Volume 50 Number 9 September 2024

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
September 29, 2024, 7:00PM
Baker Wetlands Discovery Center

Public Observing
September 29, 2024, 8:00PM
Baker Wetlands Discovery Center

Club Officers

President
Rick Heschmeyer email

AICOR
William Winkler email

NSN Coordinator
Howard Edin email

Faculty Advisor
Dr. Jennifer Delgado email.

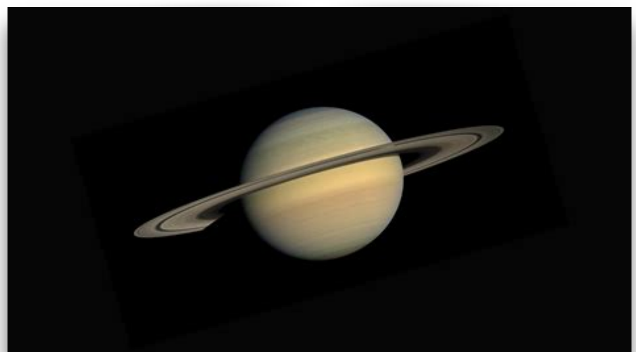
Newsletter Editor
Chuck Wehner email

Inside This Issue

Report From the Officers

By Rick Heschmeyer

After a couple of weeks of beautiful weather, the heat of summer has returned with a vengeance! Regardless of the temperatures there have been quite a few beautiful nights for observing. Saturn is rising in the east and will be at opposition early this month. We are heading towards a ring plane crossing in 2025 so the rings display a stunning slender profile right now. And since the planet is dimmer as a result, now is a great time to see how many moons you can spot circling the ringed planet.



For our first club meeting of the fall, Sarah Lamm spoke to the club about her mission as an analog astronaut and Crew Geologist as part of Crew 297 at the Mars Desert Research Station in Utah earlier this year. The facility, her research, and the challenges encountered, all provided for an interesting presentation. There was a good turnout for the public observing that followed the meeting as well.

In September, the club meeting will focus on the revolution that is taking place in amateur astronomy with the advent of "smart telescopes". These are digital telescopes controlled from a smartphone or tablet and integrate optics, image sensors, and software to deliver unique and fun experiences in a simple, all in one package.

KU's Alex Polanski, whose has presented to the club several times, has started a project to catalog and digitize KU's collection of historic glass photographic plates. He will give the club an update on the project at our October Club Meeting.

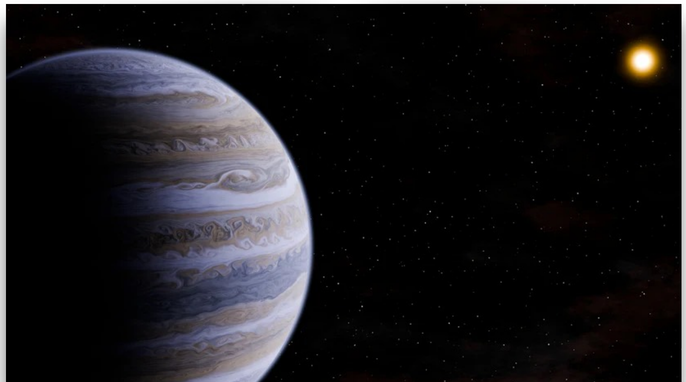
As a reminder, the dates for the remaining fall club meetings are listed below. Meetings start at 7 PM at the Blaker Wetlands Discovery Center and will be followed by public telescope observing at 8 PM, weather permitting. Hope to see you at these events.

Sunday Sep 29, 2024, Sunday, Oct 27, 2024, Sunday, Dec 8, 2024

Clear Skies!

Astronomers Were Looking for a Planet, but They Didn't Expect This One

By Kiona Smith
Inverse, July 24, 2024



This illustration shows what Epsilon Indi Ab might look like with its small orange star in the distance.

The Epsilon Indi star system is already pretty weird, but this surprising new planet just made it even weirder.

A GIANT SURPRISE

Matthews and her colleagues pointed JWST's Mid-Infrared Instrument, or MIRI, at the nearby star system Epsilon Indi, which is home to one small orange star, just a little smaller and cooler than our Sun, and a pair of brown dwarfs (objects much too large to be planets, but not quite massive enough to be stars). Other astronomers had previously noticed that Epsilon Indi A, the orange star, had a slight wobble, as if it were being pushed and pulled by the gravity of a giant gas planet in its orbit. But no one had ever actually seen that planet, and the researchers thought JWST would be up to the challenge.

They found the planet, but it wasn't where all the previous data said it should have been. Instead, it was about four times farther from the star, and about twice as massive, as the researchers had expected. That's pretty cool, both literally — its about 35 degrees Fahrenheit — but also figuratively, as it is a rare chance to study gas giants in the outer reaches of their star systems.

