Volume 49 Number 11 November 2023

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
December 3, 2023, 7:00PM
Baker Wetlands Discovery Center

Public Observing
December 3, 2023, 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

The big event for October was the Solar Eclipse. Unfortunately, the clouds had other ideas. While we had a good turnout at the Lawrence Public Library, only a couple of quick glimpses of the eclipse peeked through the clouds, one of which is pictured here.

The Physics and Astronomy Department event on campus moved their attendees indoors to watch a live stream of the eclipse due to the clouds. Hopefully Lawrence will have better luck next April's eclipse.

AAL member Jerelyn Ramirez was able to travel to the path of annularity and we originally had her scheduled to talk at the October meeting about her trip, but she will be unable to present this month. We will reschedule her presentation for a meeting after the first of the year. Instead, Rick Heschmeyer will be talking about and demonstrating several of the new online tools available to amateur astronomers for astronomical weather forecasting.

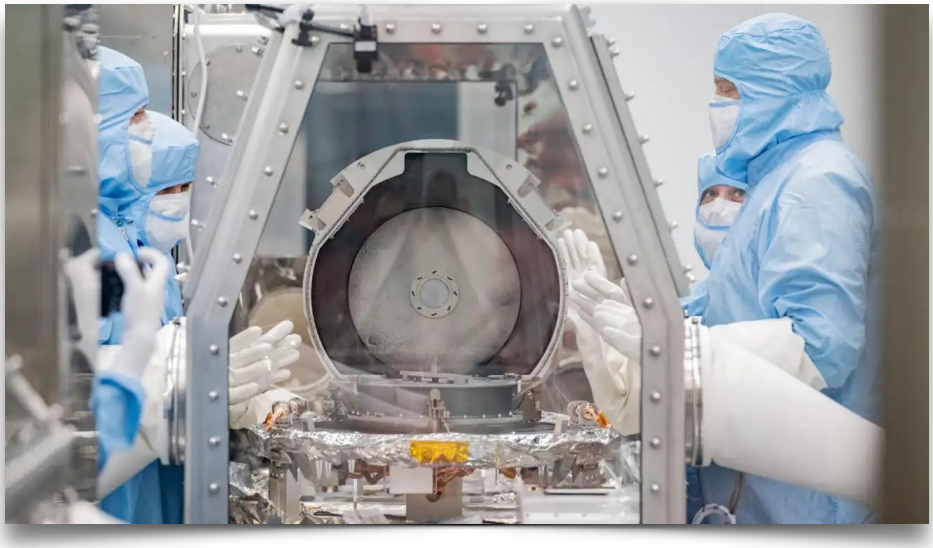
The November "Telescope Night at KU" is planned for Thursday, November 16th, starting at 7 PM. Our last club meeting of the year will take place at 7 PM on Sunday, December 3rd at Baker Wetlands Discovery Center. Our presenter will be KU Graduate Student and member of the KU ExoLab, Alex Polanski. He will be talking about the research he recently completed as part of his IPAC Visiting Graduate Fellowship at CalTech.

Public Observing will take place at the conclusion of the meeting, weather permitting.

Keep looking up!

Returned Asteroid Sample Canister Contains Way More Asteroid Than Expected

OSIRIS-REx's return from Bennu comes with a twist, as scientists face delays in disassembling the canister due to an abundance of material on the exterior.



By Passant Rabie
Gizmodo.com, October 3, 2023

Scientists working to open up the sample canister containing rock and dust from asteroid Bennu have run into a problem: there's just too much of it.

The process of disassembling the TAGSAM (Touch-and-Go Sample Acquisition Mechanism) head is taking longer than anticipated due to the abundance of material found when the canister lid was removed last week, NASA wrote in a blog post. But that's not a bad problem to have.

In October 2020, OSIRIS-REx landed on near-Earth asteroid Bennu and snagged a sample from its surface. Scientists expected to find extra bits of the asteroid in the canister outside the TAGSAM, an articulated arm on the spacecraft with a round sampler head at the end used to grab the sample. This assumption arose when they observed particles slowly escaping the head before it was stowed, according to NASA. Not only was this assumption correct, but there were also significantly more dark particles coating the inside of the canister lid and base surrounding TAGSAM than anticipated.

"The very best 'problem' to have is that there is so much material, it's taking longer than we expected to collect it," Christopher Snead, deputy OSIRIS-REx curation lead at NASA's Johnson Space Center, said in a statement. "There's a lot of abundant material outside the TAGSAM head that's interesting in its own right. It's really spectacular to have all that material there."

When the aluminum lid to the sample canister was first removed, the mission team found black dust and debris on the avionics deck of the canister. Scientists are now performing a quick-look analysis of that initial sample, "which will provide an initial understanding of the Bennu material and what we can expect to find when the bulk sample is revealed," NASA wrote.

Bennu is a small, near-Earth asteroid that makes a close pass to Earth every six years or so. Scientists believe Bennu might have broken off from a much larger carbon-rich asteroid about 700 million to 2 billion years ago, and drifted much closer to Earth since then. Analyzing the asteroid sample may help scientists piece together the origin story of Earth, and how the building blocks of life could have been delivered to our planet by way of asteroids.

The early findings from the sample, in addition to some images of the rocks and dust, will be revealed during a live broadcast on October 11 at 11:00 a.m. ET.

