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The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
January 26, 2025, 7:00PM
Baker Wetlands Discovery Center

Public Observing
January 26, 2025, 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

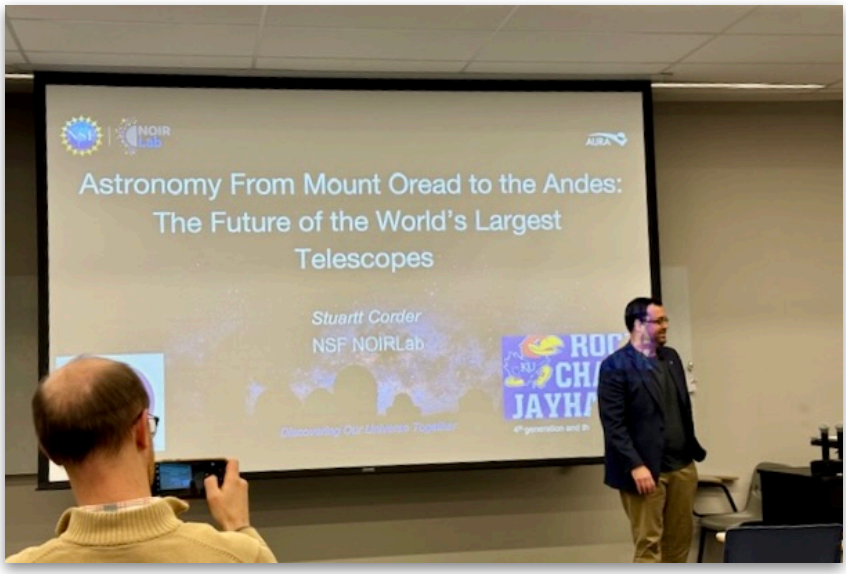
Last month, Alex Polanski, recent graduate of KU and currently the Percival Lowell Postdoctoral Fellow at Lowell Observatory presented "The KU Plate Project", his project to catalog and digitize KU's collection of historic glass photographic plates. The talk was fascinating and included not only images taken by Clyde Tombaugh himself, but also an image taken by AAL's former faculty advisor Dr. Bruce Twarog. The digitizing portion of the project is not complete and Alex promised to let us know when the website being built to house the collection will be online. Unfortunately, the weather was not as great as the presentation, and no public observing was held due to the clouds.

To close the 2024 Mid-American Regional Astrophysics Conference (MARAC) on Friday evening, December 6th, another KU alum, Dr Stuartt Corder, Deputy Director of the National Science Foundation's NOIRLab, gave a public talk about "The Future of the World's Largest Telescopes" weaving in stories of his time at KU with his work with ALMA, Gemini South, and the Vera C. Rubin Observatory in Chile.

Our first club meeting of 2025 will be on Sunday, January 26 starting at 7:00 PM at Baker Wetlands Discovery Center. AAL Member David Kolb will discuss and display his homebuilt spectroheliograph that he constructed in late 2023 in a presentation entitled "Amateur Spectroheliography with Sol'Ex". The meeting will be followed by public observing, weather permitting.

The next KU Public Telescope Night will take place on February 9, 2025. More details to follow in the February newsletter.

Happy New Year and Clear Skies!



NASA's Hubble Finds Sizzling Details About Young Star FU Orionis

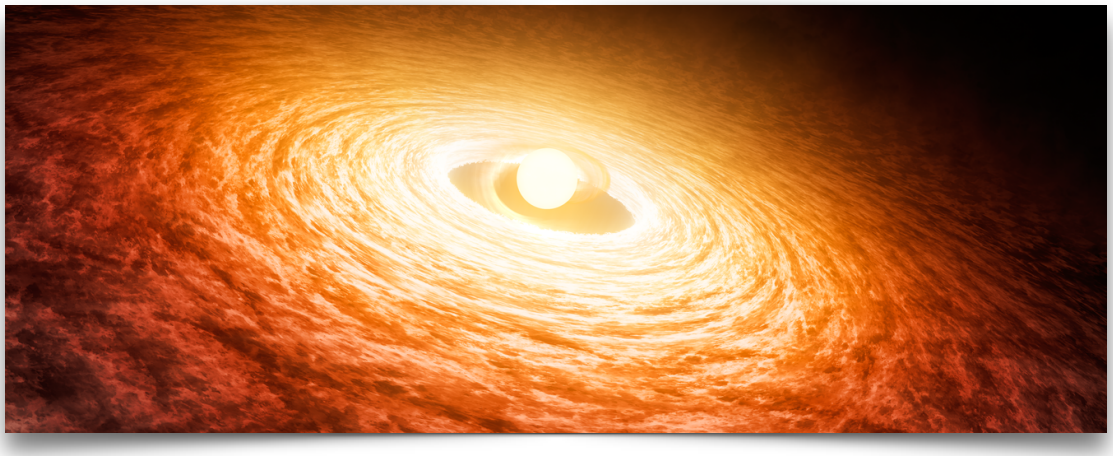
HUBBLESITE, NOVEMBER 21, 2024

Summary

Ultraviolet light reveals new information about the eruptive star's mechanisms.

