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The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

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

Public Observing
October 26, 2025, 8:00PM
Baker Wetlands Discovery Center

Club Officers

President
Rick Heschmeyer email

AICOR
William Winkler email

NSN Coordinator
Howard Edin email

Faculty Advisor
Dr. Jennifer Delgado email.

Newsletter Editor
Chuck Wehner email

Inside This Issue

Report From the Officers

By Rick Heschmeyer

David Kolb will be talking about Cecilia Payne-Gaposckin and her discovery of the composition of stars at our September Club Meeting on Sunday, September 28, 2025. The meeting starts at 7:00 PM and will be followed, weather permitting, by public telescope observing.

The first of our two scheduled fall events at the KU Field Station took place on Saturday, September 6th after being delayed one day from the original date due to inclement weather. We had a very good turnout of around 50 people, as well as help from about a half-dozen club members. Our final event at the Field Station is scheduled for Friday, October 3 at 8:00 PM. A rain date is scheduled for the following Saturday evening (same time) in the event of uncooperative weather. As we expect at least as many attendees as in September, we will need as much help as possible. Even if you don't have a telescope, we can still put you to work. Drop me a note if you what to assist.

The next KU Public Telescope Night will happen on Thursday, October 9. More information can be found at this link.

https://physics.ku.edu/astronomy-public-telescope-nights

On October 26, Dhwani Rupali Vani, of the University of Kansas, will present the talk "Biosignatures in Stone and Space: Raman Spectroscopy Bridging Geology and Astronomy". Meeting will take place at Baker Wetlands Discovery Center and start at 7 PM. It will be followed, as always weather permitting, by public observing through club telescopes.

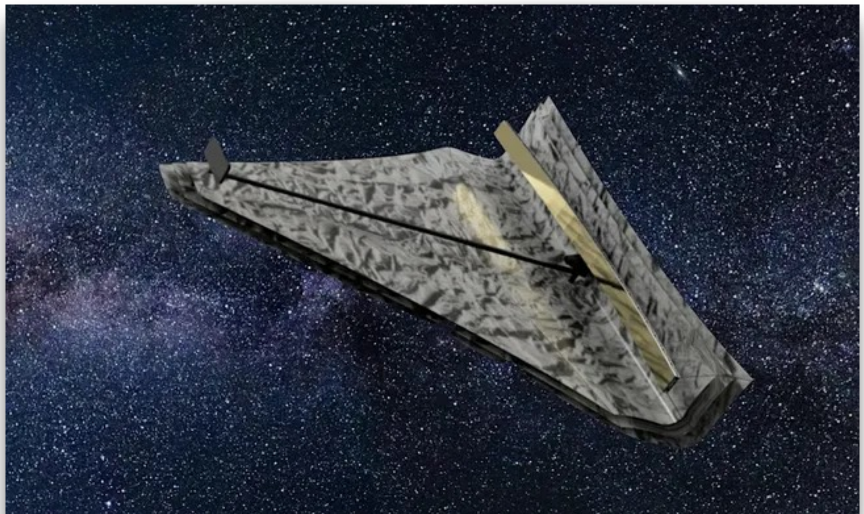
Looking forward to seeing everyone at our upcoming events.

Clear Skies!

Could a unique rectangular telescope be the key to finding Earth 2.0?

By Keith Cooper
SPACE.COM, SEPTEMBER 1, 2025

To resolve nearby Earth-like exoplanets, a new telescope design that is rectangular rather than circular may be necessary, according to a new study that explores what the next great space telescope might look like.



"We show that it is possible to find nearby, Earth-like planets orbiting sun-like stars with a telescope that is about the same size as the James Webb Space Telescope[(JWST], operating at roughly the same infrared wavelength as JWST, with a mirror that is a one by 20 meter [65.6 by 3.3 foot] rectangle instead of a circle 6.5 meters [21.3 feet] in diameter," Heidi Newberg, who is a professor of astrophysics at Rensselaer Polytechnic Institute in New York, wrote in an editorial about the concept.

Top of the National Academies' Astronomy and Astrophysics Decadal Survey is a new space telescope that is capable of imaging Earth-size planets in the habitable zone of sun-like stars. Although no design has been settled upon yet, a round-ish mirror with a minimum aperture of 26 feet (eight meters) has been mooted. This is five feet (1.5 meters larger than the current largest orbiting observatory, the JWST.

