Volume 49 Number 9 September 2023

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
September 24, 2023, 7:00PM
Baker Wetlands Discovery Center

Public Observing
September 24, 2023, 8:00PM
Baker Wetlands Discovery Center

Club Officers

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Rick Heschmeyer email

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NSN Coordinator
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Inside This Issue

Report From the Officers

By Rick Hjeschmeyer

Summer is behind us, the school year has begun, and with it the restarting of our fall club activities. For our August meeting Rick Heschmeyer presented "A History of Mars Exploration: From Canals to Invasions to Helicopters", tracing a path from Schiaparelli's earliest "canali" drawings to the newest NASA Mars mission featuring the rover Perseverance and the rotocraft Ingenuity.

Once again, the K.U. Department of Physics and Astronomy will be hosting "Telescope Nights at KU", with the first event scheduled for Thursday, September 14th. As more details on this and other Department events are finalized, we will share will the club and add to our calendar.

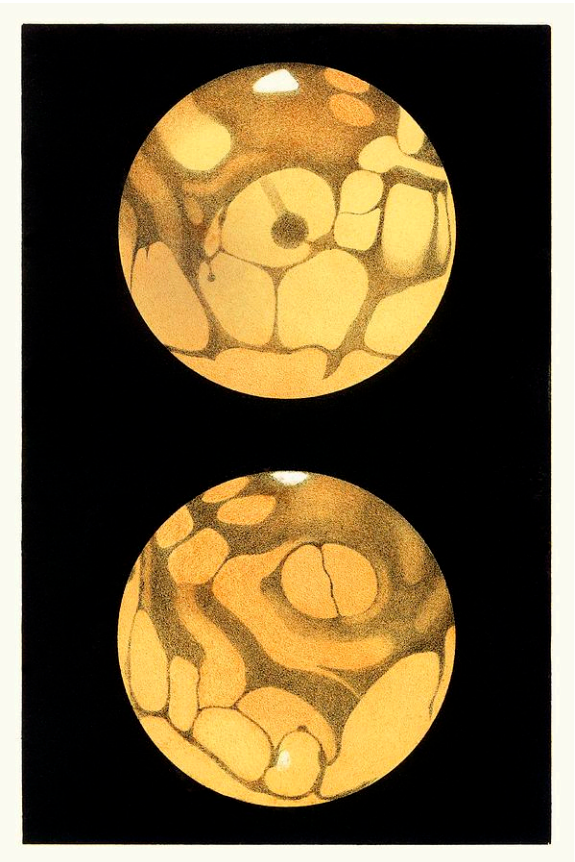
On Saturday, October 14th, a partial solar eclipse will be visible from Lawrence. Currently the plan is to have one event on the K.U. campus and another event somewhere else in Lawrence, to offer more opportunities for the public to participate. If you are willing to help with either event, please let us know. More detail of the plans will be discussed at our September club meeting.

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.

Looking forward to seeing everyone at one of our future club events. Keep looking up.

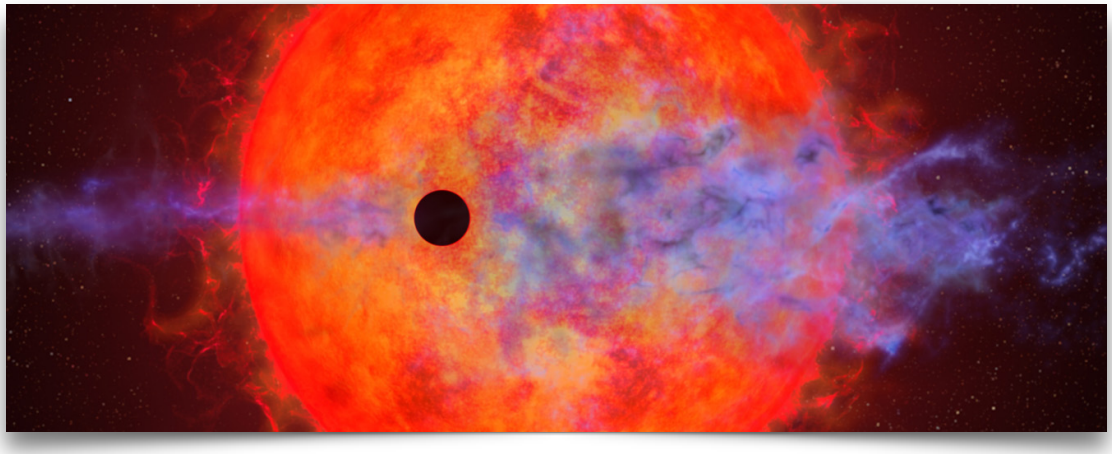


Hubble Sees Evaporating Planet Getting the Hiccups

Hubblesite, July 27, 2023

Summary

Rambunctious Star Pummels Young World with Torrential Winds and Blistering Radiation



Life around an ill-tempered red dwarf star is no fun for accompanying newborn planets. Call it a baptism of fire. Entangled magnetic fields cause a red dwarf to spit out "super-flares" that are 100 to 1,000 times more powerful than similar flares seen on our Sun. That is coupled with blistering ultraviolet radiation requiring any of the star system's inhabitants to use "Sunscreen 5,000." One of the nearest and most violent examples is AU Microscopii. The petulant star is only 1% the age of our Sun. At a distance of 32 light-years, it is only eight times farther away than the nearest star to our Sun, Proxima Centauri (which is another red dwarf).

