SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

August 2023

The Holmdel Horn Antenna by Larry Faltz

This antenna was used in 1964 by Penzias and Wilson to discover the Cosmic Microwave Background radiation, evidence of the Big Bang. A National Historic Landmark, the horn is on Crawford Hill in Holmdel, NJ on property originally owned by Bell Laboratories. The site was purchased by a developer who proposed building townhomes. Local citizens wanted to zone the site for public use and to protect the antenna. On June 13, 2023, the Holmdel Township Committee unanimously approved resolutions to begin the process of acquiring two of the three parcels that make up the property for preservation. The Township committee is leaving the third parcel to be studied as part of the redevelopment plan. It's not a done deal yet, but its closer! Read the September 2013 SkyWAAtch, p. 5 for information about our earlier visit. This photo was taken in November 2022.

Our club meetings are held at the David Pecker Conference Room, Willcox Hall, Pace University, Pleasantville, NY, or on-line via Zoom (the link is on our web site, www.westchesterastronomers.org).

☞ There is no meeting in August ☜

WAA September Meeting

Friday, September 8, 2023 at 7:30 pm

Members' Night

WAA Members

Member's Night is a WAA tradition and one of our most popular events. WAA members make short presentations on a variety of topics of interest to colleagues. Any topic relating to astronomy is welcome. if you'd like to be included on the program, contact Pat Mahon, WAA VP for Programs, at waa-programs@westchesterastronomers.org

There are no meeting August, but star parties are scheduled.

WAA October Meeting

Friday, October 13, 2023 at 7:30 pm

Space Volcanoes

Caitlin Ahrens, PhD
NASA/Goddard Space Flight Center

August Starway to Heaven

Ward Pound Ridge Reservation, Cross River, NY

August 12 (Sunset 8:00 p.m.)
Rain/cloud date August 19 (Sunset 7:50 p.m.)

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

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

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New Members

Octavia Liku	New Rochelle
Tara O'Brien	West Harrison

Renewing Members

Erik & Eva Andersen	Croton-on-Hudson
Liv Andersen	Westport, CT
Ramon Blandino	Yorktown Heights
Anthony Bonaviso	New Rochelle
Michael DiLorenzo	Yonkers
Federico Duay	Briarcliff Manor
Matthew Dugan	White Plains
Charlie Gibson	Scarsdale
Joan Indusi	Ossining
Glen & Patricia Lalli	White Plains
Gene Lewis	Katonah
Anthony Monaco	Bronx
Alfred J. Padilla	Armonk
Lydia Maria Petrosino	Bronxville
Steven Reed	New York
Peter Rothstein	Hastings on Hudson
Ihor Szkolar	White Plains

SkyWAAtch is written entirely by human beings.

ALMANAC For August 2023

Bob Kelly, WAA VP Field Events


Bob Kelly


Full Aug 1

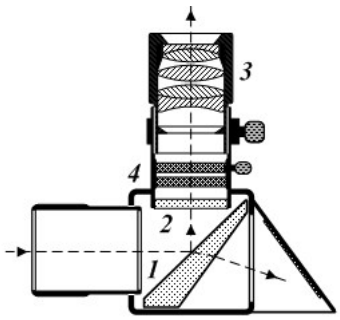

3Q Aug 8


New Aug 16


1Q Aug 24


Full Aug 30

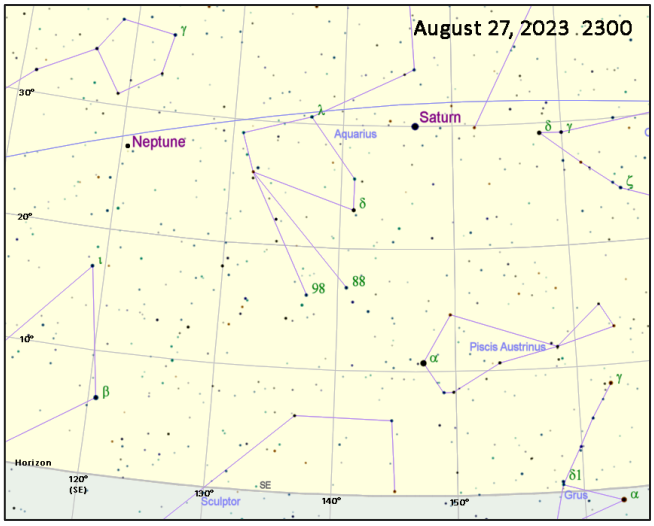
Our morning **Sun** is rising later and a bit to the right (south) of last month's Sun. It's also often red or orange, even without clouds or fog, due to the smoke from Canadian wildfires. Avoid the temptation to stare at the dimmed Sun, as the damaging rays get though smoke or haze enough to damage our eyes. Large sunspot groups are showing up, visible without magnification. This is a good time to get certified-safe solar shades ahead of the solar eclipses of October 2023 (annular) and April 2024 (total), both partial in our area) and practice by looking for large sunspot groups. Never use those solar glasses with binoculars, a camera or a telescope. Use a properly fitted solar shield on the end where the sunlight comes into the scope. Several companies are selling small binoculars with built-in proper solar filters. Never use one of those eyepiece "sun filters" that used to be sold with cheap telescopes. The only eyepiece-end device that can be used safely is a "Herschel Wedge." Given the experience of 2017, if you want a solar filter for the 2024 eclipse, get one now, since in the run-up to the event there will be enormous demand for every type of filter.



Herschel Wedge. The trapezoidal prism reflects about 4.6% of the light to the eyepiece (through a neutral density filter), while the remainder passes harmlessly out the back of the device. The solar spectrum is preserved better than a front-end filter and there is more detail on the solar disk as well. Lunt's wedges cost $290 for a 1.25" and $390 for a 2", more expensive than front end filters of mylar or aluminized glass. The wedge can only be used with a refractor. If you try it on a reflector or SCT, the secondary mirror will be damaged by the heat.

Saturn is closest to the Earth on the 27th. Saturn's two brightest moons, **Titan** and **Iapetus**, stand out together to the northwest of the planet's disk on the 22nd. You'll need a three-inch or larger telescope to see them. As Earth gets closer to Saturn, a larger telescope can show as many as six moons. Saturn's rings are tilted open 9 degrees toward us, a wonderful view. The angle will decrease until we see Saturn's rings edge-on in March 2025.

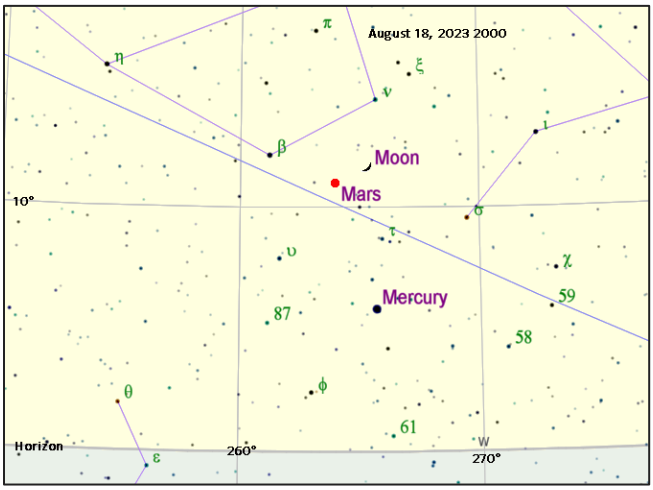
Evening twilight ends about 9:30 p.m. mid-month, followed by Jupiter-rise near 11 p.m. The Royal Astronomical Society of Canada recommends using the last quarter Moon to find Jupiter in the daytime, after sunrise on the 8th.



Venus slides into the Sun's glare, with inferior conjunction on the 13th. Venus makes a wide pass 7.7 degrees 'below' the Sun, from Earth's point of view. The Sun will be above Venus in the sky. Since this is an inferior conjunction, Venus will be closer to Earth and larger than usual: a thin crescent the apparent size of the lunar crater Copernicus. It will be extremely difficult to safely view Venus by blocking the Sun when the two bodies are so close, and we suggest you not try. By the end of the month, Venus will be out and about low in the eastern dawn sky. It'll be still very bright at magnitude -4.2, but only ten degrees above the horizon by the 6:10 a.m. sunrise.

Mars and **Mercury** are a challenge to find in the western evening sky at magnitude +1.8 and +0.3, respectively, setting well before the end of evening twilight. Try to catch them with binoculars near the 6%

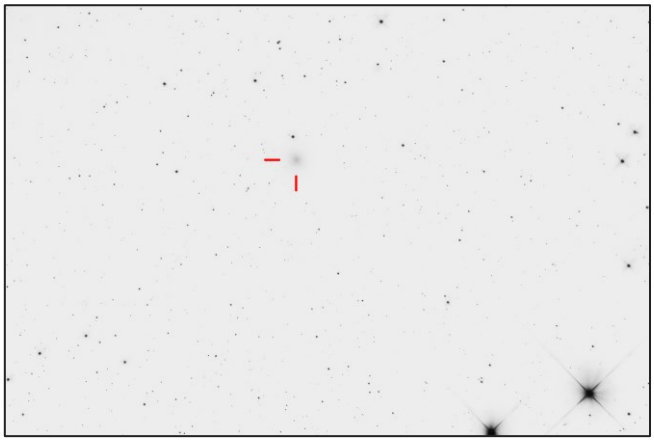
illuminated 2½-day old Moon on the 18th. Mercury then rapidly leaves the evening sky for solar conjunction, which occurs early next month. Mars is left behind as it continues its slow descent into the solar glare, scheduled for conjunction on November 18th. During the time Mars is within 2 degrees of the Sun, this year November 11 to 25, NASA takes a "solar conjunction moratorium," No attempts are made to send commands to Mars spacecraft or landers, and many instruments are shut down.



First-magnitude **Antares** disappears behind the 57 percent-lit **Moon** around 10:54 p.m. on the 24th. Get outside in advance of the disappearance and make sure everyone has their own binoculars or telescope to see the fantastic, almost instantaneous winking out of Antares behind the dark limb of the Moon. If you are out without optical aid, Antares is bright enough that you are still likely to see this event. The action will happen low in the southwestern sky, so the Moon will have set before Antares peeks out the other side. The reemergence will be visible for the middle of the country.

The **Milky Way** arches across the eastern sky, getting higher in a dark sky sooner as the Sun sets earlier and the Milky Way gets higher in the sky each week. Get to a dark site with an unobstructed southern horizon to see the wonders in Scorpius and Sagittarius after the end of twilight.

No **comets** visible in our area are brighter than magnitude +9 this month. The brightest, Comet C/2021 T4 (Lemmon), just passed through perihelion. C/2021 T4 starts August just below Scorpius, moving into Libra later in the month, dimming through magnitude +9. There may be some fainter comets visible with astronomy cameras as faint tail-less blobs. Check aerith.net for more information, light curves and finder charts.



Steve Bellavia's image of Comet C/2023 E1 (ATLAS) on June 4, 2023, shown as a negative image (red markers). The comet was about magnitude 11.

The **Perseid meteor shower** peaks from the 12th through the 14th this year, with the Moon not interfering. These crumbs from Comet 109P/Swift-Tuttle are numerous enough to show up in reasonable numbers in the evening sky. The frequency of these meteors increase later at night into the pre-dawn. This year the Earth encounters the peak around 4 a.m. on the 13th. Typically, Perseids are fast and bright.

We don't have visible overflights of the **International Space Station** until the 20th; those passes are in the morning sky. China's Tiangong space station is visible in the mornings until it shows up in the evenings from the 5th through the 20th.

