Volume 48 Number 2

February 2022

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
February 27, 2022, 7:00PM
Baker Wetlands Discovery Center

Public Observing
February 27, 2022, 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

At our January club meeting Rick Heschmeyer's presentation "Who Invented the Telescope?" took us through the history leading up to the invention of the telescope and the century of history that followed. We had clear skies following the presentation so club members were able to share their telescopes with those in attendance.

The "Telescope Night at KU" events have been very successful so far. The January event, held while school was out of session, had a nice turnout and gave the graduate students the opportunity to operate the university telescopes. The February event will take place on the evening of Thursday, February 10th. As soon as the official flyer is in hand, with time and location, I will forward to the club for anyone interested in helping. Later this year, we may hold some joint sessions between the club and the Physics & Astronomy Department folks running the Telescope Nights at KU. More to follow. Watch for updates on our Facebook page as well.

Our February meeting will take place on Sunday, February 27th at 7:00 PM at the Baker Wetlands Discovery Center. There will be a presentation "Star Planet Connection: Understanding Exoplanets through the Stars they Orbit" by Alex Polanski from the KU Physics and Astronomy Department. Alex is an Astrophysics PhD Graduate Student at KU. Public observing will follow the meeting as always, weather permitting.

Alex Polanski

I look forward to seeing everyone in next month.

Artist's impression of a habitable world orbiting a red dwarf. (ESO/M. Kornmesser)

The Red Sky Paradox Will Make You Question Our Very Place in The Universe

By Michelle Starr
ScienceAlert, December 27, 2021

On the grand cosmic scale, our little corner of the Universe isn't all that special – this idea lies at the heart of the Copernican principle. Yet there's one major aspect about our planet that's peculiar indeed: Our Sun is a yellow dwarf.

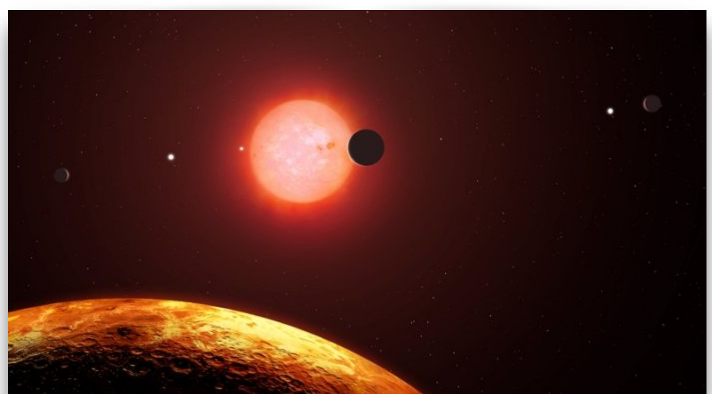
Because our home star is what we know most intimately, it would be tempting to assume that yellow and white dwarf stars (FGK dwarfs) are common elsewhere in the cosmos. However, they're far from the most multitudinous stars in the galaxy; that particular feather belongs in the cap of another type of star – red dwarf (M dwarfs).

Not only do red dwarfs make up as much as 75 percent of all stars in the Milky Way, they are much cooler and longer-lived than stars like the Sun. Much, much longer lived.

We expect our Sun to live around 10 billion years; red dwarf stars are expected to live trillions. So long, in fact, that none have yet reached the end of their main sequence lifespan during the entire 13.4 billion years since the Big Bang.

Since red dwarfs are so abundant, and so stable, and since we shouldn't automatically consider ourselves to be cosmically special, the fact we're not orbiting a red dwarf should therefore be somewhat surprising. And yet, here we are, orbiting a not-so-common yellow dwarf.

This, according to a paper by astronomer David Kipping of Columbia University, is the Red Sky Paradox – a corollary to the Fermi Paradox, which questions why we've not yet found any other forms of intelligent life,



Artist's impression of the planetary system orbiting red dwarf TRAPPIST-1. (Mark Garlick/Science Photo Library/Getty Images)

out there in the big wide Universe.

"Solving this paradox," he writes, "would reveal guidance for the targeting of future remote life sensing experiments and the limits of life in the cosmos."

Red dwarf stars are an attractive prospect for the search for extraterrestrial life. They don't burn as hot as Sun-like stars, which means any exoplanets orbiting them need to be closer to reach habitable temperatures. In turn, this could make any such exoplanets easier to find and study, since they orbit their stars more frequently than Earth does the Sun.

Indeed, astronomers have found quite a few rocky exoplanets – like Earth, Venus and Mars – orbiting red dwarf stars in this habitable zone. And some of them are even relatively close. It's tantalizing stuff, and it certainly seems like red dwarf stars ought to host life at least somewhere, which is why astrobiologists are looking.

In his paper, Kipping lays out four resolutions to the Red Sky Paradox.

Resolution I: An Unusual Outcome

The first is that, well, we're just a freaking oddball. If the rates at which life emerges around both star types are similar, then Earth is an outlier, and our emergence orbiting the Sun was just a random, one in 100 chance.

That would create tension with the Copernican principle, which states that there are no privileged observers in the Universe, and that our place in it is pretty normal. For us to be outliers would suggest that our place is not so normal.

This answer is not impossible, but nor is it a particularly satisfying one. The other three resolutions provide answers that are not only more satisfying, they could actually be testable.