Over the coming weeks, the curation team at NASA's Johnson Space Center in Houston will move the TAGSAM head into a different specialized glovebox, where it will be disassembled to reveal the bulk sample within.

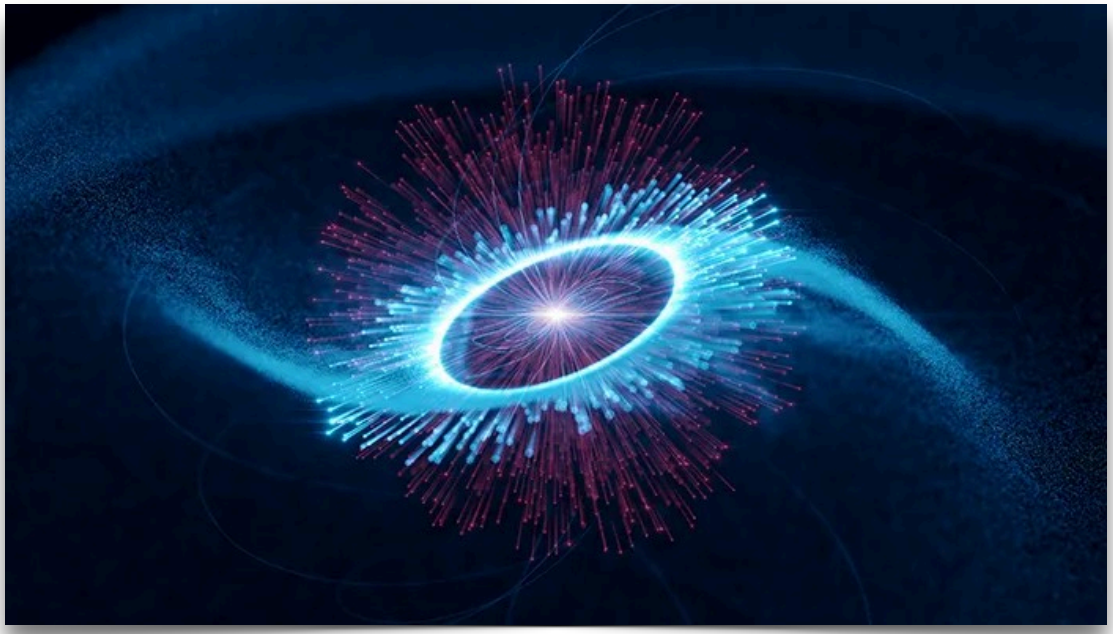
The OSIRIS-REx mission dropped off the asteroid samples in the Utah desert on September 24, from where it was airlifted to a clean room. From there, the clean room team packaged all the parts of the sample capsule for transport by aircraft to the Johnson Space Center. The team is being extra careful as to not let any Earthly contaminants into the sample canister, preserving the story of life as it is. ☀

Pulsar surprises astronomers with record-breaking gamma-rays

By Monisha Ravisetti
SPACE.COM, OCTOBER 5, 2023

"TeV pulsar astronomy is born!"

Nearly 1,000 light-years from where you're sitting lies a spinning, highly magnetized neutron star that is so dense, a tablespoon of it equals something like the weight of Mount Everest. It's an intense sight, to say the least, which is why astronomers naturally love studying it. You might've even heard its name uttered before: The Vela Pulsar.



Artist's impression of the Vela pulsar, in the center, and its magnetosphere, whose edge is marked by the bright circle. The blue tracks travelling outwards represent paths of accelerated particles. These produce gamma radiation along the arms of a rotating spiral by colliding with infrared photons emitted in the magnetosphere (in red).

And on Thursday (Oct. 5), scientists announced that data from the High Energy Stereoscopic System (HESS) observatory in Namibia indicates this cosmic marvel just became a little more marvelous. It would appear that Vela unleashed the highest-energy radiation ever seen coming from a pulsar.

Specifically, this object seems to have spit out gamma-ray photons — which are associated with wavelengths that carry the most energy of all electromagnetic spectrum waves — holding at least 20 teraelectronvolts (TeVs), or 20 trillion electronvolts. (1 electronvolt equals the amount of energy a single electron gains after being accelerated by 1 volt of electricity.)

To put that into context, Arache Djannati-Ataï, discovery team lead and scientist at the Astroparticle & Cosmology laboratory in France, says you'd need about 2,000,000 typical solar flare photons to make one 20 TeV photon. "As compared to visible light," Djannati-Ataï told Space.com, "one would need roughly 2x10^13 visible photons."

Though Vela is a pretty "normal" pulsar with rotations occurring 11 times per second, the researcher explains it's a key subject in astronomy because it's quite close to us — cosmically speaking, that is.

"Targeting it with our telescopes was almost mandatory!"

Typically, pulsars are expected to emit radiation with energies below tens of gigaelectronvolts (GeV), let alone fall into the extreme realm of TeVs. (1 gigaelectronvolt is equal to 1 billion electronvolts).

Even Vela, according to the team, originally exhibited a sort of cutoff when it comes to radiation emissions — in fact, even though some theoretical predictions had suggested Vela can emit in the TeV range, no one suspected the whopping 20 TeV figure the researchers managed to observe.

