Volume 49 Number 3 March 2023

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
March 26, 2023, 7:00PM
Baker Wetlands Discovery Center

Public Observing
March 26, 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.

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Inside This Issue

Report From the Officers

By Rick Heschmeyer

Now that Comet C2022 E3 (ZTF) excitement has subsided, I am pleased to announce that we had clear skies and were able to observe the comet during two of our three scheduled February comet observing sessions (albeit extremely cold for the session at Clinton Lake's Rockhaven Park). We had great turnouts as well, around 50 people combined for the two clear sessions. Thanks to all who helped with the observing.

The Telescope Night at KU session for February was not so lucky, as it was cancelled due to clouds.

For our February meeting on 2/26, we viewed the 2022 Critic's Choice Award-Winning documentary film “Good Night Oppy”, originally scheduled for January, but pre-empted by the comet.

In March, on 3/26, AAL's own David Kolb will be talking about his long journey in the field of astrophotography. The talk is modestly titled “Twenty Years of Lucky Imaging.” Many of David's astro-images have been featured on the club's facebook pages, so everyone should be familiar with the quality of his photos, particularly his Solar System images.

The next Telescope Night at KU is scheduled for Thursday, March 9. Once the flyer is released, I will forward to everyone and post on our Facebook page.

As a reminder, our “PlanetPalooza” event with the Lawrence Public Library, is scheduled for Monday, April 3rd, from 7:30-9:00 PM. The location will be the roof of the Parking Garage next to the Library. As these cooperative AAL/LPL events have drawn large crowds in the past, any and all help from club members will be appreciated, whether you bring a telescope or not.

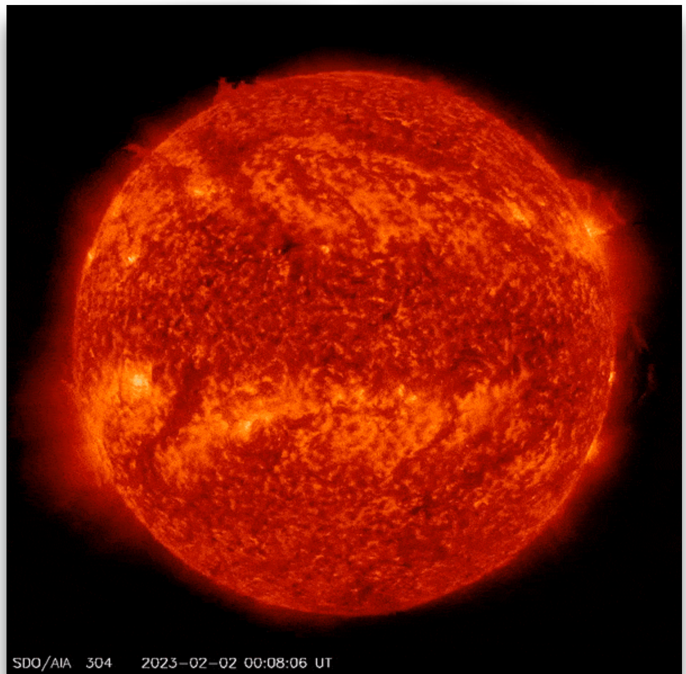
Another April event has been added to the club calendar as well. On Saturday, April 15 from 9am – noon, AAL will once again be participating in the Baker Wetlands Family Fun Day at the Discovery Center. If clear, we will be conducting solar observing. If not, we will pivot to Plan B, as we had to for last year's event.

So “Save the Date” for these two events on your calendar. Hopefully you can attend.

Strange unprecedented vortex spotted around the sun's north pole

By Tereza Pultarova
SPACE.COM, FEBRUARY 5, 2023

Scientists have just spotted a strange circular filament wobbling around the sun's pole that has them really excited.



A huge filament of solar plasma has broken off the sun's surface and is circling its north pole like a vortex of powerful winds, but scientists have no clue what caused it.

"Talk about polar vortex! Material from a northern prominence just broke away from the main filament & is now circulating in a massive polar vortex around the north pole of our star," space weather forecaster Tamitha Skov said on Twitter while sharing a video sequence taken by NASA's Solar Dynamics Observatory showing the odd whirlwind. "Implications for understanding the sun's atmospheric dynamics above 55° here cannot be overstated!"

Other solar physicists shared Skov's excitement about the unusual phenomenon. But what exactly is it and why is it important?

Scott McIntosh, a solar physicist and deputy director at the National Center for Atmospheric Research in Boulder, Colorado, told Space.com that while he has never seen a vortex like this, something odd is happening at the sun's 55 degree latitudes with clockwork regularity once every solar cycle, the 11-year period characterized by an ebb and flow in the generation of sunspots and eruptions.