Resolution II: Inhibited Life Under a Red Sky

Under this resolution, Kipping argues that yellow dwarfs are more habitable than red dwarfs, and, as a consequence, life emerges far less often around red dwarfs – around 100 times less. There's lots of theoretical evidence supporting this idea. Red dwarfs, for instance, tend to be rowdy, with lots of flare activity, and don't tend to have Jupiter-like planets.

"Much theoretical work has questioned the plausibility of complex life on M dwarfs, with concerns raised regarding tidal locking and atmospheric collapse, increased exposure to the effects of stellar activity, extended pre-main sequence phases, and the paucity of potentially beneficial Jupiter-sized companions," Kipping wrote.

Artist's impression of a red dwarf unleashing a megaflare. (NASA's Goddard Space Flight Center/S. Wiessinger)

"On this basis, there is good theoretical reasoning to support resolution II, although we emphasize that it remains observationally unverified."

Resolution III: A Truncated Window for Complex Life

Here, the argument is that life simply hasn't had enough time to emerge around red dwarf stars.

This may seem counter-intuitive, but it has to do with the pre-main sequence phase of the star's life, before it starts fusing hydrogen. In this state, the star burns hotter and brighter; for red dwarfs, it lasts about a billion years. During this time, a runaway permanent greenhouse effect could be triggered on any potentially habitable worlds.

This could mean that the window for complex biology to emerge on rocky planets on white and yellow dwarfs is a lot longer than it is on red dwarfs.

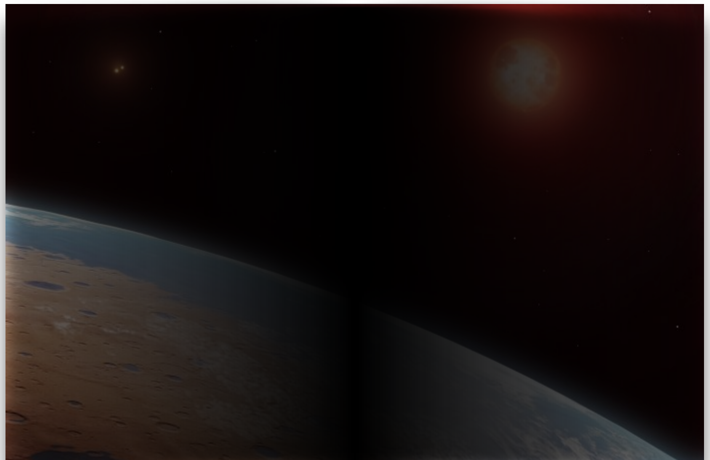
Resolution IV: A Paucity of Pale Red Dots

Finally, although around 16 percent of red dwarfs with exoplanets are listed as hosting rocky exoplanets in the habitable zone, perhaps these worlds are not as common as we thought. Our surveys sample the most massive red dwarfs, because they're the brightest and easiest to study; but what if the titchy ones, about which we know relatively little, don't have habitable zone rocky exoplanets?

Since the low-mass red dwarfs are, in fact, the most numerous, this could mean that habitable zone rocky exoplanets are 100 times less common around red dwarfs than they are around yellow dwarfs.

"In this case, intelligent life is rare amongst the cosmos and spawns universally between M- and FGK-dwarfs, but habitable worlds are at least two-orders of magnitude less common around M-dwarfs than FGKs," Kipping wrote.

"Two orders-of-magnitude is a considerable difference making this a particularly interesting explanation. This would require that the vast majority of many known Earth-sized, temperate planets around M-dwarfs are somehow inhospitable to life, or that the late-type M-dwarfs (low mass end) rarely host habitable worlds."



Artist's impression of a habitable world orbiting red dwarf Proxima Centauri. (Mark Garlick/Science Photo Library/Getty Images)

It's even possible that the answer lies in several of these resolutions, which would allow the effect in any one area to be less pronounced. And we might be able to obtain confirmation soon. As our technology improves, for instance, we will be able to better see the lower-mass red dwarf stars, and look for planets in orbit around them.

Having done that, if we find rocky exoplanets, we can take a closer look at their potential habitability, determining if they orbit in the habitable zone, and if life there could have been stymied by stellar processes.

"Ultimately," Kipping wrote, "resolving the red sky paradox is of central interest to astrobiology and SETI, with implication as to which stars to dedicate our resources to, as well as asking a fundamental question about the nature and limits of life in the cosmos." ☀

Hunting the Hunter: Observing Orion

By David Prosper
Nightskynetwork, January 2022

If you are outside on a clear January night, it's hard not to notice one distinctive star pattern above all: **Orion**! While we've covered Orion in earlier articles, we've never discussed observing the constellation as a whole. Perhaps you've received a new telescope, camera, or binoculars, and are eager to test it out. Orion, being large, prominent, and full of interesting, bright objects, is a perfect constellation to test out your new equipment and practice your observing skills - for beginners and seasoned stargazers alike.

In Greek mythology, Orion is a strong hunter, with numerous legends about his adventures. Being such a striking group of stars, cultures from all around the world have many myths about this star pattern. There are so many that we can't list them all here, but you can find a wonderful interactive chart detailing many cultures' legends on the Figures in the Sky website at figuresinthesky.visualcinnamon.com .

