AOH Newsletter

Winter 2024

News and Notes

Our streak of rained-out and clouded-out observing events continued through the Autumn months. We had a Zoom meeting in September, with the usual suspects in attendance; and we had our annual business meeting in November, where we heard officers' reports and where the only business was the consumption of several pizzas and the re-election of all the incumbent Board Members (and where the Board-elect promptly re-elected all the incumbent officers).

We did an outreach program at Kneeland School just before the October partial eclipse (see photos on the following pages). We talked about moon (and inner planet) phases, and shadows cast by planets on moons and by moons on planets. We handed out eclipse kits (glasses, pinhole cards, and instructions) for the kids to take home and share with their families.

Zoom meeting on September 30.

Allison Waltberg demonstrating a solar eclipse with a scale model of the Earth-Moon system at Kneeland School in October 2023. Photo by Grace Wheeler.

Students at Kneeland School comparing phases of the Moon in October 2023.

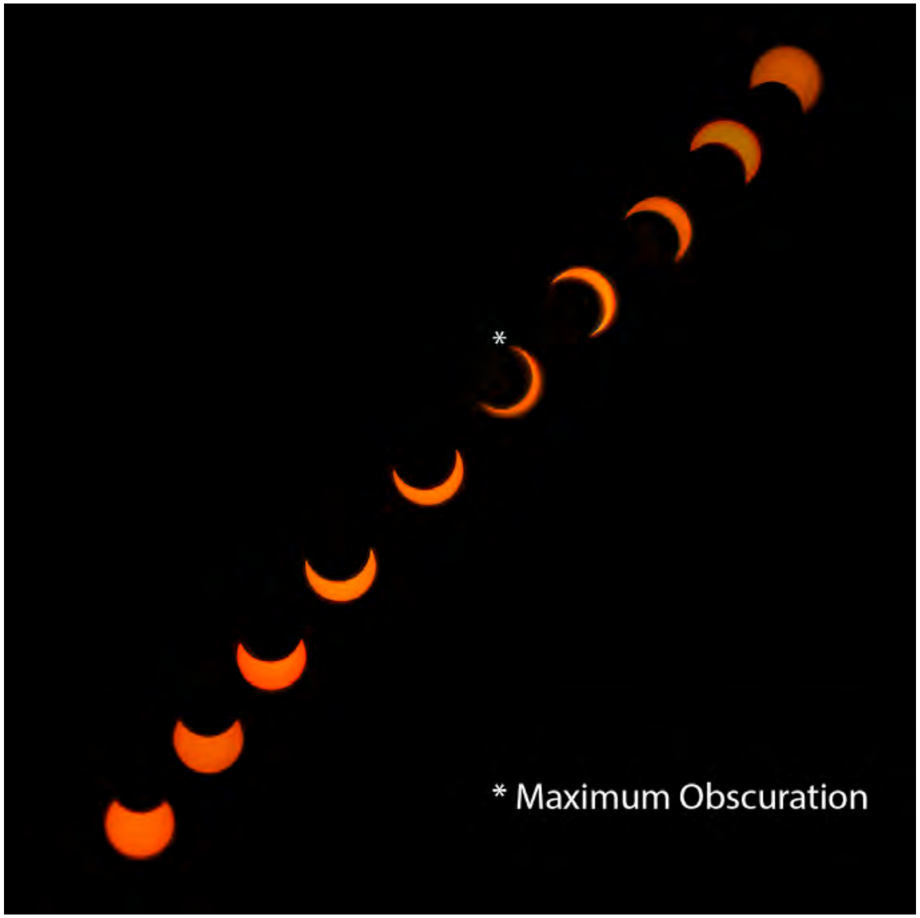
On October 14 we had mixed success with the annular/partial eclipse itself. It was totally cloudy on the Oregon coast, and partly cloudy inland along the path of annularity. Those who stayed home to see the 90% partial eclipse had partly cloudy skies which cleared up just in time (or almost in time) depending on where they were.

Brent and Catrina Howatt were in the path of annularity but got clouded out at Reedsport.

Above left: friendly clouds at Kneeland were thin enough to allow Allison and Johann Waltberg to view without a filter.

Above right: Ken Yanosko used a projection card in Arcata.

Right: Allison and Johann got a great projection shot with their kitchen colander.



Don Wheeler used a Pentax DSLR with a 40 mm lens (a little small but it did the job) and took a series of images starting at 8:30 a.m. and ending at 10 a.m. The image shows a progression of the eclipse; there is about 10 minutes between images. In Humboldt, the maximum of the eclipse (89% obscured) was at 9:18 a.m.—this image is marked with an asterisk. Artwork by Grace Wheeler.

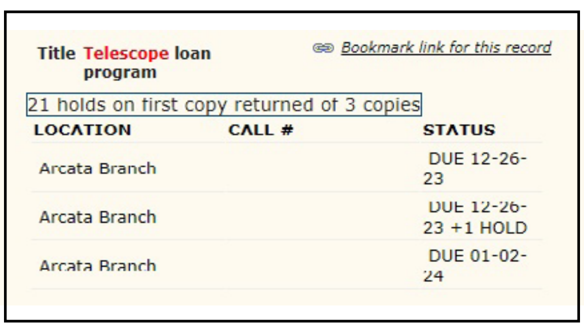
Grace Wheeler was spotted imaging the eclipse by a reporter from Redwood News; some of her pictures and a publicity plug for AOH appeared on the news broadcast that evening.

A week after the eclipse it was International Observe the Moon Night. The IOMN Committee reports that an estimated 900,000 people worldwide participated. About 40 AOH members and friends are included in this total. Those who submitted photos or sketches were rewarded with a certificate of participation from IOMN.

Above: Don Wheeler shot the Moon from his backyard in Eureka.

Right: Ken Yanosko was on a vacation tour in Vieste, Italy. This photo by fellow tourist Deb Kauffman shows Tour Leader Lara Piccioli taking a picture of the Moon and Ken while Ken gives a Moon lecture to the tour group.