The prominence mentioned by Skov, something that McIntosh describes as a "hedgerow in the solar plasma", appears exactly at the 55 degree latitude around the sun's polar crowns every 11 years. Scientists know that it has something to do with the reversal of the sun's magnetic field that happens once every solar cycle, but they have no clue what drives it.

"Once every solar cycle, it forms at the 55 degree latitude and it starts to march up to the solar poles," McIntosh told Space.com. "It's very curious. There is a big 'why' question around it. Why does it only move toward the pole one time and then disappears and then comes back, magically, three or four years later in exactly the same region?"

Scientists have regularly observed filaments tear away from this pole-embracing plasma hedgerow, but they have yet to see it form such a polar whirlwind until now.

Scientists know that the sun's polar regions play a key role in the generation of the star's magnetic field, which, in turn, drives its 11-year cycle of activity. They couldn't, however, observe that region directly.

The European Space Agency Solar Orbiter mission may shed some light on this odd phenomenon in the coming years. The mission, which is taking images of the sun from within the orbit of Mercury, will have its orbit tilted by up to 33 degrees. McIntosh thinks that might not be enough to crack the mystery of the polar vortex. Scientists might need a completely new mission to do that. ☀

Spot the King of Planets: Observe Jupiter

By David Prosper
NIGHTSKYNETWORK, FEBRUARY 2023

Jupiter is our solar system's undisputed king of the planets! Jupiter is bright and easy to spot from our vantage point on Earth, helped by its massive size and banded, reflective cloud tops. Jupiter even possesses moons the size of planets: Ganymede, its largest, is bigger than the planet Mercury. What's more, you can easily observe Jupiter and its moons with a modest instrument, just like Galileo did over 400 years ago.

Jupiter's position as our solar system's largest planet is truly earned; you could fit 11 Earths along Jupiter's diameter, and in case you were looking to fill up Jupiter with some Earth-size marbles, you would need over 1300 Earths to fill it up – and that would still not be quite enough! However, despite its awesome size, Jupiter's true rule over the outer solar system comes from its enormous mass. If you took all of the planets in our solar system and put them together they would still only be half as massive as Jupiter all by itself. Jupiter's mighty mass has shaped the orbits of countless comets and asteroids. Its gravity can fling these tiny objects towards our inner solar system and also draw them into itself, as famously observed in 1994 when Comet Shoemaker-Levy 9, drawn towards Jupiter in previous orbits, smashed into the gas giant's atmosphere. Its multiple fragments slammed into Jupiter's cloud tops with such violence that the fireballs and dark impact spots were not only seen by NASA's orbiting Galileo probe, but also observers back on Earth!

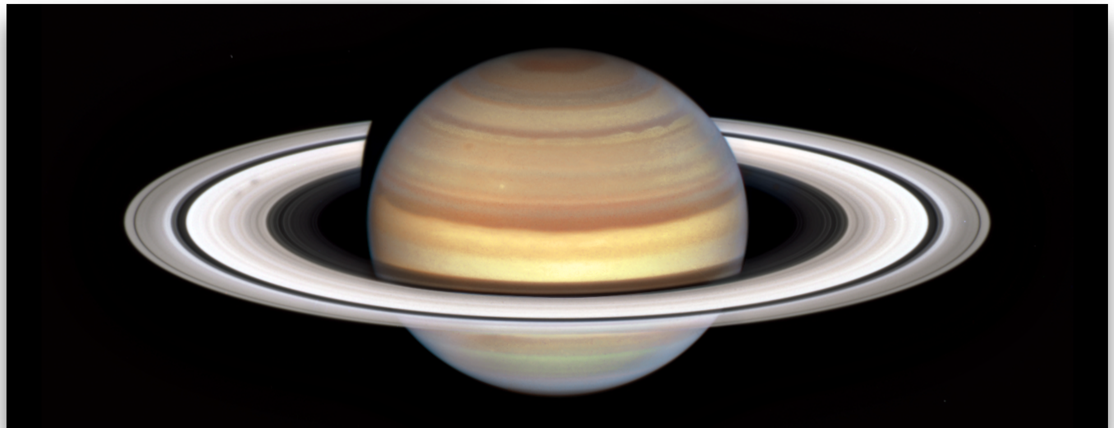
Jupiter is easy to observe at night with our unaided eyes, as well-documented by the ancient astronomers who carefully recorded its slow movements from night to night. It can be one of the brightest objects in our nighttime skies, bested only by the Moon, Venus, and occasionally Mars, when the red planet is at opposition. That's impressive for a planet that, at its closest to Earth, is still over 365 million miles *(587 million km)* away. It's even more impressive that the giant world remains very bright to Earthbound observers at its furthest distance: 600 million miles *(968 million km)*! While the King of Planets has a coterie of around 75 known moons, only the four large moons that Galileo originally observed in 1610 – Io, Europa, Ganymede, and Calisto – can be easily observed by Earth-based observers with very modest equipment. These are called, appropriately enough, the *Galilean moons.* Most telescopes will show the moons as faint star-like objects neatly lined up close to bright Jupiter. Most binoculars will show at least one or two moons orbiting the planet. Small telescopes will show all four of the Galilean moons if they are all visible, but sometimes they can pass behind or in front of Jupiter, or even each other. Telescopes will also show details like Jupiter's cloud bands and, if powerful enough, large storms like its famous Great Red Spot, and the shadows of the Galilean moons passing between the Sun and Jupiter. Sketching the positions of Jupiter's moons during the course of an evening - and night to night – can be a rewarding project! YoucandownloadanactivityguidefromtheAstronomicalSocietyofthePacificatbit.ly/drawjupitermoons

