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The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

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

Public Observing
August 25, 2024, 8:00PM
Baker Wetlands Discovery Center

Club Officers

President
Rick Heschmeyer email

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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

Fall is right around the corner, and with it our club meetings and public observing sessions will resume. But first, on Sunday, August 11, the club, together with Baker Wetlands, will be hosting a Perseid Meteor Shower watch party, starting at 9:00 pm at the Wetlands Discovery Center. Telescopes will be available for viewing of other celestial objects as well. Join us!

Our first club meeting of the fall will take place on Sunday, August 25th at 7:00 PM. The talk will be "Analog Astronaut Adventures: Insights from the Mars Desert Research Station." Sarah Lamm is a third-year Ph.D. candidate in the Geology department at KU, who recently completed a mission as an analog astronaut and Crew Geologist at the Mars Desert Research Station (MDRS). The MDRS is a facility dedicated to researching technology and science for space exploration. As part of Crew 297, Sarah and her five team members conducted experiments in southern Utah, an area with geological features that closely resemble those of Mars. Her project focused on testing the practicality of using a portable gamma-ray spectrometer in the field. She will be here talking about her experience as an analog astronaut. Sarah is also a fellow Solar System Ambassador. Sounds like an interesting and informative program!

Several planets will be gracing the evening skies this fall, starting this month with Venus, visible low in the west after sunset. Saturn reaches opposition on September 8 and will be an evening object, with Venus, for the remainder of the year. Jupiter will follow later this year.

Finally, I'd like to express my thanks to all those club members that helped out this summer. As you may or may not know, in the middle of May I fell and broke my T6 vertebrae. I spent the summer in a back brace with a 10 lb. lift limit, unable to do any club outreach. As the Queen song said, "The show must go on". Your efforts are appreciated.

The universe may have a complex geometry — like a doughnut

Scientists previously considered only a small subset of possible topologies

By Emily Conover

SCIENCENEWS, MAY 13, 2024

The cosmos may have something in common with a doughnut.

In addition to their fried, sugary goodness, doughnuts are known for their shape, or in mathematical terms, their topology. In a universe with an analogous, complex topology, you could travel across the cosmos and end up back where you started. Such a cosmos hasn't yet been ruled out, physicists report in the April 26 Physical Review Letters.

On a shape with boring, or trivial topology, any closed path you draw can be shrunk down to a point. For example, consider traveling around Earth. If you were to go all the way around the equator, that's a closed loop, but you could squish that down by shifting your trip up to the North Pole. But the surface of a doughnut has complex, or nontrivial, topology (SN: 10/4/16). A loop that encircles the doughnut's hole, for example, can't be shrunk down, because the hole limits how far you can squish it.

The universe is generally believed to have trivial topology. But that's not known for certain, the researchers argue.

"I find it fascinating … the possibility that the universe might have nontrivial or different types of topologies, and then especially the fact that we think we might be able to measure it," says cosmologist Dragan Huterer of the University of Michigan in Ann Arbor, who was not involved with the study.

A universe with nontrivial topology might be a bit like Pac-Man. In the classic arcade game, moving all the way to the right edge of the screen puts the character back at the left side. A Pac-Man trek that crosses the screen and returns the character to its starting point likewise can't be shrunk down.

Scientists have already looked for signs of complex topology in the cosmic microwave background, light from when the universe was just 380,000 years old. Because of the way space loops back on itself in a universe with nontrivial topology, scientists might be able to observe the same feature in more than one place. Researchers have searched for identical circles that appear in that light in two different places on the sky. They've also hunted for subtle correlations, or similarities, between different spots, rather than identical matches.

Those searches didn't turn up any evidence for complex topology. But, theoretical physicist Glenn Starkman and colleagues argue, there's still a chance that the universe does have something in common with a doughnut. That's because earlier research considered only a small subset of the possible topologies the universe could have.

That subset includes one type of nontrivial topology called a 3-torus, a cube that loops back on itself like a 3-D version of the Pac-Man screen. In such a topology, exiting any side of that cube brings you back to the opposite side. Searches for that simple 3-torus have come up empty. But scientists haven't yet searched for some 3-torus variations. For example, the sides of the cube might be twisted relative to one another. In such a universe, exiting the top of the cube would bring you back to the bottom, but rotated by, for example, 180 degrees.

