Volume 50 Number 2 February 2024

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
February 25, 2024, 7:00PM
Baker Wetlands Discovery Center

Public Observing
February 25, 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

After what seems like a month of cloudy, frigid weather since the start of the new year (my apologies-it has been a month!), a bright orb is currently gracing the sky as I write this at the end of January. Hopefully it plans to stay around for a while.

Our first meeting of the new year took place on Sunday, January 28, 2024. AAL Member Jerelyn Ramirez talked to us about her recent trip to observe the October Annular Solar Eclipse. We were able to do some observing after the meeting, as the clear sky reappeared after a long hiatus.

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)". Long-time AAL members will remember visiting Farpoint and I hope to discuss a possible club outing to visit the observatory again at that meeting.

At this point in time, the schedule for the spring Telescope Nights at KU has not been released. As soon as it is available, I will forward to the club membership.

And don't forget that we are only a little more that two months away from the April 8, 2024 Total Solar Eclipse, whose path will travel from western Mexico northeast through 13 US states and eastern Canada. Please let me know if you will be in Lawrence on April 8, so we can begin discussions about a possible local event for the eclipse.

Keep looking up!

NASA Study Finds Life-Sparking Energy Source and Molecule at Enceladus

JPL.NASA, DECEMBER 14, 2023

Water from the subsurface ocean of Saturn's moon Enceladus sprays from huge fissures out into space. NASA's Cassini spacecraft, which captured this image in 2010, sampled icy particles and scientists are continuing to make new discoveries from the data. Credit: NASA/JPL-Caltech/Space Science Institute Full Image Details

A study zooms in on data that NASA's Cassini gathered at Saturn's icy moon and finds evidence of a key ingredient for life and a supercharged source of energy to fuel it.

Scientists have known that the giant plume of ice grains and water vapor spewing from Saturn's moon Enceladus is rich with organic compounds, some of which are important for life as we know it. Now, scientists analyzing data from NASA's Cassini mission are taking the evidence for habitability a step further: They've found strong confirmation of hydrogen cyanide, a molecule that is key to the origin of life.

The researchers also uncovered evidence that the ocean, which is hiding below the moon's icy outer shell and supplies the plume, holds a powerful source of chemical energy. Unidentified until now, the energy source is in the form of several organic compounds, some of which, on Earth, serve as fuel for organisms.

The findings, published Thursday, Dec. 14, in Nature Astronomy, indicate there may be much more chemical energy inside this tiny moon than previously thought. The more energy available, the more likely that life might proliferate and be sustained.

"Our work provides further evidence that Enceladus is host to some of the most important molecules for both creating the building blocks of life and for sustaining that life through metabolic reactions," said lead author Jonah Peter, a doctoral student at Harvard University who performed much of the research while working at NASA's Jet Propulsion Laboratory in Southern California. "Not only does Enceladus seem to meet the basic requirements for habitability, we now have an idea about how complex biomolecules could form there, and what sort of chemical pathways might be involved."

Versatile and Energetic

"The discovery of hydrogen cyanide was particularly exciting, because it's the starting point for most theories on the origin of life," Peter said. Life as we know it requires building blocks, such as amino acids, and hydrogen cyanide is one of the most important and versatile molecules needed to form amino acids. Because its molecules can be stacked together in many different ways, the study authors refer to hydrogen cyanide as the Swiss army knife of amino acid precursors.

"The more we tried to poke holes in our results by testing alternative models," Peter added, "the stronger the evidence became. Eventually, it became clear that there is no way to match the plume composition without including hydrogen cyanide."

In 2017, scientists found evidence at Enceladus of chemistry that could help sustain life, if present, in its ocean. The combination of carbon dioxide, methane, and hydrogen in the plume was suggestive of methanogenesis, a metabolic process that produces methane. Methanogenesis is widespread on Earth, and may have been critical to the origin of life on our planet.

The new work uncovers evidence for additional energy chemical sources far more powerful and diverse than the making of methane: The authors found an array of organic compounds that were oxidized, indicating to scientists that there are many chemical pathways to potentially sustain life in Enceladus' subsurface ocean. That's because oxidation helps drive the release of chemical energy.

"If methanogenesis is like a small watch battery, in terms of energy, then our results suggest the ocean of Enceladus might offer something more akin to a car battery, capable of providing a large amount of energy to any life that might be present," said JPL's Kevin Hand, co-author of the study and principal investigator of the effort that led to the new results.