Yet Newberg believes there is another way.

If the aim is to image a planet with an atmosphere laden with water vapor, then the telescope would need to be optimized to detect light with a wavelength of 10 microns (10 millionths of a meter, equivalent to the thickness of a human hair), which is the infrared wavelength at which water vapor emits.

The JWST's Mid-Infrared Instrument (MIRI) can observe at this wavelength, and indeed it has detected water vapor in the atmosphere of hot, massive exoplanets. Observing in infrared also provides a contrast boost: a planet would be a billion times fainter than its star in visible light, but in the best case scenario it would be "only" a million times fainter at 10 microns — still extremely faint, but feasibly within range of a next-generation space telescope.

However, the JWST's 21.3-foot (6.5-meter) segmented mirror is too small to resolve an Earth-size, water-rich planet in the habitable zone of a sun-like star. The angular resolution of a telescope is determined by the observed wavelength divided by the telescope diameter and multiplied by 1.22 (called this the Rayleigh criterion). To resolve an Earth-size planet at 10 microns at a distance of about 30 light-years would require a telescope aperture approaching 20 meters (65.6 feet). But such a telescope would be prohibitively expensive and an engineering nightmare as it would need to be folded up several times to fit inside the faring of whichever rocket might launch it.

Alternatively, many small telescopes could be launched into space to work as an optical interferometer, combining the light of all the telescopes to give the resolution of a larger aperture. However, this would need extremely precise alignment between the smaller telescopes, a technological challenge that would be expensive and perhaps not even possible with current technology.

Newberg's team, however, realized that a large rectangular telescope mirror would be much more efficient than a huge circular one, and because of its relative simplicity it would be much less costly than an interferometer. A telescope mirror that is a strip with dimensions of 65.6 feet by 3.3 feet (20 meters by 1 meter) would have a smaller area than a circular mirror of the same width, and therefore be much less expensive. The idea would then be to align the telescope lengthways with the orientation of the target exoplanet relative to its star. If the planet is in another orientation, the rectangular telescope can then be rotated.

Remarkably, such a telescope would actually have a slightly smaller collecting area (65.6 square feet, or 20 square meters) than the JWST (83.3 square feet, or 25.4 square meters). The difference is that all its collecting area would be in the orientation that is needed to image a planet, with nothing wasted.

There are 69 approximately sun-like stars (spectral classes K, G and F), not to mention almost 300 of the coolest stars, M dwarfs, all within 32.6 light-years (10 parsecs) of our solar system that a new telescope could target.

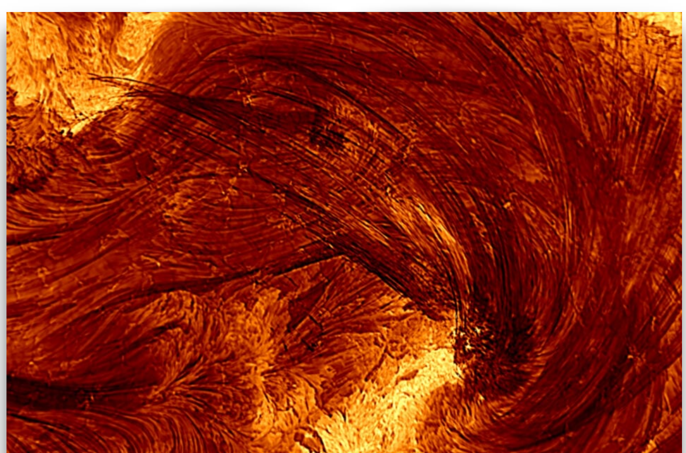
"We show that this design can, in principle, find half of all existing Earth-like planets orbiting sun-like stars within 30 light years in less than three years," writes Newberg. "If there is about one Earth-like planet orbiting the average sun-like star, then we would find around 30 promising planets."

A paper describing the new telescope concept was published on Sep. 1 in the journal Frontiers in Astronomy and Space Sciences. ☀

Our Best Look Yet at a Solar Flare Reveals the Sun's Wilder Side

By Gayoung Lee

Gizmodo, August 29, 2025



It took astronomers a little over a year to analyze the sharpest-ever images of a solar flare. But they're finally done, and the results are illuminating—literally and figuratively.