What sights can you see in Orion? Look above the variable orange-red supergiant "shoulder star" Betelgeuse to find the stars making up Orion's "club," then move across from Betelgeuse towards the bright star Bellatrix (Orion's other "shoulder") and the stars of his bow and arrow - both essential tools for the Hunter. Many interesting sights lie near Orion's "belt" and "sword." Orion's belt is made up of three bright giant stars forming an evenly spaced line: Alnitak, Alnilam, and Mintaka. Move from the belt stars towards the stars Rigel and Saiph (Orion's "feet" or "knees") to arrive at Orion's distinctive Sword, parts of which may appear fuzzy to your unaided eyes. Binoculars reveal that fuzz to be the famed Orion Nebula (M42), perched right next to the star Hatysa! Diving in deeper with a telescope will show star clusters and more cloud detail around the Nebula, and additional magnification brings out further detail inside the nebula itself, including the "baby stars" of the Trapezium and the next-door neighbor nebula M43. Want to dive deeper? Dark skies and a telescope will help to bring out the reflection nebula M78, the Flame Nebula (NGC 2024), along with many star clusters and traces of dark nebula throughout the constellation. Very careful observers under dark clear skies may be able to spot the dark nebula known as the Horsehead, tracing an equine outline below both the

Belt and the Flame Nebula. Warning: the Horsehead can be a difficult challenge for many stargazers, but very rewarding.

This is just a taste of the riches found within Orion's star fields and dust clouds; you can study Orion for a lifetime and never feel done with your observations. To be fair, that applies for the sky as a whole, but Orion has a special place for many. New telescopes often focus on one of Orion's treasures for their first test images. You can discover more of NASA's research into Orion's stars - as well as the rest of the cosmos - online at nasa.gov.

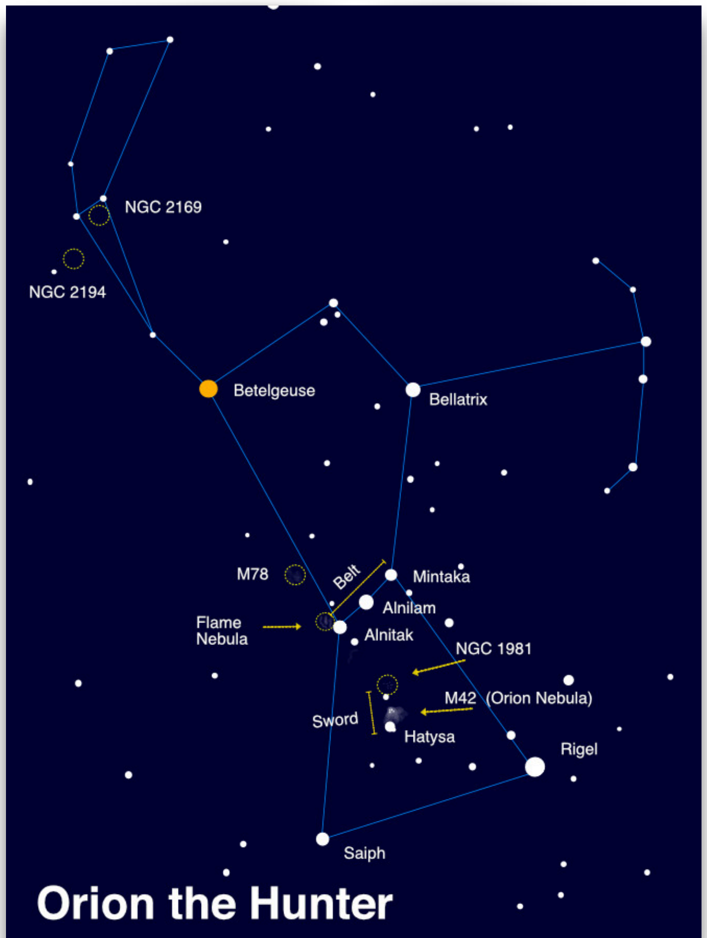
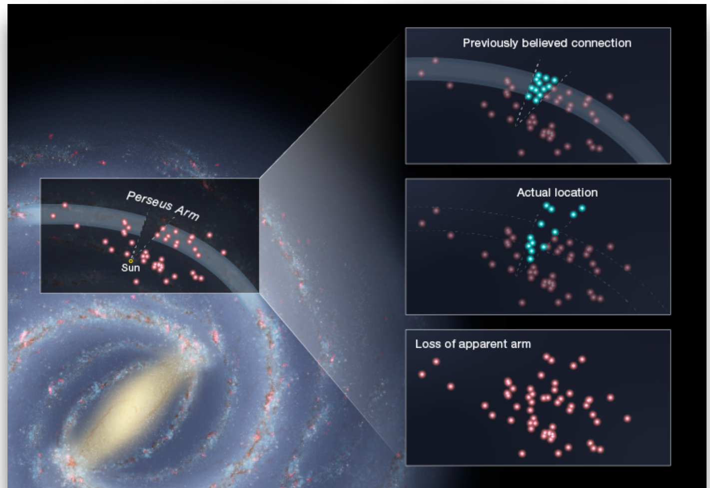


Image created with assistance from Stellarium.