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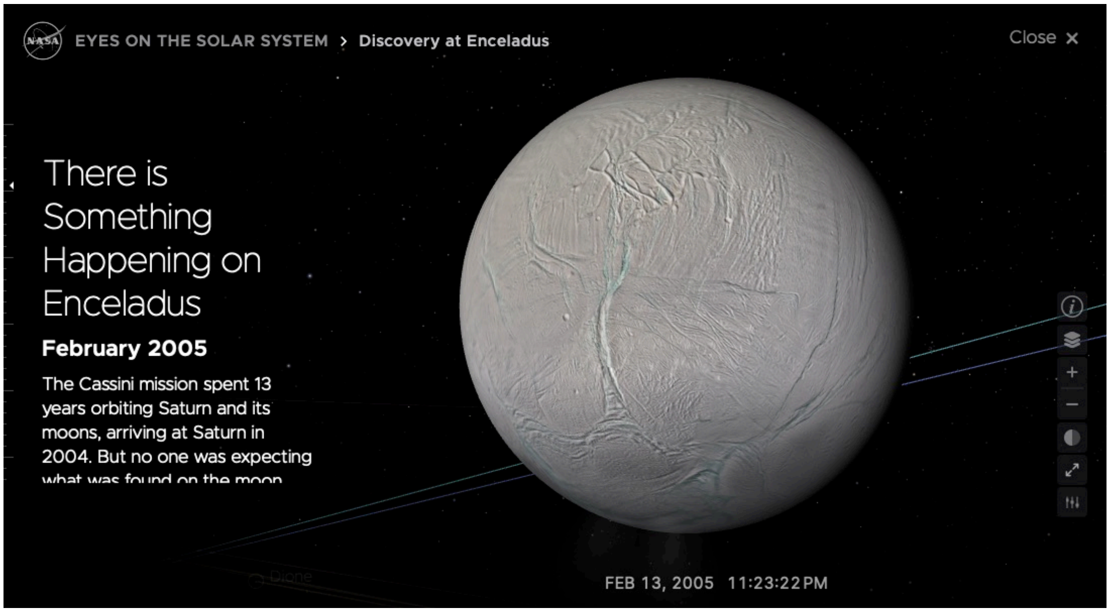
Math Is the Way

Unlike earlier research that used lab experiments and geochemical modeling to replicate the conditions Cassini found at Enceladus, the authors of the new work relied on detailed statistical analyses. They examined data collected by Cassini's ion and neutral mass spectrometer, which studied the gas, ions, and ice grains around Saturn.



NASA's Eyes on the Solar System visualization tool lets you interact with Cassini during some of its key moments flying by Enceladus. Scroll through to explore how the spacecraft discovered the moon's subsurface ocean and its icy plume.

By quantifying the amount of information contained in the data, the authors were able to tease out subtle differences in how well different chemical compounds explain the Cassini signal.

"There are many potential puzzle pieces that can be fit together when trying to match the observed data," Peter said. "We used math and statistical modeling to figure out which combination of puzzle pieces best matches the plume composition and makes the most of the data, without overinterpreting the limited dataset."

Scientists are still a long way from answering whether life could originate on Enceladus. But as Peter noted, the new work lays out chemical pathways for life that could be tested in the lab.

Meanwhile, Cassini is the mission that keeps giving – long after it revealed that Enceladus is an active moon. In 2017, the mission ended by deliberately plunging the spacecraft into Saturn's atmosphere. "Our study demonstrates that while Cassini's mission has ended, its observations continue to provide us with new insights about Saturn and its moons – including the enigmatic Enceladus," said Tom

Nordheim, a JPL planetary scientist who's a co-author of the study and was a member of the Cassini team.

More About the Mission

The Cassini-Huygens mission was a cooperative project of NASA, ESA (European Space Agency), and the Italian Space Agency. JPL, a division of Caltech in Pasadena, California, managed the mission for NASA's Space Mission Directorate in Washington. JPL designed, developed, and assembled the Cassini orbiter.

For more information about Cassini, visit: http://nasa.gov/cassini ☀

Oversized Ancient Galaxy Isn't What Astronomers First Thought

By Michelle Starr

SCIENCEALERT, DECEMBER 30, 2023

The early Universe was a wild time. In the first 2 billion years following the Big Bang 13.8 billion years ago, star formation positively roiled, and galaxies flared to life in the darkness, collided, and grew.

Interpreting the light that has traveled so far across space and time can be difficult, and we don't always get it right. In fact, the most powerful space telescope in operation has just revealed what might be a fascinating case of mistaken identity.

Discovered in 2013 as the source of rampant star formation just 880 million years after the Big Bang, a 'galaxy' named HFLS3 is not a galaxy at all. According to an analysis of data from the James Webb Space Telescope, HFLS3 is actually six galaxies undergoing an epic, giant collision at the dawn of time.

The study, led by astrophysicist Gareth Jones of the University of Oxford, has been accepted for publication in Astronomy & Astrophysics, and is available on preprint server arXiv.

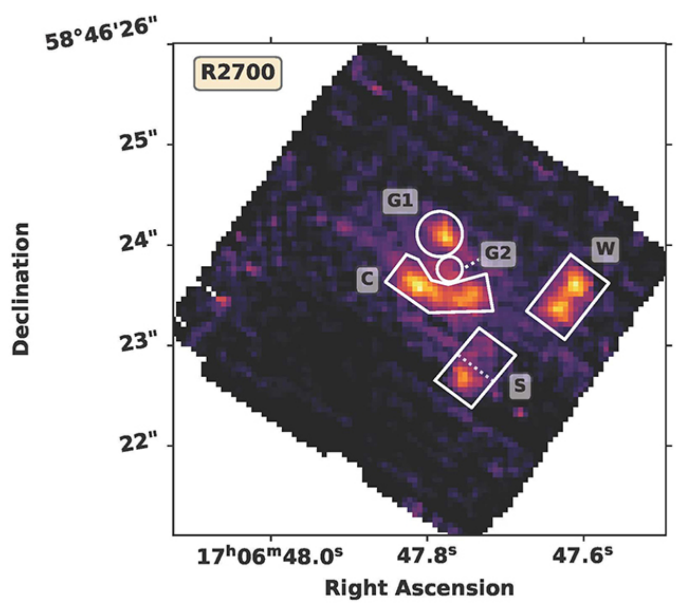
HFLS3 boggled scientists when they found it in data from the Herschel space telescope. There it was, sitting at the very beginning of the Universe during the Epoch of Reionization, pumping out stars at an astounding rate of some 3,000 solar masses per year. The Milky Way, by comparison, produces up to around 8 solar masses of stars per year, even though the two objects were thought to have around the same mass.