In 1936, young star FU Orionis (FU Ori) underwent a significant increase in brightness and has slowly declined in luminosity ever since. Once considered to be a stand-alone case, scientists have noted a small class of extremely tumultuous, young stars that experience large escalations in brightness, known as FU Ori objects.

To learn about the conditions that can lead to such significant growth in brightness, a team of astronomers wielded NASA's Hubble Space Telescope's ultraviolet capabilities to learn more about the relationship between FU Ori's stellar surface and its accretion disk. They found new, shocking details in the process.



In 1936, astronomers saw a puzzling event in the constellation Orion: the young star FU Orionis (FU Ori) became a hundred times brighter in a matter of months. At its peak, FU Ori was intrinsically 100 times brighter than our Sun. Unlike an exploding star though, it has declined in luminosity only languidly since then.

Now, a team of astronomers has wielded NASA's Hubble Space Telescope's ultraviolet capabilities to learn more about the interaction between FU Ori's stellar surface and the accretion disk that has been dumping gas onto the growing star for nearly 90 years. They find that the inner disk touching the star is extraordinarily hot—which challenges conventional wisdom.

The observations were made with the telescope's COS (Cosmic Origins Spectrograph) and instruments. The data includes the first far-ultraviolet and new near-ultraviolet spectra of FU Ori.

"We were hoping to validate the hottest part of the accretion disk model, to determine its maximum temperature, by measuring closer to the inner edge of the accretion disk than ever before," said Lynne Hillenbrand of Caltech in Pasadena, California, and a co-author of the paper. "I think there was some hope that we would see something extra, like the interface between the star and its disk, but we were certainly not expecting it. The fact we saw so much extra — it was much brighter in the ultraviolet than we predicted — that was the big surprise."

A Better Understanding of Stellar Accretion

Originally deemed to be a unique case among stars, FU Ori exemplifies a class of young, eruptive stars that undergo dramatic changes in brightness. These objects are a subset of classical T Tauri stars, which are newly forming stars that are building up by accreting material from their disk and the surrounding nebula. In classical T Tauri stars, the disk does not touch the star directly because it is restricted by the outward pressure of the star's magnetic field.

The accretion disks around FU Ori objects, however, are susceptible to instabilities due to their enormous mass relative to the central star, interactions with a binary companion, or infalling material. Such instability means the mass accretion rate can change dramatically. The increased pace disrupts the delicate balance between the stellar magnetic field and the

inner edge of the disk, leading to material moving closer in and eventually touching the star's surface.

The enhanced infall rate and proximity of the accretion disk to the star make FU Ori objects much brighter than a typical T Tauri star. In fact, during an outburst, the star itself is outshined by the disk. Furthermore, the disk material is orbiting rapidly as it approaches the star, much faster than the rotation rate of the stellar surface. This means that there should be a region where the disk impacts the star and the material slows down and heats up significantly.

"The Hubble data indicates a much hotter impact region than models have previously predicted," said Adolfo Carvalho of Caltech and lead author of the study. "In FU Ori, the temperature is 16,000 kelvins [nearly three times our Sun's surface temperature]. That sizzling temperature is almost twice the amount prior models have calculated. It challenges and encourages us to think of how such a jump in temperature can be explained."

To address the significant difference in temperature between past models and the recent Hubble observations, the team offers a revised interpretation of the geometry within FU Ori's inner region: The accretion disk's material approaches the star and once it reaches the stellar surface, a hot shock is produced, which emits a lot of ultraviolet light.

Planet Survival Around FU Ori

Understanding the mechanisms of FU Ori's rapid accretion process relates more broadly to ideas of planet formation and survival.

"Our revised model based on the Hubble data is not strictly bad news for planet evolution, it's sort of a mixed bag," explained Carvalho. "If the planet is far out in the disk as it's forming, outbursts from an FU Ori object should influence what kind of chemicals the planet will ultimately inherit. But if a forming planet is very close to the star, then it's a slightly different story. Within a couple outbursts, any planets that are forming very close to the star can rapidly move inward and eventually merge with it. You could lose, or at least completely fry, rocky planets forming close to such a star."

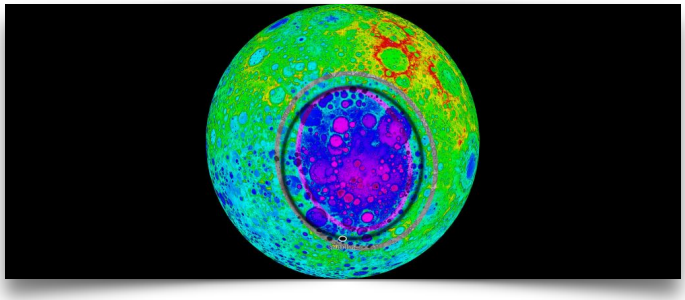
Additional work with the Hubble UV observations is in progress. The team is carefully analyzing the various spectral emission lines from multiple elements present in the COS spectrum. This should provide further clues on FU Ori's environment, such as the kinematics of inflowing and outflowing gas within the inner region.

