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The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
December 8, 2024, 7:00PM
Baker Wetlands Discovery Center

Public Observing
December 8, 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
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Inside This Issue

Report From the Officers

By Rick Heschmeyer

Fall is here and what a month October was for stargazers. In addition to the Full Hunter's Supermoon on the 17th, the Aurora Borealis was visible on October 10th as far south as Texas! Many club members were able to see and photograph the northern lights. And if that wasn't enough, a new comet graced our night sky in October. Comet C2023 A3 (Tsuchinshan-ATLAS) was visible in the morning sky prior to its perihelion on September 27, and then again around the time of its closest approach to Earth on October 12th. C2023 A3 is the brightest comet to appear in 27 years, since Comet Hale-Bopp, reaching a magnitude of -4.8 on October 9! As of this writing the comet has faded below naked-eye visibility but is still visible with binoculars or a telescope. If you haven't yet seen it, try and get out to grab a look now. It is receding from Earth and getting dimmer each night.

For our October meeting, KU's Alex Polanski, the Percival Lowell Postdoctoral Fellow at Lowell Observatory, discussed his project to catalog and digitize KU's collection of historic glass photographic plates. What a great way to preserve a part of the rich history of the astronomy program at K.U., a history dating back to the 1870's.

Our next Club Meeting will take place on Sunday, December 8th, the day after Jupiter's 2024 opposition. The meeting will start at 7:00 PM and will be followed by public observing (weather permitting). Hope to see you there!

The Telescope Nights at KU program is up and running, this time with both telescope observing outside Slawson Hall and Planetarium shows inside Slawson Hall. Note the location change to Slawson from Malott for the observing. Telescope Observing starts at 7:30pm and the planetarium shows will take place at 7:30 pm and 8:00 pm. The dates for the remaining fall nights are Thursday November 7th and Thursday December 5th. Rain or shine, the planetarium shows will still run!

Clear Skies!

NASA's Hubble Finds that a Black Hole Beam Promotes Stellar Eruptions

HUBBLESITE, SEPTEMBER 26, 2024

Summary

Nova Explosions in Double Star Systems Doubled Near Black Hole Jet

The supermassive black hole in the core of the giant elliptical galaxy M87 shoots out a blazing bright jet of plasma racing across space at nearly the speed of light. It makes the "Death Star" beam in the Star Wars trilogy look like a wimpy candle flame lighter.

Hubble astronomers have found that it seems to be dangerous just getting near to the energetic plasma jet. Stars seem to explode more frequently in the vicinity of the jet's 3,000-light-year long trajectory. The stars, called novae, erupt in double-star systems where an aging, swelled-up, normal star spills hydrogen onto a burned-out white dwarf companion star. As the hydrogen accumulates on the surface of the dwarf, it reaches a tipping point where it explodes like a hydrogen bomb. Novae frequently pop off throughout the giant galaxy of 1 trillion stars, but those near the jet seem to explode more frequently.

Astronomers guessed that something about the jet is either enhancing the fueling process and rate of explosions, or birthing new nova binaries in its vicinity. But once astronomers "crunched the numbers," both hypotheses failed. So it remains anybody's guess why black hole jets enhance the rate of nova eruptions.

In a surprise finding, astronomers using NASA's Hubble Space Telescope have discovered that the blowtorch-like jet from a supermassive black hole at the core of a huge galaxy seems to cause stars to erupt along its trajectory. The stars, called novae, are not caught inside the jet, but apparently in a dangerous neighborhood nearby.

The finding is confounding researchers searching for an explanation. "We don't know what's going on, but it's just a very exciting finding," said Alec Lessing of Stanford University, lead author of the paper published in . "This means there's something missing from our understanding of how black hole jets interact with their surroundings."

A nova erupts in a double-star system where an aging, swelled-up, normal star spills hydrogen onto a burned-out white dwarf companion star. When the dwarf has tanked up a mile-deep surface layer of hydrogen that layer explodes like a giant nuclear bomb. The white dwarf isn't destroyed by the nova eruption, which ejects its surface layer and then goes back to siphoning fuel from its companion, and the nova-outburst cycle starts over again.

