Volume 49 Number 10 October 2023

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
October 29, 2023, 7:00PM
Baker Wetlands Discovery Center

Public Observing
October 29, 2023, 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

For our September Club Meeting we discussed plans for the upcoming Solar Eclipse event hosted by the Astronomy Associates of Lawrence. The event will take place from 10AM to 2PM o Saturday, October 14th in the Lawrence Library Lawn between the library and the Vermont Street Parking Garage. We are still looking for volunteers to help with spreading the word, helping attendees, manning the telescopes, and running activities. Please reach out to me if you can assist. A link to send me an email is included on the front page of this newsletter, or you can message me via the club's Facebook page. The KU Department of Physics and Astronomy will be holding an event on campus at the same time. As those details are finalized, we will share with the club.

Also, at the September Club Meeting we revisited the talk given by KU graduate Dr. Humberto Campins about the OSIRIS-Rex Sample Return Mission to the asteroid Bennu, which had successfully returned samples to Earth earlier that day.

The sky was clear after the meeting and there was a nice crowd to view through the telescopes. Unfortunately, the September "Telescope Night at KU" was not as lucky. The observing portion was cancelled due to clouds, but the planetarium show went on as scheduled.

The remaining fall club meeting dates are listed below. If anyone has ideas for future meeting subjects, please let me know.

Sunday, October 29

Sunday, December 3

All meetings take place at Baker Wetlands Discovery Center and start at 7 PM. Public observing will start after the meeting, usually around 8 PM.

I hope we can see everyone at the Solar Eclipse event on October 14th. Keep looking up.

This extreme star might have huge tidal waves

The height of the waves could be up to three times the diameter of the sun

By Liz Kruesi
SCIENCENEWS, AUGUST 21, 2023

On one star in the Large Magellanic Cloud, enormous tidal waves of plasma might repeatedly crash across its surface as a smaller companion star's gravity tugs on the bigger star

Like ocean surf smashing on a sandy beach, enormous waves of plasma may crash onto the surface of one massive star.

The star is part of a pair, stretched and pulled by its companion's gravity. That gravitational tug-of-war causes the star's brightness to change drastically and rhythmically. Now, a computer simulation suggests that this steady heartbeat of starlight is caused by giant tidal waves undulating and breaking on the star's surface, researchers report August 10 in *Nature Astronomy*. The height of the waves could be up to three times the diameter of the sun.

"It's quite rare to see these really kind of dramatic but transformative moments in action," says astrophysicist Morgan MacLeod of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass.

The star system, dubbed MACHO 80.7443.1718, sits about 160,000 light-years away from Earth in the Large Magellanic Cloud. It hosts one visible star that is 35 times the mass of the sun and another unseen star of at least 10 solar masses. About once a month, as they orbit each other, they pass near enough that gravitational forces raise tides on both stars' surfaces, scientists suspect, much the way the moon tugs on Earth's oceans (*SN: 4/5/11*).

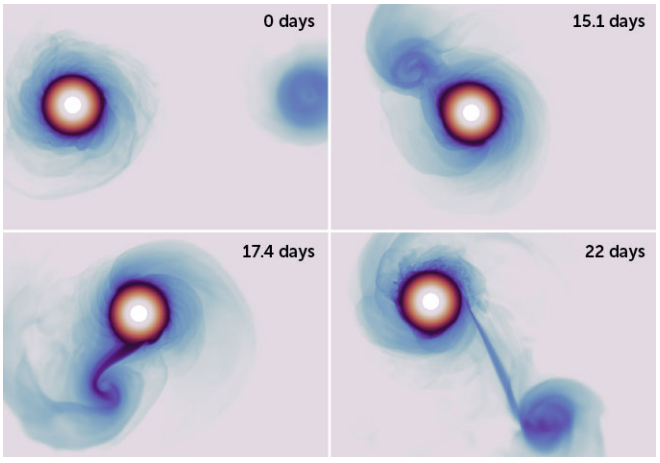
On the stars, though, that tug would be substantially more extreme. "Instead of being a few meters tall, [the tide] can be 10 percent of the diameter of the star" that's visible, says astrophysicist Jim Fuller of Caltech, who was not part of the study. On a star as big as that visible star — about 24 times as wide as the sun — that corresponds to a tidal wave roughly 3.3 million kilometers tall.

The new study, Fuller says, "shows how complicated and interesting the dynamics get when you have an extreme system like this."

Astronomers can't see the shapes of these stars through a telescope, but they can track how the brighter star's light changes over time. While the brightness of most known "heartbeat stars" changes by about a tenth of a percent, the brightness of this system changes by 20 percent.

Stellar dance

Roughly once a month, two stars about 160,000 light-years away from Earth pass close enough to one another that gravitational forces should raise tides in the plasma on both stars' surfaces. A computer simulation (shown) suggests that the gravitational tug-of-war raises enormous tides in the plasma on the larger star's surface.



MacLeod wanted to know how the dynamics of this star system lead to those visible changes. So he and Harvard astronomer Avi Loeb simulated how plasma moves on and between these stars as they orbit one another.

The waves can get big enough that they actually break and crash across the brighter star's surface, the study suggests. When an ocean wave is far from shore, it's a rolling, undulating wave. But as it comes closer to shore, it rises and collapses on itself. "Something kind of parallel is happening here," MacLeod says. The top of the wave steepens, "gets out of phase with the bottom, and it folds over on itself, and it crashes."