"To our surprise, the bright spot that appeared in our MIRI images did not match the position we were expecting for the planet," says Matthews in a recent statement. They'd been looking for a planet about three times the mass of Jupiter, which orbited its star about once every 45 or 50 years. Instead, the bright point of light in MIRI's images turned out to be a planet about six times more massive than Jupiter, and it's so far away from its star that it takes around 200 years to finish a single orbit.

For comparison, Jupiter is about five times farther from the Sun than Earth is (that's five astronomical units, or AU); at that distance, Jupiter takes about 12 years to make a full orbit. Epsilon Eridani Ab, as the new planet is called, is about 15 times farther from its star than Earth is from the Sun, and its orbit is a stretched-out oval, so its actual farthest point from its star is at least 20 AU away.

The earlier studies had drastically underestimated how huge, and how far out, Epsilon Eridani Ab actually was. That's mostly because those astronomers discovered the planet using what's called the radial velocity method, which measures how much a star wobbles back and forth as the planet, which exerts a small but noticeable gravitational tug on the star, moves around in its orbit. But astronomers were able to watch those stellar wobbles for just a tiny fraction of the planet's actual orbit, so it was almost impossible for them to accurately reconstruct the whole thing.

That left Matthews and her colleagues with a huge surprise.

A LITTLE-KNOWN TYPE OF PLANET

Giant gas planets like Jupiter and Epsilon Indi Ab form in the outer reaches of their star systems, where there's less radiation from the newborn star to blow away the gas that forms these giants. Over time, some of them migrate inward: In our own Solar System, Jupiter did some wandering in its younger days, and in many alien star systems, astronomers have discovered a type of planet called a "hot Jupiter," a gas giant that's migrated inward until it's zipping around its host star once every few days.

Hot Jupiters may be the category of planet we know the most about, even though only about 1 percent of stars actually have a hot Jupiter in their collection of planets. That's because hot Jupiters are relatively easy to spot: they're big and close to their stars, so it's easy to track their radial velocity effects or spot their silhouettes when they pass between their star and Earth.

More distant worlds, even huge gas giants like Epsilon Indi Ab, are harder to find, because their orbits are so long (see above) and because they're less likely to pass in front of their stars from our point of view, thanks to the angles involved. So the gas giants that don't end up falling inward into scorching hot orbits are sort of a gap in our knowledge of the universe — and Epsilon Indi Ab is a chance to fill in that blank spot on the cosmic map.

"In the long run, we hope to also observe other nearby planetary systems to hunt for cold gas giants that may have escaped detection," says the Max Planck Institute for Astronomy's Thomas Henning, a coauthor of the recent paper, in a statement. "Such a survey would serve as the basis for a better understanding of how gas planets form and evolve."

Meanwhile, Matthews and her colleagues also hope to get more detailed measurements of the spectrum of light coming from the planet, which could tell them what its atmosphere is made of and whether it's cloudy, hazy, or clear. ☀

Scientists pin down the origins of the moon's tenuous atmosphere

The barely-there lunar atmosphere is likely the product of meteorite impacts over billions of years

Sciencedaily, august 2, 2024

While the moon lacks any breathable air, it does host a barely-there atmosphere. Since the 1980s, astronomers have observed a very thin layer of atoms bouncing over the moon's surface. This delicate atmosphere -- technically known as an "exosphere" -- is likely a product of some kind of space weathering. But exactly what those processes might be has been difficult to pin down with any certainty.

Now, scientists at MIT and the University of Chicago say they have identified the main process that formed the moon's atmosphere and continues to sustain it today. In a study appearing in *Science Advances*, the team reports that the lunar atmosphere is primarily a product of "impact vaporization."

In their study, the researchers analyzed samples of lunar soil collected by astronauts during NASA's Apollo missions. Their analysis suggests that over the moon's 4.5-billion-year history its surface has been continuously bombarded, first by massive meteorites, then more recently, by smaller, dust-sized "micrometeoroids." These constant impacts have kicked up the lunar soil, vaporizing certain atoms on contact and lofting the particles into the air. Some atoms are ejected into space, while others remain suspended over the moon, forming a tenuous atmosphere that is constantly replenished as meteorites continue to pelt the surface.

The researchers found that impact vaporization is the main process by which the moon has generated and sustained its extremely thin atmosphere over billions of years.

"We give a definitive answer that meteorite impact vaporization is the dominant process that creates the lunar atmosphere," says the study's lead author, Nicole Nie, an assistant professor in MIT's Department of Earth, Atmospheric, and Planetary Sciences. "The moon is close to 4.5 billion years old, and through that time the surface has been continuously bombarded by meteorites. We show that eventually, a thin atmosphere reaches a steady state because it's being continuously replenished by small impacts all over the moon."