This was challenging to explain, because galaxies weren't thought to be able to grow so big so early in the Universe, or have such a high rate of star formation.

But the Herschel observations, and subsequent Hubble observations, suggested that there was more going on, with hints that maybe there was more than one galaxy inside that distant glow.

Optimized for peering into the deepest reaches of space-time with the highest resolution yet, JWST allowed astronomers to take a more detailed look at HFLS3 than we had been able to obtain previously.

In September 2022, JWST's near-infrared NIRSpec instrument took observations of the swatch of sky in which HFLS3 can be found, and Jones and his team fell on the data with gusto. And, once they processed the data and teased apart the way the light had warped as it traveled across the Universe, they realized there were signs of six distinct galaxies within.



In a volume of space just 36,000 light-years in diameter, they found, HFLS3 consists of three pairs of small galaxies locked in a dance bringing them towards an inevitable collision. That collision would have taken place within a billion years of the observation; that's a pretty short space of time for something as epic as a galactic collision.

They're so close to each other that their gravitational interactions are churning up their star-forming material, causing it to ignite with star formation, thus also explaining the extremely high rate at which new stars are being born. And the discovery offers a fascinating snapshot into the way galaxies interacted and grew during the period known as the Cosmic Dawn.

It warrants, the researchers say, further and closer investigation, both of this and other sources.

"Taken together, our results require a drastic reinterpretation of the HFLS3 field," they write in their paper.

"HFLS3 is likely not an extreme starburst, but instead represents one of the densest groups of interacting star-forming galaxies within the first billion years of the Universe. Recent and ongoing high-resolution observations … will help to further characterize this unique field."

The research has been accepted into Astronomy & Astrophysics, and is available on arXiv. ☀

Connecting the 'Dots' with Asterisms

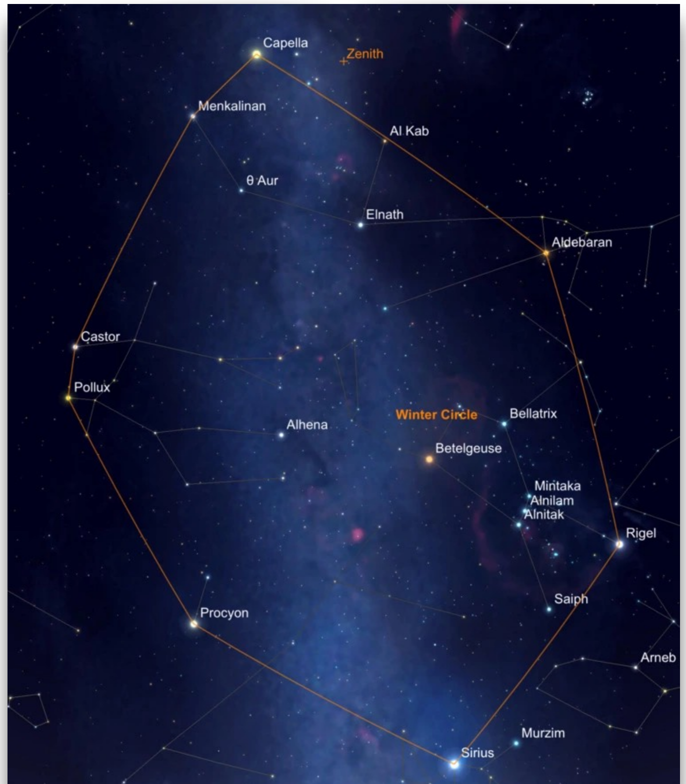
By Kat Troche

NIGHTSKYNETWORK, JANUARY 2024

In our December Night Sky Notes, we mentioned that the Orion constellation has a distinct hourglass shape that makes it easy to spot in the night sky. But what if we told you that this is not the complete constellation, but rather, an asterism?

An asterism is a pattern of stars in the night sky, forming shapes that make picking out constellations easy. Cultures throughout history have created these patterns as part of storytelling, honoring ancestors, and timekeeping. Orion's hourglass is just one of many examples of this, but did you know Orion's brightest knee is part of another asterism that spans six constellations, weaving together the Winter night sky? Many asterisms feature bright stars that are easily visible to the naked eye. Identify these key stars, and then connect the dots to reveal the shape.

