Volume 50 Number 12 December 2024

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
December 8, 2024, 7:00PM
Baker Wetlands Discovery Center

Public Observing
December 8, 2024, 7:00PM
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

Now that we are back on Standard Time, sunset occurs earlier, and the nights are longer. The temperatures are much cooler during the small window between the time change and the onset of winter, so observers need to get our and enjoy the sky. As I write this article there is a forecast for light snow on last day of November. Brrr.

As you are all probably aware, we had to make some changes to our October scheduled club meeting. KU's Alex Polanski, the Percival Lowell Postdoctoral Fellow at Lowell Observatory, was hit by the flu bug and was unable to present, so we watched a recent documentary about the Kansas Cosmosphere entitled "Moon on the Prairie". Alex will join us for our last club meeting of the year to discuss his project to catalog and digitize KU's collection of historic glass photographic plates. What better way to wrap up the fall semester at KU than to learn about the efforts to preserve a part of the rich history of the nearly 150-year-old astronomy program at K.U.

The December Telescope Night at KU is scheduled for Thursday, December 5th, with both telescope observing outside Slawson Hall and Planetarium shows inside Slawson Hall. Telescope Observing starts at 7:30pm and the planetarium shows will take place at 7:30 pm and 8:00 pm.

Also, on the following night, Friday, December 6th at 7:00pm, there will be a Public Astronomy Lecture by KU alumnus Dr. Stuartt Corder, who will talk about "The Future of the World's Largest Telescopes." This talk is free and open to the public and will take place in Room 1001 in Malott Hall.

Our first club meeting of 2025 will be on Sunday, January 26 starting at 7:00pm at Baker Wetlands Discovery Center. The meeting will be followed by public observing, weather permitting.

Happy Holidays and Clear Skies!

Saturn gets its 1st confirmed Trojan asteroid — but it might be stolen

By Robert Lea

SPACE.COM, OCTOBER 24, 2024

"The Trojan asteroid was in the process of gravitationally 'bouncing' between the giant planets when it got snagged by Saturn."

An illustration shows a Trojan asteroid following Saturn in its orbit around then sun.

Saturn has finally joined its fellow solar system giant planets as the parent of trailing asteroids called "Trojans." But the gas giant, mostly known for its spectacular rings, may have cheated a little to fit in with its contemporaries, Jupiter, Neptune and Uranus.

Saturn seems to have snatched its first known Trojan asteroid, designated 2019 UO14, a few thousand years ago as the space rock was "bouncing" around the solar system. Additionally, because the orbit of this Saturnian Trojan is unstable, Saturn seems to be a terrible parent that will lose this cosmic hanger-on in around 1,000 years.

That means astronomers will have to get to work, hunting for more asteroids that share an orbit with the sixth planet from the sun. That is, if Saturn wants to hang with its fellow gas giants and ice giants. In fact, even smaller terrestrial planets like Earth and Mars have Trojans.

"We think it is about 9 miles (15 kilometers) across, though its composition is unknown, it probably originated from the Kuiper Belt beyond Neptune," discovery team member Paul Wiegert, an astronomer at the University of Western Ontario, told Space.com. "The Trojan asteroid was in the process of gravitationally 'bouncing' between the giant planets when it got snagged by Saturn."

Wiegert explained that Trojan asteroids are space rocks that share a planet's orbit, either remaining ahead of or behind the planet. These asteroids also usually sit at an average separation from the planet of about 60 degrees, as seen from the sun's vantage point.

"With the discovery of 2019 UO14, all the gas giant planets are now known to have Trojan asteroids," he said. "Only Mercury and Venus still don't have known Trojans."

Saturn lags Jupiter in terms of Trojans

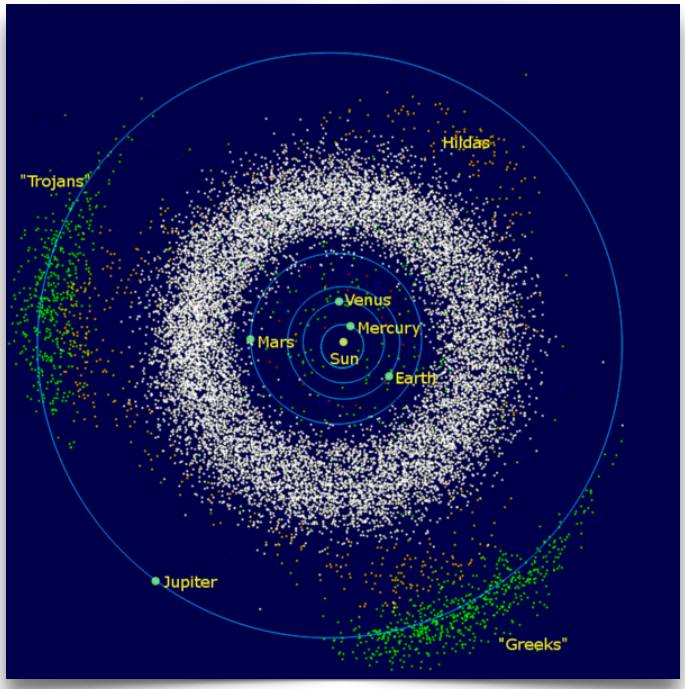
The solar system's "king of the Trojans" is, without a doubt, its largest planet: Jupiter. The fifth planet from the sun has around 10,000 known Trojan asteroids, enough to be divided into two families. One is ahead of the gas giant planet in its orbit (the Greek camp) and the other is trailing Jupiter (the Trojan camp).