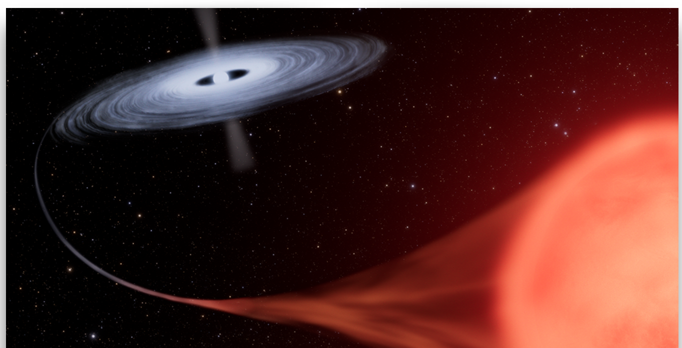
The new study considered a total of 17 possible nontrivial topologies for the cosmos. Most of those topologies, the authors determined, haven't yet been ruled out. The study evaluated the signatures that would appear in the cosmic microwave background for different types of topologies. Future analyses of that ancient light could reveal hints of these complex topologies, the researchers found.

The search is likely to be computationally challenging, probably requiring machine learning techniques to speed up calculations. The researchers also plan to hunt for signs of nontrivial topology in upcoming data from surveys of the distribution of galaxies in the cosmos, for example from the European Space Agency's Euclid space telescope (SN: 12/20/23).

There's good motivation to look for nontrivial topology, says Starkman, of Case Western Reserve University in Cleveland. Some features of the cosmic microwave background hint that the universe isn't the same in all directions (SN: 12/23/08). That kind of asymmetry could be explained by nontrivial topology. And that asymmetry, Starkman says, is "one of the biggest new mysteries about the universe that hasn't gone away." ☀

NASA's Hubble Finds Surprises Around a Star That Erupted 40 Years Ago

HUBBLESITE, JUNE 10, 2024



Summary

Hubble Telescope Revisits a Star System That is Still Extraordinarily Hot

If we could look down upon the magnificent spiral structure of our Milky Way from far above, and compress millions of years into seconds, we would see brief bursts of light, like the flashes from cameras popping off at a stadium event. These are novae, where a burned-out star, a white dwarf, ingests gas from a bloated red giant companion it is orbiting. One of the strangest of these events happened in 1975, when a nova called HM Sagittae grew 250 times brighter. It never really faded away as novae commonly do, but has maintained its brightness for decades. The latest Hubble observations show that the system has gotten hotter, but paradoxically faded a little.

Astronomers have used new data from NASA's Hubble Space Telescope and the retired SOFIA (Stratospheric Observatory for Infrared Astronomy) as well as archival data from other missions to revisit one of the strangest binary star systems in our galaxy – 40 years after it burst onto the scene as a bright and long-lived nova. A nova is a star that suddenly increases its brightness tremendously and then fades away to its former obscurity, usually in a few months or years.

Between April and September 1975, the binary system HM Sagittae (HM Sge) grew 250 times brighter. Even more unusual, it did not rapidly fade away as novae commonly do, but has maintained its luminosity for decades. Recently, observations show that the system has gotten hotter, but paradoxically faded a little.

HM Sge is a particular kind of symbiotic star where a white dwarf and a bloated, dust-producing giant companion star are in an eccentric orbit around each other, and the white dwarf ingests gas flowing from the giant star. That gas forms a blazing hot disk around the white dwarf, which can unpredictably undergo a spontaneous thermonuclear explosion as the infall of hydrogen from the giant grows denser on the surface until it reaches a tipping point. These fireworks between companion stars fascinate astronomers by yielding insights into the physics and dynamics of stellar evolution in binary systems.

"In 1975 HM Sge went from being a nondescript star to something all astronomers in the field were looking at, and at some point that flurry of activity slowed down," said Ravi Sankrit of the Space Telescope Science Institute (STScI) in Baltimore. In 2021, Steven Goldman of STScI, Sankrit and collaborators used instruments on Hubble and SOFIA to see what had changed with HM Sge in the last 30 years at wavelengths of light from the infrared to the ultraviolet (UV).

The 2021 ultraviolet data from Hubble showed a strong emission line of highly ionized magnesium that was not present in earlier published spectra from 1990. Its presence shows that the estimated temperature of the white dwarf and accretion disk increased from less than 400,000 degrees Fahrenheit in 1989 to greater than 450,000 degrees Fahrenheit now. The highly ionized magnesium line is one of many seen in the UV spectrum, which analyzed together will reveal the energetics of the system, and how it has changed in the last three decades.

"When I first saw the new data," Sankrit said, "I went – 'wow this is what Hubble UV spectroscopy can do!' – I mean it's spectacular, really spectacular."