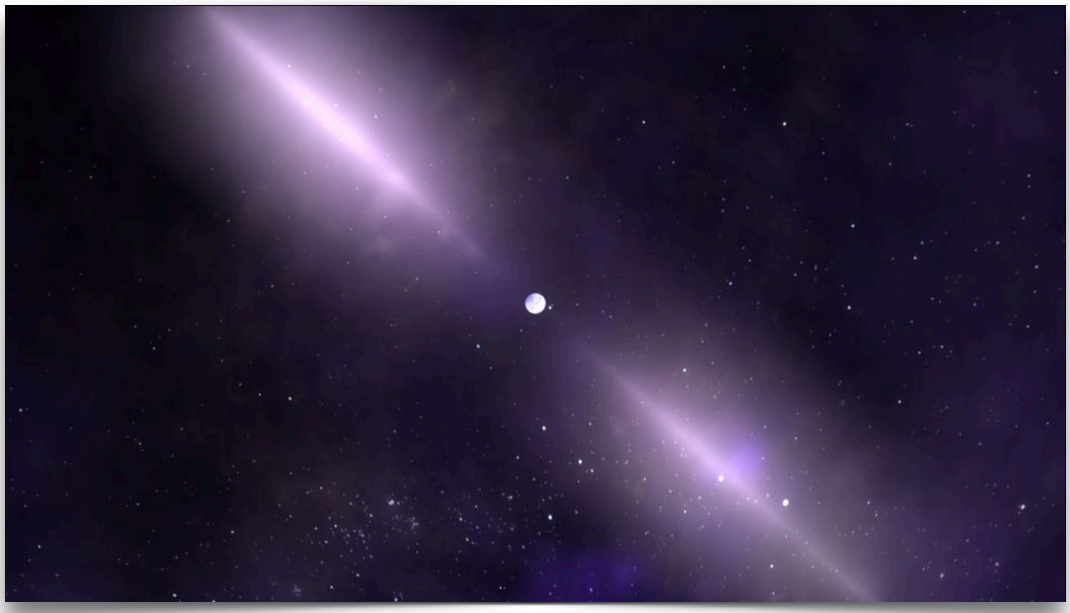
"We had searched for a pulsed emission from Vela at lower energies," Djannati-Ataï said, "But detecting photons reaching 20 TeV was really a surprise." The only other pulsar ever seen to have TeV-level emissions is the Crab Pulsar, located more than 6,000 light-years from Earth — yet even that one topped out at around 1 TeV.

And, finally, before we get into some implications of this high-energy sighting, there is one other intriguing finding to discuss about Vela.

At risk of simplification, the team found that Vela's highly energetic photons corresponded to a previously unknown spectral component of pulsars. A pulsar's "spectrum" refers to a diagram that represents all the different light intensities and energies emitted by the object. (This is not exclusive to pulsars. Scientists can study lots of cosmic entity spectra so long as there's light involved).

So essentially, with Vela's spectrum, the team noticed a steeply rising pattern and clear break between the TeV emissions and lower-level emissions. What this means is the very energetic photons couldn't have been a continuation of lower energy photons such that the latter grew and grew (and grew) until they reached TeV status.

"This is in contrast to the Crab Pulsar," Djannati-Ataï said, where the energy spectrum is in continuation of its GeV emissions.



A NASA illustration of a pulsar, a rapidly rotating neutron star, that periodically points bursts of radiation at Earth.

As to what this might mean for astronomy in general, well, first and foremost, it tells us a ton about one of the most incredible items in our universe.

"Within the zoo of cosmic objects, pulsars are fantastic," Djannati-Ataï said. "They are cosmic laboratories with incredible features that we cannot reach, by far, on Earth."

Even the origin story of pulsars is quite an impressive one. They're the leftover, spinning corpses of stars that once died in a supernova explosion, are made almost completely of neutrons and they blast out beams of radiation that sometimes sweep across our solar system. It's actually those sweeps, which happen at regular time intervals, that allow scientists to map out the spectra of these bodies.

Such extremity is also why scientists study the space around pulsars to test some major physical concepts, as Djannati-Ataï touches on by calling them "cosmic laboratories." Most notably, experts like to see whether Albert Einstein's theory of general relativity holds around pulsars because these objects are some of the most gravitationally intense things in the universe_— and general relativity is a mind-bending explanation for gravity itself. To that end, as far as we know, it does.

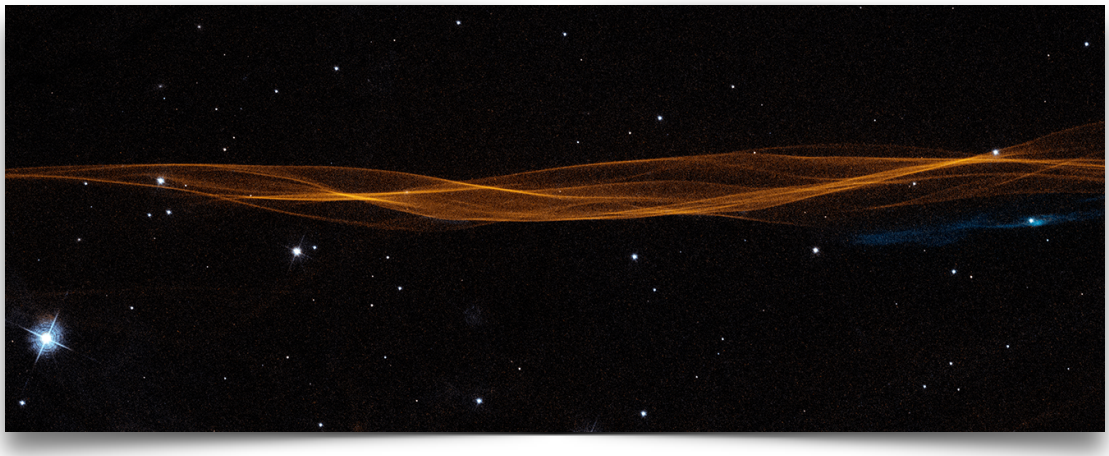
Further, Djannati-Ataï says these findings provide stringent constraints around our understanding of the source of pulsar radiation. Right now, scientists believe that source to be fast-moving electrons produced and accelerated in the pulsar's magnetosphere, which then travel toward the object's periphery. This model doesn't really explain the team's observations, however; other stuff needs to happen to produce emissions with energies as high as 20 TeV.