"A lot of these young stars are spectroscopically very rich at far ultraviolet wavelengths," reflected Hillenbrand. "A combination of Hubble, its size and wavelength coverage, as well as FU Ori's fortunate circumstances, let us see further down into the engine of this fascinating star-type than ever before." ☀

The Biggest Crater on The Moon Is Much Bigger Than We Ever Realized

By Michelle Starr

Sciencealert, December 9, 2024



The Moon bears its history on its skin. Earth's only permanent natural satellite is scored and scarred with billions of years' worth of cratering – a record of constant bombardment.

The biggest and oldest of these scars is a monster crater, one of the largest, not just on the Moon, but in the entire Solar System. The South Pole-Aitken basin covers nearly a quarter of the Moon's surface, with a diameter of some 2,500 kilometers (1,550 miles).

It's not easy to study the South Pole-Aitken basin. It's over 4 billion years old, and huge; in addition, time and subsequent impacts have done much to obscure it.

But new research suggests that the ancient, gargantuan crater may not have formed the way we thought, and may be much bigger than previous studies suggest – a discovery that has exciting implications for future lunar missions to the basin.

"It's challenging to study the South Pole-Aitken basin holistically due to its sheer enormousness, which is why scientists are still trying to learn its shape and size," says geologist Hannes Bernhardt of the University of Maryland.

"Our work challenges many existing ideas about how this massive impact occurred and distributed materials, but we are now a step closer to better understanding the Moon's early history and evolution over time."

Click here to view video.

Previous work on the South Pole-Aitken basin found that the impact was created by an oblique collision with a large object, leaving behind a crater shaped more like an oval than a circle. Under this model, the debris would have sprayed predominantly in one direction, away from the lunar south pole.

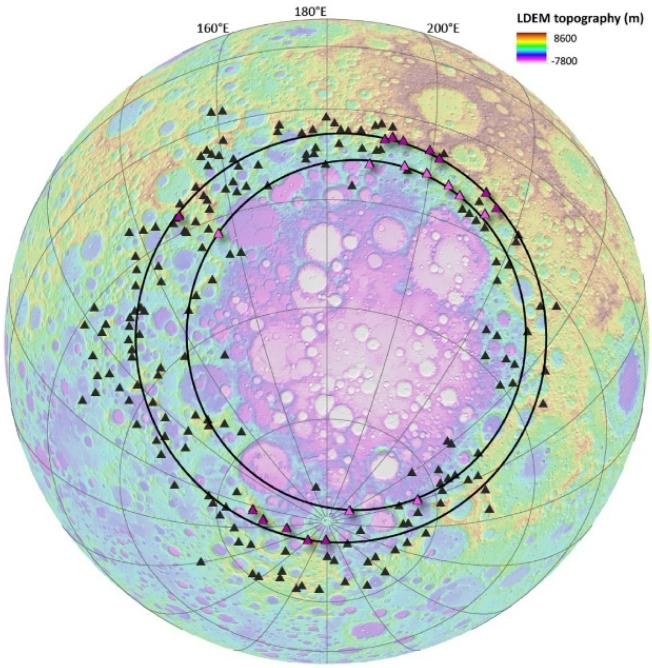
Bernhardt and his colleagues wanted to investigate the way this impact played out by studying the geological features on the surface of the Moon today. NASA's Lunar Reconnaissance Orbiter has been circling the Moon since 2009, mapping its surface and collecting a wealth of lunar geology data.

The research focused on more than 200 mountain features scattered around the outskirts of the basin that the team thought may be remnants of the crater rim. When the cataloging and the mapping was complete, however, the shape formed by these features was far more circular than the researchers expected it to be.

Impacts gouge out materials from deep under the lunar crust and spray them over the surface. Because the Moon doesn't experience erosion from geological or atmospheric weather processes that obscure impact evidence here on Earth, those materials should still be there.

"A rounder, more circular shape indicates that an object struck the Moon's surface at a more vertical angle, possibly similar to dropping a rock straight down onto the ground," Bernhardt says.

"This circular impact implies that debris from the impact is more equally distributed around it than was originally thought, which means that Artemis astronauts or robots in the south pole region may be able to closely study rocks from deep within the moon's mantle or crust – materials that are typically impossible for us to access."



The team's map, showing the mountain features they determined were related to the crater rim (triangles), and the best fits for its shape (circles).

Those materials could give us new insights into how the Moon formed – a process that is shrouded in mystery and the topic of much healthy speculation.

The current leading explanation is that Earth's satellite is a chunk of planet that broke off during a giant, early Solar System impact, but alternatives include coalescence from a cloud of debris, or gravitational capture.

A more vertical angle of approach for the impactor could explain other strange features of the basin. For example, measurements of the Moon's gravity around the region suggest that, under the giant crater, the crust of the Moon is much higher density than its surroundings. A possible explanation for this is the presence of a dense chunk of asteroid buried therein.

Having direct access to a treasure trove of minerals from early in the Moon's history could help answer such questions.