After it crashes on the stellar surface, he says, "debris that's thrown off is fed into this atmosphere around the star," like the foamy surf left behind on a beach. As the waves crash, energy is lost. That crashing, the study suggests, causes the stars' orbits to shrink, meaning eventually these stars could collide and possibly merge. ☀

Stunning solar tornado swings into space above the glowing sun

By Miguel Claro published
SPACE.COM, JULY 11, 2023

Miguel Claro is a professional photographer, author and science communicator based in Lisbon, Portugal, who creates spectacular images of the night sky. As a European Southern Observatory Photo Ambassador and member of The World At Night and the official astrophotographer of the Dark Sky Alqueva Reserve, he specializes in astronomical "Skyscapes" that connect both Earth and the night sky.

Join Miguel here as he takes us through his new 4K video, "Solar Tornado Released into Space."

I noticed that the sun's atmosphere was featuring a gigantic prominence on April 20, so I prepared my solar telescope to start the photo session.

After about one hour of images, I noticed that this sun prominence was growing even more, which means that probably something bigger was about to happen.

I couldn't imagine that one of my dreams of capturing a "solar tornado" in motion was about to turn into reality. These kinds of sun tornados are "controlled by magnetism," caused by solar magnetic fields that "twist in a furious spiral, dragging clouds of plasma around with them," according to SpaceWeather.com.

Due to my position on a terrace, my view at that time of the year is blocked after 4:30 PM local. So I only had around one hour and 20 minutes to keep capturing as many images as I could, for a time-lapse sequence that could show the evolution of this giant plasma shape.

The final result is a 4K high-resolution solar movie comprising 290 images over the course of about two hours, between 1315 and 1507 GMT.

NASA's Solar Dynamics Observatory (SDO) imaged an animation on the same day, along with the LASCO instrument aboard the NASA/European Space Agency Solar and Heliospheric Observatory (SOHO).

The instrument aboard SOHO also saw a possible coronal mass ejection, which is a stream of charged particles from the sun. Sometimes these CMEs can hit Earth's magnetic field and cause colorful auroras.

Ready to go exploring in the night sky on your own? Check out our guides on the best telescopes and best binoculars. You can also get your imaging gear ready using the best cameras for astrophotography and best lenses for astrophotography.

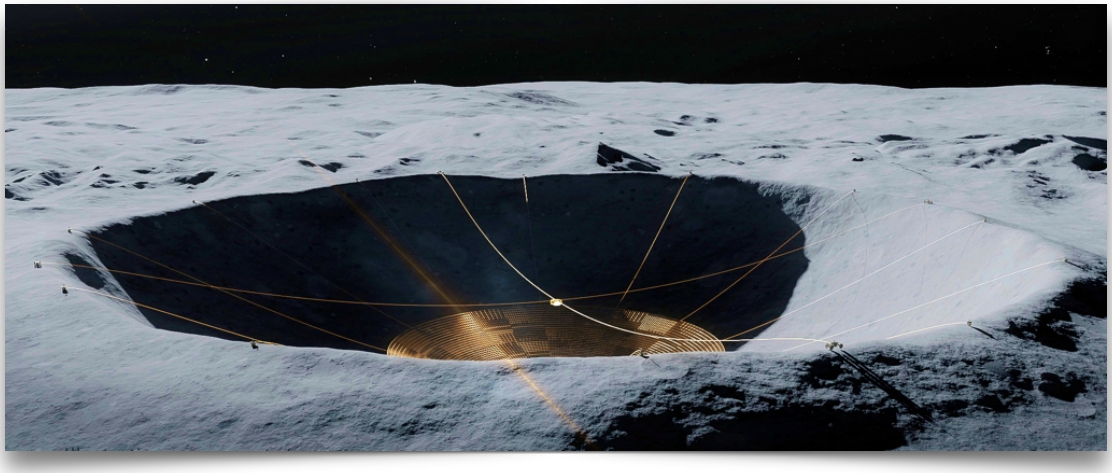
To see more of Miguel Claro's work, please see his website or follow his stories on Instagram at www.instagram.com/miguel_claro.

Editor's Note: If you snap your own photos of the sky and would like to share them with Space.com's readers, send your photo(s), comments, and your name and location to **spacephotos@space.com**. ☀

Scientists Unveil Plan For a Giant 'Hypertelescope' on The Moon

By Brian Koberlein

ScienceAlert, Sep 11 2023



We have built telescopes in our backyards, and high upon remote mountains, and even launched telescopes into space.

With each advancement in our technology, we have made amazing and surprising new discoveries about the Universe. So what should our next advance in observatories be?

Based on a new paper on the arXiv, a good choice would be the lunar surface.

Placing telescopes on the Moon is not a new idea. Already NASA has funded an exploratory grant for the Lunar Crater Radio Telescope (LCRT). During the Apollo missions, astronauts placed retroreflectors on the Moon so that astronomers could measure the distance to the Moon within millimeters

In this new paper, the authors summarize several known ideas and also introduce a new concept they call a hypertelescope.

