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The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
December 4, 2022, 7:00PM
Baker Wetlands Discovery Center

Public Observing
December 4, 2022, 8:00PM
Baker Wetlands Discovery Center

Club Officers

President
Rick Heschmeyer email

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Inside This Issue

Report From the Officers

By Rick Heschmeyer

October was a busy month. On October 13, another Telescope Night at KU took place. Dr. Ani Kokobobo spoke about "Vampires of the Earth and Sky", followed by a planetarium show and telescope observing.

On Thursday, October 20, about 75 people showed up for the Orionids Meteor Shower Watch Party at Baker Wetlands Discovery Center. Haze and some smoke from a grass fire at Forbes Field in Topeka hampered meteor viewing. While only a few meteors were seen, the dome was open, and telescopes were available to view the gas giant planets Jupiter and Saturn.

On Sunday, October 23, the KU Natural History Museum held a Pop-Up Science event called "Moon Mysteries". AAL had a table with club information as well as a telescope, and some lunar meteorites for attendees to enjoy.

November's Telescope Night at KU will take place on Thursday, November 10. Once we receive the flyer we will forward to the club via email.

We are finalizing plans for partnering with Lawrence Public Library on a large public observing event, "PlanetPalooza" that will take place on Tuesday evening, November 29, on the roof of the parking garage adjacent to the library. We had held several events there with LPL and have had great turnouts for them all. Anyone who can bring a telescope is encouraged to do so, and even if you cannot bring a telescope, any help you can provide will be appreciated. Once details have been finalized, they will be shared with club members and added to our events listings on our website and Facebook page. For now, save the date!

There will be no club meeting in November. The next club meeting will take place on Sunday, December 4. Our featured speaker that evening will be a face familiar to many of us, Dr. Bruce Twarog. This will be our last club meeting and public observing of the year. Hope to see everyone there.

Clear skies to all!

Asteroid Smacked by NASA's DART Now Has Giant Comet-Like Debris Tail

The debris of a cosmic crash is literally stretching across the sky.

The aftermath of DART's Collision with Dimorphos is the 10,000-kilometer (6,214 mile) trail of dust captured here by the SOAR Telescope.

By Eric Mack

CNET, OCTOBER 6, 2022

Instantly after NASA crashed its Double Asteroid Redirection Test spacecraft into the asteroid Dimorphos last week, telescopes watching in space and on Earth spotted a plume of dust and debris astronomers refer to as ejecta.

Now, follow-up observations show the dust is being pushed away from the asteroid by the solar wind, creating a tail that's similar to those we're accustomed to seeing trailing comets.

DART, an experiment in planetary protection, aimed to see if essentially throwing a robot probe at an object from Earth could impact the path of that object's orbit. Such an intentional maneuver could one day help humanity avoid an unpleasant encounter with an asteroid or comet that poses a serious impact threat to our planet.

Fortunately, Dimorphos poses no such threat (and in fact no known near-Earth objects are currently considered to be a significant danger). But there are plenty of asteroids and other space rocks out there that we haven't yet discovered or started tracking, so the data gained from DART could literally come in handy at just about any moment.

The collision took place on Monday, Sept. 26, and within less than two days, a well-defined tail was easily visible from ground-based telescopes.

On Sept. 28, astronomers Teddy Kareta from Arizona's Lowell Observatory and Matthew Knight of the US Naval Academy used the Southern Astrophysical Research (SOAR) Telescope in Chile to observe Dimorphos. They were able to calculate that its new tail is at least 10,000 kilometers (6,000 miles) long.

"It is amazing how clearly we were able to capture the structure and extent of the aftermath in the days following the impact," Kareta said in a statement.

