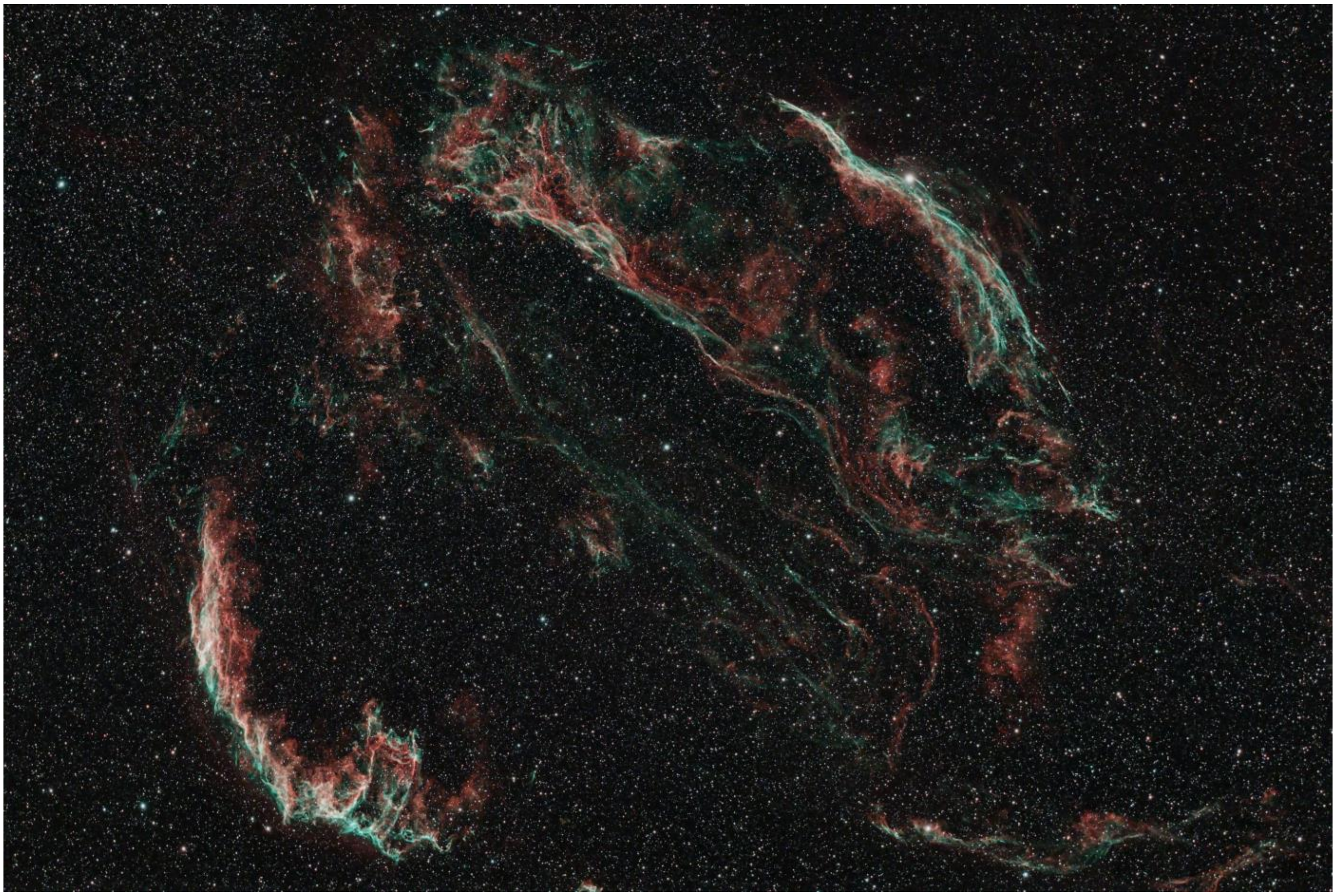
SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

September 2022



The Whole Veil Nebula by Gary Miller

Like many WAA imagers, Gary has lately been using a smaller, faster telescope, in this case a brand-new William Optics GT71G refractor. This f/5.9 instrument has a triplet air-spaced objective using FPL-53 glass. It also has a 2.5-inch precision rack-and-pinion focuser, allowing the maximum light cone to reach the camera. With a 0.8x reducer/corrector, the field in this image is 4.0x2.7 degrees. The image was made on June 26, 2022 at Ward Pound Ridge with an ASI1600MC camera through a Radian Triad Filter.

The Veil was lifted on September 5, 1784, when William Herschel first observed the brightest knot, now called NGC 6992, the bright arc on the lower left of the image. The large knot of gas below is NGC 6995. Two days later Herschel saw more nebulosity 2½ degrees to the west, now labeled NGC 6960. In Patrick Moore's Caldwell Catalog, the two sides of the Veil are C33 (Eastern Veil) and C34 (Western Veil). The bright star on the outer edge of the Western Veil is 52 Cygni. It's less than one-tenth as far away from us (201 LY) as the Veil (~2,500 LY).

WAA September Meeting

Friday, September 16 at 7:30 pm

David Pecker Conference Room
Willcox Hall,
Pace University, Pleasantville, NY

Or via Zoom

WAA Members' Night

WAA members will give short presentations on subjects of astronomical interest to the membership: equipment, techniques, observations, trips, education experiences and research. It's an annual WAA tradition. If you'd like to present, contact Pat Mahon, at waa-programs@westchesterastronomers.org.

WAA lectures are now available on the WAA YouTube channel.

WAA Members: Contribute to the Newsletter!
Send articles, photos, or observations to
waa-newsletter@westchesterastronomers.org

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WAA October Meeting

Friday, October 14 at 7:30 pm

David Pecker Conference Room
Willcox Hall,
Pace University, Pleasantville, NY

Or via Zoom

A Synthesized View of Planetary Systems

Malena Rice
Massachusetts Institute of Technology

Call: **1-877-456-5778** (toll free) for announcements, weather cancellations, or questions. Also, don't forget to visit the WAA website.

Starway to Heaven

Ward Pound Ridge Reservation, Cross River, NY

Saturday, September 17 (rain/cloud make-up date September 24)

There will be another star party on October 1st!

New Members

Linda Brunner	Yonkers
Aaren Connolly	Montrose
Susan Light	Chappaqua
Joshua Macinelli	Putnam Valley
Rita Walton	Yonkers

Renewing Members

Jason Alderman	Pelham
Thomas Boustead	White Plains
Jim Carroll	Peekskill
Michael & Ann Cefola	Commack
Walter Chadwick	Cold Spring
Andrzej Cichon	Port Chester
John & Maryann Fusco	Yonkers
Jimmy Gondek & Jennifer Jukich	Jefferson Valley
Mark Mayo	White Plains
Christopher Plourde	New Rochelle
Harry Vanderslice	Mamaroneck
Carlos Vegerano	Bronx
Michael & Angela Virsinger	Seaford
Roger Woolcott	Brewster

ALMANAC For September 2022

Bob Kelly, WAA VP of Field Events

Bob Kelly

1Q 9/3 | Full 9/10 | 3Q 9/17 | New 9/25

Bright Planets Straggle into the Evening Sky

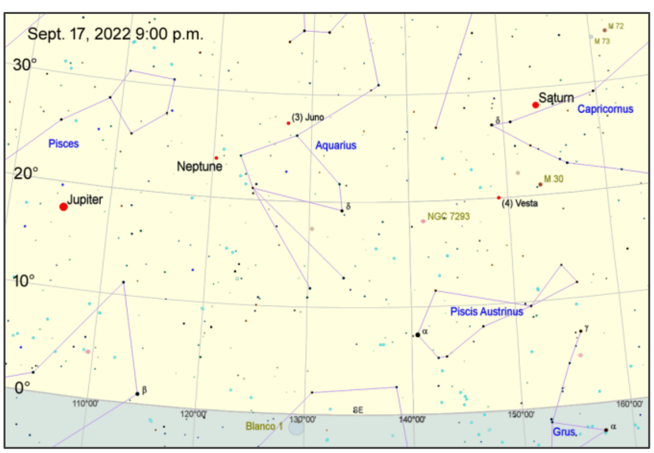
The Sun sets earlier and earlier in September, so the evening sky, with an increasing number of bright planets, comes to us earlier than it has all summer.

Jupiter rises at sunset by the end of the month, reaching opposition with the Sun on the 26th. The giant planet lives up to its reputation, appearing twice as large as any other solar system object (save for the Sun and Moon) and getting as bright as magnitude -2.9. It's a great time to track Jupiter's Galilean moons sliding around the planet. Even binoculars will show them. When Jupiter gets higher late in the evening a good telescope will show the Great Red Spot, the colorful atmospheric bands, and perhaps, at high magnification, some swirling cloud features.

Saturn gets up earlier, too, and appears at magnitude +0.4 this month. Saturn is now past its August opposition, and so it will be getting fainter as its distance from Earth grows. How many of Saturn's moons can you see? Titan is the brightest and easiest at magnitude +8.4.

Neptune comes to opposition at magnitude +7.8 on the 17th, along with asteroid **3 Juno,** and at the same magnitude. Both are in Aquarius. Magnitude +5.7 **Uranus** follows later in Aries, rising about 10 p.m.

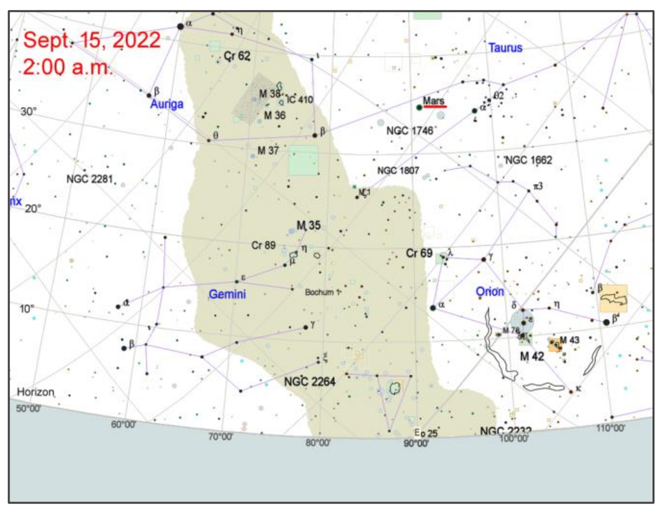
Early in the month, get outside and say goodbye to summer favorites, including Scorpius, until next year.



Are You a Morning Person?

If you like to be up and out at 5 a.m., you'll still have **Mars** high up in the south, and Jupiter lower but prominent in the southwest. Orion and the winter constellations are gaining height, so there's lots to look at in the pre-dawn sky.

Mars is a pretty sight in the horns of Taurus the Bull this month. Compare it to nearby red giant star Aldebaran. Mars will be magnitude -0.5 and Aldebaran +0.9. The ruddy planet will rise about 11 p.m. at mid-month. However, if you catch it high in the sky after midnight, Mars should appear large enough for your telescope to show some surface details. Look for dusky features on the planet. An orange filter often helps increase the contrast. Neither pole is tilted much in our direction, so the polar caps might not be visible. Mars appears only half the size of Saturn, but it's getting larger as we approach December's opposition. Its disc will enlarge from 10 arcseconds wide in September to a maximum of 17 arcseconds in December.



And We Were Blinded by the Light

Venus continues its dive into the Sun's glare. Early in the month, very low in the east at dawn, Leo's brightest star Regulus is within a couple of Moon-widths of

Venus, appearing as if Venus has a wayward moon.[1] You'll need binoculars, but it's fun to search hidden treasures like this one.

Mercury reaches inferior conjunction – it'll be between us and the Sun -- on the 23rd, passing 5 degrees south of the Sun from Earth's point of view. Venus joins Mercury in the Solar and Heliographic Observatory's C3 camera's view after the 22nd, on its way to superior conjunction -- on the far side of the Sun from our point of view -- in October. Venus will be hiding from us, but visible in the C3 camera, through mid-November. Mercury will rejoin Venus in the C3 view for a month starting in late October.

Equality Day

The equinoxes occur when the Sun is over the Earth's equator. This year's autumnal equinox is at 9:04 p.m. EDT on the 22nd. The length of a day is defined as the time period when any part of the Sun is above the horizon. This year, equal day and equal night occur on the 25th, three days after the equinox.

Satellites

Tiangong, China's growing space station, shines as bright at magnitude -2 (about as bright as Polaris) during its overflights in the last third of the month. The International Space Station is visible in the morning sky through the 12th and in the evening starting on the 13th.

Comets?

C/2017 K2 (PanSTARRS) is drifting into the evening twilight. It'll be a decent object into 2023, but only for the Southern Hemisphere. Nothing else is in binocular range as of this time.

Equinox Auroras

The Sun still appears on a trend of increasing activity as we continue into Solar Cycle number 25. At the time of the equinoxes, the Earth's magnetosphere allows more energized particles in from the Sun. Thus, auroras tend to be stronger at these times of year.

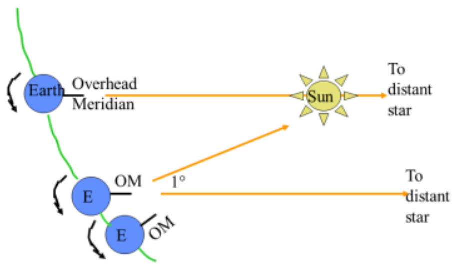
John Paladini Wins Stellafane First Prize

Our creative "junkyard astronomer" John Paladini won a special first prize at the 2022 Stellafane Amateur Telescope Makers Convention for his spectroheliograph. John described the device in the April 2017 and the August 2019 issues of SkyWAAtch.