Beware of larger-than-normal swings in tides near and following the full Moons near lunar perigee on the 2nd and the 30th. It'll be tough for any place affected by a tropical storm at those times due to the higher tides and rising sea levels. The second full Moon of the month (the "Blue Moon") will have the largest diameter of any full Moon in 2023. Saturn will photobomb the perigean Moon on the evening of the 30th. For the history of the term "Blue Moon," see the September 2015 SkyWAAtch, page 10. ■

Westchester Amateur Astronomers

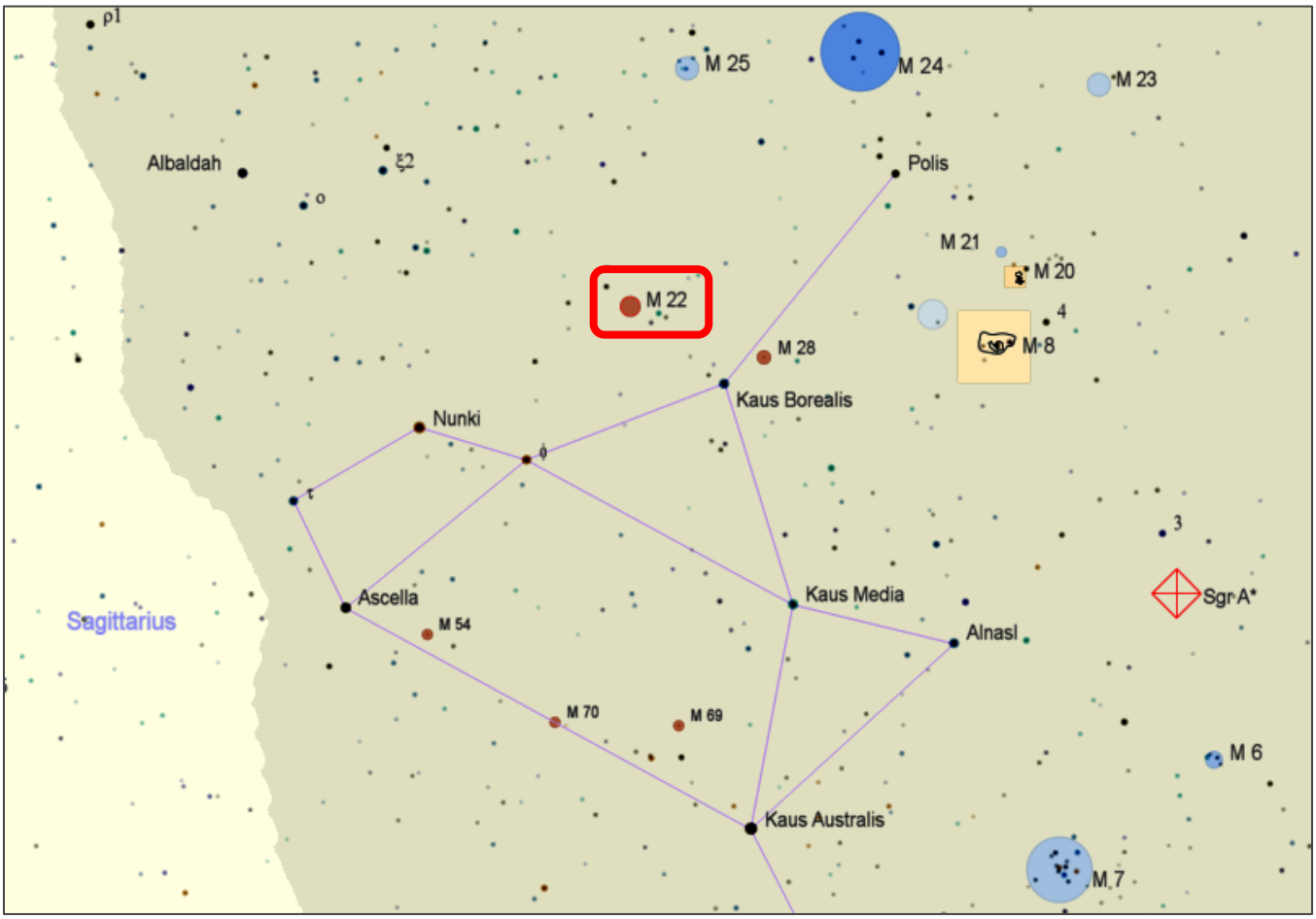
Deep Sky Object of the Month: Messier 22

Messier 22	
Constellation	Sagittarius
Object type	Globular cluster
Right Ascension J2000	18h 35m 24.0s
Declination J2000	-23° 54’ 00”
Magnitude	5.1
Size	24 x 24 arcminutes
Distance	10,600 LY
NGC designation	NGC 6656
Discovery	Abraham Ihle, 1665

M22 is located just 12½ degrees from Sagittarius A*. It’s the brightest of a clutch of globulars within 30°of the center of our galaxy. It’s well below the celestial equator, so from Westchester viewing it will be challenged by skyglow from the New York metropolitan area. But it’s bright and large enough to be easily found near the teapot of Sagittarius. M22 is one of four globulars to contain a planetary nebula, and several black holes have been detected within it.

Visibility for Messier 22			
22:00 EST	8/1	8/15	8/31
Altitude	25° 09’	24° 12’	22° 26’
Azimuth	167° 07’	180° 50’	196° 25’

For more on globular clusters, see the February 2023 SkyWAAtch, p. 9.



Cherry Springs Star Party, June 2023 David Parmet

In June I joined a few hundred of my fellow amateur astronomers at the annual Cherry Springs Star Party at Cherry Springs State Park, deep in the Allegheny Mountains of Northwestern Pennsylvania. At 2,400 feet above sea level, and with nothing of any significance throwing up light for at least 20 miles in every direction, the skies at Cherry Springs are legendary. On a clear, moonless night, you can almost read by the light of the Milky Way.

Of course, Murphy's Law being what it is, the first two nights of the event were clouded out, with the added insult of a rainstorm on the first night. But on Saturday, the clouds parted and smoke from the Canadian wildfires was at a minimum. So by 11 p.m., the whirring of gear boxes was heard throughout the park.

With the event so close to the summer solstice, there was only about 4 hours of real darkness to work with. It's easy to get overwhelmed at Cherry Springs and try to capture everything you can in the limited span of summer darkness. The sky there is pretty much what people mean when they say "big sky" *i.e.*, wide open from horizon to horizon with very little blocked by trees.

Despite some initial issues with my new setup (see below), I managed a half hour on M51 and more than an hour on the North American Nebula (see the image in the July 2023 SkyWAAtch, page 19). I had originally planned to photograph the Lagoon and Trifid nebulas but there was a large camper van parked just south of my campsite blocking that view. At popular star parties, you have to make compromises.

My basic equipment was a William Optics RedCat 51 and a ZWO ASI533MC Pro camera set on a Star Adventure GTi star tracker mount controlled with a ZWO ASIAIR Plus. The setup was pretty new for me - I purchased most of the equipment late in the winter/early spring, so feel free to blame me for the cloudy weather we've been having.

There was only a minimal amount of smoke so the Milky Way was still blazing.

A few observations:

We all already knew this, but astronomy people are the nicest, most helpful people in any hobby. As the Sun was setting, someone nearby realized he forgot an essential power plug. Within a few minutes, half a dozen people were digging through their cars to see if they had anything he could use. A solution was quickly MacGyvered and he was good to go. Later, I was having difficulty focusing both my main and guiding scopes. The guy set up next to me was more than happy to help and we quickly figured out that I had

the wrong backspacing. Within a few minutes I was up and running.

Astrophotography is taking over the hobby. Ten years ago at Cherry Springs I saw maybe a handful of serious astrophotographers. This year it seemed every third telescope had a dedicated astronomy camera or DSLR attached to the business end. I was talking with one of the vendors about this and he said with the onset of cheaper and easier to use tools, it's bringing in new and younger people and revitalizing the hobby.

Full frame image of M51. The field is 2.6 degrees square, image scale 3.12 arcseconds/pixel. The ASI533 has 9 megapixels (3008x3008).

The hobby is noticeably younger and more diverse. Along with the usual retired Baby Boomers and rapidly aging Gen Xers, I noticed a lot of male and female millennials and Gen Zers. Also, there were plenty of young families. I'm very optimistic about the future of amateur astronomy.

Probably due to the astrophotography boom, aperture fever seems to be abating. Of course there were the usual dobzillas, and giant SCTs and RASAs. But there were plenty of RedCats and similarly sized refractors in use.

Hopefully the rest of this summer won't be smoked out completely. I have plans to return in July and August and for the Black Forest Star Party in September. If you haven't made the trip already, you really should head up there the next clear and moonless night. It's definitely worth it, mainly for the clear view of the Milky Way but also for the opportunities for observing and photographing in Cherry Springs' Bortle 2 skies.

The cropped image retains an impressive amount of detail.

It's also worth it for the camaraderie of fellow amateur astronomers. I've made some good friends I keep in touch with through sharing our photos on Instagram and I've met people at Cherry Springs I've only previously known through the Internet. It's a special place, one of the few remaining dark sky locations we have left in the Northeast, outside of the wilds of Maine and the Adirondacks, and we owe it to future generations of amateur astronomers to use it so it's preserved for them. ■

David Parmet is the WAA webmaster.

Read more about Cherry Springs in Steve Bellavia's travelogue in the August 2022 SkyWAAtch.

Another Movie Telescope

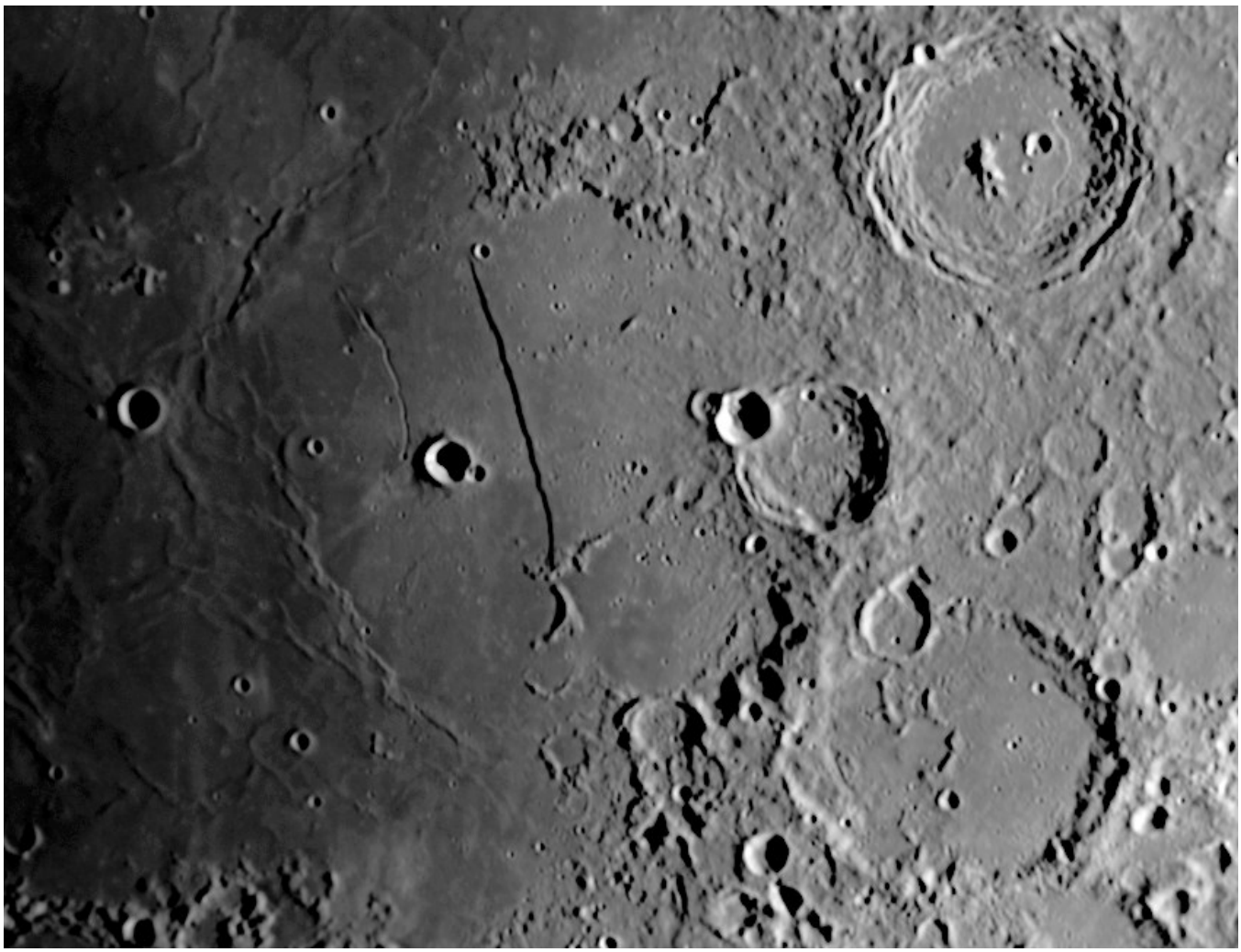
Who better to use a Celestron SCT than James Bond, 007? From a villa above Monaco, Sean Connery, returning as the British super-agent in the 1983 *Never Say Never Again*, is spying on the evil Mr. Largo's yacht, pleased to get a look at Kim Basinger prancing around on the deck in a leotard.