Hubble found twice as many novae going off near the jet as elsewhere in the giant galaxy during the surveyed time period. The jet is launched by a 6.5-billion-solar-mass central black hole surrounded by a disk of swirling matter. The black hole, engorged with infalling matter, launches a 3,000-light-year-long jet of plasma blazing through space at nearly the speed of light. Anything caught in the energetic beam would be sizzled. But being near its blistering outflow is apparently also risky, according to the new Hubble findings.The finding of twice as many novae near the jet implies that there are twice as many nova-forming double-star systems near the jet or that these systems erupt twice as often as similar systems elsewhere in the galaxy.

"There's something that the jet is doing to the star systems that wander into the surrounding neighborhood. Maybe the jet somehow snowplows hydrogen fuel onto the white dwarfs, causing them to erupt more frequently," said Lessing. "But it's not clear that it's a physical pushing. It could be the effect of the pressure of the light emanating from the jet. When you deliver hydrogen faster, you get eruptions faster. Something might be doubling the mass transfer rate onto the white dwarfs near the jet." Another idea the researchers considered is that the jet is heating the dwarf's companion star, causing it to overflow further and dump more hydrogen onto the dwarf. However, the researchers calculated that this heating is not nearly large enough to have this effect.

"We're not the first people who've said that it looks like there's more activity going on around the M87 jet," said co-investigator Michael Shara of the American Museum of Natural History in New York City. "But Hubble has shown this enhanced activity with far more examples and statistical significance than we ever had before."

Shortly after Hubble's launch in 1990, astronomers used its first-generation Faint Object Camera (FOC) to peer into the center of M87 where the monster black hole lurks. They noted that unusual things were happening around the black hole. Almost every time Hubble looked, astronomers saw bluish "transient events" that could be evidence for novae popping off like camera flashes from nearby paparazzi. But the FOC's view was so narrow that Hubble astronomers couldn't look away from the jet to compare with the near-jet region. For over two decades, the results remained mysteriously tantalizing.

Compelling evidence for the jet's influence on the stars of the host galaxy was collected over a nine-month interval of Hubble observing with newer, wider-view cameras to count the erupting novae. This was a challenge for the telescope's observing schedule because it required revisiting M87 precisely every five days for another snapshot. Adding up all of the M87 images led to the deepest images of M87 that have ever been taken.

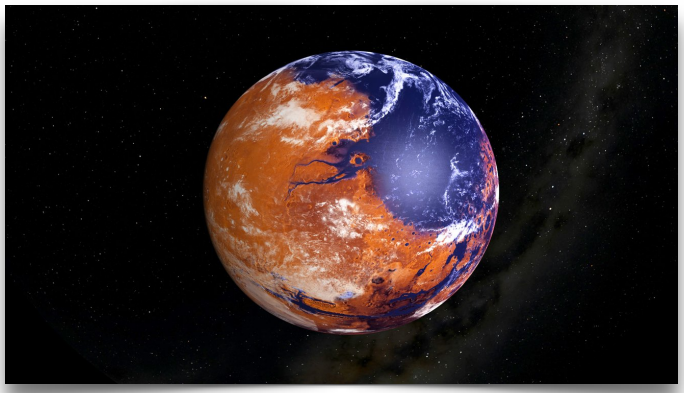
Hubble found 94 novae in the one-third of M87 that its camera can encompass. "The jet was not the only thing that we were looking at — we were looking at the entire inner galaxy. Once you plotted all known novae on top of M87 you didn't need statistics to convince yourself that there is an excess of novae along the jet. This is not rocket science. We made the discovery simply by looking at the images. And while we were really surprised, our statistical analyses of the data confirmed what we clearly saw," said Shara.

This accomplishment is entirely due to Hubble's unique capabilities. Ground-based telescope images do not have the clarity to see novae deep inside M87. They cannot resolve stars or stellar eruptions close to the galaxy's core because the black hole's surroundings are far too bright. Only Hubble can detect novae against the bright M87 background.

Novae are remarkably common in the universe. One nova erupts somewhere in M87 every day. But since there are at least 100 billion galaxies throughout the visible universe, around 1 million novae erupt every second somewhere out there. ☀

NASA: New Insights Into How Mars Became Uninhabitable

JPL, October 7, 2024



Mars today bear signs of once having had abundant water, with features resembling valleys and deltas, and minerals that only form in the presence of liquid water. This artist's concept shows how the Red Planet could have appeared billions of years ago.

