanets: the superhot super-Earth, 55 Cancri e.

Find Cancer's dim stars by looking in between the brighter neighboring constellations of Gemini and Leo. Don't get frustrated if



Artist concept of 55 Cancri e orbiting its nearby host star. Find details from the Spitzer Space Telescope's close study of its atmosphere at: bit.ly/spitzer55cancrie and the Hubble Space Telescope's observations at bit.ly/hubble55cancrie. Credit: NASA/JPL-Caltech.



Look for Cancer in between the "Sickle" or "Question Mark" of Leo and the bright twin stars of Gemini. You can't see the planets around 55 Cancri, but if skies are dark enough you can see the star itself. Can you see the Beehive Cluster?

you can't find it at first, since Cancer isn't easily visible from moderately light polluted areas. Once you find Cancer, look for its most famous deep-sky object: the Beehive Cluster! It's a large open cluster of young stars, three times larger than our Moon in the sky. The Beehive is visible to unaided eyes under good sky conditions as a faint cloudy patch, but is stunning when viewed through binoculars or a wide-field telescope. It was one of the earliest deep-sky objects noticed by ancient astronomers, and so the Beehive has many other names, including Praesepe, Nubilum, M44, the Ghost, and Jishi qi. Take a look at it on a clear night through binoculars. Do these stars look like a hive of buzzing bees? Or do you see something else? There's no wrong answer, since this large star cluster has intrigued imaginative observers for thousands of years.

55 Cancri is a nearby binary star system, about 41 light years from us and faintly visible under excellent dark sky conditions. The larger star is orbited by at least five planets including 55 Cancri e, (a.k.a. Janssen, named after one of the first telescope makers). Janssen is a "super-earth," a large rocky world 8 times the mass of our Earth, and orbits its star every 18 hours, giving it one of the shortest years of all known planets! Janssen was the first exoplanet to have its atmosphere successfully analyzed. Both the Hubble and recently-retired Spitzer space telescopes confirmed that the hot world is enveloped by an atmosphere of helium and hydrogen with traces of hydrogen cyanide: not a likely place to find life, especially since the surface is probably scorching hot rock. The NASA Exoplanet Catalog has more details about this and many other exoplanets at bit.ly/nasa55cancrie.

How do astronomers find planets around other star systems? The Night Sky Network's "How We Find Planets" activity helps demonstrate both the transit and wobble methods of exoplanet detection: bit.ly/findplanets. Notably, 55 Cancri e was discovered via the wobble method in 2004, and then the transit method confirmed the planet's orbital period in 2011!

Want to learn more about exoplanets? Get the latest NASA news about worlds beyond our solar system at nasa.gov.

David Prosper describes himself as a "professional amateur" astronomer. He is a former administrator of the NASA Night Sky Network program.

After Words

OF THE ECLIPSES OF THE MOON AND THE SUN.

"For it is evident that the sun is hid by the intervention of the moon, and the moon by the opposition of the earth, and that these changes are mutual, the moon, by her interposition, taking the rays of the sun from the earth, and the earth from the moon."

Pliny the Elder, *Natural History* (77 a.d.)

Grace Wheeler
Gemini, 2026