The star beats-up the system's innermost planet, AU Microscopii b, which is about four times Earth's diameter. Orbiting just 6 million miles from the evil star's "dragon's breath," the planet's largely hydrogen atmosphere is being stripped off, as viewed by the Hubble Space Telescope. But this happens in fits and starts. During one passage of the planet across the face if its star, Hubble detected hydrogen boiling off to create a large cloud ahead of the planet. This unexpected variability is evidence that the interaction between the planet and the red dwarf's feisty fireworks is probably more complex and unpredictable than imagined.

A young planet whirling around a petulant red dwarf star is changing in unpredictable ways orbit-by-orbit. It is so close to its parent star that it experiences a consistent, torrential blast of energy, which evaporates its hydrogen atmosphere — causing it to puff off the planet.

But during one orbit observed with the Hubble Space Telescope, the planet looked like it wasn't losing any material at all, while an orbit observed with Hubble a year and a half later showed clear signs of atmospheric loss.

This extreme variability between orbits shocked astronomers. "We've never seen atmospheric escape go from completely not detectable to very detectable over such a short period when a planet passes in front of its star," said Keighley Rockcliffe of Dartmouth College in Hanover, New Hampshire. "We were really expecting something very predictable, repeatable. But it turned out to be weird. When I first saw this, I thought 'That can't be right.'"

Rockcliffe was equally puzzled to see, when it was detectable, the planet's atmosphere puffing out in front of the planet, like a headlight on a fast-bound train. "This frankly strange observation is kind of a stress-test case for the modeling and the physics about planetary evolution. This observation is so cool because we're getting to probe this interplay between the star and the planet that is really at the most extreme," she said.

Located 32 light-years from Earth, the parent star AU Microscopii (AU Mic) hosts one of the youngest planetary systems ever observed. The star is less than 100 million years old (a tiny fraction of the age of our Sun, which is 4.6 billion years old). The innermost planet, AU Mic b, has an orbital period of 8.46 days and is just 6 million miles from the star (about 1/10th the planet Mercury's distance from our Sun). The bloated, gaseous world is about four times Earth's diameter.

AU Mic b was discovered by NASA's Spitzer and TESS (Transiting Exoplanet Survey Satellite) space telescopes in 2020. It was spotted with the transit method, meaning telescopes can observe a slight dip

in the star's brightness when the planet crosses in front of it.

Red dwarfs like AU Microscopii are the most abundant stars in our Milky Way galaxy. They therefore should host the majority of planets in our galaxy. But can planets orbiting red dwarf stars like AU Mic b be hospitable to life? A key challenge is that young red dwarfs have ferocious stellar flares blasting out withering radiation. This period of high activity lasts a lot longer than that of stars like our Sun.

The flares are powered by intense magnetic fields that get tangled by the roiling motions of the stellar atmosphere. When the tangling gets too intense, the fields break and reconnect, unleashing tremendous amounts of energy that are 100 to 1,000 times more energetic than our Sun unleashes in its outbursts. It's a blistering fireworks show of torrential winds, flares, and X-rays blasting any planets orbiting close to the star. "This creates a really unconstrained and frankly, scary, stellar wind environment that's impacting the planet's atmosphere," said Rockcliffe.

Under these torrid conditions, planets forming within the first 100 million years of the star's birth should experience the most amount of atmospheric escape. This might end up completely stripping a planet of its atmosphere.

"We want to find out what kinds of planets can survive these environments. What will they finally look like when the star settles down? And would there be any chance of habitability eventually, or will they wind up just being scorched planets?" said Rockcliffe. "Do they eventually lose most of their atmospheres and their surviving cores become super-Earths? We don't really know what those final compositions look like because we don't have anything like that in our solar system."

While the star's glare prevents Hubble from directly seeing the planet, the telescope can measure changes in the star's apparent brightness caused by hydrogen bleeding off the planet and dimming the starlight when the planet transits the star. That atmospheric hydrogen has been heated to the point where it escapes the planet's gravity.

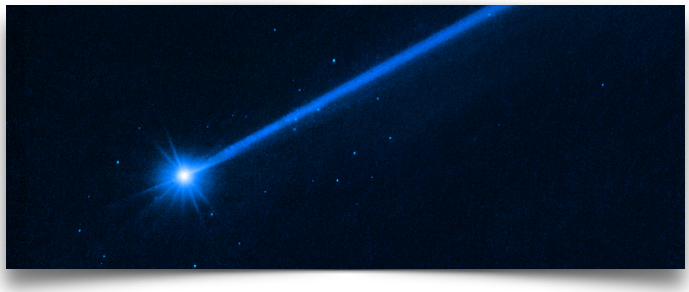
The never-before-seen changes in atmospheric outflow from AU Mic b may indicate swift and extreme variability in the host red dwarf's outbursts. There is so much variability because the star has a lot of roiling magnetic field lines. One possible explanation for the missing hydrogen during one of the planet's transits is that a powerful stellar flare, seen seven hours prior, may have photoionized the escaping hydrogen to the point where it became transparent to light, and so was not detectable.

Another explanation is that the stellar wind itself is shaping the planetary outflow, making it observable at some times and not observable at other times, even causing some of the outflow to "hiccup" ahead of the planet itself. This is predicted in some models, like those of John McCann and Ruth Murray-Clay from the University of California at Santa Cruz, but this is the first kind of observational evidence of it happening and to such an extreme degree, say researchers.