We're not sure what the strange device across the front of the scope is supposed to be. Connery twists the end and it makes clicking noises, so perhaps we're supposed to believe it's some kind of camera, but it's not an accessory we've ever seen on a telescope. It's not a focuser, because he tweaks the actual focuser during the scene, and anyway you focus an SCT by moving the main mirror. Meade made one that moved the corrector plate/secondary assembly to focus, but apparently it didn't work very well.

Never Say Never Again is a remake of the 1965 movie *Thunderball*. Bad guy Adolfo Celi's yacht *Disco Volante* becomes bad guy Klaus Maria Brandauer's *Flying Saucer.* As usual, 007 kills a bunch of people, including the bad guy, and gets the girl. The film gets its name from a comment Connery made in 1971, saying he would "never again" play 007 after having made six Bond films in nine years. Can you name them? In order?

The Rupes Recta

Larry Faltz



May 28, 2023 at 2147, CPC800, ASI290MM. Moon age 9d 9h. (LF)

Among the Moon's many dramatic features, one that I always look for is the Rupes Recta, in English the "Straight Wall." It isn't exactly straight, and it may not quite be a wall. It can be seen as a dark streak in the eastern Mare Nubium just after first quarter and as a light streak around third quarter, although most people don't get to view the third quarter Moon since that means getting out of bed in the wee hours to observe.

Even the smallest modern telescope can show the Rupes Recta. (We'll call it variously Rupes Recta, Straight Wall or just Wall in this article.) It casts a sharp shadow just after the Sun rises in the area, which occurs around lunar day 8.5. By day 11 or so, the Sun's angle is high enough that there's no longer a shadow, and it won't be until around day 21 that the Sun's angle over the waning Moon brightens the wall's face enough to again distinguish it from the surrounding plains. The Sun sets on it on day 23.

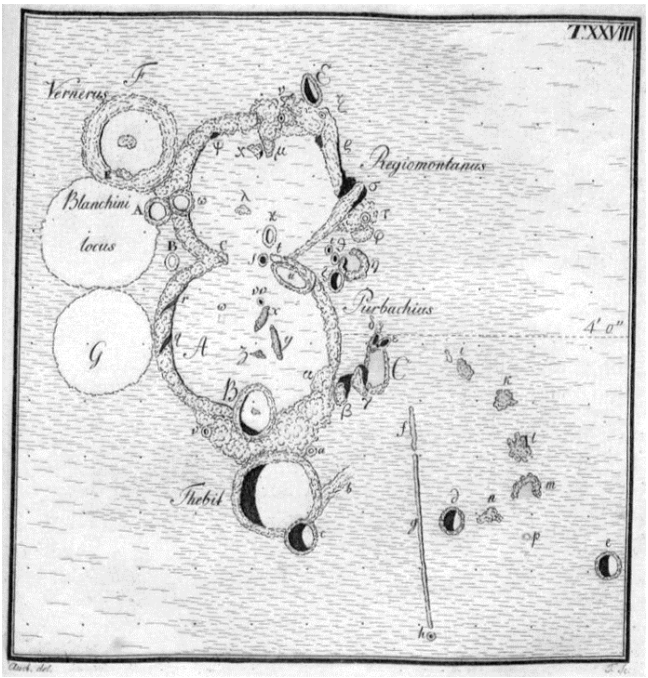
The Rupes Recta does not appear on any lunar maps before the end of the 18th century (see the four earliest Moon maps on page 15). It was missed by Robert Hooke, who devoted a chapter of his groundbreaking microscope book *Micrographia* of 1665 (famed for its engraving of a gigantic flea) to telescopic observations. Traditionally, Johann Hieronymus Schröter (1745–1816) is credited with its discovery.

Schröter went to the University of Gottingen where he got a law degree but was introduced to astronomy by mathematics professor and poet Abraham Gotthelf Kästner. Taking a position in the bureaucracy of Hanover, Schröter, through an interest in music,

met Isaak Herschel, an oboist and father of William Herschel, the great musician-astronomer who by that time was living in Bath, England and beginning his full commitment to astronomical pursuits. Schröter became friendly with the entire Herschel family. William Herschel's brother Dietrich helped Schröter purchase a Dollond refractor in 1779, a 2.5-inch diameter, 3-foot focal length achromat (probably much like the one on page 17 of this issue). Telescopes were usually referred to by their focal lengths in the 18th century. When Herschel discovered Uranus in 1781, the observing bug hit Schröter big time. Like William he dedicated more and more of his time to observing. To be able to do this, he moved from busy Hanover to sleepy rural Lilienthal in 1782 as the town's magistrate. He purchased 4.75- and 6.5-inch diameter reflectors (4-foot and 7-foot focal lengths) from William Herschel.

August 18, 2014, 0400. Moon age 22d 9h. From a full-disk image. Stellarvue SVR105, Canon T3i. (LF)

In 1787, Herschel announced the discovery of volcanic activity on the Moon. This erroneous observation, probably the misinterpretation of earthshine illuminating the rays of craters Aristarchus, Copernicus and Kepler, nevertheless convinced Schröter to embark on a systematic study of the Moon's surface, which had not been mapped with what could then be called "modern" instruments (reflectors and Gregorians with well-made speculum-metal mirrors and two-element achromatic refractors). His *Selenotopographische Fragmente zur genauern Kenntniss der Mondfläche* (Selenotopographic fragments for more detailed knowledge of the lunar surface) was published in 1791. This work collected many descriptions and drawings of lunar formations. Using a micrometer, he measured the heights of several lunar mountains. He identified, for the first time in print, the Rupes Recta and the rille north of Aristarchus that is known today as Schröter's Valley.

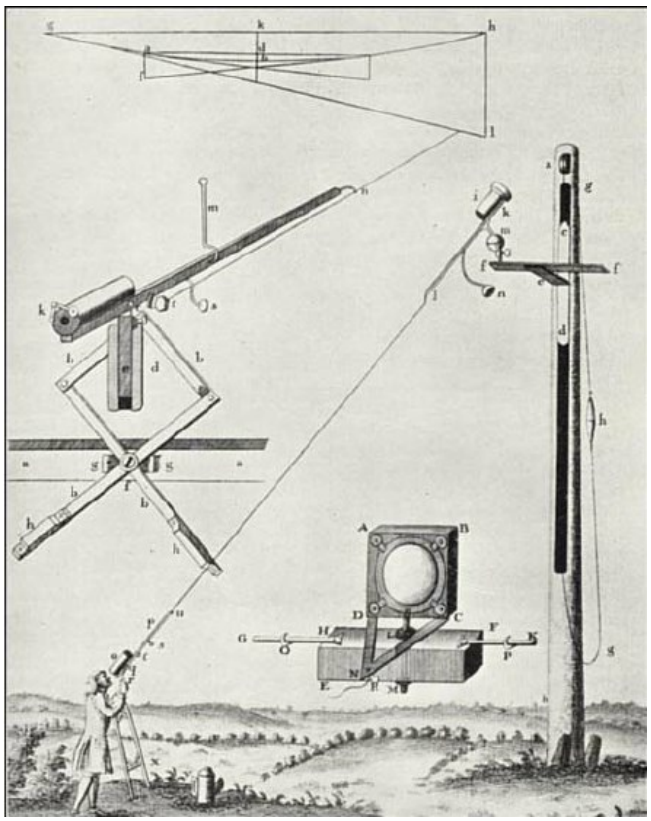


Schröter's drawing of the Rupes Recta (south is up) (ETH Zurich)

After publication of the lunar atlas, Schröter obtained even larger telescopes, including a 9.5-inch diameter (13-foot) reflector and a 20-inch diameter (27-foot) behemoth that was the largest instrument in Europe at the time. These instruments were made by Johann Gottlieb Schrader, who had discovered that easily tarnished speculum metal, an alloy of copper and tin, could be made more reflective by coating with arsenic vapor (don't try this at home!). He later bought two refractors made by Joseph von Frauenhofer, with the financial support of English King George III, who was also William Herschel's patron and a cousin of the Hanoverian nobility. Sadly, Schröter's observatory was destroyed and all his instruments lost in 1813 when Napoleon's retreating army torched the village of Lilienthal. (More stories on the fate of telescopes, including Herschel's, in the January 2021 SkyWAAtch, p. 13.)

Schröter was not, however, the first person to see the Rupes Recta. Priority belongs to Christiaan Huygens,

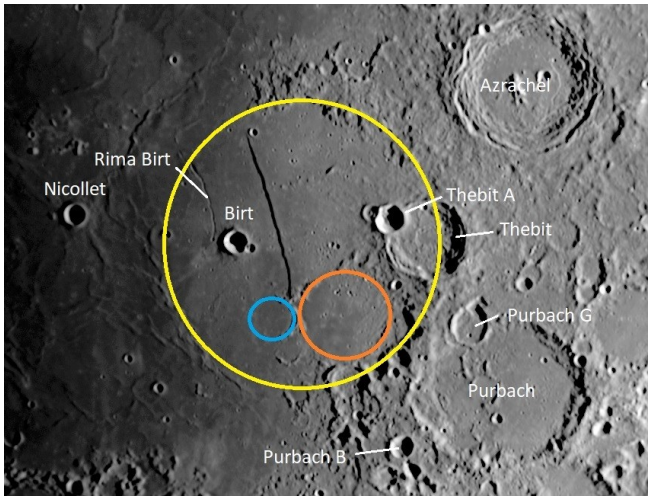
the Dutch astronomer, lens maker, scholar and diplomat, who observed the feature on the night of May 30-31, 1686, using an “aerial telescope” with a 123-foot focal length. Because singlet lenses used in the first century of telescopic astronomy had substantial chromatic aberration (not to mention aberrations due to difficulty grinding and polishing an accurate figure), the focal lengths had to be very long. The fields of view were narrow, but that wasn’t the only problem. How do you aim and stabilize a tube 123 feet long, more than one-third the length of a football field? The answer was the “aerial telescope”, a tubeless refractor with the objective and eyepiece aligned and stabilized by a taut wire. The views through this instrument were undoubtedly fleeting, demanding patience on the part of the observer. Huygens’ observations of the Moon were unknown until his notebooks were published in 1925.



Huygens’ Aerial Telescope

Just how high and how steep is this crack in the Moon’s surface, and how did it get there?