While radio telescopes on the lunar far side such as LCRT are perhaps the most popular proposal, others include the Life Finder Telescope At Lunar Poles (LFTALP), which would be an array of 6.5-meter telescopes focused on studying exoplanet atmospheres as they transit their star.

Then there is the Lunar Optical UV Explorer (LOUVE), which focuses on bright ultraviolet objects. There are even proposals for a gravitational wave observatory similar to LIGO.

The problem with all of these proposals is that they will require construction at a technical level that would be a challenge even on Earth. The idea of building array observatories and the like on the Moon is a lofty goal, but it is currently far beyond our technical abilities.

So the authors propose a somewhat simpler idea. A basic optical telescope that would take advantage of the lunar terrain. The power of an optical telescope depends largely on the size of its primary mirror and the focal length of the telescope. On Earth, focal length can be increased by having multiple mirrors.

A hypertelescope could use a mirror array as the primary mirror arranged along the terrain of a crater. The detector cluster of the telescope could then be suspended by a cable, similar to the way the detectors of Arecibo Observatory were suspended above the mesh dish.

Since the mirrors wouldn't need to be large, they would be much easier to construct, and the general shape of the crater would mean less "earthworks" needed to put them in place.

A variant of this idea would be to place mirrors on one side of a crater, and the instrumentation on the other. This would allow for a very large focal length, the the observational range such such a telescope would be limited.

All of these ideas are still in their early stages. And there are serious challenges that would need to be overcome beyond their construction.

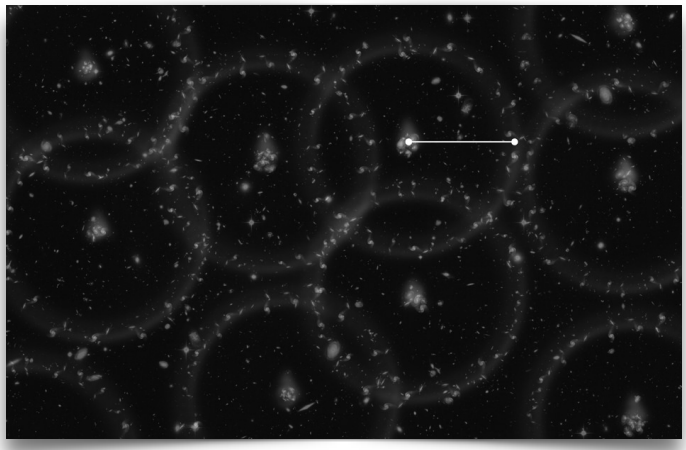
Dust would accumulate on the mirrors over time, and would need to be removed. And although the Moon has much less seismic activity than Earth, it could still affect the alignment of mirrors and detectors.

But one thing that's clear is that we will return to the Moon, and where humans go they build telescopes. A lunar observatory is only a matter of time. ☀

Another New Way to Measure Distance in the Universe: Baryon Acoustic Oscillations

By Matt Williams

Universtoday, Sep 7, 2023



An artist's concept of the latest, highly accurate measurement of the Universe from BOSS. The spheres show the current size of the "baryon acoustic oscillations" (BAOs) from the early universe, which have helped to set the distribution of galaxies that we see in the universe today. Galaxies have a slight tendency to align along the edges of the spheres — the alignment has been greatly exaggerated in this illustration. BAOs can be used as a "standard ruler" (white line) to measure the distances to all the galaxies in the universe

Measuring cosmic distances is a major challenge thanks to the fact that we live in a relativistic Universe. When astronomers observe distant objects, they are not just looking through space but also back in time. In addition, the cosmos has been expanding ever since it was born in the Big Bang, and that expansion is accelerating. Astronomers typically rely on one of two methods to measure cosmic distances (known as the Cosmic Distance Ladder). On the one hand, astronomers rely on redshift measurements of the Cosmic Microwave Background (CMB) to determine cosmological distances.

Conversely, they will rely on local observations using parallax measurements, variable stars, and supernovae. Unfortunately, there is a discrepancy between redshift measurements of the CMB and local measurements, leading to what is known as the Hubble Tension. To address this, a team of astronomers from several Chinese universities and the University of Cordoba conducted a two-year statistical analysis of one million galaxies. From this, they've developed a new technique that relies on Baryon Acoustic Oscillations (BAO) to determine distances with a greater degree of precision.

The team included Kun Xu, a postgraduate researcher at Shanghai Jiao Tong University (SJTU) and the Institute for Computational Cosmology (ICC) at the University of Durham; Yipeng Jing, a professor at the Tsung-Dao Lee Institute and Shanghai Key Laboratory for Particle Physics and Cosmology at SJTU; and Gong-Bo Zhao, the Deputy Director of the National Astronomy Observatories (NAO-CAS), the University of Chinese Academy of Sciences (UCAS), and the Institute for Frontiers in Astronomy and Astrophysics (IFAA). They were joined by Antonio J. Cuesta, an associate professor of physics at the University of Cordoba. The paper that describes their findings recently appeared in the journal *Nature Astronomy*.