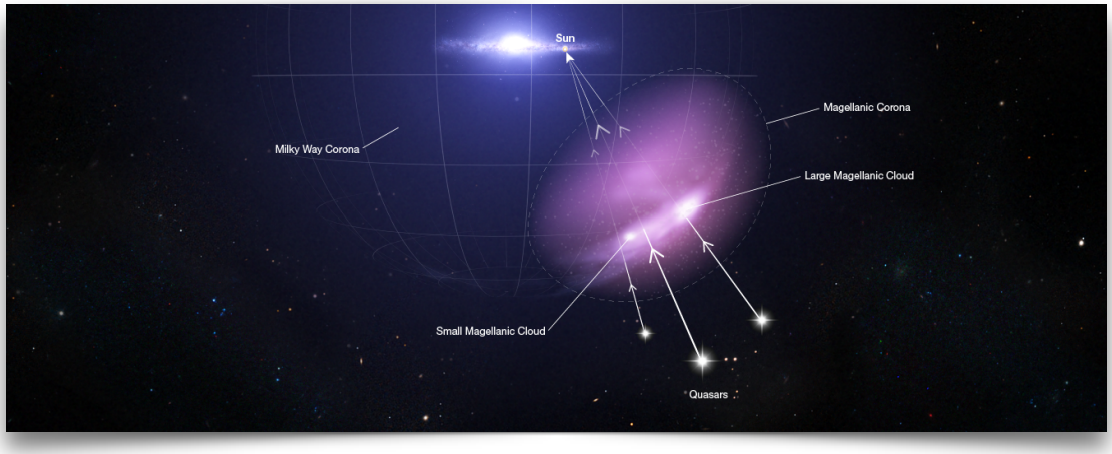
The observations and more conducted by numerous other astronomers will begin to paint a more detailed picture of the DART impact in coming weeks, including how much material the asteroid ejected and how much of it is made up of larger chunks versus fine dust.

The hope is all this will also better inform any future efforts to divert more threatening space rocks that attempt to call on Earth without an invitation. ☀

HUBBLE DETECTS PROTECTIVE SHIELD DEFENDING A PAIR OF DWARF GALAXIES

HUBBLESITE, SEPTEMBER 28, 2022

SCIENTISTS CONFIRM THE EXISTENCE OF THE ELUSIVE MAGELLANIC CORONA, A PROTECTIVE HALO OF HOT, IONIZED GAS PREVIOUSLY KNOWN ONLY IN THEORY.



For billions of years, the Milky Way's most massive companions – the Large and Small Magellanic Clouds – have been on a tumultuous journey through space, orbiting one another while being torn by the gravitational pull of our own galaxy.

Recent theoretical predictions suggest that these dwarf satellite galaxies must be protected by a pervasive shield that prevents the Milky Way from removing their essential star-forming gas. This so-called Magellanic Corona, made of supercharged gas with temperatures of half a million degrees, would act as a sort of cosmic crash zone around the Magellanic Clouds, keeping the stars and disk relatively unscathed during collisions. Although simulations show that the Magellanic Corona should exist, observational evidence has remained elusive.

Using a combination of the unique ultraviolet vision of the Hubble Space Telescope and the Far Ultraviolet Spectroscopic Explorer, along with the probing power of distant quasars, scientists have finally been able to detect and begin to map the Magellanic Corona. The discovery of this diffuse halo of hot gas, extending more than 100,000 light-years from the Large Magellanic Cloud and covering much of the southern sky, confirms the prediction and illuminates our understanding of how small galaxies can interact with larger galaxies without losing the fuel needed for future star formation.

For billions of years, the Milky Way's largest satellite galaxies – the Large and Small Magellanic Clouds – have followed a perilous journey. Orbiting one another as they are pulled in toward our home galaxy, they have begun to unravel, leaving behind trails of gaseous debris. And yet – to the puzzlement of astronomers – these dwarf galaxies remain intact, with ongoing vigorous star formation.

"A lot of people were struggling to explain how these streams of material could be there," said Dhanesh Krishnarao, assistant professor at Colorado College. "If this gas was removed from these galaxies, how are they still forming stars?"

With the help of data from NASA's Hubble Space Telescope and a retired satellite called the Far Ultraviolet Spectroscopic Explorer (FUSE), a team of astronomers led by Krishnarao has finally found the answer: the Magellanic system is surrounded by a corona, a protective shield of hot supercharged gas. This cocoons the two galaxies, preventing their gas supplies from being siphoned off by the Milky Way, and therefore allowing them to continue forming new stars.