Northern Hemisphere observers can find Orion during January evenings in the east/southeast skies. Can you spot the Orion nebula with your naked eye, in Orion's sword? How does it look via binoculars or a telescope? What other details can you discern? Please note that some deep sky objects aren't listed here for clarity's sake. For example, M43, a nebula located directly above M42 and separated by a dark dust lane, is not shown. Orion's Belt and Sword are crowded, since they star-forming regions! You can read more in our November 2019 article Orion: Window Into a Stellar Nursery, at bit.ly/orionlight. ☀

Our Milky Way May be More Fluffy, Less Wiry



HUBBLESITE, DECEMBER 16, 2021

When you go outside at night in a rural location with dark skies, you can look up and see a band of stars crossing the sky. That band is our Milky Way galaxy, which we see edge-on since we're inside of it. If we could travel faster than light and climb above the plane of our galaxy, we would see a flat disk with spiral arms wrapping around the core. But what shape, exactly, would those spiral arms have? Stuck here with no bird's-eye view, we have to apply other methods to measure the galaxy's shape.

Moving outward from Earth's location, astronomers have constructed a model of the neighboring spiral arm, known as the Perseus arm. Previous work suggested that the Perseus arm possesses a narrow and distinct shape. However new research shows that at least a portion of the Perseus arm may be illusory, without any well-defined structure. The illusion is a result of complexities first predicted by W. Burton in 1971.

Our Milky Way has long been known to be a spiral galaxy, shaped much like a fried egg with a bulbous central bulge and a thin, flat disk of stars. For decades, astronomers have struggled to map the Milky Way's disk and its associated spiral arms. As the old saying goes, you can't see the forest for the trees, and if you're in the middle of the forest, how can you map its groves without a bird's-eye view?

Previous work has suggested that the Milky Way is what's known as a "grand design" spiral, with long, narrow, well-defined spiral arms. However, new research finds that at least one portion of the outer Milky Way (beyond the Sun's location) is much more clumpy and chaotic.

"We have long had a picture of the galaxy in our minds, based on a combination of measurements and inference," said Josh Peek of the Space Telescope Science Institute (STScI) in Baltimore, Maryland. "This work calls that picture into question. We don't see evidence that pieces we've been connecting up are actually connected."

Distances are Key

When mapping our galaxy, the biggest challenge is finding the distance to any given star, star cluster, or gas clump. The gold standard is to use parallax measurements of naturally occurring radio sources called masers, some of which are found in high-mass star-forming regions.

However, this technique inevitably leaves gaps.

To fill those gaps, astronomers switch from examining star-forming regions to gas clouds, and more specifically, the motions of those gas clouds. In an ideal situation, the line-of-sight motion we measure for a gas cloud is directly related to its distance due to the overall rotation of the Milky Way. As a result, by measuring gas velocities, we can determine distances and hence the underlying structure of the galaxy.

The question then becomes, what about a non-ideal situation? While the motion of any given gas cloud might be dominated by its rotation around the galactic center, it undoubtedly has some additional, more random motions as well. Can those extra motions throw off our maps?

Chunky and Lumpy

To investigate this question, Peek and his colleagues examined not the gas, but the dust. In general within our galaxy, gas and dust are closely associated, so if you can map one, you also map the other.

3D dust maps can be created by examining the colors of large collections of stars spread across the sky. The more dust that is between the star and our telescope, the redder the star will appear compared to its natural color.

Peek and his team examined a region of space known as the Perseus spiral arm, which is beyond our Sun in the Milky Way's disk. They compared the distances measured via dust reddening to those determined by the velocity relationship. They found that many of the clouds do not, in fact, lie at the distance of the Perseus arm, but instead stretch along a distance of some 10,000 light-years.

"We don't have long, skinny spiral arms after all, at least in this section of the galaxy. There are chunks and lumps that don't look like anything," explained Peek. "It's a good possibility that the outer disk of the Milky Way resembles the nearby galaxy Messier 83, with shorter, chopped-up pieces of arms."

Revising Our Map

While this latest research focused on the outer Milky Way, Hubble Fellow Catherine Zucker, a member of Peek's team at STScI, is planning to extend that work to the inner Milky Way. The region interior to the Sun's orbit is where the spiral arms that are most actively forming stars reside.

Zucker plans to create 3D dust maps using existing large-scale infrared surveys to measure the reddening of some 1 to 2 billion stars. By linking those new dust maps with existing gas velocity surveys, astronomers can refine our map of the inner Milky Way much as they have already done with the outer galaxy.

"Previous 3D dust mapping efforts have largely relied on data at wavelengths visible to the human eye. No one has used deep infrared data to create a 3D dust map," said Zucker. "We may find that this region, like the Perseus arm, is more chaotic and less well defined."

Even more insights may come from the upcoming Nancy Grace Roman Space Telescope and Vera Rubin Observatory. The Roman Space Telescope will have the capability to map the entire galactic plane in a few hundred hours. Also, its infrared measurements will cut through the dust.

"We could see clear to the other side of the galaxy for the first time. If a survey like this is selected for Roman, it would be stunning," said Peek.

Rubin, on the other hand, will be able to make deep observations of faint objects at a variety of optical wavelengths. By combining Roman's infrared view of the sky with Rubin's deep, multi-wavelength optical data, we may finally map our own cosmic "forest." ☀

Physicists' Devotion to Symmetry Has Led Them Astray Before

By Tom Siegfried
SCIENCENEWS, MARCH 31, 2021

Physicists have a lot in common with Ponce de León and U2's Bono. After decades of searching, they aren't getting any younger. And they still haven't found what they're looking for.

In this case, the object of the physicists' quest is SUSY. SUSY is not a real person or even a fountain relevant to aging in any way. It's a mathematical framework based on principles of symmetry that could help physicists better explain the mysteries of the universe. Many experts believe that particles predicted by SUSY are the weakly interacting massive particles, or WIMPs, that supposedly make up the invisible "dark matter" lurking throughout the cosmos.

