Volume 48 Number 1 March 2022

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting

April 24, 2022, 7:00PM
Baker Wetlands Discovery Center

Public Observing

April 24, 2022, 8:00PM
Baker Wetlands Discovery Center

Club Officers

President
Rick Heschmeyer email

AICOR
William Winkler email

NSN Coordinator
Howard Edin email

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Dr. Jennifer Delgado email.

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Inside This Issue

Report From the Officers

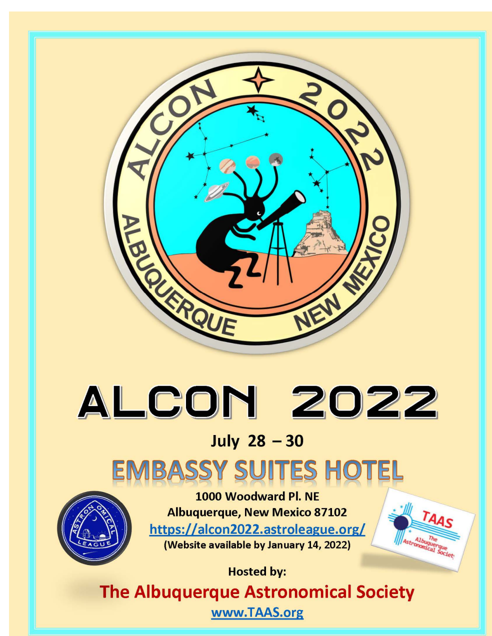
By Rick Heschmeyer

At our March club meeting, Jerelyn Ramirez, past president of the Kansas Astronomical Observers (KAO) club in Wichita, Kansas and a member of the Library Telescope Task Force, will be discussing the Library Telescope Program.

The March "Telescope Night at KU" was a mixed success. The observing portion of the evening was cancelled due to weather, but KU Graduate Student Mindy Townsend gave her talk, "Mess-ier Around and Find Out: A Guide to Astronomy's Most Sought-After Treasures" through zoom. It was very entertaining and there were discussions at the conclusion about possibly holding a "Messier Marathon" in the future. The April "Telescope Night at KU" is scheduled for Thursday, April 14. I will forward the event flyer to the club once I receive it.

On the Saturday before our April club meeting, April 23rd, Baker Wetlands Discovery Center will be hosting a Family Fun Day at the Center. AAL has agreed, once again, to have a table set up and offer Safe Solar Observing for the public at the event. If you are interested in helping please contact me.

Our April club meeting will take place on Sunday, April 24th at 7:00 PM at the Baker Wetlands Discovery Center. I recently obtained two transcription disks with audio recordings from Professor N. Wyman Storer, who from 1935 until 1950 was the entire Astronomy Department at KU. We will discuss a quick history of the KU Astronomy program, its facilities, and Dr. Storer, and listen to the recordings. As usual, if weather permits, public telescope observing will follow the meeting.



Currently, there is no planned May club meeting as the Lawrence City Band concerts in South Park are tentatively scheduled to start the first week of June. More to come once dates are confirmed.

Looking forward to seeing everyone at an upcoming event.

Astronomers see an Enormous Shockwave, 60 Times Bigger Than the Milky Way

By Andy Tomaswick

UNIVERSETODAY, FEBRUARY 27, 2022

Astronomers have a thing for big explosions and collisions, and it always seems like they are trying to one-up themselves in finding a bigger, brighter one. There's a new entrant to that category – an event so big it created a burst of particles over 1 billion years ago that is still visible today and is 60 times bigger than the entire Milky Way.

That shockwave was created by the merger of two galaxy clusters to create a supercluster known as Abell 3667. This was one of the most energetic events in the universe since the Big Bang, according to calculations by Professor Francesco de Gasperin and his time from the University of Hamburg and INAF. When it happened over 200 million years ago, it shot out a wave of electrons, similar to how a particle accelerator would. All these years later, those particles are still traveling at Mach 2.5 (1500 km / s), and when they pass through magnetic fields, they emit radio waves.

Those radio waves are what Dr. de Gasperin and his colleagues observed using a new telescope array in South Africa known as MeerKAT. Radio signals alone weren't enough to characterize the shockwave itself, though – the XMM-Newton X-ray observatory also spent some time focused on Abell 3667.