With data from NASA's flying telescope SOFIA, which retired in 2022, the team was able to detect the water, gas, and dust flowing in and around the system. Infrared spectral data shows that the giant star, which produces copious amounts of dust, returned to its normal behavior within only a couple years of the explosion, but also that it has dimmed in recent years, which is another puzzle to be explained.

With SOFIA astronomers were able to see water moving at around 18 miles per second, which they suspect is the speed of the sizzling accretion disk around the white dwarf. The bridge of gas connecting the giant star to the white dwarf must presently span about 2 billion miles.

The team has also been working with the AAVSO (American Association of Variable Star Observers), to collaborate with amateur astronomers from around the world who help keep telescopic eyes on HM Sge; their continued monitoring reveals changes that haven't been seen since its outburst 40 years ago.

"Symbiotic stars like HM Sge are rare in our galaxy, and witnessing a nova-like explosion is even rarer. This unique event is a treasure for astrophysicists spanning decades," said Goldman.

The initial results from the team's research were published in The Astrophysical Journal , and Sankrit is presenting research focused on the UV spectroscopy at the 244th meeting of the American Astronomical Society in Madison, Wisconsin. ☀

Night Sky Notes: A Hero, a Crown, and Possibly a Nova!

By Vivian White

NIGHTSKYNETWORK, JULY 2024

High in the summer sky, the constellation Hercules acts as a centerpiece for late-night stargazers.

At the center of Hercules is the “Keystone,” a near-perfect square shape between the bright stars

Vega and Arcturus that is easy to recognize and can serve as a guidepost for some amazing sights.

While not the brightest stars, the shape of the hero’s torso, like a smaller Orion, is nearly directly

overhead after sunset. Along the edge of this square, you can find a most magnificent jewel - the

Great Globular Cluster of Hercules, also known as Messier 13.

Type to enter text Look up after sunset during summer months to find Hercules! Scan between Vega and Arcturus, near the distinct pattern of Corona Borealis. Once you find its stars, use binoculars or a telescope to hunt down the globular clusters M13 (and a smaller globular cluster M92). If you enjoy your views of these globular clusters, you’re in luck - look for another great globular, M3, in the nearby constellation of Boötes. Image created with assistance from Stellarium: stellarium.org

Globular clusters are a tight ball of very old stars, closer together than stars near us. These clusters

orbit the center of our Milky Way like tight swarms of bees. One of the most famous short stories,

Nightfall by Isaac Asimov, imagines a civilization living on a planet within one of these star clusters.

They are surrounded by so many stars so near that it is always daytime except for once every millennium, when a special alignment (including a solar eclipse) occurs, plunging their planet into darkness momentarily. The sudden night reveals so many stars that it drives the inhabitants mad.

Back here on our home planet Earth, we are lucky enough to experience skies full of stars, a beautiful Moon, and regular eclipses. On a clear night this summer, take time to look up into the Keystone of Hercules and follow this sky chart to the Great Globular Cluster of Hercules. A pair of binoculars will show a faint, fuzzy patch, while a small telescope will resolve some of the stars in this globular cluster.

A red giant star and white dwarf orbit each other in this animation of a nova similar to T Coronae Borealis. The red giant is a large sphere in shades of red, orange, and white, with the side facing the white dwarf the lightest shades. The white dwarf is hidden in a bright glow of white and yellows, which represent an accretion disk around the star. A stream of material, shown as a diffuse cloud of red, flows from the red giant to the white dwarf. When the red giant moves behind the white dwarf, a nova explosion on the white dwarf ignites, creating a ball of ejected nova material shown in pale orange. After the fog of material clears, a small white spot remains, indicating that the white dwarf has survived the explosion. NASA/Goddard Space Flight Center

Bonus! Between Hercules and the ice-cream-cone-shaped Boötes constellation, you'll find the small constellation Corona Borealis, shaped like the letter "C." Astronomers around the world are watching T Coronae Borealis, also known as the "Blaze Star" in this constellation closely because it is predicted to go nova sometime this summer. ☀

The origins of dark comets

SCIENCENEWS, JULY 10, 2024

Summary

Up to 60% of near-Earth objects could be dark comets, mysterious asteroids that orbit the sun in our solar system that likely contain or previously contained ice and could have been one route for delivering water to Earth, according to a University of Michigan study.