Hubble follow-up observations of more AU Mic b transits should offer additional clues to the star and planet's odd variability, further testing scientific models of exoplanetary atmospheric escape and evolution. ☀

Hubble Sees Boulders Escaping from Asteroid Dimorphos

Hubblesite, July 20, 2923



Summary

The 2022 DART mission impact rattled the asteroid's surface

Sorry Chicken Little, the sky is not falling — at least not yet.

Wayward asteroids present a real collision hazard to Earth. Scientists estimate that an asteroid measuring several miles across smashed into Earth 65 million years ago and wiped out the dinosaurs, among other forms of life, in a mass extinction. Unlike the dinosaurs, humanity can avoid this fate if we begin practicing how to knock an Earth-approaching asteroid off course.

This is trickier than how it has been depicted in science fiction movies like Deep Impact. Planetary scientists first need to know how asteroids were assembled. Are they flying rubble piles of loosely agglomerated rocks, or something more substantial? This information would help provide strategies on how to successfully deflect a menacing asteroid.

As a first step, NASA did an experiment to smash into an asteroid to see how it is perturbed. The DART (Double Asteroid Redirection Test) spacecraft impact on asteroid Dimorphos happened on September 26, 2022. Astronomers using the Hubble Space Telescope continue following the aftermath of the cosmic collision. A surprise is the discovery of several dozen boulders lifted off the asteroid after the smashup. In Hubble pictures they look like a swarm of bees very slowly moving away from the asteroid. This might mean that smacking an Earth-approaching asteroid might result in a cluster of threatening boulders heading in our direction.

The popular 1954 rock song "Shake, Rattle and Roll," could be the theme music for the Hubble Space Telescope's latest discovery about what is happening to the asteroid Dimorphos in the aftermath of NASA's DART (Double Asteroid Redirection Test) experiment. DART intentionally impacted Dimorphos on September 26, 2022, slightly changing the trajectory of its orbit around the larger asteroid Didymos.

Astronomers using Hubble's extraordinary sensitivity have discovered a swarm of boulders that were possibly shaken off the asteroid when NASA deliberately slammed the half-ton DART impactor spacecraft into Dimorphos at approximately 14,000 miles per hour.

The 37 free-flung boulders range in size from three feet to 22 feet across, based on Hubble photometry. They are drifting away from the asteroid at little more than a half-mile per hour – roughly the walking speed of a giant tortoise. The total mass in these detected boulders is about 0.1% the mass of Dimorphos.

"This is a spectacular observation – much better than I expected. We see a cloud of boulders carrying mass and energy away from the impact target. The numbers, sizes, and shapes of the boulders are consistent with them having been knocked off the surface of Dimorphos by the impact," said David Jewitt of the University of California at Los Angeles, a planetary scientist who has been using Hubble to track changes in the asteroid during and after the DART impact. "This tells us for the first time what happens when you hit an asteroid and see material coming out up to the largest sizes. The boulders are some of the faintest things ever imaged inside our solar system."

Jewitt says that this opens up a new dimension for studying the aftermath of the DART experiment using the European Space Agency's upcoming Hera spacecraft , which will arrive at the binary asteroid in late 2026. Hera will perform a detailed post-impact survey of the targeted asteroid. "The boulder cloud will still be dispersing when Hera arrives," said Jewitt. "It's like a very slowly expanding swarm of bees that eventually will spread along the binary pair's orbit around the Sun."

The boulders are most likely not shattered pieces of the diminutive asteroid caused by the impact. They were already scattered across the asteroid's surface, as evident in the last close-up picture taken by the DART spacecraft just two seconds before collision, when it was only seven miles above the surface.

Jewitt estimates that the impact shook off two percent of the boulders on the asteroid's surface. He says the boulder observations by Hubble also give an estimate for the size of the DART impact crater. "The boulders could have been excavated from a circle of about 160 feet across (the width of a football field) on the surface of Dimorphos," he said. Hera will eventually determine the actual crater size.

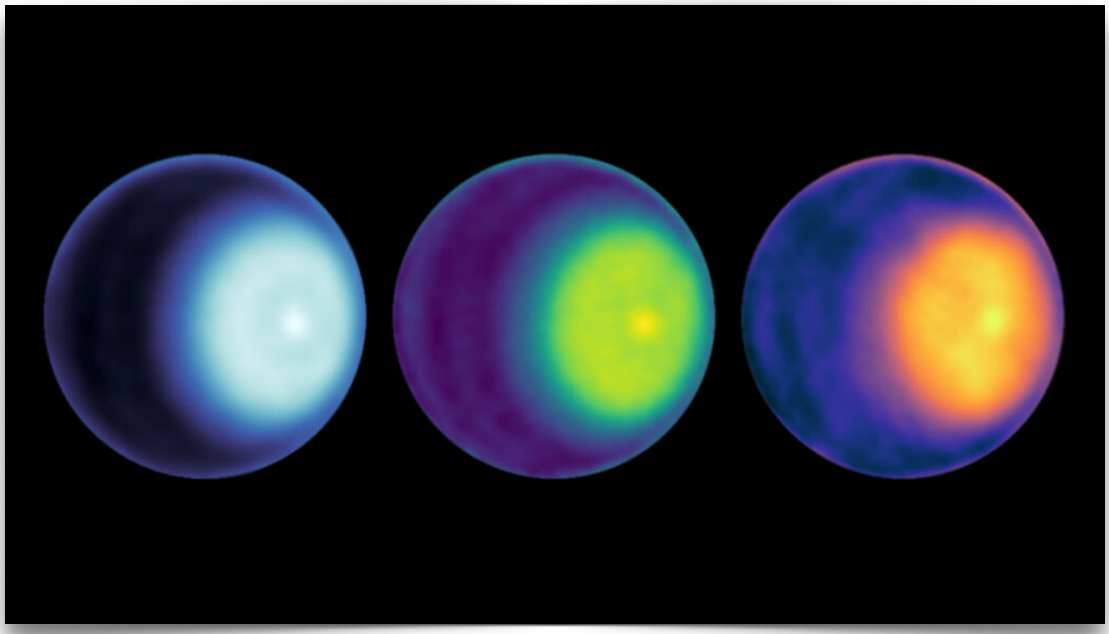
Long ago, Dimorphos may have formed from material shed into space by the larger asteroid Didymos. The parent body may have spun up too quickly or could have lost material from a glancing collision with another object, among other scenarios. The ejected material formed a ring that gravitationally coalesced to form Dimorphos. This would make it a flying rubble pile of rocky debris loosely held together by a relatively weak pull of gravity. Therefore, the interior is probably not solid, but has a structure more like a bunch of grapes.