And though the researchers have some ideas, they intend to fully solve that puzzle with future observations. For now, we can enjoy how these results have officially opened up a new path for scientists who work among the stars.

As Djannati-Ataï puts it, "TeV pulsar astronomy is born!" ☀

Living on the Edge: Supernova Bubble Expands in New Hubble Time-Lapse Movie

HUBBLESITE, SEPTEMBER 28, 2023



Summary

20,000-Year-Old Explosion Continues Expanding Into Space

The abrupt, explosive death of a massive star, called a supernova, is one of the biggest blasts in the universe since the big bang. What's left behind are shredded stellar remnants resembling a fluffy cotton ball. The explosion expands from a smudge of light into a wispy, entangled cobweb of glowing gasses.

One of the nearest supernova remnants is the Cygnus Loop, located high in the summer sky. It has ballooned to 120 light-years in diameter. The energy needed to inflate such a huge structure is beyond imagination.

If it could be seen with the naked eye, the Cygnus Loop would be the angular diameter of six full Moons stretched across the sky. Put another way, it would appear to be the width of three fingers held at arm's length. Given its size, the Cygnus Loop is a favorite target of amateur star gazers.

Astronomers used the power of the Hubble Space Telescope to zoom in for a close-up look at one sliver of the nebula. They found gossamer filaments resembling wrinkles in a bedsheet stretched across two light-years. The filaments are at the outer edge of the expanding bubble, plowing into interstellar space.

Analyzing the shock wave's location, astronomers found that the filaments haven't slowed down at all in the last 20 years of Hubble observations. The filaments haven't even changed shape. The material is speeding into interstellar space at over half a million miles per hour – fast enough to travel from Earth to the Moon in less than half an hour!

Though a doomed star exploded some 20,000 years ago, its tattered remnants continue racing into space at breakneck speeds – and NASA's Hubble Space Telescope has caught the action.

The nebula, called the Cygnus Loop, forms a bubble-like shape that is about 120 light-years in diameter. The distance to its center is approximately 2,600 light-years. The entire nebula has a width of six full Moons as seen on the sky.

Astronomers used Hubble to zoom into a very small slice of the leading edge of this expanding supernova bubble, where the supernova blast wave plows into surrounding material in space. Hubble images taken from 2001 to 2020 clearly demonstrate how the remnant's shock front has expanded over time, and they used the crisp images to clock its speed.

By analyzing the shock's location, astronomers found that the shock hasn't slowed down at all in the last 20 years, and is speeding into interstellar space at over half a million miles per hour – fast enough to travel from Earth to the Moon in less than half an hour. While this seems incredibly fast, it's actually on the slow end for the speed of a supernova shock wave. Researchers were able to assemble a "movie" from

Hubble images for a close-up look at how the tattered star is slamming into interstellar space.

"Hubble is the only way that we can actually watch what's happening at the edge of the bubble with such clarity," said Ravi Sankrit, an astronomer at the Space Telescope Science Institute in Baltimore, Maryland. "The Hubble images are spectacular when you look at them in detail. They're telling us about the density differences encountered by the supernova shocks as they propagate through space, and the turbulence in the regions behind these shocks."

A very close-up look at a nearly two-light-year-long section of the filaments of glowing hydrogen shows that they look like a wrinkled sheet seen from the side. "You're seeing ripples in the sheet that is being seen edge-on, so it looks like twisted ribbons of light," said William Blair of the Johns Hopkins University, Baltimore, Maryland. "Those wiggles arise as the shock wave encounters more or less dense material in the interstellar medium." The time-lapse movie over nearly two decades shows the filaments moving against the background stars but keeping their shape.

"When we pointed Hubble at the Cygnus Loop we knew that this was the leading edge of a shock front, which we wanted to study. When we got the initial picture and saw this incredible, delicate ribbon of light, well, that was a bonus. We didn't know it was going to resolve that kind of structure," said Blair.

Blair explained that the shock is moving outward from the explosion site and then it starts to encounter the interstellar medium, the tenuous regions of gas and dust in interstellar space. This is a very transitory phase in the expansion of the supernova bubble where invisible neutral hydrogen is heated to 1 million degrees Fahrenheit or more by the shock wave's passage. The gas then begins to glow as electrons are excited to higher energy states and emit photons as they cascade back to low energy states. Further behind the shock front, ionized oxygen atoms begin to cool, emitting a characteristic glow shown in blue.

