Volume 50 Number 1 January 2024

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
January 28, 2024, 7:00PM
Baker Wetlands Discovery Center

Public Observing
January 28, 2024, 8:00PM
Baker Wetlands Discovery Center

Club Officers

President
Rick Heschmeyer email

AICOR
William Winkler email

NSN Coordinator
Howard Edin email

Faculty Advisor
Dr. Jennifer Delgado email.

Newsletter Editor
Chuck Wehner email

Inside This Issue

Report From the Officers

By Rick Heschmeyer

We closed the year with an excellent presentation by Alex Polanski on hot, and large, exoplanets orbiting other stars. Unfortunately, the weather following the meeting was not as excellent, and our public observing session was cancelled due to clouds.

The December Geminids meteor shower, one of the best showers of the year, suffered from clouds as well around Lawrence.

Our first meeting of the new year will take place on Sunday, January 28, 2024. AAL Member Jerelyn Ramirez will talk to us about her recent trip to observe the October Annular Solar Eclipse. The meeting will start at 7:00 PM, and will be followed by public telescope observing, weather permitting.

For our February 25th meeting, NEKAAL member Gary Hug, will update us on happenings at that club's Farpoint Observatory in talk titled "The 27-inch Tombaugh Reflector Revised (again)".

If anyone has ideas for program at future club meetings, please let me know.

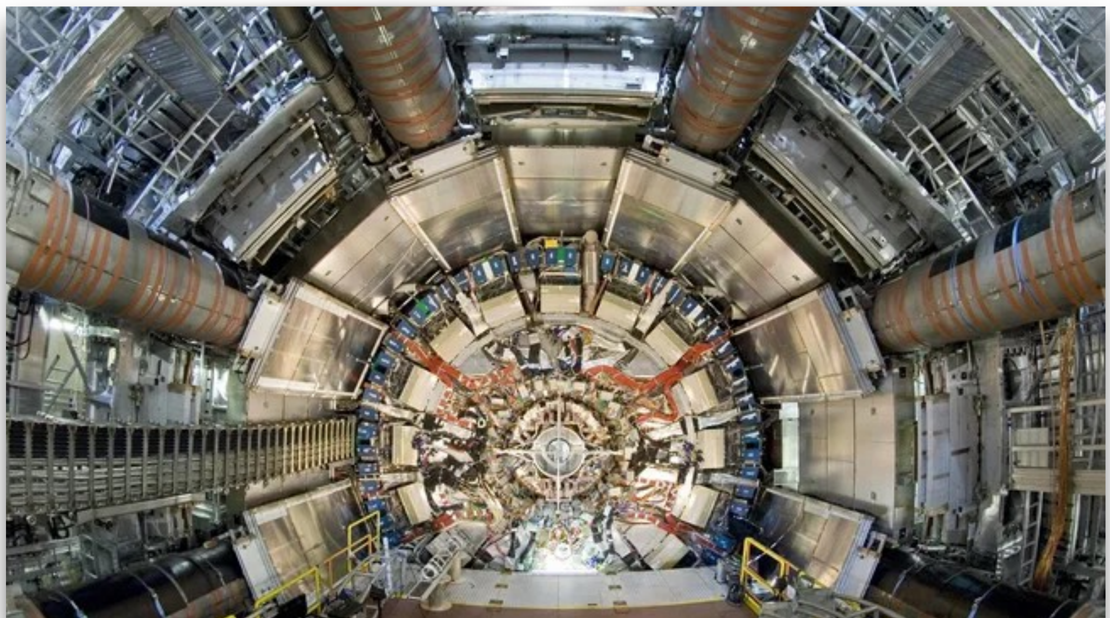
We hope to see you at one of these upcoming events, and hope everyone has a wonderful holiday season.

Keep looking up!

Dark matter may be hiding in the Large Hadron Collider's particle jets

By Keith Cooper
SPACE.COM, NOVEMBER 28, 2023

If dark matter is made from "dark" versions of the basic building blocks of ordinary matter, the world's largest particle accelerator should be able to pin it down.



A new search for dark matter has turned up empty handed — but, in a silver lining, the effort provided important limits that will help future experiments narrow down the hunt for this elusive substance.

Most astronomers believe that dark matter accounts for 85 percent of all mass in the universe, and that its existence would explain the apparent extra gravity detectable around galaxies and within huge galaxy clusters. However, so far, no one has been able to identify what dark matter is made of.

Until recently, the front-runner suspect had been a breed of particle called a WIMP, which is a neat acronym for Weakly Interacting Massive Particles. These theoretical particles are thought to barely interact with normal matter, except when it comes to gravity. However, the Large Hadron Collider (LHC), the world's largest and most powerful particle accelerator, has failed to turn up evidence for the existence of WIMPs.