"One of the most exciting implications of our research is how it is applicable to missions to the Moon and beyond," Bernhardt says. ☀

Einstein's gravity endures despite a dark energy puzzle

An analysis upholds general relativity but hints dark energy may vary over time

Scientists mapped galaxies with the Dark Energy Spectroscopic Instrument at the Mayall telescope (shown) at Kitt Peak National Observatory in Arizona.

By Emily Conover
Sciencenews, November 19, 2024

Scientists could be wrong about dark energy. But they're right about gravity, a new study suggests.

Dark energy, the mysterious phenomenon that causes the expansion of the cosmos to accelerate, is widely thought to have had a constant density throughout the history of the universe. But dark energy may instead be waning, researchers from the Dark Energy Spectroscopic Instrument, or DESI, collaboration report November 19 in a batch of papers posted to the project's website and arXiv.org.

The finding reaffirms an April report from the same team that had come to a similar conclusion (SN: 4/4/24). Simultaneously, the new analysis — a more thorough look at the same data used in the earlier report — confirms that the DESI data agree with general relativity, Albert Einstein's theory of gravity, with no evidence for alternative, "modified gravity" theories.

DESI makes a 3-D map of galaxies throughout the cosmos. The project's previous analysis focused only on one type of information gleaned from that map: baryon acoustic oscillations, sound waves in the early universe that left imprints on the cosmos that are visible today (SN: 3/4/19).

The new analysis adds information on how galaxies and other structures evolve over cosmic history. "This is the first time we are sensitive to how structure grows with time," says cosmologist Dragan Huterer of the University of Michigan in Ann Arbor. "This is significant because the growth of structure is well known to be very sensitive to dark energy and modified gravity."

In both analyses, the researchers found signs of a variation in dark energy's equation of state, the relationship between its pressure and density over time. "We are pointing at the same conclusion, and this is … completely reassuring," says cosmologist Pauline Zarrouk of CNRS and the Laboratoire de Physique Nucléaire et de Hautes Énergies in Paris. Because the two analyses are based on the same data, "if we were not seeing the same [conclusion], that would really be an issue." (In both cases, the team combined DESI's data with other cosmological data, including data on the cosmic microwave background, the oldest light in the universe.)

With the first result, DESI researchers were sticking their necks out, says physicist Daniel Scolnic of Duke University. "They're not backing away from that. A lot of times when there's some big result in cosmology, it feels like a month later … it's gone." But with DESI, "their neck's still out. I really respect that and appreciate that."

If dark energy is confirmed to vary, it would send a jolt through cosmology, overthrowing scientists' accepted theory, the standard cosmological model. That theory has been extremely successful at describing the cosmos, but it includes poorly understood components, like dark energy and the likewise

unidentified source of mass called dark matter (SN: 8/26/24).

In an attempt at a more satisfying explanation of the cosmos, some scientists are tweaking general relativity, which describes gravity as a result of mass warping spacetime. Modified gravity theories could potentially do away with the need for dark matter or dark energy (SN: 7/5/24). But the structure formation that DESI observed was consistent with that predicted by general relativity. And there's no evidence for modified gravity, although the theories are not fully ruled out.

In the new study, a puzzle persists about the masses of neutrinos, lightweight subatomic particles that are plentiful in the cosmos. Like DESI's first analysis, the new findings indicate that the sum of the masses of the three types of neutrinos is smaller than expected, at least by some accounts (SN: 9/20/24). That could hint that cosmologists have misunderstood something about the nature of the cosmos or about neutrinos themselves.

In 2025, the DESI collaboration plans to release results based on the project's first three years of data. That will be a true test of how robust the results are, including whether dark energy indeed changes over time.

Scolnic envisions the standard cosmological model as a bonfire. While scientists had been enjoying sitting around the warm glow, with the DESI results, sparks have begun to fly. "This is when you tell everyone, 'Let's just take a step back from the bonfire, just to be safe. … We're not throwing water on the whole thing, but definitely just one step back.'" ☀

Jaw-Dropping Image Captures Black Hole Jet Smashing Into Mystery Object

A new image by the Chandra X-ray Observatory reveals an unidentified celestial object, dubbed C4, getting blasted by a jet of energetic particles, raising questions about its identity.