It's not clear how the boulders were lifted off the asteroid's surface. They could be part of an ejecta plume that was photographed by Hubble and other observatories. Or a seismic wave from the impact may have rattled through the asteroid – like hitting a bell with a hammer – shaking lose the surface rubble.

"If we follow the boulders in future Hubble observations, then we may have enough data to pin down the boulders' precise trajectories. And then we'll see in which directions they were launched from the surface," said Jewitt. ☀

A cyclone has been spotted swirling over Uranus' north pole for the first time

By Allison Gasparini
Sciencenews, July 12, 2023



A cyclone at the north pole of Uranus appears as a bright spot in these false-color images of the planet taken at three different wavelengths of radio waves.

Though it looks like a smooth, solid, pale blue orb, there's more going on beneath the clouds of Uranus than meets the eye.

A polar cyclone has been spotted at the planet's north pole, researchers report in the May 28 *Geophysical Research Letters*. Observed with radio telescopes, the find is the first direct evidence of a cyclone on Uranus. A previous spacecraft flyby hinted at a similar storm at the planet's south pole.

"It's really exciting to see this polar structure come into view," says Michael Roman, a planetary scientist at the University of Leicester in England who was not involved with the research. The observations "show a rather unique structure that we simply have never been able to study before."

In 1986, NASA's Voyager 2 spacecraft revealed winds at the center of Uranus' south pole were moving faster than those in neighboring areas and were rotating. This evidence pointed to something dynamic like a cyclone occurring at the pole. But the spacecraft's instruments weren't sensitive enough to confirm the storm.

In recent years, as the north pole of Uranus turned more toward Earth, scientists were able to probe the other side of the ice giant, where they spotted similar hints of a swirling storm. Using the Very Large Array radio observatory in New Mexico, planetary scientist Alex Akins and colleagues probed the temperature under the clouds for more atmospheric clues. "What we saw with the VLA was kind of the last piece of [evidence]," says Akins, of the Jet Propulsion Laboratory in Pasadena, Calif.

New thermal emission observations from 2021 and 2022 show a spot on the north pole where the gas beneath the clouds is warmer and drier than its surroundings, suggesting the presence of a low-pressure region in the midst of those spinning winds. "These contrasts look similar to what we see in hurricanes on Earth," Akins says.

Excluding Mercury, all the planets in our solar system have now been observed to host some kind of swirling air mass at their poles (*SN: 10/14/08*).

Akins plans to continue to observe the cyclone to see how it changes. Previous observations from 2015 suggest it is growing stronger. Researchers wouldn't expect Uranus' atmospheric circulation to change on such a relatively short timescale, Akins says, so a continued strengthening of the storm would suggest there's more to learn about how the planet's atmosphere works.

In 2022, experts brought together by the National Academies of Sciences, Engineering, and Medicine recommended NASA send a probe to Uranus (*SN: 4/20/22*). "The more we can learn about Uranus as we begin to plan a mission," Roman says, "the better we can focus our planning for that mission." ☀

Neutrinos offer a new view of the Milky Way

By James R Riordon

Sciencenews, June 29, 2023

Physicists used the ghostly subatomic particles coming from within our galaxy to make a new map

Artificial intelligence helped pick neutrino needles from a haystack of data collected by the IceCube neutrino detector (an aboveground lab, shown) in Antarctica to draw a new map of the Milky Way.

Scientists have made the first image of the Milky Way using neutrinos.

The extremely low-mass subatomic particles have no electric charge, and pass easily through gas, dust and even stars on their way from the places where they originate to detectors here on Earth. High-energy neutrinos zip throughout the cosmos, but where they come from is usually a mystery.

Now, by combining artificial intelligence and data collected over the course of a decade with the IceCube detector in Antarctica, researchers have found the first evidence of high-energy neutrinos that originated from inside the Milky Way and mapped the particles onto an image of the galaxy's plane. It's the first time our galaxy has been imaged with anything other than light.

The map includes suggestions of specific high-energy neutrino sources within the Milky Way that might be the remnants of past supernova star explosions, the cores of collapsed supergiant stars or other as-yet-unidentified objects, the team reports in the June 30 *Science*. But more research is needed to clearly pick those sorts of features out of the data.