This discovery, which was just published in Nature, addresses a novel aspect of galaxy evolution. "Galaxies envelope themselves in gaseous cocoons, which act as defensive shields against other galaxies," said co-investigator Andrew Fox of the Space Telescope Science Institute in Baltimore, Maryland.

Astronomers predicted the corona's existence several years ago. "We discovered that if we included a corona in the simulations of the Magellanic Clouds falling onto the Milky Way, we could explain the mass of extracted gas for the first time," explained Elena D'Onghia, a co-investigator at the University of

Wisconsin–Madison. “We knew that the Large Magellanic Cloud should be massive enough to have a corona.”

But although the corona stretches more than 100,000 light-years from the Magellanic clouds and covers a huge portion of the southern sky, it is effectively invisible. Mapping it required scouring through 30 years of archived data for suitable measurements.

Researchers think that a galaxy’s corona is a remnant of the primordial cloud of gas that collapsed to form the galaxy billions of years ago. Although coronas have been seen around more distant dwarf galaxies, astronomers had never before been able to probe one in as much detail as this.

“There’re lots of predictions from computer simulations about what they should look like, how they should interact over billions of years, but observationally we can't really test most of them because dwarf galaxies are typically just too hard to detect,” said Krishnarao. Because they are right on our doorstep, the Magellanic Clouds provide an ideal opportunity to study how dwarf galaxies interact and evolve.

In search of direct evidence of the Magellanic Corona, the team combed through the Hubble and FUSE archives for ultraviolet observations of quasars located billions of light-years behind it. Quasars are the extremely bright cores of galaxies harboring massive active black holes. The team reasoned that although the corona would be too dim to see on its own, it should be visible as a sort of fog obscuring and absorbing distinct patterns of bright light from quasars in the background. Hubble observations of quasars were used in the past to map the corona surrounding the Andromeda galaxy.

By analyzing patterns in ultraviolet light from 28 quasars, the team was able to detect and characterize the material surrounding the Large Magellanic Cloud and confirm that the corona exists. As predicted, the quasar spectra are imprinted with the distinct signatures of carbon, oxygen, and silicon that make up the halo of hot plasma that surrounds the galaxy.

The ability to detect the corona required extremely detailed ultraviolet spectra. “The resolution of Hubble and FUSE were crucial for this study,” explained Krishnarao. “The corona gas is so diffuse, it’s barely even there.” In addition, it is mixed with other gases, including the streams pulled from the Magellanic Clouds and material originating in the Milky Way.

By mapping the results, the team also discovered that the amount of gas decreases with distance from the center of the Large Magellanic Cloud. “It’s a perfect telltale signature that this corona is really there,” said Krishnarao. “It really is cocooning the galaxy and protecting it.”

How can such a thin shroud of gas protect a galaxy from destruction?

“Anything that tries to pass into the galaxy has to pass through this material first, so it can absorb some of that impact,” explained Krishnarao. “In addition, the corona is the first material that can be extracted. While giving up a little bit of the corona, you're protecting the gas that's inside the galaxy itself and able to form new stars.” ☀

Physicists dream big with an idea for a particle collider on the moon

A lunar particle accelerator could reach 1,000 times the energy of Earth’s largest collider

By Emily Conover

Sciencenews, June 10, 2022

If you could peer into a particle physicist’s daydream, you might spy a vision of a giant lunar particle accelerator. Now, researchers have calculated what such an enormous, hypothetical machine could achieve.

A particle collider encircling the moon could reach an energy of 14 quadrillion electron volts, physicists report June 6 at arXiv.org. That’s about 1,000 times

the energy of the world's biggest particle accelerator, the Large Hadron Collider, or LHC, at CERN near Geneva.

It's not an idea anyone expects will become reality anytime soon, says particle physicist James Beacham of Duke University. Instead, he and physicist Frank Zimmermann of CERN considered the possibility "primarily for fun." But physicists of future generations could potentially build a collider on the moon, Beacham says.