Last year, NSF's Daniel K. Inouye Solar Telescope captured a high-resolution image of a solar flare crossed with dark strands of coronal loops. Further analysis revealed that the solar flare was an X-class flare—the most powerful class—in a decay phase. The coronal loop strands averaged around 30 miles (48 kilometers) in width, with a minimum thickness of 13 miles (21 km), which would make them the smallest coronal loops ever seen. A detailed account of the imaging and analysis was published in The Astrophysical Journal Letters on August 25, 2025.

"These flares are among the most energetic events our star produces, and we were fortunate to catch this one under perfect observing conditions," said Cole Tamburri, study lead author and a postdoctoral student at the University of Colorado Boulder, in a release.

The solar incentive

For astronomers, every crackle, cough, and combustive explosion from the Sun registers as a warning signal for an incoming solar storm—a burst of energy with the power to jumble up Earth's weather and network systems. That, along with the obvious academic motivations, drives researchers to zoom in on our star's fiery surface.

Coronal loops are thin plasma arches tracing across the Sun's magnetic field lines. These plasma ribbons often precede solar flares, so paying attention to their motion could help Earthbound observers better understand the dynamics of solar weather.

Solving a solar mystery

The finding also represents the first observational confirmation of how wide coronal loops can grow—a metric that has long remained in the realm of theory. The unprecedentedly sharp details of Inouye's image allowed astronomers to analyze each loop.

"It's like going from seeing a forest to suddenly seeing every single tree," Tamburri added. "This opens the door to studying not just their size, but their shapes, their evolution, and even the scales where magnetic reconnection—the engine behind flares—occurs."

The researchers are also wondering if coronal loops could represent "fundamental building blocks of flare architecture," they said. If so, that knowledge alone could revolutionize how researchers perceive data from the Sun—and therefore its effect on Earth.

"It's a landmark moment in solar science," Tamburri said. "We're finally seeing the Sun at the scales it works on." ☀

'A bundle of microscopic tornadoes' may have given the universe its structure

By Andrey Feldman
LIVESCIENCE, JUNE 19, 2025

When invisible dark matter spins, it may form clumps of "vortexes" that stretch across space, forming the cosmic web that links all galaxies, new research proposes.

The universe's invisible dark matter might swirl into spinning clumps laced with countless tiny vortices, new theoretical work suggests.

The findings, published May 30 in the journal Physical Review D, offer a fresh perspective on the strange behavior of "ultralight" dark matter — a hypothetical substance made of extremely light elementary particles.

In the new study, physicists explored what happens when a dark matter halo rotates — a natural expectation for real galaxies, which typically spin as they evolve. Based on their theoretical modeling and detailed simulations, the authors found that this exotic material could behave like a superfluid, forming stable, rotating cores threaded with vortex lattices much like those seen in laboratory experiments.

A special kind of dark matter

Unlike the standard view of dark matter as a cloud of heavy, sluggish particles with no internal structure, the new research focuses on dark matter made of particles lighter than a millionth of an electron's mass. These particles may not float passively in space; if they interact slightly with one another through a repulsive force, they can behave more like a quantum fluid.

That fluid-like behavior allows the formation of "solitons" — compact, coherent structures where gravity's pull inward is balanced by an outward pressure from self-interactions.

"Solitons are classical solutions of the equations of motion," Philippe Brax, a theoretical physicist at Université Paris-Saclay and co-author of the study, told Live Science. "They correspond to hydrostatic equilibria where the attractive gravitational force is balanced by the repulsive particle self-interaction, somewhat like the Sun, which is also in hydrostatic equilibrium."

These solitons could range from the size of stars to entire galaxies, depending on the unknown mass of the dark matter particle. In larger cases, they could help explain why the centers of galaxies appear less densely packed with dark matter than predicted — a long-standing issue in cosmology.

From spinning clouds to vortex lattices

The researchers simulated what happens when clouds of this unusual dark matter rotate. The result was surprising: Instead of spinning smoothly like a hurricane or a solid sphere, the solitons developed an internal lattice of microscopic vortices.