The Mare Nubium is of pre-Nectarian origin; that is, it is a feature from the Moon’s earliest epoch, when the Moon’s crust formed by mineral crystallization of a global magma ocean. Along its eastern edge, a period of geologic activity and meteorite bombardment raised highlands. The Rupes Recta sits close to the crater Thebit, which comes from the Imbrian period about a billion years after the Moon formed. Close inspection of the area shows a circular formation about 135 km in diameter that has the appearance of an ancient impact crater that has mostly been filled in with lava. This feature was called “Ancient Thebit” by Charles A. Wood in an article in *Sky & Telescope* in 2008, but that name does not appear on lunar maps. Below, I annotated a copy of my image to show this feature, demarcated in yellow. A second remnant, probably another lava-filled crater, is outlined in red. Finally, there is an arc-shaped feature, likened by Huygens to a sword-handle (with the Rupes Recta being the sword’s blade), at the southern end of the Wall, possibly the eastern edge of a crater whose western wall was somehow subsumed. This feature is demarcated in blue.



Once things settled, the floor of Ancient Thebit was stressed and either the western half settled or the eastern half rose, creating the rift that we now recognize as the Rupes Recta.

Because the Straight Wall is so straight (duh!), British astronomers in the 19th century referred to it as “The Railway.” It is 110 km long. Because of its sharp appearance visually and in images, it was presumed to be a steep cliff, truly a wall.

In 1960, Joseph Ashbrook, then at the Harvard Observatory, determined the height of the Rupes Recta by making measurements of the width of its shadow on seven nights between 1957 and 1957, making a total of 98 observations with a 6-inch reflector (and prob-

ably a micrometer eyepiece, although this is not stated in his article).[1] He compared the shadow dimension with known widths of local craters Birt, Thebit and Birt A. He estimated the height to be between 220 and 370 meters and showed this plot (he included two 1878 measurements by J.F.J. Schmidt).

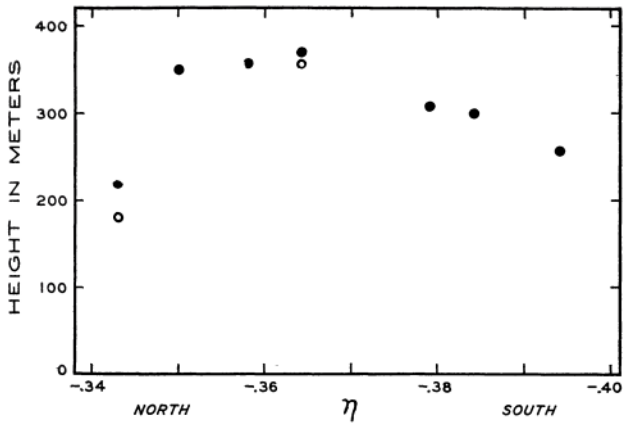


FIG. 1.—Heights of points on the lunar Straight Wall. Filled circles are from recent estimates of shadow length, open circles from micrometer measures by Schmidt.

Ashbrook noted that "Since all of the heights are relative to the foot of the wall, we cannot tell whether the crest is actually convex or whether the lower surface east of the fault is concave."

Ashbrook then determined the Sun's elevation, relative to the Wall, when "a line from Sun's center to a wall point lies in the plane of the face." He was able to make two determinations, obtaining slopes of 36.4° and 48.2°, taking the mean to be 42.3°. Ashbrook also reports that Patrick Moore made an observation with a 12.5" reflector at a point when the Sun's colongitude (height relative to a point on the lunar surface) was 52.2°. He could make out the Straight Wall as a "grey line, perfectly distinct" but Moore saw no shadow. This would give the slope as 41.0° by Ashbrook's calculation. His conclusion is that "The exposed face of the Straight Wall has an average inclination to the horizontal of 41°, with an uncertainty of perhaps ±3°. This is an exceptionally steep slope for any large-scale lunar feature.

Trying to reproduce Ashbrook's technique with a 10-inch Newtonian in 2003, Steve Boint got a slightly higher value for the height, in some areas along the fault of 600-630 meters. He did not try to calculate the slope.[2]

An image on-line, attributed to one Ron Miller (and with a link to the Life Magazine web site but not to a specific issue) shows it as an impenetrable, steep precipice that certainly looks like more than 41°.

Artistic rendering attributed to Ron Miller.

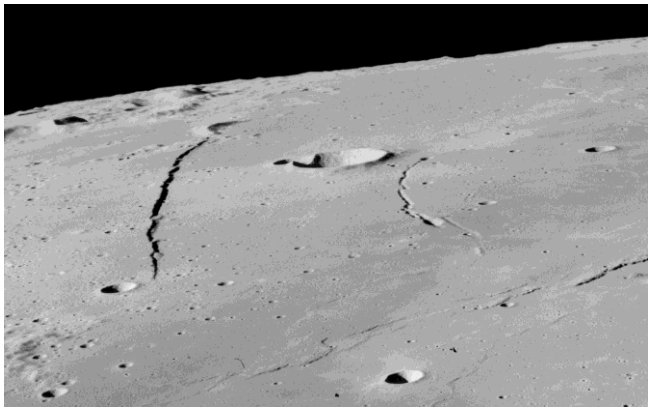


Image from Apollo 16 Command Module (NASA). Seen from the north.

Although the Apollo missions did not land anywhere near the Rupes Recta, it was photographed from the Apollo 16 Command Module by Thomas Mattingly. On day 6 of the mission, Mattingly reported,

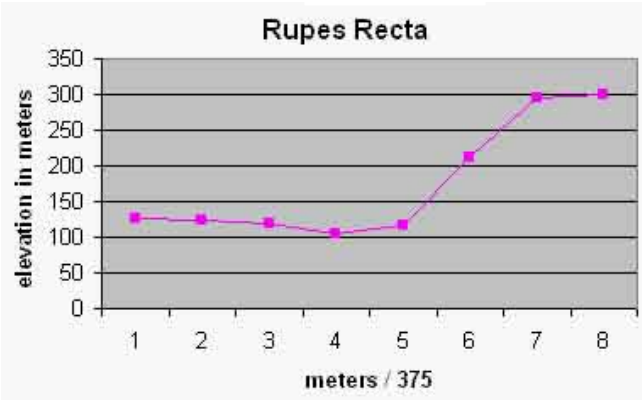
> Boy, that straight wall really shows up from here. Just so they know that's a pretty interesting thing. …I tell you, Stu (Roosa, flight controller), that Straight Wall really is a hummer out there.

A thread on CloudyNights from 2005 started by user "Aurora" documented his effort to calculate the slope

[1] Ashbrook, J, The Lunar Straight Wall, *Publications of the Astronomical Society of the Pacific*, 1960: 72, 55-58.

[2] Boint's paper was published in the Spring 2003 issue of *Selenology: Journal of the American Lunar Society* http://the-moon.us/wiki/Measuring_Rupes_Recta

from an image in the Lunar Consolidated Atlas,[3] converting it into a terrain map with special software and analyzing "control points" on the map. The result was a graph of elevation across the wall at one point. The incline was estimated to be just 7.53 degrees.



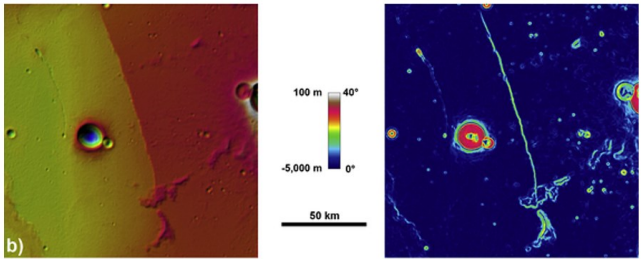
Commentary by other CloudyNights users suggested that there was observational evidence the slope varied along the length of the Wall. "Aurora" analyzed a second point on the Wall, finding a slope of 13.5 degrees, still much less than the earlier estimates.

In his 2006 article in S&T, Charles A. Wood remarks,

> Various authors report that the scarp is 250 to 300 meters high, but my measurements of its shadow length suggest that it may rise as much as 450 m above the basin's western floor. In spite of appearances, the Straight Wall is not a sheer cliff, though it is relatively steep — rising above the mare plain at an angle greater than 20°.

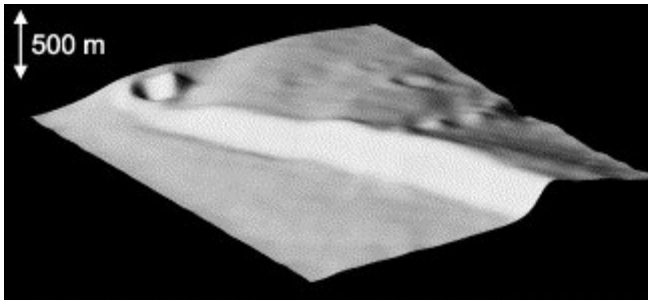
Images from the Lunar Reconnaissance Orbiter Camera (LROC) have also been used to determine the slope. A study published in 2012 used "stereo-photogrammetry" combined with laser ranging to make topographical measurements of lunar features.[4]

The Rupes Recta was among the areas highlighted in the paper. These images are taken from Figure 8.



The image on the left shows the elevations, while that on the right shows the slope. The plain to the west is clearly lower than on the eastern side. The slope of the Rupes Recta appears fairly consistent. If you blow up the image and closely examine the colors along the thin line of the face of the Rupes Recta, it appears that its slope ranges between 15 and 25 degrees (green and yellow). Admittedly, the width of the feature is quite small, and I see a few dots of red, so it's possible that details are not sufficiently resolved.

In 2012, an Argentinian blogger, Claudio Martinez, hosted an on-line discussion about lunar elevations, and included this figure of the north end of the Wall derived from shadow measurements. The exact source of the data isn't specified. It doesn't look quite right to me, as it shows an upslope on the eastern side that isn't evident on other images or analyses.



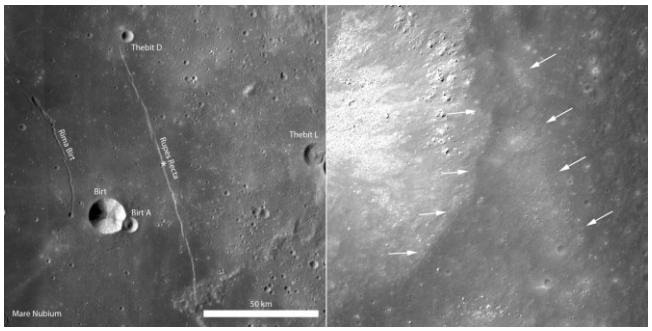
An angle of 25 degrees is a grade of 46%. This means if you were to walk 100 feet, you'd have to climb 46. feet. That's very, very steep. It's a steep expert ski slope, about the angle of Killington's Outer Limits or the top part of Tourist Trap on Vail's Riva Ridge. When you look over the edge of Tourist Trap, as I did many times in my ski days, it looks like you are falling off the edge of the world. It's not a vertical cliff face like Yosemite's El Capitan, but it's still imposingly pitched.

More recently, LROC data and images have probed details of the Rupes Recta's morphology and for-

[3] Undoubtedly image C1995 taken on May 29, 1996, https://www.lpi.usra.edu/resources/cla/info/f15/. The Atlas images were made with the 61-inch USNO reflector at Flagstaff, AZ.

[4] Scholten, F, et. al, GLD100: The near-global lunar 100 m raster DTM from LROC WAC stereo image data, Journal of Geophysical Research: Planets; 2012; 117: E12, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011JE003926.

mation history, using the close-up images that are LROC's specialty.