Nie's co-authors are Nicolas Dauphas, Zhe Zhang, and Timo Hopp at the University of Chicago, and Menelaos Sarantos at NASA Goddard Space Flight Center.

Weathering's roles

In 2013, NASA sent an orbiter around the moon to do some detailed atmospheric reconnaissance. The Lunar Atmosphere and Dust Environment Explorer (LADEE, pronounced "laddie") was tasked with remotely gathering information about the moon's thin atmosphere, surface conditions, and any environmental influences on the lunar dust.

LADEE's mission was designed to determine the origins of the moon's atmosphere. Scientists hoped that the probe's remote measurements of soil and atmospheric composition might correlate with certain space weathering processes that could then explain how the moon's atmosphere came to be.

Researchers suspect that two space weathering processes play a role in shaping the lunar atmosphere: impact vaporization and "ion sputtering" -- a phenomenon involving solar wind, which carries energetic charged particles from the sun through space. When these particles hit the moon's surface, they can transfer their energy to the atoms in the soil and send those atoms sputtering and flying into the air.

"Based on LADEE's data, it seemed both processes are playing a role," Nie says. "For instance, it showed that during meteorite showers, you see more atoms in the atmosphere, meaning impacts have an effect. But it also showed that when the moon is shielded from the sun, such as during an eclipse, there are also changes in the atmosphere's atoms, meaning the sun also has an impact. So, the results were not clear or quantitative."

Answers in the soil

To more precisely pin down the lunar atmosphere's origins, Nie looked to samples of lunar soil collected by astronauts throughout NASA's Apollo missions. She and her colleagues at the University of Chicago acquired 10 samples of lunar soil, each measuring about 100 milligrams -- a tiny amount that she estimates would fit into a single raindrop.

Nie sought to first isolate two elements from each sample: potassium and rubidium. Both elements are "volatile," meaning that they are easily vaporized by impacts and ion sputtering. Each element exists in the form of several isotopes. An isotope is a variation of the same element, that consists of the same number of protons but a slightly different number of neutrons. For instance, potassium can exist as one of three isotopes, each one having one more neutron, and there being slightly heavier than the last. Similarly, there are two isotopes of rubidium.

The team reasoned that if the moon's atmosphere consists of atoms that have been vaporized and suspended in the air, lighter isotopes of those atoms should be more easily lofted, while heavier isotopes would be more likely to settle back in the soil. Furthermore, scientists predict that impact vaporization, and ion sputtering, should result in very different isotopic proportions in the soil. The specific ratio of light to heavy isotopes that remain in the soil, for both potassium and rubidium, should then reveal the main process contributing to the lunar atmosphere's origins.

With all that in mind, Nie analyzed the Apollo samples by first crushing the soils into a fine powder, then dissolving the powders in acids to purify and isolate solutions containing potassium and rubidium. She then passed these solutions through a mass spectrometer to measure the various isotopes of both potassium and rubidium in each sample.

In the end, the team found that the soils contained mostly heavy isotopes of both potassium and rubidium. The researchers were able to quantify the ratio of heavy to light isotopes of both potassium and rubidium, and by comparing both elements, they found that impact vaporization was most likely the dominant process by which atoms are vaporized and lofted to form the moon's atmosphere.

"With impact vaporization, most of the atoms would stay in the lunar atmosphere, whereas with ion sputtering, a lot of atoms would be ejected into space," Nie says. "From our study, we now can quantify the role of both processes, to say that the relative contribution of impact vaporization versus ion sputtering is about 70:30 or larger." In other words, 70 percent or more of the moon's atmosphere is a product of meteorite impacts, whereas the remaining 30 percent is a consequence of the solar wind.

"The discovery of such a subtle effect is remarkable, thanks to the innovative idea of combining potassium and rubidium isotope measurements along with careful, quantitative modeling," says Justin Hu, a postdoc who studies lunar soils at Cambridge University, who was not involved in the study. "This discovery goes beyond understanding the moon's history, as such processes could occur and might be more significant on other moons and asteroids, which are the focus of many planned return missions."

"Without these Apollo samples, we would not be able to get precise data and measure quantitatively to understand things in more detail," Nie says. "It's important for us to bring samples back from the moon and other planetary bodies, so we can draw clearer pictures of the solar system's formation and evolution."

This work was supported, in part, by NASA and theNational Science Foundation. ☀

NASA's Hubble Traces Dark Matter in Dwarf Galaxy Using Stellar Motions

HUBBLESITE, JULY 11, 2024

Summary

The telescope's longevity is an asset in gaining clarity about the universe's invisible glue.

When theory and observations favor different results, how can astronomers determine which one is more feasible?