"When the initial conditions are such that the dark matter cloud rotates, the end result is a rotating soliton at the center of the collapsed halo," said study co-author Patrick Valageas, also of the Université Paris-Saclay. "This soliton shows an oblate shape aligned with the initial rotation axis, and displays a solid-body rotation supported by quantized vortices."

These vortices aren't like swirling winds or whirlpools in water. Rather, they resemble the quantized vortex lines that appear in superfluids like liquid helium, where the fluid rotates not as a whole but through an array of discrete spinning threads. At the center of each vortex, the dark matter density drops to zero, and together, the vortices align into a regular, lattice-like pattern.

"Our simulations show that these vortex lines are aligned with the total angular momentum and follow circular orbits inside the soliton," Valageas said. "The rotation is not like a smooth wind but more like a bundle of microscopic tornadoes arranged in a crystal pattern."

One intriguing idea the researchers raised is whether these tiny vortex structures have implications on much larger scales. In particular, they speculated that some vortex lines might extend beyond a single halo, connecting galaxies through the vast filaments of the cosmic web — the gigantic tendrils of dark matter that shape the universe's large-scale structure.

"At this stage, the idea that some of these vortex lines could join different halos through the filaments of the cosmic web is a hypothesis," Brax noted. If true, it could mean that quantum effects in dark matter subtly influence how galaxies align and move within these colossal threads.

Detecting such vortex structures would be challenging. Because dark matter doesn't emit or absorb light, scientists can only infer its presence from its gravitational influence on visible matter like stars and gas.

Still, there may be ways to glimpse their effects. "These vortices are associated with troughs in the dark matter density," Brax said. "As such, they imprint characteristic features in the gravitational potential, which may influence the orbits of stars or gas clouds in galaxies like the Milky Way."

In more speculative scenarios, if dark matter interacts even weakly with ordinary matter or light, the vortices might leave more direct fingerprints — but for now, that remains an open question.

The team plans to investigate whether the predicted vortex lattices can be detected through astronomical observations and whether they truly connect to the cosmic filaments that stretch across space.

For now, these ghostly whirlpools remain invisible — but as theory and technology advance, scientists may find that the cosmos is not just filled with unseen matter but woven with patterns of spinning quantum threads. ☀

Satellite Companies Like SpaceX Are Ignoring Astronomers' Calls to Save the Night Sky

Most satellite constellations exceed recommended brightness levels, with some even visible to the naked eye.

AST SpaceMobile is one of the biggest offenders with its massive BlueWalker satellites.

By Passant Rabie
GIZMODO, AUGUST 28, 2025

There are more than 12,000 active satellites circling Earth at the moment, a growing figure that has nearly doubled in less than three years. This recent boom in the satellite industry has been a major headache for astronomers, with bright satellites appearing as streaks in telescope images of the universe and tarnishing views of the night skies.

A new paper reveals that satellite constellations are brighter than the recommended limits set forth by astronomers, with only one company adhering to the guidelines. The paper, appearing in the preprint server arXiv, compares the observed brightness magnitudes of satellite constellations in Earth orbit with brightness limits established by the International Astronomical Union's (IAU) Center for the Protection of the Dark and Quiet Sky (CPS).

Nearly all the satellites were found to exceed the limit of +7 brightness magnitude, thereby interfering with observations of the cosmos. The brightest satellites belonged to Texas startup AST SpaceMobile, with its

BlueWalker constellation exceeding a brightness magnitude of +2.

Saving our views of space

Due to more affordable access to space, the cost of launching satellites to orbit is at an all-time low. In response to the growing number of satellites, the IAU established its center in 2022 in an effort to ensure satellite constellations do not interfere with the study and enjoyment of the night skies.

Although there are no official regulations in place, the CPS established recommendations for maximum acceptable brightness for satellites orbiting below 341 miles (550 kilometers). The IAU established a maximum brightness of +7 magnitude for professional astronomy and below +6 magnitude as the aesthetic reference so it does not impact the public's ability to stargaze without interference from satellites.

SpaceX's Starlink constellation, which includes more than 8,000 satellites currently in orbit, is of major concern to astronomers due to its size and brightness levels. SpaceX has been working with the IAU and other astronomy groups to mitigate the effects of its satellites on astronomical observations after its satellites photobombed a number of telescope images. Early versions of Starlink satellites were at a brightness magnitude of around +3, but SpaceX's modifications have decreased that number to +5 or +6.