So far, though, SUSY has been something of a disappointment. Despite multiple heroic searches, SUSY has remained concealed from view. Maybe it is a mathematical mirage.

If SUSY does turn out to be a myth, it won't be the first time that symmetry has led science on a wild WIMP chase. Reasoning from the symmetry of circular motion originally suggested the existence of a new form of matter out in space more than two millennia ago. Devotion to that symmetry blinded science to the true nature of the solar system and planetary motion for the next 19 centuries.

You can blame Plato and Aristotle. In their day, ordinary matter supposedly consisted of four elements: earth, air, fire and water. Aristotle built an elaborate theory of motion based on those elements. He insisted that they naturally moved in straight lines; earth and water moving straight down (toward the center of the world), air and fire moving straight up. In the heavens, though, Aristotle noticed that motion appeared to be circular, as the stars rotated around the nighttime sky. "Our eyes tell us that the heavens revolve in a circle," he wrote in On the Heavens. Since the known four elements all moved in a straight line, Aristotle deduced that the heavens must consist of a fifth element, called aether — absent on Earth but predominant in space.

Plato, on theoretical rather than observational grounds, had already insisted that circularity's symmetry signified perfection, and therefore circular motion should be required in the heavens. And so for centuries, the assumption that celestial motion must be circular held a stranglehold on natural philosophers attempting to understand of the universe. As late as the 16th century, Copernicus was willing to depose Aristotle's Earth from the middle of everything but still believed that the Earth and other planets revolved around the sun with a combination of circular motions. Another half century passed before Kepler established that planetary orbits are elliptical, not circular.

Aristotle's belief in an exotic form of matter in space is not so different from the picture scientists paint of the heavens today, albeit in a rather more rigorous and sophisticated theoretical way. Dark matter predominates in space, astronomers believe; it is inferred to exist from gravitational effects altering the motions of stars and galaxies. And physicists have determined that the dark matter cannot (for various noncircular reasons) be made of the same ordinary matter found on Earth.

SUSY particles have long been one of the most popular proposals for the identity of this cosmic dark matter, based on more complicated notions of symmetry than those available to Plato and Aristotle. And since the onset of the 20th century, symmetry math has generated an astounding string of scientific successes. From Einstein's relativity to the theory of elementary particles and forces, symmetry considerations now form the core of science's understanding of nature.

These mathematical forms of symmetry are more elaborate examples of symmetry as commonly understood: a change that leaves things looking like they did before. A perfectly symmetric face looks the same when a mirror swaps left with right. A perfect sphere's appearance is not altered when you rotate it to see the other side. Rotate a snowflake by any multiple of 60 degrees and you see the same snowflake.

In a similar way, more sophisticated mathematical frameworks, known as symmetry groups, describe aspects of the physical world, such as time and space or the families of subatomic particles that make up matter or transmit forces. Symmetries in the equations of such math can even predict previously unknown phenomena. Symmetry in the equations describing subatomic particles, for instance, revealed that for each particle nature allowed an antimatter particle, with opposite electric charge.

In fact, all the known ordinary matter and force particles fit neatly into the mathematical patterns described by symmetry groups. But none of those particles can explain the dark matter.

SUSY particles as a dark matter possibility emerged in the 1970s and 1980s, when theorists proposed an even more advanced symmetry system. That math, called supersymmetry (hence SUSY), suggested the existence of a "super" partner particle for each known particle: a force-particle partner for every matter particle, and a matter-particle partner for every force particle. It was an elegant concept mathematically, and it solved (or at least ameliorated) some other vexing theoretical problems. Plus, of the super partner particles it predicted, the lightest one (whichever one that was) seemed likely to be a perfect dark matter WIMP.

Alas, efforts to detect WIMPs (which should be hitting the Earth all the time) have almost all failed to find any. One experiment that did claim a WIMP detection seems to be on shaky ground — a new experiment, using the same method and materials, reports no such WIMP evidence. And attempts to produce SUSY particles in the world's most powerful particle accelerator, the Large Hadron Collider, have also come up empty.

Some physicists have therefore given up on SUSY. And perhaps supersymmetry has been as misleading as the Greek infatuation with circular motion. But the truth is that SUSY is not a theory that can be slain by a single experiment. It is a more nebulous mathematical notion, a framework within which many specific theories can be constructed.

"You can't really kill SUSY because it's not a thing," physicist Patrick Stengel of the International Higher School of Advanced Studies in Trieste, Italy, said at a conference in Washington, D.C., in 2019. "It's not an idea that you can kill. It's basically just a framework for a bunch of ideas."

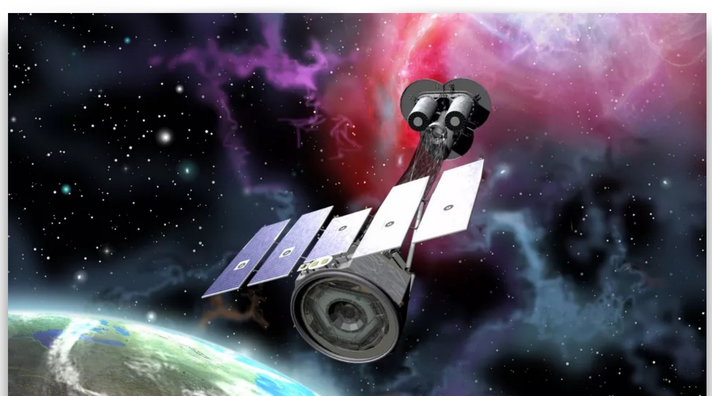
At the same conference, University of Texas at Austin physicist Katherine Freese pointed out that there was never any guarantee that the Large Hadron Collider would discover SUSY. "Even before the LHC got built, there were a lot of people who said, well, it might not go to a high enough energy," she said.