The Cygnus Loop was discovered in 1784 by William Herschel, using a simple 18-inch reflecting telescope. He could have never imagined that a little over two centuries later we'd have a telescope powerful enough to zoom in on a very tiny slice of the nebula for this spectacular view. ☀

The black hole–powered jet in galaxy M87 is making stars explode

The surprising discovery is puzzling astronomers

By Ken Croswell

Sciencenews, October 13, 2023

The black hole at the center of galaxy M87 (illustrated) fuels a powerful jet of gas that is triggering the explosions of stars in the galaxy, a study finds.

High-speed gas shooting from the galaxy M87 is causing stars to go nova, a study suggests, and no one knows how.

A nova occurs after a dense star known as a white dwarf receives gas from an orbiting star (*SN: 2/12/21*). As the white dwarf's intense gravity squeezes the gas, it heats up and explodes, but both stars survive the violence. In fact, over millions of years, the same star goes nova again and again. Recent observations indicate that these eruptions forged much, and perhaps most, of the universe's supply of the valuable metal lithium (*SN: 5/7/19*).

Nova explosions erupt in our galaxy as well as others, including the giant elliptical M87, whose jet of fast-moving gas is powered by the black hole at the galaxy's center (*SN: 4/10/19*). Now Hubble Space Telescope data show that there's an excess of these explosions along M87's jet, researchers report in a study submitted September 28 to arXiv.org.

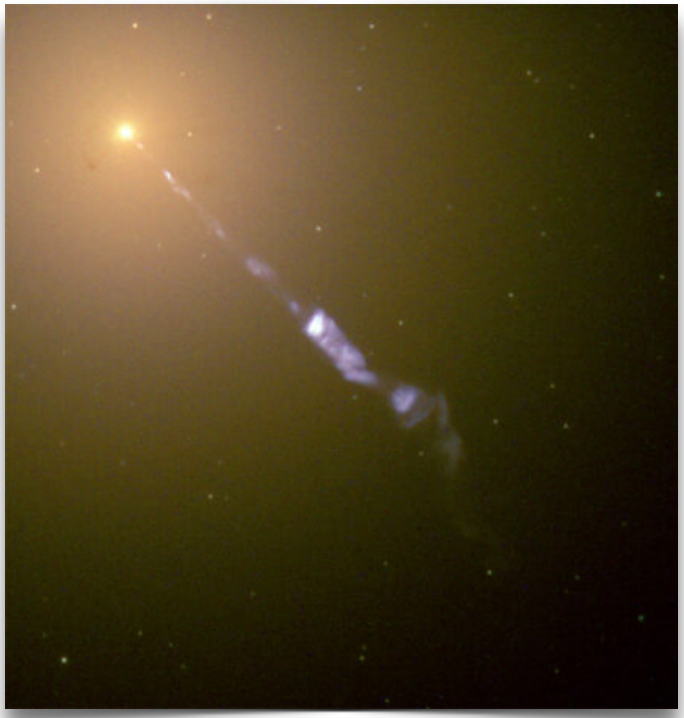
Alec Lessing, an undergraduate student at Stanford University, Michael Shara, an astronomer at the American Museum of Natural History in New York City, and their colleagues used the telescope to locate 135 nova outbursts in M87, whose jet is many thousands of light-years long. The galaxy itself is 54 million light-

years from Earth, at the heart of the nearest galaxy cluster, named Virgo.

After identifying the nova explosions, the team plotted their positions in the galaxy. “It was striking to the eye,” Shara says of the plot. “The novae appeared to be preferentially aligned with the jet.”

By dividing the galaxy into 10 equal sectors, the astronomers found that 25 blasts occurred along the jet — versus only 10 to 16 in each of the galaxy’s other sectors. The chance that this is just a statistical fluke is only about 0.3 percent, the researchers say.

“I was really surprised,” says Massimo Della Valle, an astronomer at the Italian National Institute for Astrophysics in Naples, who was not involved with the new study. “If these objects are novae, the jet has to be responsible for this somehow.”



The Hubble Space Telescope snapped this composite picture of the galaxy M87 and its jet of fast-moving gas, which is many thousands of light-years long.

“I was really surprised,” says Massimo Della Valle, an astronomer at the Italian National Institute for Astrophysics in Naples, who was not involved with the new study. “If these objects are novae, the jet has to be responsible for this somehow.”

Perhaps, he says, the jet pushes interstellar gas onto white dwarf stars in nova systems, increasing the amount of material that accumulates on the stars’ surfaces. As a result, the white dwarfs explode more frequently than they otherwise would, accounting for the surplus of nova outbursts along the jet.

The jet itself, Shara says, doesn’t seem to supply enough gas or radiation to explain the explosions. “The jet is to blame, but we just don’t know why or how,” he says. “It is somehow causing the novae to be more prevalent in that sector, but whether it’s because it’s triggering the novae somehow or birthing the novae — making more of them there — or some other process … we don’t know.”

For additional clues, Shara hopes to use Hubble to examine other galaxies that resemble M87, to see whether their jets are also accompanied by such eruptions. ☀

Source of largest ever Mars quake revealed

Sciencedaily, October 17, 2023

Summary

Scientists have announced the results of an unprecedented collaboration to search for the source of the largest ever seismic event recorded on Mars. The study rules out a meteorite impact, suggesting instead that the quake was the result of enormous tectonic forces within Mars' crust.

A global team of scientists have announced the results of an unprecedented collaboration to search for the source of the largest ever seismic event recorded on Mars. The study, led by the University of Oxford, rules out a meteorite impact, suggesting instead that the quake was the result of enormous tectonic forces within Mars' crust.

