SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

May 2023

Messier 78 by Arthur Miller

Most observers are satisfied looking at the Great Orion Nebula, M42, and don't venture into the upper half of the constellation to study M78 (NGC 2068) and its gauzy companions, which are labeled in an arc from left to right NGC 2061, NGC 2067 and NGC 2064. Although it's somewhat faint, perhaps with a cumulative magnitude of 8.0, it can be a binocular object if you are in very dark, clear skies. The field of this image, made with an 11-inch SCT, is 30.6 x 22.7 arcminutes.

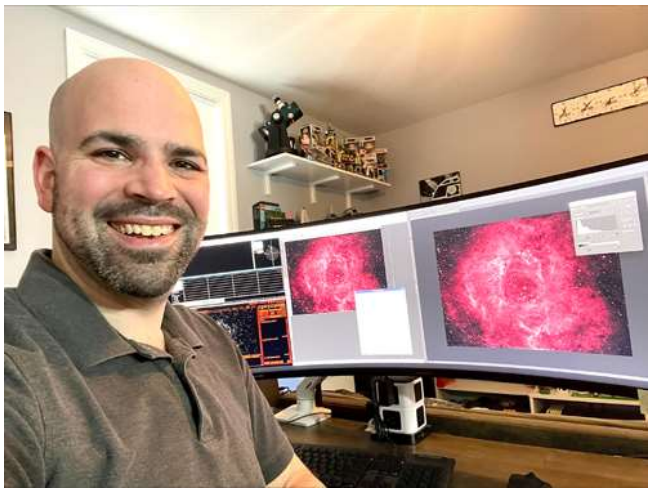
Club meetings are held at the David Pecker Conference Room, Willcox Hall, Pace University, Pleasantville, NY, and on-line via Zoom (the link is on our web site, www.westchesterastronomers.org).

WAA May Meeting

Friday, May 12 at 7:30 pm

Introduction to Astrophotography

Jordan Webber
Westchester Amateur Astronomers



Jordan Webber, WAA's Senior Vice President, will discuss how to get started in astrophotography. Although the talk is directed at newcomers, more experienced imagers will have the opportunity to see some of his techniques and images.

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

Also In This Issue

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

WAA June Meeting

Friday, June 9 at 7:30 pm

Searching for New Physics in the Universe's Oldest Light

J. Colin Hill, PhD
Department of Physics, Columbia University

Starway to Heaven

Ward Pound Ridge Reservation

Saturday May 13 (Sunset 20:08)
Cloud/Rain date Saturday May 20 (Sunset 20:15)

New Members

Linda Biderman	Plainview
Melissa Demarest	Tarrytown
Chelsea Maresca	New York
Daniel Margul	Ossining
Suzanne Rynne Ostermiller	Scarsdale
Fredric Perlman	Pleasantville
Ash Perry	Larchmont
Jill Telesco	New Canaan
Tina-Marie Vorgia	Larchmont

Renewing Members

Arun Agarwal	Chappaqua
Pramod Agrawal	Bardonia
Jason Alderman	Pelham
Donna Cincotta	Yonkers
John DeCola	Mt Kisco
Kevin Doherty	White Plains
Edi Lentini	Armonk
Arthur Linker	Scarsdale
Gary Miller	Pleasantville
Tom Morrissey	Pelham
Anthony Ortega	Scarsdale
David Parmet	Mt. Kisco
James Peale	Bronxville
Neil Roth	Somers
Ajay Royyuru	Yorktown Heights
Charles Scheinberg	White Plains
Pierre-Yves Sonke	Tarrytown
Dante Torrese	Ardsley
Jordan Webber	Rye Brook
Ernest Wieting	Cortlandt Manor
Alan Young	Tarrytown
Alexandr Zaytsev	Holtsville