The results of all those observations is a better understanding of the physics of the merger of these galaxy clusters, which were "much more complex than we initially thought," said Dr. de Gasperin. The shockwaves themselves look like "filaments that trace the location of giant magnetic field lines." What is clear from the pictures is that, even when scientists are simply looking for big collisions, the resulting radio images might be awe-inspiring in themselves. ☀

Picture of galaxy cluster Abell 3667, where the white color in the center is a concatenation of 550 distinct galaxies, but the red structures represent the shockwaves formed during the creation of this supercluster.

Embracing the Equinox

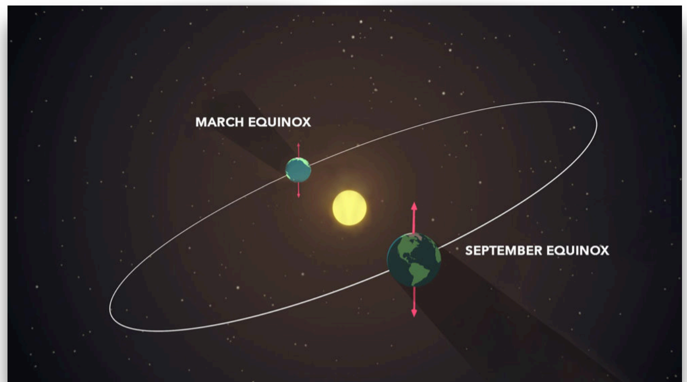
By David Prosper
NASANIGHTSKYNETWORK, MARCH 2022

Depending on your locale, equinoxes can be seen as harbingers of longer nights and gloomy weather, or promising beacons of nicer temperatures and more sunlight. Observing and predicting equinoxes is one of the earliest skills in humanity's astronomical toolkit. Many ancient observatories around the world observed equinoxes along with the more pronounced solstices. These days, you don't need your own observatory to know when an equinox occurs, since you'll see it marked on your calendar twice a year! The word "equinox" originates from Latin, and translates to **equal** (equi-) **night** (-nox). But what exactly *is* an equinox?

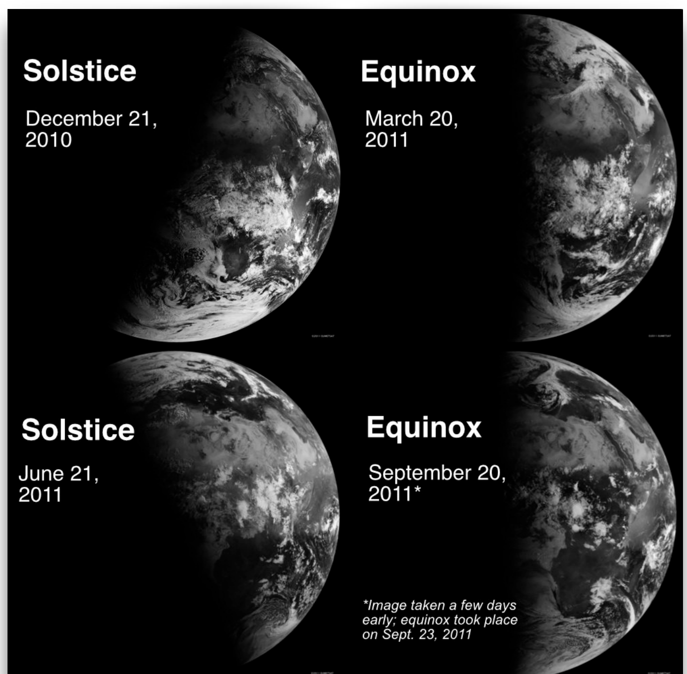
An **equinox** occurs twice every year, in March and September. In 2022, the equinoxes will occur on March 20, at exactly 15:33 UTC (*or 11:33 am EDT*), and again on September 23, at 01:04 UTC *(or September 22 at 9:04 pm EDT)*. The equinox marks the exact moment when the center of the Sun crosses the plane of our planet's equator. The day of an equinox, observers at the equator will see the Sun directly overhead at noon. After the March equinox, observers anywhere on Earth will see the Sun's path in the sky continue its movement further north every day until the June solstice, after which it begins traveling south. The Sun crosses the equatorial plane again during the September equinox, and continues traveling south until the December solstice, when it heads back north once again. This movement is why some refer to the March equinox as the **northward equinox**, and the September equinox as the **southward equinox**.