Asterisms Through the Seasons



Try looking for these asterisms this season and beyond:

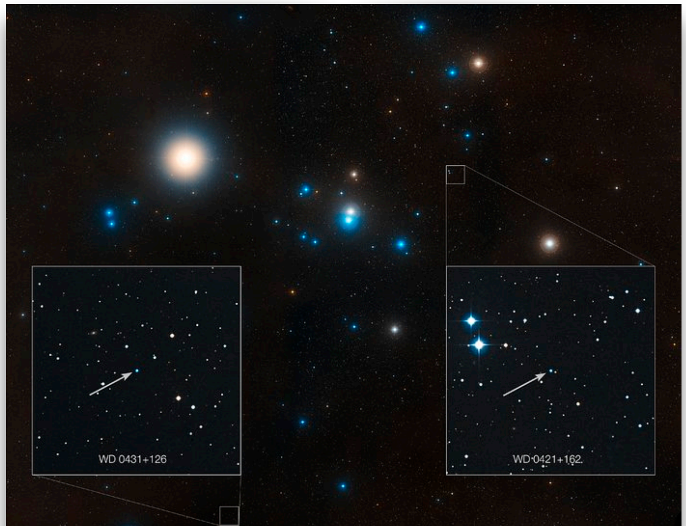
• **Winter Circle** – this asterism, also known as the Winter Hexagon, makes up a large portion of the Winter sky using stars Rigel, Aldebaran, Capella, Pollux, Procyon, and Sirius as its points. Similarly, the **Winter Triangle** can be found using Procyon, Sirius, and Betelgeuse as points. **Orion's Belt** is also considered an asterism.

• **Diamond of Virgo** – this springtime asterism consists of the following stars: Arcturus, in the constellation Boötes; Cor Caroli, in Canes Venatici; Denebola in Leo, and Spica in Virgo. Sparkling at the center of this diamond is the bright cluster **Coma Berenices**, or Bernice's Hair – an ancient asterism turned constellation!

• **Summer Triangle** – as the nights warm up, the Summer Triangle dominates the heavens. Comprising the bright stars Vega in Lyra, Deneb in Cygnus, and

Altair in Aquila, this prominent asterism is the inspiration behind the cultural festival Tanabata. Also found is Cygnus the Swan, which makes up the **Northern Cross** asterism.

• **Great Square of Pegasus –** by Autumn, the Great Square of Pegasus can be seen. This square- shaped asterism takes up a large portion of the sky, and consists of the stars: Scheat, Alpheratz, Markab and Algenib.



This image shows the region around the Hyades star cluster, the nearest open cluster to us. The Hyades cluster is very well-studied due to its location, but previous searches for planets have produced only one. A new study led by Jay Farihi of the University of Cambridge, UK, has now found the atmospheres of two burnt-out stars in this cluster — known as white dwarfs — to be "polluted" by rocky debris circling the star. Inset, the locations of these white dwarf stars are indicated

Tracing these outlines can guide you to objects like galaxies and star clusters. The Hyades, for example, is an open star cluster in the Taurus constellation with evidence of rocky planetary debris. In 2013, Hubble Space Telescope's Cosmic Origins Spectrograph was responsible for breaking down light into individual components. This observation detected low levels of carbon and silicon – a major chemical for planetary bodies. The Hyades can be found just outside the Winter Circle and is a favorite of both amateur and professional astronomers alike.

How to Spot Asterisms

• **Use Star Maps and Star Apps –** Using star maps or stargazing apps can help familiarize yourself with the constellations and asterisms of the night sky.

• **Get Familiar with Constellations –** Learning the major constellations and their broader shapes visible each season will make spotting asterisms easier.

• **Use Celestial Landmarks –** Orient yourself by using bright stars, or recognizable constellations. This will help you navigate the night sky and pinpoint specific asterisms. Vega in the Lyra constellation is a great example of this.

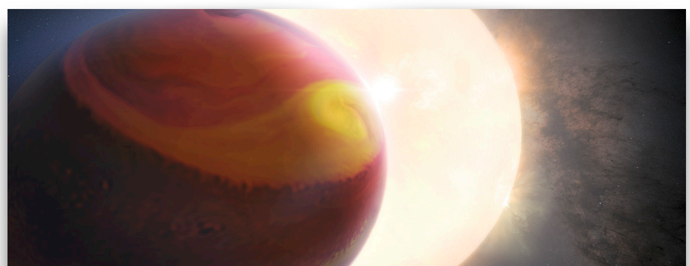
Learn more about how to stay warm while observing this Winter with our upcoming mid-month article on the Night Sky Network page through NASA's website!

NASA's Hubble Observes Exoplanet Atmosphere Changing Over 3 Years

HUBBLESITE, JANUARY 04, 2024

Summary

Stormy weather on display on a "hot Jupiter"



The Jupiter-sized planet WASP-121 b is no place to call home. For starters, it orbits very close to a star that is brighter and hotter than the Sun. The planet is so dangerously close to its star that its upper atmosphere reaches a blazing 3,400 degrees Fahrenheit – hotter than a steel blast furnace.

A torrent of ultraviolet light from the host star is heating the planet's upper atmosphere, which is causing the magnesium and iron gas to escape into space. Powerful gravitational tidal forces from the star have altered the planet's shape so that it appears more football shaped. By combining several years of Hubble Space Telescope observations with computer modelling, astronomers have found evidence for massive cyclones swirling on the hellish planet. The cyclones are repeatedly created and destroyed due to the large temperature difference between the star-facing side and dark night-time side of the exoplanet.

By combining several years of observations from NASA's Hubble Space Telescope along with conducting computer modelling, astronomers have found evidence for massive cyclones and other dynamic weather activity swirling on a hot, Jupiter-sized planet 880 light-years away.

The planet, called WASP-121 b, is not habitable. But this result is an important early step in studying weather patterns on distant worlds, and perhaps eventually finding potentially habitable exoplanets with stable, long-term climates.

For the past few decades, detailed telescopic and spacecraft observations of neighboring planets in our solar system show that their turbulent atmospheres are not static but constantly changing, just like weather on Earth. This variability should also apply to planets around other stars, too. But it takes lots of detailed observing and computational modelling to actually measure such changes.