Thus, theorists are having to scramble to find alternative theories of what dark matter could be.

"WIMPs is one class of particles that are hypothesized to explain dark matter as they do not absorb or emit light and don't interact strongly with other particles," Deepak Kar, a professor of physics of the University of the Witwatersrand in Johannesburg, said in a statement. "However, as no evidence of WIMPs has been found so far, we realized that the search for dark matter needed a paradigm shift."

Some alternative models of dark matter posit that, rather than being weakly interacting, dark matter could actually interact strongly with some particles in the Standard Model, which is a framework of particle physics that describes every known particle as well as how each particle interacts with, and relates to, one another. Dark matter particles are believed to exist beyond the Standard Model's scope; the models that predict strongly interacting dark matter, rather,describe an entire menagerie of theoretical particles starting with basic "dark quarks" and "dark gluons." Those are like dark mirrors of quarks and gluons that are the fundamental building blocks of all visible matter and surely present in the Standard Model.

Now, Kar and his former student, Sukanya Sinha who is now at the University of Manchester in the U.K., have developed a new way of searching for these potential dark quarks and dark gluons in high-energy collisions between protons that take place within the LHC.

When protons come together at almost the speed of light inside the LHC, they are smashed apart into their component quarks and gluons that swiftly decay to produce a shower of short-lived subatomic particles. These particle showers are referred to as "jets."

Kar and Sinha's idea, which formed the basis of Sinha's Ph.D., is that possible dark quarks and dark gluons could decay to produce a mixture of particles, some ordinary and some dark as well. This would result in what they refer to as "semi-visible" jets. Jets are produced in pairs, they explain, and if one normal jet and one semi-visible jet were produced side-by-side, the dark particles would carry away some of the energy, leading to a telltale energy imbalance reading because the dark particles would not be seen.

Kar and Sinha have led a search for these energy imbalances with the LHC's ATLAS experiment. Because a slight mis-measurement of two normal jets could mimic the energy imbalance of a semi-visible jet, however, the data from ATLAS had to be analyzed very carefully.

The duo found no evidence for semi-visible jets — but that doesn't mean they don't exist.

The ATLAS results, published in the journal Physics Letters B, point to upper limits for the properties of these theoretical dark particles, allowing future experiments searching for them to be fine-tuned. ☀

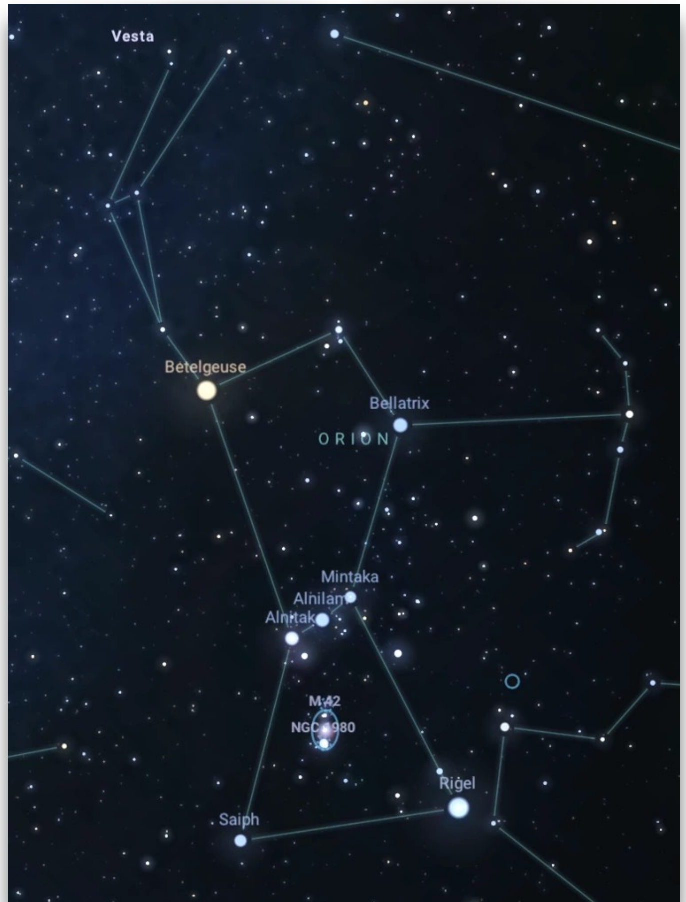
A Flame in the Sky – the Orion Nebula

By Kat Troche

NIGHTSKYNETWORK, NOVEMBER 20, 2023

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.