So SUSY may yet turn out to be an example of symmetry that leads physics to success. But just in case, physicists have pursued other dark matter possibilities. One old suggestion that has recently received renewed interest is a lightweight hypothetical particle called an axion (*SN: 3/24/20*).

Of course, if axions do exist, symmetry fans could still rejoice — the motivation for proposing the axion to begin with was resolving an issue with yet another form of symmetry. ☀

NASA's Newly Launched X-Ray Space Telescope is Ready to Start Observing the Cosmos

By Amy Thompson
Space.com, January, 2021



An artist's depiction of the IXPE observatory in space. (Image credit: NASA)

CAPE CANAVERAL, Fla. — NASA's newest space observatory, the Imaging X-ray Polarimetry Explorer (IXPE), is set to begin spying on some of the universe's most dramatic objects — black holes and neutron stars — potentially changing our understanding of the cosmos in the process.

The 730-pound (330 kilograms) IXPE satellite launched to orbit on Dec. 8 atop a previously flown SpaceX Falcon 9 rocket, bound for an equatorial perch where it will peer out into the universe, helping to unlock the mysteries of some of its most enigmatic residents.

Following its successful liftoff, the $214 million satellite has spent the past month checking out its various systems. According to the mission's lead, astrophysicist Martin Weisskopf of NASA's Marshall Spaceflight Center, its three identical detectors (built by ASI, the Italian Space Agency) are set to begin a two-year campaign to observe the polarization of light emanating from these cosmic entities.

"I'm pleased to tell you that the commissioning phase has been successfully completed," Weisskopf said Monday (Jan. 10) during a news briefing held during the 239th meeting of the American Astronomical Society (AAS). "Tomorrow we'll start taking our first science data."

The X-ray universe

X-rays are one tool that astronomers can use to observe and understand the universe. X-rays are a high-energy type of light that typically emanates from extremely energetic objects — like superheated jets spewing from black holes or the explosions of stars — and enables astronomers to study these events in a way they can't by using other wavelengths.

But X-rays are tricky because they can be studied in detail only from space, as they're mostly blocked out by Earth's atmosphere. To that end, NASA has launched a fleet of space-based observatories to peer inside cosmic sources like the gaseous nebulae where stars are born, and to probe the mysteries of black holes.

One such observatory, called Chandra, launched in 1999 and is NASA's flagship X-ray space telescope. It's tasked with detecting X-ray emissions from the extremely hot regions around exploded stars, galaxy clusters and black holes.

Chandra works in tandem with two other NASA space observatories — the Neutron Star Interior Composition Explorer (NICER) telescope, which flies on the International Space Station, and the Nuclear Spectroscopic Telescope Array (NuStar) — as well as the European Space Agency's XMM-Newton to study the X-ray universe.

These observatories have detected stellar nurseries and provided solid evidence of the existence of dark energy, and even a way to estimate its density.

But IXPE is about to look at the X-ray universe in a way that's rarely been done before: through the polarization of light.

IXPE's mission

The use of imaging X-ray polarimetry is what sets IXPE apart from its predecessors. Polarization refers to the orientation of light wave oscillations. It can provide scientists clues about how X-rays were made and what type of matter they traveled through.

This will, in turn, provide scientists with helpful information like the orientation of incoming electric and magnetic fields. Armed with this data, astronomers can glean more information from the X-rays emitted by astrophysical phenomena.

The IXPE satellite will provide astronomers with a new tool to probe the mysteries of the universe. The refrigerator-sized satellite is equipped with three identical telescopes that will be able to study the polarization of light from cosmic sources such as black holes and superdense stellar corpses known as neutron stars. With IXPE's observations, astronomers will be able to study the structure and mechanisms that power these types of enigmatic cosmic objects.