The quake, which had a magnitude of 4.7 and caused vibrations to reverberate through the planet for at least six hours, was recorded by NASA's InSight lander on May 4 2022. Because its seismic signal was similar to previous quakes known to be caused by meteoroid impacts, the team believed that this event (dubbed 'S1222a') might have been caused by an impact as well, and launched an international search for a fresh crater.

Although Mars is smaller than Earth, it has a similar land surface area because it has no oceans. In order to survey this huge amount of ground -- 144 million km2 -- study lead Dr Benjamin Fernando of the University of Oxford sought contributions from the

European Space Agency, the Chinese National Space Agency, the Indian Space Research Organisation, and the United Arab Emirates Space Agency. This is thought to be the first time that all missions in orbit around Mars have collaborated on a single project. Each group examined data from their satellites orbiting Mars to look for a new crater, or any other tell-tale signature of an impact (e.g. a dust cloud appearing in the hours after the quake).

After several months of searching, the team announced today that no fresh crater was found. They conclude that the event was instead caused by the release of enormous tectonic forces within Mars' interior. The results, published today in the journal *Geophysical Research Letters*, indicate that the planet is much more seismically active than previously thought.

Dr Fernando said: 'We still think that Mars doesn't have any active plate tectonics today, so this event was likely caused by the release of stress within Mars' crust. These stresses are the result of billions of years of evolution; including the cooling and shrinking of different parts of the planet at different rates. We still do not fully understand why some parts of the planet seem to have higher stresses than others, but results like these help us to investigate further. One day, this information may help us to understand where it would be safe for humans to live on Mars and where you might want to avoid!'

He added: 'This project represents a huge international effort to help solve the mystery of S1222a, and I am incredibly grateful to all the missions who contributed. I hope this project serves as a template for productive international collaborations in deep space.'

Dr Daniela Tirsch, Science Coordinator for the High Resolution Stereo Camera on board the European Space Agency's Mars Express Spacecraft said: 'This experiment shows how important it is to maintain a diverse set of instruments at Mars, and we are very glad to have played our part in completing the multi-instrumental and international approach of this study.'

From China, Dr Jianjun Liu (National Astronomical Observatories, Chinese Academy of Sciences) added: 'We are willing to collaborate with scientists around the world to share and apply this scientific data to get more knowledge about Mars, and are proud to have provided data from the colour imagers on Tianwen-1 to contribute to this effort.'

Dr Dimitra Atri, Group Leader for Mars at New York University Abu Dhabi and contributor of data from the UAE's Hope Spacecraft, said: 'This has been a great opportunity for me to collaborate with the InSight team, as well as with individuals from other major missions dedicated to the study of Mars. This really is the golden age of Mars exploration!'

Dr Constantinos Charalambous of Imperial College London, a co-author on the study, said: 'The absence of a crater in our image search for S1222a marks a significant milestone in interpreting seismic signals on Mars, crucial for distinguishing impact events from tectonic forces on the Red Planet.'

S1222a was one of the last events recorded by InSight before its end of mission was declared in December 2022. The team are now moving forward by applying knowledge from this study to future work, including upcoming missions to the Moon and Saturn's moon Titan.

About InSight

- InSight was a NASA mission dedicated to the study of the martian interior through geophysics, especially seismology (the study of Earthqukes).
- It launched from California in May 2018 and landed on Mars in November of that year. The last data were returned in December 2022, after the spacecraft lost power due to increasing dust accumulation on its solar panels.
- External partners to the InSight mission included the UK, France, Germany, and Switzerland. Within the UK, Imperial College London and the University of Oxford are lead institutions.
- During its time on Mars, InSight recorded over 1,300 marsquake events. Of these, at least 8 were from meteoroid impact events. The largest two formed craters around 150m in diameter. If the S1222a event was formed by an impact, we would expect the crater to be at least 300m in diameter. ☀