The paper, however, does raise concern that although the Starlink Minis are four times larger than the new generation Starlinks, the Gen 2 Mini satellites orbit Earth at a lower altitude of 279 miles (450 kilometers). As a result, the mean apparent brightness of the newer Starlinks is greater despite the company's mitigation efforts to decrease its satellite's reflection.

The worst of the worst

SpaceX's competitor, AST SpaceMobile, is the worst offender by far. The company's BlueWalker satellites have an average apparent magnitude of +3.3, often outshining most objects in the night sky. The BlueWalker satellites boast an array that stretches across 693 square feet, the largest communications array ever deployed in low Earth orbit. AST SpaceMobile is seeking to build a constellation of 100 satellites.

While most companies violated the suggested guidelines, one company stuck to them. London-based OneWeb has 652 satellites in orbit with an average apparent magnitude of +7.85, meeting the adjusted limit considering their altitude of 745 miles (1,200 kilometers) above Earth's surface.

The IAU's center has only set forth suggestive guidelines so far, but it wants to expand its efforts to encourage governments and state officials to better regulate the booming industry. So far, the center's calls have been largely ignored, suggesting regulations do need to be in place if we want to maintain our views of the skies. ☀

The Backyard Observer October 2025

By Rick Heschmeyer

AQUILA

This month's destination is the constellation Aquila, the Eagle. Aquila has a long history, being an early Babylonian constellation connected to an old Babylonian myth of a king who rides an eagle to watch the world from above.

Alpha Aquilae-Altair is the brightest star in Aquila with a magnitude of 0.76 making it the 12th brightest star in the night sky. Altair is relatively close to Earth at only 17 light years distant. One interesting fact about Altair is that is spins so fast it is not spherical, but is flattened into an ablate shape, bulging at the equator and flattened at its poles. Its name is a shortened version of its original Arabic name of "the flying eagle". Altair is also one of the three stars of the Summer Triangle asterism.

The Summer Triangle is composed of Altair, Vega (in Lyra), and Deneb (in Cygnus). It rides high overhead in late summer and early Autumn and is the traditional signpost star grouping of summer. The asterism is bisected by the glow of the Milky Way, visible if you get away from city lights.

NGC 6709 is an open star cluster near the Celestial Equator, southwest of the star Zeta Aquilae. It is visible with the help of binoculars or small telescopes. Its 60 or so stars lie at a distance of about 3500 light years.

NGC 6781 is planetary nebula. It is called the Snow Globe Nebula due to its shape. Unfortunately, it takes larger amateur telescopes to see this small object.

Barnard's E Nebula is a great example of a dark nebula, objects that emit no light and reflect no starlight. We see them only because they lie in front of more distant, bright backgrounds along the same line of sight from Earth. It is in fact two dark nebulae, labelled in E. E. Barnard's catalogue of dark nebulae as B142 and B143. It is a great object for binocular viewing. Just center 3rd-magnitude Gamma Aquilae in your binoculars. Barnard's E lies 1.6° west-northwest of the star.

While Aquila does not contain any bright Messier objects, its location near the summer Milky Way provides glimpses of some under appreciated deep sky objects, as well a great part of the sky for casual binocular sweeps our local galaxy.

Planetary Nebulae

NGC 6741 Phantom Streak Nebula) A small, faint disk.

NGC 6751 Glowing Eye Nebula) Complex shell structure.

NGC 6781 Another notable planetary nebula.

Galaxies

NGC 6814 A galaxy located in the constellation.

NGC 6922 Another galaxy within Aquila.

Observation Tips Most of these objects are best seen with a small telescope.

Star Clusters

NGC 6709 A prominent open cluster.