Such a fantastical machine would probably be buried under the moon's surface to avoid wild temperature swings, the researchers say, and could be powered by a ring of solar panels around the moon.

To understand how the laws of physics work at energies higher than that of the LHC, scientists will need bigger accelerators (*SN: 1/22/19*). For example, the proposed Earth-based Future Circular Collider would be 100 kilometers in circumference, dwarfing the LHC's 27-kilometer ring. A collider encircling the moon would be about 11,000 km around.

While building a collider that big on Earth might be possible, it could potentially displace people who live in its path — not an issue on the moon. But, like other proposed projects that could alter the moon's appearance (*SN: 6/7/19*), the idea raises thorny questions about who gets to decide the fate of the Earth's companion, Beacham acknowledges. Those questions will presumably be left for future generations to sort out. ☀

Black hole is 'burping out' a 'spaghettified' star it devoured years ago

By Robert Lea

SPACE.COM, OCTOBER 14, 2022

Three years after a black hole shredded and devoured a small star, the cosmic titan is lighting up the night sky with violent emissions as it burps out material from its messy stellar meal.

In October 2018, the black hole — located in a galaxy 665 million light-years from Earth — was observed tearing up a star that had wandered too close. The event itself wasn't surprising to astronomers, who often observe these violent encounters between stars and greedy black holes. These so-called tidal disruption events (TDEs) happen when objects such as stars approach black holes and the massive gravitational influence they encounter generates tidal forces that stretch the star in one direction while squashing it in the other direction, thus "spaghettifying" the stellar body.

As this spaghettified material falls onto the black hole, it heats up and generates a flash of light that astronomers can spot from millions of light-years away. Occasionally, the black hole spits some of this stellar material back out into space. In other words, black holes are messy eaters.

However, there's something unusual about this TDE, designated AT2018hyz: Despite not having feasted on anything since this small star, which has about one-tenth the mass of the sun, the black hole is now spewing the material from its last meal.

"This caught us completely by surprise — no one has ever seen anything like this before," Yvette Cendes, an astronomer at the Harvard & Smithsonian Center for Astrophysics who led the research, said in a statement. "It's as if this black hole has started abruptly burping out a bunch of material from the star it ate years ago."

Cendes and her team determined that this material is being ejected from the black hole at around 300 million mph (480 million kph) — about half the speed of light. For comparison, TDEs usually spit out this material at about 10% the speed of light.

Why it took so long for this black hole to burp out its last meal is also a mystery.

"This is the first time that we have witnessed such a long delay between the feeding and the outflow," study co-author Edo Berger, an astronomy professor at Harvard University, said in the statement.

Bright radio "burps"

The astronomers spotted this event as they were searching for signs of TDEs that have occurred over the past few years. Data they collected in radio waves with the Very Large Array in New Mexico showed that this black hole had mysteriously burst back to life in June 2021. This finding encouraged them to investigate AT2018hyz further.

"We applied for Director's Discretionary Time on multiple telescopes, which is when you find something so unexpected, you can't wait for the normal cycle of telescope proposals to observe it," Cendes said. "All the applications were immediately accepted."

The team studied the event in multiple wavelengths of light and with a range of telescopes — including the VLA, the MeerKAT radio telescope in South Africa, and the Atacama Large Millimeter/submillimeter Array in Chile — and found that the most striking observations of AT2018hyz were in radio frequencies.

"We have been studying TDEs with radio telescopes for more than a decade, and we sometimes find they shine in radio waves as they spew out material while the star is first being consumed by the black hole," Berger said. "But in AT2018hyz there was radio silence for the first three years, and now it's dramatically lit up to become one of the most radio-luminous TDEs ever observed."

Study co-author Sebastian Gomez, a postdoctoral fellow at the Space Telescope Science Institute in Baltimore, studied AT2018hyz in 2018 with visible-light telescopes such as the 1.2-meter (3.9 feet) telescope at the Fred Lawrence Whipple Observatory in Arizona. At that time, he had considered this TDE unremarkable.

"We monitored AT2018hyz in visible light for several months until it faded away, and then set it out of our minds," Gomez said in the statement.