NASA's Juno mission currently orbits Jupiter, one of just nine spacecraft to have visited this awesome world. Juno entered Jupiter's orbit in 2016 to begin its initial mission to study this giant world's mysterious interior. The years have proven Juno's mission a success, with data from the probe revolutionizing our understanding of this gassy world's guts. Juno's mission has since been extended to include the study of its large moons, and since 2021 the plucky probe, increasingly battered by Jupiter's powerful radiation belts, has made close flybys of the icy moons Ganymede and Europa, along with volcanic Io. In 2024 NASA will launch the Europa Clipper mission to study this world and its potential to host life inside its deep subsurface oceans in much more detail. Find the latest discoveries from Juno and NASA's missions at nasa.gov. ☀

HUBBLE CAPTURES THE START OF A NEW SPOKE SEASON AT SATURN

HUBBLESITE, FEBRUARY 9, 2023

New images of Saturn from NASA's Hubble Space Telescope herald the start of the planet's "spoke season" surrounding its equinox, when enigmatic features appear across its rings. The cause of the spokes, as well as their seasonal variability, has yet to be fully explained by planetary scientists.



Like Earth, Saturn is tilted on its axis and therefore has four seasons, though because of Saturn's much larger orbit, each season lasts approximately seven Earth years. Equinox occurs when the rings are tilted edge-on to the Sun. The spokes disappear when it is near summer or winter solstice on Saturn. (When the Sun appears to reach either its highest or lowest latitude in the northern or southern hemisphere of a planet.) As the autumnal equinox of Saturn's northern hemisphere on May 6, 2025, draws near, the spokes are expected to become increasingly prominent and observable.

The suspected culprit for the spokes is the planet's variable magnetic field. Planetary magnetic fields interact with the solar wind, creating an electrically charged environment (on Earth, when those charged particles hit the atmosphere this is visible in the northern hemisphere as the aurora borealis, or northern lights). Scientists think that the smallest, dust-sized icy ring particles can become charged as well, which temporarily levitates those particles above the rest of the larger icy particles and boulders in the rings.

The ring spokes were first observed by NASA's Voyager mission in the early 1980s. The transient, mysterious features can appear dark or light depending on the illumination and viewing angles.

"Thanks to Hubble's OPAL program, which is building an archive of data on the outer solar system planets, we will have longer dedicated time to study Saturn's spokes this season than ever before," said NASA senior planetary scientist Amy Simon, head of the Hubble Outer Planet Atmospheres Legacy (OPAL) program.

Saturn's last equinox occurred in 2009, while NASA's Cassini spacecraft was orbiting the gas giant planet for close-up reconnaissance. With Cassini's mission completed in 2017, and the Voyager spacecrafts long gone, Hubble is continuing the work of long-term monitoring of changes on Saturn and the other outer planets.

"Despite years of excellent observations by the Cassini mission, the precise beginning and duration of the spoke season is still unpredictable, rather like predicting the first storm during hurricane season," Simon said.

While our solar system's other three gas giant planets also have ring systems, nothing compares to Saturn's prominent rings, making them a laboratory for studying spoke phenomena. Whether spokes could or do occur at other ringed planets is currently unknown. "It's a fascinating magic trick of nature we only see on Saturn —for now at least," Simon said.