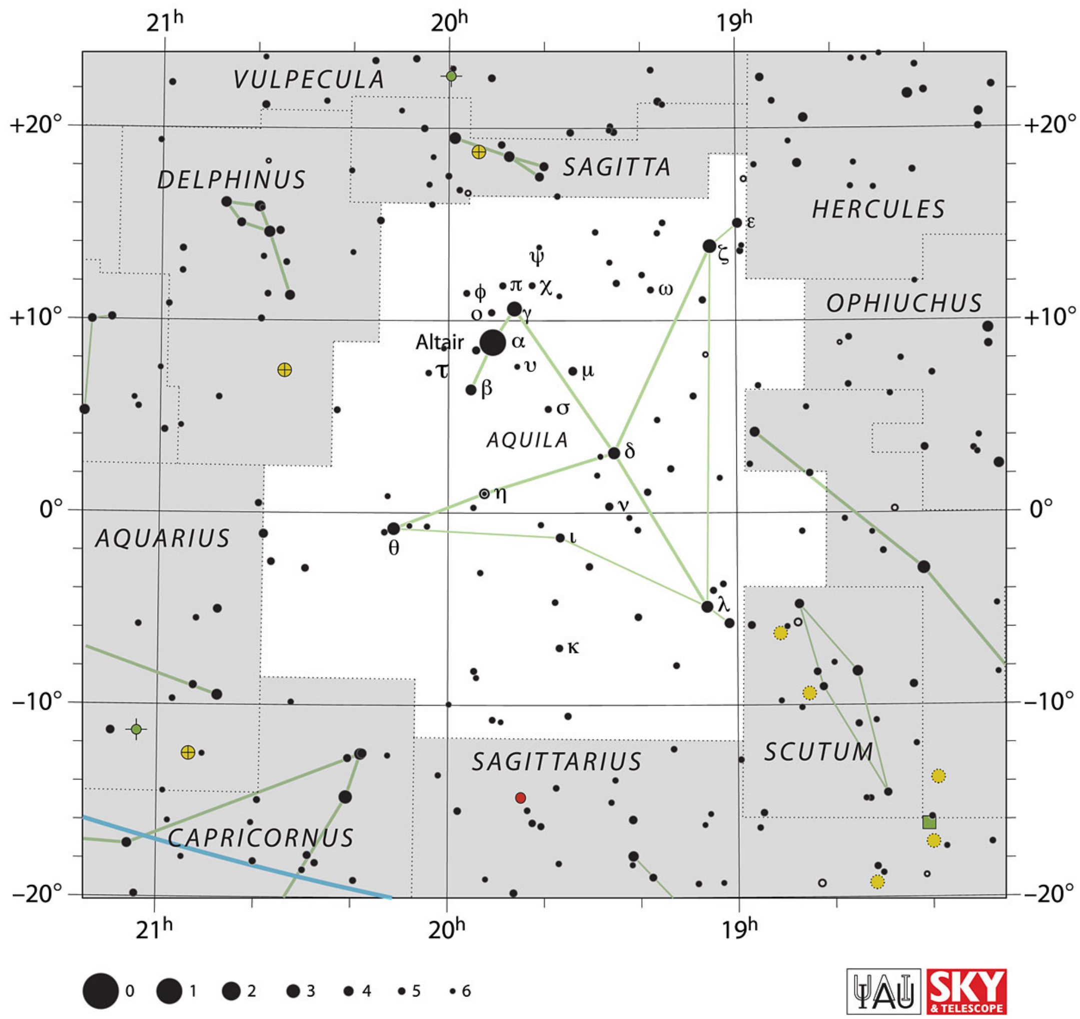
NGC 6755 An open cluster in the Milky Way

NGC 6760 A globular cluster in the center of Aquila.

Other Objects

Bernard's E Nebula A pair of dark nebulae.

Hercules-Corona Borealis Great Wall An extremely large structure of extragalactic objects.



The Moon could finally reveal dark matter

Sciencenews, September 18, 2025

Ordinary matter, which makes up the stars, planets, and everything we can see, makes up only about 20 per cent of all matter in the Universe. The remaining 80 per cent is believed to be dark matter: a mysterious substance that does not emit, absorb, or reflect light, and whose true nature remains one of the greatest unsolved problems in modern physics. Despite its invisibility, dark matter is known to play a vital role in the formation of galaxies, such as the Milky Way, and in shaping the large-scale structure of the Universe.

One of the key properties of dark matter is the mass of its constituent particles. If these particles are relatively light, such as less than about 5 per cent of electron mass, then dark matter is considered warm and would inhibit the formation of structures smaller than galaxies. However, if the particles are heavier, dark matter is classified as cold, which would promote the growth of smaller-scale structures.