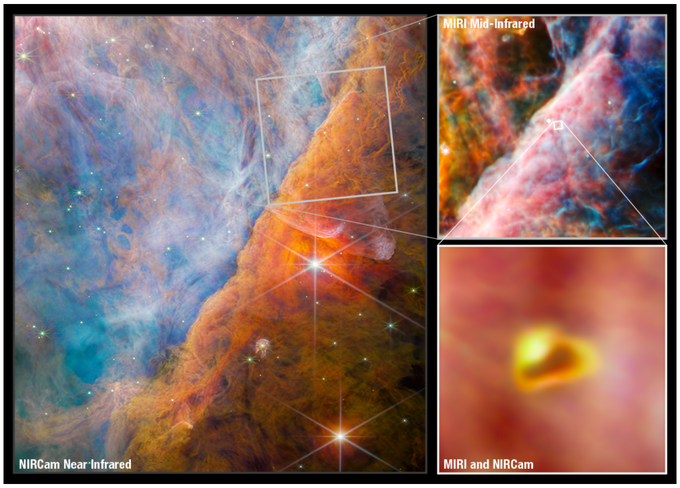
As we've previously mentioned, Orion is a great way to test your sky darkness. With the naked eye, you can easily spot this hourglass-shaped constellation. Known as an epic hunter in Greco-Roman antiqity, Orion and all its parts have many names and meanings across many cultures. In Egyptian mythology, 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.

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.

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.

In addition to the Night Sky Network Dark Sky Wheel, a fun activity you can share with your astronomy club would be Universe Discovery Guide: Orion Nebula, Nursery of Newborn Stars. This will allow you to explain to audiences how infrared astronomy, like JWST, helps to reveal the secrets of nebulae. Or you can use public projects like the NASA-funded MicroObservatory to capture M42 and other objects.

Learn more about what to spy in the winter sky with our upcoming mid-month article on the Night Sky Network page through NASA's website! ☀

NASA's Hubble Measures the Size of the Nearest Transiting Earth-Sized Planet

HUBBLESITE, NOVEMBER 16, 2023

Rocky World Is Too Hot for Life as We Know It

Lots of planets around neighboring stars are not seen directly. Instead, they are found when they temporarily pass in front of their parent star, an event called a transit. During the transit they block out a little bit of light from the star, essentially casting a shadow to Earth-watchers. Astronomers learn a lot from these transient events. They can measure the planet's orbital period, study its atmosphere, and estimate its size. What's tricky is that the planet may only graze the edge of the star during a transit, giving an inaccurate measurement of its diameter. One such nearby exoplanet, LTT 1445Ac, only 22 light-years away, was first identified by NASA's Transiting Exoplanet Survey Satellite (TESS). But TESS does not have the required optical resolution to pin down the planet's exact diameter by refining its trajectory across the face of a star. Along came Hubble with its sharp vision to precisely measure the planet's diameter to be only 1.07 times Earth's diameter. This makes it a cousin of Earth in terms of size. But that's where all similarity ends. LTT 1445Ac is too close to its red dwarf sun for habitability. Surface temperatures are roughly 500 degrees Fahrenheit – the temperatures inside a pizza oven.

NASA's Hubble Space Telescope has measured the size of the nearest Earth-sized exoplanet that passes across the face of a neighboring star. This alignment, called a transit, opens the door to follow-on studies to see what kind of atmosphere, if any, the rocky world might have.

The diminutive planet, LTT 1445Ac, was first discovered by NASA's Transiting Exoplanet Survey Satellite (TESS) in 2022. But the geometry of the planet's orbital plane relative to its star as seen from Earth was uncertain because TESS does not have the required optical resolution. This means the detection could have been a so-called grazing transit, where a planet only skims across a small portion of the parent star's disk. This would yield an inaccurate lower limit of the planet's diameter.

"There was a chance that this system has an unlucky geometry and if that's the case, we wouldn't measure the right size. But with Hubble's capabilities we nailed its diameter," said Emily Pass of the Center for Astrophysics | Harvard & Smithsonian in Cambridge, Massachusetts.

Hubble observations show that the planet makes a normal transit fully across the star's disk, yielding a true size of only 1.07 times Earth's diameter. This means the planet is a rocky world, like Earth, with approximately the same surface gravity. But at a surface temperature of roughly 500 degrees Fahrenheit, it is too hot for life as we know it.

The planet orbits the star LTT 1445A, which is part of a triple system of three red dwarf stars that is 22 light-years away in the constellation Eridanus. The star has two other reported planets that are larger than LTT 1445Ac. A tight pair of two other dwarf stars, LTT 1445B and C, lies about 3 billion miles away from LTT 1445A, also resolved by Hubble. The alignment of the three stars and the edge-on orbit of the BC pair suggests that everything in the system is co-planar, including the known planets.