Measurements from the agency's Curiosity rover are providing clues as to how the Red Planet's ancient climate transformed.

NASA's Curiosity rover, currently exploring Gale Crater on Mars, is providing new details about how the ancient Martian climate went from potentially suitable for life — with evidence for widespread liquid water on the surface — to a surface that is inhospitable to terrestrial life as we know it.

Although the surface of Mars is frigid and hostile to life today, NASA's robotic explorers at Mars are searching for clues as to whether it could have supported life in the distant past. Researchers used instruments on board Curiosity to measure the isotopic composition of carbon-rich minerals (carbonates) found in Gale Crater and discovered new insights into how the Red Planet's ancient climate transformed.

"The isotope values of these carbonates point toward extreme amounts of evaporation, suggesting that these carbonates likely formed in a climate that could only support transient liquid water," said David Burtt of NASA's Goddard Space Flight Center in Greenbelt, Maryland, and lead author of a paper describing this research published Oct. 7 in the Proceedings of the National Academy of Sciences. "Our samples are not consistent with an ancient environment with life (biosphere) on the surface of Mars, although this does not rule out the possibility of an underground biosphere or a surface biosphere that began and ended before these carbonates formed."

Isotopes are versions of an element with different masses. As water evaporates, light versions of carbon and oxygen were more likely to escape into the atmosphere, while the heavy versions were left behind more often, accumulating into higher abundances and, in this case, eventually being incorporated into the carbonate rocks. Scientists are interested in carbonates because of their proven ability to act as climate records. These minerals can retain signatures of the environments in which they formed, including the temperature and acidity of the water, and the composition of the water and the atmosphere.

The paper proposes two formation mechanisms for carbonates found at Gale. In the first scenario, carbonates are formed through a series of wet-dry cycles within Gale Crater. In the second, carbonates are formed in very salty water under cold, ice-forming (cryogenic) conditions in Gale Crater.

"These formation mechanisms represent two different climate regimes that may present different habitability scenarios," said Jennifer Stern of NASA Goddard, a co-author of the paper. "Wet-dry cycling would indicate alternation between more habitable and less habitable environments, while cryogenic temperatures in the mid-latitudes of Mars would indicate a less habitable environment where most water is locked up in ice and not available for chemistry or biology, and what is there is extremely salty and unpleasant for life."

These climate scenarios for ancient Mars have been proposed before, based on the presence of certain minerals, global-scale modeling, and the identification of rock formations. This result is the first to add isotopic evidence from rock samples in support of the scenarios.

The heavy isotope values in the Martian carbonates are significantly higher than what's seen on Earth for carbonate minerals and are the heaviest carbon and oxygen isotope values recorded for any Mars materials. In fact, according to the team, both the wet-dry and the cold-salty climates are required to form carbonates that are so enriched in heavy carbon and oxygen.

"The fact that these carbon and oxygen isotope values are higher than anything else measured on Earth or Mars points towards a process (or processes) being taken to an extreme," said Burtt. "While evaporation can cause significant oxygen isotope changes on Earth, the changes measured in this study were two to three times larger. This means two things: 1) there was an extreme degree of evaporation driving these isotope values to be so heavy, and 2) these heavier values were preserved so any processes that would create lighter isotope values must have been significantly smaller in magnitude."

This discovery was made using the Sample Analysis at Mars (SAM) and Tunable Laser Spectrometer (TLS) instruments aboard the Curiosity rover. SAM heats samples up to nearly 1,652 degrees Fahrenheit (almost 900 degrees Celsius) and then the TLS is used to analyze the gases that are produced during that heating phase.

Funding for this work came from NASA's Mars Exploration Program through the Mars Science Laboratory project. Curiosity was built by NASA's Jet Propulsion Laboratory, which is managed by Caltech in Pasadena, California. JPL leads the mission on behalf of NASA's Science Mission Directorate in Washington. NASA Goddard built the SAM instrument, which is a miniaturized scientific laboratory that includes three different instruments for analyzing chemistry, including the TLS, plus mechanisms for handling and processing samples. ☀

We May Have Found Our First-Ever Exomoon, Opening A New Chapter in Space Exploration

By Jackie Appel

POPULARMECHANICS, OCTOBER 18, 2024

Scientists think that they have gathered compelling evidence for the presence of an exomoon—a moon orbiting around a planet outside of our Solar System.