Our Sun shines equally on both the Northern and Southern Hemispheres during equinoxes, which is why they are the only times of the year when the Earth's North and South Poles are simultaneously lit by sunlight. Notably, the length of day and night on the equinox aren't precisely equal; the date for that split depends on your latitude, and may occur a few days earlier or later than the equinox itself. The complicating factors? Our Sun and atmosphere! The Sun itself is a sphere and not a point light source, so its edge is refracted by our atmosphere as it rises and sets, which adds several minutes of light to every day. The Sun doesn't neatly wink on and off at sunrise and sunset like a light bulb, and so there isn't a *perfect* split of day and night on the equinox - but it's very close.

Equinoxes are associated with the changing seasons. In March, Northern Hemisphere observers welcome the longer, warmer days heralded by their **vernal**, or spring, equinox, but Southern Hemisphere observers note the shorter days – and longer, cooler nights - signaled by their **autumnal**, or fall, equinox. Come September, the reverse is true. Discover the reasons for the seasons, and much more, with NASA at nasa.gov



This (not to scale) image shows how our planet receives equal amounts of sunlight during equinoxes.

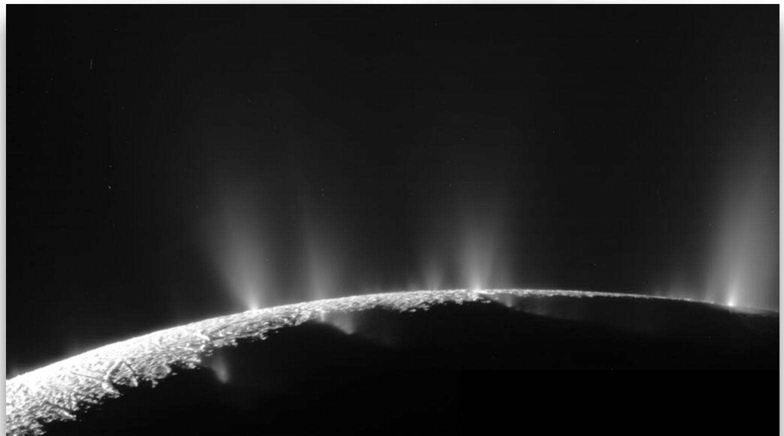


Scenes of Earth from orbit from season to season, as viewed by EUMETSAT. Notice how the terminator - the line between day and night - touches both the North and South Poles in the equinox images. See how the shadow is lopsided for each solstice, too: sunlight pours over the Northern Hemisphere for the June solstice, while the sunlight dramatically favors the Southern Hemisphere for the December solstice.

Enceladus' plumes might not come from an underground ocean

By Llisa Grossman
SCIENCENEWS, JANUARY 3, 2022

Saturn's icy moon Enceladus sprays water vapor into space. Scientists have thought that the plumes come from a deep subsurface ocean — but that might not be the case, new simulations suggest.



Saturn's moon Enceladus sprays dramatic plumes of water vapor (shown in an image from the Cassini spacecraft). Whether those plumes come from a subsurface ocean or from the moon's icy shell is a matter of debate.

Instead, the water could come from pockets of watery mush in the moon's icy shell, scientists report December 15 at the American Geophysical Union's fall meeting.

"Maybe we didn't get the straw all the way through the ice shell to the ocean. Maybe we're just getting this weird pocket," says planetary scientist Jacob Buffo of Dartmouth College.

The finding is "a cautionary tale," Buffo says. The hidden ocean makes Enceladus one of the best places to search for life in the solar system (*SN: 4/8/20*). Concepts for future missions to Enceladus rely on the idea that taking samples of the plumes would directly test the contents of the ocean, without needing to drill or melt through the ice. "That could be true," Buffo says. But the simulations suggest "you could be sampling this slushy region in the middle of the shell, and that might not be the same chemistry as is down in the ocean."