The Library Telescope Program (see Newsletters Spring 2022 p. 5, Summer 2022 p. 7, and Summer 2023 p. 1) continues to expand. There are now three telescopes available for checkout from the Arcata Public Library. The public is highly enthused; as of this writing there are 21 holds for the scopes.



Title Telescope loan program

Bookmark link for this record

21 holds on first copy returned of 3 copies

LOCATION	CALL #	STATUS
Arcata Branch		DUE 12-26-23
Arcata Branch		DUE 12-26-23 +1 HOLD
Arcata Branch		DUE 01-02-24

Above: Brent, Sue, Ken, and Mark at the presentation of the third telescope to the Arcata Library last November.

Left: the card catalog entry for the scope, as of this writing.

Dues

AOH memberships expire at the end of the year. If you have not already done so, please go to our membership page where you can fill out a renewal form and either mail it in or renew online. Family memberships are $25 per year.

Calendar

The 2024 AOH Calendar is available for download by AOH members from our calendar page. You get photos, dates of historical events, dates of predictable astronomical phenomena, and potential dates of AOH activities.

Observing Events

Saturdays nearest the new moon early in 2024 are January 13, February 10, and March 9, so we will plan to observe at Kneeland on those dates. The March date will be our Messier Marathon date. We will also try to do public observing at Arts Alive in Eureka on January 6 and February 3. As usual, check our upcoming events page for up-to-date information.

Eclipse

By now you should have made travel plans for the April 8, 2024 total eclipse. You want to be in Mexico, somewhere between Texas and Maine, or Eastern Canada to see totality. If you stay home, you will get a 38% partial eclipse here in Humboldt County.

ALCON

Also the 2024 Astronomical League Convention is scheduled for July 17-20 in Kansas City. In the past the Board has offered to pay the registration fee to one AOH member who is willing to go and represent the club. Contact one of the officers on our contact page if you are interested.

Thanks

Thanks to Allison, Barry, Catrina, Deb, Don, Grace, and Susan for Newsletter help.

—Ken

2024 AOH Potluck

The Annual AOH Potluck Dinner, Outreach Award Presentations, Prize Drawings, and Special Guest Lecture will be held on Saturday, February 17, 2024.

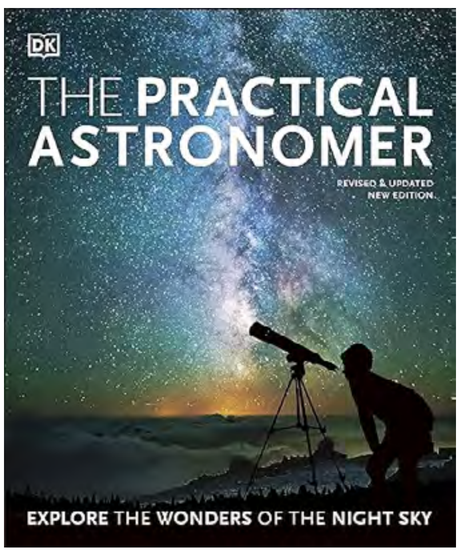
The event will be at the Eureka Woman's Club, 1531 J Street, in Eureka.

This year's Featured Speaker will be Dr. Jon Pedicino of the College of the Redwoods, who will give a talk entitled "Are We Alone in the Universe?"

Be sure to mark this date on your calendar.

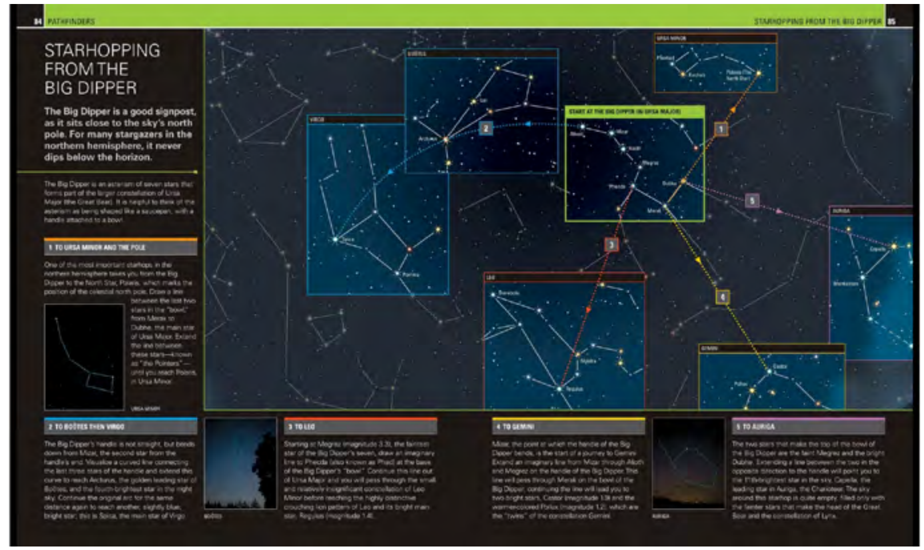
Book Review: *The Practical Astronomer* by Will Gater and Anton Vamplew

by Ken Yanosko



This 2020 book is the "new and revised edition" of a 2010 creation. It is 264 pages long and is available in both paperback format (9 by 8 inches, for $24.99) and Kindle format (for $9.99, although I got mine on a Black Friday sale for $1.99). So bear in mind that my enthusiasm for this book may be influenced in part by the deal I got. And no, the seller didn't know I was going to write a review.

I don't own a Kindle device—I read Kindle books using the free apps on my phone, my tablet, and my desktop. But unlike most Kindle books, this one does not have a "liquid" display, i.e. one where you can adjust the font size and page layout to suit yourself. Each page layout is fixed, and pages are meant to be viewed two at a time. This works fine on my 9 by 6 inch tablet in landscape mode, and the ability of the tablet to zoom its display by "pinching" and "unpinching" lets me get all the detail I need.



Above: a screenshot of a two-page layout as it appears on my tablet in landscape mode.

Right: a photo of the tablet showing a zoomed-in portion of the layout above.

continued on page 16

Wide-Field Imaging of NGC 2264

by Grace Wheeler

NGC 2264 is a large emission nebula in the constellation Monoceros that encompasses two deep sky objects: the Christmas Tree Cluster and the Cone Nebula.