To make the discovery, an international team of astronomers assembled and reprocessed Hubble observations of WASP-121 b taken in 2016, 2018 and 2019.

They found that the planet has a dynamic atmosphere, changing over time. The team used sophisticated modelling techniques to demonstrate that these dramatic temporal variations could be explained by weather patterns in the exoplanet's atmosphere.

The team found that WASP-121 b's atmosphere shows notable differences between observations. Most dramatically, there could be massive weather fronts, storms, and massive cyclones that are repeatedly created and destroyed due to the large temperature difference between the star-facing side and dark side of the exoplanet. They also detected an apparent offset between the exoplanet's hottest region and the point on the planet closest to the star, as well as variability in the chemical composition of the exoplanet's atmosphere (as measured via spectroscopy).

The team reached these conclusions by using computational models to help explain observed changes in the exoplanet's atmosphere. "The remarkable details of our exoplanet atmosphere simulations allows us to accurately model the weather on ultra-hot planets like WASP-121 b," explained Jack Skinner, a postdoctoral fellow at the California Institute of Technology in Pasadena, California, and co-leader of this study. "Here we make a significant step forward by combining observational constraints with atmosphere simulations to understand the time-varying weather on these planets."

"This is a hugely exciting result as we move forward for observing weather patterns on exoplanets," said one of the principal investigators of the team, Quentin Changeat, a European Space Agency Research Fellow at the Space Telescope Science Institute in Baltimore, Maryland. "Studying exoplanets' weather is vital to understanding the complexity of exoplanet atmospheres on other worlds, especially in the search for exoplanets with habitable conditions."

WASP-121 b is so close to its parent star that the orbital period is only 1.27 days. This close proximity means that the planet is tidally locked so that the same hemisphere always faces the star, in the same way that our Moon always has the same side pointed at Earth. Daytime temperatures approach 3,450 degrees Fahrenheit (2,150 degrees Kelvin) on the star-facing side of the planet.

The team used four sets of Hubble archival observations of WASP-121 b. The complete data-set included observations of WASP-121 b transiting in front of its star (taken in June 2016); WASP-121 b passing behind its star, also known as a secondary eclipse (taken in November 2016); and the brightness of WASP-121 b as a function of its phase angle to the star (the varying amount of light received at Earth from an exoplanet as it orbits its parent star, similar to our Moon's phase-cycle). These data were taken in March 2018 and February 2019, respectively.

"The assembled data-set represents a significant amount of observing time for a single planet and is currently the only consistent set of such repeated observations," said Changeat. The information that we extracted from those observations was used to infer the chemistry, temperature, and clouds of the atmosphere of WASP-121 b at different times. This provided us with an exquisite picture of the planet changing over time." ☀

A century ago, Alexander Friedmann envisioned the universe's expansion

By Tom Siegfried

SCIENCENEWS, MAY 20, 2022

For millennia, the universe did a pretty good job of keeping its secrets from science.

Ancient Greeks thought the universe was a sphere of fixed stars surrounding smaller spheres carrying planets around the central Earth. Even Copernicus, who in the 16th century correctly replaced the Earth with the sun, viewed the universe as a single solar system encased by the star-studded outer sphere.

But in the centuries that followed, the universe revealed some of its vastness. It contained countless stars agglomerated in huge clusters, now called galaxies.

Then, at the end of the 1920s, the cosmos disclosed its most closely held secret of all: It was getting bigger. Rather than static and stable, an everlasting and ever-the-same entity encompassing all of reality, the universe continually expanded. Observations of distant galaxies showed them flying apart from each other, suggesting the current cosmos to be just the adult phase of a universe born long ago in the burst of a tiny blotch of energy.

It was a surprise that shook science at its foundations, undercutting philosophical preconceptions about existence and launching a new era in cosmology, the study of the universe. But even more surprising, in retrospect, is that such a deep secret had already been suspected by a mathematician whose specialty was predicting the weather.

A century ago this month (May 1922), Russian mathematician-meteorologist Alexander Friedmann composed a paper, based on Einstein's general theory of relativity, that outlined multiple possible histories of the universe. One such possibility described cosmic expansion, starting from a singular point. In essence, even without considering any astronomical evidence, Friedmann had anticipated the modern Big Bang theory of the birth and evolution of the universe.

"The new vision of the universe opened by Friedmann," writes Russian physicist Vladimir Soloviev in a recent paper, "has become a foundation of modern cosmology."

Friedmann was not well known at the time. He had graduated in 1910 from St. Petersburg University in Russia, having studied math along with some physics. In graduate school he investigated the use of math in meteorology and atmospheric dynamics. He applied that expertise in aiding the Russian air force during World War I, using math to predict the optimum release point for dropping bombs on enemy targets.

After the war, Friedmann learned of Einstein's general theory of relativity, which describes gravity as a manifestation of the geometry of space (or more accurately, spacetime). In Einstein's theory, mass distorts spacetime, producing spacetime "curvature," which makes masses appear to attract each other.

Friedmann was especially intrigued by Einstein's 1917 paper (and a similar paper by Willem de Sitter) applying general relativity to the universe as a whole. Einstein found that his original equations allowed the universe to grow or shrink. But he considered that unthinkable, so he added a term representing a repulsive force that (he thought) would keep the size of the cosmos constant. Einstein concluded that space had a positive spatial curvature (like the surface of a ball), implying a "closed," or finite universe.