Astronomers have long sought to determine the dark matter particle mass by studying small-scale structures composed of gas and stars because this information is crucial for particle physicists to develop theoretical models of dark matter.

A new study led by The University of Tsukuba Postdoctoral Fellow Hyunbae Park, who carried out this study during his time as a University of Tokyo Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU, WPI) Project Researcher, and including Kavli IPMU Professor and Max Planck Insitute for Astrophysics Visiting Scientist Naoki Yoshida, focused on small gas clouds that existed during the cosmic Dark Ages, the first 100 million years after the Big Bang before the formation of stars and galaxies. Because the formation and evolution of stars and galaxies involve complex and poorly understood processes, simulating their behavior accurately remains a major challenge in modern computational astrophysics. By targeting an era before these complexities arose, the researchers were able to simulate early cosmic structures with unprecedented precision.

The simulation results revealed how gas gradually cooled as the Universe expanded while developing small gas clumps via gravitational interaction with dark matter during the Dark Ages. The gas in these clumps became much denser than in the average Universe and heated up due to compression. This variation in density and temperature was imprinted in the 21-centimeter radio emission from hydrogen atoms. The team modeled this ancient signal from the primordial gas clouds and found that its sky-averaged strength depends sensitively on whether dark matter is warm or cold. According to the researchers, this difference could allow future lunar experiments to distinguish between competing dark matter scenarios.

The Dark Ages signal is expected to appear at frequencies around 50 MHz or lower with a characteristic frequency modulation, and the difference between the two dark matter scenarios is less than a milli-kelvin in brightness temperature. These frequencies are heavily contaminated by human-made signals on Earth, and further obscured by the ionosphere making it virtually impossible to detect the signal from ground-based observatories. In contrast, the far side of the Moon offers a radio-quiet environment, shielded from terrestrial interference, and is considered an ideal location for detecting the elusive Dark Ages signal.

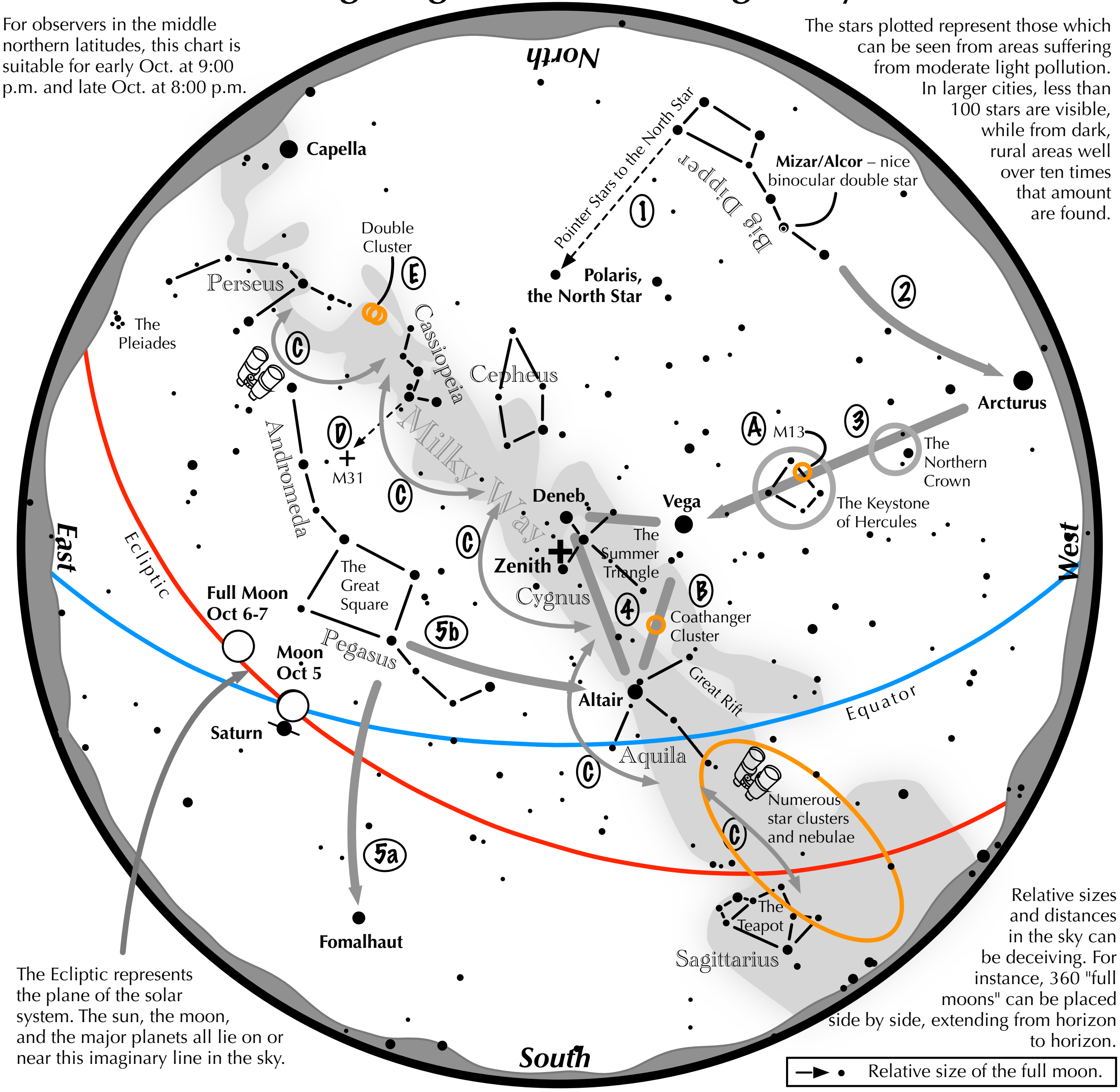
Although building radio observatories on the Moon poses major technological and financial challenges, an increasing number of nations are pursuing such missions as part of the new space race, combining scientific ambition with technological advancement. With this growing international momentum, it is now considered feasible to determine the mass of dark matter particles through lunar-based observations in the coming decades. Among these nations, Japan is actively developing the Tsukuyomi project, which plans to deploy radio antennas on the Moon.