"Transiting planets are exciting since we can characterize their atmospheres with spectroscopy, not only with Hubble but also with the James Webb Space Telescope. Our measurement is important because it tells us that this is likely a very nearby terrestrial planet. We are looking forward to follow-on observations that will allow us to better understand the diversity of planets around other stars," said Pass.

This research is published in The Astronomical Journal

The James Webb telescope took some stunning images in 2023

By James R Riordon

Just a year and a half into its mission, JWST is revolutionizing our view of the cosmos

This year, the James Webb Space Telescope celebrated its first full year of operation, during which it returned a treasure trove of images. And it's just getting started.

Since it first began sending pictures back home in July 2022 from its location 1.5 million kilometers beyond Earth's orbit, JWST has peered deeper in space and farther back in time than any previous telescope could manage (*SN: 7/11/22*). Hundreds of scientific papers have already been published based on JWST images, barely a year and a half into the telescope's planned 10-year lifetime.

But JWST may end up having much more than a decade to study the cosmos. Thanks to a perfect launch, the mission was left with far more fuel to point the telescope than expected, astrophysicist Jane Rigby of NASA's Goddard Spaceflight Center in Greenbelt, Md., said in September at the First Year of JWST Science Conference in Baltimore. "Now we have more than 25 years of propellant."

If the first 18 months of JWST science are any indication, the telescope could be ushering in a decades-long golden age for astronomy. Here's just a few of the things JWST showed us in 2023.

A closer look at the nearest stellar nursery

The swirling Rho Ophiuchi cloud complex is a dusty delivery room packed with about 50 young stars comparable in size to our sun or smaller (*SN: 2/18/08*). These infants were born when gas and dust in the cloud condensed in quantities large enough for gravity to kick-start the fusion reactions that burn in the hearts of stars.In an image that JWST collected of the stellar nursery in July, the very youngest stars are still

ensconced in dark regions across the top and down the right. Infant stars announce themselves with jets of hydrogen molecules that appear as streaks of long wavelength infrared light, colored red in this depiction, that result when the new stars develop.

The JWST image is clear enough to reveal shadows around some of the stars that could be dusty disks like the one that encircled our sun when it was young. Those disks in turn are where planets are born. Our own sun started out in the same sort of stellar nursery 4.6 billion years ago.

At 390 light-years from Earth, Rho Ophiuchi is the closest stellar nursery to us. Because there are no stars between us and the nursery, JWST has a front row seat to let us see the birth and early lives of stars much like the sun.

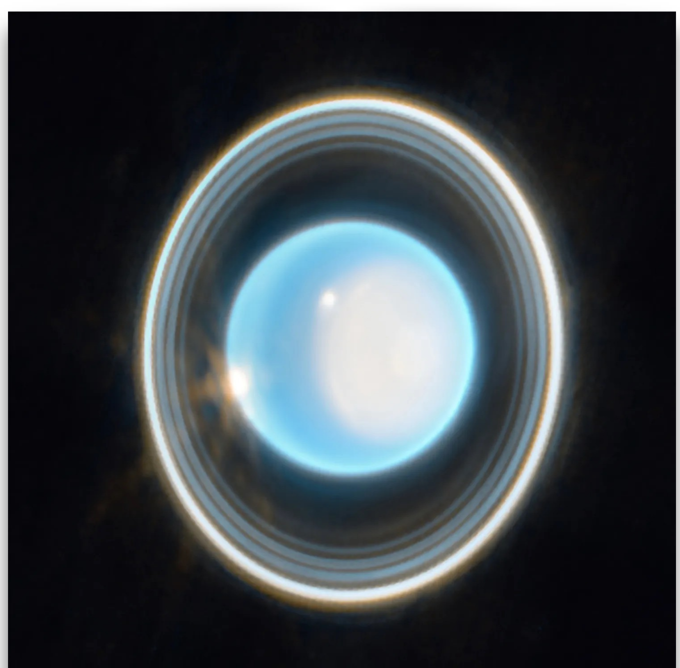
Could it be twins?

Glowing columns bracket what seems to be a young star that's destined to grow to eventually rival our sun in size. The jets, designated HH 211, are about 1,000 light-years from Earth and embedded in the cloud of dust that bore the star. These columns are visible because the jets of gas that young stars emit in the early stages of their lives ram into the dust nearby at supersonic speeds.The images of the jets captured with JWST's infrared cameras have up to 10 times the resolution of any previous pictures of HH 211. Ripples along the center of the outflows hint that HH 211 may in fact be twins — a pair of young stars orbiting each other — instead of a lone star.