By analyzing the movements of a mysterious cloud of sodium moving around the planet WASP-49 b, the team was able to construct a compelling argument for the presence of an exomoon.

While many candidates have been put forth, there has never been a confirmed detection of an exomoon.

Moons probably aren't exclusive to our Solar System. Most things probably aren't (including life, but that's another discussion). But for as many far-off stars and exoplanets we've found at this point in our space-investigation history, we haven't yet definitively found an exomoon—a moon located anywhere other than our little star system.

We've definitely found candidates, but we have yet to confirm anything—in part because several candidates have become less likely with more data, and in part because of just how truly difficult exomoons are to see. In general, they're dim, small, and block less light from stars for less time than planets. That said, a new study published in *The Astrophysical Journal Letters* might have gotten us a step closer than ever before to spotting a natural satellite around another world in a whole different system.

The secret? Sodium.

The team behind this new study—lead by Caltech researcher Apurva Oza—turned some of our best observational equipment on a mysterious cloud of sodium that has been seen floating around the planet WASP-49 b (which itself orbits the star WASP 49). This cloud was first discovered in 2017, and Oza has been studying it pretty much since then in the hopes that it is indicative of a volcanic exomoon.

See, by all accounts, the sodium shouldn't be there. WASP-49 b (a hot, Saturn-like planet) and the star it orbits are both made primarily of hydrogen and helium. The trace amounts of sodium they do have could in no way maintain this cloud, which seems to be actively replenished at a rate of 220,000 pounds of sodium per second. But, nonetheless, there it is.

So, the team dug in, and they managed to find several pieces of evidence that seem to point fairly compellingly in the exomoon direction. For one, the cloud twice seemed to jump in size as if being refueled, despite not being right next to the planet at

those times. And for another, the cloud is moving in the wrong direction for it to be a planetary atmospheric phenomenon. “We think this is a really critical piece of evidence,” Oza said in a press release. “The cloud is moving in the opposite direction that physics tells us it should be going if it were part of the planet’s atmosphere.”

On top of their observations, the team ran models to try and understand the behavior of this cloud. Eventually, they found that its seemingly irregular movements in front of, behind, and around both WASP-49 and WASP-49 b—as well as its apparent lack of tether to any particular spot on the surface of WASP-49 b—were best matched by the presence of a moon on an eight-hour-long orbit around the planet.

These already exciting data points are even further strengthened by the fact that we have actually seen a moon behaving in pretty much this exact way right in our own cosmic backyard. Jupiter’s moon Io is the most volcanic object in our Solar System, fueled by the constant push-and-pull deformations of tidal forces exacted on it by its planetary host. It spews so much gas and debris that, according to NASA, it can create clouds around Jupiter that are up to 1,000 times the radius of the planet itself. If this potential exomoon is anything like Io, it’s firmly in the realm of possibility that it would create a cloud of sodium that we could see long before we were able to detect the planet directly.

The potential existence of this moon is exciting, but if we want to confirm its presence, we’re going to need to act fast. (Well, fast on a cosmic scale, anyway). The tidal forces needed to generate the amount of volcanic activity needed to make a cloud of sodium like this are extremely strong, and are likely taking a serious toll on the structural integrity of the moon. In addition, if you spew a bunch of the stuff you’re made of out into the universe via big volcanoes, you don’t have that material inside of you anymore, making you even weaker. Over time, if we are right about the nature of this object, it is basically going to disintegrate into nothing more than debris around a distant star. “If there really is a moon there,” Oza said, “it will have a very destructive ending.”

Good thing our telescopes are getting better and better. Eventually, there’s a good chance we’ll be able to know for sure exactly what is making this cloud. Until then, we’ll just have to patiently settle for promising evidence. ☀

Optical illusion gives rare green comet an ‘anti-tail’ that seemingly defies physics

By Harry Baker

Livescience, January 25, 2023

C/2022 E3 (ZTF), a comet that has recently made headlines as it flies closer to Earth, briefly developed an ethereal third tail thanks to a weird optical illusion.

A rare green comet, which has been streaking across the night sky as it approaches Earth for the first time since the Stone Age, briefly grew a bizarre third tail. This "anti-tail" appeared to streak in the wrong direction, seemingly breaking the rules of physics.