[1] Venus was thought by some early astronomers to have a Moon. See "Moon Lost, Moon Found" on page 5 of the May 2019 SkyWAAtch.

Astronomy 101: Sidereal Time

A day (really a "solar day") is defined as the interval between two successive appearances of the Sun on the meridian, which is "local noon." The Earth is not just rotating on its axis, but also revolving around the Sun. After one local noon, the Earth will have had to rotate a little bit more than 360 degrees for the Sun to reappear on the meridian.



What if we determined the interval between two consecutive appearances of a distant star on the meridian, exactly 360 of rotation? The stars are so far away that no additional rotation is needed from one meridian position to the next. The rotation, a sidereal day, is 23 hours 56 minutes 4.0905 seconds long. Just as you can build a clock to divide the time between successive solar noons into 24 hours, or 1440 minutes, or 86,400 seconds, you can build a clock to divide the time between successive "sideral noons" in the same way. The sidereal hours, minutes and seconds are 0.273% shorter than their solar counterparts.

The advantage for astronomy is that the sidereal time is exactly the right ascension coordinate that is on the meridian at your location that instant. It's always a local time. Right ascension (RA) and declination define the position of any object on the celestial sphere. RA is measured as an offset from "the First Point of Aries," the location on the celestial sphere where the ecliptic crosses the celestial equator in the spring. (The "First Point of Aries" is now in Pisces!). RA is measured in hours, minutes and seconds while declination (distance perpendicular to the celestial equator) is measured in degrees, hours and minutes. Declination is simply the displacement from the celestial equator, the projection of the Earth's equator into the sky. If you moved 15 degrees east or west on the surface of the Earth, the sidereal time would differ by one hour (because 360÷24=15).

Stars essentially stay put but objects in the solar system move on trajectories within the celestial sphere. Their positions in RA and Dec at a particular time are determined using the object's Keplerian coordinates. These six numbers, unique for each object, are what your planetarium program or app uses to calculate a planet position at any time.

When the Sun is at exactly 12h 00m 00s right ascension, which is at the autumnal equinox directly opposite the First Point of Ares on the celestial sphere, solar time and sidereal time will be, for a moment, identical all along some meridian on the Earth.

There are many apps that will report the sidereal time at your location. We like the simple *LSTclock*.

Another Movie Telescope

Randolph Scott has just wrestled a surveying telescope away from a drunken Dakota Indian in the 1941 color film *Western Union*, directed by Fritz Lang and co-starring Robert Young and Dean Jagger. The brave has looked through the scope, laughed and said, "Good medicine!" He doesn't want to give it back, so Scott has to get physical.

The film was based on a novel by Zane Grey. Written between 1902 and his death in 1939, Grey's novels are substantially responsible for our idealization of the tough, brave American western hero, embodied by John Wayne and, as in this film, Randolph Scott. Grey's most popular novel was the 1912 *Riders of the Purple Sage.*

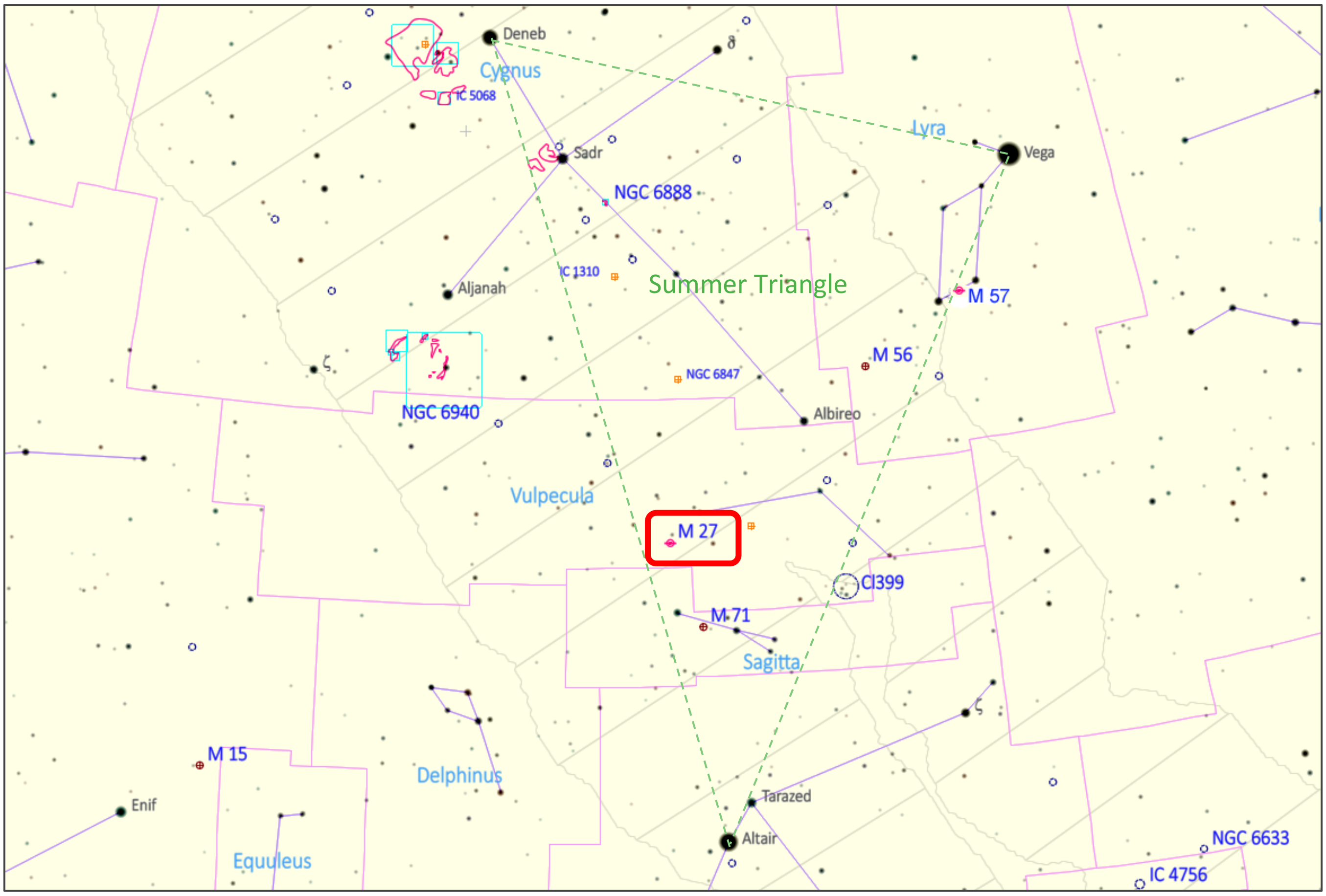
Deep Sky Object of the Month: Messier 27

Messier 27	
Constellation	Vulpecula
Object type	Planetary Nebula
Right Ascension J2000	19h 59m 36.340s
Declination J2000	+22° 43′ 16.09″
Magnitude	7.4
Size	8.0′ x 5.6′
Distance	About 400 parsecs
NGC designation	6853
Discovery	Messier 1764

The Editor's favorite DSO, the Dumbbell Nebula is easy with small telescopes and spectacular in a large one. I've seen it in a 3-inch f/6 refractor at Ward Pound Ridge. It's a big smudge but patient observation reveals some structure. It helps to enhance the contrast with a moderately aggressive light pollution filter. There's more great stuff in the area of the Summer Triangle than the Ring and Albireo!

Visibility for M27 (Westchester, NY)			
10:00 pm EDT	9/1/22	9/15/22	9/30/22
Altitude	71° 25′	69° 15′	61° 24′
Azimuth	172° 36′	210° 35′	237° 47′

The central star, G 185-32, is magnitude 13.5 and might be visible in an 8″ or larger scope.

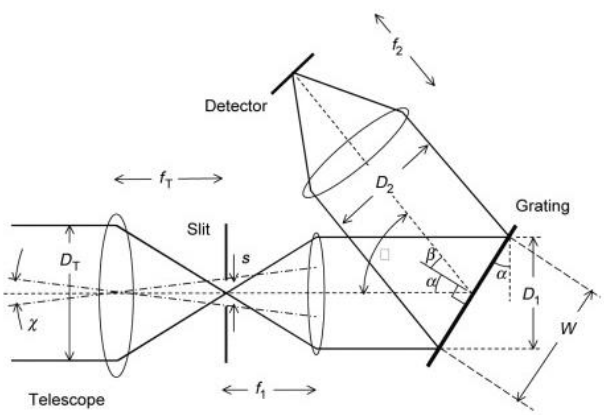


Notes from the Junkyard Astronomer John Paladini

Observe Solar Prominences with an Open-slit Telespectroscope

In the April 2017 Sky*WAA*tch I wrote an article on how to build a spectroheliograph to observe the Sun in any wavelength. The spectroheliograph was invented in the early 1890s by George Ellery Hale when he was an undergraduate at MIT. I decided to go further back in historical solar observing time and build a telespectroscope, a device that is also used to observe prominences.

Since you will be observing the Sun, standard precautions and care about solar observing must be followed. You must accept full responsibility for eye safety when embarking on any solar project, and you need to follow common sense safety rules.



The fundamental design of a grating telespectroscope

Definitions

A **spectroscope** is the instrument that separates white light into its component colors (wavelengths).

A **telespectroscope** is simply a telescope with a spectroscope attached. In modern times it is simply called an **open slit spectroscope**, the telescope component is assumed. The open slit spectroscope is a variation of the fixed slit spectroscope. It allows the user to vary the size of the slit opening with a turnable knob or other means.

A **dispersion grating** is the part of the spectroscope that does the actual job of separating the light into its component wavelengths.

Anamorphic/anamorphosis are terms relating to a distorted projection or image that appears normal when viewed from a particular point but looks distorted from another point.

Doppler distortion is the change in the image caused by looking through a spectrum emission line. The more the spectrum is stretched (by using a grating with more lines per millimeter) the greater the distortion.

Some history of solar prominences

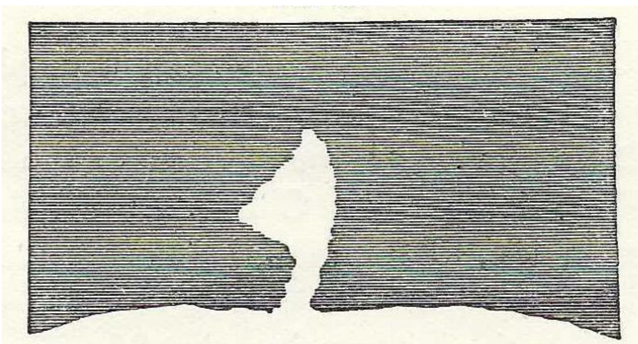
Until 1868, the only way to see solar prominences was during a total eclipse of the sun. Although the solar corona was mentioned in ancient sources, prominences were not described until 1733 when Swedish astronomer Birger Vassenius described three pinkish clouds detached from the limb of the Moon during a total solar eclipse.

For a period of time, it was debated whether prominences were volcanoes on the Moon, an optical illusion or even a mirage. The debate was settled in 1860 when photography was first employed by Warren De la Rue and Angelo Secchi. At that point it was realized they were solar phenomena.

There have been many eclipses observed by man. Two of them have changed or added to our body of knowledge in a big way. The eclipse of May 29, 1919 is perhaps the most famous one because Einstein's theory that gravity bends light was tested and proven. This was a big deal and changed our view of how the universe operates.

The second most important one, in my opinion, was the eclipse of August 18, 1868. At this event French astronomer Jules Janssen was the first to use the newly developed spectroscope to study the Sun. It led to the discovery of a new element that had not been found on Earth. Because it was found on the Sun, it was named "helium," after the Greek god who embodied the Sun. More than 50 years later this element will be a critical piece of evidence to reveal how the Sun produces energy. At the 1868 eclipse, spectroscopy unveiled the composition of the chromosphere and prominences. They were found to be mostly hydrogen, some helium and traces of some other elements. Because of these findings, astronomers realized that technology could be used to reveal parts of the Sun that normally can be seen only during an eclipse.

Astronomers using a spectroscope noticed that when they looked at the edge of the Sun ribbon (the light from the Sun stretched-out by the grating) there were little spikes sticking out from the solar disc. Janssen, Lockyer, and Huggins realized that they were the solar prominences, and they were bright enough to be able to be seen in full daylight. The race was on to develop an instrument that could visualize these features better.



Huggins's first observation of a prominence in full sunshine. From C.A. Young, *The Sun*, New York: D. Appleton & Co., 1896, p. 201.

When sunlight hits a diffraction grating it gets stretched. But stretching light causes it to get dimmer. The critical finding was that the spectral emission lines themselves do not get much dimmer but only stretched further apart. (Actually, they get do get dimmer but at a much lower rate than the rest of the light). That means that the main body of sunlight, the photosphere, dims but the emission lines from the chromosphere remain, which is essentially what happens during eclipse.

Janssen was the first to try seeing a whole prominence by simply tapping the telescope to vibrate the image. This method would be used twenty years later in spectrohelioscopes. But this is not that satisfactory for a human observer. It was Huggins who came up with the idea that all you had to do is place the spectroscope's slit tangent to the edge of the Sun and carefully open it to a small degree, making the whole prominence observable. He was the first to draw what he saw.

This method worked so well that it may have delayed development of the spectrohelioscope by twenty years.