The caption[5] for these photographs reads:

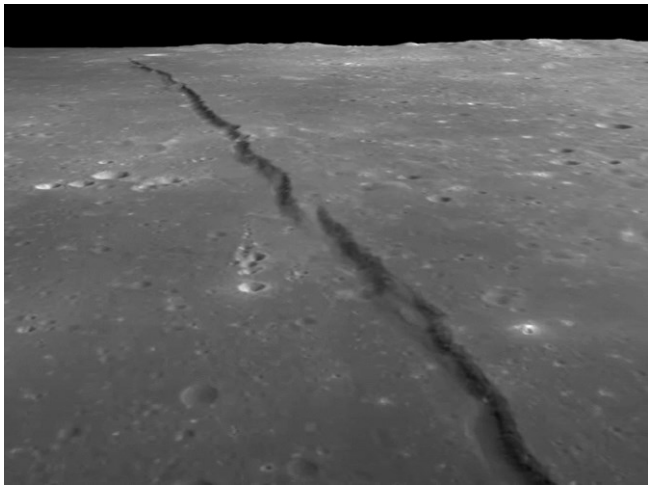
> Linear rilles are surface manifestations of structural faulting that formed when the lunar crust was pulled apart. The widths of these linear rilles range from as little as a few meters to kilometers across; Rupes Recta is between 1 - 3 km wide across its length. In addition, Rupes Recta is composed of several en echelon segments - the linear rille is not a single, uninterrupted 100 km length fault! There are at least 5 large fault segments visible at the LROC WAC scale (100 m/pixel) that range from ~8 km to 50 km in length.
>
> The cliff-face of Rupes Recta is noted by the arrows on the right side of the image. At some point after the formation of Rupes Recta, an impact occurred and excavated material from the fault wall. The arrows on the left side of the image (forming a somewhat-curvilinear path) denote the crater wall. Subsequent down-slope movement of eroded debris and blocks is visible. Image width is 840 m, illumination from the left, and the low-incidence angle of this image highlights the albedo variations.

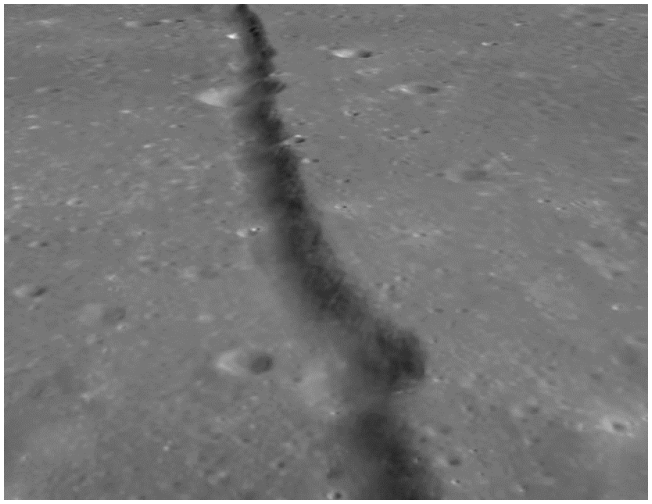
The crack started in the center and propagated bidirectionally, growing northwards and southwards by segment linkage, with the segments still in evidence as shown in the LROC image.

Linear rilles like the Rupes Recta are not thought to be associated with volcanism. It's possibly a graben, a depressed segment of planetary crust bordered by parallel faults, but there would still have to be a vertical displacement event since the sides are not at the same level. On the Moon, the most visible true graben is the Valles Alpes (Alpine Valley). The Rupes Recta probably formed no earlier than 3.2 billion years ago, making it one of the youngest of the large-scale faults on the Moon.

[5] http://lroc.sese.asu.edu/posts/287.

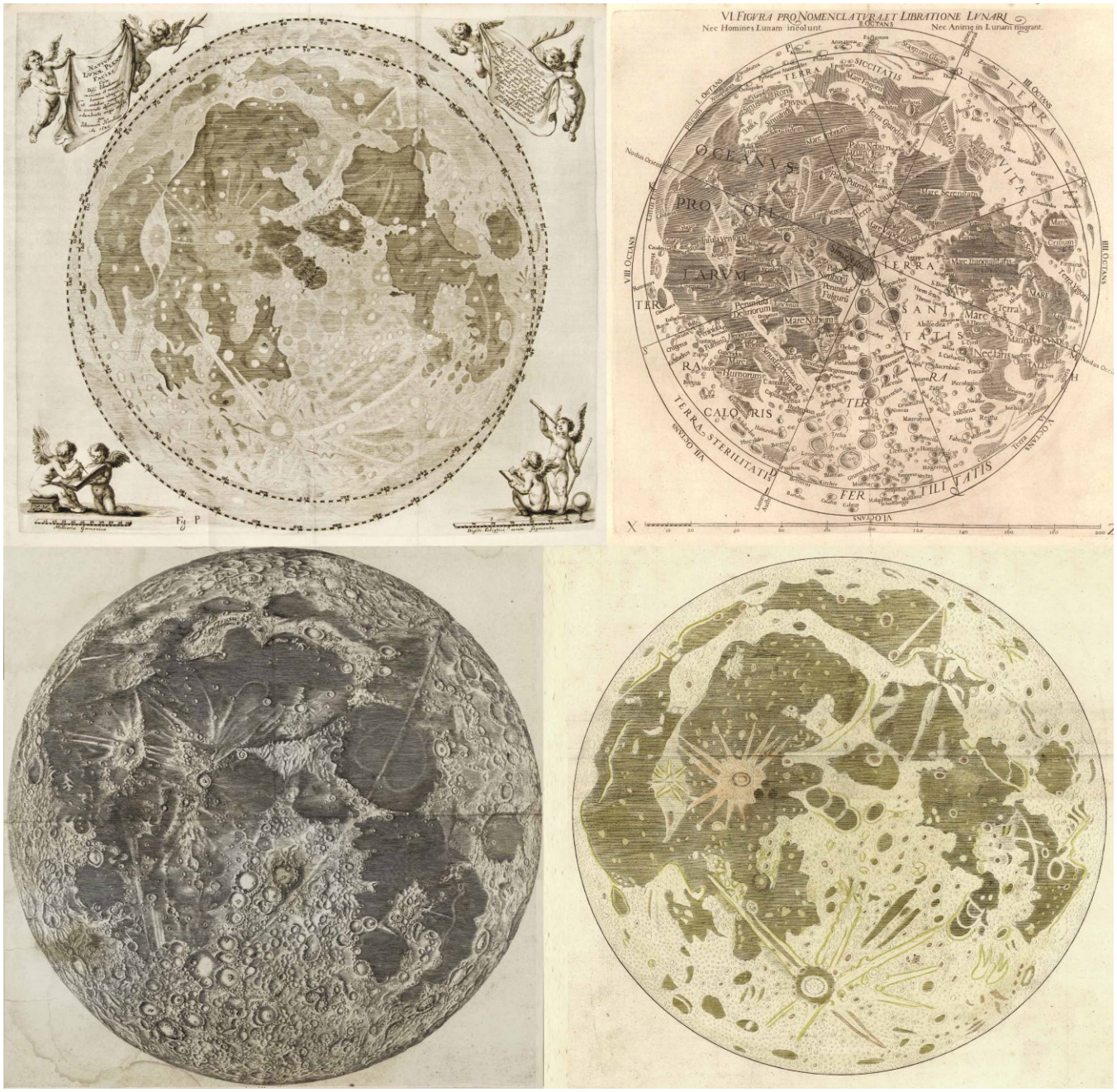
Perhaps the most revealing image of the Rupes Recta is provided by the Japanese Kaguya mission (originally named SELENE, for the Selenological and Engineering Explorer), using its laser altimeter to reconstruct a visual image. JAXA made a "flyby" video, from which confirms the LROC finding that the Rupes Recta has a more complex slope than can be expressed by a single value. Parts of it may indeed be cliff-like. Here are two slightly cropped frames of a flyby video made from Kayuga data, published in 2009. One gets a sense that the center of the fault is actually slightly depressed relative to its western edge.





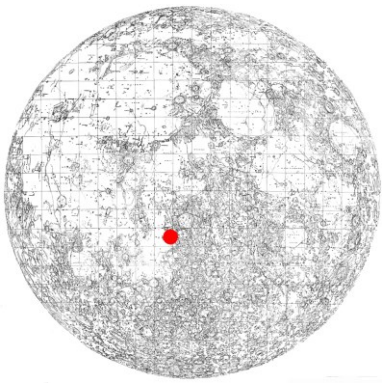
The full video, lasting two minutes and including the nearby Rima Birt and Birt crater, is at https://www.youtube.com/watch?v=DyMG99zestE.

While the Moon has many sinuous rilles and channels, there are only a few truly linear features, the Rupes Recta being the largest and easiest to spot. Go for it the next time you can bring a scope out in the evening on lunar day 9-10. ■



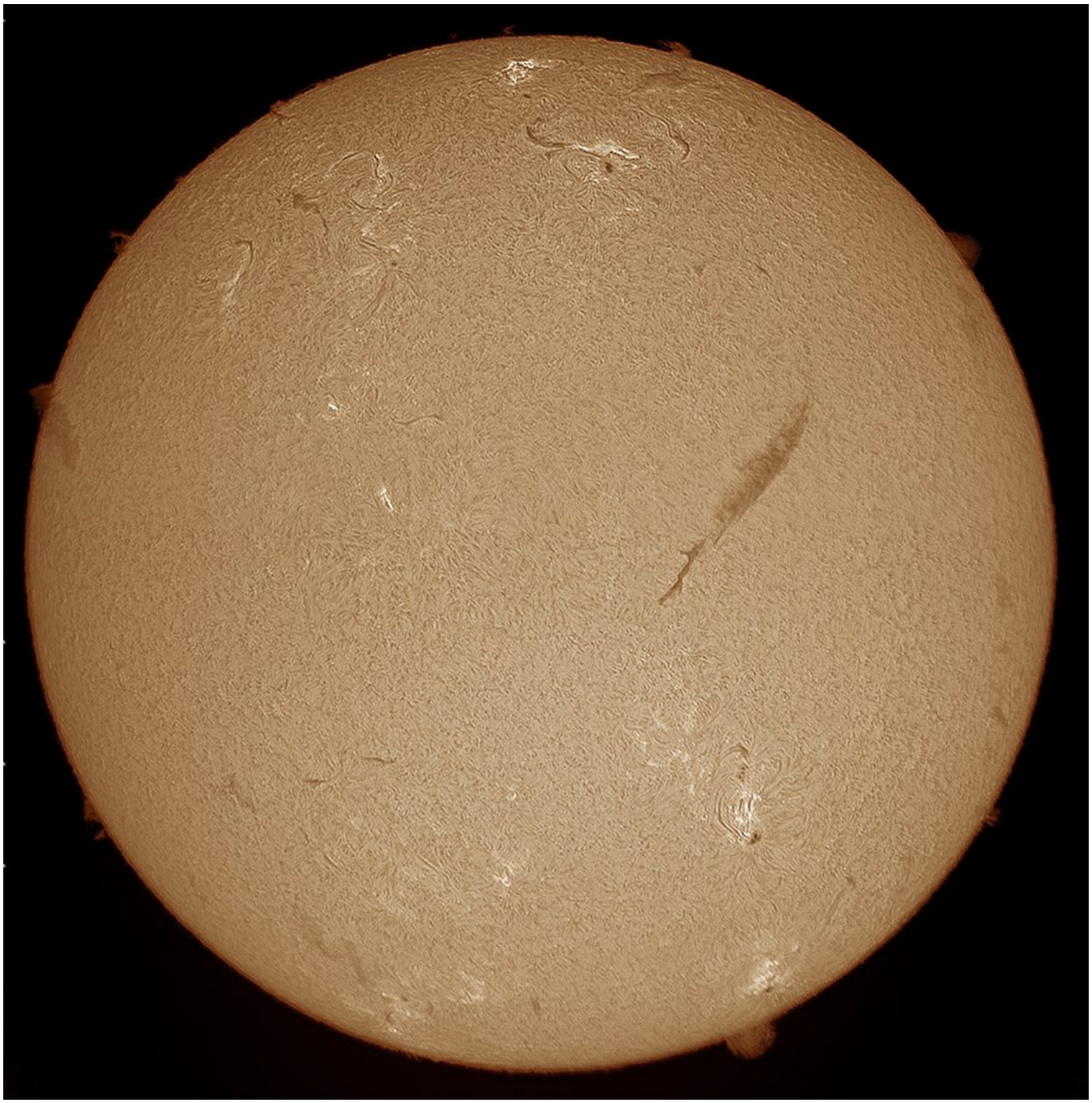
Seventeenth Century Moon maps. Clockwise from upper left: Johannes Hevelius, 1647; Giovanni Battista Riccioli, 1651, Athanasius Kircher, 1669, Gian Domenico Cassini, 1670.