Now, the team will investigate whether the delay between feeding and emitting is unique to AT2018hyz or if it's a more common event that astronomers have missed.

"The next step is to explore whether this actually happens more regularly and we have simply not been looking at TDEs late enough in their evolution," Berger said. ☀

Astronomers just spotted the most powerful flash of light ever seen

By Tereza Pultarova

SPACE.COM, OCTOBER 14, 2022

Astronomers just detected what may be the most powerful flash of light ever seen.

The so-called gamma-ray burst, the most energetic type of electromagnetic explosion known to exist in the universe, was first spotted by telescopes Sunday (Oct. 9).

Gamma-ray bursts, which were discovered accidentally by U.S. military satellites in the 1960s, are likely produced when giant stars explode at the ends of their lives before collapsing into black holes, or when ultradense stellar remnants known as neutron stars collide. Within seconds, these explosions unleash as much energy as the sun will emit during its entire 10-billion-year lifetime.

The flash detected Sunday was the strongest one ever observed, releasing 18 teraelectronvolts of energy. Scientists are still analyzing the measurements, but if the findings are confirmed, the gamma-ray burst would be the first gamma-ray burst ever found to carry more than 10 teraelectronvolts of energy.

At first, the strength of the flash confused astronomers; they thought it must have been produced by a relatively close source. They also initially believed that the energy was coming in X-rays, rather than in gamma-rays. Subsequent analyses of the signal confirmed that it was indeed a gamma-ray burst coming from a source some 2.4 billion light-years away. While not exactly nearby, the gamma-ray burst is still the closest ever seen.

Although this gamma-ray burst was within a safe distance from Earth, a much closer one would be catastrophic to our planet. Such an energetic flash within thousands of light-years from Earth would strip the planet of its protective ozone layer and likely cause mass extinction. In fact, scientists think one of the biggest mass-extinction events in Earth's history — the Ordovician extinction, which occurred 450 million years ago — may have been triggered by such a blast, according to NASA.

Although the recently spotted gamma-ray burst, dubbed GRB221009A, appeared 20 times closer to Earth than an average gamma-ray burst, it is still far enough away to cause more excitement than concern.

"This is indeed a very exciting event!" Gemma Anderson, an astronomer at Curtin University in Australia, who studies similar phenomena, told ScienceAlert.

“This event being so nearby but also very energetic means the radio, optical, X-ray and gamma-ray light it produces is extremely bright and therefore easy to observe. We can therefore study this gamma ray burst with lots of big and small telescopes around the world and collect very comprehensive datasets as it first brightens and then fades away.”

Gamma-ray bursts come in two varieties. Short gamma-ray bursts are rarer and last no longer than two seconds. These bursts make up about 30% of all such events and are believed to be caused by collisions of neutron stars. The other type, long gamma-ray bursts, can last up to several minutes and are likely produced by hypernovas, stellar explosions that are 100 times brighter than supernovas, in which supermassive stars die after running out of the hydrogen fuel in their cores.

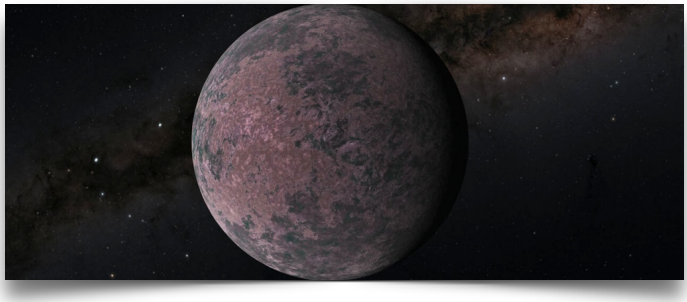
Astronomers mostly see the afterglow of these explosions that comes from electrons energized by the blast. GRB221009A appears to be a long gamma-ray burst, but astronomers don't know yet what gave rise to it.

"It is still too early to tell," Anderson told ScienceAlert. "The light from an underlying supernova will take days to brighten. However, given this gamma-ray burst's long duration, it may be a very powerful type of supernova.”