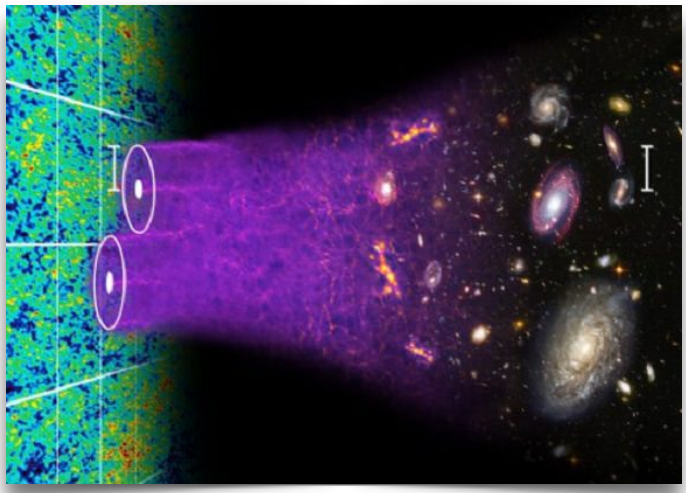
Baryon Acoustic Oscillations, first demonstrated in 2005, are one of the few traces of the Big Bang that can still be detected in the cosmos (like the CMB). During the first 380,000 years after the Big Bang, these waves propagated through matter so hot it behaved like a liquid, like ripples through a pond. As the Universe expanded and cooled over the next 500 million years, these waves effectively became "frozen in time." Since the exact duration of these waves is known, they are very useful for measuring cosmological distances based on the separation between galaxies.

Detecting BAOs and determining their size is essential to accurately mapping the Universe out to objects billions of light-years away (cosmological distances). For their study, the team used statistical methods to examine close to one million galaxies contained in the twelfth data release (DR12) from the Baryon Oscillation Spectroscopic Survey (BOSS) CMASS samples, combined with the Dark Energy Spectroscopic Instrument (DESI) Legacy Imaging Surveys. This allowed them to obtain accurate information on the ellipticity of the galaxies and the density around them.

This was important since the gravitational force of neighboring galaxies typically stretches out galaxies to the point where they are in relative proximity to each other. But in some places throughout the Universe, this effect is not as intense. Upon examining all the combined data, they found that their method showed

where BAOs could be found. As Prof. Cuesta stated in a University of Cordoba press release:

"It is in those points, where galaxies do not point where they should, where statistics tell us that the Baryon Acoustic Oscillations are located, since these waves also act as points of gravity attraction. The first practical application that this study could have is to establish more precisely where the galaxies are located, and the separation between them and the Earth, but, in a way, we are also gazing into the past."

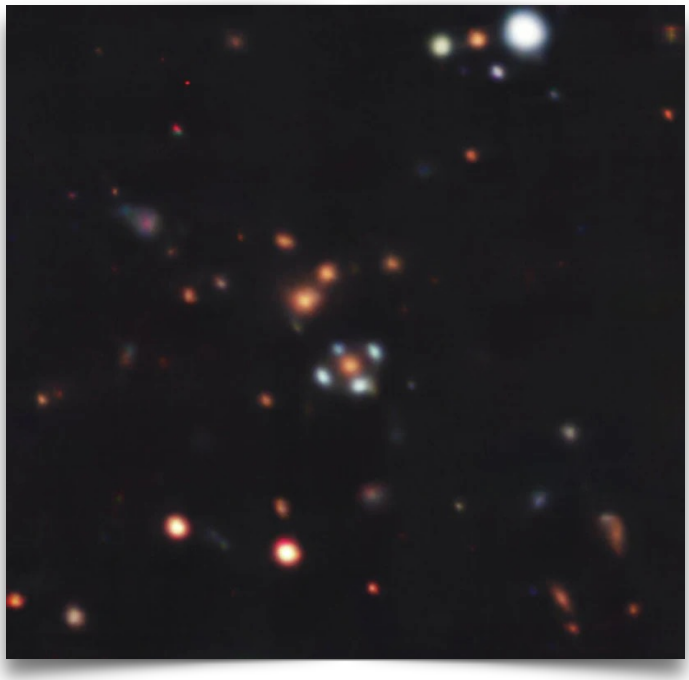


An illustration of the concept of BAOs, which are imprinted in the early Universe and can still be seen today in surveys like BOSS

Combined with other methods in the Cosmic Ladder, this independent technique could help resolve one of the more troubling issues in modern cosmology. Obtaining accurate estimates of cosmic distances will open new doors in astronomy, including how the Universe has expanded over time. This could lead to revolutionary insight into the physics that govern the cosmos, potentially resolving questions about the existence and role of Dark Matter and Dark Energy – two of the greatest mysteries in modern astronomy.

They could also reveal that our notions of how gravity behaves on the largest of scales (as described by General Relativity) require some revision, perhaps leading to the adoption of alternative models like Modified Newtonian Dynamics (MOND). ☀

Astronomers Spot Rare Phenomenon That Einstein Predicted We'd Never See



By Kiona Smith

Inverse, september 13, 2023

Gravitational lensing is the gift that keeps on giving.

Astronomers have just spotted a phenomenon in the sky that Albert Einstein predicted we'd never see — and it's one of dozens observed so far.

The four light blue spots surrounding the little orange blob in this image from the Very Large Telescope (yes, that is its official name, VLT for short) are actually four images of the same galaxy, projected by a **gravitational lens** in a rare formation called an **Einstein cross**.