Hubble's OPAL program will add both visual and spectroscopic data, in wavelengths of light from ultraviolet to near-infrared, to the archive of Cassini observations. Scientists are anticipating putting these pieces together to get a more complete picture of the spoke phenomenon, and what it reveals about ring physics in general. ☀

The Kuiper Belt's dwarf planet Quaoar hosts an impossible ring

By Lisa Grossman

SCIENCENEWS, FEBRUARY 8, 2023

The ring lies outside a typical, mathematically determined distance from the small world

Dwarf planet Quaoar, shown in this artist's illustration, is only the third small object in the solar system with a known ring.

The dwarf planet Quaoar has a ring that is too big for its metaphorical fingers. While all other rings in the solar system lie within or near a mathematically determined distance of their parent bodies, Quaoar's ring is much farther out.

"For Quaoar, for the ring to be outside this limit is very, very strange," says astronomer Bruno Morgado of the Federal University of Rio de Janeiro. The finding may force a rethink of the rules governing planetary rings, Morgado and colleagues say in a study published February 8 in *Nature*.

Quaoar is an icy body about half the size of Pluto that's located in the Kuiper Belt at the solar system's edge (*SN: 8/23/22).* At such a great distance from Earth, it's hard to get a clear picture of the world.

So Morgado and colleagues watched Quaoar block the light from a distant star, a phenomenon called a stellar occultation. The timing of the star winking in and out of view can reveal details about Quaoar, like its size and whether it has an atmosphere.

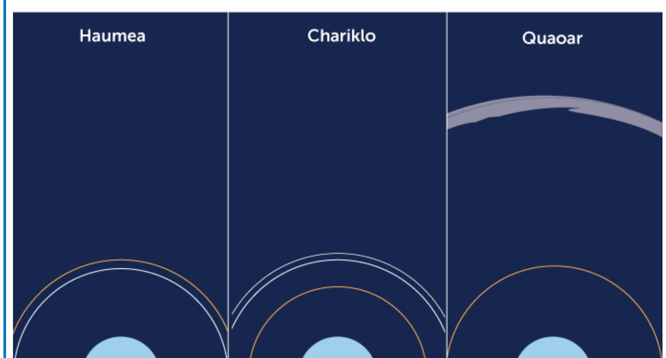
The researchers took data from occultations from 2018 to 2020, observed from all over the world, including Namibia, Australia and Grenada, as well as space. There was no sign that Quaoar had an atmosphere. But surprisingly, there was a ring. The finding makes Quaoar just the third dwarf planet or asteroid in the solar system known to have a ring, after the asteroid Chariklo and the dwarf planet Haumea (*SN: 3/26/14*; *SN: 10/11/17*).

Even more surprisingly, "the ring is not where we expect," Morgado says.

Far-out ring

In this illustration, dwarf planet Haumea and asteroid Chariklo both have rings (white) that are close to their Roche limits (yellow), to the best of astronomers' understanding. Quaoar, in contrast, has a ring that is clearly well beyond its Roche limit, an imaginary line beyond which rings aren't thought to be stable.

Rings around three small objects in the solar system



Known rings around other objects lie within or near what's called the Roche limit, an invisible line where the gravitational force of the main body peters out. Inside the limit, that force can rip a moon to shreds, turning it into a ring. Outside, the gravity between smaller particles is stronger than that from the main body, and rings will coalesce into one or several moons.

"We always think of [the Roche limit] as straightforward," Morgado says. "One side is a moon forming, the other side is a ring stable. And now this limit is not a limit."

For Quaoar's far-out ring, there are a few possible explanations, Morgado says. Maybe the observers caught the ring at just the right moment, right before it turns into a moon. But that lucky timing seems unlikely, he notes.

Maybe Quaoar's known moon, Weywot, or some other unseen moon contributes gravity that holds the ring stable somehow. Or maybe the ring's particles are colliding in such a way that they avoid sticking together and clumping into moons.

The particles would have to be particularly bouncy for that to work, "like a ring of those bouncy balls from toy stores," says planetary scientist David Jewitt of UCLA, who was not involved in the new work.

The observation is solid, says Jewitt, who helped discover the first objects in the Kuiper Belt in the 1990s. But there's no way to know yet which of the explanations is correct, if any, in part because there are no theoretical predictions for such far-out rings to compare with Quaoar's situation.

That's par for the course when it comes to the Kuiper Belt. "Everything in the Kuiper Belt, basically, has been discovered, not predicted," Jewitt says. "It's the opposite of the classical model of science where people predict things and then confirm or reject them. People discover stuff by surprise, and everyone scrambles to explain it."