Increasing confidence in one theory over another oftentimes requires building a richer dataset to improve current models and lower uncertainties. A team of scientists have done just that to help alleviate the murkiness of a long-standing debate: the cusp-core problem. By analyzing NASA's Hubble Space Telescope data gathered over an almost two-decade span, astronomers have charted stellar movements within a galaxy and discovered the likely clumping of dark matter in its center.

The qualities and behavior of dark matter, the invisible "glue" of the universe, continue to be shrouded in mystery. Though galaxies are mostly made of dark matter, understanding how it is distributed within a galaxy offers clues to what this substance is, and how it's relevant to a galaxy's evolution.

While computer simulations suggest dark matter should pile up in a galaxy's center, called a density cusp, many previous telescopic observations have indicated that it is instead more evenly dispersed throughout a galaxy. The reason for this tension between model and observation continues to puzzle astronomers, reinforcing the mystery of dark matter.

A team of astronomers has turned toward NASA's Hubble Space Telescope to try and clarify this debate by measuring the dynamic motions of stars within the Draco dwarf galaxy, a system located roughly 250,000 light-years from Earth. Using observations that spanned 18 years, they succeeded in building the most accurate three-dimensional understanding of stars' movements within the diminutive galaxy. This required scouring nearly two decades of Hubble archival observations of the Draco galaxy.

"Our models tend to agree more with a cusp-like structure, which aligns with cosmological models," said Eduardo Vitral of the Space Telescope Science Institute (STScI) in Baltimore and lead author of the study. "While we cannot definitively say all galaxies contain a cusp-like dark matter distribution, it's exciting to have such well measured data that surpasses anything we've had before."

Charting the Movements of Stars

To learn about dark matter within a galaxy, scientists can look to its stars and their movements that are dominated by the pull of dark matter. A common approach to measure the speed of objects moving in space is by the Doppler Effect – an observed change of the wavelength of light if a star is approaching or receding from Earth. Although this line-of-sight velocity can provide valuable insight, only so much can be gleaned from this one-dimensional source of information.

Besides moving closer or further away from us, stars also move across the sky, measured as their proper motion. By combining line-of-sight velocity with proper motions, the team created an unprecedented analysis of the stars' 3D movements.

"Improvements in data and improvements in modeling usually go hand in hand," explained Roeland van der Marel of STScI, a co-author of the paper who initiated the study more than 10 years ago. "If you don't have very sophisticated data or only one-dimensional data, then relatively straightforward models can often fit. The more dimensions and complexity of data you gather, the more complex your models need to be to truly capture all the subtleties of the data."

A Scientific Marathon (Not a Sprint)

Since dwarf galaxies are known to have a higher proportion of dark matter content than other types of galaxies, the team honed in on the Draco dwarf galaxy, which is a relatively small and spheroidal nearby satellite of the Milky Way galaxy.

"When measuring proper motions, you note the position of a star at one epoch and then many years later measure the position of that same star. You measure the displacement to determine how much it moved," explained Sangmo Tony Sohn of STScI, another co-author of the paper and the principal investigator of the latest observational program. "For this kind of observation, the longer you wait, the better you can measure the stars shifting."

The team analyzed a series of epochs spanning from 2004 to 2022, an extensive baseline that only Hubble could offer, due to the combination of its sharp stable vision and record time in operation. The telescope's rich data archive helped decrease the level of uncertainty in the measurement of the stars' proper motions. The precision is equivalent to measuring an annual shift a little less than the width of a golf ball as seen on the Moon from Earth.

With three dimensions of data, the team reduced the amount of assumptions applied in previous studies and considered characteristics specific to the galaxy – such as its rotation, and distribution of its stars and dark matter – in their own modeling efforts.

An Exciting Future

The methodologies and models developed for the Draco dwarf galaxy can be applied to other galaxies in the future. The team is already analyzing Hubble observations of the Sculptor dwarf galaxy and the Ursa Minor dwarf galaxy.

Studying dark matter requires observing different galactic environments, and also entails collaboration across different space telescope missions. For example, NASA's upcoming Nancy Grace Roman Space Telescope will help reveal new details of dark matter's properties among different galaxies thanks to its ability to survey large swaths of the sky.

"This kind of study is a long-term investment and requires a lot of patience," reflected Vitral. "We're able to do this science because of all the planning that was done throughout the years to actually gather these data. The insights we've collected are the result of a larger group of researchers that has been working on these things for many years."