Astronomers use gravitationally lensed images like these to study galaxies that would normally be too faint and too far away to see. In this case, the light from the little blue galaxy dates back to 11 billion years ago.

This perfectly aligned pair of galaxies are the stars of a recent paper **in The Astrophysical Journal Letters**.

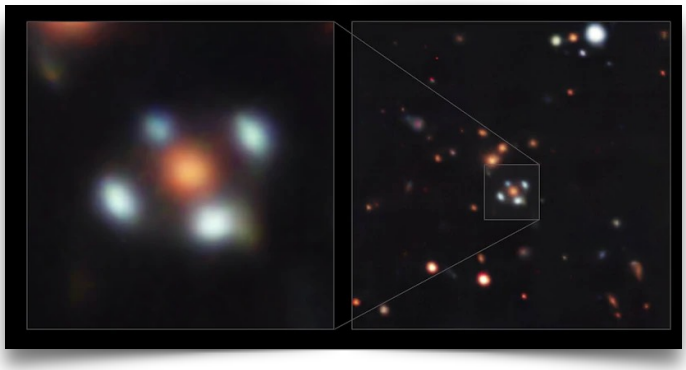
WEIRD PHYSICS TRICK

From our point of view here on Earth, that little blue galaxy lies directly behind the orange one. Because the orange galaxy is so massive, it actually bends the fabric of spacetime, so light has to follow curved paths around the galaxy instead of shining straight through it. Physicists call this a gravitational lens. The little blue galaxy's light emerges from this gravitational lens four times, creating what's called an Einstein cross.

Einstein crosses, or Einstein rings, happen when a gravitational lens, a very distant object, and a telescope line up perfectly across billions of light-years of space. When a gravitational lens is something big and messy, like a whole galaxy cluster, distant objects' light gets stretched and distorted into arcs or just slightly bent. If the mass that forms the gravitational lens is a sphere, you get an **Einstein ring**. But if the mass that forms the lens is elliptical, you get four images of the distant object projected around the lens: an Einstein cross.

Astronomer **Aleksandar Cikota** and his colleagues used an instrument on the VLT to split the light from each pixel of this image into a spectrum, or all the individual wavelengths of light that add up to the color we see. Those spectra of light revealed information about the two galaxies' ages and chemical makeup.

The distant blue galaxy turns out to be 11 billion light years away and bursting with star formation; that's why it looks so blue, despite being so far away. Such a distant galaxy would normally be red because as the universe expands, the light waves shining from the galaxy get stretched out, becoming longer and, therefore, redder. On the other hand, the orange galaxy is only about 5 billion light years away, but it looks redder because it's full of dust and aging stars.



NOBODY IS ALWAYS RIGHT

Physicist and hairstyle icon Albert Einstein predicted gravitational lenses as part of his theory of general relativity. Another physicist predicted that if Earth, the gravitational lens, and a distant object were lined up exactly right, the lens would turn the distant object's image into a halo or ring of light around the lens.

Einstein agreed with the prediction but wrote back, "There is no hope of observing this phenomenon directly." He thought we'd never find distant galaxies in such perfect alignment and that we'd never have telescopes capable of seeing the cosmos in enough detail.

But astronomers discovered the first so-called "Einstein ring" in 1998. Years earlier, in 1985, a different team of astronomers spotted the first known "Einstein cross." Today, astronomers have documented dozens of these formations, and Cikota and his colleagues say it's likely more will turn up over the next decade thanks to upcoming telescopes like Euclid and Nancy Grace Roman. ☀

Carbon source found on surface of Jupiter's moon Europa

Sciencedaily, September 23, 2023

Summary:

Astronomers using data from NASA's James Webb Space Telescope have identified carbon dioxide in a specific region on the icy surface of Europa.

Jupiter's moon Europa is one of a handful of worlds in our solar system that could potentially harbor conditions suitable for life. Previous research has shown that beneath its water-ice crust lies a salty ocean of liquid water with a rocky seafloor. However, planetary scientists had not confirmed if that ocean contained the chemicals needed for life, particularly carbon.

Astronomers using data from NASA's James Webb Space Telescope have identified carbon dioxide in a specific region on the icy surface of Europa. Analysis indicates that this carbon likely originated in the subsurface ocean and was not delivered by meteorites or other external sources. Moreover, it was

deposited on a geologically recent timescale. This discovery has important implications for the potential habitability of Europa's ocean.

"On Earth, life likes chemical diversity -- the more diversity, the better. We're carbon-based life. Understanding the chemistry of Europa's ocean will help us determine whether it's hostile to life as we know it, or if it might be a good place for life," said Geronimo Villanueva of NASA's Goddard Space Flight Center in Greenbelt, Maryland, lead author of one of two independent papers describing the findings.

"We now think that we have observational evidence that the carbon we see on Europa's surface came from the ocean. That's not a trivial thing. Carbon is a biologically essential element," added Samantha Trumbo of Cornell University in Ithaca, New York, lead author of the second paper analyzing these data.

NASA plans to launch its Europa Clipper spacecraft, which will perform dozens of close flybys of Europa to further investigate whether it could have conditions suitable for life, in October 2024.

A Surface-Ocean Connection

Webb finds that on Europa's surface, carbon dioxide is most abundant in a region called Tara Regio -- a geologically young area of generally resurfaced terrain known as "chaos terrain." The surface ice has been disrupted, and there likely has been an exchange of material between the subsurface ocean and the icy surface.