The Backyard Observer, November 2023

By Rick Heschmeyer

ANDROMEDA

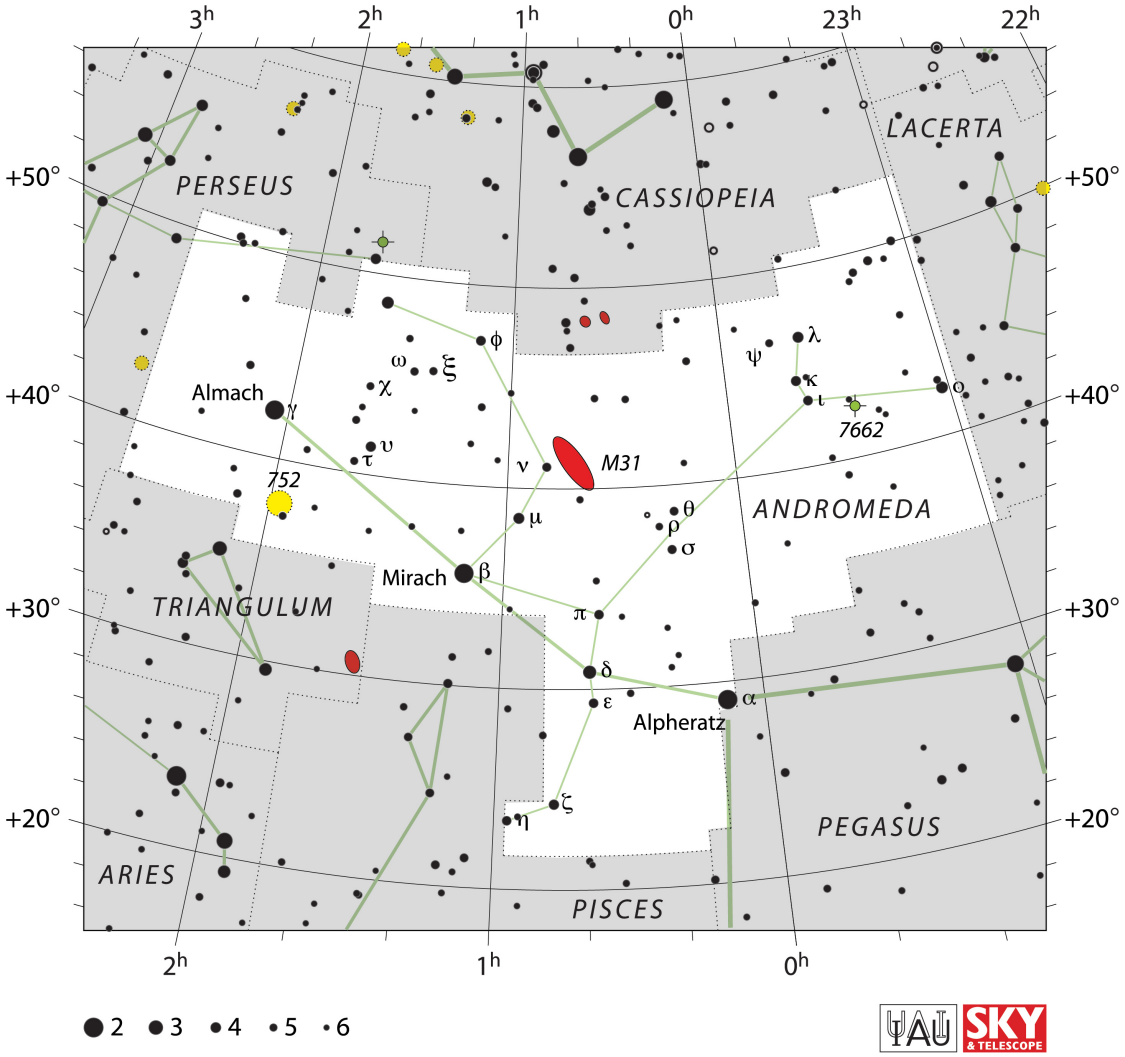
We will start this month by referring to last month's constellation, Pegasus. Recall the star Alpheratz, former the Delta star in Pegasus, but since 1930 the Alpha star in this month's constellation Andromeda.

Gamma Andromedae, also known as Almach, is a fine double star in small telescopes. As bright as the brighter stars of The Big Dipper, Almach is made up of two colorful stars. The brighter star is orange in color, the dimmer shines with a blue color. The pair is 120 light years distant.

Messier 31, better known as the Andromeda Galaxy, is the brightest and nearest spiral galaxy to the Milky Way. From a dark sky, M31 is the most distant object visible with the naked eye. First observed over 3000 years ago by the Arabic astronomer al-Sufi, calling it the "Little Cloud". Two companion galaxies, both elliptical galaxies, are visible in telescope, Messier 32 and Messier 110.

NGC 752 is a nice open cluster located in Andromeda, and is a good object in binoculars and small telescopes due to its large size. It is old for an open cluster at around 1.5 billion years in age. The light from the cluster left on its journey to earth about 1300 years ago. A telescope will reveal about 60 stars, although recent research shows over 300 member stars. It was discovered by Caroline Herschel in 1783.