Cassini's map was based on drawings he made during different lunar phases, using black and white chalk on a blue background. The drawings were then combined to make a full Moon map 12 feet across. The original map is lost, although one might hope that it hides in some ultra-obscure corner of the Paris Observatory, which opened just three years before the map was made, with Cassini as its director. This information is related in Joseph Ashbrook's wonderful 1984 collection of his essays for Sky and Telescope, *The Astronomical Scrapbook,* pages 241-242.



Location of the Rupes Recta

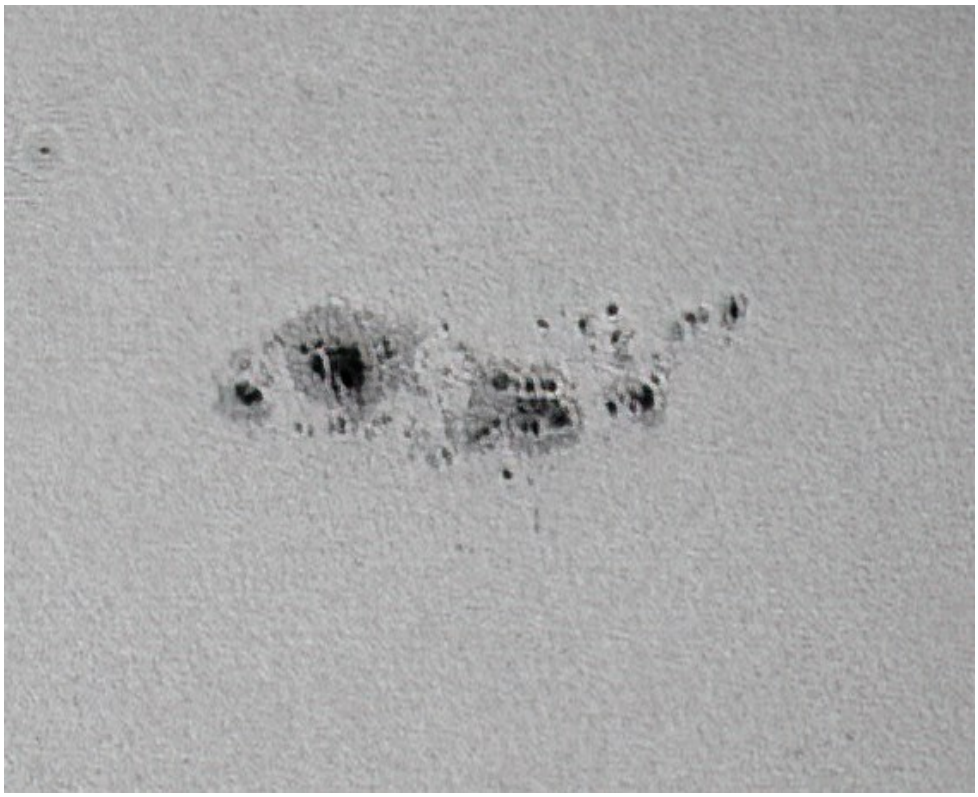
Images by Members



Here's Rick Bria's 2-panel mosaic of the Sun on June 1, 2023. It's a stack of 100 frames (each half) using an 80-mm Lunt hydrogen-alpha telescope and QHY 290 monochrome camera. The color was added in post-processing.

Making a mosaic with an Hα telescope can be challenging. The illumination of the image coming through the internal Fabry-Perot etalon, which provides the narrow band-pass around the Hα line, can be very sensitive to the exact angle of the object with the optical axis of the telescope. Offsetting the axis by ¼ degree, half the width of the Sun, might result in adjacent parts of the disc not being at exactly the same intensity. This was not a problem for Rick, who merged the images seamlessly.

Sunspots Through a 230 Year Old Telescope by John Paladini



Why should a well-cared-for old telescope not be productive? John Paladini owns a 2.4-inch refractor made around 1790 by Dollond & Co. The scope is an achromatic doublet of approximately 1,025-mm focal length, giving around f/17. John made this image on June 29, through a little bit of the Canadian haze, with a mylar filter and an ASI290 Mini camera.

John Dollond (1706-1761) was the son of Huguenot refugees who came to England in 1685 when Louis XIV revoked the Edict of Nantes. Like his father, he was a silk weaver but in his teens he became interested in mathematics, optics and astronomy. His son Peter opened an optical shop, and it was successful enough for Peter to encourage his father to abandon silk weaving in 1752 to make optical instruments, including telescopes and sextants. John Dollond was probably not the inventor of the achromatic doublet, but he patented the design on April 19, 1758. After his death, Peter carried on the business, inventing the triplet lens and defending his father's patent by bringing twelve lawsuits against rival opticians who were also making achromatic doublets. The patent expired in 1772, after which competition increased and prices fell. However, the Dollond firm was known to make the best refractor telescopes and spyglasses of the day. Lord Nelson bought one a few weeks before Trafalgar. Peter supplied lenses for the Royal Observatory Greenwich, including a 5-inch triplet that is still *in situ* in one of the observatory's historic transit telescopes. The Dollond firm became the retail opticians Dollond and Aitchison, a company which persisted into the 21st century, and was merged into Boots Opticians in 2009.

(L) John Dollond (portrait by Benjamin Wilson, Royal Museums Greenwich), (R) Peter Dollond (portrait by John Hoppner, Yale Center for British Art)

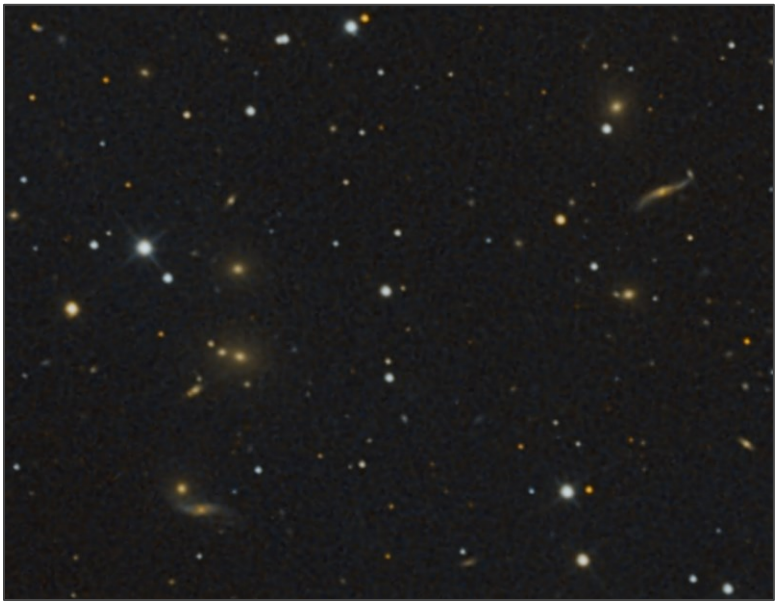
John Dollond presented a paper to the Royal Society on his lens design and was awarded the society's Copley Medal in 1758. He was made a Fellow of the Royal Society in the year of his death.

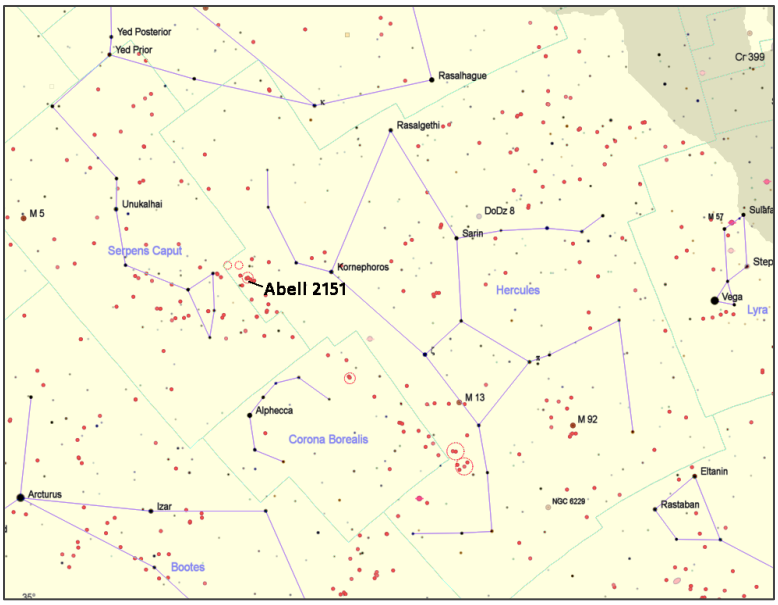
95% Moon on June 1 by Larry Faltz

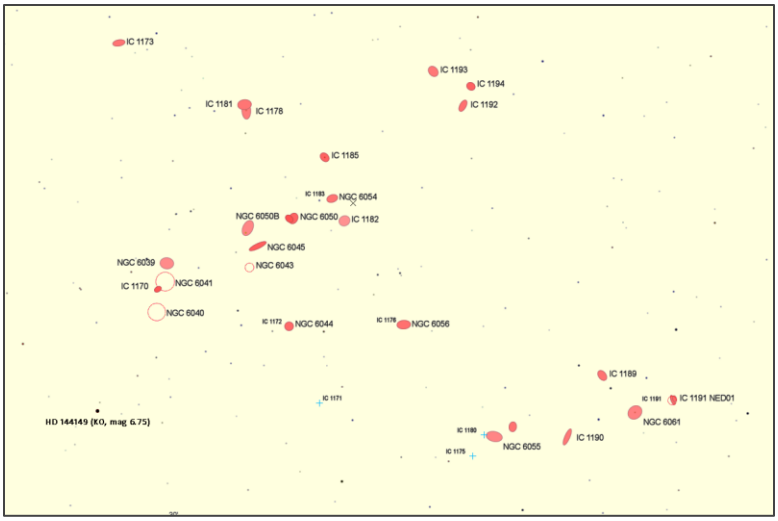
The mostly-illuminated Moon isn't terribly interesting for imaging or viewing details, except for a tiny sliver of features along its shadowed edge. Sometimes, though, a full disc image can be pleasing. In the past I would use a DSLR to capture the full lunar disc because the sensors on my planetary cameras were too small for my lowest focal length telescope, an 80-mm f/6 Stellarvue Nighthawk doublet. For this image, I used a deep-sky camera, a ZWO ASI183MC (lent by WAAer Charlie Gibson), whose APC-sized 20 megapixel sensor was more than large enough to capture the full disk. The sensitive chip allows exposures of less than a millisecond. Because of the camera's large number of pixels, its download speed is at most 14 frames per second even with a slightly reduced "region of interest." At a high frame rate, the camera may acquire data faster than it can transfer to the computer, even with a USB3 connection and a fast i7 laptop. Eventually the camera's on-board buffer runs out of room and it begins to drop frames. The effective frame rate drops to just 2-3 per second, but it keeps chugging away. With good seeing on June 1st and accurate tracking on an AZ-GTI alt-az mount (the key to tolerating a slow frame rate), I was able to collect almost 2,000 frames in about 7 minutes and then align and stack the best 10% in the usual manner. After conversion to monochrome, gentle wavelet processing and a little tweaking of the levels, the final image is sharper than I have gotten in the past with a DSLR.