"Previous observations from the Hubble Space Telescope show evidence for ocean-derived salt in Tara Regio," explained Trumbo. "Now we're seeing that carbon dioxide is heavily concentrated there as well. We think this implies that the carbon probably has its ultimate origin in the internal ocean."

"Scientists are debating how much Europa's ocean connects to its surface. I think that question has been a big driver of Europa exploration," said Villanueva. "This suggests that we may be able to learn some basic things about the ocean's composition even before we drill through the ice to get the full picture."

Both teams identified the carbon dioxide using data from the integral field unit of Webb's Near-Infrared Spectrograph (NIRSpec). This instrument mode provides spectra with a resolution of 200 x 200 miles (320 x 320 kilometers) on the surface of Europa, which has a diameter of 1,944 miles, allowing astronomers to determine where specific chemicals are located.

Carbon dioxide isn't stable on Europa's surface. Therefore, the scientists say it's likely that it was supplied on a geologically recent timescale -- a conclusion bolstered by its concentration in a region of young terrain.

"These observations only took a few minutes of the observatory's time," said Heidi Hammel of the Association of Universities for Research in Astronomy, a Webb interdisciplinary scientist leading Webb's Cycle 1 Guaranteed Time Observations of the solar system. "Even with this short period of time, we were able to do really big science. This work gives a first hint of all the amazing solar system science we'll be able to do with Webb."

Searching for a Plume

Villanueva's team also looked for evidence of a plume of water vapor erupting from Europa's surface. Researchers using NASA's Hubble Space Telescope reported tentative detections of plumes in 2013, 2016, and 2017. However, finding definitive proof has been difficult.

The new Webb data shows no evidence of plume activity, which allowed Villanueva's team to set a strict upper limit on the rate of material potentially being ejected. The team stressed, however, that their non-detection does not rule out a plume.

"There is always a possibility that these plumes are variable and that you can only see them at certain times. All we can say with 100% confidence is that we did not detect a plume at Europa when we made these observations with Webb," said Hammel.

These findings may help inform NASA's Europa Clipper mission, as well as ESA's (European Space Agency's) upcoming Jupiter Icy Moons Explorer (JUICE).

The two papers will be published in *Science* on Sept. 21. ☀

The Backyard Observer, October 2023

By Rick Heschmeyer

PEGASUS

As the autumn constellations rise higher in the eastern sky each evening, we will turn our attention to the “guidepost” fall constellation of Pegasus this month. Pegasus was the winged horse of Greek mythology, born from the severed head of the gorgon Medusa after the hero Perseus had slain her. Pegasus is easy to find in the autumn sky, as it is a large constellation, the seventh largest in the sky.

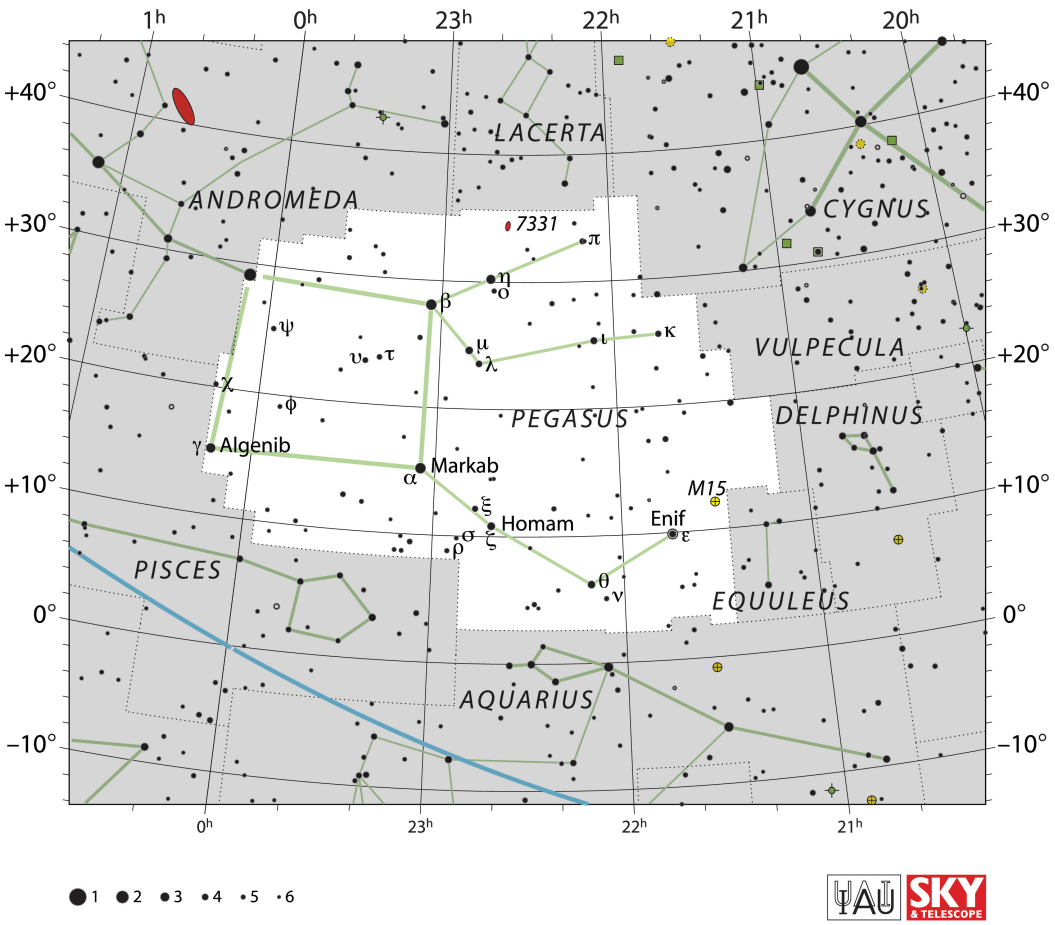
Just look for the asterism “The Great Square” making up the horse’s “body” in depictions of the constellation. The northwest star in the square, formally known as Delta Pegasi, is now an official member of the neighboring constellation Andromeda, Alpha Andromedae. The star’s proper name Alpheratz translates into “the navel of the horse.” Pegasus is a large constellation, the seventh largest in the sky.