By Isaac Schultz

Gizmodo, December 11, 2024An

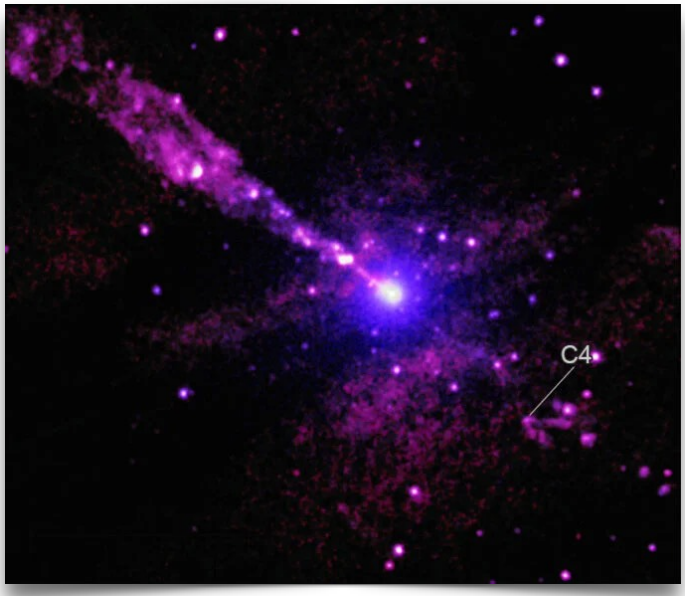
An immense jet of material spewing out of a black hole 12 million light-years away is hitting something in space, but astronomers aren't exactly sure what.

The structure popped up in a recent ultra-deep X-ray image taken by NASA's Chandra X-ray Observatory—in fact, the deepest X-ray image ever taken of the galaxy, called Centaurus A. The unknown blockade, dubbed C4, is emitting plenty of X-rays. A recent astronomical team's findings surrounding Centaurus A and the surprise obstruction were published in *The Astrophysical Journal*.

Black holes are areas of spacetime with gravity so intense that light cannot escape them beyond a point called the event horizon. Black holes can be anywhere between several times the mass of our Sun (barring the existence of primordial black holes) to many billions of times the Sun's mass.

But black holes have other extreme physics at work; the objects sometimes emit jets of particles moving at nearly the speed of light. These jets can catalyze stellar eruptions—literally, they can cause stars to explode—and they can also be staggeringly large; in September, a group of astronomers identified black hole jets 140 times longer than the width of the Milky Way.

C4 has V-shaped arms, visible in the Chandra image (shown below; the top image is a wide-field shot that doesn't show C4). The apparent V-shape is caused by a jet from the black hole hitting the object.



C4, as seen in a Chandra image. Image: NASA/CXC/SAO/D.

Though the arms of the V-shape emanating from C4 appear quite small—especially compared to the immense jet on the other side of the black hole—they each stretch 700 light-years in length. For reference,

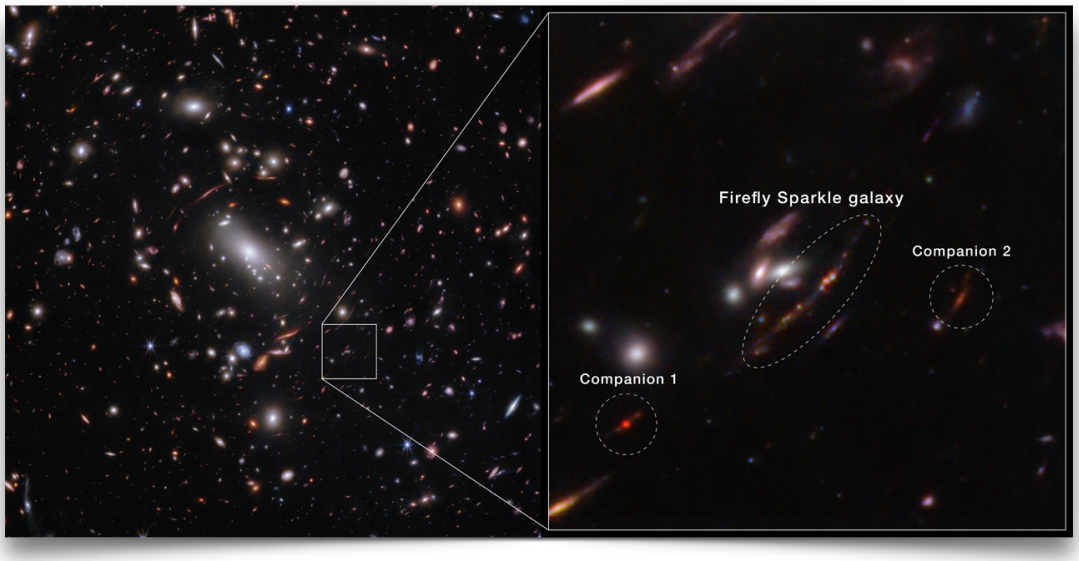
and as noted in the Chandra X-ray Observatory release, the black hole's jet is 30,000 light-years long, and the nearest star to the Sun is four light-years away. All this is a reminder that the universe is gargantuan.

It's not the first time a black hole jet has smacked into something—in fact, astronomers previously saw the Centaurus A jet hitting objects, perhaps stars or gas clouds. But C4's V-shape is irregular, and may be related to the kind of object the jet is striking or the way in which the jet is coming into contact with the object.

Black hole jets are some of the flashiest astrophysical phenomena around and evidently have plenty more tricks up their sleeves. While we may not know what C4 is anytime soon, rest assured that researchers are on the case. ☀

A new galaxy, like our own

Sciencedaily, December 11, 2024



Stunning new photographs by a Wellesley College-led team of astronomers have revealed a newly forming galaxy that looks remarkably similar to a young Milky Way.