My telespectroscope

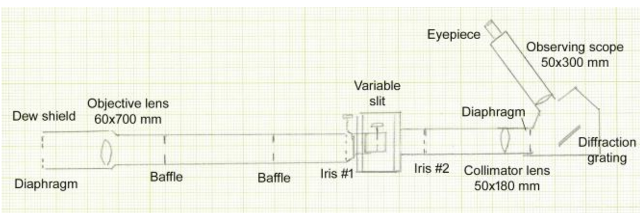
Building the telespectroscope

With this technique one can observe prominences on any clear day. This led to studying their forms and types. Astronomers made some very lovely illustrations of prominences using this method.

To build a telespectroscope, first read the April 2017 article. You can skip all the software information since that is not relevant here. However, there are a few changes that need to be made to the actual rig.

1) Use a grating that is either 600 lines per millimeter (lpmm) or 1200 lpmm instead of 1800 or 2400 lpmm. This is required to reduce Doppler distortion. The diffraction grating is tiltable with fine control. This permits the spectral line to be selected.
2) Replace the spectroheliograph telescope with a larger aperture scope. Since we are observing prominences and since they are quite small, a larger scope is needed. I use a 60-mm by 700-mm focal length scope.
3) Unlike the spectroheliograph, which is locked into a mounting rail to prevent smearing while building the image, an open slit scope needs to rotate. My scope can rotate 90 degrees left and right. This is required to place the slit tangent to the solar limb. The "rig" sits on two beveled wood holders that allow rotation. A retaining ring was added to the front point so the rig will not slide down. In true "junkyard style" I use Velcro straps to hold everything in place. It may seem kludgy, but it works fairly well. Of course, if you want to spend a lot of money and have custom parts machined or 3D-printed, go right ahead!

4) You should utilize a clock drive that is well aligned to celestial north and running at a solar tracking rate (unlike a spectroheliograph). This will allow you to lock onto the prominence for extended viewing. This is a must if you want to make an image. Imaging with this setup is similar to regular planetary imaging.
5) The spectroheliograph's fixed slit needs to be replaced with a slit whose aperture can be varied. I used one I purchased from Surplus Shed. This is the key component that makes all this work.
6) Iris diaphragms and baffles should be used in the device to reduce stray light. I added two variable irises, one at end of telescope and one inside of the collimator (see the spectroheliograph article). I also added diaphragms on lens entrance and before the grating. Thorlabs makes nice diaphragms. The baffles are made from cardboard.



Open slit spectroscope design

How to use the telespectroscope

This instrument works, but you need to understand the restrictions that do not exist in modern filter methods or even with a spectroheliograph.

On one of my first attempts at prominence capture I found a prom and placed it on the short length of the slit. The prominence was there but it was very distorted and shrunken. This is anamorphosis, a word that I learned from Chris Imbee, who I consider a master of this technique. He's been using it for 25 years. He taught me that a grating image has a direction. This is why you need to rotate slit so its tangent to the location of the prominence.

A second factor that affects the image is Doppler distortion. The more lines per millimeter of the grating, the greater the Doppler distortion. It's not that bad if you use 1200 or better yet 600 lpmm (see Chris Imbee's links at the end of this article). The distortion compresses the image as shown in the image on page 10). The formula for this compression is

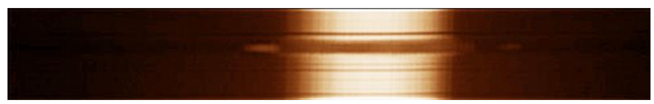
$$H = h\frac{\sin t}{\sin k}$$

where H is the true height, h the apparent height, and t and k are the inclinations of grating to the viewing telescope and the collimator.

The bottom line is to rotate the scope so the prominence appears on long length of the slit with the beam cutting across from top or bottom.

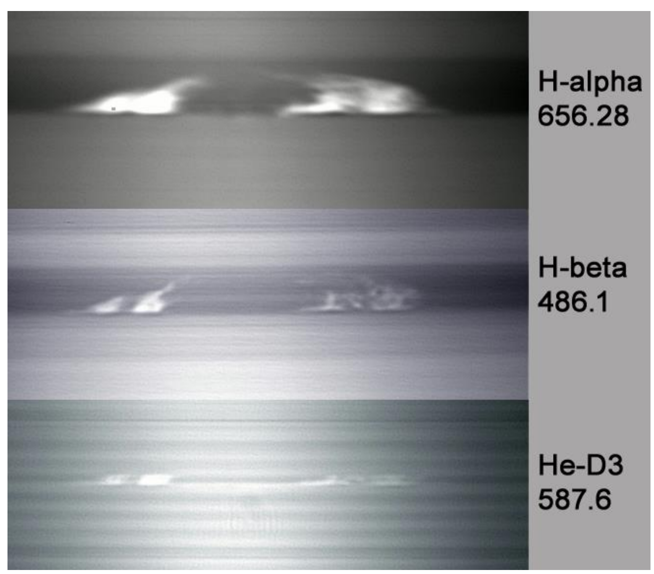
How to find prominences

First keep the slit in very narrow and search for prominences on the solar light beam. You will recognize them as little spikes of light sticking out from the main beam of sunlight. If a prominence is found at start or end of beam (entering or exiting), consider yourself lucky. Then all you need to do is to start opening the slit. Otherwise rotate the scope slowly in direction of the prominence until the main beam is right behind or before the prominence.



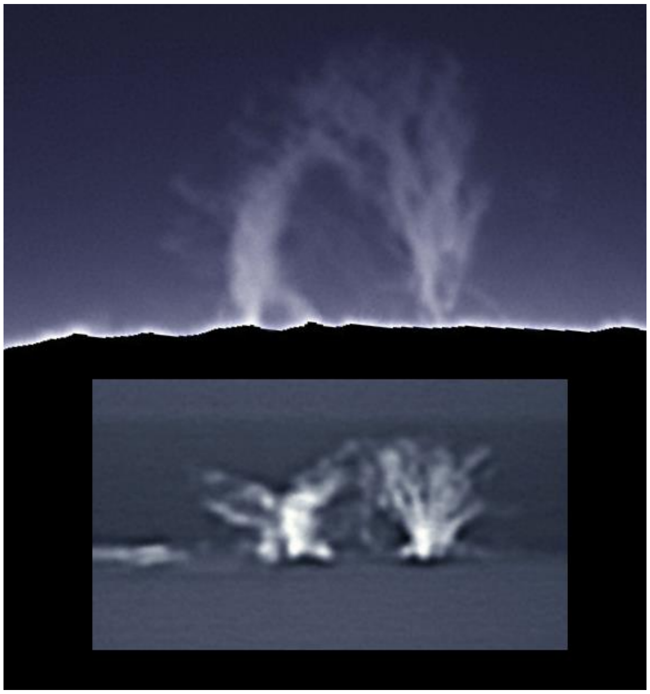
A prominence sticking out from the solar light beam.

Once you find a prominence slowly open slit until entire prominence is visible. Do not open more than needed as the more the slit opens the more background light (noise) will be present. Also keep in mind that the slit needs to be opened very slightly to see very narrow emission lines such as helium D3.



The same prominence on July 3, 2022, at three different wavelengths, showing the anamorphosis and Doppler distortion

The advantage of this instrument is that you can see visually (live) prominences in various wavelengths. Hydrogen alpha telescopes can only show prominences at 656.28 nanometers. Prominences can be seen at the helium (HeD3) and hydrogen beta wavelengths. Keep in mind these prominences are less intense than H-alpha and so the prominence needs to be very bright. I'd recommend starting with hydrogen alpha, since it's so bright.

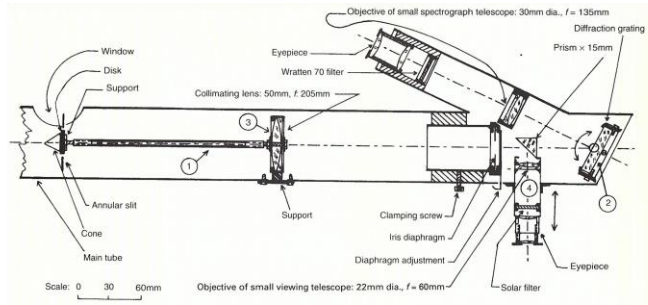


Prominence of June 19, 2022 at 656.28 nm. Top: DayStar H-alpha telescope. Bottom: Telespectroscope.

Newer designs and improvements.

The prominence telespectroscope fell out of favor but never totally went away. My build is called the "classic" version, a variable straight-slit and classic-angle spectroscope. Since the Sun is round, it would be better if the slit was an arc instead of a straight line. This would allow more of the sun's edge to be seen, as well as reduce stray light. Making a slit in the form of an arc is much more difficult and in addition the arc size must match solar image size to work optimally. Another improvement is the Littrow spectroscope design. This uses only one achromat with a grating, thereby reducing the dispersion angle and resulting in less anamorphosis. I may attempt to build this sometime in the future.

The most advanced design is the corona-spectrograph. It is the marriage between the Lyot coronagraph and open slit spectroscope. This is the design that Chris Imbee uses (see diagram). It uses an occulting disk to block most of the Sun's disk (and therefore the main body of light) with a curved slit matched to the edge of the occulting disk. This design is a bit of a challenge to build but gives the best contrast and maximum view.



Jacques Costard's advanced corona-spectroscope as used by Chris Imbee. The prism is just a beam splitter to allow a white light (filtered) view of the Sun's disk, to align the device.

Although the telespectroscope is considered an outdated instrument, it is simpler to construct than a spectrohelioscope and isn't limited to one wavelength like a hydrogen-alpha telescope that uses an Fabry-Pérot etalon.

Some of Chris Imbee images and videos

https://solarchatforum.com/viewtopic.php?t=36763

https://www.youtube.com/watch?v=2i17Uxfz4gs

https://www.youtube.com/watch?v=NENIufTqt2k

https://www.youtube.com/watch?v=aetIrgaHDvU

Two of my videos

https://www.youtube.com/watch?v=LVoob-WDJrE

https://www.youtube.com/watch?v=39VtTSqr4Yg

Additional reading

Martinez, Patrick, The *Observer's Guide to Astronomy*, Volume 1, Cambridge University Press, 1994

Roth, Gunther, *Handbook of Practical Astronomy*, Springer, 2009 ■

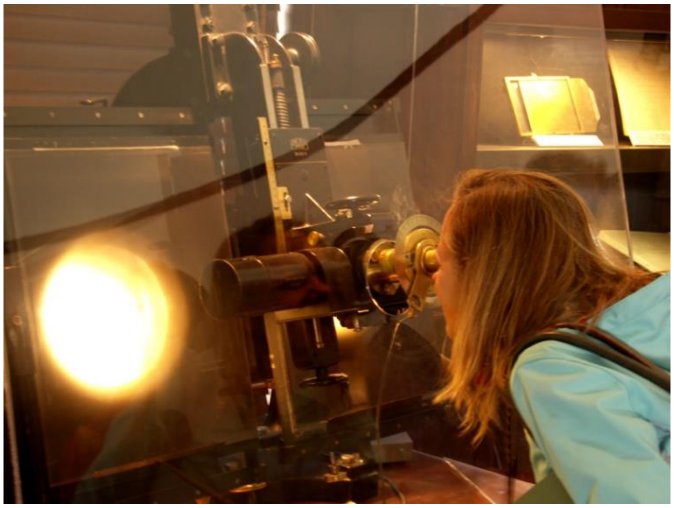
Westchester Amateur Astronomers

Pluto **Robin Stuart**

The dwarf planet Pluto (arrowed) is captured in these single 10-minute exposures taken on the overnight hours of the 25th and 26th of July through a Televue NP127 using a ZWO ASI2600MC cooled CMOS camera. The field is just under half a degree wide and north is up. Pluto was in retrograde in the constellation Sagittarius, shining at magnitude 14.6, appearing around 20° above the horizon. At the time it was 5 billion km (3.1 billion miles) from Earth. The bright star to the lower left of center is 9th magnitude HD 188785.

Pluto was discovered in 1930 by Clyde Tombaugh, working at Lowell Observatory in Flagstaff, Arizona using a 13-inch telescope specially constructed for the search. Hour-long hand-guided exposures were made onto 14″×17″ glass photographic plates that were then painstakingly scanned with a *blink comparator*. With his observation of Pluto, Tombaugh became the discoverer of the Kuiper belt. Unfortunately, impassioned but misguided attempts, even by some otherwise reputable scientists, to have Pluto maintain its classification as a planet have tended to overshadow the true significance of his achievement.


Editor's note: You can see the Pluto astrograph and even look through Tombaugh's blink comparator at the Lowell Observatory. I made these photos on a trip there in 2011. In case you were wondering, the boxing glove on the Pluto scope's counterweight rod was installed in the 1990s by now-retired Lowell telescope engineer Ralph Nye after he banged his head on it in the dark.



In the Footsteps of Galileo Part 3 — Florence & Controversy Larry Faltz

After Galileo's escape from the Inquisition in 1616,[1] he returned to Florence, where he had been living since 1610, an honored member of the court of the Medicis. His life was not an easy one even though he held the lofty title of "Principal Mathematician and Philosopher to the Grand Duke of Tuscany." Although he had an income, he had a lot of expenses. He had three children by Marina Gamba, whom he never married. Virginia (better known to history by her convent name Maria Celeste) was born in 1600, Livia in 1601 and his son Vincenzo in 1606. When Galileo moved from Padua to Florence in 1610, he took his daughters with him. Marina and Vincenzo stayed in Pisa, but she died two years later, and Vincenzo came to Florence. He was legitimized in 1619 as Galileo's heir, a favor done for the astronomer by the Grand Duke. In the family tradition, he played the lute extremely well and may also have been a luthier. Fine motor skills appear to be a trait of the Galilei family. Virginia and Livia had, by virtue of their illegitimacy, very poor prospects for marriage without an enormous dowry that Galileo was either unable or unwilling to contemplate. In 1613 he put them in the convent of San Matteo in Arcetri, just south of Florence, where they were protected but lived in abject poverty, occasionally receiving infusions of money, food and goods from their father.