Watching the weather on a ringed ice giant

Even in a brief, 12-minute exposure with JWST cameras, there are signs that it was a cloudy day in at least a few places on giant, icy Uranus. This view of the planet's north pole, taken in February, is possible because Uranus is tilted on its side. The overhead perspective makes the faint inner rings visible with unprecedented resolution (*SN: 9/23/22*). Other notable features include a pair of bright spots in the planet's atmosphere that appear to be clouds, and a large, misty-looking polar cap.

The polar cap seems to form only as the orbit of Uranus exposes the north pole to the sun, and it fades away as the planet continues on its way. What the cap



is, and why it's present only when the pole faces the sun, is not yet clear. Future JWST studies and longer photographic exposures could solve the puzzle, along with giving us additional stunning views of the icy blue giant.

Elements for life in the Orion Nebula

Signs of chemicals crucial for the formation of life have turned up in the disk of dust around a star deep in a portion of the Orion Nebula known as the Orion Bar. Although too small to be visible in this image of the nebula that JWST captured in June, the disk surrounds a dwarf red star designated d203-506.

The cool, red star isn't much like our sun, but it exists in harsh conditions similar to the ones that our sun probably experienced early in life, thanks to the radiation bathing it from young, hot stars nearby.

JWST detected a carbon and hydrogen compound in the red star's disk that suggests chemicals important for the development of life can withstand the intense radiation in stellar nurseries.

Surprisingly, the radiation that many researchers thought would disrupt organic molecules may instead provide the energy needed to create the chemicals that are the building blocks of life.

Peering into the heart of the crab

There is a small bright dot near the middle of the Crab Nebula in this JWST image released in October. The dot is a tiny, immensely dense neutron star that was left behind after a supernova explosion that appeared in Earth's sky in the year 1054. The neutron star has intense magnetic fields that whip around as it spins, seemingly stirring up a smoky cloud.

The wispy, white features are not smoke, but radiation that results when the neutron star's magnetic fields accelerate electrons to super high speeds, close to the speed of light. The fine structure in the nebula's image shows curving white rows that mark the lines of the magnetic fields.

The Crab Nebula's entire origin story is not yet clear, but the details that JWST's infrared cameras provide, in conjunction with images from the Hubble Space Telescope and other observatories, are helping astronomers to piece the Crab's backstory together (*SN: 5/23/22*).

These five images hint at what we're likely to see from JWST over the next quarter century of observations. "Trying to keep pace with the results coming from JWST can be a daunting and challenging task," said astronomer Marc Postman of the Space Telescope Science Institute in Baltimore at the September conference. "The sheer volume and diversity of discoveries are both exhilarating and challenging. And that's precisely the kind of challenge we love to embrace." ☀

Volume 50 Number 1 **January 2024**

The Backyard Observer, January 2024

By Rick Heschmeyer

CASSIOPEIA

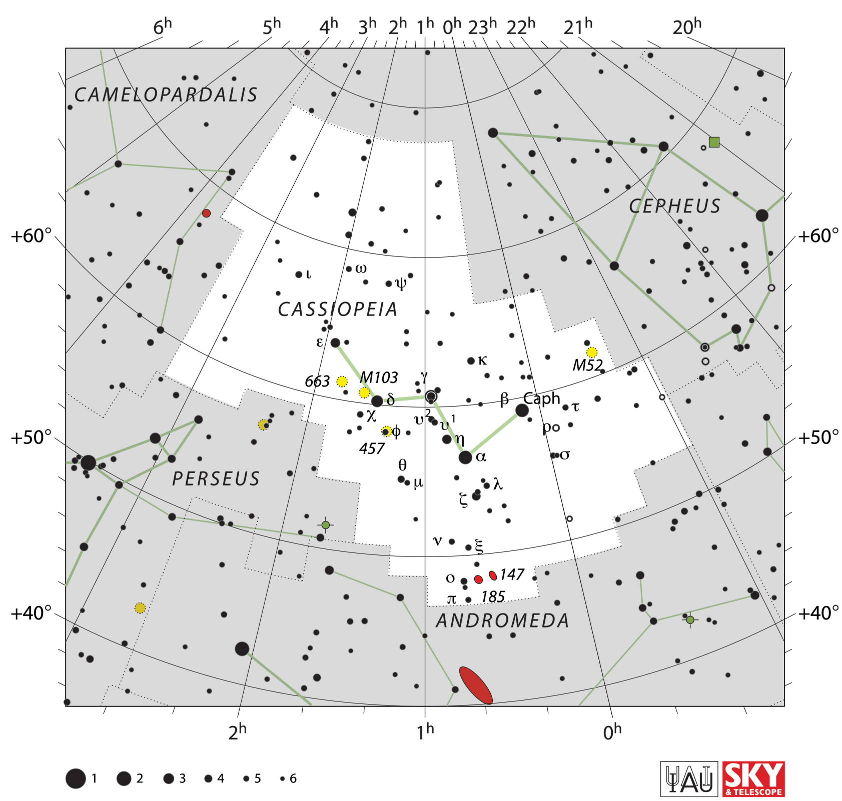
This month's constellation is one of the night sky's most distinctive and recognizable star pattern, Cassiopeia, the Queen. It is also part of the Andromeda/Perseus mythology that we have been visiting the past few months. For most observers in northern latitudes Cassiopeia is a circumpolar constellation, meaning that due to its proximity to the pole star, Polaris, it remains in view year-round. Resembling the letter W, or the letter M, or a Greek Sigma, depending upon the time of year, this month Cassiopeia rides high overhead. Located in a very rich portion of the Milky Way, the entire area provides breathtaking views in binoculars and low power telescopes. Cassiopeia is also home for several open clusters, the brightest of which we will explore this month. But first let's start with a few beautiful double stars.