These Jovian Trojans are considered so scientifically important that the NASA mission Lucy will visit the Greek camp in August 2027 when it performs a flyby of the asteroid Eurybates and its moonlet, Queta. The spacecraft will then visit three more Greek camp asteroids before its mission concludes in 2033.

Jupiter's gravitational influence is responsible for the amount of Trojans in its orbit, and this influence

actually interferes with Saturn's ability to build its own Trojan family, or at least to hang on to one.

"There are some reasons to expect Saturn Trojans to be less common than for the other gas giants," Wiegert said. "Primarily, Jupiter acts to destabilize Saturnian Trojans and shorten their lifetimes



The inner solar system with the main asteroid belt between Mars and Jupiter highlighted and the two Jovian "camps" of Trojan asteroids indicated.

considerably, shoving them out of the Saturn Trojan state and back into the background population of small bodies in the solar system."

Jupiter's first discovered Trojan, 588 Achilles, was identified in 1906 by German astronomer Max Wolf. In other words, there has been quite the delay in detecting Saturn's first confirmed Trojan. Astronomers saw the first hints of 2019 UO14 in 2019, but are only now confirming that it shares the gas giant's orbit.

Wiegert added that the Trojans of Saturn are not more difficult to detect, in principle, meaning astronomers have been puzzled as to why they haven't been discovered earlier. Answering this conundrum didn't come down to a clever new approach or technique, but rather a quality astronomers need to have in spades: patience.

"We didn't really do anything different in terms of the approach used in this case; it was really just a matter of carefully watching the lists of nightly small body observations looking for likely candidates," he said. "Kudos go to Andrew Walker of Australia, one of our co-authors, for noticing it first."

Wiegert and colleagues will now attempt to determine more of the characteristics of 2019 UO14, which should help identify from where it originated. Initial indications point to this Saturnian Trojan coming from the Kuiper belt, a ring of icy bodies at the edge of the solar system, but there are irregularities the team must iron out before this is confirmed.

"2019 UO14 is similar to some of the Trojans of Uranus and Neptune, but we
don't know enough about them yet to say if they are identical," Wiegert said. "Currently, it seems not."

"We'll absolutely be looking for more Trojans around Saturn now that we've got our first one," Wiegert said. "We expect there to be more, but probably not a lot more. I'd guess, and it is little more than an educated guess, that we might find 10 more Saturn Trojans bigger than 0.62 miles (1 km) — but we'll have to wait and see.

"The excitement level is up, and we'll be looking carefully to spot the next one!" ☀

‘Cosmic Dandelion’: A Mysterious 900-Year-Old Nebula Gets Mapped in Stunning Detail

The supernova that caused the nebula was recorded by Japanese and Chinese astronomers in the 12th century. Now, we know exactly what the aftermath looks like.

By Adam Kovac

Gizmodo.com, October 27 2024

Somewhere out in deep space, there’s a beautiful cosmic weed, blasting its metaphorical pollen away from its core at ludicrous speeds. For almost 900 years, the massive space explosion that caused this weed to bloom was a mystery. Now, a cutting edge telescope is providing our best look yet at the results.

The weed is actually a nebula, named Pa 30 nebula, and its shape has some eccentricities. In 2023, astronomers from Dartmouth College and Louisiana

State University described the matter blasted away from the explosion as clumping together into filaments, which sprout from the center like the puff of a dandelion. Following up on that research, other astronomers have now mapped those filaments for the first time.

Humanity's interest in the nebula can be traced back to the year 1181, when astronomers in Japan and China both recorded seeing a new star. After six months, it was gone, but not forgotten. In 2013, an amateur astronomer named Dana Patchick was looking at images taken by NASA's Wide-field Infrared Survey Explorer, a now-decommissioned infrared space telescope. He identified a nebula in the region of space where the star may have been, 7,500 light years away from Earth, in the Cassiopeia constellation. In the decade that followed, astronomers concluded Pa 30 nebula was likely the remnants of a supernova, which the ancient astronomers had witnessed all those years ago.

Click here to see video.

Nebulas are brightly glowing, and frequently gigantic, collections of matter, such as ionized gas and space dust. But not all nebulas are alike. Some are composed of the remnants of stars, which die in massive explosions. That's what happened in Pa 30 Nebula's case, and some of the results are unique among known nebulae. At its core, a remnant of its birthing star remains, with a surface temperature of 360,000 degrees Fahrenheit (200,000 Celsius). For reference, our Sun has a surface temperature of about 10,000 degrees Fahrenheit (5,500 Celsius). The star is also shooting material away from itself at the ludicrous speed of 620 miles (1,000 kilometers) per second.