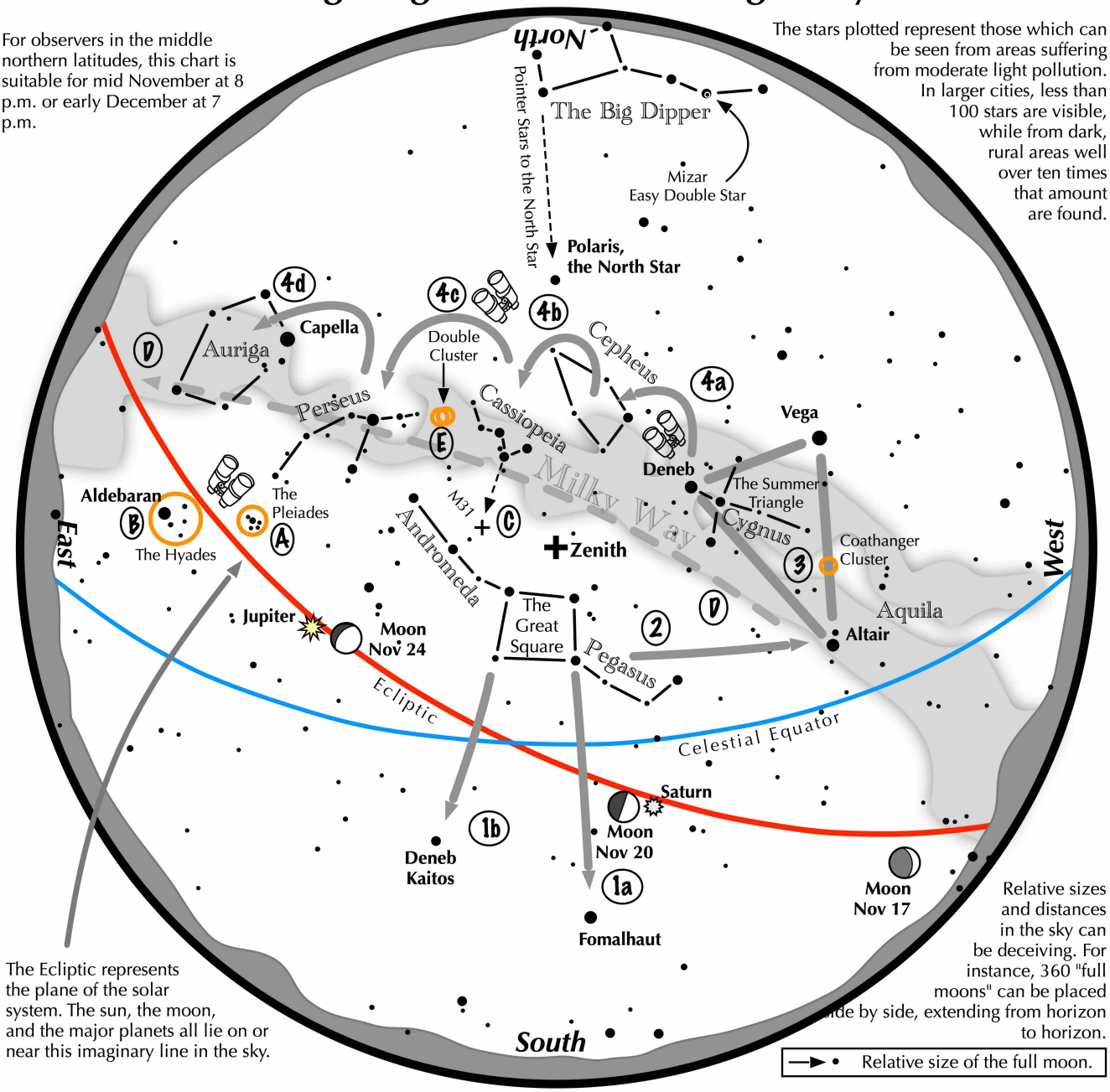
NGC 7662 is a fine planetary nebula, one of the finest in the night sky. Also know as the Blue Snowball Nebula. It is round and ring-like at high magnification. It was discovered by Caroline's brother, William Herschel in 1784, who noted its blue color. It is best viewed in telescopes of 6" in diameter. It is located about 5700 light years away.



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.

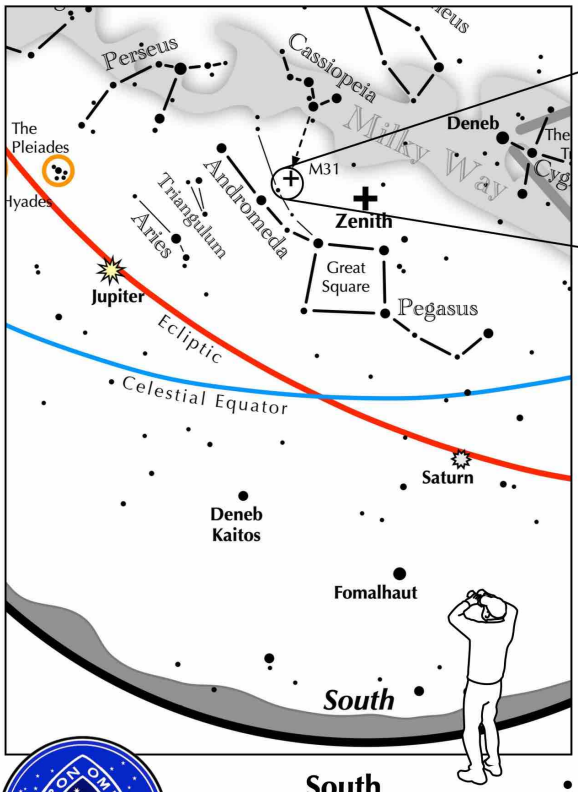
Navigating the November night sky: Simply start with what you know or with what you can easily find.

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.

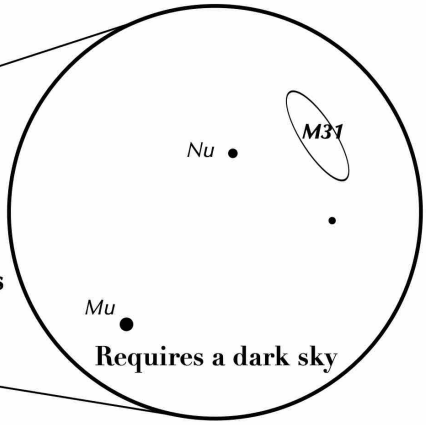
Binocular Highlights

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.

If you can observe only one celestial event this month, consider this one:



South
90 minutes after sunset



Have you seen M31, the Andromeda Galaxy?

Look high in the south 90 minutes after sunset in November.

- Find the Great Square nearly at the zenith.
- Identify the line of four stars beginning at the northeast corner of the Great Square and extending northeast.
- Identify a second but dimmer line extending more northeasterly than the first line. These two lines represent Andromeda.
- Identify the third star on each line.
- A line passing through those two stars and extending northwest for the same length lands on M31.

or ...

- Draw an arrow pointing southward through the three westernmost stars of Cassiopeia's "W."
- Extend that line for the same length as Cassiopeia is wide.
- It ends on M31.

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.