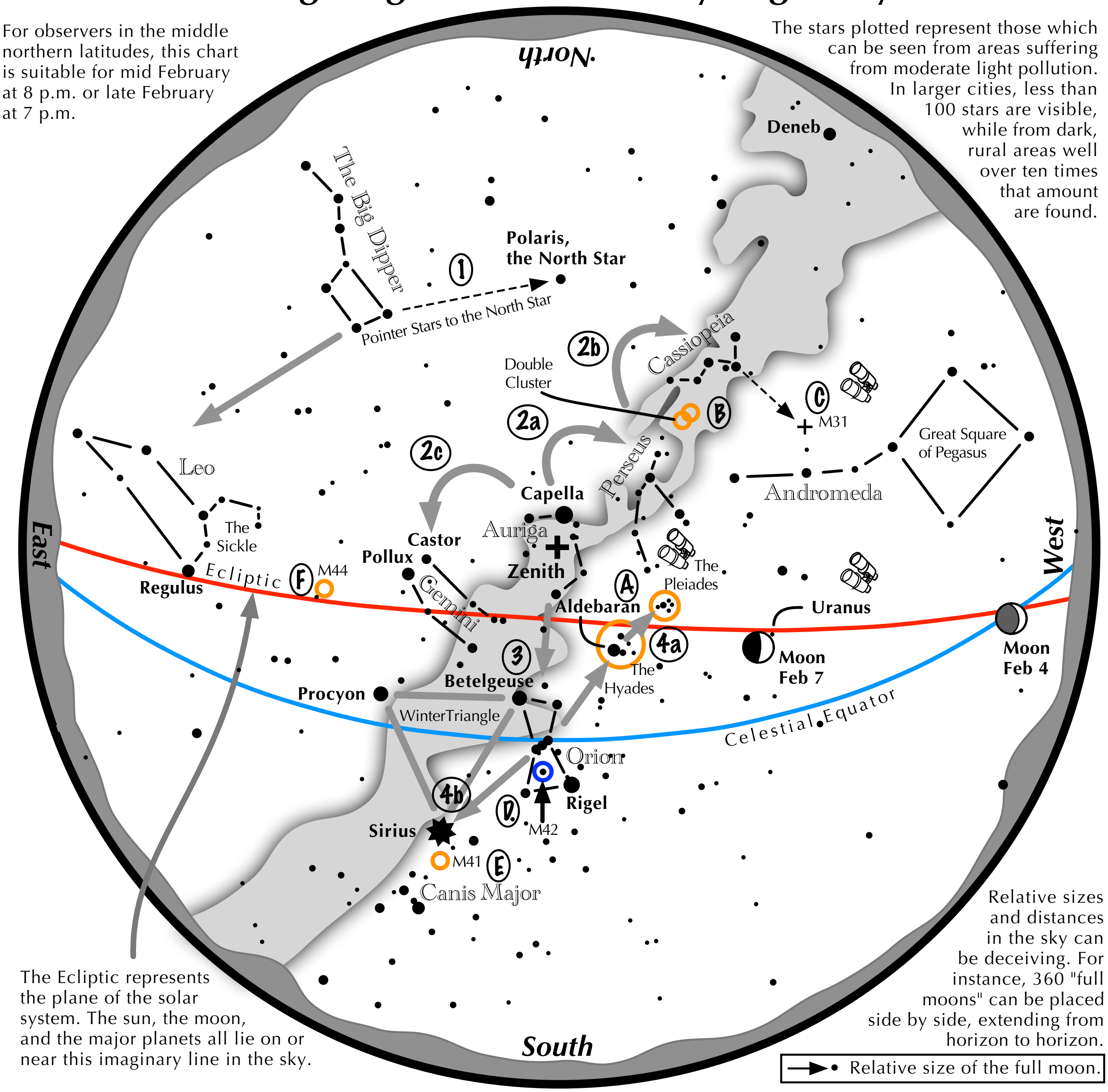
"The launch of IXPE marks a bold and unique step forward for X-ray astronomy," Weisskopf told Space.com before the launch. "IXPE will tell us more about the precise nature of cosmic X-ray sources than we can learn by studying their brightness and color spectrum alone."

IXPE's first target is a supernova remnant called Cassiopeia A (Cas a for short). Located approximately 11,000-light-years from Earth, it's the remains of an exploded star. Using its three identical telescopes, IXPE will observe the stellar corpse for a period of three weeks. ☀

Navigating the mid February Night Sky

For observers in the middle northern latitudes, this chart is suitable for mid February at 8 p.m. or late February 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.

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

1 Above the northeast horizon rises the Big Dipper. Draw a line from its two end bowl stars upwards to the North Star.

2 Face south. Overhead twinkles the bright star Capella in Auriga. Jump northwestward along the Milky Way first to Perseus, then to the "W" of Cassiopeia. Next jump southeastward from Capella to the twin stars of Castor and Pollux in Gemini.

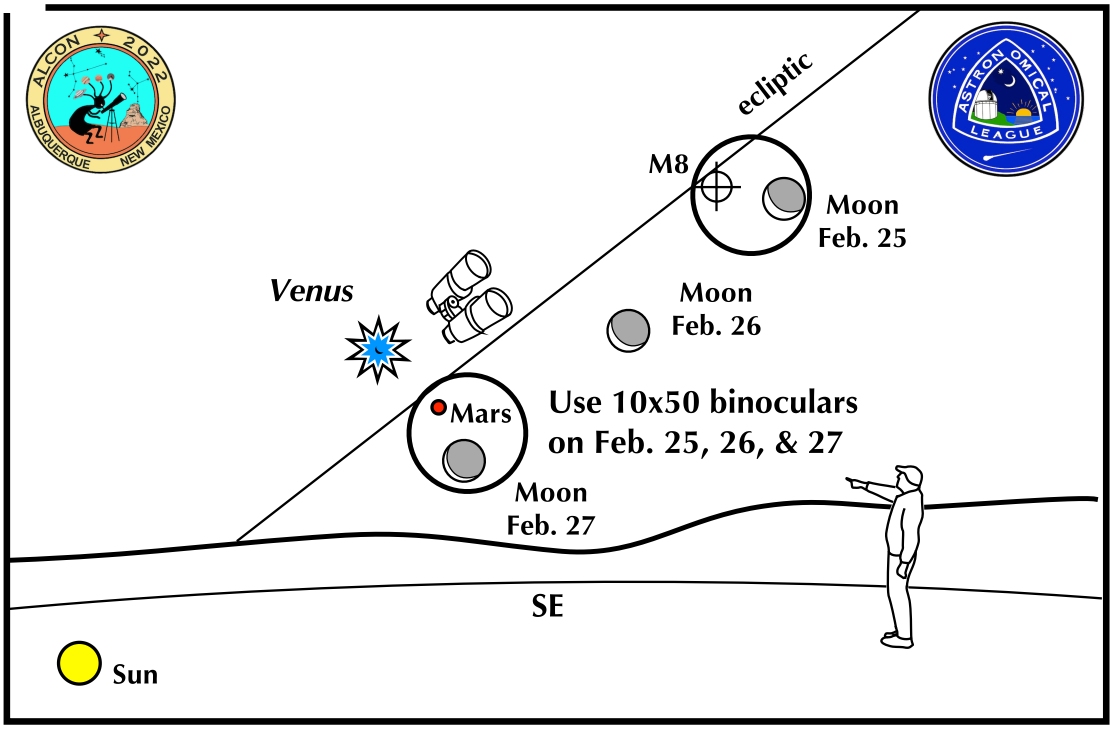
3 Directly south of Capella stands the constellation of Orion with its three Belt stars, its bright red star Betelgeuse, and its bright blue-white star Rigel.