More observations of Quaoar, or more discoveries of seemingly misplaced rings elsewhere in the solar system, could help reveal what's going on.

"I have no doubt that in the near future a lot of people will start working with Quaoar to try to get this answer," Morgado says. ☀

Four classes of planetary systems

SCIENCENEWS, FEBRUARY 14, 2023

In our solar system, everything seems to be in order: The smaller rocky planets, such as Venus, Earth or Mars, orbit relatively close to our star. The large gas and ice giants, such as Jupiter, Saturn or Neptune, on the other hand, move in wide orbits around the sun. In two studies published in the scientific journal *Astronomy & Astrophysics*, researchers from the Universities of Bern and Geneva and the National Centre of Competence in Research (NCCR) PlanetS show that our planetary system is quite unique in this respect.

Like peas in a pod

"More than a decade ago, astronomers noticed, based on observations with the then groundbreaking Kepler telescope, that planets in other systems usually resemble their respective neighbours in size and mass – like peas in a pod," says study lead author Lokesh Mishra, researcher at the University of Bern and Geneva, as well as the NCCR PlanetS. But for a long time it was unclear whether this finding was due to limitations of observational methods. "It was not possible to determine whether the planets in any individual system were similar enough to fall into the class of the 'peas in a pod' systems, or whether they were rather different – just like in our solar system," says Mishra.

Therefore, the researcher developed a framework to determine the differences and similarities between planets of the same systems. And in doing so, he discovered that there are not two, but four such system architectures.

Four classes of planetary systems

"We call these four classes 'similar', 'ordered', 'anti-ordered' and 'mixed'," says Mishra. Planetary systems in which the masses of neighbouring planets are similar to each other, have similar architecture. Ordered planetary systems are those, in which the mass of the planets tends to increase with distance from the star – just as in our solar system. If, on the other hand, the mass of the planets roughly decreases with distance from the star, researchers speak of an anti-ordered architecture of the system. And mixed architectures occur, when the planetary masses in a system vary greatly from planet to planet.

"This framework can also be applied to any other measurements, such as radius, density or water fractions," says study co-author Yann Alibert, Professor of Planetary Science at the University of Bern and the NCCR PlanetS. "Now, for the first time, we have a tool to study planetary systems as a whole and compare them with other systems."

The findings also raise questions: Which architecture is the most common? Which factors control the emergence of an architecture type? Which factors do not play a role? Some of these, the researchers can answer.

A bridge spanning billions of years

"Our results show that 'similar' planetary systems are the most common type of architecture. About eight out of ten planetary systems around stars visible in the night sky have a 'similar' architecture," says Mishra. "This also explains why evidence of this architecture was found in the first few months of the Kepler mission." What surprised the team was that the "ordered" architecture – the one that also includes the solar system – seems to be the rarest class.

According to Mishra, there are indications that both the mass of the gas and dust disk from which the planets emerge, as well as the abundance of heavy elements in the respective star play a role. "From rather small, low-mass disks and stars with few heavy elements, 'similar' planetary systems emerge. Large, massive disks with many heavy elements in the star give rise to more ordered and anti-ordered systems. Mixed systems emerge from medium-sized disks. Dynamic interactions between planets – such as collisions or ejections – influence the final architecture," Mishra explains.

"A remarkable aspect of these results is that it links the initial conditions of planetary and stellar formation to a measurable property: the system architecture. Billions of years of evolution lie in between them. For the first time, we have succeeded in bridging this huge temporal gap and making testable predictions. It will be exciting to see if they will hold up," Alibert concludes. ☀

A New 'Dark Energy' Discovery Might Have Just Revolutionized Our Idea of the Universe

By Jordan Pearson
VICE, FEBRUARY 17, 2023

For decades, a major cosmic mystery has puzzled scientists: Why is the universe's expansion accelerating, rather than slowing down due to gravity? The search for an answer has led groups all over the world to look for an invisible force dubbed dark energy that could explain this observation. Now, new research may have finally given us just the breakthrough we've been waiting for.

A pair of new papers published by a team of 17 international scientists offers the first observational evidence of a source for dark energy. According to the team, after poring over data covering 9 billion years of cosmic evolution, the most likely answer is black holes—but not how you probably understand them.

“If the theory holds, then this is going to revolutionize the whole of cosmology, because at last we've got a solution for the origin of dark energy that's been perplexing cosmologists and theoretical physicists for more than 20 years," study co-author Chris Pearson, from RAL Space in the UK, said in a statement.