Many of Galileo's places of residence in Florence are either unknown or gone. He apparently preferred in his later years to live outside of the center of the city. In 1617, a year after he was admonished to stop professing Copernicanism, he bought the Villa dell'Ombrellino, a spacious building on a hillside in the Bellosguardo district not far for the Porte Romano, just six-tenths of a mile south of the Arno. Its elevation was perfect for an astronomer, and he used his telescopes there over the next 14 years until he moved to Arcetri in 1631. The villa dates from 1372 but has been much expanded over the years. The most extensive work was done by Alice Keppel, who owned it at the beginning of the 20th century. A famous beauty, she was the mistress of the eldest son of Queen Victoria, England's King Edward VII, who ruled from 1901 to 1910. She was also the great grandmother of Camilla Parker-Bowles.[2] Upon Keppel's death in 1947, the property passed to her daughter Violet Trefusis, who was famous for her long-standing affair with the writer Vita Sackville-West, whose later lover was Virginia Woolf. The villa is now a conference center. It was not on our *Sky & Telescope* itinerary. One imagines that any direct evidence of Galileo's presence is no longer there, although I am sure there's a bust or plaque somewhere. There are busts of Galileo everywhere, it seems.

The Villa dell'Ombrellino today

Galileo had a wide circle of friends and admirers but surrounding them was a circle of scientific and ecclesiastical adversaries. It didn't help that his arrogance, intensity, argumentative style and occasional lack of diplomacy alienated a number of important astronomers, whom he saw and treated as competitors rather than colleagues.

Galileo certainly got credit for the discoveries in the *Sidereus Nuncius*. He was beaten to priority for sunspots by Christoph Scheiner, a Jesuit priest and mathematician from Ingolstadt in Bavaria.[3] After reading

[1] See the August 2022 SkyWAAtch.

[2] The Duchess of Cornwall, or Mrs. Prince Charles, in case you forgot.

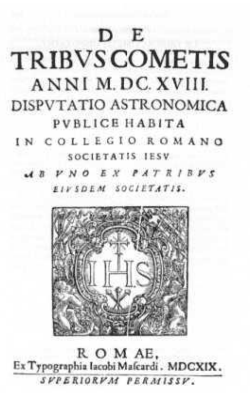
[3] Actually, neither Scheiner nor Galileo was the first to see sunspots telescopically. The Frieslander Johannes Fabricius published a 22-page pamphlet titled *De Maculis in Sole observatis et Apparente earum cum Sole Conversione Narratio* (Narration on Spots Observed on the Sun and their Apparent Rotation with the Sun) on June 13, 1611. Using a camera obscura, he observed them with his father, an astronomer who had corresponded with Tycho Brahe and Johannes Kepler. The pamphlet was sold at the Frankfurt Book Fair that year, but apparently never made it to Ingolstadt or Italy.

Galileo's book, Scheiner obtained his own telescope and observed sunspots in April 1611. He wrote a letter to the Augsburg banker Mark Welser, who published it on January 5, 1612. Scheiner used the nom de plume "Apelles," since as a Jesuit he was concerned about the propriety of describing something new in the heavens, a conflict with accepted Aristotelian doctrine that anything outside of the realm of Earth must be perfect and unchanging. Scheiner thought that sunspots were small clouds or stars orbiting the Sun, like the satellites of Jupiter.

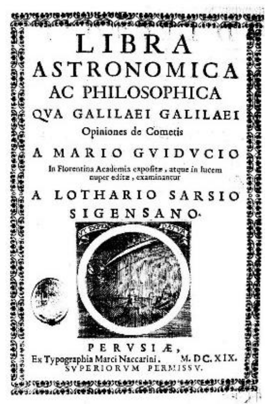
Welser asked Galileo for a response, which he provided with his own letter. He claimed that he had seen sunspots before "Apelles," in 1610. He located them on the surface of the Sun and reported that they changed their shapes before disappearing. Thus, the Sun was not perfect, an argument against Aristotle. By the time the dust settled, Scheiner had written a second letter and Galileo had sent two more. The *Accademia dei Lincei*, the Lynxes of which Galileo was such a prominent member, published them in 1613; a third of the copies included Scheiner's two letters. There was an apparent truce between the two astronomers, but it was not to last. Scheiner continued to observe, compile meticulous data and write about sunspots. Although he was wrong about their nature, at least in his early work, his observations of the Sun were quite sophisticated.

Copernicus' *De Revolutionibus* was placed on the Index in March 1616 and Galileo was warned about teaching or professing Copernicanism. He returned to Florence. He seemed hardly dissuaded from looking for more evidence of a moveable Earth. It has been suggested that a letter in the Inquisition's file describing the admonition, evidence at his 1633 trial, might have been placed there without Galileo's knowledge. He may have presumed that his conversations with Bellarmine and Pope Paul V following the Inquisition's decision implied a license to continue exploring his ideas, just to do it *sotto voce* and not proselytize among the clerics in Rome.

The astronomical event that set things inevitably in motion for the famous trial in 1633 was the appearance of three comets in 1618. Among those who studied them was Orazio Grassi, a multitalented Jesuit who was an architect, astronomer and mathematician. As I mentioned in the July 2022 Sky*WAA*tch, Grassi designed the Church of Sant'Ignazio at the Roman College. He even wrote the libretto and staging for an extravagant opera by Giovanni Girolamo Kapsperger that was performed when Ignatius Loyola was canonized in 1622.


DE
TRIBVS COMETIS
ANNI M.DC.XVIII.
DISPVTATIO ASTRONOMICA
PVBLICE HABITA
IN COLLEGIO ROMANO
SOCIETATIS IESV
AB VNO EX PATRIBVS
EIVSDEM SOCIETATIS.
ROMAE,
Ex Typographia Iacobi Mascardi. MDCXIX.
SVPERIORVM PERMISSV.


DISCORSO
DELLE COMETE
DI MARIO GVIDVCCI
FATTO DA LVI
NELL'ACCADEMIA FIORENTINA
NEL SVO MEDESIMO CONSOLATO
IN FIRENZE
Nella Stamperia di Pietro Cecconcelli, Alle Stelle Medicee. 1619.
CON LICENZIA DE' SVPERIORI.


LIBRA
ASTRONOMICA
AC PHILOSOPHICA
QVA GALILAEI GALILAEI
Opiniones de Cometis
A MARIO GVIDVCIO
In Florentina Academia expositæ, atque in lucem nuper editæ, examinantur
A LOTHARIO SARSIO
SIGENSANO.
PERVSIÆ,
Ex Typographia Marci Naccarini. M.DC.XIX.
SVPERIORVM PERMISSV.


IL SAGGIATORE
Nel quale
nella
LIBRA ASTRONOMICA E FILOSOFICA
DI LOTARIO SARSI SIGENSANO
VIRGINIO CESARINI
GALILEO GALILEI
del

Grassi gave a lecture on the comets at the Roman College in early 1619. He found, like Tycho with the comet of 1577, that they did not demonstrate any parallax, correctly concluding that they were beyond the orbit of the Moon. In spite of this difference with Aristotle, Grassi's cosmology was slavishly orthodox. Galileo read the published lecture. The margins of his copy are filled with demeaning insults. His response was the *Discorso delle Comete* (Discourse on Comets, 1619), the authorship of which was given as Mario Guiducci, Galileo's fellow Florentine and Lynx. It was known that Galileo was the actual author. Galileo believed, like Aristotle, that comets were atmospheric phenomena, but Grassi's arguments were anti-Copernican, so Galileo mounted a general attack on Scheiner and the Jesuits of the Roman College. He did not make any friends in Rome with this pamphlet.

Grassi responded quickly with *Libra astronomica ac philosophica* (Astronomical and Philosophical Balance) under a *nom de plume*, Lotario Sarsi

Sigensano, an anagram of his Latinized name. He presented more observational evidence and noted that some of Galileo's ideas were potentially dangerous, conflicting with established Church doctrine.

Galileo may have been humiliated by the idea that someone other than him had discovered a new celestial phenomenon, somehow demeaning his status as the number one astronomer of the day.[4] There was also disagreement about whether telescopes are capable of enlarging the size of stars (versus just making them brighter), which Galileo took as a challenge to his eminence as the most expert telescopist. So, Galileo sharpened his pen further, and in October 1623 he published *Il Saggiatore* (The Assayer).

On its title page, *Il Saggiatore* provides an example of Galileo's inventive wit by announcing that

> … with exquisite and just balance the things contained in the *Astronomical and Philosophical Balance* of Lotario Sarsi Sigensano are weighed.

You get a glimpse of how easily Galileo takes umbrage by the beginning of the text, which is addressed to Virginio Cesarini, a fellow Lynx who became the Chamberlain to Pope Urban VIII.

> I have never understood, Your Excellency, why it is that every one of the studies I have published in order to please or to serve other people has aroused in some men a certain perverse urge to detract, steal, or deprecate that modicum of merit which I thought I had earned, if not for my work, at least for its intention.

It's an aggressive work, full of outrage at his enemies but also a clear exposition of the scientific method and the importance of geometry, which Galileo used for most of his proofs (right or wrong). It is in this work that we find his famous statement

> In Sarsi I seem to discern the firm belief that in philosophizing one must support oneself upon the opinion of some celebrated author, as if our minds ought to remain completely sterile and barren unless wedded to the reasoning of some other person. Possibly he thinks that philosophy is a book of fiction by some writer, like the *Iliad* or *Orlando Furioso*, productions in which the least important thing is whether what is written there is true. Well, Sarsi, that is not how matters stand. Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures without which it is humanly impossible to understand a single word of it; without these, one wanders about in a dark labyrinth.

There's some nonsense in *Il Saggiatore*, such as Galileo's peculiar explanation for the rough surface of the Moon, as he found with his telescope.

> As to his question why the moon is not smooth, I reply that it and all the other planets are inherently dark and shine by light from the sun.[5] Hence they must have rough surfaces, for if they were smooth as mirrors no reflection would reach us from them and they would be quite invisible to us.[6]

While *Il Saggiatore* has some peculiar ideas, there are also some wonderful insights, examples of intelligent reasoning and appeals to experiment. At one point, criticizing Sarsi's reliance on Aristotle, Galileo says

> It is news to me that any man would actually put the testimony of writers ahead of what experience shows him.

Galileo even manages to recognize what we now call the "Dunning-Kruger effect," the proposition, well demonstrated by experimental psychology, that basically says that the stupider people are, the less stupid they think they are.[7] He writes

> Long experience has taught me this about the status of mankind with regard to matters requiring thought: the less people know and understand about them, the more positively they attempt to argue concerning them, while on the other hand to know and understand a multitude of things renders men cautious in passing judgment upon anything new.

And, appealing to the importance of thinking for oneself rather than merely relying on doctrine,

> I say that the testimony of many has little more value than that of few, since the number of people who reason well in complicated matters is much smaller than that of those who reason badly. If reasoning were like hauling I should agree that several reasoners would be worth more than one, just as several horses can haul more sacks of grain than one can. But reasoning is like racing,

[4] Grassi did not mention him by name in either work, and apparently Galileo took this as another insult.
[5] True.
[6] What???
[7] https://is.gd/dkeffect and Tom Nichol's book, *The Death of Expertise* (2017)

> and not like hauling, and a single Arabian steed can outrun a hundred plowhorses. So when Sarsi brings in this multitude of authors it appears to me that instead of strengthening his conclusion, he merely ennobles our case by showing that we have outreasoned many men of great reputation

Il Saggiatore deals with the flights of arrows, the shape of comet tails, how telescopes work, what causes heat, the nature of sound, what causes weight and other topics. There is even a description of inertial frames, the precursor to relativity. There's only one mention of Copernicus, in a discussion of the "third motion" of the Earth, which Copernicus had added to keep it in the right orientation to account for the seasons. Galileo cites an experiment that he performed with a ball floating in a bowl of water, and writes

> anyone who would reflect upon the matter more carefully would see that Copernicus had spoken falsely when he attributed his "third motion" to the earth, since this would not be a motion at all, but a kind of rest.

This "correction," which replaces the "third motion" with simple inertia, is a clever way of dissimilating (for the Inquisition, perhaps?), indicating that his Copernican enthusiasm might not be absolute.

Although there is no direct endorsement of a moveable Earth, by taking on Sarsi (one doubts that his identity as the Jesuit Orazio Grassi was unknown) and Aristotle, the philosophical rock upon which Catholic cosmology was built, Galileo was surely sticking his pro-Copernican neck out, even if just a little. Why would he do this? Because on August 6, 1623, Galileo's friend Maffeo Barberini, whose acquaintance he made in 1611 during his Roman triumph, was elected Pope Urban VIII.

Barberini was Tuscan by birth, raised in Rome and educated by the Jesuits but not a member of the order. He graduated from the University of Pisa with a law degree. He was wealthy, cultured and a great supporter of the arts. He wrote a lot of poetry, from which he garnered fawning praise. He was the prime sponsor of the great sculptor and architect Gian Lorenzo Bernini, whose work can be seen all over Rome, perhaps most famously the *baldacchino* in St. Peter's, the Fountain of the Four Rivers in the Piazza Navona and the Fountain of Tritone at the foot of the Via Veneto. His sculptures in the Borghese Gallery[8] in Rome rival anything by Michelangelo.