"We find the material in the filaments is expanding ballistically," said Tim Cunningham, a NASA Hubble Fellow at the Harvard and Smithsonian Center for Astrophysics, in a statement. "This means that the material has not been slowed down nor sped up since the explosion. From the measured velocities, looking back in time, you can pinpoint the explosion to almost exactly the year 1181."

Cunningham and his colleagues wanted to get a better idea of the shape of those filaments. They turned to a device in Hawaii called the Keck Cosmic Web Imager (KCWI), which detects light in the visible spectrum. Different colors move with different amounts of energy. For instance, blue has relatively high energy levels compared to red. The difference in energy allowed the astronomers to map out which matter was moving in the Earth's direction, and which was moving away. The result was a 3D map of the nebula's filaments. The shape is asymmetrical, which hints that the original explosion was also asymmetrical. There's also a weird cavity of nothingness, that's up to 3 light years wide, between the star remnant in the middle and the filaments, which is likely the result the explosion destroying all the matter that was too close to its center. (It should be noted Pa 30 nebula is hardly alone in being a celestial body with a weird shape.)

"A standard image of the supernova remnant would be like a static photo of a fireworks display," said Christopher Martin, a professor of physics at Caltech, who worked on the ensuing study, which was published in *The Astrophysical Journal Letters*. "KCWI gives us something more like a 'movie' since we can measure the motion of the explosion's embers as they streak outward from the central explosion."

The question that remains is why this nebula took on this shape. Cunningham said it could be because a shock wave condensed the speeding dust into beams, but nothing is certain. Even after almost a millennium, some mysteries continue to persist. ☀

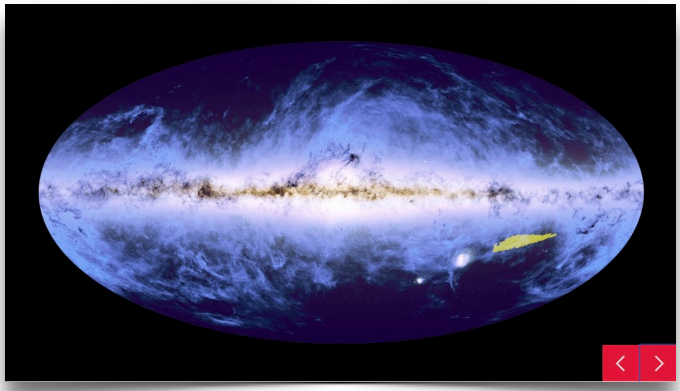
Snippet of Euclid Mission's Cosmic Atlas Released by ESA

JPL, October 15, 2024

With contributions from NASA, the mission will map a third of the sky in order to study a cosmic mystery called dark energy.

ESA (the European Space Agency) has released a new, 208-gigapixel mosaic of images taken by Euclid, a mission with NASA contributions that launched in 2023 to study why the universe is expanding at an accelerating rate. Astronomers use the term "dark energy" in reference to the unknown cause of this accelerated expansion.

The new images were released at the International Astronautical Congress in Milan on Oct. 15.



The location and actual size of the newly released Euclid mosaic is highlighted in yellow on a map of the entire sky captured by ESA's Planck mission and a star map from ESA's Gaia mission.

The mosaic contains 260 observations in visible and infrared light made between March 25 and April 8 of this year. In just two weeks, Euclid covered 132 square degrees of the southern sky — more than 500 times the area of the sky covered by a full Moon.

The mosaic accounts for 1% of the wide survey Euclid will conduct over six years. During this survey, the telescope observes the shapes, distances, and motions of billions of galaxies out to a distance of more than 10 billion light-years. By doing this, it will create the largest 3D cosmic map ever made.

This first piece of the map already contains around 100 million stars and galaxies. Some 14 million of

Dive into a snippet of the great cosmic atlas being produced by the ESA Euclid mission. This video zooms in on a 208-gigapixel mosaic containing about 14 million galaxies and covering a portion of the southern sky more than 500 times the area of the full Moon as seen from Earth.

these galaxies could be used by Euclid to study the hidden influence of dark energy on the universe.

"We have already seen beautiful, high-resolution images of individual objects and groups of objects from Euclid. This new image finally gives us a taste of the enormity of the area of sky Euclid will cover, which will enable us to take detailed measurements of billions of galaxies," said Jason Rhodes, an observational cosmologist at NASA's Jet Propulsion Laboratory in Southern California who is the U.S. science lead for Euclid and principal investigator for NASA's Euclid dark energy science team.

Galaxies Galore

Even though this patch of space shows only 1% of Euclid's total survey area, the spacecraft's sensitive cameras captured an incredible number of objects in great detail. Enlarging the image by a factor of 600 reveals the intricate structure of a spiral galaxy in galaxy cluster Abell 3381, 470 million light-years away

This image shows an area of the Euclid mosaic zoomed in 150 times. The combination of visible and infrared light reveals galaxies that are interacting with each other in cluster Abell 3381, 470 million light-years away from Earth.