Eta Cassiopeiae, called Achird, is a colorful double star that is visible to the naked eye. It can be split with a small telescope. This stellar duo has been dubbed the "Easter Egg Double" because the two stars colors are reminiscent of that holiday, being yellow and purple.

Iota Cassiopeiae is an interesting triple star system that is visible in telescopes in the 4–6-inch aperture range at medium magnifications. The brighter of the three stars shines with a yellowish hue while the two dimmer stars shine with a bluish tint.

Messier 52 is the first of several fine open, or galactic, clusters that we will discuss within Cassiopeia. It is the 52nd item listed in Charles Messier's catalog, and was discovered by Messier in September, 1774, while he was observing a comet in the same region of sky. It lies about 5,000 light years distant. In small scopes many of the 120 cluster members can be seen to form a fan-shaped pattern within the cluster. A bright orange star can be seen in one corner of the cluster.

Messier 103 was the last entry of the original Messier catalog although modern scholars have expanded the list to 110 objects. It was actually discovered by Pierre Méchain in 1781. M 103 can be seen in binoculars as a soft glow just northeast of Delta Cassiopeiae. In telescopes the cluster's triangular or wedge-shaped outline becomes apparent. A bright star is placed in each corner of the cluster. The brightest of these corner stars, Struve 131, is actually a blue and white double star.