The findings suggest that asteroids in the asteroid belt, a region of the solar system roughly between Jupiter and Mars that contains much of the system's rocky asteroids, have subsurface ice, something that has been suspected since the 1980s, according to Aster Taylor, a U-M graduate student in astronomy and lead author of the study.

The study also shows a potential pathway for delivering ice into the near-Earth solar system, according to Taylor. How Earth got its water is a longstanding question.

"We don't know if these dark comets delivered water to Earth. We can't say that. But we can say that there is still debate over how exactly the Earth's water got here," Taylor said. "The work we've done has shown that this is another pathway to get ice from somewhere in the rest of the solar system to the Earth's environment."

The research further suggests that one large object may come from the Jupiter-family comets, comets whose orbits take them close to the planet Jupiter. The team's results are published in the journal Icarus.

Dark comets are a bit of a mystery because they combine characteristics of both asteroids and comets. Asteroids are rocky bodies with no ice that orbit closer to the sun, typically within what's called the ice line. This means they are close enough to the sun for any ice the asteroid may have been carrying to sublimate, or change from solid ice directly into gas.

Comets are icy bodies that show a fuzzy coma, a cloud that often surrounds a comet. Sublimating ice carries dust along with it, creating the cloud. Additionally, comets typically have slight accelerations propelled not by gravity, but by the sublimation of ice, called nongravitational accelerations.

The study examined seven dark comets and estimates that between 0.5 and 60% of all near-Earth objects could be dark comets, which do not have comae but do have nongravitational accelerations. The researchers also suggest that these dark comets likely come from the asteroid belt, and because these dark comets have nongravitational accelerations, the study findings suggest asteroids in the asteroid belt contain ice.

"We think these objects came from the inner and/or outer main asteroid belt, and the implication of that is that this is another mechanism for getting some ice into the inner solar system," Taylor said. "There may be more ice in the inner main belt than we thought. There may be more objects like this out there. This could be a significant fraction of the nearest population. We don't really know, but we have many more questions because of these findings."

In previous work, a team of researchers including Taylor identified nongravitational accelerations on a set of near-Earth objects, naming them "dark comets." They determined that the dark comets' nongravitational accelerations are likely the result of small amounts of sublimating ice.

In the current work, Taylor and their colleagues wanted to discover where the dark comets came from.

"Near-Earth objects don't stay on their current orbits very long because the near-Earth environment is messy," they said. "They only stay in the near-Earth environment for around 10 million years. Because the solar system is much older than that, that means near-Earth objects are coming from somewhere -- that we're constantly being fed near-Earth objects from another, much larger source."

To determine the origin of this dark comet population, Taylor and their coauthors created dynamical models that assigned nongravitational accelerations to objects from different populations. Then, they modeled a path these objects would follow given the assigned nongravitational accelerations over a period of 100,000 years. The researchers observed that many of these objects ended up where dark comets are today, and found that out of all potential sources, the main asteroid belt is the most likely place of origin.

One of the dark comets called 2003 RM, which passes in an elliptical orbit close to Earth, then out to Jupiter and back past Earth, follows the same path that would be expected from a Jupiter family comet, Taylor says -- that is, its position is consistent with a comet that was knocked inward from its orbit.

Meanwhile, the study finds that the rest of the dark comets likely came from the inner band of the asteroid belt. Since the dark comets likely have ice, this shows that ice are present in the inner main belt.

Then, the researchers applied a previously suggested theory to their population of dark comets to determine why the objects are so small and quickly rotating. Comets are rocky structures bound together by ice -- picture a dirty ice cube, Taylor says. Once they get bumped within the solar system's ice line, that ice starts to off gas. This causes the object's acceleration, but it can also cause the object to spin quite fast -- fast enough for the object to break apart.

"These pieces will also have ice on them, so they will also spin out faster and faster until they break into more pieces," Taylor said. "You can just keep doing this as you get smaller and smaller and smaller. What we suggest is that the way you get these small, fast rotating objects is you take a few bigger objects and break them into pieces."

As this happens, the objects continue to lose their ice, get even smaller, and rotate even more rapidly.

The researchers believe that while the larger dark comet, 2003 RM, was likely a larger object that got kicked out of the outer main belt of the asteroid belt, the six other objects they were examining likely came from the inner main belt and were made by an object that had gotten knocked inward and then broke apart. ☀

Life signs could survive near surfaces of Enceladus and Europa

ScienceDaily, July 21, 2024

Europa, a moon of Jupiter, and Enceladus, a moon of Saturn, have evidence of oceans beneath their ice crusts. A NASA experiment suggests that if these oceans support life, signatures of that life in the form of organic molecules (e.g. amino acids, nucleic acids, etc.) could survive just under the surface ice despite the harsh radiation on these worlds. If robotic landers are sent to these moons to look for life signs, they would not have to dig very deep to find amino acids that have survived being altered or destroyed by radiation.