The extraordinary images -- taken with NASA's James Webb Space Telescope -- show a galaxy that glitters with 10 distinct star clusters that formed at different times, much like our own Milky Way.

Cocooned in a diffuse arc, and resembling fireflies "dancing" on a summer night, the newly discovered galaxy -- which the Wellesley team have dubbed the "Firefly Sparkle" -- was taking shape around 600 million years after the Big Bang, around the same time that our own galaxy was beginning to take shape.

Wellesley College astronomer Lamiya Mowla is co-lead author of the paper, which was published Wednesday, Dec. 11, in *Nature.*

Mowla says the discovery is particularly important because the mass of the Firefly Sparkle is similar to what the Milky Way's mass might have been at the same stage of development. (Other galaxies Webb has detected from this time period are significantly more massive.)

"These remarkable images give us an unprecedented picture of what our own galaxy might have looked like when it was being born," Mowla says. "By examining these photos of the Firefly Sparkle, we can better understand how our own Milky Way took shape."

Glimpses of a young galaxy forming in a way so similar to our own are unparalleled, Mowla says. The JWST images show a Milky Way-like galaxy in the early stages of its assembly in a universe that's only 600 million years old.

"As an observational astronomer studying the structural evolution of astronomical objects in the early Universe, I want to understand how the first stars, star clusters, galaxies, and galaxy clusters formed in the infant Universe and how they changed as the Universe got older," Mowla notes. Of the Firefly Sparkle, she says, ""I didn't think it would be possible to resolve a galaxy that existed so early in the universe into so many distinct components, let alone find that its mass is similar to our own galaxy's when it was in the process of forming.

"There is so much going on inside this tiny galaxy, including so many different phases of star formation," Mowla told NASA. "These images are the very first glimpse of something that we'll be able to study -- and learn from -- for many years to come."

Mowla, who co-led the project with Kartheik Iyer, a NASA Hubble Fellow at Columbia University in New York, is an assistant professor of physics and astronomy at Wellesley, and a 2013 graduate of the college. ☀

The Backyard Observer, January 2025

By Rick Heschmeyer

ORION

The winter sky offers the finest display of bright stars to be seen in any season. If you look due south any time this month you will see the brightest constellation of any season. ORION, the Hunter. The constellation is marked by three bright stars in a line, evenly spaced, forming the “Belt of Orion” asterism. From east to west the three stars are Alnitak, a triple-star system, Alnilam, the brightest of the three belt stars as seen from Earth, and Mintaka, a multiple star system made up of five stars. This asterism is sometimes known as the Triplets, The Three Kings, or The Three Sisters. The Orion Correlation Theory is a fringe theory, most say debunked, that the alignment of the three main pyramids in Giza is correlated to the spacing of the three primary stars in Orion’s Belt.

These stars, along with the other blue/white stars in the constellation are part of what is known as the Orion OB1 Association, the largest collection of bright stars in the sky. The stars in this association appear so bright in our night sky not only due to their intrinsic luminosity, but also to their nearness to our Solar System, which lies in the Orion Arm of the Milky Way Galaxy. Orion is of great interest to astronomers not only for its bright stars, but also for its multiple stars systems and its vast regions of nebulosity. We will discuss many of these features this month.

Alpha Orionis, whose proper name is Betelgeuse, marks the right shoulder of Orion (literally translates from the original Arabic as “armpit of the Central One”) and is the only bright star in the constellation not a member of the Orion Association. This is one of the largest stars known, its diameter being about 800 times that of the Sun. Betelgeuse is a red Supergiant star, cooler than the hot B-type stars such as Rigel. When viewed with the naked eye its color is more orange than red. In 2024, Betelgeuse was seen to dim about a half-magnitude, leading many to surmise that the star was about to go supernova. Or could this have been a repeat of the “Great Dimming” seen in 2019/2020? Or just a sign of the star’s instability? Only time will tell.

Beta Orionis is more commonly called Rigel, and is the brightest star in Orion, despite its designation as the Beta star in the constellation. It marks the Hunter’s left foot in mythological interpretations. It is a blue supergiant star and is the seventh brightest star in the sky (fifth brightest in the Northern Hemisphere), even at its distance of 864 light years! It is a quadruple star, but its smaller companions cannot be viewed with amateur equipment.

Iota Orionis marks the southern tip of Orion’s sword. It is a beautiful and colorful triple star system for the small telescope, whose components have been described as white, blue, and deep red.