"What really strikes me about these new images is the tremendous range in physical scale," said JPL's Mike Seiffert, project scientist for the NASA contribution to Euclid. "The images capture detail from clusters of stars near an individual galaxy to some of the largest structures in the universe. We are beginning to see the first hints of what the full Euclid data will look like when it reaches the completion of the prime survey."

Visble as well are clouds of gas and dust located between the stars in our own galaxy. Sometimes called "galactic cirrus" because they look like cirrus clouds at Earth, these clouds can be observed by Euclid's visible-light camera because they reflect visible light from the Milky Way. ☀

November's Night Sky Notes: Snowballs from Space

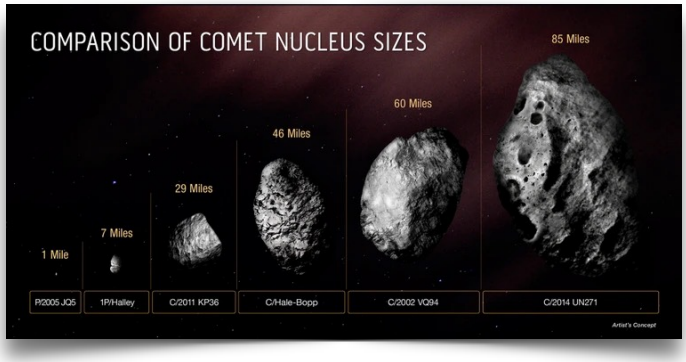
By Kat Troche

Nightskynetwork, November 2024

If you spotted comet C/2023 A3 (Tsuchinshan-ATLAS) in person, or seen photos online this October, you might have been inspired to learn more about these visitors from the outer Solar System. Get ready for the next comet and find out how comets are connected to some of our favorite annual astronomy events.

Comet Composition

A comet is defined as an icy body that is small in size and can develop a 'tail' of gas as it approaches the Sun from the outer Solar System. The key traits of a comet are its nucleus, coma, and tail.



The nucleus of the comet is comprised of ice, gas, dust, and rock. This central structure can be up to 80 miles wide in some instances, as recorded by the Hubble Space Telescope in 2022 – large for a comet but too small to see with a telescope. As the comet reaches the inner Solar System, the ice from the nucleus starts to vaporize, converting into gas. The gas cloud that forms around the comet as it approaches the Sun is called the coma. This helps give the comet its glow. But beware: much like Icarus, sometimes these bodies don't survive their journey around the Sun and can fall apart the closer it gets.

The most prominent feature is the tail of the comet. Under moderately dark skies, the brightest comets show a dust tail, pointed away from the Sun. When photographing comets, you can sometimes resolve the second tail, made of ionized gases that have been

Comet McNaught over the Pacific Ocean. Image taken from Paranal Observatory in January 2007.

electronically charged by solar radiation. These ion tails can appear bluish, in comparison to the white color of the dust tail.

The ion tail is also always pointed away from the Sun. In 2007, NASA's STEREO mission captured images of C/2006 P1 McNaught and its dust tail, stretching over 100 million miles. Studies of those images revealed that solar wind influenced both the ion and dust tail, creating striations – bands – giving both tails a feather appearance in the night sky.

Coming and Going

Comets appear from beyond Uranus, in the Kuiper Belt, and may even come from as far as the Oort Cloud. These visitors can be short-period comets like Halley's Comet, returning every 76 years.

This may seem long to us, but long-period comets like Comet Hale-Bopp, observed from 1996-1997 won't return to the inner Solar System until the year 4385. Other types include non-periodic comets like

NEOWISE, which only pass through our Solar System once.

A view of the 2023 Perseid meteor shower from the southernmost part of Sequoia National Forest, near Piute Peak.
Debris from comet Swift-Tuttle creates the Perseids.

But our experiences of these comets are not limited to the occasional fluffy snowball. As comets orbit the Sun, they can leave a trail of rocky debris in its orbital path. When Earth finds itself passing through one of these debris fields, we experience meteor showers! The most well-known of these is the Perseid meteor shower, caused by Comet 109P/Swift-Tuttle. While this meteor shower happens every August in the northern hemisphere, we won't see Comet Swift-Tuttle again until the year 2126.

See how many comets (and asteroids!) have been discovered on NASA's Comets page, learn how you can cook up a comet, and check out our mid-month article where we'll provide tips on how to take astrophotos with your smartphone! ☀

Saturn's moon Titan may have a 6-mile-thick crust of methane ice — could life be under there?

By Robert Lea

SPACE.COM, OCTOBER 30, 2024

"If life exists in Titan's ocean under the thick ice shell, any signs of life would need to be transported up Titan's ice shell. This is more likely to occur if Titan's ice shell is warm and connecting."

An illustration of Saturn's moon Titan with the gas giant planet in background.

Scientists have discovered that the icy shell of Saturn's largest moon, Titan, could possess an insulated, six-mile-thick (9.7-kilometer-thick) layer of methane ice beneath its surface. Ironically, this layer may make signs of life from the subsurface ocean of Titan easier to detect. And, down the line, the discovery could benefit the fight against human-driven climate change on Earth.