Enceladus has beguiled planetary scientists since NASA's Cassini spacecraft revealed the moon's dramatic plumes in 2005 (*SN: 8/23/05*). At the time, researchers wondered if the spray originated on Enceladus' icy surface, where friction from quakes could melt ice and let it escape as pure water vapor into space. But later evidence collected by Cassini convinced most scientists that the geysers are from fractures in the shell that reach all the way to a salty, subsurface sea (*SN: 8/4/14*).

One of the most convincing pieces of evidence was the fact that the plumes contain salts, said physicist Colin Meyer of Dartmouth in a talk at the meeting, which was held virtually and in New Orleans. Early versions of the quake idea couldn't account for those salts, and instead suggested that any salts in the melted ice would be left on the surface as the water escaped into space, like the sheen of salt left on your skin after you sweat, he says.

But Meyer, who has studied the physics of sea ice on Earth, realized that pockets of meltwater in the ice shell could concentrate salts and other compounds. He, Buffo and colleagues applied computer simulations developed for sea ice on Earth to the observed icy conditions on Enceladus. The team found that Enceladus could easily generate pockets of mush within its shell and vent the contents of that mush out into space, salts and all.

That does not mean Enceladus doesn't have an ocean, Meyer says — it almost certainly does. And it does not mean the ocean isn't habitable, Buffo adds.

The implications of the results "are huge," especially for proposed life-finding missions to Enceladus, says planetary scientist Emily Martin of the Smithsonian National Air and Space Museum in Washington, D.C., who was not involved in the work.

"If those plumes aren't tapping into the ocean, it will really shift our perspective on what that plume is telling us about the interior of Enceladus," Martin says. "And that's a big deal." ☀

Wild New Paper Says 'Quantum Gravity' Could Emerge From a Holographic Universe

By Mike Mcrae

SCIENCEALERT, MARCH 11, 2022

In the last decades of his life, Albert Einstein hoped to unite his description of gravity with existing models of electromagnetism under a single master theory.

It's a quest that continues to vex theoretical physicists to this day. Two of our best models of reality – Einstein's general theory of relativity and the laws of quantum mechanics – are as immiscible as oil and water.

Whatever a combination of the two looks like, it will almost certainly reveal foundations to the Universe quite unlike anything we can visualize.

A newly published mathematical discovery describes the emergence of gravity within a so-called 'holographic' model of the Universe; it was found by a team of researchers from Chalmers University of Technology in Sweden and MIT in the US.

Strange as it might sound, it's the best place for us to start in our search for a complete understanding on how space, time, and matter all emerge from deeper laws.

"When we seek answers to questions in physics, we are often led to new discoveries in mathematics too," says Chalmers University mathematician, Daniel Persson.

"This interaction is particularly prominent in the search for quantum gravity – where it is extremely difficult to perform experiments."

Despite their discrete ability to predict the behavior of everything from electron jumps to black hole bumps with uncanny precision, quantum physics and general relativity arise out of two very different systems of thought.

The quantum Universe is blocky, yet hazy when viewed up close, like pixels that blur into a confusing mess of color when you press your face against the screen.

General relativity relies on a seamless continuum of space and time that curves in response to mass with clear conviction, even when viewed on the smallest of scales.

There are other metaphors we can use to describe how the Universe might operate, each with their own mathematical frameworks, each a little more obscure than the last.

Some involve adding unseen dimensions wrapped up in mind-bending geometries. The holographic principle used by the researchers here is a strange example that involves taking dimensions away.

You can think of it like this: All the information telling how particles push and pull together is encoded on something more akin to a flat surface than the 3D space we think we live in, not unlike how a sense of depth appears when you look at a flat, holographic sticker.

There's a good reason to think of physics this way. Quantum versions of gravity embedded in 4D spacetime quickly become extremely complicated and unworkable.

If our spacetime were to curve far enough back on itself to create a kind of cylinder, it would necessarily have a 'flat' boundary. It also just so happens that those unwieldy theories of quantum gravity would have corresponding theories on this boundary, theories that are a lot simpler to work with.

This new paper effectively mixes different models governing particles and their waves and how they transform in fields within a holographic setting, to land upon the mathematical equivalent of gravity working as a natural consequence of these interactions.