Telescopes all over the world (and in Earth's orbit) are now pointing at the dusty galaxy from which the flash emerged. They will try to observe the light generated by the explosion in as many wavelengths as possible to get the most complete picture of its origin.

"When you are dealing with cosmic explosions that blast out stellar remains at near the speed of light, leaving a black hole behind, you are watching physics occurring in the most extreme environments that are impossible to recreate on Earth," Anderson told ScienceAlert. "We still don't fully understand this process. Such a nearby explosion means we can collect very high quality data to study and understand how such explosions occur.” ☀

Desolate World Had Atmosphere Blown Away Completely, Astronomers Think



By Carolyn Collins Petersen

Sciencealert, October 24, 2022

What if you placed an Earth-sized planet in a close orbit around an M-dwarf star? It's more than an academic question, since M dwarfs are the most numerous stars we know.

A group of astronomers studying the planet GJ 1252b found an answer, and it's not pretty.

Since this planet is so close to its star, it receives a lot of heat. And that proximity is deadly in another way.

"The pressure from the star's radiation is immense, enough to blow a planet's atmosphere away," said Michelle Hill, a University of California Riverside astrophysicist and co-author of a recent paper focused on GJ 1252b.

The planet lies some 65 light-years from Earth and orbits its star twice every 24 Earth hours. The heat from the star renders this world inhospitable.

This is not terribly different from Mercury in our solar system. There's no atmosphere and the planet is alternately heated and frozen as it orbits the Sun. In fact, Earth also loses a little atmosphere to solar activity.

However, volcanism and other processes release gases back into our atmosphere. Earth is lucky; planets like Mercury and GJ 1252b are not. And, that has profound implications in the search for life-friendly worlds.

What is it about M Dwarf Stars?

There are millions and millions of M dwarf stars in our galaxy alone. They range in size from about a tenth to two-thirds of the mass of the Sun. These can be active, sending flares and outbursts through their systems. Most have at least one planet in their habitable zones and others at a variety of distances.

That's not a great combo if you want to find life on their planets. The stellar activity that blasts away planetary atmospheres obviously also destroys any chances for life on those worlds.

And, since M dwarfs are so numerous, their ubiquity may undercut the number of planets in the galaxy that actually DO support life. That's not great news for planets like GJ 1252b.

"It's possible this planet's condition could be a bad sign for planets even further away from this type of star," Hill said.

"This is something we'll learn from the James Webb Space Telescope, which will be looking at planets like these."

Even though M dwarfs could be atmosphere killers, it's not all doom and gloom.

For example, many of the 5,000 stars in Earth's solar neighborhood are M dwarfs. Even if a large fraction of them blast their planets into uninhabitability, at least 1,000 others (not all of them M dwarfs) could foster conditions suitable for life on their worlds.

"If a planet is far enough away from an M dwarf, it could potentially retain an atmosphere. We cannot conclude yet that all rocky planets around these stars get reduced to Mercury's fate," Hill said.

"I remain optimistic."

Looking for an Atmosphere on GJ 1252b

The science behind the situation at GJ 1252b is intriguing. Astronomers used Spitzer Space Telescope data to assess the infrared radiation from the planet as a secondary eclipse blocked its light.

The measurements showed that the star blasts the planet. Daytime surface temperatures range around 1,227 degrees Celsius (2,242 degrees Fahrenheit). That's hot enough to melt gold, silver, and copper.

The heat, coupled with assumed low surface pressure, led the researchers to believe there was no atmosphere there. But, let's assume for a moment that there WAS a carbon dioxide atmosphere. That would trap heat on the surface, and maybe allow that blanket to exist for a while.

However, it turns out that GJ 1252b isn't so fortunate.