These results are published today in The Astrophysical Journal. The Hubble Space Telescope has been operating for over three decades and continues to make ground-breaking discoveries that shape our fundamental understanding of the universe. Hubble is a project of international cooperation between NASA and ESA (European Space Agency). NASA's Goddard Space Flight Center in Greenbelt, Maryland, manages the telescope and mission operations. Lockheed Martin Space, based in Denver, Colorado, also supports mission operations at Goddard. The Space Telescope Science Institute (STScI) in Baltimore, Maryland, which is operated by the Association of Universities for Research in Astronomy, conducts Hubble science operations for NASA. ☀

September's Night Sky Notes: Marvelous Moons

By Kat Troche

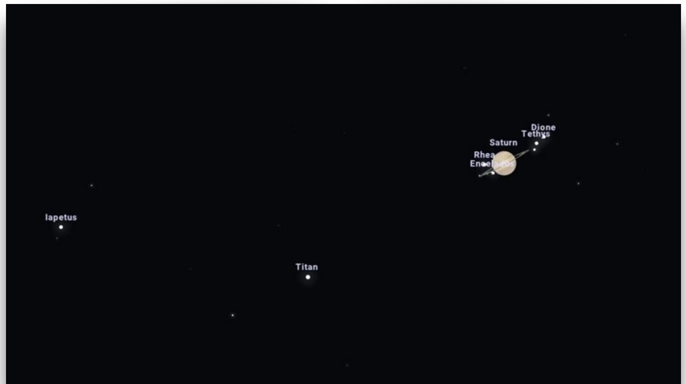
NIGHTSKYNETWORK, SEPTEMBER 2024

September brings the gas giants Jupiter and Saturn back into view, along with their satellites. And while we organize celebrations to observe our own Moon this month, be sure to grab a telescope or binoculars to see other moons within our Solar System! We recommend observing these moons (and planets!) when they are at their highest in the night sky, to get the best possible unobstructed views.

The More the Merrier

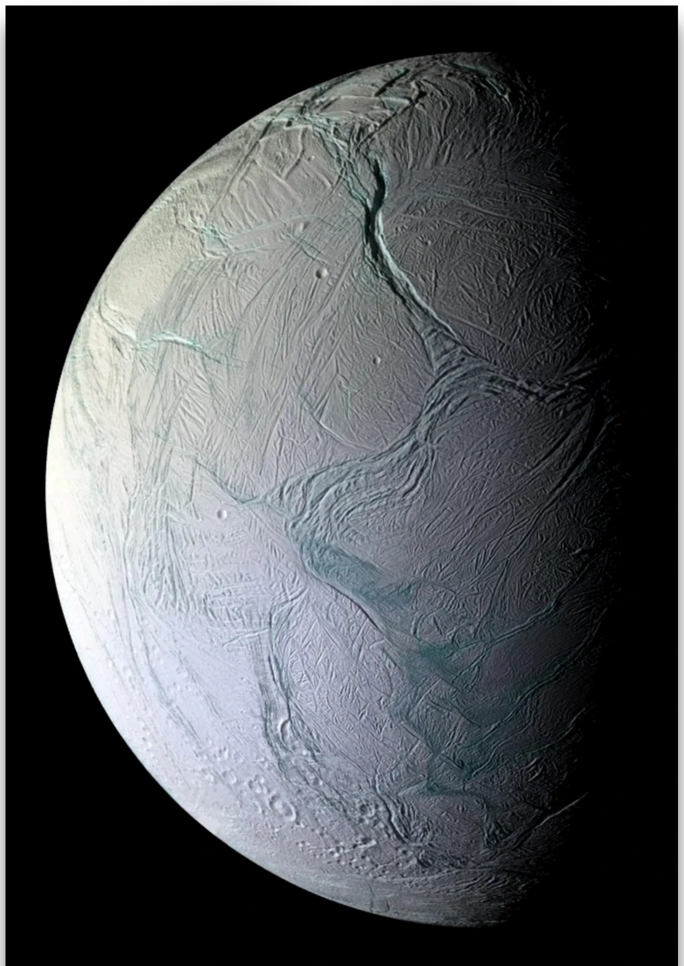
As of September 2024, the ringed planet Saturn has 146 identified moons in its orbit. These celestial bodies range in size; the smallest being a few hundred feet across, to Titan, the second largest moon in our solar system.

Even at nearly 900 million miles away, Titan can be easily spotted next to Saturn with a 4-inch telescope, under urban and suburban skies, due to its sheer size. With an atmosphere of mostly nitrogen with traces of hydrogen and methane, Titan was briefly explored in 2005 with the Huygens probe as part of the Cassini-



The Saturnian system along with various moons around the planet Saturn: Iapetus, Titan, Enceladus, Rhea, Tethys, and Dione.

Huygens mission, providing more information about the surface of Titan. NASA's mission Dragonfly is set to explore the surface of Titan in the 2030s.



This mosaic of Saturn's moon Enceladus was created with images captured by NASA's Cassini spacecraft on Oct. 9, 2008, after the spacecraft came within about 16 miles (25 kilometers) of the surface of Enceladus.