The team's research provides essential theoretical guidance for these near-future missions to maximize their scientific return. ☀

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.

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.

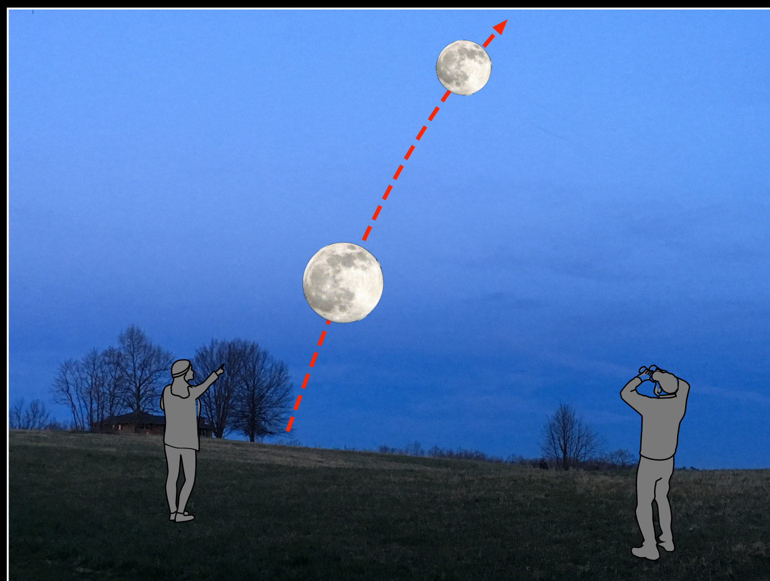
4 Nearly overhead lie the summer triangle stars of Vega, Altair, and Deneb.

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.

Big Moon Rising: Is it real?



When the full moon rises, it seems to be unusually large. Later, when it has climbed higher in the sky, it returns to its expected apparent size. Why is this the case?

A. When the moon is close to the horizon, its apparent size can be compared to those of distant landscape objects. So, it seems larger than it is.
B. When it is near the horizon, it is closer to us than when it is overhead. So, it appears bigger.
C. It is an unconscious psychological effect. The same effect occurs over a featureless sea.

Look at the moon through a drinking straw when it is rising, and later, when it has climbed a good distance above the horizon. Does the apparent size of the moon through the straw appear to change?

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C. would be the most correct. The psychological effect is not well understood.

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.