The comet — named C/2022 E3 (ZTF) but more commonly referred to as the "green comet" thanks to a chemical reaction that emits a greenish glow around the cosmic cannonball — was first discovered in March 2022 heading towards Earth from the Oort Cloud, a collection of icy objects in the outer solar system.

Normally, comets like this have two tails: one made from dust, which is blown off the comet by solar wind; and one made of gas from within the comet that sublimates, or transitions, directly from solid to gas. But on Jan. 21, several astrophotographers, including Ruslan Merzlyakov in Denmark and Alessandro Carrozzi in Italy, snapped pictures of the green comet with a third tail that was pointed towards the sun instead of away from it.

This bizarre third tail is known as an "anti-tail," and although it is made up from the same stuff as the comet's other tails, it is not actually part of the comet. Instead, it's an optical illusion caused by Earth moving through the comet's orbital plane, according to Spaceweather.com.

Related: Blazing comet tail is whipped by solar winds in astonishing astronomy photo

A comet's twin tails are often clearly visible — the dust tail reflects sunlight, while the gas within the other tail becomes ionized, giving it a faint glow.

The released gas eventually cools and becomes invisible, but the leftover dust is left to drift in the wake of the comet's trajectory around the sun, or orbital plane. When Earth crosses through a comet's orbital plane, some of this dust is reilluminated by the sun and appears as a bright streak, which can appear to shoot out of the comet in the opposite direction to its other tails, depending on the comet's trajectory and orientation. But in reality, this is just an optical illusion, and there is no extra tail. ☀

JWST spots the first known 'steam world'

By Lisa Grossman

Sciencenews, October 22, 2024

This exoplanet's atmosphere is going full steam ahead.

A planet beyond our solar system called GJ 9827d has an atmosphere composed almost completely of hot water molecules, astronomers report in the Astrophysical Journal Letters October 4.

"We're using the term 'steam world,'" says astronomer Ryan MacDonald at the University of Michigan in Ann Arbor.

GJ 9827d was discovered in 2017 orbiting a star about 100 light-years from Earth. At about twice Earth's size and three times Earth's mass, it's a type of planet called a sub-Neptune (SN: 8/8/22). Worlds like this are the most common in the galaxy, although our solar system doesn't have any.

But just knowing the planet's size and mass isn't enough to deduce what it's made of. To probe exoplanet skies, astronomers analyze starlight filtering through the planet's atmosphere as it passes in front of its parent star (SN: 6/7/24).

MacDonald and colleagues used the James Webb Space Telescope to observe two such passes, or transits, of GJ 9827d in November 2023. The Hubble space telescope had made similar observations and saw signs of water molecules in the planet's atmosphere, astronomers reported last year. But it wasn't enough to tell if the atmosphere just had a little water in it, or if it was a whole water world.

Combining the two telescopes' views made it unambiguously clear that the atmosphere was nearly all water. The planet's temperature is about 340° Celsius, so all of that water should be vapor.

Such steam worlds "have been predicted, but this is the first observational evidence that they really exist," Macdonald says. "I feel like a Star Trek explorer."

There might not be a solid rocky surface beneath the planet's steamy skies. Deep in the atmosphere, the pressure from all that water should get high enough to force the water molecules into weird and exotic forms of matter, like supercritical fluids or hot high-pressure ices, MacDonald says.

That makes GJ 9827d an unlikely place to find life. But studying its atmosphere is good practice for observing planets that might be habitable.

"It is the proof of principle that we can detect heavier atmospheres," MacDonald says. "We're on the right track to where we want to be, astrobiologically." ☀

The Backyard Observer, November 2024

By Rick Heschmeyer

CEPHEUS

The onset of Autumn brings many changes for backyard observers. The nights are getting longer giving us more time to examine the night sky, and the nights are getting cooler, a pleasant break from the hot evenings of the summer. This month's constellation Cepheus, the King, is a circumpolar constellation, meaning it is visible from our latitude all year long. It is particularly well-placed for viewing this month. It's brightest stars form a box shape with a triangle on top, or a tall, narrow house shape.

Beta Cephei is an easy double star for small telescopes. The star's traditional name is Alderamin. The primary star's color has been described as greenish-white while the dimmer companion is blue.