"The challenge is to describe how gravity arises as an 'emergent' phenomenon. Just as everyday phenomena – such as the flow of a liquid – emerge from the chaotic movements of individual droplets, we want to describe how gravity emerges from a quantum mechanical system at the microscopic level," says mathematician Robert Berman, also Chalmers University.

As a bonus, this new work could also point the way to explanations on other large-scale phenomena, such as the Universe-expanding fuel we currently refer to as dark energy.

Elegant as the mathematics might be, theorists have the luxury of filling their work with caveats and assumptions in order to find intriguing new patterns. For example, whether our Universe curves back on itself enough to have the kind of boundary necessary for the holographic principle is an open question in itself, one few cosmologists are convinced of.

Still, when you're trying to work out a problem even Einstein couldn't solve, starting with the unimaginable isn't a bad way to begin. ☀

Death spiral: A black hole spins on its side

Science news, February 25, 2022

The observation by the researchers from Tuorla Observatory in Finland is the first reliable measurement that shows a large difference between the axis of rotation of a black hole and the axis of a binary system orbit. The difference between the axes measured by the researchers in a binary star system called MAXI J1820+070 was more than 40 degrees.

Often for the space systems with smaller objects orbiting around the central massive body, the own rotation axis of this body is to a high degree aligned with the rotation axis of its satellites. This is true also for our solar system: the planets orbit around the Sun in a plane, which roughly coincides with the equatorial plane of the Sun. The inclination of the Sun rotation axis with respect to orbital axis of the Earth is only seven degrees.

"The expectation of alignment, to a large degree, does not hold for the bizarre objects such as black hole X-ray binaries. The black holes in these systems were formed as a result of a cosmic cataclysm -- the collapse of a massive star. Now we see the black hole dragging matter from the nearby, lighter companion star orbiting around it. We see bright optical and X-ray radiation as the last sigh of the infalling material, and also radio emission from the relativistic jets expelled from the system," says Juri Poutanen, Professor of Astronomy at the University of Turku and the lead author of the publication.By following these jets, the researchers were able to determine the direction of the axis of rotation of the black hole very accurately. As the amount of gas falling from the companion star to the black hole later began to decrease, the system dimmed, and much of the light in the system came from the companion star. In this way, the researchers were able to measure the orbit inclination using spectroscopic techniques, and it happened to nearly coincide with the inclination of the ejections.

"To determine the 3D orientation of the orbit, one additionally needs to know the position angle of the system on the sky, meaning how the system is turned with respect to the direction to the North on the sky. This was measured using polarimetric techniques," says Juri Poutanen.

The results published in the *Science* magazine open interesting prospects towards studies of black hole formation and evolution of such systems, as such extreme misalignment is hard to get in many black hole formation and binary evolution scenarios.

"The difference of more than 40 degrees between the orbital axis and the black hole spin was completely unexpected. Scientists have often assumed this difference to be very small when they have modeled the behavior of matter in a curved time space around a black hole. The current models are already really complex, and now the new findings force us to add a new dimension to them," Poutanen states.

The key finding was made using the in-house built polarimetric instrument DIPol-UF mounted at the Nordic Optical Telescope, which is owned by the University of Turku jointly with the Aarhus University in Denmark. ☀

The Earth Just Got Hit By A Solar Storm

By Benjamin Taub

IFLSCIENCE!, MARCH 14, 2022

The Sun is having a moment, and the Earth just got caught in the crosshairs of a coronal mass ejection. According to the US National Oceanic and Atmospheric Administration (NOAA), the solar outburst resulted in a moderate geometric storm, with "disturbed conditions" expected to continue for the next day or so.

Coronal mass ejections are large discharges of plasma and magnetic fields from the Sun's corona. They can be emitted in any direction, and occasionally get blasted straight towards our home planet, like the one that occurred on March 10.

The ensuing storm can produce varying levels of disruption, depending on its strength. In most cases, the only noticeable effect is an increase in the intensity of the aurora borealis and aurora australis, which can be observed from lower latitudes than would normally be the case.