"Based on our experiments, the 'safe' sampling depth for amino acids on Europa is almost 8 inches (around 20 centimeters) at high latitudes of the trailing hemisphere (hemisphere opposite to the direction of Europa's motion around Jupiter) in the area where the surface hasn't been disturbed much by meteorite impacts," said Alexander Pavlov of NASA's Goddard Space Flight Center in Greenbelt, Maryland, lead author of a paper on the research published July 18 in Astrobiology. "Subsurface sampling is not required for the detection of amino acids on Enceladus -- these molecules will survive radiolysis (breakdown by radiation) at any location on the Enceladus surface less than a tenth of an inch (under a few millimeters) from the surface."

The frigid surfaces of these nearly airless moons are likely uninhabitable due to radiation from both high-speed particles trapped in their host planet's magnetic fields and powerful events in deep space, such as exploding stars. However, both have oceans under their icy surfaces that are heated by tides from the gravitational pull of the host planet and neighboring moons. These subsurface oceans could harbor life if they have other necessities, such as an energy supply as well as elements and compounds used in biological molecules.

The research team used amino acids in radiolysis experiments as possible representatives of biomolecules on icy moons. Amino acids can be created by life or by non-biological chemistry. However, finding certain kinds of amino acids on Europa or Enceladus would be a potential sign of life because they are used by terrestrial life as a component to build proteins. Proteins are essential to life as they are used to make enzymes which speed up or regulate chemical reactions and to make structures. Amino acids and other compounds from subsurface oceans could be brought to the surface by geyser activity or the slow churning motion of the ice crust.

To evaluate the survival of amino acids on these worlds, the team mixed samples of amino acids with ice chilled to about minus 321 Fahrenheit (-196 Celsius) in sealed, airless vials and bombarded them with gamma-rays, a type of high-energy light, at various doses. Since the oceans might host microscopic life, they also tested the survival of amino acids in dead bacteria in ice. Finally, they tested samples of amino acids in ice mixed with silicate dust to consider the potential mixing of material from meteorites or the interior with surface ice.

The experiments provided pivotal data to determine the rates at which amino acids break down, called radiolysis constants. With these, the team used the age of the ice surface and the radiation environment at Europa and Enceladus to calculate the drilling depth and locations where 10 percent of the amino acids would survive radiolytic destruction.

Although experiments to test the survival of amino acids in ice have been done before, this is the first to use lower radiation doses that don't completely break apart the amino acids, since just altering or degrading them is enough to make it impossible to determine if they are potential signs of life. This is also the first experiment using Europa/Enceladus conditions to evaluate the survival of these compounds in microorganisms and the first to test the survival of amino acids mixed with dust.

"Slow rates of amino acid destruction in biological samples under Europa and Enceladus-like surface conditions bolster the case for future life-detection measurements by Europa and Enceladus lander missions," said Pavlov. "Our results indicate that the rates of potential organic biomolecules' degradation in silica-rich regions on both Europa and Enceladus are higher than in pure ice and, thus, possible future missions to Europa and Enceladus should be cautious in sampling silica-rich locations on both icy moons."

A potential explanation for why amino acids survived longer in bacteria involves the ways ionizing radiation changes molecules -- directly by breaking their chemical bonds or indirectly by creating reactive compounds nearby which then alter or break down the molecule of interest. It's possible that bacterial cellular material protected amino acids from the reactive compounds produced by the radiation. ☀

The Backyard Observer, August 2024

By Rick Heschmeyer

SERPENS

Start by finding last month's constellation Ophiuchus, the Serpent Bearer. The serpent he is bearing is none other than this month's feature constellation, Serpens. The only constellation that is divided into two parts. Serpens Cauda, the Serpent's tail, and Serpens Caput, the Serpent's head lie on opposite sides of Ophiuchus. We will look at each individually here.