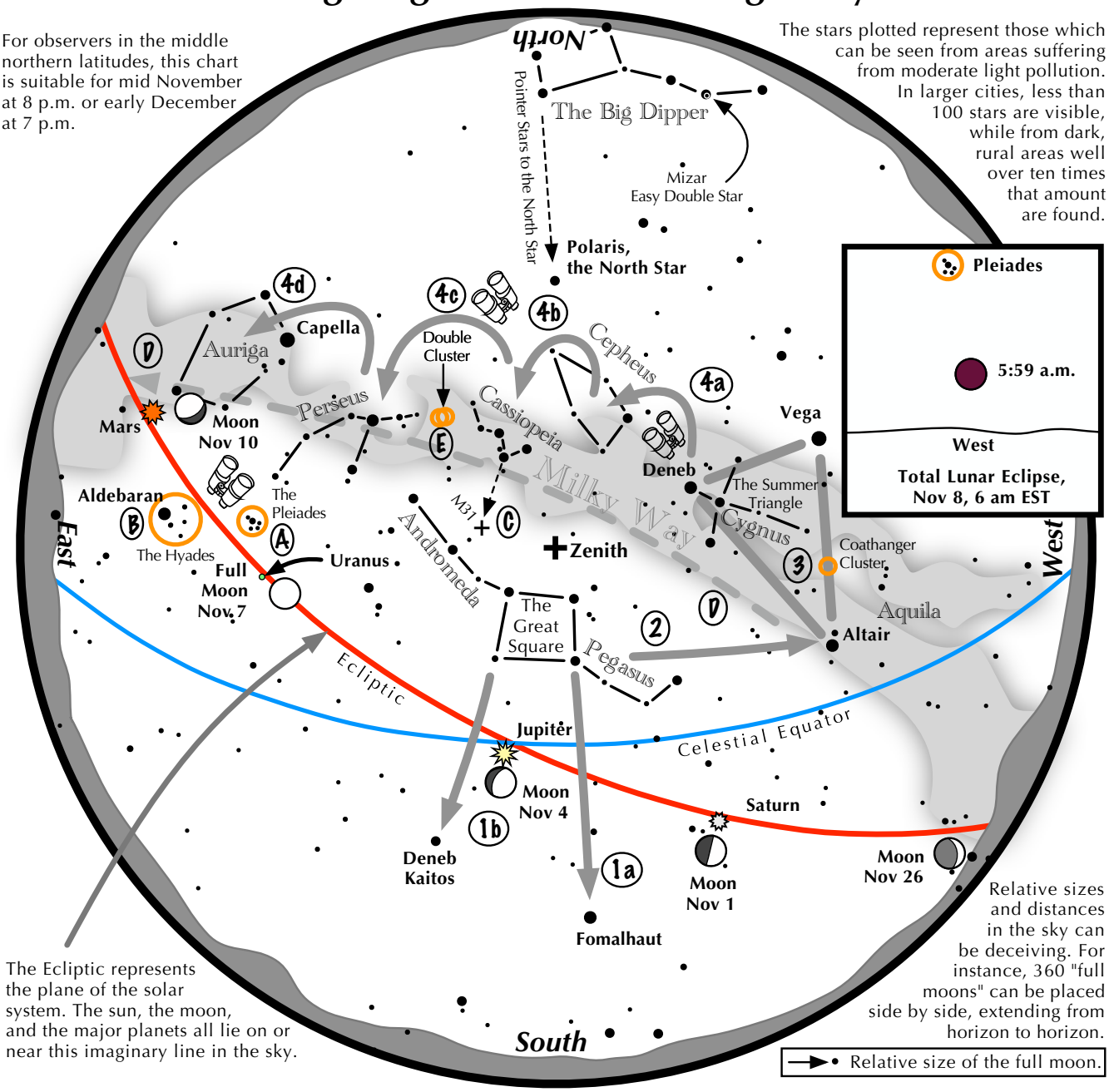
"The planet could have 700 times more carbon than Earth has, and it still wouldn't have an atmosphere. It would build up initially, but then taper off and erode away," said Stephen Kane, UCR astrophysicist and study co-author.

In the long run, if this study holds true across a substantial population of M dwarf stars, that'll shift the search for habitable planets to other candidates around less-volatile stars. ☀

Navigating the November Night Sky

For observers in the middle northern latitudes, this chart is suitable for mid November at 8 p.m. or early December at 7 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.