Titan may be a moon, but it is also more similar to Earth than any other solar system planet. That's because it is the only planet or moon in the solar system other than Earth to possess an atmosphere as well as liquid rivers, lakes and seas. Because of the frigid temperatures of Titan, however, this liquid is composed of hydrocarbons like methane and ethane. Still, the surface ice of Titan is indeed composed of water.

The new results from a team of planetary scientists at the University of Hawaii at Mānoa revealed that methane gas may also be trapped within Titan's ice shell, forming a distinct crust up to six miles thick. This gas could warm the underlying ice shell and help molecules rise to the surface of Titan, some of which could indicate the presence of life. This warming may also help explain Titan's methane-rich atmosphere.

"If life exists in Titan's ocean under the thick ice shell, any signs of life, biomarkers, would need to be transported up Titan's ice shell to where we could more easily access or view them with future missions," research team leader and University of Hawaii scientist Lauren Schurmeier said in a statement. "This is more likely to occur if Titan's ice shell is warm and connecting."

The team was first tipped off to the potential existence of this connecting layer of methane ice by the

presence of shallow impact craters on Titan. Only 90 impact craters have been seen on the surface of the Saturnian moon, and these have been confusing to observe because they should be hundreds of feet deeper than they actually are.

"This was very surprising because, based on other moons, we expect to see many more impact craters on the surface and craters that are much deeper than what we observe on Titan," Schurmeier said. "We realized something unique to Titan must be making them become shallower and disappear relatively quickly."

Investigating Titan's shallow craters

To further delve into the mystery of Titans' swallow impact craters, Schurmeier and colleagues turned to computer modeling. This allowed them to test how much the surface of Saturn's largest moon would relax and rebound after an asteroid impact if its icy shell were coated with an insulating layer of methane clathrate.

Methane clathrate, or "methane hydrate," is a solid compound in which a large amount of methane is trapped within the crystalline structure of water, creating a solid similar to ice.

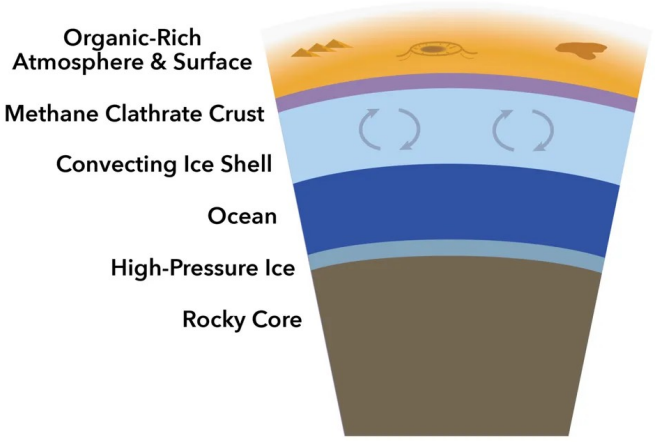
Considering craters of similar size on an icy moon of Jupiter that's comparable to Titan, Ganymede, the researchers could compare possible depths of impact craters on the Saturnian moon.

"Using this modeling approach, we were able to constrain the methane clathrate crust thickness to five to 10 kilometers [about three to six miles] because simulations using that thickness produced crater depths that best matched the observed craters," added Schurmeier. "The methane clathrate crust warms Titan's interior and causes surprisingly rapid topographic relaxation, which results in crater shallowing at a rate that is close to that of fast-moving warm glaciers on Earth."

The thickness of this methane icy shell matters because it could eventually explain why Titan's atmosphere is particularly rich with this hydrocarbon. It could also help scientists better understand Titan's carbon cycle, its liquid methane-based "hydrological cycle," and the changing climate of the Saturnian moon.

"Titan is a natural laboratory to study how the greenhouse gas methane warms and cycles through the atmosphere," Schurmeier explained. "Earth's methane clathrate hydrates, found in the permafrost of Siberia and below the arctic seafloor, are currently destabilizing and releasing methane.

"So, lessons from Titan can provide important insights into processes happening on Earth."



The thickness of the methane clathrate crust, when viewed in the light of the topography of Titan, means that the Saturnian moon's interior is likely warm and flexible rather than cold and rigid, as once believed.

"Methane clathrate is stronger and more insulating than regular water ice," Schurmeier added. "A clathrate crust insulates Titan's interior, makes the water ice shell very warm and ductile, and implies that Titan's ice shell is or was slowly convecting."

And that convection means that biomarkers indicating life could have been hoisted from Titan's subsurface ocean and carried to its outer icy shell, just awaiting discovery.

This research could act as a helpful guide to NASA scientists who intend to investigate Titan using the forthcoming Dragonfly spacecraft. Dragonfly is set to launch in 2028 and hopefully reach the Saturnian system in 2034 to conduct up-close observations of Titan's icy surface.