Previously, only a few high-ene rgy neutrinos have been traced back to their potential birthplaces, all outside the Milky Way. Those include two that appeared to come from black holes shredding their companion stars and others from a highly active galaxy known as a blazar (*SN: 5/16/22, SN: 7/12/18*).

"We're quite unambiguously seeing neutrinos from both galactic and extragalactic space these days," says physicist Kate Scholberg of Duke University who was not involved with the research. "There's so much more to learn, and it can be tremendous fun to figure out how to see the universe with neutrino eyes."

Neutrino astronomy could potentially allow us to see distant objects in a way that no other telescopes can match. That's because neutrinos can cross huge expanses of space without being absorbed or deflected. X-rays, gamma rays, optical light and the charged particles that make up cosmic rays, on the other hand, can be deflected or absorbed along the way, which may obscure their origins.

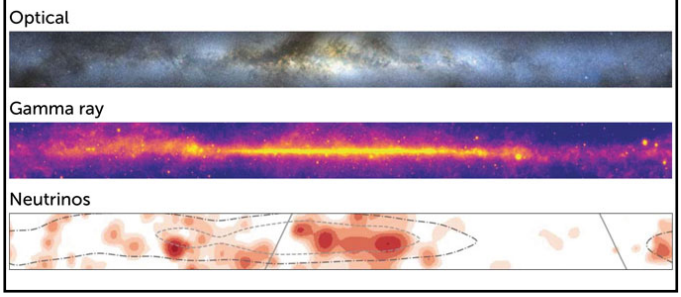
To physicist Naoko Kurahashi Neilson of Drexel University in Philadelphia, the map she and her team produced is the latest contribution to a shift in neutrino science. In the past, neutrino observatories like IceCube haven't provided the sorts of views of the sky that telescopes relying on optical light, X-rays or gamma rays offer.

"When I first joined IceCube," Kurahashi Neilson says, "I used to do air quotes" when using the phrase *neutrino astronomy*. "I don't do that anymore.… I don't have to because we're starting to resolve things" in

neutrino images that resemble the astronomical images from other telescopes.

Three ways to map the Milky Way

In these three views, the Milky Way is seen in visible light (top), in gamma rays (middle) and in high-energy neutrinos (bottom). This first-ever particle-based map is based on data collected with the enormous IceCube detector embedded deep in the Antarctic ice. Dust obscures portions of the visible light map, and gamma rays can come from a variety of sources. Neutrinos have the potential to pinpoint locations where high-energy cosmic rays coming from supernova remnants, the cores of collapsed stellar giants and other as-yet-unidentified sources interact with dust in the galaxy, creating the neutrinos.



The downside of neutrinos is that they're extremely hard to detect. The IceCube experiment is enormous in part to overcome that challenge. It consists of 5,160 sensors in a cubic array one kilometer on a side embedded deep in the Antarctic ice. The large size of the experiment increases the odds of seeing a tiny fraction of the neutrinos flying through space from the Milky Way and other places in the cosmos.

Of the 100,000 or so neutrinos that IceCube scientists observe each year, some leave long tracks in the detector that potentially point back to where the neutrinos came from. Many of the neutrino signals in IceCube, though, are known as cascade events. They make bursts of light in the detector, but don't reveal neutrino origins as well as tracks can.

"This is data we used to throw away in terms of astronomy," Kurahashi Neilson says. There's still information indicating where the neutrinos come from in the data. But it's difficult to identify the promising cascades in the hundreds of thousands of meaningless, background events that IceCube has collected.

Kurahashi Neilson decided to take up the challenge by plowing through a decade of IceCube cascade data with the help of an artificial intelligence system known as a neural network. "You can train the neural nets to identify which events are worth keeping … [and] which events are more background-like," Kurahashi Neilson says.

It's an approach Kurahashi Neilson pioneered in 2017 and steadily improved until she and her colleagues were able to identify the neutrinos used in the new map.

"It's an impressive analysis and the techniques may well not yet be pushed to their limits," Scholberg says. "Clearly a lot more work needs to be done, but it's very exciting to see the basic expectation [of Milky Way neutrinos] verified. This is an important step forward in understanding of the high-energy particle sky." ☀

Sun 'umbrella' tethered to asteroid might help mitigate climate change

Sciencenews, July 31, 2023

Earth is rapidly warming and scientists are developing a variety of approaches to reduce the effects of climate change. István Szapudi, an astronomer at the University of Hawai'i Institute for Astronomy, has proposed a novel approach -- a solar shield to reduce the amount of sunlight hitting Earth, combined with a tethered, captured asteroid as a counterweight. Engineering studies using this approach could start now to create a workable design that could mitigate climate change within decades.

The paper, "Solar radiation management with a tethered sun shield," is published in *Proceedings of the National Academy of Sciences*.

One of the simplest approaches to reducing the global temperature is to shade the Earth from a fraction of the Sun's light. This idea, called a solar shield, has been proposed before, but the large amount of weight needed to make a shield massive enough to balance gravitational forces and prevent solar radiation pressure from blowing it away makes even the lightest materials prohibitively expensive. Szapudi's creative solution consists of two

innovations: a tethered counterweight instead of just a massive shield, resulting in making the total mass more than 100 times less, and the use of a captured asteroid as the counterweight to avoid launching most of the mass from Earth.