One other star is of note. Enif, representing the nose of the horse, is a triple star system that lies about 500 light years away. Enif is the brightest star in the constellation at magnitude 2.4. The two brightest stars in the system exhibit colors of yellow and violet.

Messier 15 is a bright, rich, compact globular cluster, one of the finest globular clusters in the northern sky. It was discovered in 1746 by the astronomer Miraldi. Despite its distance, about 35,000 light years, it is the 12th brightest globular cluster in the sky. It is the only globular cluster known to contain a planetary nebula.

The brightest galaxy in Pegasus is NGC 7331. It was discovered almost 250 years ago by Sir William Herschel, and is the brightest galaxy in the NGC 7331 Group of Galaxies. It is a group in appearance only, the other galaxies are much more distant, but just happen to coincidentally lie in the same general direction. NGC 7331 is a spiral galaxy that lies about 40 million light years distant. From a dark sky site, observers have been able to discern the galaxy in binoculars of 50mm aperture or larger, with its bright core surrounded by an oval shaped glow.

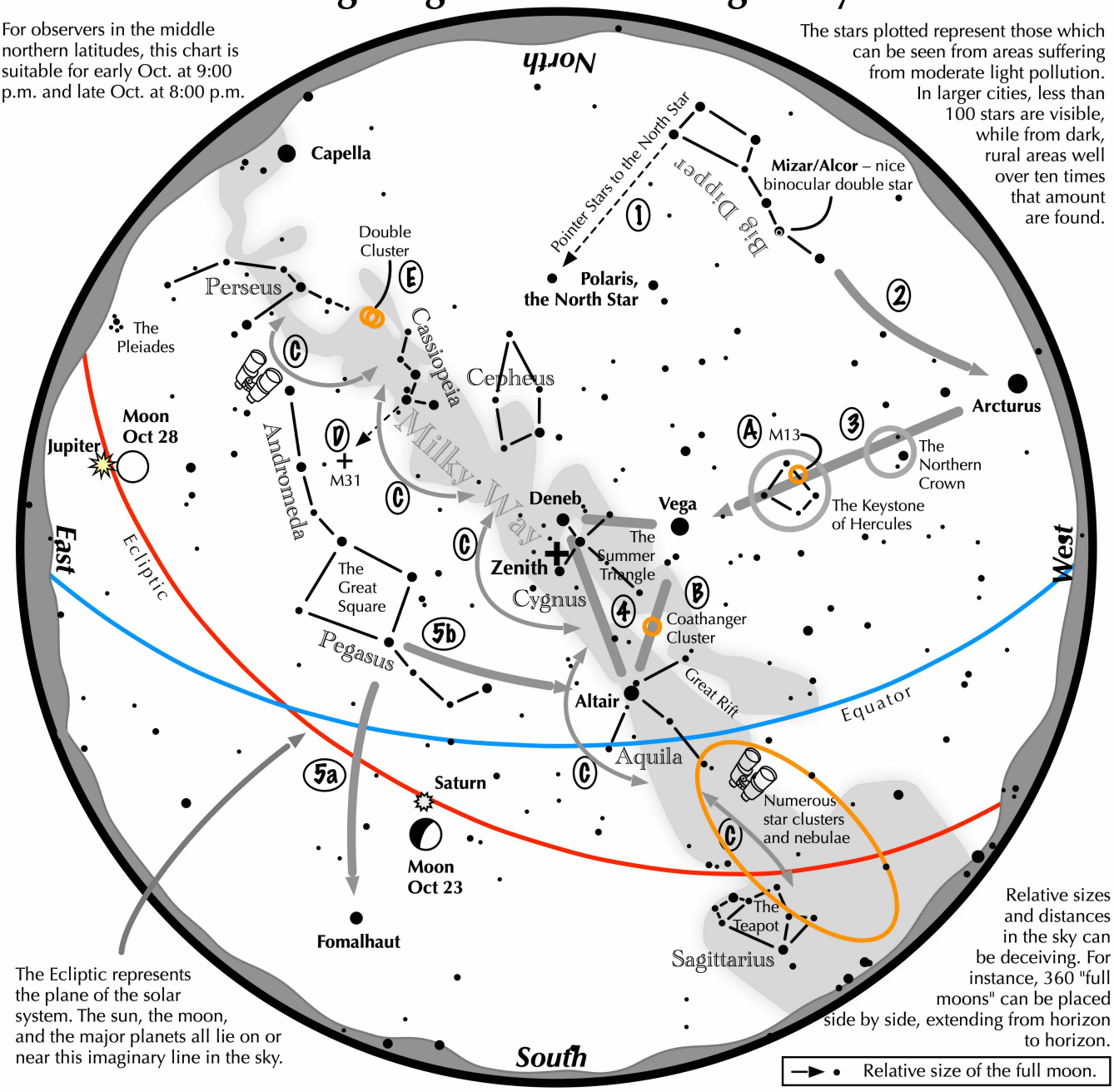
There is one meteor shower associated with the constellation, the weak July Pegasids, that has a maximum of only about 3 meteors per hour on July 11 each year. The origin of this shower is likely Comet 1979 Y1 (Bradfield).