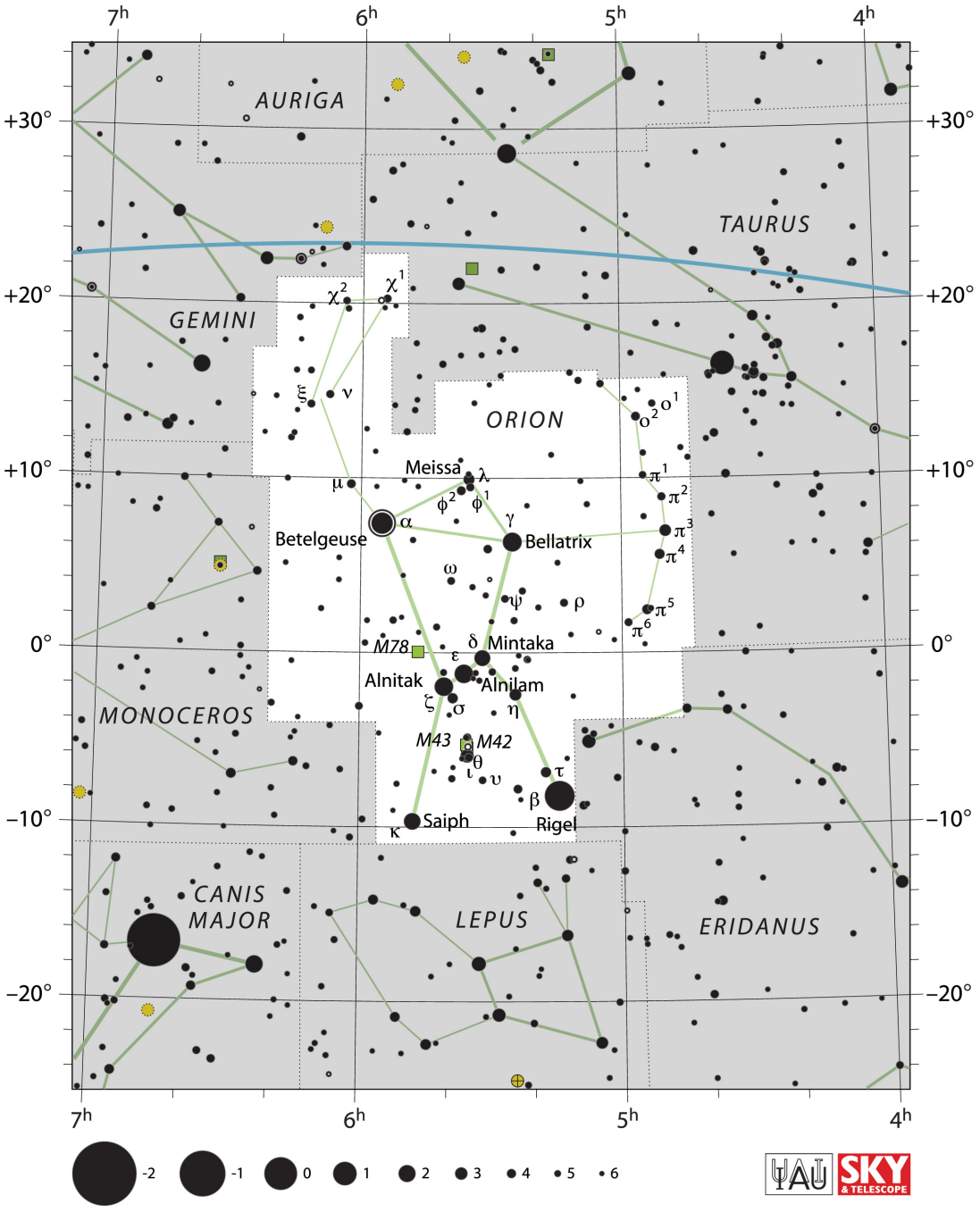
Theta Orionis is the diamond-shaped, quadruple star system embedded in the heart of the “Great Orion Nebula", often called the “Trapezium". It is perhaps the most famous multiple star system in the heavens. The four components are very hot, very young stars that formed from the same cloud of gas that they illuminate today, the “Great Orion Nebula”. A small telescope will resolve Theta Orionis into its four components. Note as well the “Fish Mouth”, a dark nebula forming an indentation in the bright nebula just north of the Trapezium.

Messier 42 is the Great Orion Nebula. This is the finest example of an emission or diffuse nebula in the sky. The showcase of Orion. So bright it can be seen with the naked eye as a hazy “star” in Orion’s sword, even at its distance of 1350 light years. In binoculars, the wispy structure of the gaseous cloud can be discerned, along with its slightly greenish color. But to fully appreciate the magnificence of the Orion Nebula you should observe it with a telescope. The nebula is visible because the gases from which it is made, mostly hydrogen. absorb the ultraviolet radiation from Theta Orionis and reradiates it as visible light, thus the name emission nebula. This cloud of glowing gas contains all the materials necessary for the construction of stars. In fact, astronomers know that star formation is taking place in the Great Orion Nebula right now, making it a stellar nursery, containing over 700 stars in some stage of being born. The nebula’s immensity is astounding. It measures nearly 30 light years across or 20,000 times the diameter of the entire solar system!

Messier 43, also known as De Mairan's Nebula, is the smaller, detached northern portion of the Great Orion Nebula. It is often ignored in favor of M42 as it is separated from M42 by a large dust lane, known as the Northeast Dark Lane.

Messier 78 is another portion of the same vast nebulosity that envelops the entire constellation, this nebula differs from M42 in that it is a reflection nebula. As the name implies it shines not by fluorescence, but by reflecting the light of nearby stars. Smaller and less detailed than M42, this nebula is an easy target for small scopes. Two bright stars can be seen in the cloud, one of those whose light we see illuminating the nebula.