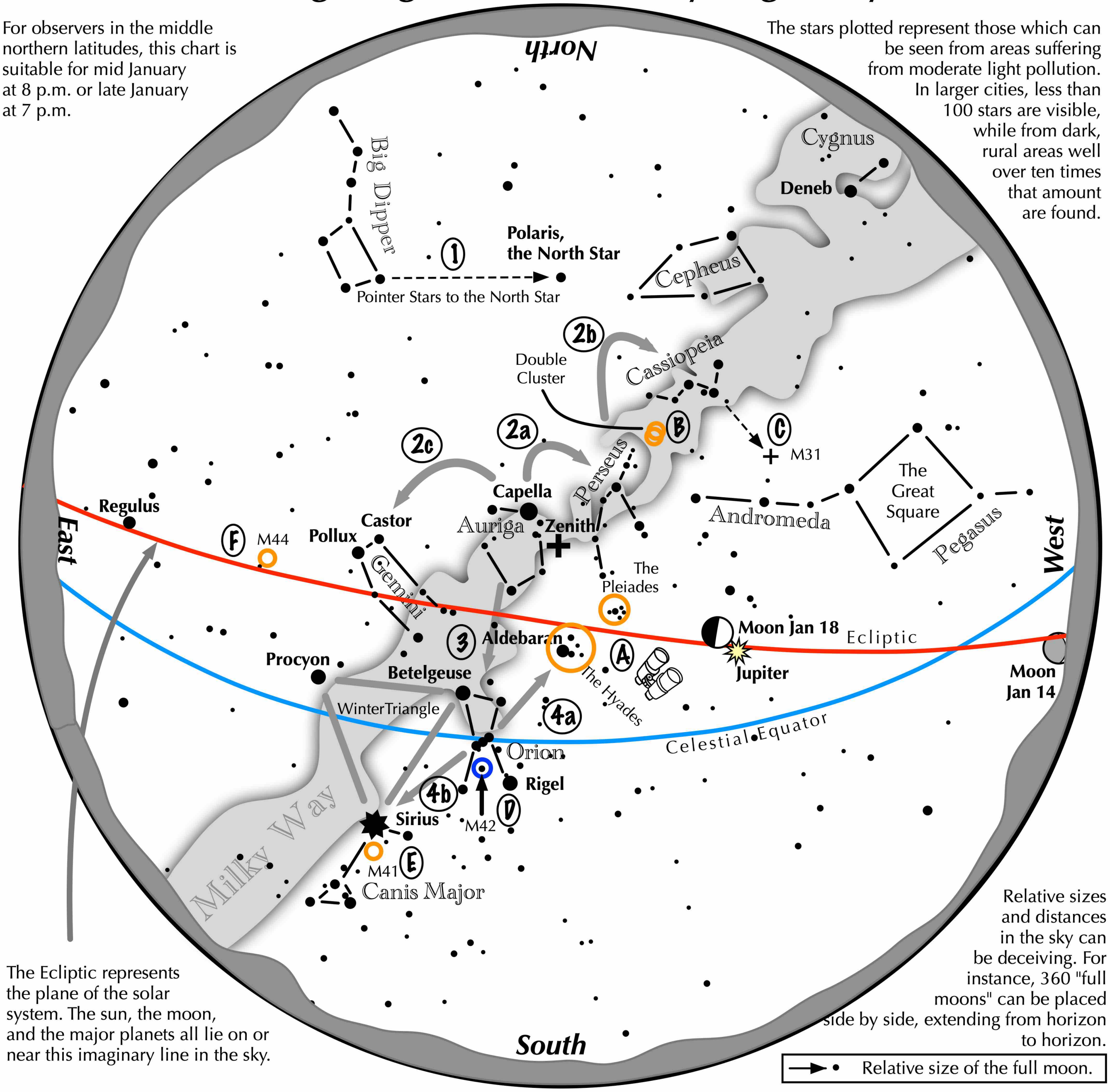
NGC 457 is one of my favorite clusters. It is one of the brightest and best clusters in the constellation. This cluster, about twice the size of M 103, lies adjacent to Phi Cassiopeiae, which is probably a cluster member. If Phi is truly a cluster member, then it would be one of the brightest stars known. Phi and another dimmer star, HD 7902, mark the southeast corner of the cluster looking for all the world like a ghostly pair of eyes looking down on us. Traditionally called the "Owl Cluster," many modern observers have christened it the "E.T. Cluster" after the likeable alien from the movie, complete with stick-like arms and legs. Many of the 80 or so stars in the cluster can be seen in small telescopes.

T

Navigating the mid January Night Sky

For observers in the middle northern latitudes, this chart is suitable for mid January at 8 p.m. or late January at 7 p.m.

The stars plotted represent those which can be seen from areas suffering from moderate light pollution. In larger cities, less than 100 stars are visible, while from dark, rural areas well over ten times that amount are found.



The Ecliptic represents the plane of the solar system. The sun, the moon, and the major planets all lie on or near this imaginary line in the sky.

Relative sizes and distances in the sky can be deceiving. For instance, 360 "full moons" can be placed side by side, extending from horizon to horizon.

→• Relative size of the full moon.

Navigating the winter night sky: Simply start with what you know or with what you can easily find.

1 Above the northeast horizon rises the Big Dipper. Draw a line from its two end bowl stars upwards to the North Star.

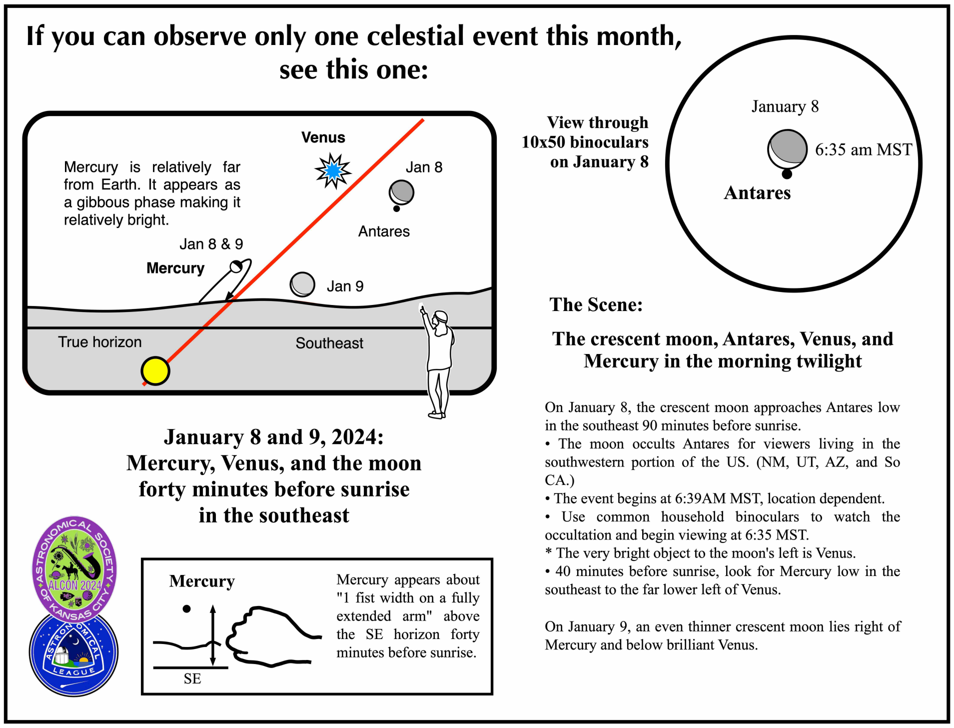
2 Face south. Overhead twinkles the bright star Capella in Auriga. Jump northwestward along the Milky Way first to Perseus, then to the "W" of Cassiopeia. Next Jump southeastward from Capella to the twin stars Castor and Pollux of Gemini.