The key to the discovery was tracking the rate of black hole growth relative to their position in the history of the universe. The researchers found that black holes embedded in ancient galaxies that formed in the early universe—which are now dead, and thus don’t form new material to feed their black holes—were more massive than could be explained by the traditional methods of growth, which are eating stars and merging with other black holes. The researchers also found that the black holes were getting more massive in relative lockstep with the expansion of the universe. This, the researchers wrote, is known as "cosmological coupling."

"We thus propose that stellar remnant black holes are the astrophysical origin of dark energy," the authors wrote in the study.

This conclusion requires us to think of black holes a little differently than we normally might. Typically, black holes are envisioned as containing a singularity, where even gravity breaks down. What this idea assumes is that instead of a singularity, black hole interiors contain vacuum energy. Vacuum energy stems from the idea that, rather than a vacuum being a total void, it actually has a complex structure on the quantum scale.

As an American Astronomical Society blog on the new research explains: "Traditional singularity-containing black holes would have a coupling strength of 0, while vacuum-energy black holes would have a coupling strength of 3. Ultimately, the team found the coupling strength to be around 3.11, and they ruled out the possibility of zero coupling at 99.98% confidence."

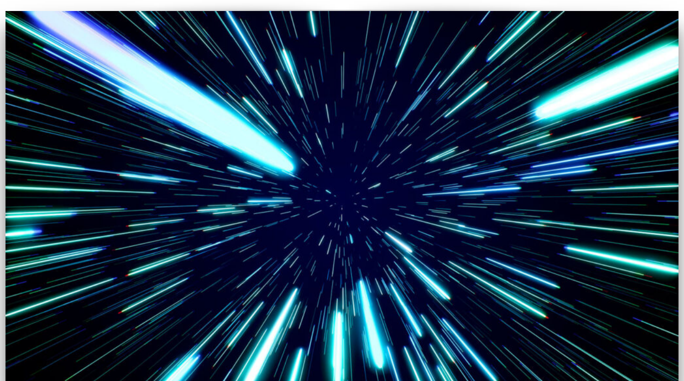
While this discovery is certainly mind-blowing, it actually fits neatly into existing models of the universe. It means there is no need to conceive of some external force causing the universe to expand, and it does away with the requirement that black holes contain singularities, which remain a thorny problem in physics.

"We're really saying two things at once: that there's evidence the typical black hole solutions don't work for you on a long, long timescale, and we have the first proposed astrophysical source for dark energy," first author Duncan Farrah from the University of Hawai`i, which led the research, said.

"What that means, though, is not that other people haven't proposed sources for dark energy, but this is the first observational paper where we're not adding anything new to the Universe as a source for dark energy: black holes in Einstein's theory of gravity are the dark energy." ☀

50 years ago, physicists found the speed of light

By Nikk Ogasa
SCIENCENEWS, DECEMBER 9, 2022

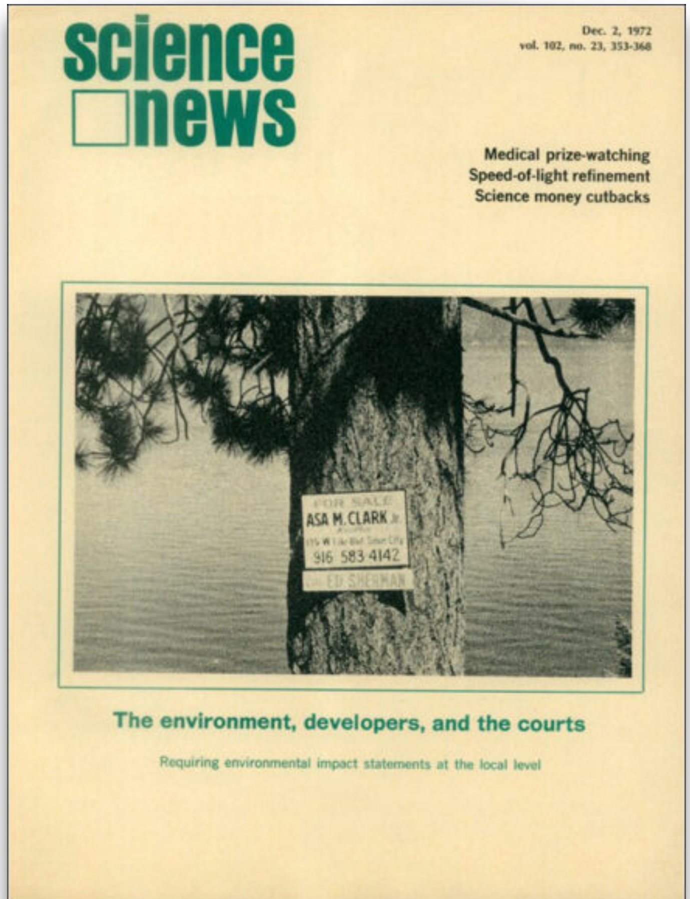


In the 1970s, scientists measured the speed of light: 299,792.456 kilometers per second, or 299,792,456 meters per second. Fifty years later, they continue putting light through its paces.