An image of NGC 2264 (Figure 1) shows that the Christmas Tree Cluster is a triangular arrangement of bright stars that resembles the lights on a Christmas tree. S Monocerotis, the luminous O-type star in the cluster, is the trunk of the tree, while the bright star HD 47887 sits at the top. The Cone Nebula is notched into the tree's apex like a tree topper.

While the star cluster is easily seen with binoculars or a telescope, the Cone nebula and the cluster's surrounding nebulosity are difficult to visualize even with large telescopes. Images from long exposure astrophotography are required to reveal the darkly hued Cone Nebula as well as the brighter emission and reflection nebulae.

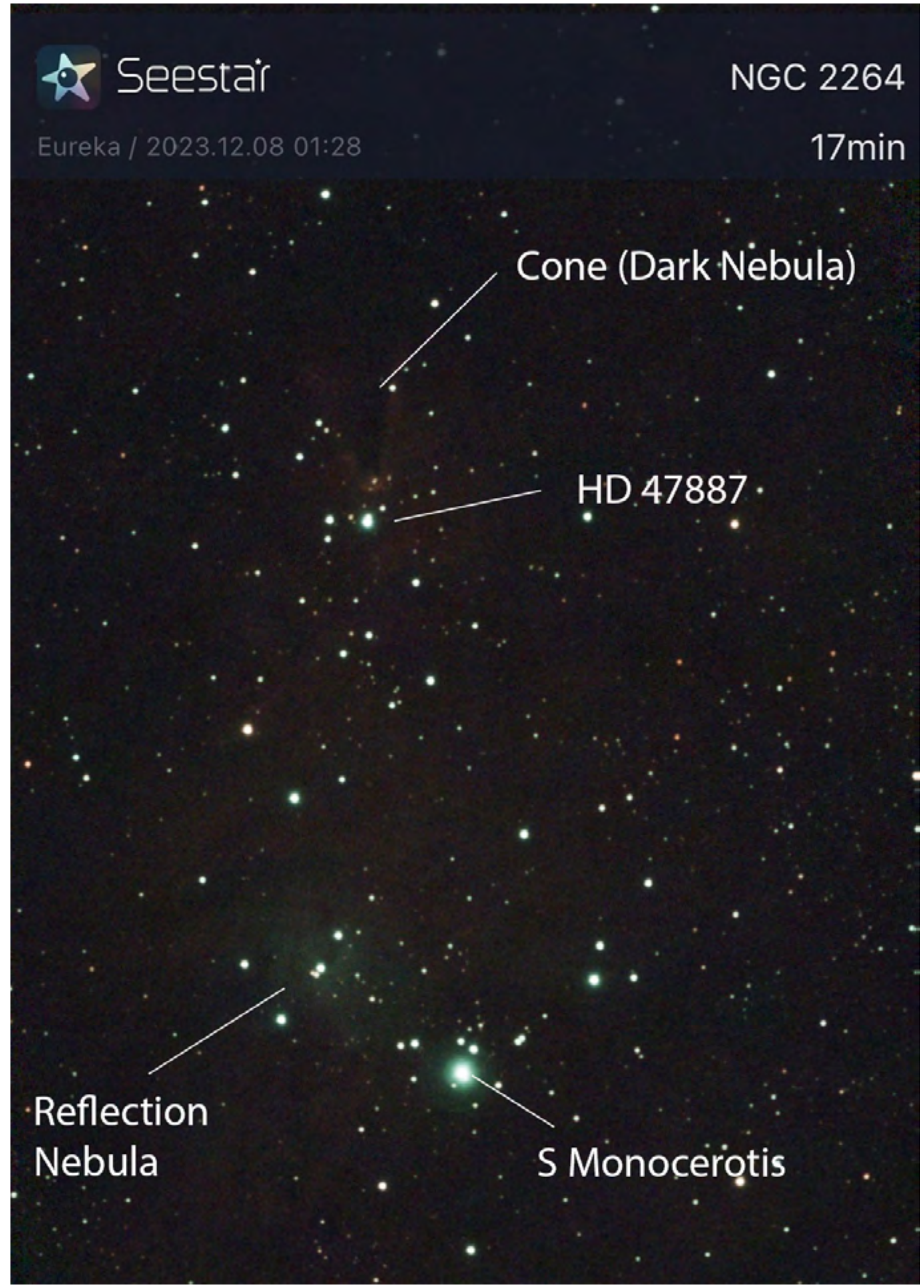


Figure 1. NGC 2264 as seen with a Seestar S50 smart telescope. This is a reasonably good simulation of the view through a telescope: The star cluster resembles a lighted Christmas tree with the star HD47887 at the top (and below the Cone Nebula) and S Monocerotis forming the trunk. The Cone Nebula is the upside down cone at the top of the tree. The stars of the Christmas Tree are embedded in an emission nebula which glows red from ionized hydrogen. A reflection nebula sits to the left of S Monocerotis; this type of nebula reflects the blue light of nearby stars.

The image was created with the livestacking of 10-second exposures. The integration time was 17 minutes.

For the past year, I have been broadening my astrophotography horizon to include deep-sky imaging. In November, I chose to image the Christmas Tree Cluster because I wanted to do a deep-sky object that was festive (and fun!) A wide-field image of NGC 2264 and the surrounding Mon OB1 cloud complex was captured with a 70mm refractor telescope and a DSLR with a large frame sensor. A nebula filter (Ha/OIII) was used to detect ionized hydrogen from the emission nebula. The final stacked image was created by stacking 171 light frames (2-minute exposures at 1600 ISO) and 30 dark frames in Affinity Photo; the total integration time was 5.7 hours. The image was post-processed in Photoshop and the result is shown in Figure 2.

The location of NGC 2264 and its deep-sky objects is denoted by the circle in Figure 2. The two primary objects are the Cone Nebula and the Christmas Tree Cluster. NGC 2264 is unique in that it contains three types of nebulae: dark, emission, and reflection.