Copernicus, far from becoming invisible after 1616, was being widely discussed, if not openly supported. In Italy his cosmology may have been debated *sub rosa*, but in Protestant countries, the Inquisition had no influence, and Luther and Melanchthon, the anti-Copernican founders of Protestantism, were long gone. Unlike Catholicism, Lutheranism did not require central control of the interpretation of scripture. Diffusion of new ideas throughout the intellectual world of Europe could not have been effectively suppressed even in Catholic countries due to the power of books. We should also remember that the document condemning *De Revolutionibus* to the *Index* in 1616 did not explicitly declare it a heresy, but only that it was leading to the "spreading and acceptance by many of the false Pythagorean doctrine, altogether contrary to the Holy Scripture." Perhaps just smoke, rather than fire. The admonition of Bellarmine to Galileo was not widely known, there being no mass media to report it, so its impact on intellectual debate may have been limited. You can discuss something without "professing" it. Does teaching about something inevitably mean you are affirming that it's true? Not even the Jesuits would have said that. Christopher Clavius was an expert in Copernican orbital mathematics, yet a confirmed Aristotelian.

There was another aspect to Galileo's worldview that was at play. In his *Discourse on Floating Bodies* (1612), Galileo had suggested that atoms exist. It was a theory that never had any experimental verification after it was first proposed by Leucippus and Demosthenes in the 5th century BC, but was part of the "intellectual background," the aggregate of rational thought about how the world worked. He returned to it in *Il Saggiatore,* in a discussion of the senses, saying

> There are bodies which constantly dissolve into minute particles, some of which are heavier than air and descend, while others are lighter and rise up.... To excite in us tastes, odors, and sounds I believe that nothing is required in external bodies except shapes, numbers, and slow or rapid movements. I think that if ears, tongues,

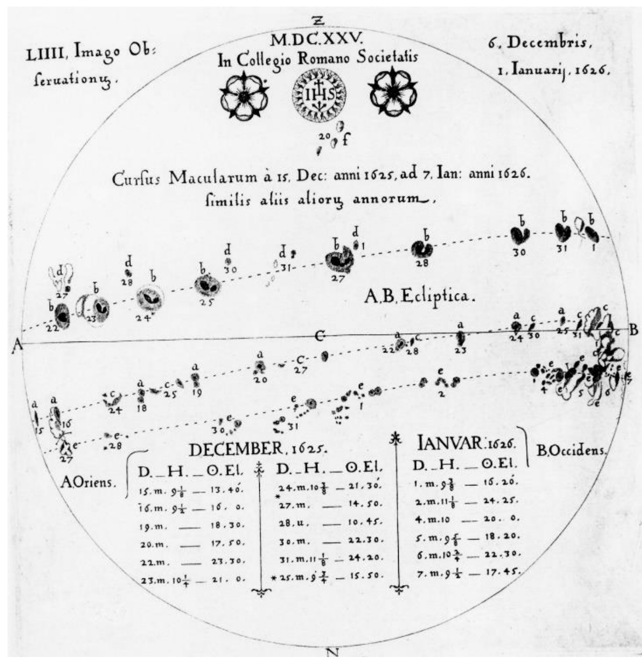
[8] The Rape of Proserpina , Apollo and Daphne, David, and Aeneas, Anchises and Ascanius

and noses were removed, shapes and numbers and motions would remain, but not odors or tastes or sounds.

"Atomism" conflicted with the idea of transubstantiation. If everything was made of discrete atoms, how could the bread and wine *actually become* the body and blood of Jesus Christ during the Eucharist?[9] This was actually a far more serious breach than merely advocating heliocentrism. Grassi wrote a response to *Il Saggiatore*, which was published in Paris in 1626 and later given an imprimatur by the Jesuits for publication in Rome. Galileo was given reassurances from highly placed church officials that potential charges of atomist heresy wouldn't stick, and the matter was dropped. But atomism remained a potential issue that may have weighed against Galileo later on.

It was natural for the pope and Galileo, both poets and appreciators of fine art, to respect each other's aesthetic sensibility and intellect. Galileo could speak frankly to Urban about his astronomical ideas, assuming that he would not be resistant to scientific realities. When still just Maffeo Barberini, Urban had opposed the admonition of 1616. As pope he was reported to have been delighted at *Il Saggiatore* and its tweaking of the Jesuits. In the spring of 1624, he had several audiences with Galileo. Although he would not change the official church position on Copernicus, he told Galileo that the Church had "never condemned nor ever would condemn the doctrine as heretical, but only as rash." He asked Galileo to examine the evidence for and against the two opposing viewpoints. He assumed he would get an objective, balanced analysis. Galileo started writing in 1624 and had substantially completed the work by 1629, slowed by various ailments, an appointment to the Florentine government and other activities.

Meanwhile, Christoph Scheiner, now in Rome, continued his solar studies and sharpened his own anti-Galilean claws. He published *Rosa Ursina sive Sol* in 1630. This four-volume work has an impressive collection of sunspot observations, correctly calculates the rotational period of the Sun, reports the tilt of the Sun's rotational axis (between 7 and 7½ degrees, spanning the correct value of 7.25 degrees), discusses the equipment he used to make his observations, and even describes the function of the human eye. His sunspot data proved quite useful because it preceded the Maunder Minimum, the period from 1645 to 1715 when the Sun exhibited hardly any spots. *Rosa Ursina* is an impressive work of science, except for its last volume, in which Scheiner, ever the obedient Jesuit, quotes extensively from scripture and the writings of important theologians to show how his observations support the geocentric theory and not Copernican heliocentrism. He speaks of Galileo in friendly terms, even dedicating the first book to the Florentine, but corrects a dozen of his errors. That, plus mutual charges of plagiarism, the battle for priority, and Galileo's persistent stoking of his own outrage, was enough to incite Galileo and his followers once again. He threw some juicy jibes at Scheiner and the Jesuits into his new book.

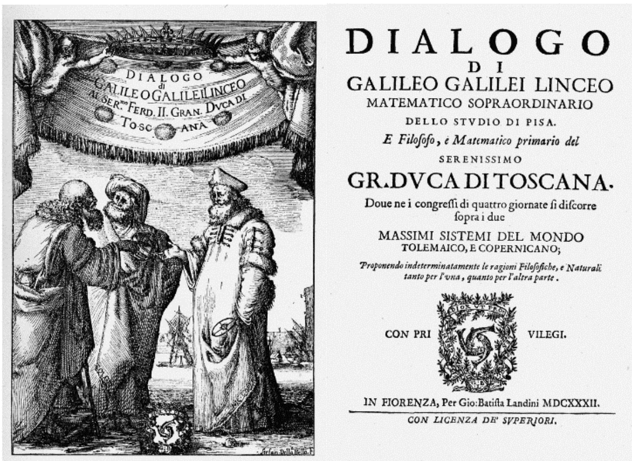


Sunspot drawings in Scheiner's *Rosa Ursina*

The *Dialogo* is a four-day conversation between three acquaintances: Salviati, a proponent of Copernicus (and Galileo's alter ego), Sagredo, an intelligent but neutral party, and Simplicio, a dyed-in-the-wool Aristotelian philosopher and geocentrist, revealed to be a man of limited intellectual creativity, wedded to tradition and seemingly unable to think for himself. Salviati and Sagredo were named after late friends, Galileo's fellow Lynxes, and Galileo tells us that he will "make their fame live on in these pages, so far as

[9] The Council of Trent stated that Christ is "really, truly, substantially present" during the Eucharist.

my poor abilities will permit, by introducing them as interlocutors in the present argument." He also tells us that he chose "Simplicio" because the character quotes the 6th century philosopher Simplicius, who had written commentaries on Aristotle. "I have thought fit to leave him under the name of the author he so much revered, without mentioning his own." It was a choice that ultimately may have backfired. "Simplicio" is close to "semplice," Italian for "simple." Which, of course, was intended.



DIALOGO
DI
GALILEO GALILEI LINCEO
MATEMATICO SOPRAORDINARIO
DELLO STVDIO DI PISA.
E Filosofo, e Matematico primario del
SERENISSIMO
GR.DVCA DI TOSCANA.
Doue ne i congressi di quattro giornate si discorre sopra i due
MASSIMI SISTEMI DEL MONDO
TOLEMAICO, E COPERNICANO;
Proponendo indeterminatamente le ragioni Filosofiche, e Naturali tanto per l'una, quanto per l'altra parte.
CON PRI VILEGI.
IN FIORENZA, Per Gio:Batista Landini MDCXXXII.
CON LICENZA DE' SVPERIORI.

At the outset, Galileo tries to duck any accusations of pro-Copernican bias by stating that the work "takes the Copernican side with a pure mathematical hypothesis." Nevertheless, he plays all his cards face up, by also writing in the preface that

> First, I shall try to show that all experiments practicable upon the earth are insufficient measures for proving its mobility, since they are indifferently adaptable to an earth in motion or at rest. I hope in so doing to reveal many observations unknown to the ancients. Secondly, the celestial phenomena will be examined, strengthening the Copernican hypothesis until it might seem that this must triumph absolutely. Here new reflections are adjoined which might be used in order to simplify astronomy, though not because of any necessity imported by nature. In the third place, I shall propose an ingenious speculation. It happens that long ago I said that the unsolved problem of the ocean tides might receive some light from assuming the motion of the earth. This assertion of mine, passing by word of mouth, found loving fathers who adopted it as a child of their own ingenuity. Now, so that no stranger may ever appear who, arming himself with our weapons, shall charge us with want of attention to such an important matter, I have thought it good to reveal those probabilities which might render this plausible, given that the earth moves.

The work is far broader than just a review of astronomy as a justification of Copernicanism, a critique of Aristotle's *De Cielo* (On the Heavens), or a restatement of Galileo's erroneous theory of the tides. It addresses fundamental geometrical and physical questions, the nature of movement, the role experiment, and even a review of Gilbert's discoveries about magnetism. There is a thought experiment that visualizes inertia and relativity. Simplicio is treated humanely, but is constantly shown to be wrong, even dense.

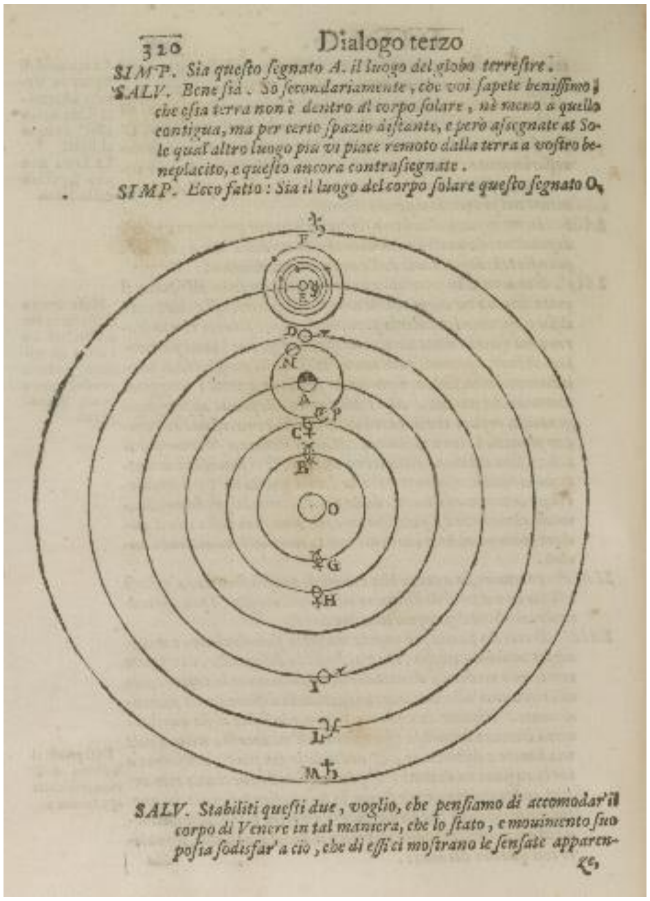
As in *Il Saggiatore*, Galileo attacks the reliance on philosophers of the past, with Salviati saying to Simplicio

> If what we are discussing were a point of law or of the humanities, in which neither true nor false exists, one might trust in subtlety of mind and readiness of tongue and in the greater experience of the writers, and expect him who excelled in those things to make his reasoning most plausible, and one might judge it to be the best. But in the natural sciences, whose conclusions are true and necessary and have nothing to do with human will, one must take care not to place oneself in the defense of error; for here a thousand Demostheneses and a thousand Aristotles would be left in the lurch by every mediocre wit who happened to hit upon the truth for himself. Therefore give up this idea and this hope of yours that there may be men so much more leaned, erudite, and well-read than the rest of us as to be able to make that which is false become true in defiance of nature.

And on the second day, Sagredo offers this story to illustrate the silliness of Simplicio's constant appeals to prior authority:

> One day I was at the home of a very famous doctor in Venice, where many persons came on account of their studies, and others occasionally came out of curiosity to see some anatomical dissection performed by a man who was truly no less learned than he was a careful and expert anatomist. It happened on this day that he was investigating the source and origin of the nerves, about which there exists a notorious controversy between the Galenist and Peripatetic doctors. The anatomist showed that the great trunk of nerves, leaving the brain and passing through the nape, extended on down the spine and then branched out through the whole body, and that only a single strand as fine as a thread arrived at the heart. Turning to a gentleman whom he knew to be a Peripatetic philosopher, and on whose account he had been exhibiting and demonstrating everything with unusual care, he asked this man whether he was at last satisfied and convinced that the nerves originated in the brain and not in the heart. The philosopher, after considering

for a while, answered: "You have made me see this matter so plainly and palpably that if Aristotle's text were not contrary to it, stating clearly that the nerves originate in the heart, I should be forced to admit it to be true."