Saturn's moon Enceladus was also explored by the Cassini mission, revealing plumes of ice that erupt from below the surface, adding to the brilliance of Saturn's rings. Much like our own Moon, Enceladus remains tidally locked with Saturn, presenting the same side towards its host planet at all times.

The Galilean Gang

The King of the Planets might not have the most moons, but four of Jupiter's 95 moons are definitely the easiest to see with a small pair of binoculars or a small telescope because they form a clear line. The Galilean Moons – Ganymede, Callisto, Io, and Europa – were first discovered in 1610 and they continue to amaze stargazers across the globe.

The Jovian system: Europa, Io, Ganymede, and Callisto.

- Ganymede: largest moon in our solar system, and larger than the planet Mercury, Ganymede has its own magnetic field and a possible saltwater ocean beneath the surface.
- Callisto: this heavily cratered moon is the third largest in our solar system. Although Callisto is the furthest away of the Galilean moons, it only takes 17 days to complete an orbit around Jupiter.
- Io: the closest moon and third largest in this system, Io is an extremely active world, due to the push and pull of Jupiter's gravity. The volcanic activity of this rocky world is so intense that it can be seen from some of the largest telescopes here on Earth.
- Europa: Jupiter's smallest moon also happens to be the strongest candidate for a liquid ocean beneath the surface. NASA's Europa Clipper is set to launch October 2024 and will determine if this moon has conditions suitable to support life. Want to learn more? Rewatch the July 2023 Night Sky Network webinar about Europa Clipper here. ☀

The Backyard Observer, September 2024

By Rick Heschmeyer

DELPHINUS

This month's feature constellation, Delphinus the Dolphin, is one of the smallest in the night sky, ranking 69th in size of the 88 constellations. It is well placed during the end of summer/early fall time frame.

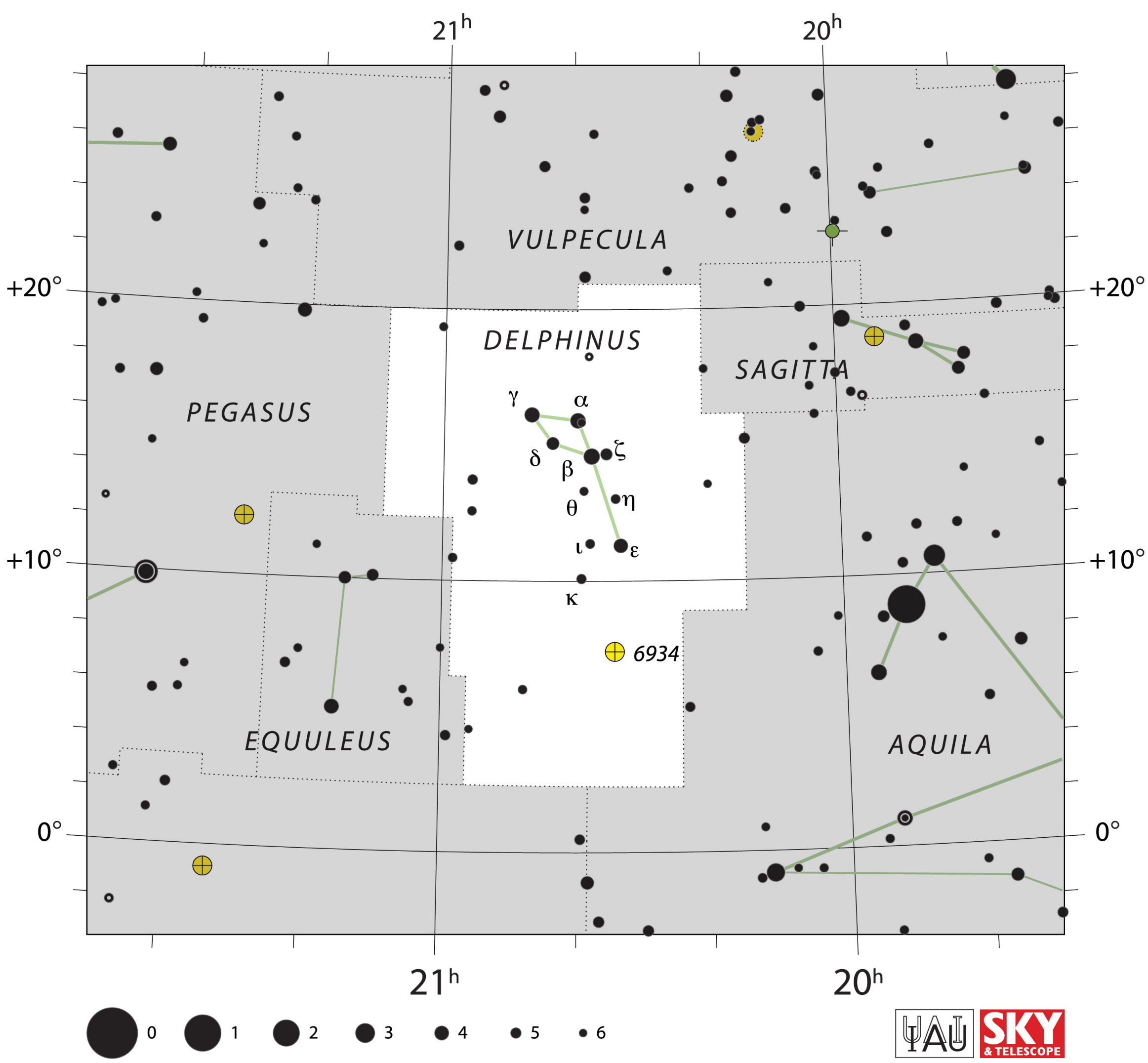
To find it, draw a line between two stars of the Summer Triangle, Deneb in Cygnus and Altair in Aquila. Delphinus lies just outside the Summer Triangle along this line.You'll need a reasonably dark sky to see, as the constellation's stars are dim. The constellation somewhat resembles a dolphin, although some would describe its shape as kite-like. The rhombus-shaped "body" of the dolphin is an asterism named "Job's Coffin", an unusual name that according to *Astronomy Magazine* is "lost to history".