The team's research was published on Sept. 30 in The Planetary Science Journal. ☀

The Backyard Observer, December 2024

By Rick Heschmeyer

PISCES

Just south and east of the "Great Square of Pegasus" is the home of this month's constellation, PISCES, the Fishes. PISCES has traditionally been represented by two fish, each with a cord tied around its tailfin. The two cords, in turn, are tied in a knot at Alpha Piscium. This area of the sky has been called a "dull and obscure region" and indeed Sky Catalogue 2000.0, Volume 2, a catalogue of deep sky objects, lists no diffuse nebulae, no dark nebulae, no planetary nebulae, no open clusters, and no globular clusters. Several dozen galaxies are listed but most are out of reach of modest amateur instruments. Yet Pisces still contains several interesting stops on our celestial voyage and we will visit a few this month.

Directly south of the "Great Square" and easily visible to the naked eye, lies the pentagonal asterism of the Circlet of Pisces. It is composed of the stars Iota, Theta, Gamma, Kappa, and Lambda Piscium, and represents the westernmost of the two fishes that make up the constellation. An asterism is a prominent group, or pattern, of stars, often named, but not itself a constellation.

Alpha Piscium is more often known by its Arabic proper name El Rischa, meaning the knot. Alpha Piscium is the point where the cords coming from the two fishes are joined in constellation depictions. Alpha is also a close double star for medium-sized (4-8 inch) telescopes.

Zeta Piscium is an easy double star for small instruments. The colors of the stars are whitish/yellow and pale rose/lilac according to Rev. Webb, a famous 19th century observer and author. To fully appreciate the immense scale of the universe, the next time you observe Zeta Piscium imagine stretching 13 of our own Solar Systems end to end between the two components. At their current estimated separation that is very close to the distance between them!

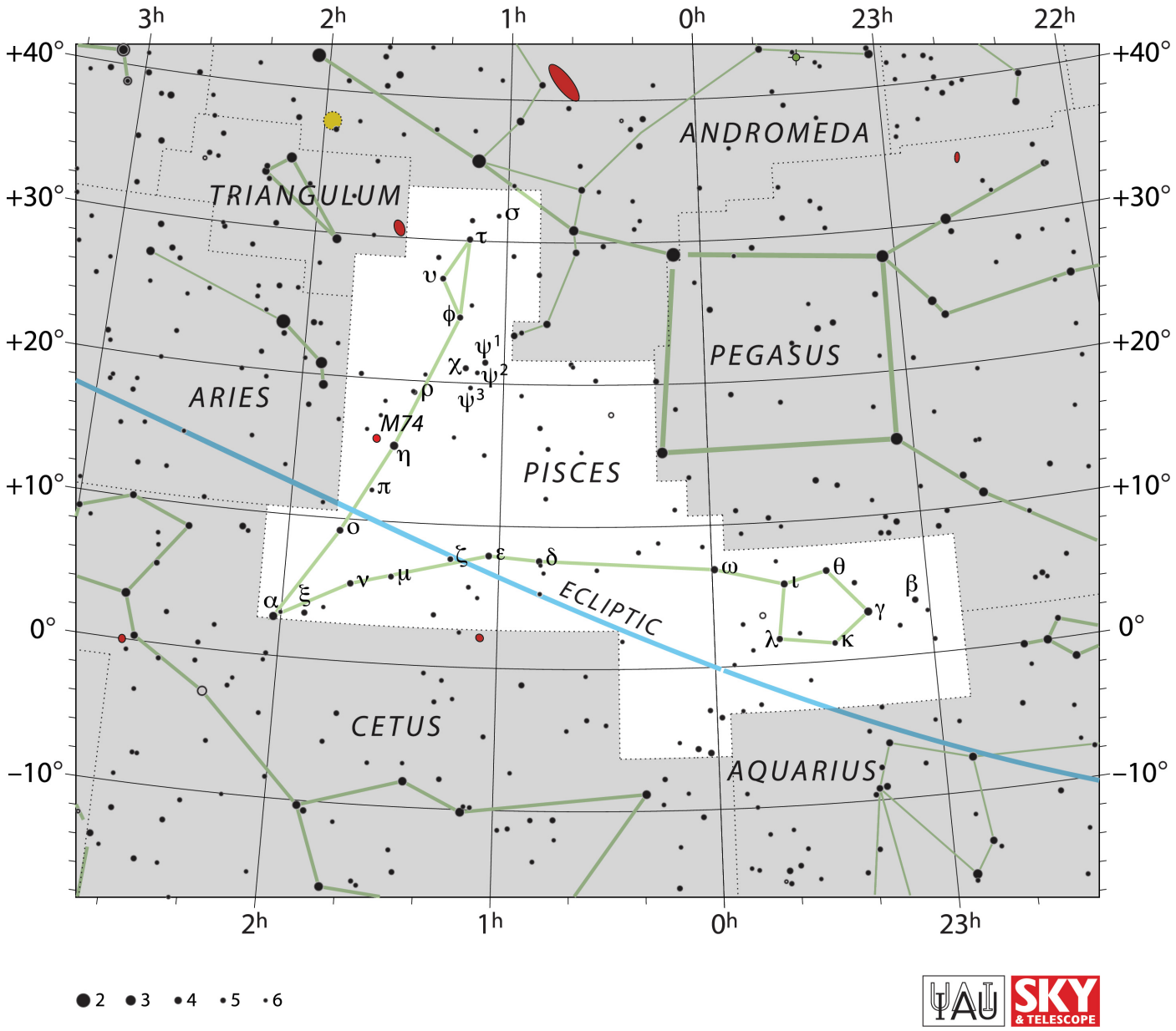
19 Piscium is located just east of the "Circlet", 19 Piscium belongs to a class of stars known as carbon stars. The name derives from the fact that bands of carbon have been found in the spectrum of these stars. Having a very low temperature in comparison to other stars, 19 Piscium displays a deep red color. Binoculars show the star well and offer a wide enough field of view that an observer can compare the star's ruddy color to nearby 21 and 22 Piscium, both of which are hotter stars and shine with a blur hue.