A New Figure for the Cosmic Speed Limit

Science News, December 2, 1972

A group at the National Bureau of Standards at B-oulder, Colo., now reports an extremely accurate [speed of light] measurement using the wavelength and frequency of a helium-neon laser.… The result gives the speed of light as 299,792.4562 kilometers per second.



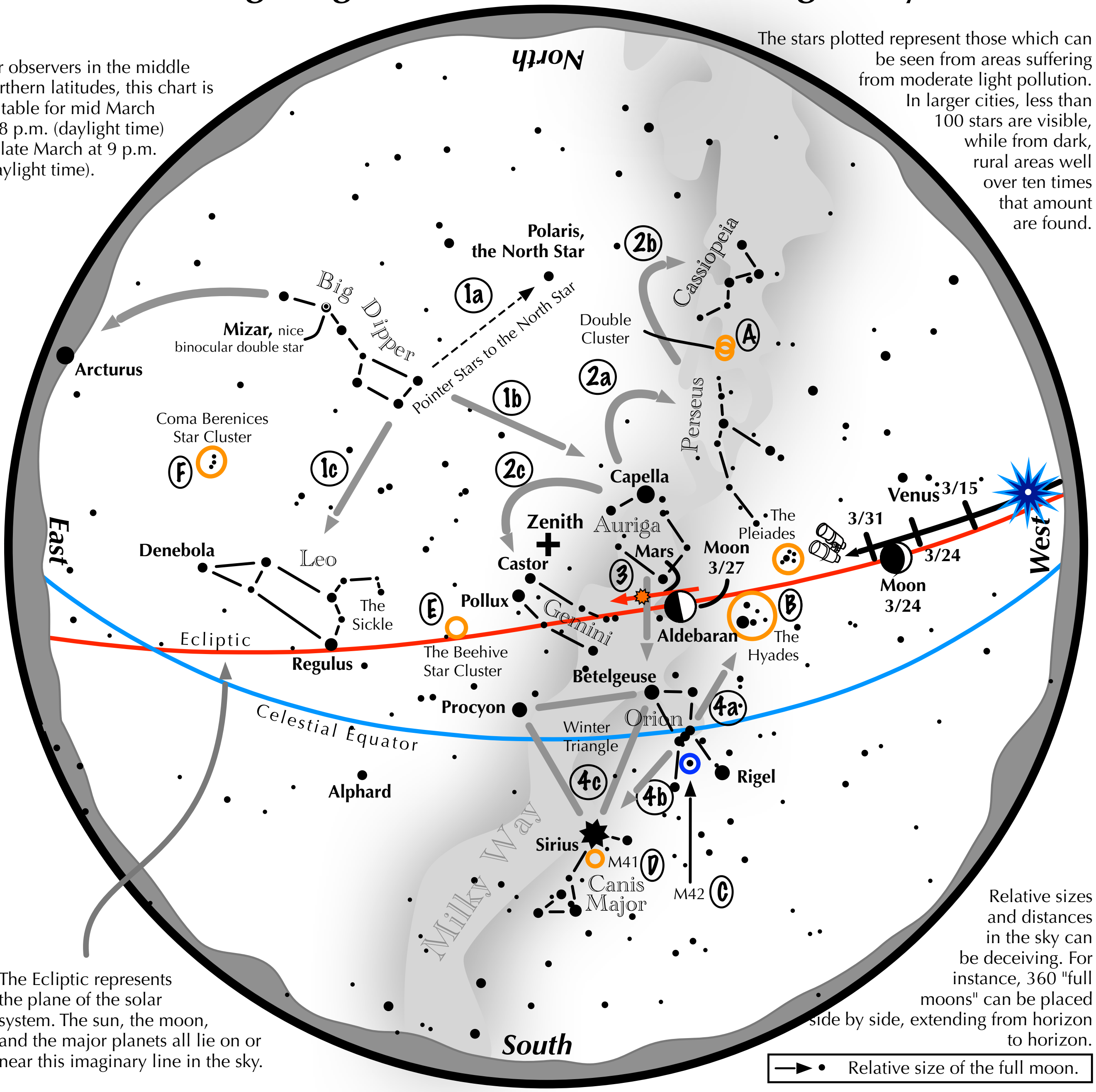
Update

That 1972 experiment measured the two-way speed of light, or the average speed of photons that traveled from their source to a reflective surface and back. The result, which still holds up, helped scientists redefine the standard length of the meter (*SN: 10/22/83, p. 263*). But they weren't done putting light through its paces. In the late 1990s and early 2000s, photons set a record for slowest measured speed of light at 17 meters per second and froze in their tracks for one-thousandth of a second (*SN: 1/27/01, p. 52*). For all that success, one major hurdle remains: directly testing the one-way speed of light. The measurement, which many scientists say is impossible to make, could resolve the long-standing question of whether the speed of light is uniform in all directions. ☀

Navigating the mid to late March Night Sky

For observers in the middle northern latitudes, this chart is suitable for mid March at 8 p.m. (daylight time) or late March at 9 p.m. (daylight time).