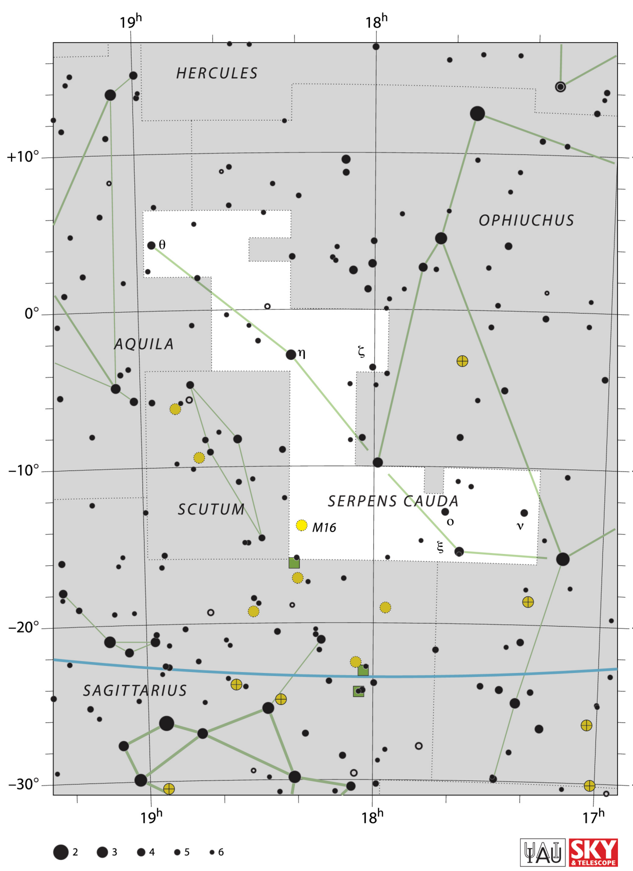
Serpens Cauda occupies the eastern side of Ophiuchus and contains Alpha Serpentis, the brightest star in constellation. Also known as Unukalhai, or Cor Serpentis, for the "heart of the serpent." The star is 74 light years distant.

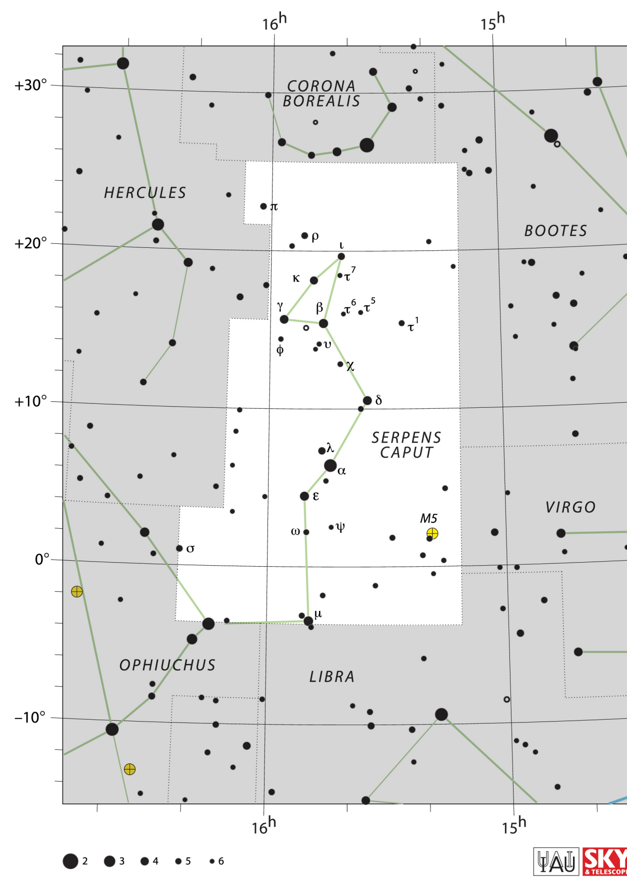
Messier 16 is certainly the most famous object in Serpens Cauda, for that matter in all of Serpens! More commonly known as "The Eagle Nebula," M16 is located north of the Teapot asterism in Sagittarius. It is an open cluster with associated nebulosity, and at magnitude 6, is visible in binoculars and small telescopes under dark skies. Larger telescopes begin to show the famous "Pillars of Creation" shown in the gorgeous Hubble image. M16 lies 7000 light years from Earth.

Hopping over to the western side of Ophiuchus, Serpens Caput lies farther from the Summer Milky Way, and contains fewer bright objects.

Messier 5 is a very nice globular cluster and lies about one-third the distance as M16, at about 25,000 light years. M5 is one of the oldest globulars in our galaxy, with an estimated age of 13 billion years. From a dark location the cluster can be seen in binoculars as a faint hazy patch, despite the fact that the cluster contains between 100,000-500,000 stars!