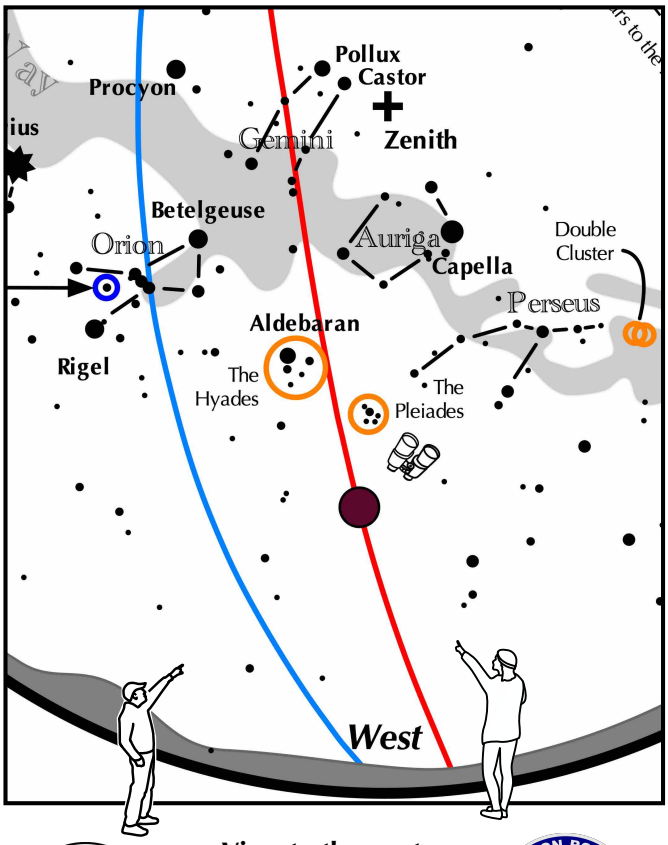
Navigating the November night sky: Simply start with what you know or with what you can easily find.

1. Face south. Almost overhead lies the "Great Square" with four stars about the same brightness as those of the Big Dipper. Extend a line southward following the Square's two westernmost stars. The line strikes Fomalhaut, the brightest star in the south. A line extending southward from the two easternmost stars, passes Deneb Kaitos, the second brighest star in the south.
2. Draw a line westward following the southern edge of the Square until 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, then to Perseus, and finally to Auriga with its bright star Capella.

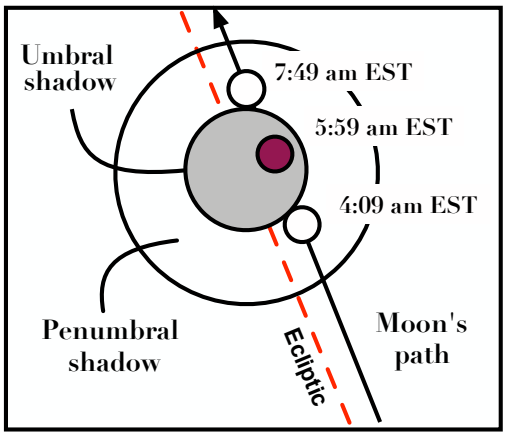
Binocular Highlights

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. **E.** The Double Cluster.

In the early morning of November 8, try this challenge:



View to the west on November 8 from 1:09 a.m. PST to 4:49 a.m. PST



The Moon slides through a total eclipse

In the early morning hours of Nov. 8, the brilliant full moon slides into Earth's shadow. East coast viewers can view until mid eclipse before the morning twilight becomes too bright. Viewers farther west in the US can witness the complete total and partial phases.

- Even though the partial umbral eclipse begins at 4:09 EST, darkening may not be noticed for another 5 minutes.
- At mid eclipse, what color is the moon? How dark is it?
- Before the eclipse begins, the moon's sky glow blocks viewing the Pleaides star cluster and many other sky objects. During totality, though, the Pleiades, the Double Cluster, and M42 will all be visible. Now you can say that you've seen these celestial wonders during a full moon!

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.