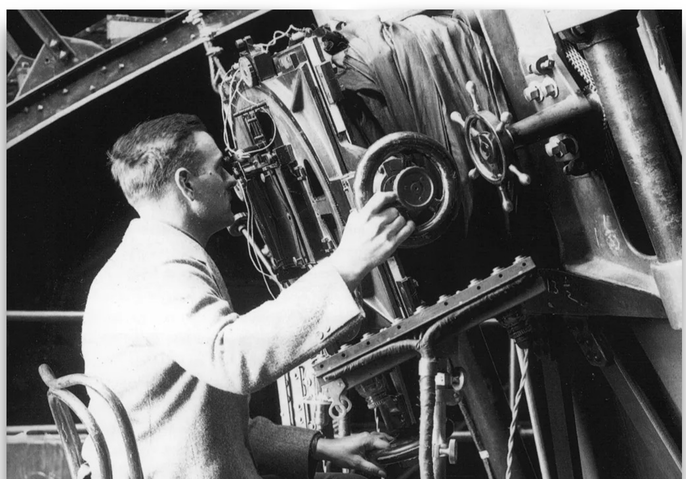
Friedmann accepted the new term, called the cosmological constant, but pointed out that for various values of that constant, along with other assumptions, the universe might exhibit very different behaviors. Einstein's static universe was a special case; the universe might also expand forever, or expand for a while, then contract to a point and then begin expanding again.

Friedmann's paper describing dynamic universes, titled "On the Curvature of Space," was accepted for publication in the prestigious *Zeitschrift für Physik* on June 29, 1922.

Einstein objected. He wrote a note to the journal contending that Friedmann had committed a mathematical error. But the error was Einstein's. He later acknowledged that Friedmann's math was correct, while still denying that it had any physical validity.

Friedmann insisted otherwise.

He was not just a pure mathematician, oblivious to the physical meanings of his symbols on paper. His in-depth appreciation of the relationship between equations and the atmosphere persuaded him that the math meant something physical. He even wrote a book (*The World as Space and Time*) delving deeply into the connection between the math of spatial geometry and the motion of physical bodies. Physical bodies "interpret" the "geometrical world," he declared, enabling scientists to test which of the various possible geometrical worlds humans actually inhabit. Because of the physics-math connection, he



In 1929, Edwin Hubble (shown) reported that distant galaxies appear to be flying away from us faster than nearby galaxies, key evidence that the universe is expanding.

averred, "it becomes possible to determine the geometry of the geometrical world through experimental studies of the physical world."

So when Friedmann derived solutions to Einstein's equations, he translated them into the possible physical meanings for the universe. Depending on various factors, the universe could be expanding from a point, or from a finite but smaller initial state, for instance. In one case he envisioned, the universe began to expand at a decelerating rate, but then reached an inflection point, whereupon it began expanding at a faster and faster rate. At the end of the 20th century, astronomers measuring the brightness of distant supernovas concluded that the universe had taken just such a course, a shock almost as surprising as the expansion of the universe itself. But Friedmann's math had already forecast such a possibility.

Friedmann emphasized that astronomical knowledge in his day was insufficient to reveal which of the possible mathematical histories the universe has chosen. Now scientists have much more data, and have narrowed the possibilities in a way that confirms the prescience of Friedmann's math.

Friedmann did not live to see the triumphs of his insights, though, or even the early evidence that the universe really does expand. He died in 1925 from typhoid fever, at the age of 37. But he died knowing that he had deciphered a secret about the universe deeper than any suspected by any scientist before him. As his wife remembered, he liked to quote a passage from Dante: "The waters I am entering, no one yet has crossed." ☀

The Backyard Observer, February 2024

By Rick Heschmeyer

AURIGA

High in the evening sky this month hovers an easily recognizable stellar pentagon of bright stars known as Auriga, the Charioteer. Strangely, the Charioteer is depicted with a goat on its shoulder with the goat's kids under its arm. The story of this unusual arrangement is unfortunately lost to antiquity. Best known for its open star clusters, Auriga is also home to several interesting stars.