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 March 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. Its top bowl stars point west to Capella in Auriga, nearly overhead. Leo reclines below the Dipper's bowl.

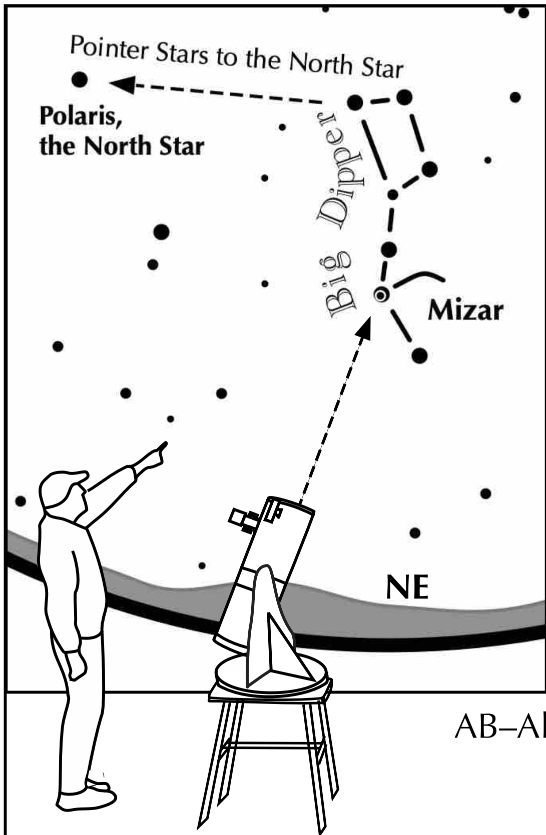
2 From Capella jump northwestward along the Milky Way to Perseus, then to the "W" of Cassiopeia. Next jump southeastward from Capella to the twin stars of Castor and Pollux in Gemini.

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. It is a member of the Winter Triangle.

Binocular Highlights

A: Between the "W" of Cassiopeia and Perseus lies the Double Cluster. **B:** Examine the stars of the Pleiades and Hyades, two naked eye star clusters. **C:** M42 in Orion is a star forming nebula. **D:** Look south of Sirius for the star cluster M41. **E:** M44, a star cluster barely visible to the naked eye, lies to the southeast of Pollux. **F:** Look high in the east for the loose star cluster of Coma Berenices.



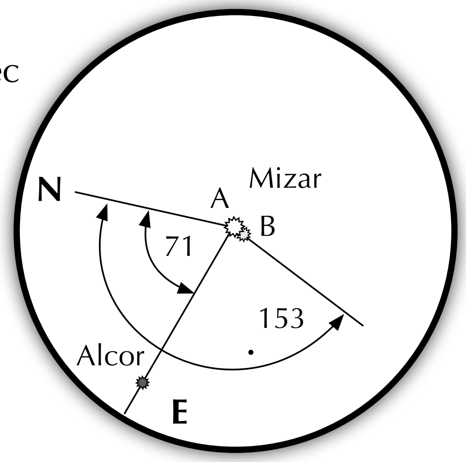
Other Suns: Mizar

How to find Mizar on a March evening

Look northeast toward the Big Dipper. The second star from the end of the Dipper's handle is Mizar. The 4th magnitude Alcor is immediately next to it.

Suggested magnification: >40x
Suggested aperture: >3 inches

Mizar
A-B separation: 14 sec
A magnitude: 2.2
B magnitude: 3.9
Position Angle: 153 º
A color: white
B color: pale green?



AB–Alcor separation: 11 min
Alcor: 4.0
PA: 71º

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.