Typically, these aurorae are only visible at high latitudes, close to the north and south poles, and arise when charged particles from the Sun interact with Earth's magnetic field. When a coronal mass ejection occurs, an increased number of these particles reach our atmosphere, resulting in greater ionization of molecules and a more spectacular light show.

According to the NOAA, a G2 level geometric storm hit the Earth on March 13. This corresponds to a "moderate" storm, which is powerful enough to cause voltage issues for high-altitude power systems and pose problems for spacecraft by generating an increase in drag. Aurorae have been observed as far south as New York during previous G2 level solar storms.

For reference, the most extreme geometric storms are classed as G5, and have been known to cause entire power grids to collapse and aurorae to become visible all the way down in Florida.

While the current solar storm is nowhere near that strong, it has brought the Northern Lights to parts of the UK. According to the UK Met Office, the nightly spectacular may continue to linger in parts of Scotland for the next day or so, with further mild solar storms expected until March 15.

So far, 2022 has seen more than its fair share of outbursts from our star, and while life down here on Earth has remained largely unaffected, conditions in orbit have been somewhat chaotic. Last month, for instance, dozens of Starlink satellites were struck by a geometric storm shortly after launching, knocking them off course and causing them to burn up in Earth's atmosphere.

Our Sun has a natural 11-year cycle of activity, measured from minimum (the least activity) to maximum (the most active, with sunspots, flares, and storms) and back to the minimum. Solar Cycle 25, the 25th since reliable records of solar activity began, started in December 2019 – so we're heading towards a solar maximum of peak activity in 2025.

With three years to go until the next solar maximum, more events like these are to be expected in the near future, although whether or not the Sun produces anything more dramatic than a G2 storm remains to be seen. ☀

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

By Emily Conover

SCIENCENEWS, JUNE 10, 2021

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

A particle collider encircling the moon could reach an energy of 14 quadrillion electron volts, physicists report June 6 at arXiv.org. That's about 1,000 times the energy of the world's biggest particle accelerator, the Large Hadron Collider, or LHC, at CERN near Geneva.

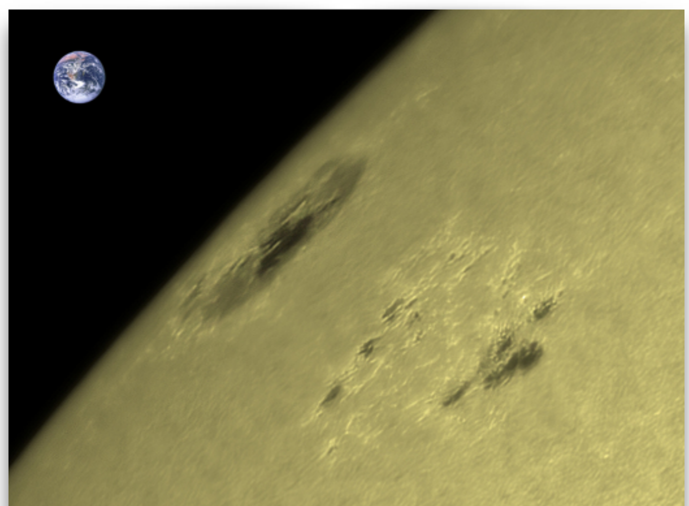
It's not an idea anyone expects will become reality anytime soon, says particle physicist James Beacham of Duke University. Instead, he and physicist Frank Zimmermann of CERN considered the possibility "primarily for fun." But physicists of future generations could potentially build a collider on the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