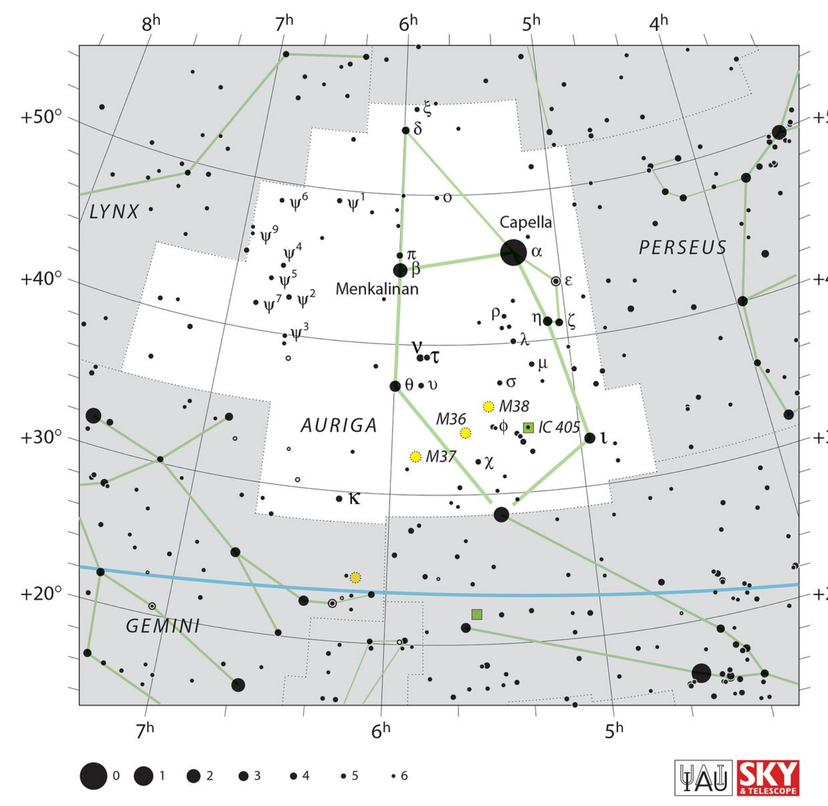
Alpha Aurigae, more commonly known as Capella, is the sixth brightest star in the northern night sky. Interestingly, Capella lies closer to the pole star, Polaris, than any other first magnitude star. This bright yellow star, because of its proximity to Polaris, is circumpolar, meaning it is visible from our vantage point on Earth year-round. Capella is nicknamed "The Goat Star" as it represents the goal on the charioteer's shoulder in renderings of the constellation. Her three kids, Epsilon, Zeta, and Eta Aurigae, two of which are bizarre variable stars, are immediately beneath her.

Gamma Aurigae (Beta Tauri), also known as El Nath, is a star shared by two constellations; Auriga and Taurus. When the German astronomer Johan Bayer started the system of designating the brightest stars in each constellation using Greek letters in 1604, he solved the problem of which constellation El Nath belonged to by giving it a designation in both constellations. Thus, El Nath has been known by either/both names, although according to the "official" constellation boundaries adopted by the International Astronomical Union in 1930, Gamma Aurigae is preferred.

Epsilon Aurigae is an interesting eclipsing variable star. Normally a third-magnitude star, something very strange happens once every 27 years, when the star dims by a full magnitude, for almost two YEARS! The system is thought to be comprised of an F-supergiant star, officially named Almaaz (the traditional name for the system), and a companion which is thought to be a huge dark disk orbiting an unknown object.

Messier 36 is the first of three bright open clusters in the constellation, catalogued by the French comet hunter Charles Messier. The cluster contains about 60 stars and is visible with most optical aid. Observers with telescopes should look for the double star Struve 737 near the center of the cluster. This is the sparsest Messier cluster in Auriga.

Messier 37 is usually touted as the premier open cluster in Auriga. It is rich, containing over 150 stars. In binoculars and small telescopes (60mm and smaller) its stars cannot be resolved and the cluster appears nebulous. But as the aperture of the instrument increases so does the number of stars visible. This is one of the finest open clusters in the night sky for owners of small to medium aperture telescopes.



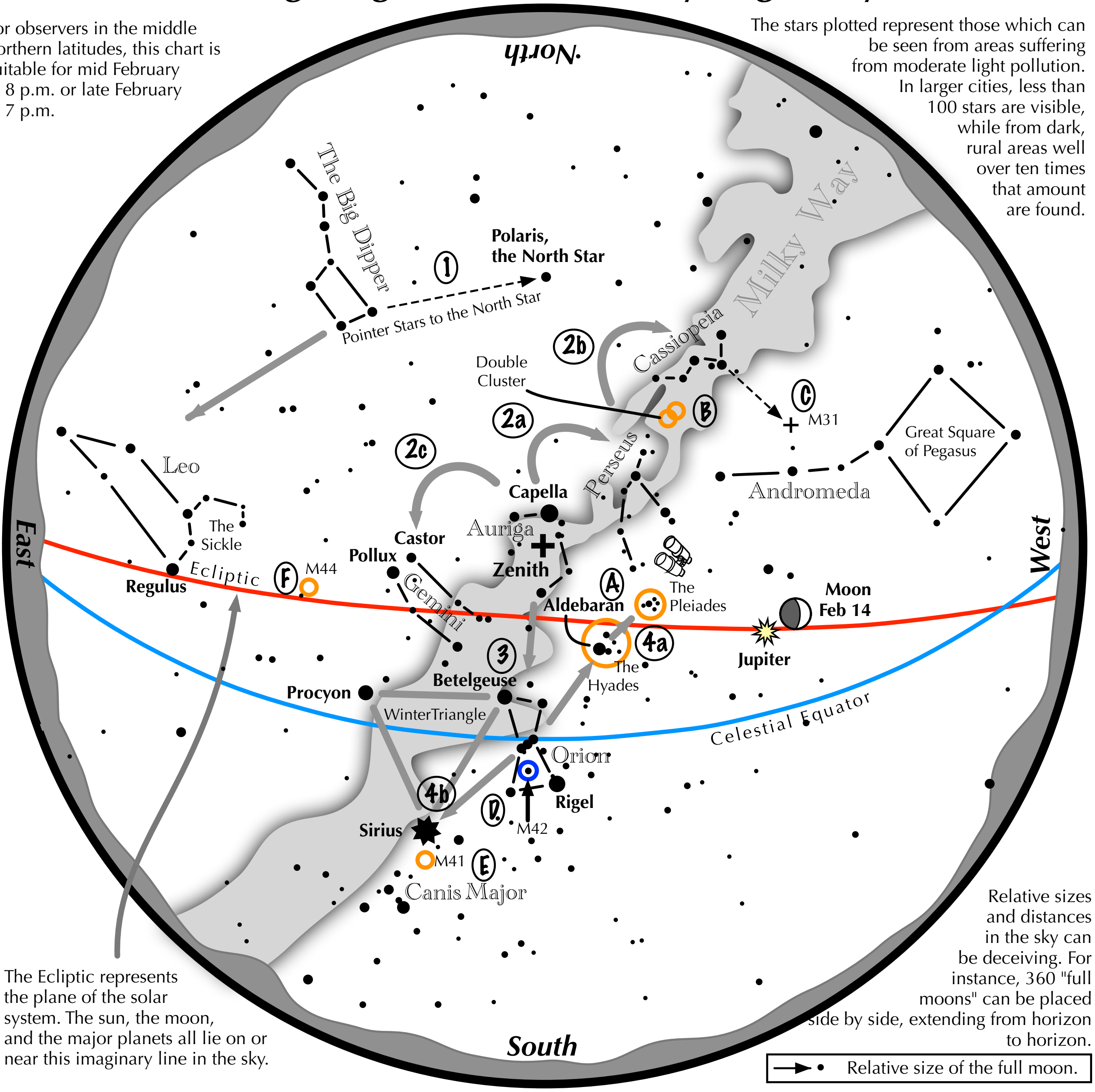
Messier 38 is the last of the triumvirate of open clusters catalogued by Messier in the constellation. The cluster is visible with any optical aid, although a telescope of three-inch aperture or larger is needed to resolve individual stars. With a population of over 100 stars, Messier 38 also exhibits multiple bright stars arranged in pairs. Many observers have described Messier 38's unusual shape as resembling an upside-down Greek letter pi.