"In Hawai'i, many use an umbrella to block the sunlight as they walk about during the day. I was thinking, could we do the same for Earth and thereby mitigate the impending catastrophe of climate change?" Szapudi said.

Szapudi began with the goal of reducing solar radiation by 1.7%, an estimate of the amount needed to prevent a catastrophic rise in global temperatures. He found that placing a tethered counterbalance toward the Sun could reduce the weight of the shield and counterweight to approximately 3.5 million tons, about one hundred times lighter than previous estimates for an untethered shield.

While this number is still far beyond current launch capabilities, only 1% of the weight -- about 35,000 tons -- would be the shield itself, and that is the only part that needs to be launched from Earth. With newer, lighter materials, the mass of the shield can be reduced even further. The remaining 99% of the total mass would be asteroids or lunar dust used as a counterweight. Such a tethered structure would be faster and cheaper to build and deploy than other shield designs.

Today's largest rockets can only lift about 50 tons to low Earth orbit, so this approach to solar radiation management would be challenging. Szapudi's approach brings the idea into the realm of possibility, even with today's technology, whereas prior concepts were completely unachievable. Also, developing a light-weight but strong graphene tether connecting the shield with the counterweight is crucial. ☀

Possible seasonal climate patterns on early Mars

Sciencenews, august 9, 2023

"These exciting observations of mature mud cracks are allowing us to fill in some of the missing history of water on Mars. How did Mars go from a warm, wet planet to the cold, dry place we know today? These mud cracks show us that transitional time, when liquid water was less abundant but still active on the Martian surface," said Nina Lanza, principal investigator of the ChemCam instrument onboard the Curiosity rover. "These features also point to the existence of wet-dry environments that on Earth are extremely conducive to the development of organic molecules and potentially life. Taken as a whole, these results a giving us a clearer picture of Mars as a habitable world."

The presence of long-term wet environments, such as evidence of ancient lakes on Mars, is well-documented, but far less is known about short-term climate fluctuations.

After years of exploring terrain largely composed of silicates, the rover entered a new area filled with sulfates, marking a major environment transition. In this new environment, the research team found a change in mud crack patterns, signifying a change in the way the surface would have dried. This indicates that water was still present on the surface of Mars episodically, meaning water could have been present for a time, evaporated, and repeated until polygons, or mud cracks, formed.

"A major focus of the Curiosity mission, and one of the main reasons for selecting Gale Crater, is to understand the transition of a 'warm and wet' ancient Mars to a 'cold and dry' Mars we see today," said Patrick Gasda of the Laboratory's Space Remote Sensing and Data Science group and coauthor of the paper. "The rover's drive from clay lakebed sediments to drier non-lakebed and sulfate-rich sediments is part of this transition."

On Earth, initial mud cracks in mud form a T-shaped pattern, but subsequent wetting and drying cycles cause the cracks to form more of a Y-shaped pattern, which is what Curiosity observed. Additionally, the rover found evidence that the mud cracks were only a few centimeters deep, which could mean that wet-dry cycles were seasonal, or may have even occurred more quickly, such as in a flash flood.

These findings could mean that Mars once had an Earth-like wet climate, with seasonal or short-term flooding, and that Mars may have been able to support life at some point.

"What's important about this phenomenon is that it's the perfect place for the formation of polymeric molecules required for life, including proteins and RNA, if the right organic molecules were present at this location," Gasda said "Wet periods bring molecules together while dry periods drive reactions to form polymers. When these processes occur repeatedly at the same location, the chance increases that more complex molecules formed there."

The Backyard Observer, September 2023

By Rick Heschmeyer

CYGNUS

After visiting Vega in the constellation Lyra last month, this month we will shift our attention to another constellation containing a bright star in the Summer Triangle asterism, Cygnus. In mythology Cygnus represented a swan. The brightest star in Cygnus is Deneb, a magnitude 1.25 blue-supergiant star, marks the tail of the Swan and one of the vertices of the Summer Triangle. It is the 19th brightest star in the night sky and lies 2600 light-years distant. It also tips the Northern Cross" asterism, made up of the central stars of the constellation. It also has a companion star, so is a spectroscopic binary.

Cygnus was one of the original 48 constellations described by Hipparcus. Lying in the summer Milky Way it is the home of several interesting objects.

Albireo, or Beta Cygni, is a beautiful double star, whose stars shine gold and blue. The double can be seen in large binoculars or a telescope and lies slightly more than 400 light years away.

Messier 39 is a loose open cluster about 950 light years from Earth consisting of about 30 stars.