Hercules Galaxy Cluster by Olivier Prache

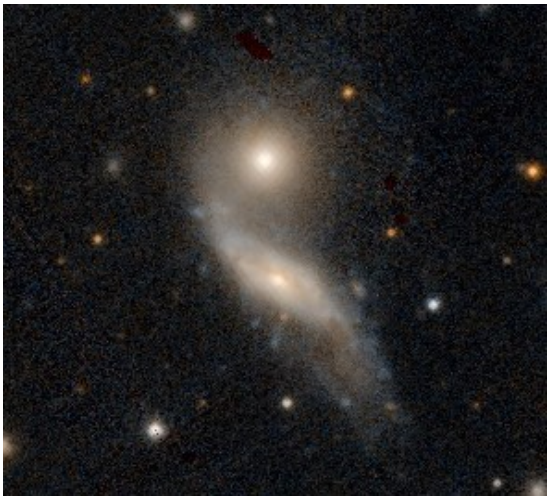
The Hercules Galaxy Cluster (Abell 2151) lies in a region incredibly rich in galaxies. Abell 2151 contains over 200 of them, of which 28 are bright enough to be NGC or IC objects. Well over 100 are visible in this image in its original resolution. The brightest galaxy in the cluster is NGC 6041, magnitude 13.5. Only one other galaxy is brighter than magnitude 14. The cluster is about 500 million light years distant, so it is not surprising that it is faint. The image was made by Olivier's Pleasantville-based 12.5-inch f/8 Hyperion astrograph and FLI ML16803 CCD camera. He collected data over three nights for a total of 5 hours of integration. Olivier wrote, "It was challenging to make the faint fuzzies visible without compromising the quality of the background." The field is 46.2 x 47.8 arcminutes, centered at RA 16h 05m 20.285s, Dec +17° 44' 14.812". The bright foreground star is HD 144149.







We made an enlargement of the brightest galaxies in the cluster, just above HD 144149. Some of the galaxies show evidence of gravitational interaction with one or more neighbors. Two edge-on spiral galaxies are distorted and not completely planar. The spiral galaxy NGC 6040, on the lower left, shows clear evidence of being affected by the close elliptical galaxy SDSS J160426.50+174431.1, also named NGC 6040B, *g* magnitude 14.98, as seen in this image from the Dark Energy Survey camera on the 4-meter Victor Blanco telescope at Cerro Tololo in Chile.



Using the XMM-Newton and Chandra X-ray satellites, hot gas was discovered in the cluster, segregating into two groups. One group has a cool core, and some galaxies in that region appear to still be in formation. (Tiwari, J, Singh, KP, The Hercules cluster in X-rays with XMM-Newton and Chandra, *Monthly Notices of the Royal Astronomical Society*, 2021; 500: 5524-5542).

Abell 2151 is only a part of a larger structure, the Hercules Supercluster, consisting of Abell 2147, 2151, and 2152. In 1998, some 414 galaxies were identified in the supercluster. More recent studies show that A2151 consists of five subclusters, A2147 of two and A2152 of at least two. The total mass of the supercluster is estimated to be 2.1 ± 0.2 × 10^{15} M☉. (Monteiro-Oliveira, R. et. al, Unveiling the internal structure of Hercules supercluster, *Monthly Notices of the Royal Astronomical Society*, 2022; 509: 3470-3487).

Busy Goings-On in Cygnus by Steve Bellavia

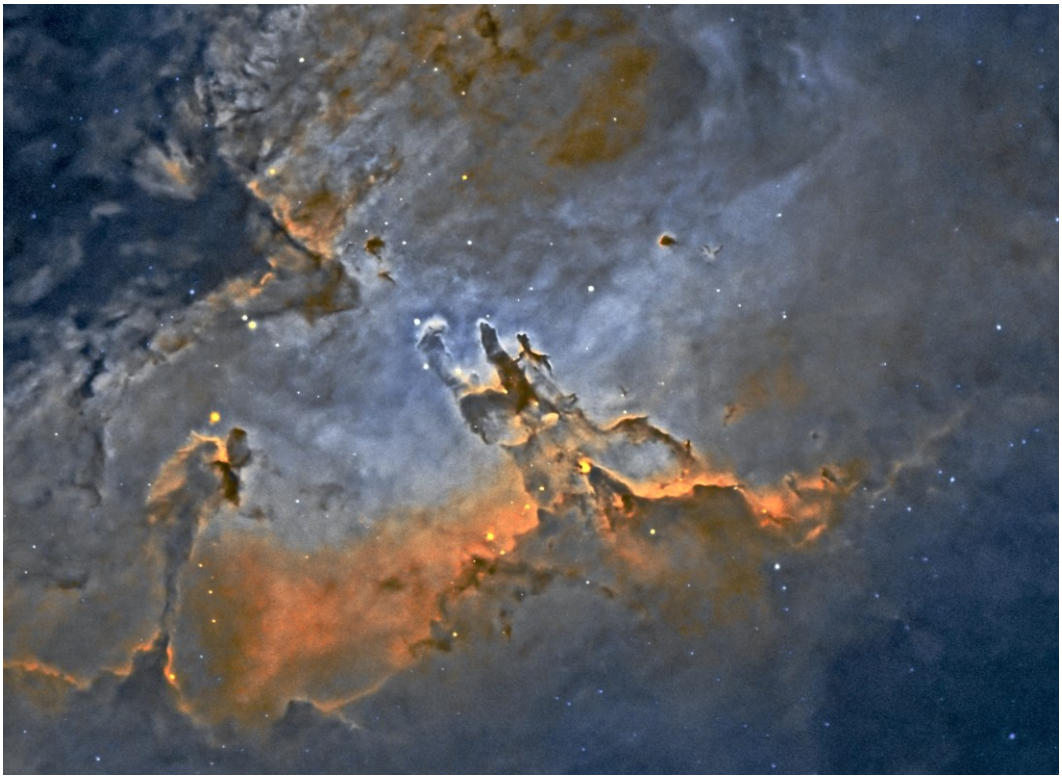
The Milky Way in Cygnus has many interesting HII regions, the most famous of which are the North American Nebula, the Pelican Nebula and the Crescent Nebula. This image of a 2.86 x 2.0 degree field (almost six full Moons wide) is centered about 3½ degrees northwest of Deneb. It contains Sharpless objects SH2-115 and SH2-116, along with planetary nebulae PK086+05.1 (also known as Weinberger 1-10, upper left), and PK085+04.1 (also known as Abell 71, upper-right), as well as several Lynds Bright Nebulas.

The universe is mostly hydrogen. In interstellar space (within the galaxy) hydrogen exists either as ionic plasma (HII, dissociated protons and electrons), atoms (H) or molecules (H_2). The ratio depends on the local pressure, temperature and magnetic field. In areas of star formation, ultraviolet radiation from newborn stars, especially large hot stars of the O, B and A classes, ionizes the hydrogen to form HII regions, which we detect primarily by recording the emission of the red hydrogen alpha wavelength at 656.28 nm. The actual density of an HII region is 10^2 to 10^4 protons per cubic centimeter. One cc of water has around 6.6×10^{22} protons. HII regions are dramatic, important (and pretty) but actually there's almost nothing there!

Steve made this image on the grounds of the Custer Institute in Southold, Long Island. Steve has long been associated with Custer in a variety of roles. He used a William Optics 71 Star II f/4.9 Petzval quadruplet refractor to feed the wide field into an ASI294MM Pro camera. The image was made with narrow-band filters (Hα, OIII, SII), combining a total of 4 hours 8 minutes of signal plus various calibration frames.

Steve's detailed technical information is at https://www.astrobin.com/bv6ajb/.

Eagle Nebula, Color of Your Choice by Gary Miller



There is more than one way to skin a cat, or to display a nebula (or if you're Monet, to paint a haystack). Gary collected data on July 11 at Ward Pound Ridge over 2½ hours, and processed it in two ways, one in "natural" color (top) and then using PixInsight to transform the nebula to the Hubble palette.

Draco Triplet by Steve Bellavia

This triplet in the circumpolar constellation Draco consists of the edge-on spiral NGC 5981 (mag 13), the elliptical NGC 5982 (mag 11.1), and the face on spiral NGC 5985 (mag 11.1), all within an extent of 15 arcminutes, half the diameter of the full Moon. The group is 13 degrees east of the Pinwheel Galaxy, M101. To the left of NGC 5981 is a tiny spiral, NGC 5976 (mag 14.8). The group is about 100 million light years away.

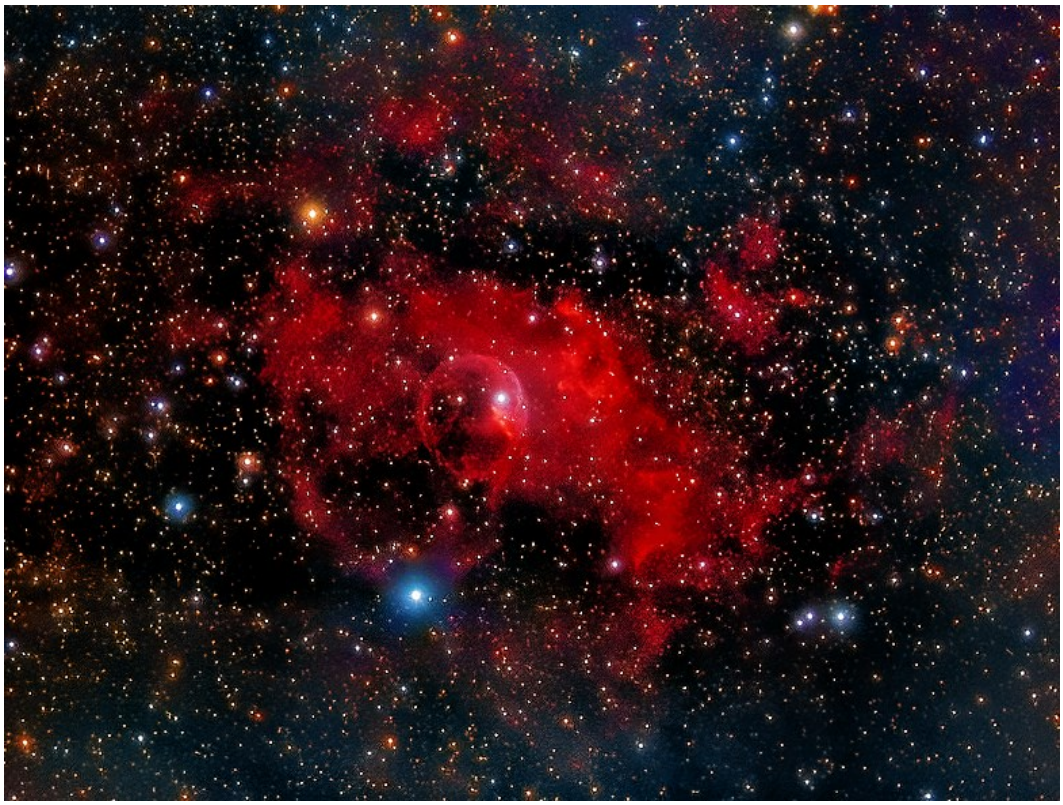
Steve made this image on the night of May 14-15 in Southold, Long Island. Technical information is at https://www.astrobin.com/hziups/.

Here's Steve's DSLR shot of our satellite, 85% illuminated, at 6:00 p.m. on May 1, 2023.