4 Use Orion's three Belt stars to point northwest to the red star Aldebaran and the Hyades star cluster, then to the Pleiades star cluster. Travel southeast from the Belt stars to the brightest star in the night sky, Sirius, a member of the Winter Triangle.

Binocular Highlights

A: Examine the stars of two naked eye star clusters, the Pleiades and the Hyades.
B: Between the "W" of Cassiopeia and Perseus lies the Double Cluster.
C: The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval.
D: M42 in Orion is a star forming nebula. **E:** Look south of Sirius for the star cluster M41. **F:** M44, a star cluster barely visible to the naked eye, lies southeast of Pollux.

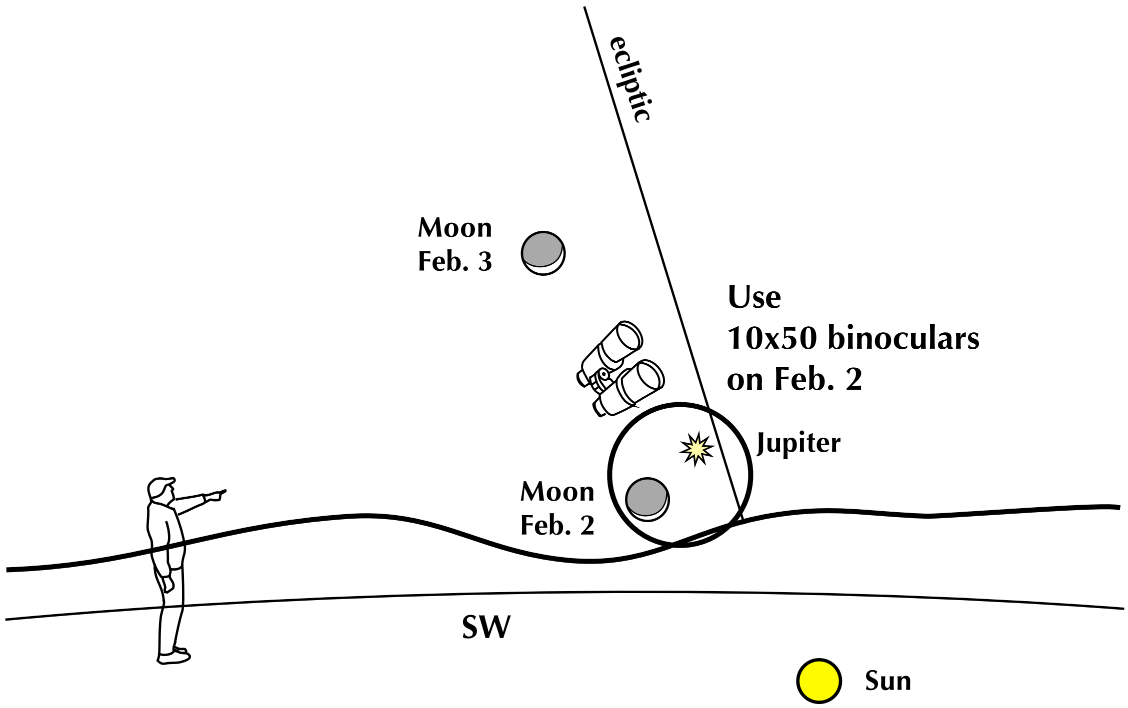
If you can see only one celestial event in the morning this February, see this one.



Crescent Moon passes Venus and Mars

• Look in the southeast beginning 60 minutes before sunrise on February 25-27.
• On Feb. 25 & 26, Venus shines brightly low above the southeastern horizon with the crescent moon glowing to its right.
• On Feb. 27, the very thin crescent moon lies to the lower right of Venus and the much dimmer Mars lies between them.
• Try spotting the star forming nebula M8 with binoculars. On the 25th, the moon and M8 are positioned on opposite sides of binocular field.

If you can see only one celestial event in the evening this February, see this one.



- Look in the southwest beginning 30 minutes after sunset on February 2.
- Jupiter shines low above the horizon with the very thin crescent moon glowing immediately to its lower left.
- The moon is 1.7 days past new for East Coast viewers, and 1.9 days for West Coast observers.
- This is a good opportunity to observe the moon and fulfill the "young moon" requirement for the Astronomical League's Lunar Observing Program.

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.