Delta Cephei is one of the most famous of all variable stars. It is a member of a class of variable known as Cepheid variables, of which it is the namesake. These are stars which pulsate over short periods of time. A relationship between the period of these pulsations and the luminosity of the stars, discovered in 1908 by Henrietta Swan Leavitt after studying thousands of variable stars in the Magellanic Clouds. Because Cepheid variables can be used as "standard candles" to measure distances they were used to prove that the "spiral nebulae," once thought to be new solar systems in formation, were distant galaxies outside our own Milky Way. This concept revolutionized astronomy in the twentieth century.

Mu Cephei is a slightly variable red giant star, possibly the reddest star in the north celestial hemisphere. Because of its bright, deep red color it has been dubbed Herchel's Garnet Star, after Sir William Herschel who noted its "very fine garnet color" in his observations.

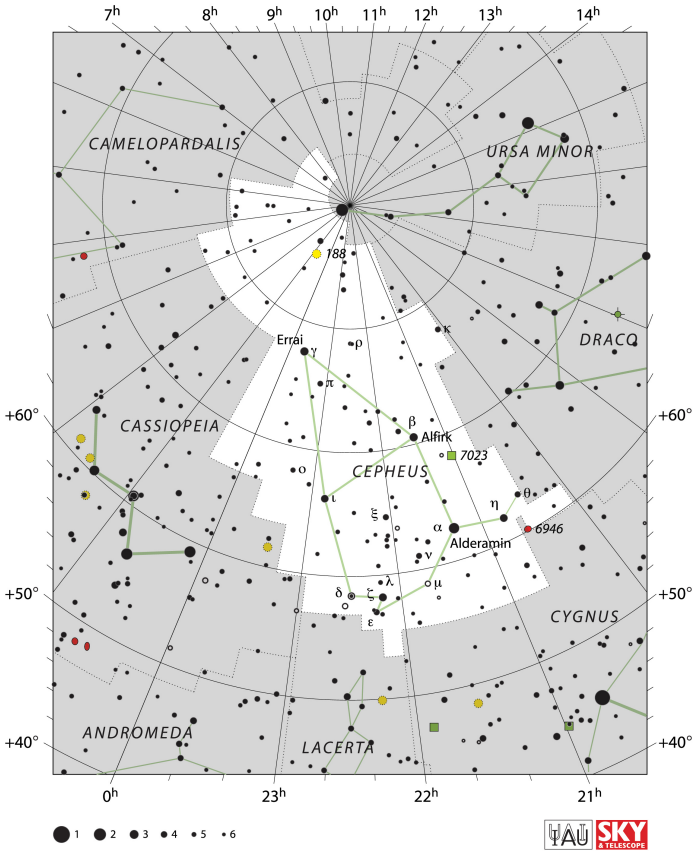
Xi Cephei is considered the finest double star in Cepheus. Medium aperture telescopes will reveal the pair's breathtaking yellow and blue/green colors.

NGC 188 is an unusual open cluster for two reasons. First, it is the closest cluster to the North Celestial Pole. As such it lies quite a distance from the galactic plane where most open clusters are located. Second NGC 188 is one the oldest known open clusters. Most open clusters are, in astronomical terms, "young" aggregations in the one-billion-year-old and younger range. But NGC 188 has an ancient estimated age of 7-12 billion years. It lies about 5000 light years from us. Because of its distance a 6-inch or larger telescope is needed to resolve any stars in the cluster, although smaller scopes will reveal a dim, circular haze.

NGC 7023, also called the Iris Nebula, is a bright reflection nebula, associated with an open cluster, in Cepheus. Telescopes are needed to corral this bluish nebula.

NGC 6946 is a 9th magnitude spiral galaxy, also known as the Fireworks Galaxy, located right on the Cepheus/ Cygnus border. Due to its larger size, it has a low surface brightness. Small to medium aperture telescopes will show a faint haze surrounding a brighter core. Larger telescopes are required to pick out the spiral arms.