Enjoy the serpent this summer, and don't worry, it won't bite!

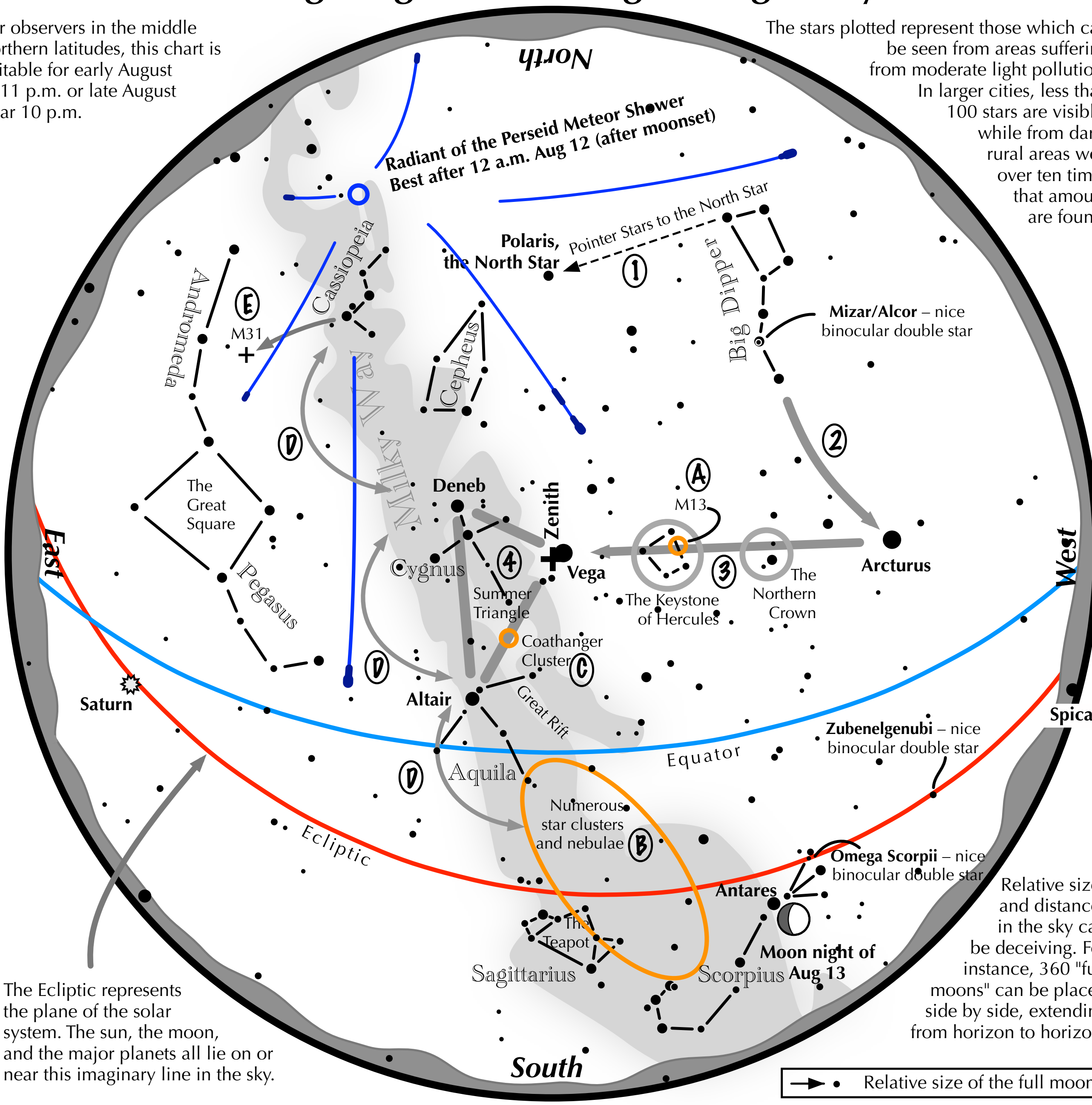




Navigating the mid August Night Sky

For observers in the middle northern latitudes, this chart is suitable for early August at 11 p.m. or late August near 10 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.



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.

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.