35 Piscium is a wide double star, visible in binoculars. The primary star is white while the companion has a distinct bluish color. The blue star is also slightly variable.

Messier 74 is a nearly perfect example of a face-on spiral galaxy. Unfortunately, it is also one of the most difficult Messier galaxies to observe. A six-to-eight-inch telescope, and dark skies, are needed to observe M74, and even then, it is a challenge. The difficulty arises because even though the galaxy's nuclear region is bright, almost stellar, the spiral arm region of the galaxy has a very low surface brightness.

Pisces is also the home of the Vernal Equinox, the point at which the path the Sun takes across the sky, the Ecliptic, intersects the Celestial Equator signaling the first day of Spring in the Northern Hemisphere. Due to precession Pisces is only a temporary home for the Vernal.

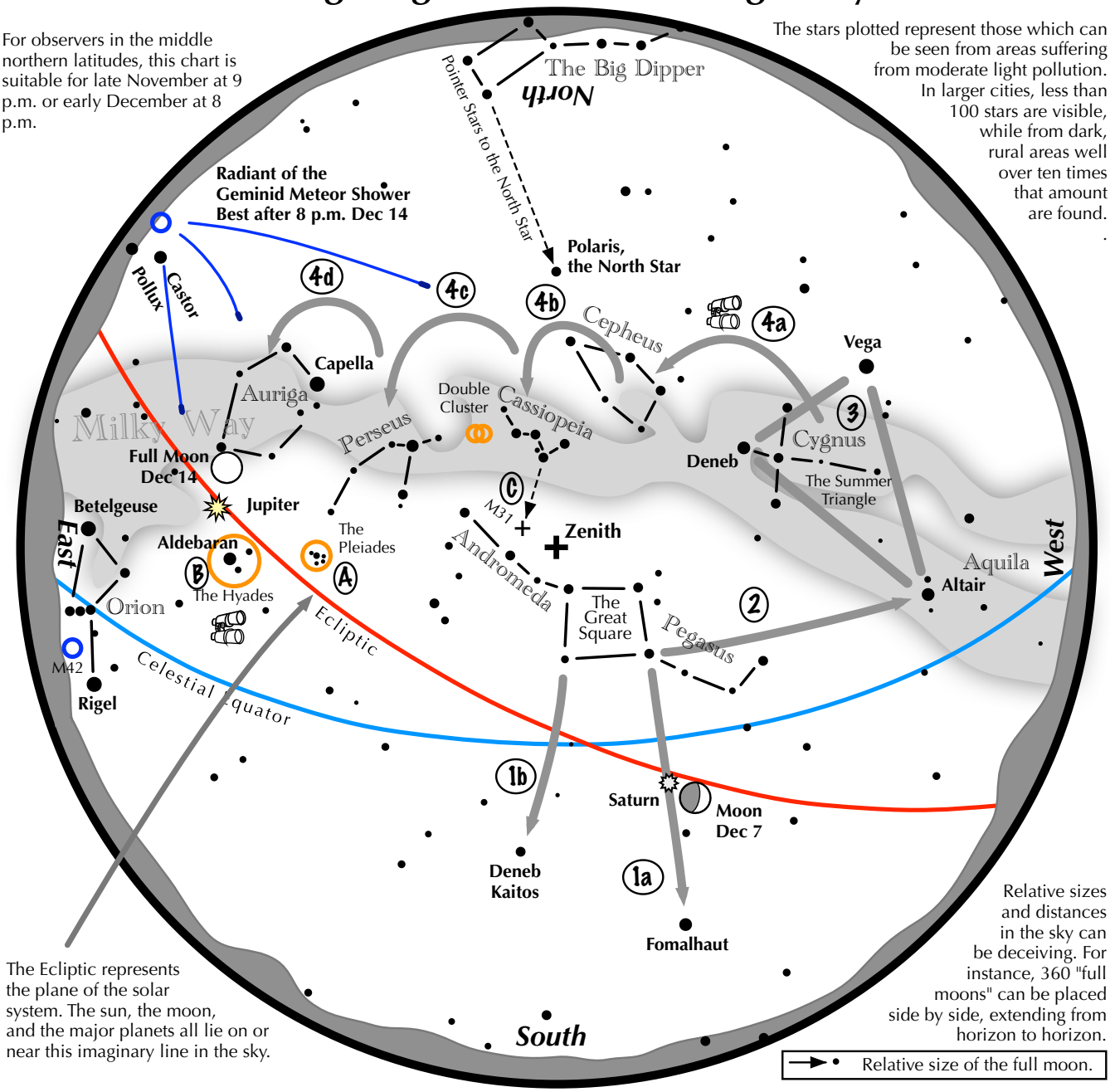
See map on next page ☀


3h
2h
1h
0h
23h
22h
+40°
+30°
+20°
+10°
0°
−10°
ANDROMEDA
TRIANGULUM
PEGASUS
ARIES
PISCES
CETUS
AQUARIUS
ECLIPTIC
M74
σ
τ
υ
φ
ψ1
χ
ψ2
ρ
ψ3
η
π
ο
ζ
ε
δ
ω
ι
θ
β
γ
λ
κ
ν
μ
α
ξ
2 3 4 5 6
IAU SKY & TELESCOPE

Navigating the December Night Sky

For observers in the middle northern latitudes, this chart is suitable for late November at 9 p.m. or early December at 8 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.

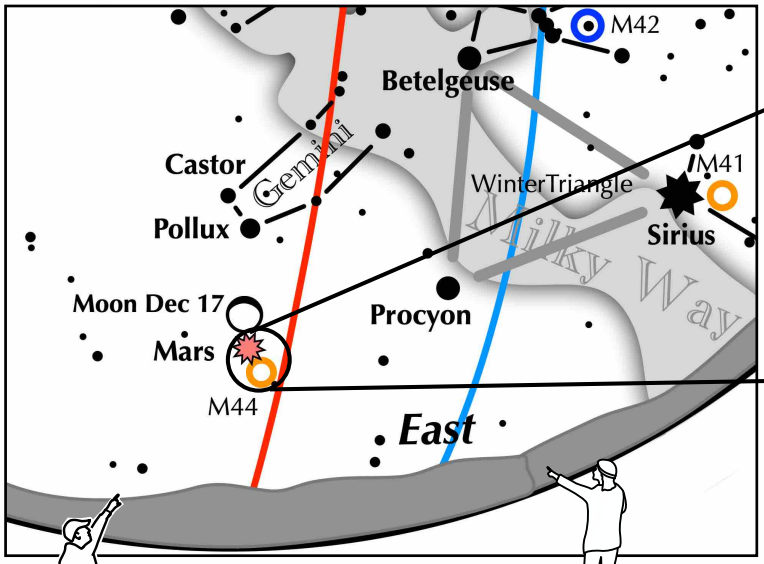
→• Relative size of the full moon.

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

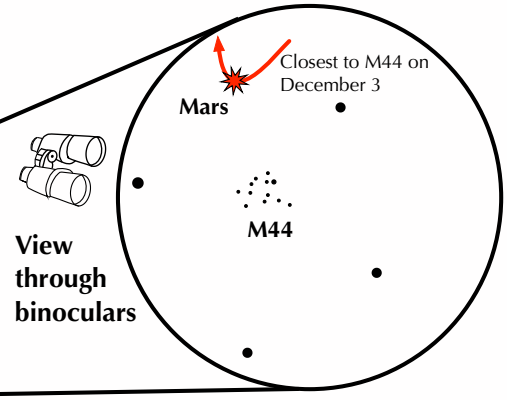
1. Face south. Almost overhead is the "Great Square" with four stars about the same brightness as those of the Big Dipper. Extend an imaginary line southward following the Square's two westernmost stars. The line strikes Fomalhaut, the brightest star in the southwest. A line extending southward from the two easternmost stars, passes Deneb Kaitos, the second bright star in the south.