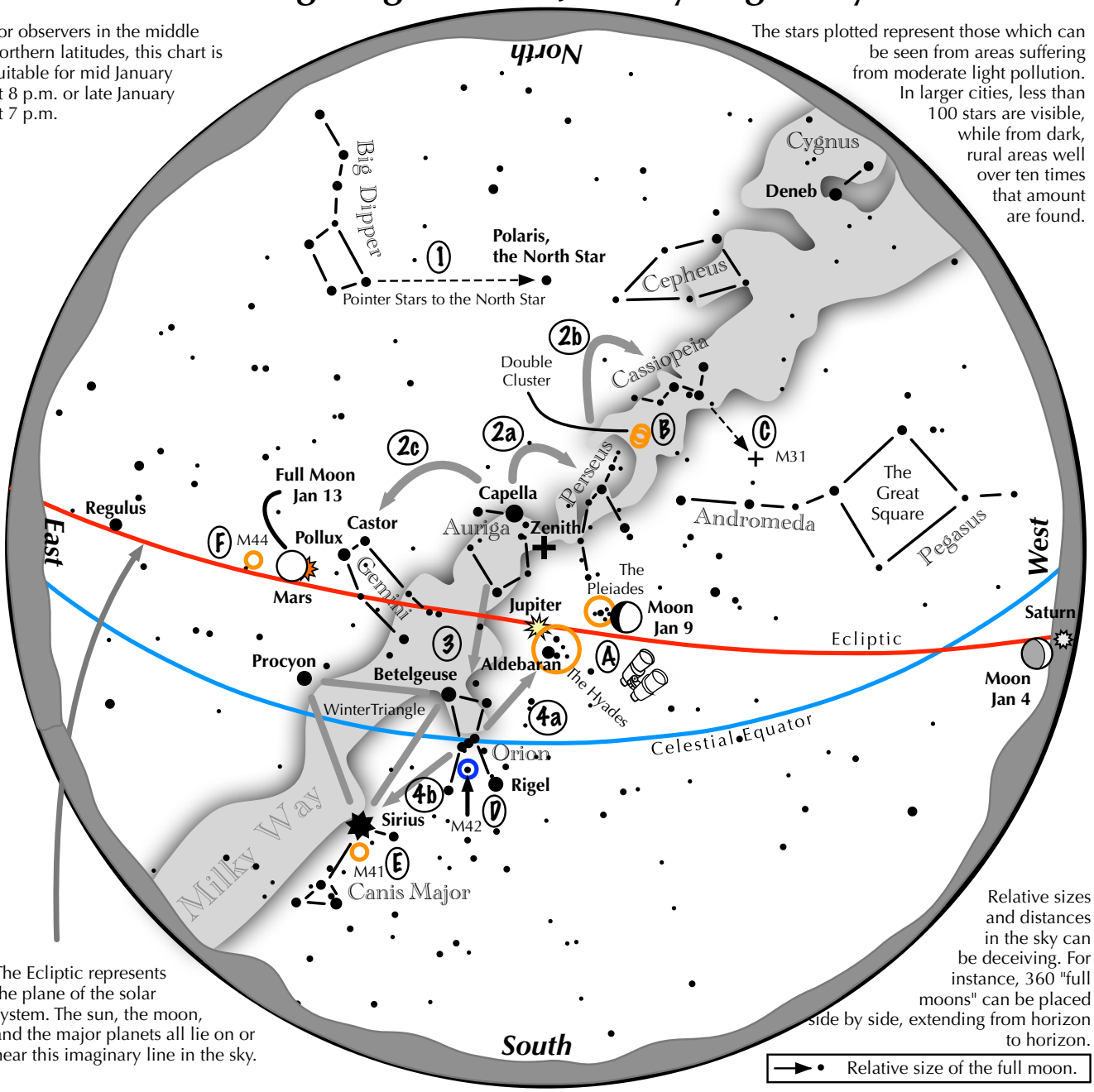
There are many other areas of interest in Orion, too many to list here. Many hours can be spent scanning the constellation with optical aid. Search with diligence, and a good star map, and you should find double and multiple stars and areas of nebulosity to your heart's content.



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.

Astronomy Associates of Lawrence - Annual Dues

Membership includes the AAL monthly club newsletter, membership in the national organization,

the Astronomical League and their quarterly newsletter, the Reflector.
AAL is also affiliated with the Night Sky Network

Name_____

Address_____

City_____State_____Zip_____

Email_____Phone_____

Annual Dues Regular/Family Membership $**12.00** Student Membership $ **6.00**

Checks should be made out to **KUEA**

For more info, check out the club Web site https://astronaal.ku.edu/aboutaal

Please fill out the form above and return it with your dues to:

Astronomy Associates of Lawrence

Rm. 1082, Malott Hall

1251 Wescoe Hall Dr.

Lawrence, Kansas 66045

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.