The brightest star in Delphinus is Beta Delpini, more commonly called Rotanev, and lies 101 light years from Earth. The second brightest star, Alpha Delphini's common name is Sualocin. These stars were names by the Italian astronomer Nicolaus Venator. Look closely, the two stars' names are Venator's first and last name spelled backwards!

One deep sky object shows up on our constellation map. NGC 6934 is a relatively large globular star cluster found near the star Eplison Delphini. This cluster, at about 50,000 light years from Earth, was discovered in 1785 by William Herschel. Due to its distance, it is one of the most distant globulars in the Milky Way, the cluster cannot be seen with the naked eye but can be glimpsed in a dark sky with binoculars.

Take some time to search out the dolphin in spit of its size and brightness and you will be rewarded by seeing one of the original constellations catalogued by the Greek astronomer Ptolemy of Alexandra over two thousand years ago!

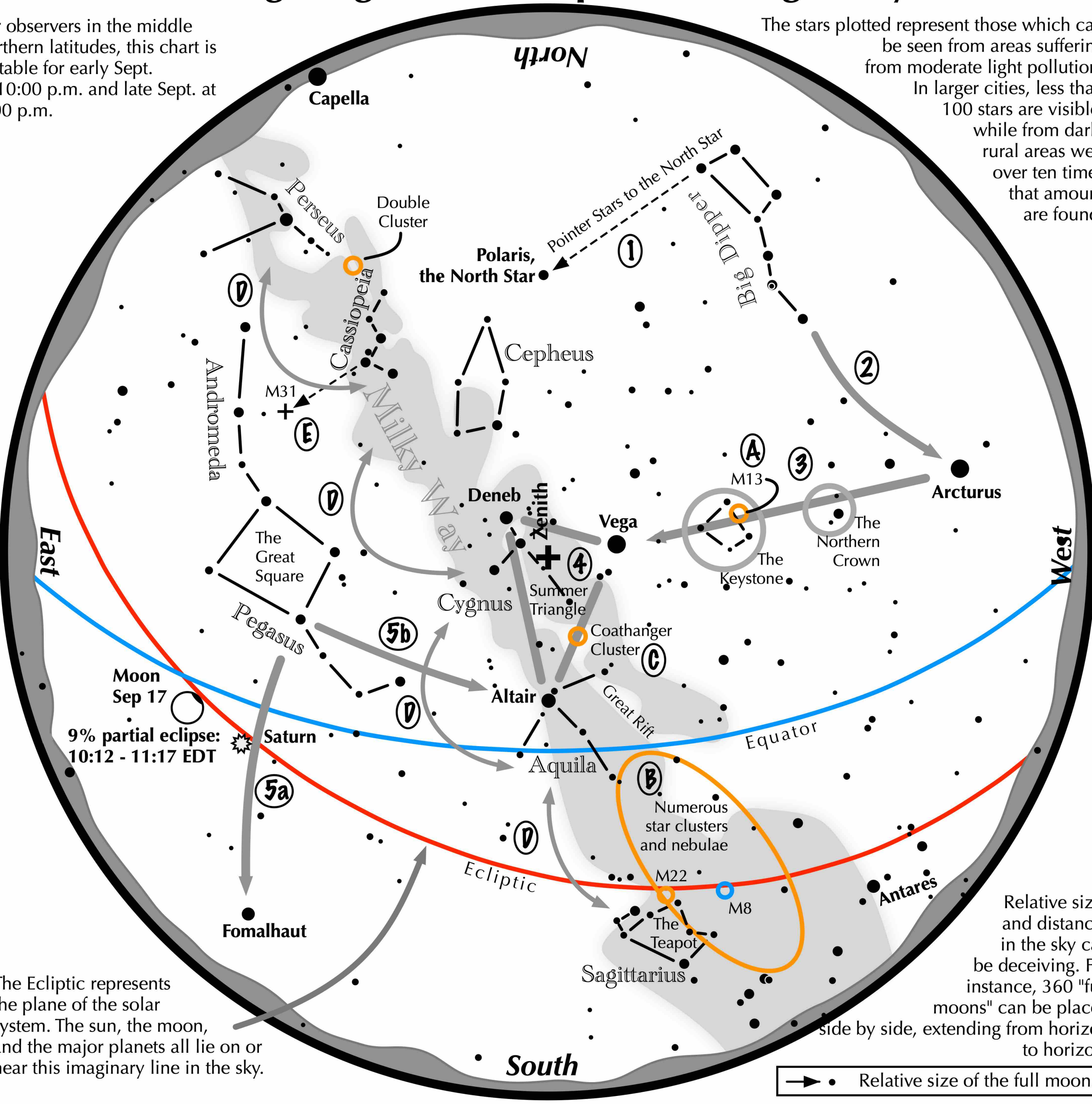
Until next month, keep looking up!