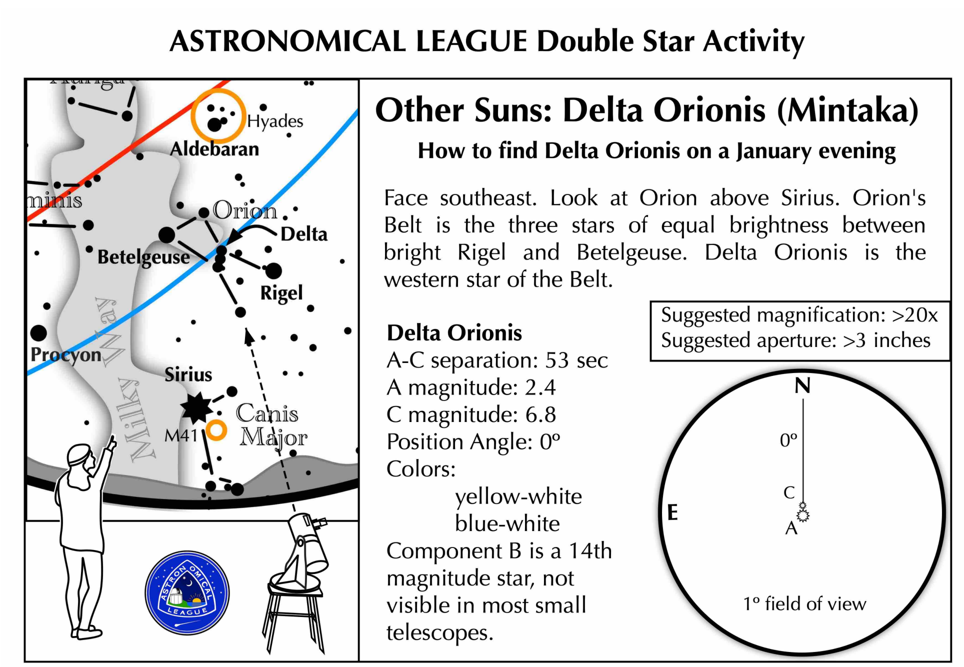
3 Directly south of Capella stands the constellation of Orion with its three Belt Stars, its bright red star Betelgeuse, and its bright blue-white star, Rigel.

4 Use Orion's three Belt stars to point to the red star Aldebaran, then to the Hyades, and the Pleiades star clusters. Travel southeast from the Belt stars to the brightest star in the night sky, Sirius.

Binocular Highlights

A: Examine the stars of the Pleiades and Hyades, two naked eye star clusters. **B:** Between the "W" of Cassiopeia and Perseus lies the Double Cluster. **C:** The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval. **D:** M42 in Orion is a star forming nebula. **E:** Look south of Sirius for the star cluster M41. **F:** M44, a star cluster barely visible to the naked eye, lies to the southeast of Pollux.





About Astronomy Associates

The club is open to all people interested in sharing their love for astronomy. Monthly meetings are typically on the last Sunday of each month and often feature guest speakers, presentations by club members, and a chance to exchange amateur astronomy tips. These meetings and the public observing sessions that follow are scheduled at the Baker Wetlands Discovery Center, south of Lawrence. All events and meetings are free and open to the public. Periodic star parties are scheduled as well.

Because of the flexibility of the schedule due to holidays and alternate events, it is always best to check the Web site for the exact Sundays when events are scheduled.

Copies of the Celestial Mechanic can also be found on the web at newsletter.
Annual Dues for the club are: $12 for regular members; $6 for students Membership forms can be accessed at the club website form.