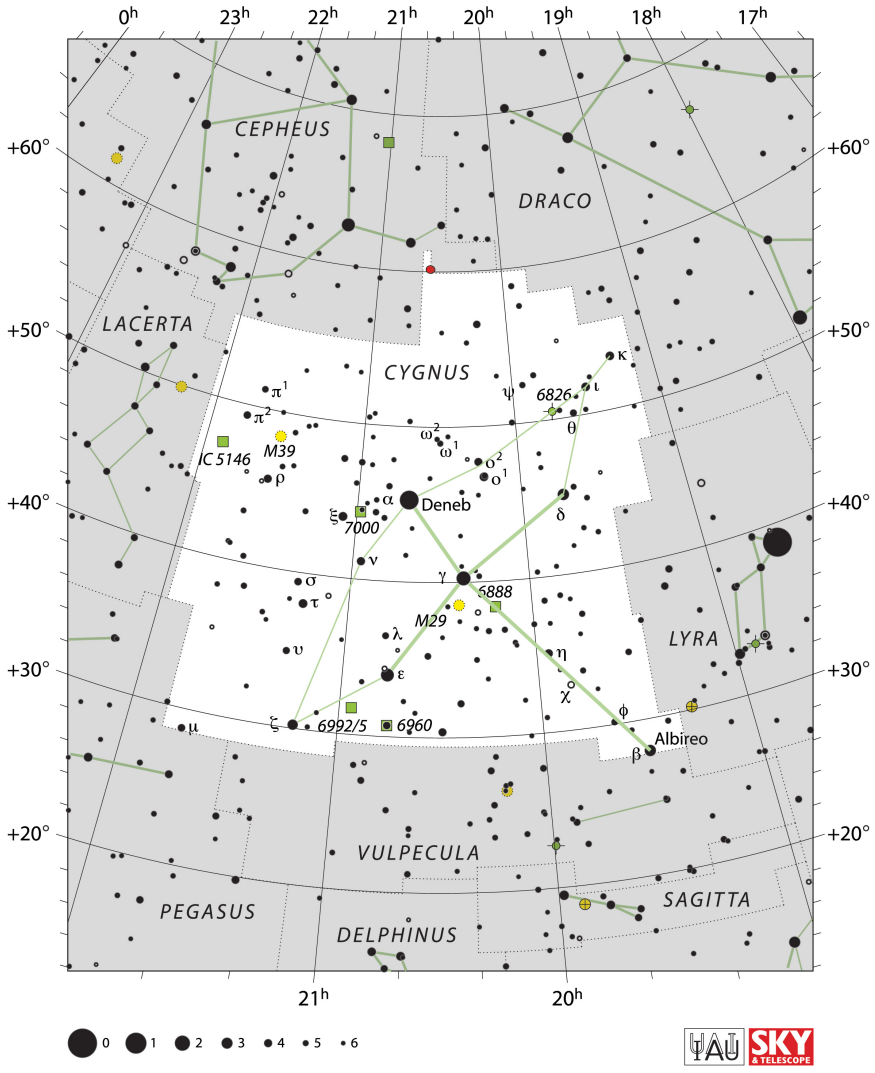
NGC 3910 is another open cluster in the constellation and is sometimes known by the name The Rocking Horse Cluster. First discovered in 1828 by John Herschel, the cluster has the shape of a crescent, like the base of a rocking horse, thus the name.

NGC 6826 is a planetary nebule known as the Blinking Planetary Nebula, as its visibility blinks in and out due to the brightness of its central star. Focus on the star and the nebula disappears. Focus away from the star, a technique known as averted vision, and the nebula reappears.

Another famous nebulosity in Cygnus is The North American Nebula. While most often seen in long-exposure images, from a dark site the nebula can be seen with the naked eye, appearing as a bright patch of the Milky Way. It is large and diffuse, spanning about 4 Moon widths across the sky.

The Veil Nebula is a supernova remnant located near Epsilon Cygni. The brightest portion of the Veil is known as NGC 6992 is visible from a dark site in binoculars.

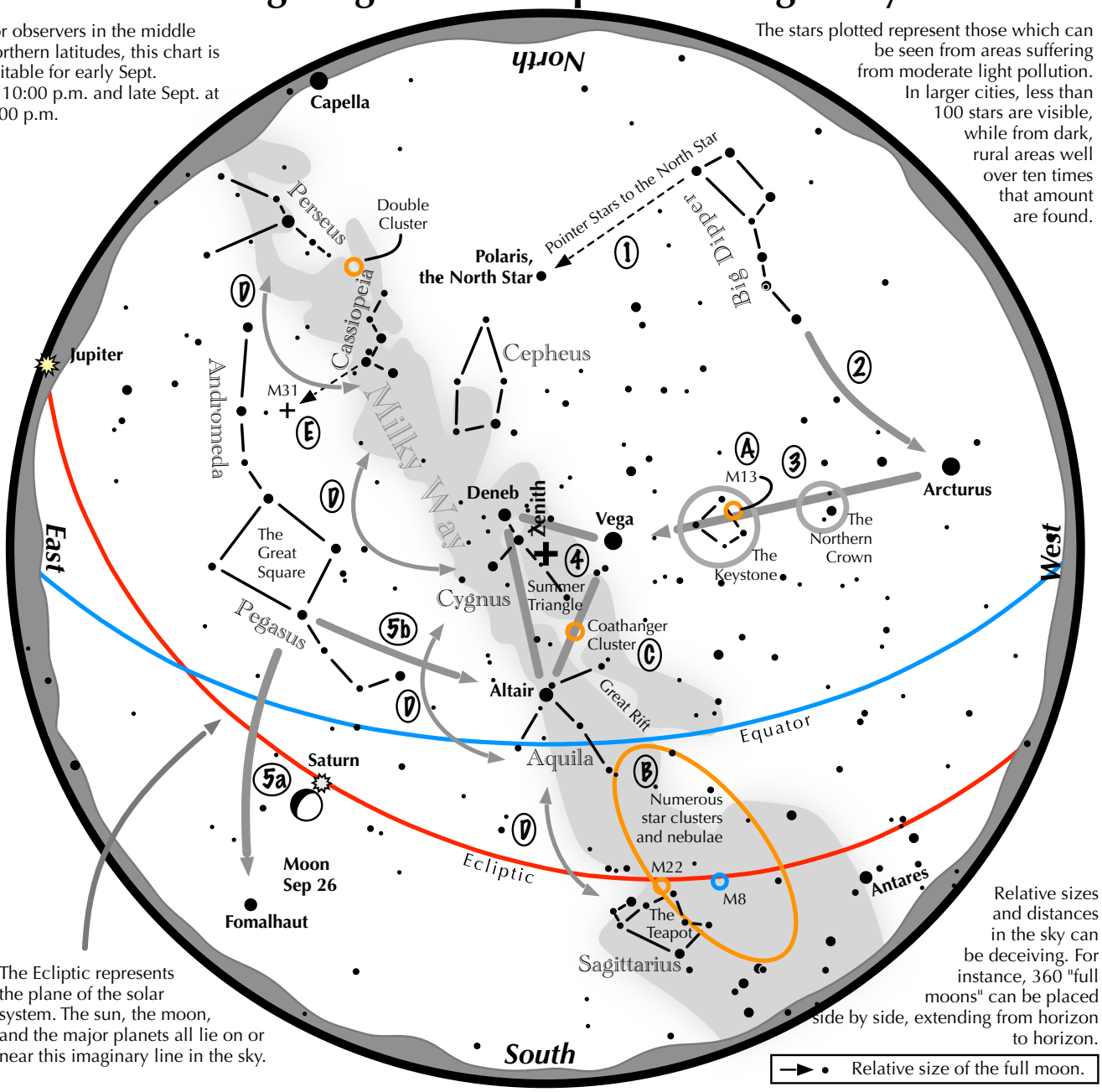
Enjoy this Milky Way rich area of the night sky by scanning with binoculars and enjoy the views.