310 Dialogo terzo

SIMP. Sia queſto ſegnato A. il luogo del globo terreſtre.

SALV. Bene ſtà. So ſecondariamente, che voi ſapete beniſſimo, che eſſa terra non è dentro al corpo ſolare, nè meno à quello contigua, ma per certo ſpazio diſtante, e però aſſegnate al Sole qual'altro luogo più vi piace remoto dalla terra a voſtro beneplacito, e queſto ancora contraſſegnate.

SIMP. Ecco fatto: Sia il luogo del corpo ſolare queſto ſegnato O.

SALV. Stabiliti queſti due, voglio, che penſiamo di accomodar'il corpo di Venere in tal maniera, che lo ſtato, e mouimento ſuo poſſa ſodisfar'a ciò, che di eſſi ci moſtrano le ſenſate apparenze,

Salviati’s diagram of the Copernican solar system, from the Library of Congress’s copy of the *Dialogo*

It's a lengthy book, some 495 pages of printed text (plus two for the title pages shown on page 17 of this issue of *SkyWAAtch* and one for the imprimaturs from the Vatican and Florentine clergy). There are copious printed marginal notes that guide the argument. As in *Il Saggiatore*, Galileo is merciless, if a good bit less personal, in his attacks on those he disagrees with, and sometimes, as in *Il Saggiatore*, he is wrong. Except for the tides his claims are sound, and the Copernican view is triumphant not only because of the strength of Salviati’s arguments but because Simplicio is indeed simple and can’t make any effective counterarguments. Surprisingly, Tycho’s system, which has the planets orbiting the Sun but the Sun orbiting the Earth, isn’t dealt with at all.

On September 22, 1631, while the book was being typeset, Galileo moved to the Villa Il Gioiello, in the neighborhood known as the Pian dei Guillari after a street of the same name in the Florentine suburb of Arcetri. It is up the hill from a property that his son had purchased a couple of years earlier. It was much closer to the convent of San Matteo where his daughters were living. As part of our tour, we visited the house, which is generally not open to the public.

Google Earth image of Florence, the Arno and the suburbs to the south.

Il Gioiello is on a narrow, hilly, winding street opposite other houses of similar age. The only thing that distinguishes it is a bust of Galileo set into the wall, with a plaque that calls him the “divine Galileo.” The original villa had a substantial amount of farmland, but when it became state property in 1942, only the house and a small garden were retained. It was placed in the care of *the Universita degli Studi di Firenze* (Florence University) and the *Osservatoria Astrofisico di Arcetri* (Arcetri Observatory). The house was restored at the turn of this century to be ready for the 400th anniversary of Galileo’s telescopic discoveries in 2009. It serves primarily as a site for scientific and cultural programs.

At the exact time of our visit, a guide opened the door and ushered us into the courtyard. He described what Galileo’s life was like during the eleven years he lived there. All of Galileo’s possessions were sold off after his death by his son Vincenzo, so there is really nothing original in the house except for the structure itself. The rooms are small, but those on the back side of the house have lovely views across the valley. There is another courtyard with a loggia and beyond it a garden in which Galileo grew his own grapes for the wine of which he was so fond. It was fermented and stored in a basement wine cellar, which now holds modern oak barrels. He also grew vegetables, medicinal herbs and flowers. A couple of the rooms had modern furniture and equipment set up for meetings. One small room held a reconstruction of Galileo's desk, and another displayed a copy of his telescope on a tripod.

The façade and front door of Il Gioiello

Being physically closer to his daughter Virginia, or Maria Celeste as she was called in the convent of San Matteo, was a great comfort to Galileo, who was 67 when he moved into the house. Dava Sobel's *Galileo's Daughter* tells the story of their relationship, based primarily on 124 letters that Maria Celeste wrote to her father, from May 1623 until December 1633 just prior to her death in 1634 at the age of just 34.[10] About her sister Livia, whose convent name was Arcangela, we know much less. She was sickly throughout her life but lived until the age of 58.

In spite of his wealth and culture, Urban VIII was vain, consumed with his own greatness, profligate and insecure. He constantly consulted astrologers. He was a master at nepotism, giving highly paid sinecures to many in his large extended family. He ran up enormous debts. At one point 80% of the Papal State's income went for interest payments. He was militarily aggressive, the last pope to be so. He made enemies among the Jesuits and Dominicans. Plots were afoot to replace him as early as 1629, but he survived until 1644.

Villa Il Gioiello. Clockwise from top: Our group in the entrance courtyard; re-creation of Galileo's desk, the kitchen, view southwest from the top floor, interior courtyard, S&T Senior Editor Kelly Beatty with replica of Galileo's telescope.

Galileo went to Rome in 1630 to pitch the book to Church authorities, whose imprimatur he needed to get it published. They required that the original title, *Dialogue on the Ebb and Flow of the Sea*, be dropped because it would look as if they were acknowledging that Galileo had proof of heliocentrism. A few other changes were requested. The book was renamed *Dialogo sopra i due massimi sistemi del mondo* (Dialogue Concerning the Two Chief World Systems). It was dedicated to Ferdinando II, Grand Duke of Tuscany, the son of Cosimo II whom Galileo tutored some thirty years before and who had welcomed him back to Florence after his telescopic discoveries.

During his Rome trip in May 1630, Galileo had been granted another audience with Urban. A month later the pope met with Niccolò Riccardi, a Dominican who was Master of the Sacred Palace (the chief censor of Rome). Urban told Riccardi that he and Galileo had agreed that exposing objections to Aristotle and showing evidence for Copernicus would be proof that the Church had a complete understanding of the science, showing that its reasons for banning Copernicus were not made out of ignorance but to

[10] Sobel's translation of all the letters is in her book *Letters to Father*.

reassert the ultimate power and omniscience of God. Galileo would make this point (referred to as "the medicine") at the end of the book. We should recall that Galileo came to Rome in early 1616 with the intent of preventing the embarrassment that he thought the Church would experience if it did not find ways of justifying what was evidently true. Now he seemed on the threshold of achieving his goal.

At the end of the *Dialogo*, following an extensive discussion of the tides, Simplicio is given these words:

> I know that if asked whether God in His infinite power and wisdom could have conferred upon the watery element its observed reciprocating motion [the tides] using some other means than moving its containing vessels [the Earth's motion], both of you would reply that He could have, and that He would have known how to do this in many ways which are unthinkable to our minds. From this I forthwith conclude that, this being so, it would be excessive boldness for anyone to limit and restrict the Divine power and wisdom to some particular fancy of his own.

To which Salviati responds

> An admirable and angelic doctrine, and well in accord with another one, also Divine, which, while it grants to us the right to argue about the constitution of the universe (perhaps in order that the working of the human mind shall not be curtailed or made lazy) adds that we cannot discover the work of His hands. Let us, then, exercise these activities permitted to us and ordained by God, that we may recognize and thereby so much the more admire His greatness, however much less fit we may find ourselves to penetrate the profound depths of His infinite wisdom.

It sounds right, but it was a mistake. The assertion of God's omnipotence was given to the dunderhead Simplicio. His rigidity, dogmatism and lack of insight had been parodied throughout. It was even more gratuitous to have Salviati (Galileo) conclude, in effect, "Yes, but…" It ultimately undermined Urban's support. The medicine was given to the wrong patient.

When the *Dialogo* was published in February 1632 in Florence, Galileo had no inkling of what was to come. He expected to be lionized, and his dream of having the Church accept and endorse Copernicus seemed within reach. Inside the Church, perhaps excepting the rigid Jesuits whose members Grassi and Scheiner he had ridiculed, Galileo had many friends, right up to Urban himself. Yet circumstances began to change, as much because of the flawed character of the pope and the intrigue that surrounded him as the strength of Galileo's arguments.

In Venice, the book was lauded. Galileo sent eight copies to Rome, to be distributed among the most important personages, although not to Urban himself. Very quickly, someone informed the pope about the language Galileo used to implement his instructions of May 1630. Urban, suspicious and paranoid, may have needed to assert a doctrinal view to offset a potential revolt by Dominicans and Jesuits. He worried about assassination, and even employed a food taster. In July 1632 he ordered the publisher to cease printing the *Dialogo* and mandated that all extant copies were to be confiscated.

Orazio Grassi, the Jesuit who had battled with Galileo over comets and who, as the eponymous Sarsi, had been the target of *Il Saggiatore*, denied any involvement and claimed to regret the sequence of events. He wrote "He ruined himself by being so fond of his own ideas and by not appreciating others. It is no wonder that everybody conspired against him."

By September 1632, Urban was really stewing, telling Francesco Niccolini, the Florentine ambassador to Rome, that "Galileo's book involves great harm to religion, indeed, the worst ever conceived." The book was "extremely perverse…troublesome and dangerous…pernicious." Acknowledging to Niccolini that he had discussed the issues with Galileo before publication, Urban said Galileo "had dared to enter when he should not have, into the most serious and dangerous subjects which could be stirred up at this time." That the subject was cool in 1624 but volcanically hot in 1632 likely tells us something about the deterioration of Urban's position and his need to strike some sort of pose. The chorus of conservative clerics in Rome and Florence became ever louder and more demanding.

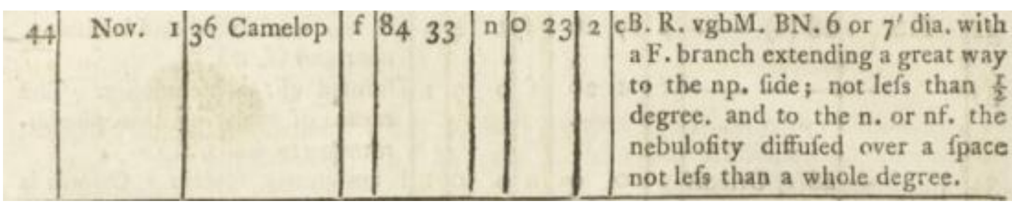
In August 1632, Urban appointed a special panel to determine whether the matter should be brought before the Holy Office (the Inquisition). That it was not directly referred shows that Urban may still have regarded Galileo as a friend. Finding the archived note of Paul V's admonition to Galileo in 1616 sealed Galileo's fate, as we shall report in next month's SkyWAAtch, when we finish the report of our trip. ■

Images by Members

NGC 2403 by Gary Miller

A star-forming galaxy in the constellation Camelopardalis, NGC 2403 is an outlying member of the M81 group. It's considered to be very similar in size and structure to M33, the Triangulum galaxy. At magnitude 8.9 it's visible in moderate-sized telescopes.

NGC 2403 was discovered by William Herschel on November 1, 1788, listed among the "Fifth Class (Very Large Nebulas)" in the second of the three publications that comprised his catalog. It's number 44.



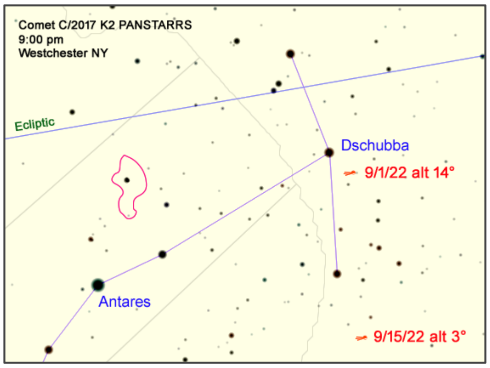
44	Nov. 1	36 Camelop	f	84 33	n	0 23	2	cB. R. vgbM. BN. 6 or 7′ dia. with a F. branch extending a great way to the np. ſide; not leſs than ½ degree. and to the n. or nf. the nebuloſity diffuſed over a ſpace not leſs than a whole degree.

Herschel used the "20-foot" reflector at Slough to observe the objects in his three catalogs. This instrument had a speculum mirror of some 18.7 inches in diameter, and so was f/12.8. The eyepiece chosen for sweeping the sky gave a magnification of 157x, and a field of 15′ 4″. One can imagine him coming upon this bright blob filling half the field of his telescope and calling down excitedly to his sister Caroline so she could transcribe the description and the coordinates. He may, however, have been in error about the extent of nebulosity being "a whole degree."

NGC 2403 was the first galaxy outside of the local group in which Edwin Hubble found Cepheid variables.

Gary made this image in early May at Ward Pound Ridge with a 127-mm refractor.

Comet C/2017 K2 PANSTARRS



This fairly bright telescopic (binocular in dark skies) comet was overhead in June and July. It is heading to the southern hemisphere in September, you might be able to catch it in the head of Scorpius at the beginning of the month, although very low. It will be around magnitude 8. The finder chart is for 9:00 pm, which will be the end of nautical twilight. On September 1st it will be 14° above the horizon in the southwest, but within a week it may drop too low for observations to be successful because of atmospheric extinction (the so-called "airmass").

Steve Bellavia
7/20/22

William Optics GT-71 refractor
ZWO ASI533MC camera.