Since Auriga lies in the winter Milky Way, the constellation gives binocular users the chance to scan the rich star fields within the constellation. When scanning this way, the three Messier clusters stand out as islands of condensed richness. Enjoy!

Navigating the mid February Night Sky

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

Navigating the February 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 of Castor and Pollux in 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.

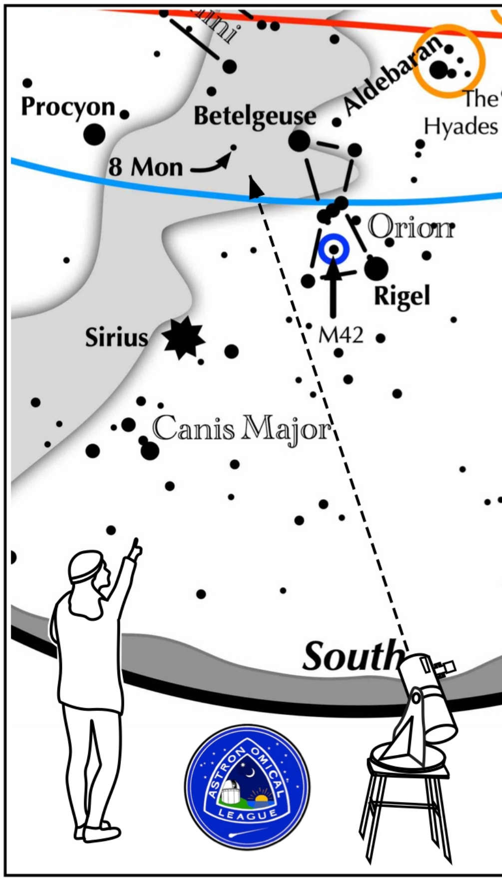
4 Use Orion's three Belt stars to point northwest to the red star Aldebaran and the Hyades star cluster, then to the Pleiades star cluster. Travel southeast from the Belt stars to the brightest star in the night sky, Sirius, a member of the Winter Triangle.

Binocular Highlights

A: Examine the stars of two naked eye star clusters, the Pleiades and the Hyades.
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 southeast of Pollux.

Astronomical League *www.astroleague.org/outreach; duplication is allowed and encouraged for all free distribution.*

ASTRONOMICAL LEAGUE Double Star Activity



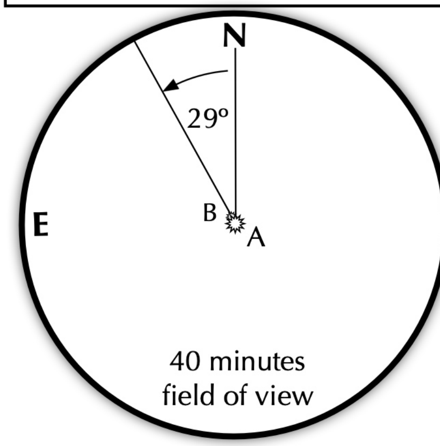
Other Suns: Epsilon (8) Monocerotis

How to find Epsilon Monocerotis on a February evening

Face south. Look for the Winter Triangle stars of Betelgeuse and Procyon. Epsilon Monocerotis is about 1/3 between Betelgeuse and Procyon. It is a 4.3 magnitude star so dark skies are needed to spot it.

Suggested magnification: >20x
Suggested aperture: >3 inches

Epsilon (8) Mon
A-B separation: 12 sec
A magnitude: 4.4
B magnitude: 6.6
Position Angle: 29°
Colors:
white
lilac



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.