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

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

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

BIG SUNSPOT ALERT



SPACEWEATHER.COM, MARCH 23, 2022

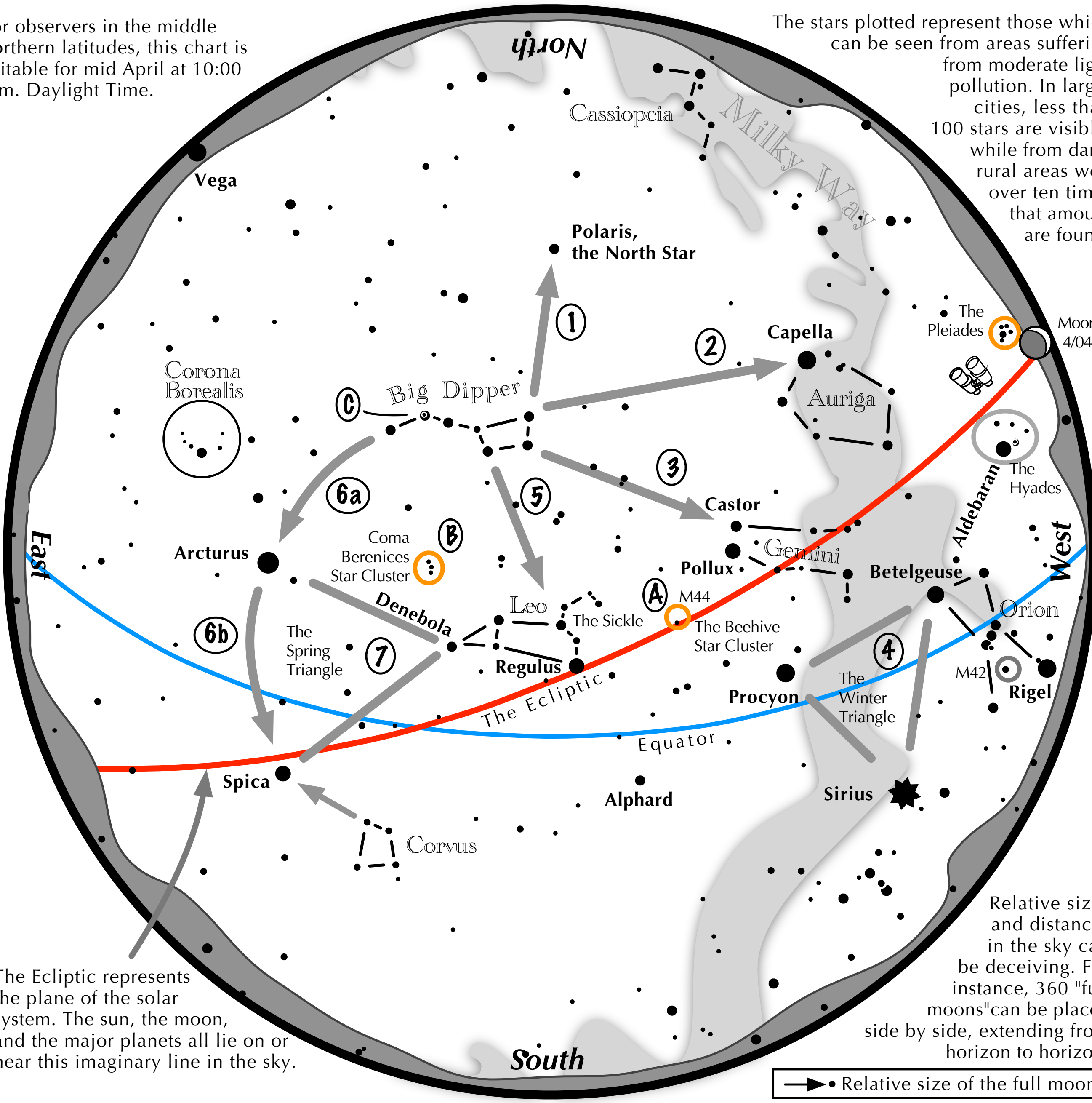
A large sunspot is emerging over the sun's northeastern limb today. Philippe Tosi photographed it from his backyard observatory in Nîmes, France.

"It is a big one," says Tosi, who inserted an image of Earth for scale. The sunspot's primary dark core is at least twice as wide as our planet. Furthermore, newly-arriving images from NASA's Solar Dynamics Observatory suggest there may be additional dark cores following just behind it. ☀

Navigating the April Night Sky, Northern Hemisphere

For observers in the middle northern latitudes, this chart is suitable for mid April at 10:00 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.

• Relative size of the full moon.