The Cone Nebula is a towering pillar of dark nebulosity made of high concentrations of dust and cold molecular hydrogen. Pillars are thought to be factories where stars and planets are formed and incubated. The conical shape of the pillar is sculpted by the stellar winds of young blue stars in the nearby Christmas Tree Cluster. The winds erode the tip of the cone, and the nebular material is carried away and ultimately compressed into the thicker part of the cone. This is why the cone faces outward from the cluster of stars.

The Christmas Tree Cluster is an open cluster of young stars (about 3 million years) embedded in a diffuse emission nebula. Star formation occurs throughout the nebula with the greatest activity at the Cone Nebula and at S Monocerotis. Ultraviolet radiation from S Monocerotis and young blue stars ionizes molecular hydrogen and causes the red glow of the nebula. To the left of S Monocerotis is a reflection nebula which is illuminated by the light of nearby stars. In this case, the glow of the reflection nebula does not come from ionized gas, but from dust grains that reflect the light of nearby stars. Reflection nebulae are usually bluish (see Figure 1) because blue light is less scattered than other wavelengths of visible light. (Note: in Figure 2. the reflection nebula is white.)

Figure 2. The Wide-Field Imaging of NGC 2264 and the Surrounding Mon OB1 Cloud Complex. The image shows the location of NGC 2264, the Fox Fur Nebula, Hubble's Variable Nebula, and B39 dark nebula.

The Fox Fur Nebula (Figures 2 and 3) is the star-forming region below NGC 2264. Because of its proximity to NGC 2264, the nebula is often lumped in with this designation. The Fox Fur Nebula is named for its resemblance to the “head of a red fox fur stole” with its canine-like head and tendrils of gas. The head of the fox is to the right of S monocerotis (SM), and the snout is beneath the reflection nebula (RN).

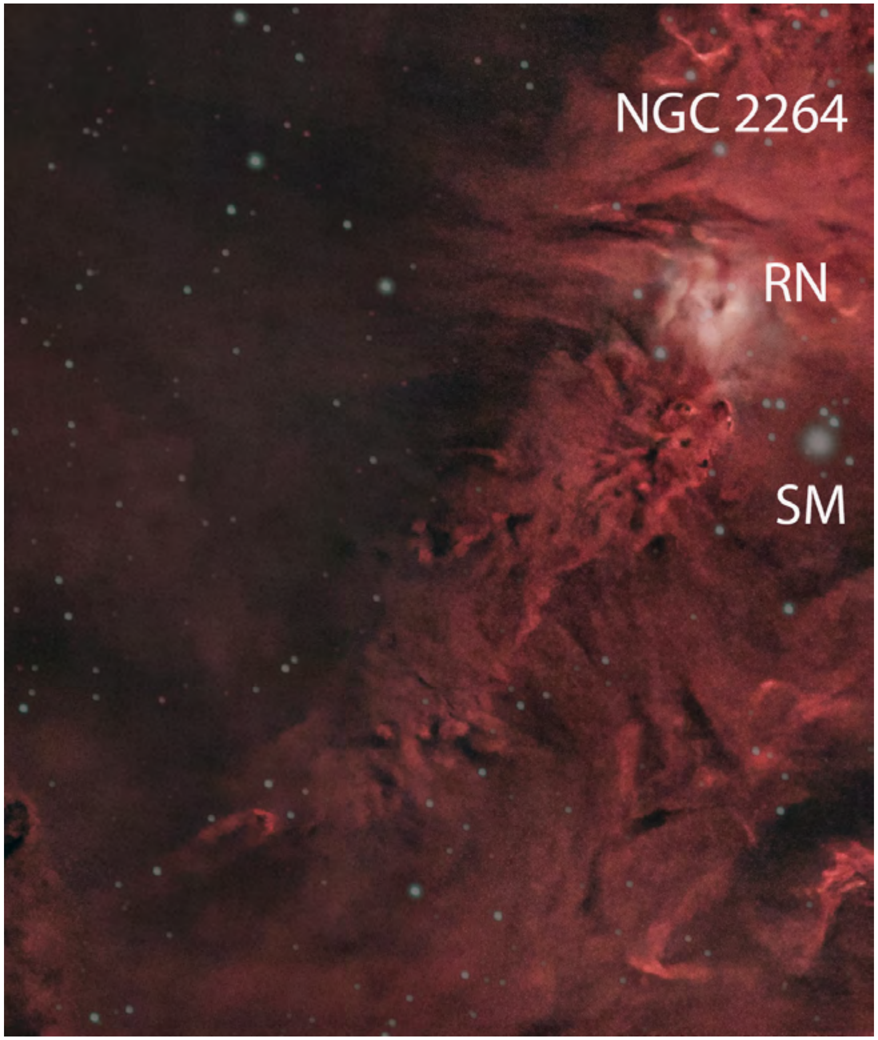


Figure 3. The Fox Fur Nebula. For this image, the Fox Fur Nebula from Figure 2 was cropped and sharpened. The color was adjusted so that is easier to see the canine-like features and the tendrils making up the fur stole. S Monocerotis (SM), Reflection Nebula (RN).

Hubble’s Variable Nebula (NGC 2261) is a comet-like object to the upper left of NGC 2264 (Figure 2.) Hubble's Variable Nebula was the first object viewed through the newly built Palomar 200-inch telescope and bears the name of William Hubble who studied it for eight years. NGC 2261 is illuminated by the star R Monocerotis which is hidden by the gas and dust of the nebula. The changes in the illumination of NGC 2261 is due to the variable density of dust clouds that block the light from R Monocerotis. An enlarged image NGC 2261 (Figure 4) is shown below.

Bonus Santa Claus. Pareidolia is the phenomenon of seeing familiar objects in inanimate things. An example of pareidolia is the “Face on Mars” (Google this term to bring up the image). In the wide-field image of NGC 2264 (Figure 2) I can see Santa Claus' head. The

Figure 4. Hubble’s Variable Nebula. The nebula was imaged with a six-inch SCT and an Atik Infinity camera (Dec. 2017).

pattern of the dark nebula against the red clouds creates Santa's eyes, nose, mouth, full beard, and pointy cap. A search on the internet did not yield an astronomical designation for this specific object, but I did find a couple of unofficial names. An astro-imager on Astrobin dubbed it "The Razorback" which is a type of feral pig. Another astro-imager on the forum Cloudy Nights referred to the object's dark nebular spine as "The Philippine Nebula." Rather than point out the object, I'll let the readers search for Santa Claus (or the pig or the Philippines). In the spirit of the holidays, I'm calling it "The Santa Claus Nebula" as it fits in with festive nature of the Christmas Tree Cluster.