2. Draw another line, this time westward following the southern edge of the Square. It strikes Altair, part of the "Summer Triangle."
3. Locate Vega and Deneb, the other two stars of the "Summer Triangle. Vega is its brightest member while Deneb sits in the middle of the Milky Way.
4. Jump along the Milky Way from Deneb to Cepheus, which resembles the outline of a house. Continue jumping to the "W" of Cassiopeia, to Perseus, and finally to Auriga with its bright star Capella.

Binocular Highlights
A and B: Examine the stars of the Pleiades and Hyades, two naked eye star clusters.
C: The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval.
D: Sweep along the Milky Way from Altair, past Deneb, through Cepheus, Cassiopeia and Perseus, then to Auriga for many intriguing star clusters and nebulous areas.

On a moonless evening in December, try this challenge:



View to the east-northeast in December 90 minutes after sunset



View through binoculars

Mars approaches the Beehive

On evenings in December, the Red Planet flies near the Beehive star cluster. On the night of December 3, it is closest.

Be sure to use binoculars to spot the many stellar bees of M44. The cluster has over 1000 stars, but only two dozen or so will be picked out with binoculars.

On December 7, Mars starts its retrograde motion, moving slightly each evening westward until February.

Even though Mars and M44 lie near each other in binoculars, they are nowhere near each other in three-dimensional space. M44 is 50 million times farther than the Mars!

It has taken the light from M44's stars over 575 years to reach your eyes!

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.