Two Star-Fired Nebulas by Arthur Miller

Imaged with 11-inch Celestron SCT from Quail Creek, Arizona.

NGC 2359, Thor's Helmet, in Canis Major. The Wolf-Rayet star WR7 powers this emission nebula. It is getting ready to go supernova. It's the brightest star in the center of the nebula.



NGC 7635, the Bubble Nebula, in Cassiopeia. The stellar wind from the hot star SAO 20575 (class O6.5), with a surface temperature of >30,000K, excavates a cavity in the HII region. The star is easily seen within the bubble, near a tongue of glowing hydrogen.

Big Things from a Small Package by Jordan Solomon

Jordan uses a Vaonis Vespera "smart telescope," a no-eyepiece computerized 50-mm f/4 quadruplet refractor mated with a Sony IMX462 back-illuminated CMOS sensor with a 1/2.8 format, a 2.9 µm pixel size, and a resolution of 1920 x 1080 pixels. The field of view is 1.61° x 0.91°. The 462 chip was developed as a planetary imager, but it is clearly sensitive and low-noise, especially when coupled with the Vespera's live stacking and processing software, to provide fine images of deep sky objects. The scope can even compose mosaics automatically. Jordan sent a bunch of recent images that we'll show over the next few months. Both these images were made at Cherry Springs in Pennsylvania.

Messier 27 (Dumbbell Nebula)

Messier 8 (Lagoon Nebula)

NGC 7331 and the Deer Lick Group by Arthur Rotfeld

Arthur sent this "reworked" image of the barred spiral galaxy NGC 7331 in Pegasus, surrounded by the so-called "fleas" of unbarred spirals NGC 7335 and NGC 7336, the barred spiral NGC 7337 and the elliptical NGC 7340, all making up the "Deer Lick Group. Also listed as Caldwell 30, the magnitude 9.5 galaxy is 9.7 x 4.5 arcminutes in size. Herschel first saw it on September 5, 1784, and gave it the designation I-53, his class I objects being "bright nebulae." About 47 million light years distant, it is much closer than, and not gravitationally bound to, the "fleas," which are several hundred thousand light years farther away. NGC 7331 is tilted 22° from edge-on. It's a large galaxy, a bit more massive than the Milky Way and about the same size as the Andromeda Galaxy, M31. To the lower right is the star-like elliptical galaxy NGC 7325 (triangulate the red arrowheads) and further away the spiral NGC 7326 (blue arrowheads). The bright star in the lower right is HD214181, Vmag 9.07, K2. The field of this image is 31.2 x 23.5 arcminutes, about one full Moon across. Half a degree to the SSW is the famous galaxy cluster Stephan's Quartet, with much fainter and smaller galaxies.

The name "Deer Lick" was not chosen to relate the galaxy group as to a cervine animal. It was coined by the late amateur astronomer Tomm Lorenzin. He wrote that the "entire retinue [was] given the moniker 'Deer Lick Group' in commemoration of one of the finest nights of viewing EVER, at Deer Lick Gap, just off the Blue Ridge Parkway, in the NC mountains." In 1992, he published *1000+: The Amateur Astronomer's Field Guide to Deep Sky Observing*. The web site http://www.1000plus.com/2000plus/, as of this writing still available online, lists 2092 objects with locations, maps and descriptions. O'Meara's *Deep Sky Companions: The Caldwell Objects* (2002) doesn't mention the nickname, but now it's in common use.

Research Highlight of the Month

Ice Cube Collaboration (388 authors), Observation of high-energy neutrinos from the Galactic plane, *Science* 380: 1338-1343, 30 June 2023.

The origin of cosmic rays is still a mystery, primarily because they do not reach Earth in a straight line from their source. As charged particles, their trajectories would be bent by the Milky Way's complex magnetic field. Cosmic rays collide with particles in the interstellar medium (ISM), generating either charged or neutral pions (made of two quarks). Pions decay quickly (π^+ and π^- in $2x10^{-8}$ seconds, producing muons and muon neutrinos, and π^0 in $8x10^{-17}$ seconds, producing gamma rays). Gamma rays may arise from other sources in the ISM, particularly cosmic electrons, while the high-energy neutrinos have a distinct origin and pass through space unmolested, thus being capable of revealing their origin.

The IceCube Observatory at the South Pole was designed to detect high energy astrophysical neutrinos by observing Cerenkov radiation generated by muons formed by rare neutrino collisions with nuclei in the ice. Unfortunately, each of these astrophysical neutrino collisions is accompanied by 100 million muons generated outside of the detector by cosmic ray collisions in the Earth's atmosphere. Needle in a haystack, indeed! To deal with this contamination, the detector prefers to look "up," that is, to register particles coming through the Earth from the north because atmospheric muons arising from that direction are absorbed by our planet. But the center of the Milky way is below the celestial equator, making it a "southern" object. For the detector to distinguish southern astronomical neutrino-generated muons from southern background muons, the collaboration used machine learning to evaluate ten years of data and fit the results to several models. They were able to identify neutrino emission from the galactic plane with a significance of 4.5σ. This is consistent with diffuse emission of neutrinos from cosmic rays orbiting in the galaxy's magnetic field and interacting with the ISM) although a population of unresolved point sources could not be ruled out.

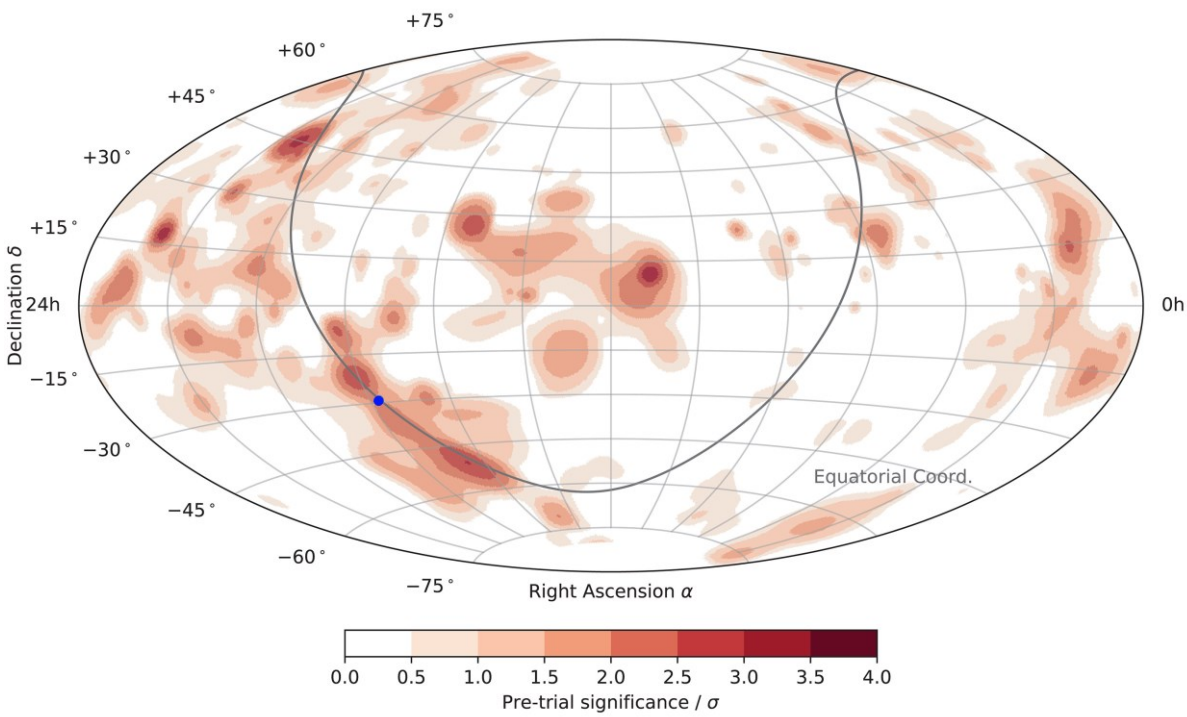


Fig. 4. All-sky point source search. A map of the best-fitting pretrial significance for the all-sky search, shown on an Aitoff projection of the celestial sphere, in equatorial coordinates (J2000 equinox). The Galactic plane is indicated with a grey curve, and the Galactic Center is indicated with a blue dot. Although some locations appear to have significant emission, the trial factor for the number of points searched means that these points are all individually statistically consistent with background fluctuations. Thus, diffuse emission is favored over point sources.

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
NEW LISTING Apertura AD8 8-inch f/5.9 Dobsonian	Purchased from High Point January 2022, used once. The scope is in new condition. 2" Crayford dual-speed focuser, mirror cooling fan, RACI finder. Two eyepieces, Farpoint lifting straps, 1 lb magnetic counterweight, Bob's Knobs installed. Apertura collimator. Original boxes with foam packing.	$500	Mark Lane jmarklane@gmail.com
Nagler Type 1 9mm Eyepiece	82 degree apparent field of view. 12.4-mm eye relief. The original Nagler design. Fits both 1¼-inch and 2-inch focusers. 7 lens elements. A fabled eyepiece. Like new condition, in the original box. A current Type 6 Nagler, essentially the same optics, costs $335. Image here. Donated to WAA.	$175	WAA ads@westchesterastronomers.org
NEW LISTING Orion 6-inch f/5 reflector on EQ mount	Little used, if at all. The mount is a solid non-goto equatorial mount but has an electric RA drive as well as slow-motion stalks. The setting circles are large and very readable, unlike many EQ mounts for scopes of this size. Two Plössl eyepieces (9 and 25 mm), an Orion flashlight, counterweights, gold-colored aluminum tripod. Good intro scope for a bright young person. Donated to WAA.	$200	WAA ads@westchesterastronomers.org
Orion Starblast 6-inch reflector	Orion's famous 6-inch f/5 table-top Dobsonian. reflector. 1¼" focuser. All original with red-dot finder, 25-mm and 10-mm Orion Plössl eyepieces, hex wrenches, tube rings, mount, bolts, manual. Optics are pristine; tube has a couple of very minor blemishes. Orion's image is here. A new one is $449. Good intro scope.	$175	Larry Faltz lfaltzmd@gmail.com
Orion Glass Solar Filter for 6" telescope	A glass (not mylar) solar filter with maximum inside diameter 193 mm. Perfect for 6" f/5 or f/8 reflector. New condition with original documentation. New mylar filters of this size list for $150.	$100	Larry Faltz lfaltzmd@gmail.com
Eyepiece holder for Dobsonian	Anodized aluminum. Bolts onto side of rocker box. Very solid. Holds three 2" and two 1½" eyepieces. Made by Astrozap. Similar ones are sold by ScopeStuff for $32. See picture here.	$15	Larry Faltz lfaltzmd@gmail.com
ADM R100 Tube Rings	Pair of 100 mm adjustable rings with large Delrin-tipped thumb screws. Fits tubes 70-90 mm. You supply the dovetail bar. Like new condition, no scratches. See them on the ADS site at https://tinyurl.com/ADM-R100. List $89.	$50	Larry Faltz lfaltzmd@gmail.com
Tiltall photo/spotting scope tripod	TE Original Series solid aluminum tripod with 3-way head, center stalk. Very solid. 3-section legs. Height range 28.5"-74". Can carry up to 44 lbs. Folded length 29.6". Weighs 6 lbs. Carry bag. Image here. List $199.50. Donated to WAA.	$75	WAA ads@westchesterastronomers.org
RUBYLITH Screens	I have two 1/8" thick rubylith screens for placing over a laptop or tablet screen. Sizes are 14½x9" (for 17" diagonal 16:9 laptop) and 10½ x 7" for a tablet. Includes strong rubber retainers. I don't need them anymore. First come, first served.	Free	Larry Faltz lfaltzmd@gmail.com

Want to list something for sale in the next issue of the WAA newsletter? Send the description and asking price to waa-newsletter@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!*