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Grace Wheeler is a former President of AOH. She has also been Newsletter Editor and Outreach Chair, and is a frequent contributor to the Newsletter. She lives in Eureka with her husband Don and with parrots named Pip, Gauguin, and Linus.

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

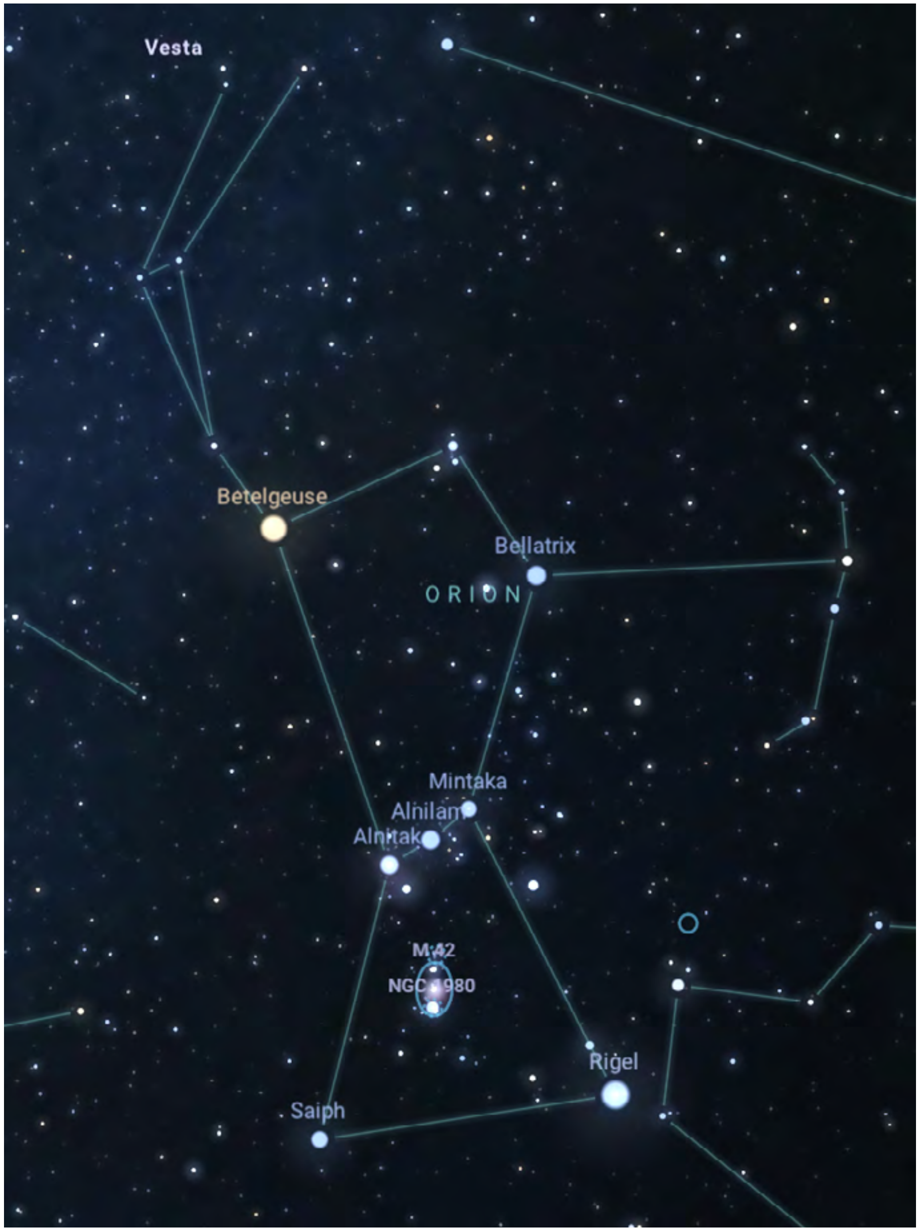
December's Night Sky Notes: A Flame in the Sky - the Orion Nebula

by Kat Troche

It's that time of year again: Winter! Here in the Northern Hemisphere, the clear, crisp sky offers spectacular views of various objects, the most famous of all being Orion the Hunter.

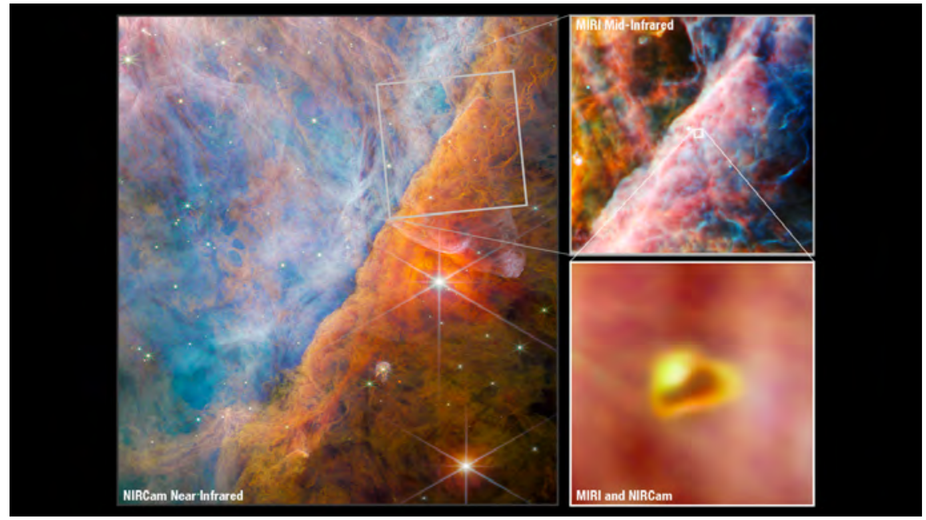
As we've previously mentioned, Orion is a great way to test your sky darkness. [See Newsletter, Winter 2022, page 10.] With the naked eye, you can easily spot this hourglass-shaped constellation. Known as an epic hunter in Greco-Roman antiquity, Orion and all its parts have many names and meanings across many cultures. In Egyptian mythology, this constellation represented the god Sah. The Babylonians referred to it as The Heavenly Shepard. In most cultures, it is Orion's Belt that has many stories: Shen in Chinese folklore, or Tayamnicankhu in Lakota storytelling. But the Maya of Mesoamerica believed that part of Orion contained The Cosmic Hearth – the fire of creation.