John Paladini
7/14/22

Celestron
"Comet Catcher"
5.5" f/3.6 reflector
ASI290MM camera

Jupiter and Io by John Paladini

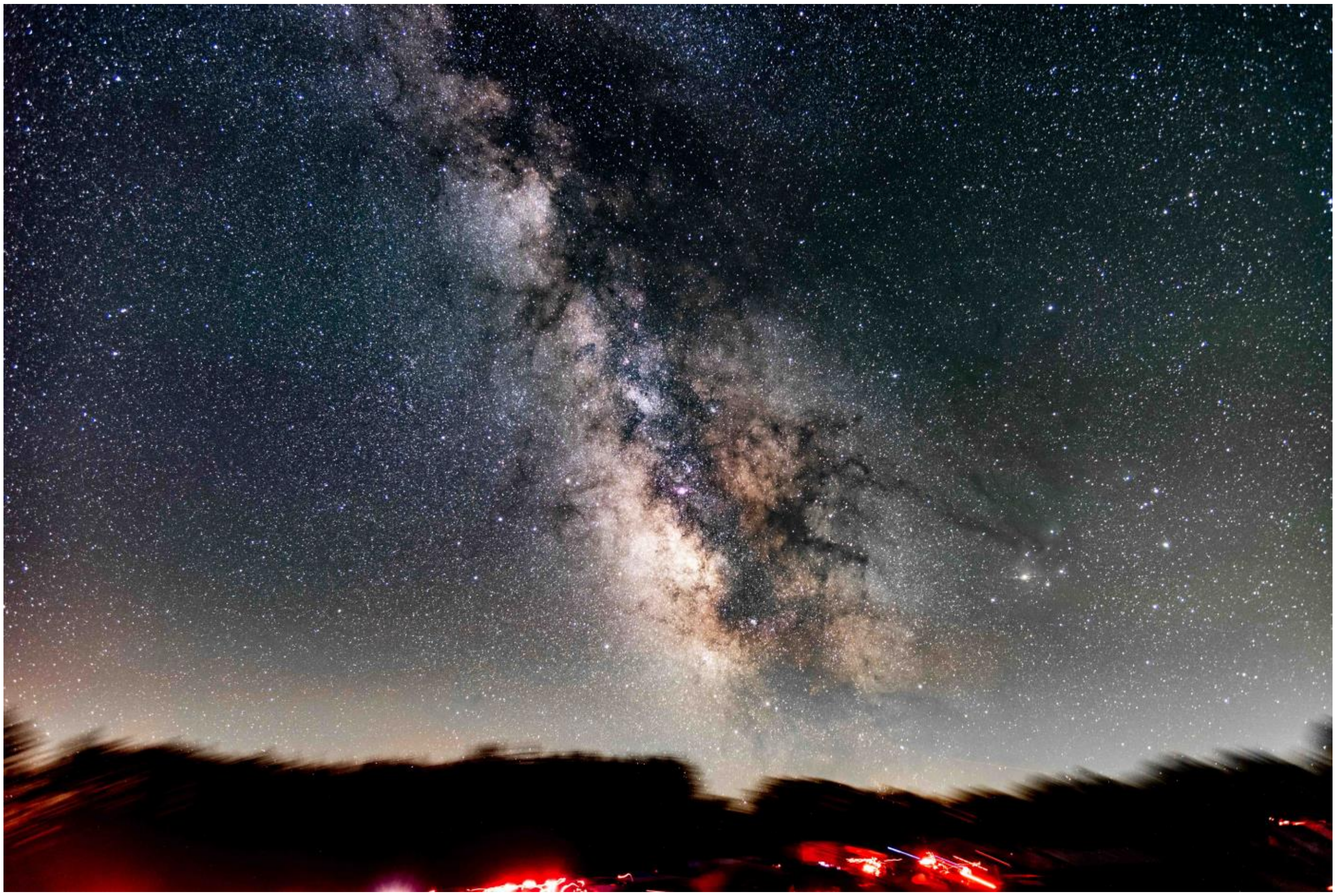
Jupiter is finally coming into the evening sky. On August 8th John had to wait until about 4:00 a.m. for the planet to be on the meridian so it would be at its highest altitude that night (50°), which helps to minimize atmospheric effects. He used a Meade 7-inch Maksutov with a 2x Barlow and an ASI290MC camera.

Shadow Transits of Jupiter for September 2022

Date	Moon	Ingress	Egress	Altitude at Ingress	Altitude at Egress
9/6	Europa	21:46	00:20	17	42
9/7	Io	23:36	01:50	35	49
9/14	Europa	00:21	02:55	45	46
9/15	Io	01:31	03:34	49	40
9/16	Io	19:59	22:14	5	29
9/20	Ganymede	20:07	23:26	10	42
9/21	Europa	02:57	05:30	42	19
9/22	Io	03:26	05:46	37	15
9/23	Io	21:54	00:09	31	47
9/28	Ganymede	00:08	03:01	48	38
9/30	Io	23:50	02:04	47	43

Here are the shadow transits of Jupiter that will be visible from our area during the night this month. Please note that for transits starting after mid-night, the date given is the calendar date. For example, the 9/14 shadow transit of Eu-ropa begins at 21 minutes after midnight on the evening of Tuesday, 9/13-14.

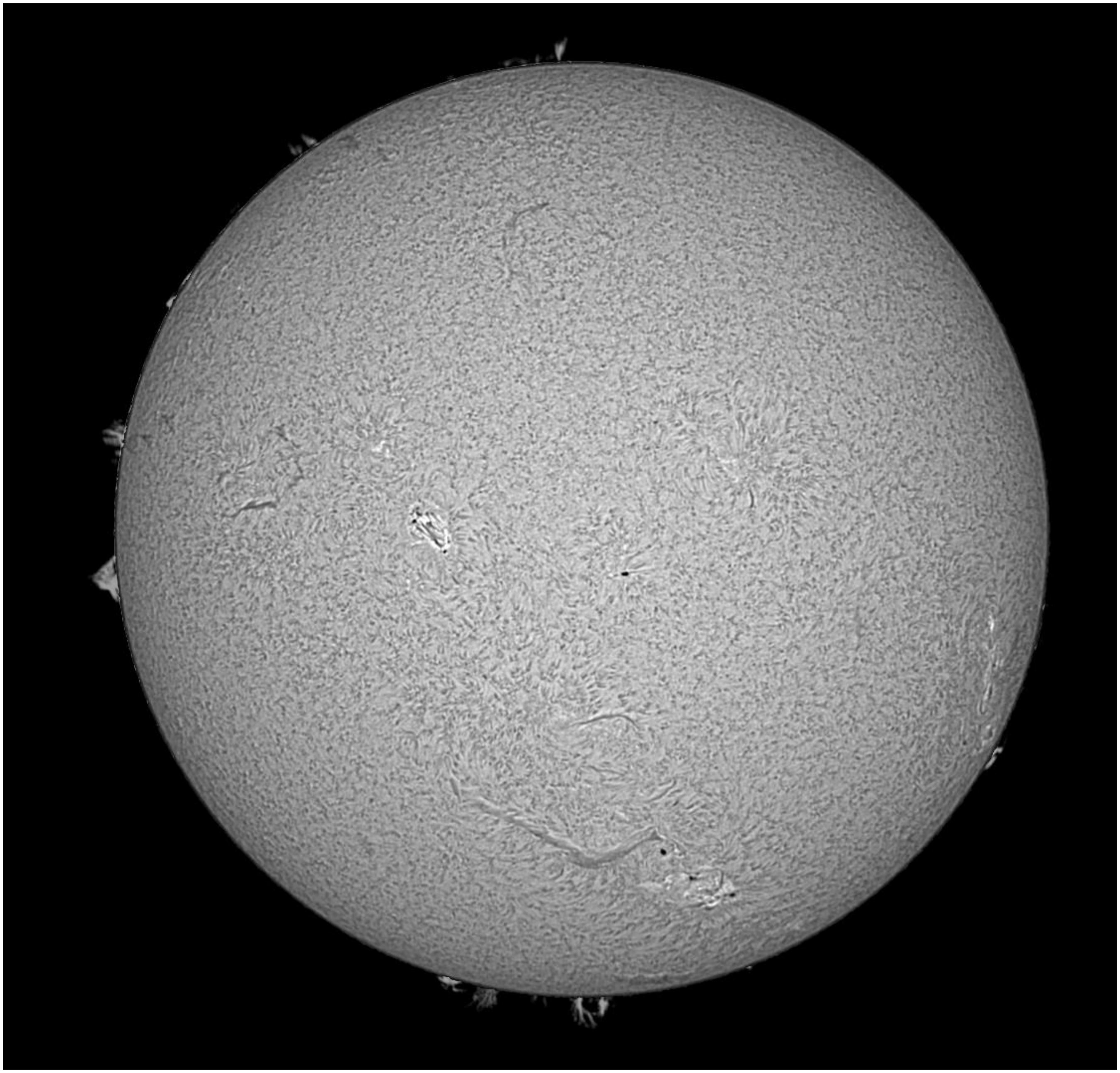
The Milky Way from Cherry Springs by David Parmet



David went to Cherry Springs on the last weekend in July. He wrote, “Ten-minute exposure and not a single plane or satellite. I don’t know how I managed that. Technical details – Nikon D810, ISO 800, ƒ4/ for 10 minutes. 24-mm. Star Adventurer 2i star tracker. Shot on a very clear and very crowded Saturday night at Cherry Springs.”

Larry Faltz snapped this twilight image with his cell phone on July 30 at Ward Pound Ridge Reservation. Fortunately, the sky cleared, with both transparency and seeing above average for a summer night. Although it was not an official star party night, there were quite a few WAA members taking advantage of our Special Use permit, and some people camping in the park joined us to share the night sky.

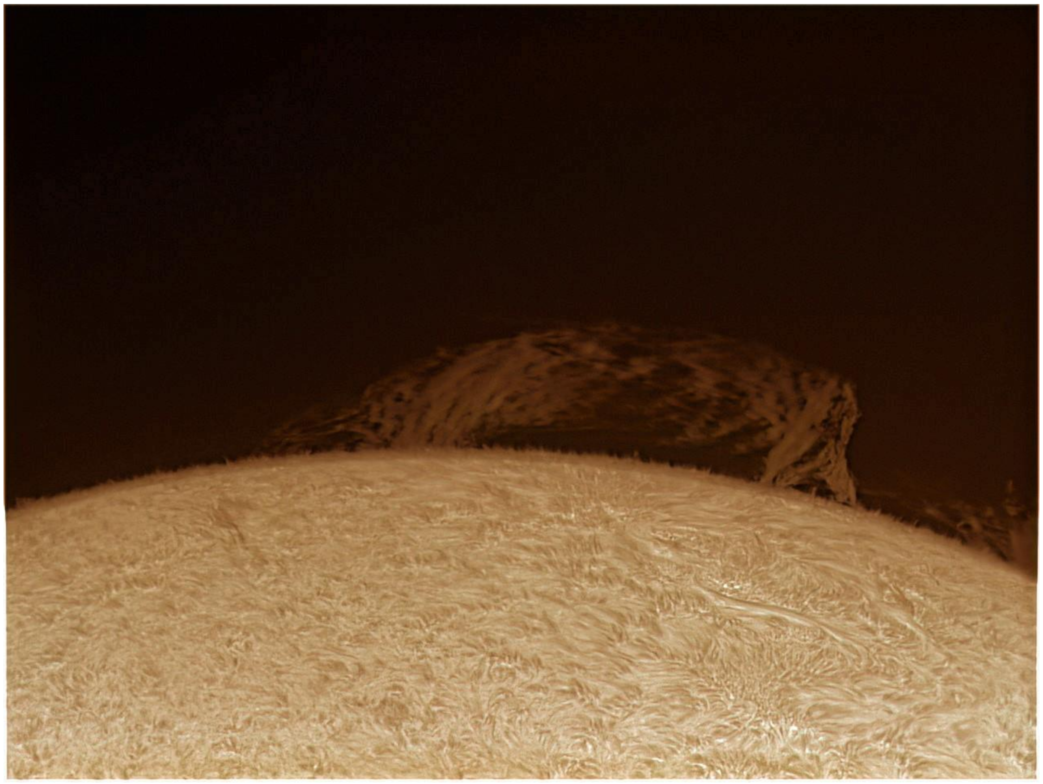
Composite H-alpha solar disc by Larry Faltz



The increasingly active Sun has been putting on a great show for owners of hydrogen-alpha telescopes. This is a merger of two images, one exposed for the Sun's face and one for the prominences. The free image-manipulation program Gimp was used to make the background of the surface image transparent. Then the image was layered on top of the prominence image. Lunt 60-mm single-stack telescope (bandpass 0.7 Å at 656.28 nm) on Sky-Watcher AZ-GTI mount, ASI 290MM monochrome camera, 0.5x focal reducer. Autostakkaert!3 and Registax 6.0 processing. June 19, 2022, approximately 10:15 a.m. It's a good idea, if you can, to image the Sun in the morning, before the ground has a chance to re-radiate the day's solar heat, which will increase thermals in the atmosphere, especially just above the observer. Solar radiation is 1,361 watts per square meter on the Earth's surface.

Close-up of Prominences in Hydrogen-Alpha by John Paladini

John made these hydrogen alpha images with a DayStar Quark on a vintage Edmund Scientific four-inch f/15 refractor. August 2, 2022, Mahopac, NY. He used a monochrome camera and colored the images to mimic the red H-alpha appearance.