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.

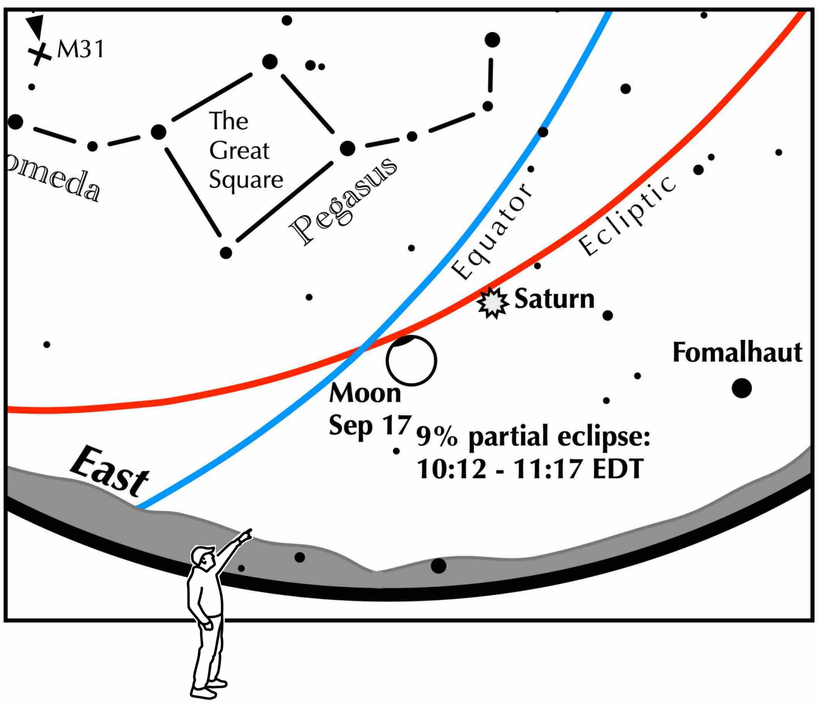
4 The stars of the summer triangle, Vega, Altair, and Deneb, shine overhead.

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.

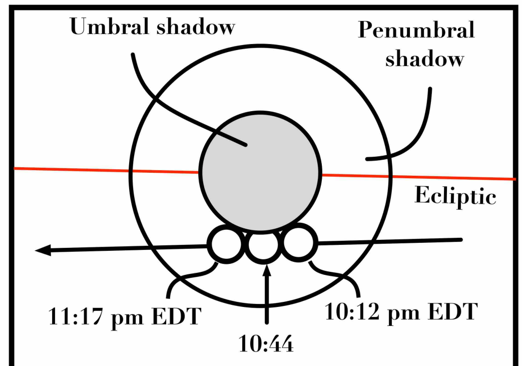
Binocular Highlights

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.

A partial lunar eclipse that is a nibble, not a bite!



View to the southeast on September 17 from 10:12 through 11:17 pm EDT. Mid eclipse lands at 10:44 pm



Partial umbral lunar eclipse
Moon's path, September 17

The Moon slides through a partial umbral eclipse

A very partial umbral lunar eclipse occurs on the night of September 17. Bring out the binoculars for a better look at Earth's shadow taking a nibble out of the moon. Only about 9% of the surface will be in umbral shadow. The event will be slight enough that the casual observer might not notice it.

Mid eclipse and the best view occurs at 10:44 pm EDT. West Coast observers will find it low above the southeastern horizon.

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.