1,500 light years away from Earth sits the star-forming region, and crown jewel of Orion – Messier 42 (M42), the Orion Nebula. Part of the "sword" of Orion, this 24 light year wide cloud of dust and gas sits below the first star in Orion's Belt, Alnitak, and can easily be spotted with the naked eye under moderate dark skies. You can also use binoculars or a telescope to resolve more details, such as the Trapezium: four stars in the shape of a keystone (or baseball diamond). These young stars make up the core of this magnificent object.



Orion constellation from Stellarium Web

Of course, it's not just for looking at! M42 is easily one of the most photographed nebulae around, imaged by amateur astrophotographers, professional observatories and space telescopes alike. It has long been a place of interest for the Hubble, Spitzer, and Chandra X-ray Space Telescopes, with James Webb Space Telescope now joining the list in February 2023. Earlier this year, NASA and the European Space Agency released a new photo of the Orion Nebula taken from JWST's NIRCam (Near-Infrared Camera), which allowed scientists to image this early star forming region in both short and long wavelengths.



ESA/Webb, NASA, CSA, M. Zamani (ESA/Webb), PDRs4ALL ERS Team

But stars aren't the only items visible here. In June 2023, JWST's NIRCam and MIRI (mid-infrared instrument) imaged a developing star system with a protoplanetary disk forming around it. That's right – a solar system happening in real time – located within the edges of a section called the Orion Bar. Scientists have named this planet-forming disk d203-506, and you can learn more about the chemistry found here. By capturing these objects in multiple wavelengths of light, astronomers now have even greater insight into what other objects might be hiding within these hazy hydrogen regions of our night sky. This technique is called Multi-spectral Imaging, made possible by numerous new space based telescopes.

Kat Troche is a Project Coordinator and Night Sky Network Administrator for the Astronomical Society of the Pacific.

Light Pollution

by Barry Evans

"The thought of light traveling billions of years from distant galaxies only to be washed out in the last billionth of a second by the glow of the nearest strip mall depresses me no end."

Sönke Johnson, Ecologist at Duke University

Are you appreciating the Milky Way these winter evenings? Beyond your dark-accustomed eyes, you need two assets: no moon in the night sky and being away from lights. Not just city lights, either, but your neighbor's back porch light or the glow from the grow tent across the way. Fact is, if you are seeing that broad swath of ghostly light which Romans called Via Lactea — a spray of milk from Hera's breast — you're lucky. In North America, 80 percent of us can't see it from where we live because there's just too much ambient light around. Yet this is our home, the galaxy in which we live.

It wasn't always thus, of course. Before Edison (among others) invented the electric light bulb in the 1880s, everyone was familiar with the Milky Way. And with stars, too, not just the Big Dipper and other bright ones, but about 2,000 of them, visible now only on moonless nights well away from artificial lights. Not to mention other galaxies. Really dark skies will reveal the glow of the Andromeda galaxy whose light left there two-and-a-half million years ago ("The Farthest Object," Sept. 18, 2008). Andromeda is the farthest naked eye object — unless you've got terrific (read: young) night vision, in which case, check out the Pinwheel galaxy.

Composite view of Earth at night from the Suomi NPP satellite, orbiting 512 miles overhead. NASA Earth Observatory.

Because the Milky Way was so easily seen in the old days, every ancient civilization that we know of invented stories for what they saw: River of Light (Aramaic), Snake of the Skies (Akkadian), Shadow Path (Bengali), Grey Goose Way (Chuvash), Deer's Leap (Georgian), Straw Thief (Kurdish), the Fair Cow's Path (Irish), Silver River (Vietnamese) and on and on. The point is all these people knew it well enough to give it a name and make up stories about it. (I have to wonder how Cherokee people came up with the Way the Dog Ran Away.)

If we humans have lost something by not being able to see the Milky Way, pity the many species with whom we share the planet, who are suffering — some to the point of extinction — because of light pollution. Consider for example:

Unlike many other forms of human-generated pollution (such as car exhaust, waterborne estrogen or long-lived insecticides in soils) light pollution is easily fixable. For instance, white and blue light are far more damaging to animals than orange light, which, lumen for lumen, emits less energy. So streetlights can easily be converted to orange sodium vapor and can also be hooded to prevent light spillage. Are you listening, city public works?

Barry Evans lives in Old Town Eureka with his girlfriend (and wife) Louisa Rogers, several kayaks and bikes, and a stuffed gorilla named "Nameless." A recovering civil engineer, he is the author of two McGraw-Hill popular science books and has taught science and history.

Barry is a member of AOH, and writes a regular column entitled "Field Notes" for the North Coast Journal. This article appeared originally in https://www.northcoastjournal.com/life-outdoors/light-pollution-28241485, and appears here with the permission of the author.

Do we live in a giant void? It could solve the puzzle of the universe's expansion.

by Indranil Banik

One of the biggest mysteries in cosmology is the rate at which the universe is expanding. This can be predicted using the standard model of cosmology, also known as Lambda-cold dark matter (ΛCDM). This model is based on detailed observations of the light left over from the Big Bang – the so-called cosmic microwave background (CMB).

The universe's expansion makes galaxies move away from each other. The further away they are from us, the more quickly they move. The relationship between a galaxy's speed and distance is governed by "Hubble's constant", which is about 43 miles (70 km) per second per Megaparsec (a unit of length in astronomy). This means that a galaxy gains about 50,000 miles per hour for every million light years it is away from us.