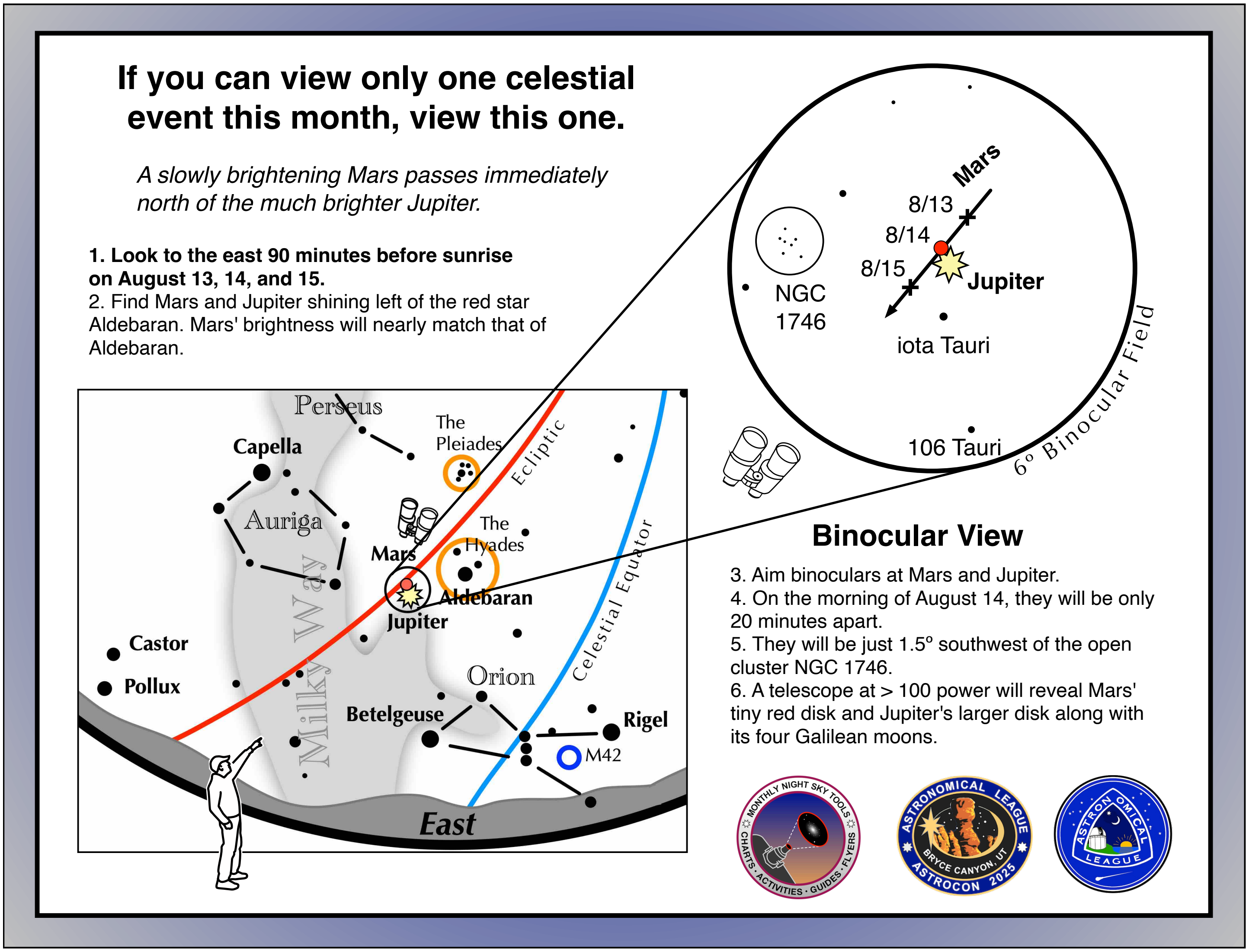
→ • Relative size of the full moon.

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

1. Extend a line north from the two stars at the tip of the Big Dipper's bowl. It passes by Polaris, the North Star.
2. Follow the arc of the Dipper's handle. It intersects Arcturus, the brightest star in the June evening sky.
3. To the northeast of Arcturus shines another star of the same brightness, Vega. Draw a line from Arcturus to Vega. It first meets "The Northern Crown," then the "Keystone of Hercules." A dark sky is needed to see these two dim stellar configurations.
4. High in the East lies the summer triangle stars of Vega, Altair, and Deneb.

Binocular Highlights

A: On the western side of the Keystone glows the Great Hercules Cluster.
B: Between the bright stars Antares and Altair, hides an area containing many star clusters and nebulae.
C: 40% of the way between Altair and Vega, twinkles the "Coathanger," a group of stars outlining a coathanger.
D: Sweep along the Milky Way for an astounding number of faint glows and dark bays, including the Great Rift.
E: The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval.



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.