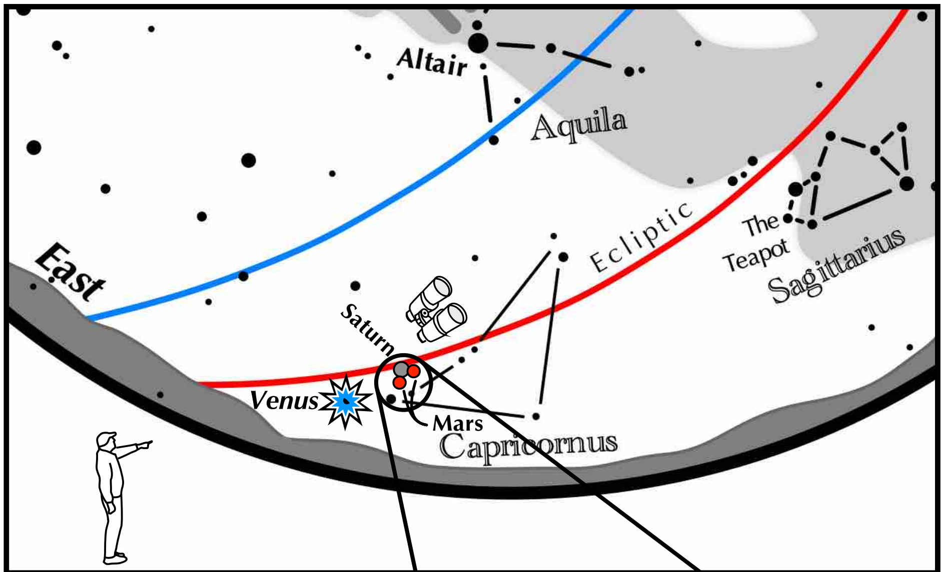
Navigating the April night sky: Simply start with what you know or with what you can easily find.

1 Extend an imaginary line north from the two stars at the tip of the Big Dipper's bowl. It passes Polaris, the North Star.
2 Draw another imaginary line west across the top two stars of the Dipper's bowl. It strikes Capella low in the northwest.
3 Through the two diagonal stars of the Dipper's bowl, draw a line pointing to the twin stars of Castor and Pollux in Gemini.
4 Look in the west-southwest for the bright Winter Triangle stars of Sirius, Procyon, and Betelgeuse.
5 Directly below the Dipper's bowl reclines the constellation Leo with its primary star, Regulus.
6 Follow the arc of the Dipper's handle. It first intersects Arcturus, then continues to Spica.
7 Arcturus, Spica, and Denebola form the Spring Triangle, a large equilateral triangle.

Binocular Highlights
A: M44, a star cluster barely visible to the naked eye, lies to the southeast of.Pollux.
B: Look nearly overhead for the loose star cluster of Coma Berenices.
C: In the Big Dipper's handle shines Mizar next to a dimmer star, Alcor.

Astronomical League
www.astroleague.org /outreach

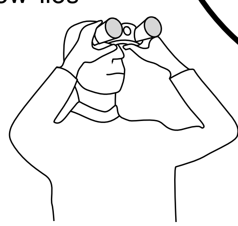
If you can see only one celestial event in the morning this April, see this one.

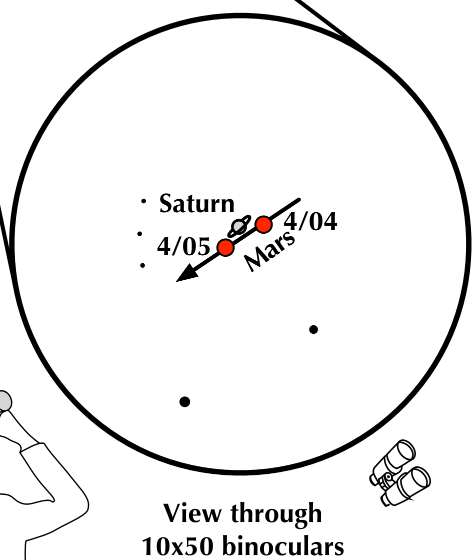


Mars Slides Below Saturn

On the first few mornings of April, look to the east–southeast 60 minutes before sunrise.

- The dazzling object is Venus.
- To its immediate west, shine two starlike objects: Saturn and the slightly dimmer, but red Mars.
- On April 4, Mars lies to the right of Saturn (west).
- On April 5, Mars has slid underneath Saturn, and now lies on its left (east).





View through 10x50 binoculars

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.