But unfortunately for the standard model, this value has recently been disputed, leading to what scientists call the "Hubble tension". When we measure the expansion rate using nearby galaxies and supernovas (exploding stars), it is 10% larger than when we predict it based on the CMB.

In our new paper, we present one possible explanation: that we live in a giant void in space (an area with below average density). We show that this could inflate local measurements through outflows of matter from the void. Outflows would arise when denser regions surrounding a void pull it apart – they'd exert a bigger gravitational pull than the lower density matter inside the void.

In this scenario, we would need to be near the centre of a void about a billion light years in radius and with density about 20% below the average for the universe as a whole – so not completely empty.

Artist's conception of the Giant Void and the filaments and walls that surround it. Pablo Carlos Budassi/wikipedia, CC BY-SA

Such a large and deep void is unexpected in the standard model – and therefore controversial. The CMB gives a snapshot of structure in the infant universe, suggesting that matter today should be rather uniformly spread out. However, directly counting the number of galaxies in different regions does indeed suggest we are in a local void.

Tweaking the laws of gravity

We wanted to test this idea further by matching many different cosmological observations by assuming that we live in a large void that grew from a small density fluctuation at early times.

To do this, our model didn't incorporate ΛCDM but an alternative theory called Modified Newtonian Dynamics (MOND).

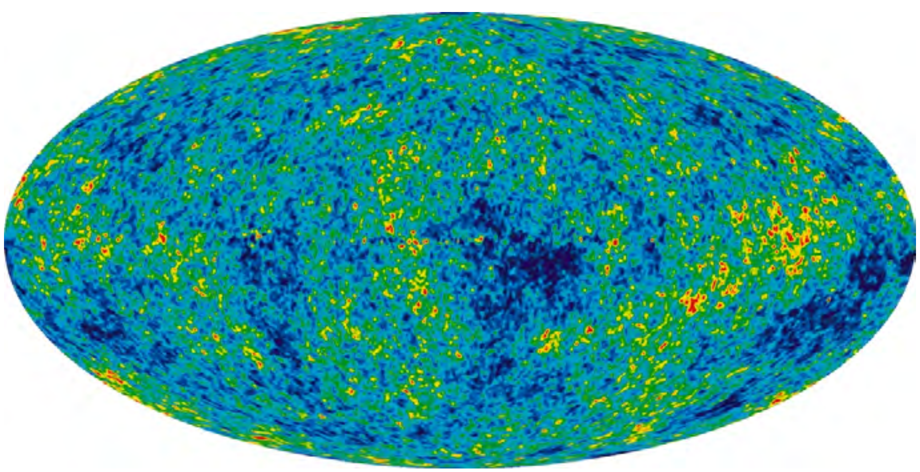
MOND was originally proposed to explain anomalies in the rotation speeds of galaxies, which is what led to the suggestion of an invisible substance called "dark matter". MOND instead suggests that the anomalies can be explained by Newton's law of gravity breaking down when the gravitational pull is very weak – as is the case in the outer regions of galaxies.

The overall cosmic expansion history in MOND would be similar to the standard model, but structure (such as galaxy clusters) would grow faster in MOND. Our model captures what the local universe might look like in a MOND universe. And we found it would allow local measurements of the expansion rate today to fluctuate depending on our location.

Recent galaxy observations have allowed a crucial new test of our model based on the velocity it predicts at different locations. This can be done by measuring something called the bulk flow, which is the average velocity of matter in a given sphere, dense or not. This varies with the radius of the sphere, with recent observations showing it continues out to a billion light years.

Interestingly, the bulk flow of galaxies on this scale has quadruple the speed expected in the standard model. It also seems to increase with the size of the region considered – opposite to what the standard model predicts. The likelihood of this being consistent with the standard model is below one in a million.

This prompted us to see what our study predicted for the bulk flow. We found it yields a quite good match to the observations. That requires that we are fairly close to the void centre, and the void being most empty at its centre.



CMB temperature fluctuations (colour differences). NASA

Case closed?

Our results come at a time when popular solutions to the Hubble tension are in trouble. Some believe we just need more precise measurements. Others think it can be solved by assuming the high expansion rate we measure locally is actually the correct one. But that requires a slight tweak to the expansion history in the early universe so the CMB still looks right.

Unfortunately, an influential review highlights seven problems with this approach. If the universe expanded 10% faster over the vast majority of cosmic history, it would also be about 10% younger – contradicting the ages of the oldest stars.

The existence of a deep and extended local void in the galaxy number counts and the fast observed bulk flows strongly suggest that structure grows faster than expected in ΛCDM on scales of tens to hundreds of millions of light years.

Interestingly, we know that the massive galaxy cluster El Gordo formed too early in cosmic history and has too high a mass and collision speed to be compatible with the standard model. This is yet more evidence that structure forms too slowly in this model.

Since gravity is the dominant force on such large scales, we most likely need to extend Einstein's theory of gravity, General Relativity – but only on scales larger than a million light years.

However, we have no good way to measure how gravity behaves on much larger scales – there are no gravitationally bound objects that huge. We can assume General Relativity remains valid and compare with observations, but it is precisely this approach which leads to the very severe tensions currently faced by our best model of cosmology.

Einstein is thought to have said that we cannot solve problems with the same thinking that led to the problems in the first place. Even if the required changes are not drastic, we could well be witnessing the first reliable evidence for more than a century that we need to change our theory of gravity.

Indranil Banik is a Postdoctoral Research Fellow in Astrophysics, University of St. Andrews. He receives funding from the Science and Technology Facilities Council to conduct tests of modified gravity theories.

The Moon Illusion: Why Does the Moon Look So Big Sometimes?

by Preston Dyches

Why does the Moon look so big when it's rising or setting? The Moon illusion is the name for this trick our brains play on us. Photographs prove that the Moon is the same width near the horizon as when it's high in the sky, but that's not what we perceive with our eyes. Thus it's an illusion rooted in the way our brains process visual information. Even though we've been observing it for thousands of years, there's still not a satisfying scientific explanation for exactly why we see it.