Navigating the October Night Sky

For observers in the middle northern latitudes, this chart is suitable for early Oct. at 9:00 p.m. and late Oct. at 8:00 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.

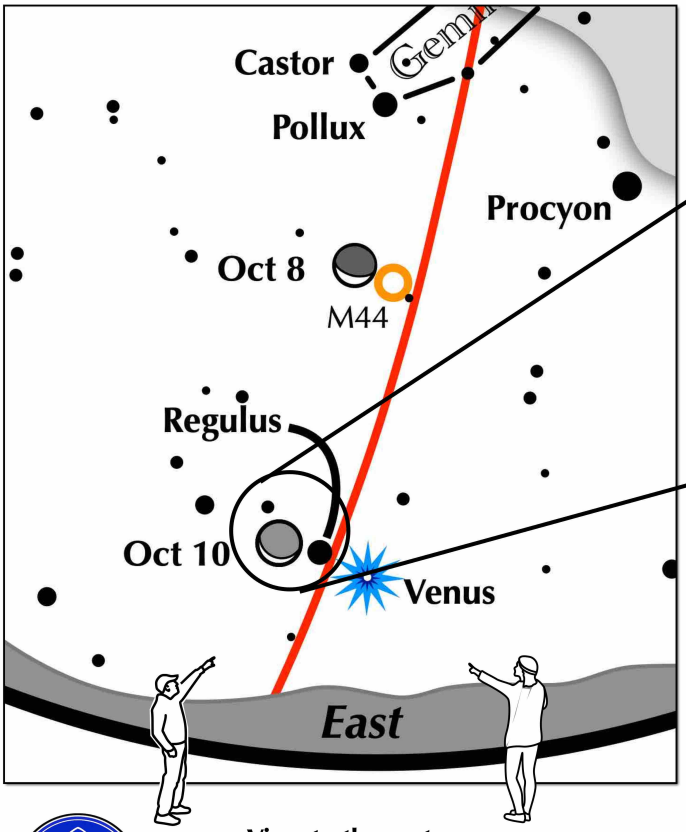
Navigating the October night sky: Simply start with what you know or with what you can easily find.

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 early October 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. Nearly overhead lie the summer triangle stars of Vega, Altair, and Deneb.
5. High in the east are the four moderately bright stars of the Great Square. Its two southern stars point west to Altair. Its two western stars point south to Fomalhaut.

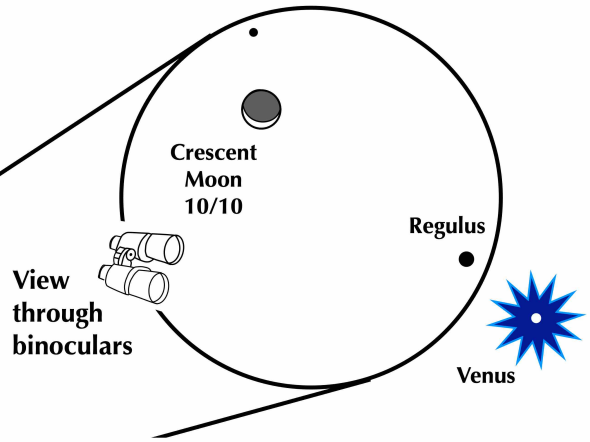
Binocular Highlights

A: On the western side of the Keystone glows the Great Hercules Cluster, a ball of 500,000 stars. **B:** 40% of the way between Altair and Vega, twinkles the "Coathanger," a group of stars outlining a coathanger. **C:** Sweep along the Milky Way for an astounding number of fuzzy star clusters and nebulae amid many faint glows and dark bays, including the Great Rift. **D:** The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval. **E:** Between the "W" of Cassiopeia and Perseus lies the Double Cluster.

In the early morning on October 10, try this challenge:



View to the east
on October 10
90 minutes before sunrise



Crescent moon meets Venus and Regulus

On the morning of October 10, the crescent moon, glowing full with earthshine, floats left of brilliant Venus. Look 90 minutes before sunrise.

Between them, shines Leo's brightest star, Regulus.

Two mornings earlier a thicker crescent moon was near M44, the Beehive star cluster.

The meeting of the crescent moon and Venus also occurs on the mornings of November 9 when the moon nearly covers Venus, and of December 9.

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.