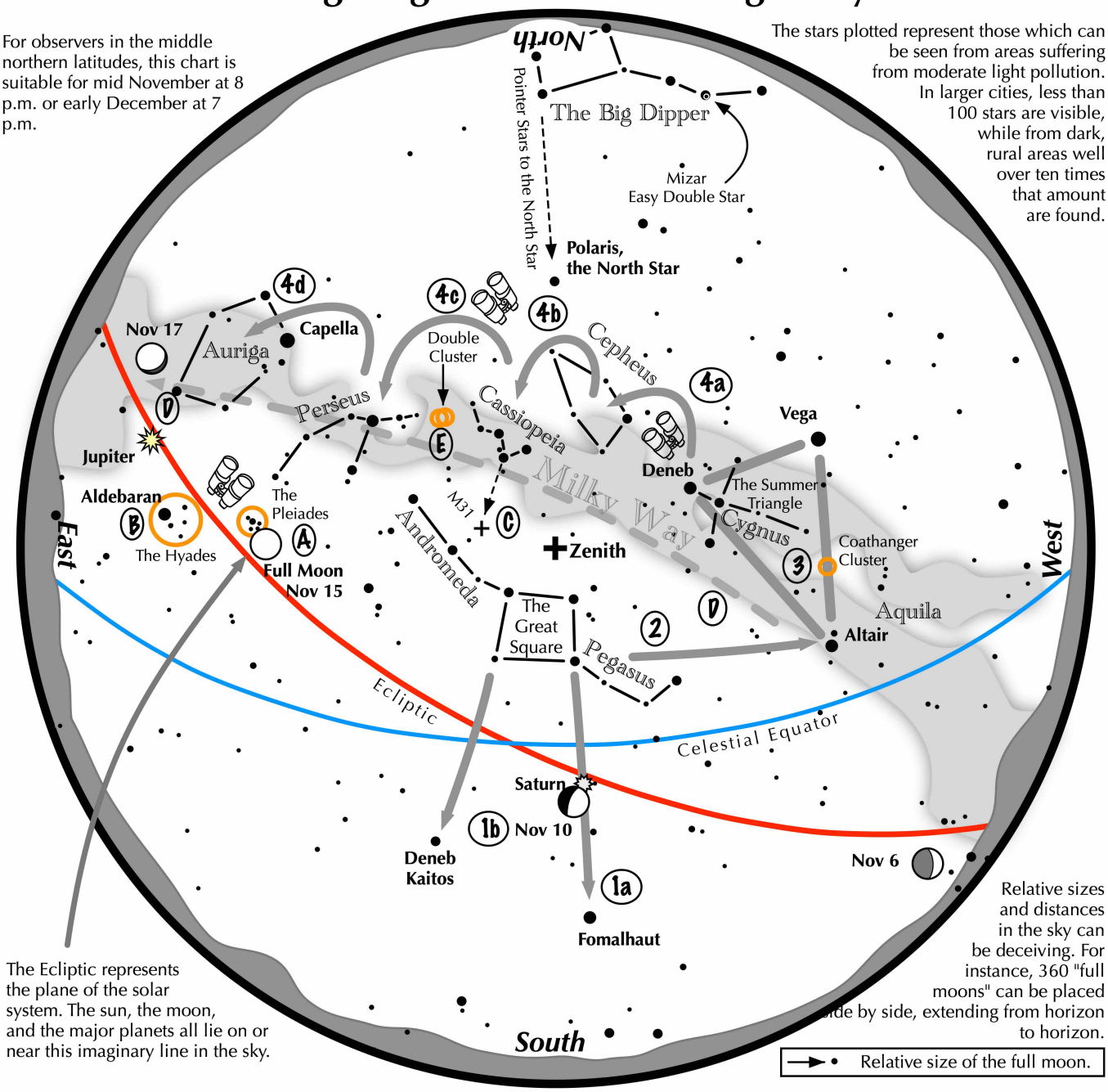
Until next month, keep looking up!