Go out on the night of the full moon and find a good spot to watch it rise. It can be breathtaking, eliciting an awestruck "Wow!" from any skywatcher. When we observe the Moon near the horizon, it often looks HUGE – whether it's peeking over the shoulder of a distant mountain, rising out of the sea, hovering behind a cityscape, or looming over a thicket of trees.

But here's the thing: it's all in your head. Really. The Moon's seeming bigness is an actual illusion, rather than an effect of our

A supermoon occurs when the Moon's orbit is closest (perigee) to Earth at the same time the Moon is full. NASA/Bill Dunford

Moon rising over mountain peaks. NASA/Bill Dunford

atmosphere or some other physics. You can prove it for yourself in a variety of ways.

How to prove the Moon illusion

Hold up your outstretched index finger next to the Moon. You'll find that your fingernail and the Moon are about the same size. Or try looking at the Moon through a paper tube, or bend over and look backward between your legs. When you view it like this, the Moon will be nowhere near as big as it had seemed.

Another ironclad way to size-check the Moon is to take a photo when it's near the horizon, and another when it's high in the sky. If you keep your camera zoom settings the same, you'll find that the Moon is the same width, side to side, in both photos. (It may actually appear a little bit squashed in the vertical direction when it's near the horizon. This is the result of the atmosphere acting like a weak lens.)

Photographers can simulate the Moon illusion by taking pictures of the Moon low on the horizon using a long lens, with buildings, mountains, or trees in the frame. So, remember when you see dazzling photos that feature a giant Moon above the landscape: those images are created by zooming in on distant objects near the ground. In other words, the Moon looks bigger in those photos because it's a zoomed-in view.

A supermoon rises Dec. 3, 2017, in Washington. This full Moon was the first of three consecutive supermoons. NASA/Bill Ingalls

The Moon DOES look more yellow near the horizon

There's one notable way in which the Moon's appearance is actually different when it's low in the sky. It tends to have a more yellow or orange hue, compared to when it's high overhead. This happens because the Moon's light travels a longer distance through the atmosphere. As it travels a longer path, more of the shorter, bluer wavelengths of light are scattered away, leaving more of the longer, redder wavelengths. (Dust or pollution can also deepen the reddish color.)

Why do we see the Moon illusion?

Brace yourself: we don't really know. Well, not really. Depending on your mindset, this news might be unsatisfying, or it could be a reason to marvel at our mysterious brains. But despite the fact that people have been observing this illusion for thousands of years, we still don't have a rock-solid scientific explanation for it.

In general, the proposed explanations have to do with a couple of key elements of how we visually perceive the world: how our brains perceive the size of objects that are nearer or farther away, and how far away we expect objects to be when they're close to the horizon. It seems that our brains don't know that the Moon's distance doesn't change that much no matter where it is in the sky on a given night.

There's also some thinking that objects in the foreground of your lunar view play a role. Perhaps trees, mountains, and buildings help to trick your brain into thinking the Moon is both closer and bigger than it is? There's an effect discovered a century ago called the Ponzo illusion that describes how this works. In the illusion, you have a scene where two lines are converging, like railroad tracks stretching away into the distance. On top of these lines are drawn two horizontal bars of equal length. Surprisingly, the horizontal bars appear to be different sizes, because your brain's hard-wired sense of how distance works forces you to perceive it this way. This effect is related to how forced perspective works in paintings.

But this isn't a perfect explanation, either. NASA astronauts in orbit also see the Moon illusion, and they have no foreground objects to act as distance clues. So, there's likely more going on.

A day Moon rises over mountains in Utah. NASA/Bill Dunford

Maybe just enjoy it?

In the absence of a complete explanation for why we see it like that, we can still agree that – real or illusion – a giant Moon is a beautiful sight. So, until someone puzzles out exactly what our brains are up to, it's probably best to just enjoy the Moon illusion, and the moody, atmospheric, and sometimes downright haunting vistas it creates.

Preston Dyches is a Public Engagement Specialist at NASA JPL.

continued from page 5

(Of course the paper copy will give you 9 by 16 inch layouts, so for that edition the display size is not an issue.)

Aside from the format, what can be said about the book's content? Well, it seems to cover the needs of the rank beginner as well as the intermediate to advanced amateur. The first three chapters (70 pages) give beginner-level descriptions of the Solar System, stars, clusters, nebulae, and galaxies; how things appear and (apparently) move when viewed from Earth; and how to use binoculars, telescopes, and cameras for astro-imaging.

The next 100 pages is a single chapter titled "Pathfinders" which includes charts and descriptions of all 88 constellations and their relationships in the sky. The authors explain how to start at large, bright, easy-to-find objects and then star-hop around to find the less prominent constellations and the brighter deep-space objects. (See the sample spread back on page 5.) Those who have seen me pushing around my vintage orange-tube C-8 know that this is my favorite part of the book, and one I heartily recommend, no matter how sophisticated your AI-controlled light bucket may be.

Chapter 5 is all about the Solar System. There are guides for finding and observing the major planets and their moons. There are tips on viewing the Sun and Moon. There is a discussion of comets and their relation to meteor showers. There is a discussion of atmospheric phenomena: solar and lunar haloes, auroras, and noctilucent clouds. And there is a nice checklist for dealing with "Unidentified Sky Objects" (a much better term than "Unidentified Flying Objects" or "Unidentified Aerial Phenomena" since they don't all fly and they aren't all in the air). Chapter 6 is a set of monthly star charts, valid for both hemispheres. Chapter 7 has more lists: bright stars, constellations, and Messier objects; and an almanac of eclipses and planetary events. Unfortunately, the latter runs only through 2026, but lists of this type are easy to find on the internet.

I really like this book, and I can recommend it to anyone, no matter what his or her level of expertise. The paper copy would look great on any coffee table, and the e-copy would be a useful addition to any moderately-sized color-screen device. I probably wouldn't use it out in the field, but it is a nice little cloudy-night companion.

After Words

"One of the basic rules of the universe is that nothing is perfect. Perfection simply doesn't exist ... Without imperfection, neither you nor I would exist."

Stephen Hawking
"Into the Universe with Stephen Hawking"
Discovery Channel, 2010

The real reason Rudolph got the job:

Remo Nortsa. Used with permission.