Navigating the mid September Night Sky

For observers in the middle northern latitudes, this chart is suitable for early Sept. at 10:00 p.m. and late Sept. at 9:00 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.

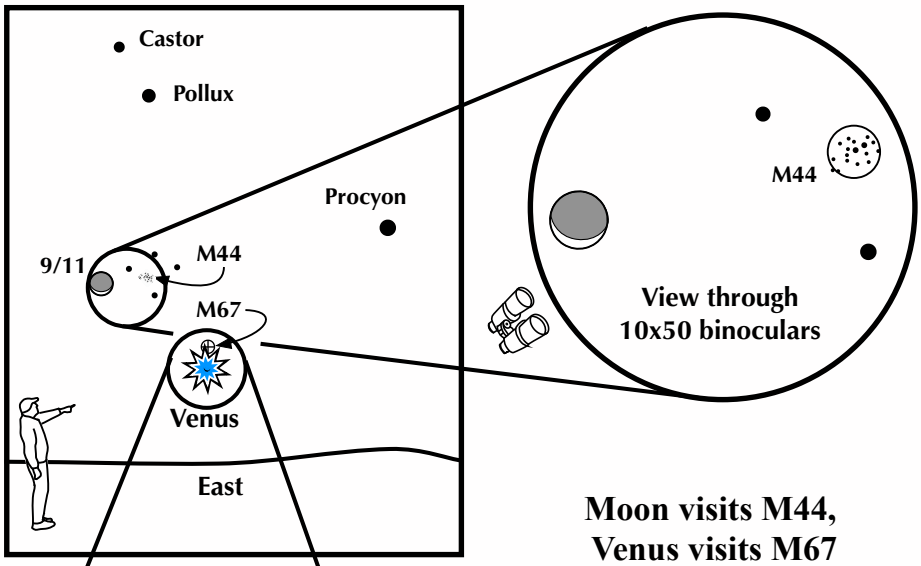
Navigating the mid September night sky: Simply start with what you know or with what you can easily find.

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 September evening sky.
3. Nearly overhead shines a star of similar brightness as Arcturus, 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. The stars of the summer triangle, Vega, Altair, and Deneb, shine overhead.
5. The westernmost two stars of the Great Square, which lies high in the east, point south to Fomalhaut. The southernmost two stars point west to Altair.

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.

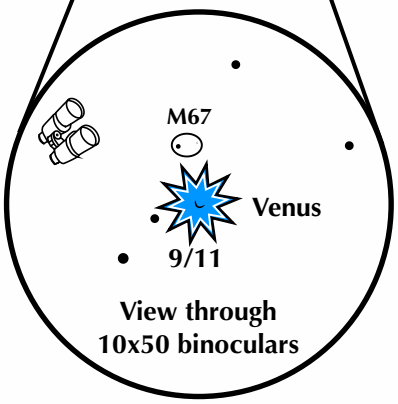
If you can see only one celestial event in the morning this September, see this one.

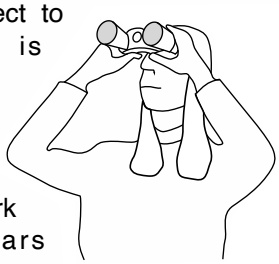


Moon visits M44, Venus visits M67

On the morning of Sep 11, look to the east 90 minutes before sunrise.

- The crescent moon, full with earthshine, glows left of M44, the Beehive cluster.
- M44 can easily be seen in binoculars.
- The dazzling object to their lower right is Venus.
- Just above Venus lies another star cluster, M67. If viewed from a dark location, binoculars should reveal its fuzzy presence.
- If the binoculars are securely mounted, the tiny crescent of Venus should be barely discerned amid the planet's glare.





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.