Navigating the November Night Sky

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

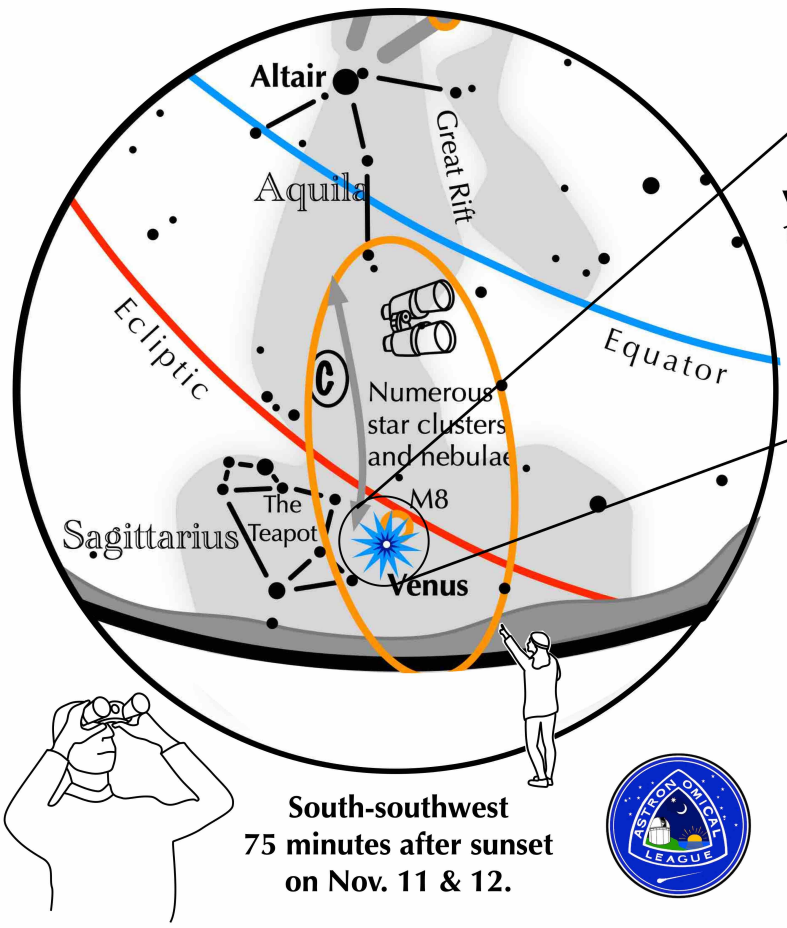
Navigating the November night sky: Simply start with what you know or with what you can easily find.

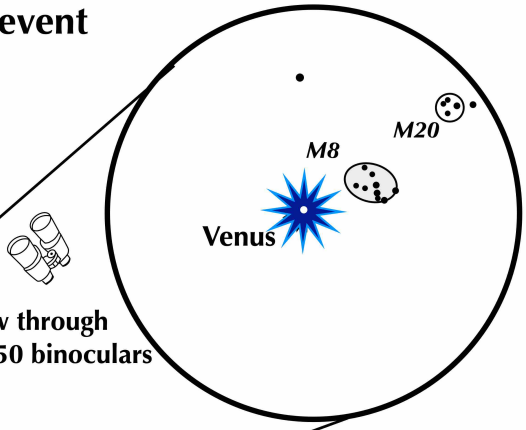
1. Face south. Almost overhead lies the "Great Square" with four stars about the same brightness as those of the Big Dipper. Extend a line southward following the Square's two westernmost stars. The line strikes Fomalhaut, the brightest star in the south. A line extending southward from the two easternmost stars, passes Deneb Kaitos, the second brighest star in the south.
2. Draw a line westward following the southern edge of the Square until it strikes Altair, part of the "Summer Triangle."
3. Locate Vega and Deneb, the other two stars of the Summer Triangle. Vega is its brightest member, while Deneb sits in the middle of the Milky Way.
4. Jump along the Milky Way from Deneb to Cepheus, which resembles the outline of a house. Continue jumping to the "W" of Cassiopeia, then to Perseus, and finally to Auriga with its bright star Capella.

Binocular Highlights

A and B: Examine the stars of the Pleiades and Hyades, two naked eye star clusters. **C:** The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval. **D:** Sweep along the Milky Way from Altair, past Deneb, through Cepheus, Cassiopeia and Perseus, then to Auriga for many intriguing star clusters and nebulous areas. **E.** The Double Cluster.

If you can observe only one evening celestial event this month, consider this one:





View through 10x50 binoculars

South-southwest 75 minutes after sunset on Nov. 11 & 12.

Venus reveals celestial treasures

Look to the south-southwest 75–90 minutes after sunset.

- On November 11 & 12, look for Venus low in the south-southwest. It will be the brightest object in the area.
- Use binoculars to view Venus. To its immediate upper right, subtly glows a nebulous star cluster, M8, nicknamed "the Lagoon Nebula" (4100 L-Y distant).
- To the upper right of M8 dimly glows another star forming nebula and cluster, M20, called "the Trifid Nebula" (5200 L-Y distant).

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.