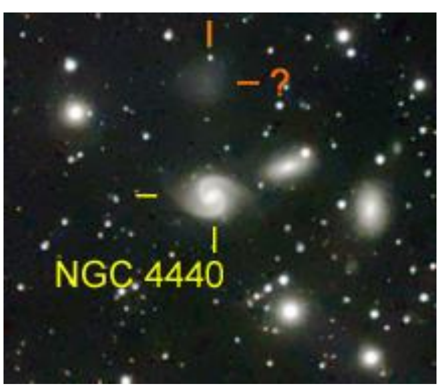


Galaxies Galore: The Virgo Cluster by Robin Stuart

This 2° wide image shows the heart of the Virgo cluster of galaxies. The cluster is centered some 54 million light years from Earth. The three largest galaxies are, from right to left, M84, M86 and M87. Comparing them to the spiral galaxies in the cluster it is clear that their status as *giant ellipticals* is well-deserved. M84 and M86 lie in *Markarian's Chain*, the structure that curves up to the top left of the frame and whose members share a common motion. The pair of interacting galaxies at the center, NGC 4438 (lower) and NGC 4435 (upper) are known as Markarian's Eyes. NGC 4438 exhibits a highly distorted disk and is known to trail filaments of ionized gas that extend to M86. The gas is suggestive of a past interaction between the two. At the bottom center of the frame note the elegant barred spiral galaxy, NGC 4440.

The image is a stack of 18 10-minute subframes taken through a Televue NP127 using a ZWO2600MC cooled CMOS camera, on the night of May 1st from a dark sky site at Eustis, Maine. Processing was done with PixInsight.

Robin Stuart



Editor's Note:

When Robin submitted this image, he wrote, "I wonder about the faint smudge just above the barred spiral NGC4440 at the bottom center. It's real, as it can be made out in some images by others." In this enlargement of the region around NGC 4440, the mysterious smudge is indicated with an orange question mark.

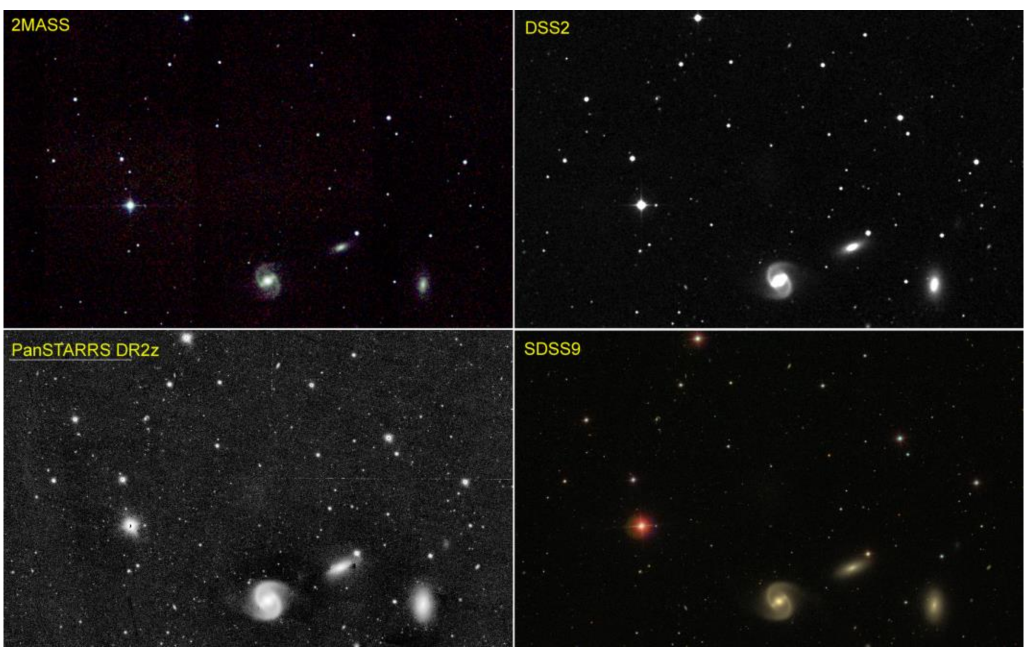
Intrigued, I investigated. I logged on to the *Centre de Données Astronomiques de Strasbourg* (Strasbourg astronomical Data Center, CDS) at https://cds.u-strasbg.fr/ and entered "NGC 4440" into the CDS Portal search box. This brought up an image of the field around NGC 4440. Images are available from 18 different instruments, ranging from the Fermi gamma ray telescope to the AllWISE infrared space telescope. The size of the field can be enlarged or reduced.

It was simply a matter of cycling through the different instruments' images for any evidence of a distinct object in the right place. Only the PanSTARRS DR2z image showed anything. I repositioned the image so that the "smudge" was close to the center and hit the "Update" button. Scrolling down the page to the "Tabular Data" section, the object LEDA 40932 was the closest object in the list, so I entered that into the search box. Now the smudge was *exactly* centered and CDS confirmed the object's identity. Simbad, the actual astronomical database within CDS, identified it as a "Galaxy towards a Cluster of Galaxies," an appellation I had never heard before, nor could I find it in the CDS glossary. I suspect they meant "Galaxy *near* a Cluster of Galaxies," translating inexpertly from French.

The NASA/IPAC Extragalactic Database (NED), to which you can link directly from the CDS page, catalogues this object as VCC 1052. VCC is the Virgo Cluster Catalog, published in 1985 in the *Astrophysical Journal*. Binggeli, Sandage and Tammann made photographic plates using the du Pont 2.5-meter telescope at Las Campanas Observatory in Chile. They identified 2096 galaxies, of which 1277 were Virgo cluster members, 574 were possible members, and 245 were background galaxies. They categorized VCC 1052 as a "dwarf elliptical." Whiting, *et. al.*[1] call it a "spherical galaxy." It is extremely faint, with magnitudes in the various visual bands around 19.0. It has a very low surface brightness.

VCC 1052 is an example of a "harassed galaxy." These are galaxies that have had "multiple high-speed encounters with other galaxies in the cluster environment, combined with tidal heating resulting from the interactions with the cluster's potential well [which] can remove stellar mass and significantly change the morphology, the strength of the effect likely being tied to the local environment density. In this case, a galaxy is expected to lose some (but not all) of its intrinsic angular momentum.... Indications for harassment are found in the existence of very low surface brightness dwarfs, *e.g.,* VCC 1052." [2]

Robin's capture of this faint, exotic object is a terrific feat of astrophotography. LF



The exact same field from 4 different instruments as shown in CDS. Only the PanSTARRS image on the lower left shows a barely perceptible fuzzy blob in the center that is the galaxy catalogued as LEDA 40932 and VCC 1052.

[1] An Observational Limit on the Dwarf Galaxy Population of the Local Group, *Astrophysical Journal*, 2007; 133: 715-733.
[2] Rys, A, Falcon-Barosso, J, Van der Ven, G, Virgo cluster and field dwarf ellipticals in 3D – I. On the variety of stellar kinematic and line-strength properties, *MNRAS* 2013; 428, 2980–2994.

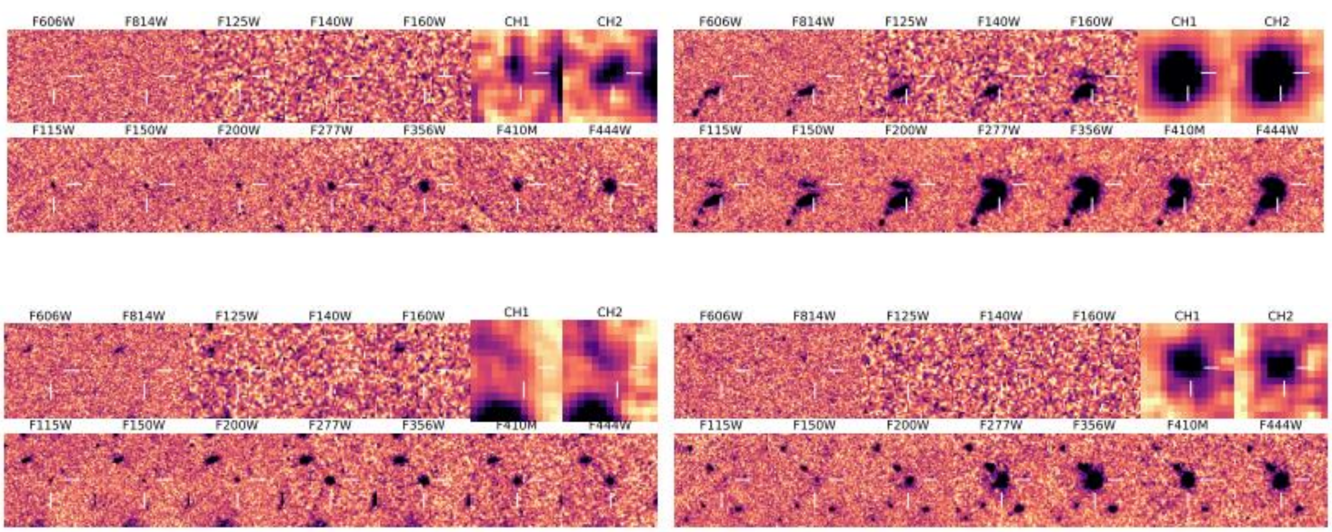
Research Highlight of the Month

Barrufet, L, Oesch, PA, Weibel, A. et. al., Unveiling the Nature of Infrared Bright, Optically Dark Galaxies with Early JWST Data, https://arxiv.org/pdf/2207.14733.pdf (submitted to MNRAS).

Although the first James Webb Space Telescope images were only released on July 12, the science program has been in operation a bit longer, and results are pouring into the literature seemingly faster than light is pouring into the telescope. Already a number of remarkable observations have been made, including the possible identification of a galaxy at a red shift of 16.6, beating Hubble's long-distance champion GN-z11 whose red shift was "only" 11.09.

These distant galaxies in the early universe are barely resolved. The large mirror, sensitive cameras and infrared spectral capabilities of the JWST, combined with what is already known about distant objects from other instruments and models that relate mass to spectral distribution, allow astronomers to extract a lot more detail about these structures than could be done before.

Over the last few years, both ALMA and Spitzer/IRAC observations have revealed a population of likely massive galaxies at $z > 3$ that was too faint to be detected in the Hubble Space Telescope. However, due to the very limited photometry for individual galaxies, the true nature of these "HST-dark galaxies" has remained elusive. This paper presents the first sample of such galaxies observed with very deep, high-resolution NIRCam imaging from JWST's Early Release Science Program (CEERS). Thirty-three HST-dark sources were selected based on their images in the 1.6 µm to 4.4 µm (IR) bands. Physical properties were derived from 12-band multi-wavelength photometry. The galaxies are at red shifts $z \sim 2-8$. They appear to be generally heavily dust-obscured and massive ($\sim 10^{10}\ M_\odot$) and are actively forming stars. These findings suggests that an important fraction of massive galaxies may have been missing from our understanding of galaxy distribution at $z > 3$ all the way into the reionization epoch, which is much earlier and finding the onset of reionization is one of the JWST scientific goals. The HST-dark sources lie on the main-sequence of galaxies and add an obscured star formation rate density (SFRD) of 1.3 (+1.6, −1.0) × $10^{-3}\ M_\odot$/yr/Mpc^3 at $z \sim 6$, similar to previous estimates.



These are two panels of a figure in the paper showing four different galaxies as imaged by Hubble (top row of each panel, frames labeled F606W through F160W) and Spitzer (CH1 and CH2) and through seven filters on JWST's NIRCam (bottom row). The increased sensitivity and resolution are evident. The Spitzer detections show the much lower resolution of its camera. The authors point out that "most of these sources would not have been easily selected in previous data and they would have potentially been missing from our cosmic census."

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
Meade 90-mm refractor	Meade 90-mm f/1000 DS series refractor. Computer controlled. Diagonal, tripod, manuals and batteries included, no eyepieces. Fits perfectly in included Orion case. Great condition. Picture at https://is.gd/Meade90.	$99	Marc Favreau mfavreau@optonline.net
Meade 8" SCT LX-80	Go-to mount, tripod. Tube wrapped in Reflectix for faster cooling. See https://is.gd/16F0Tv.	$600	Greg Borrelly gregborrelly@gmail.com
Celestron SE mount	No optical tube. Go-to alt-az mount and tripod. Can carry 12 lb payload or tube up to 17". Upgradeable hand control.	$300	Greg Borrelly gregborrelly@gmail.com
Celestron Binoviewer	Use both eyes with your telescope. Original case, with two 18-mm eye pieces.	$180	Greg Borrelly gregborrelly@gmail.com
Celestron Cometron telescope	Small, lightweight 114 mm f/4 reflector. Red dot finder, 25 mm eyepiece. Dovetail mount. A starter scope for a smart child. No tripod (use a camera tripod). Excellent condition.	$50	WAA ads@westchesterastronomers.org
Want to list something for sale in the next issue of the WAA newsletter? Send the description and asking price to ads@westchesterastronomers.org. Member submissions only. Please offer only serious and useful astronomy equipment. WAA reserves the right not to list items we think are not of value to members.			
Buying or selling items is at your own risk. WAA is not responsible for the satisfaction of the buyer or seller. Commercial listings are not accepted. Items must be the property of the member or WAA. WAA takes no responsibility for the condition or value of the item, or for the accuracy of any description. We expect but cannot guarantee that descriptions are accurate. Items subject to prior sale. WAA is not a party to any sale unless the equipment belongs to WAA (and will be so identified). Sales of WAA equipment are final. *Caveat emptor!*			

The Astronomer at the Museum

The Metropolitan Museum of Art has this 18-inch-high barrel made of tin-glazed earthenware. It was made in Mexico in the first half of the 18th century. It has four whimsical figures, one of which appears to be a mariner or explorer holding a telescope and a compass. The figures are Asian and in Asian dress, suggesting that the piece was intended either for export to China or as a faux piece of Chinese pottery.