ALMANAC For May 2023

Bob Kelly, WAA VP of Field Events


Bob Kelly


Full May 5

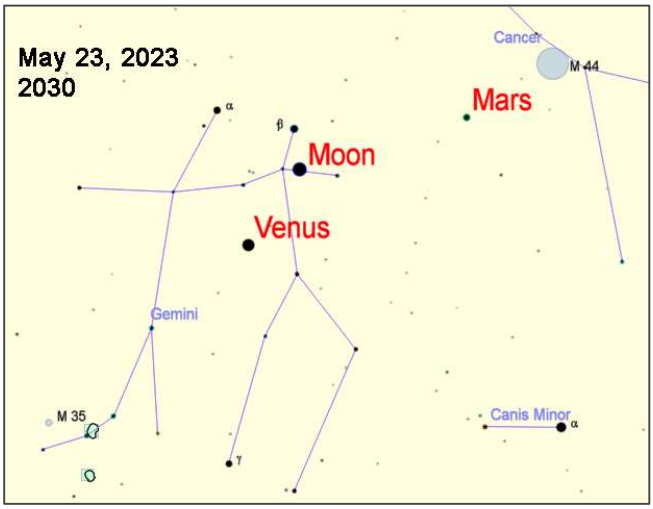

3Q May 12


New May 19


1Q May 27

Venus stands out in the evening sky. The cloud-covered inner planet is more than 42 degrees away from the Sun the entire month. You'll need a telescope to see that Venus is just a bit more than half-lit and shrinking in phase while gaining in size. Venus is so dazzlingly bright at magnitude -4.2, it's hard to make out the phase. It's best to catch it in a bright sky – during daytime or as early after sunset as you can find it.

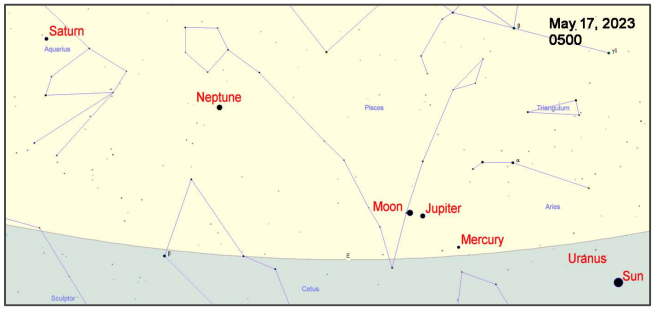
It's a good time to find Venus in the daytime sky. It's highest, 75 degrees up due south, in the mid- to late-afternoon. Block out that Sun with a sturdy object, like a building. It helps to determine in advance where your telescope's eyepiece comes to focus on celestial objects. Mark the location of sharp focus on the eyepiece holder, or focus on the Moon, if it's out.



Venus and **Mars** flirt with **Gemini**, bracketing the twins for first half of the month. Mars starts May as the red heart of Pollux, and Pollux looks like he's trying to catch Mars with his right arm around the 11th. Venus takes those places on the 26th and 30th. Mars approaches the **Beehive Cluster** (M44) as May ends. It's hard to believe how much Mars has dimmed. Now at magnitude +1.5, 22 stars are brighter than the faded reddish planet. A crescent **Moon** joins the fun on the 22nd and 23rd. The parings are not close (7° and 4° respectively), but the two bodies are so bright and near enough to be a wonderful sight.

On 5th, the new Moon just misses the darkest shadow of the Earth. The penumbral lunar eclipse is visible only in the eastern hemisphere.

Saturn is low in the pre-dawn sky. The Moon points it out on the 13th. **Jupiter** is emerging from its conjunction with the Sun. The Moon welcomes it to the morning sky by running over it on the 17th. Seeing the Moon in twilight near Jupiter will help us find the giant planet, so low in the morning sky.



The occultation of Jupiter by the Moon starts after sunrise, so you'll need a telescope to see this event. The occultation starts about 7:40 a.m, with Jupiter reappearing at 8:50 a.m. Jupiter's surface brightness is even less than the Moon's, so the striped planet will look dimmer, even at magnitude -2.1, when emerges from the unilluminated side of the Moon. Look for them 40 degrees above the horizon in the southeast. And, block out that Sun, just 26 degrees away!

The *Canadian Observer's Handbook 2023* predicts many double shadow transits (two of Jupiter's moons' shadows on the planet's disk) in the second half of May, into early June. You can also use the inexpensive Sky & Telescope app for your phone.

Mercury does its best not to be seen, following Jupiter after leaving solar conjunction on the 1st. Despite standing out 25 degrees ahead of the Sun at its maximum on the 29th, it's as dim as Mars and very low in the Northern Hemisphere sky. The better view is from the Southern Hemisphere.

The **Tiangong** space station is visible in the evening sky, but only during the first third of the month. The **International Space Station** is visible after sunset ear-

ly this month, transitioning to a morning show in the second half of May. For several nights around the 12th, the ISS is visible every 93 minutes all night. We might see three overflights before midnight at our May star party, scheduled for the 13th.

The **Eta Aquariids** meteor shower peaks on the morning of 6th, but it is largely a Southern Hemisphere show. We could catch a dozen or two an hour in a dark sky. But, this year a full Moon will spoil the view, up all night and setting after sunrise on the 6th. ■

WAA Member Picnic

Saturday June 17, 2023 from 12pm to 4pm. Rain or shine!
Croton Point Park: Pavilion 1

***The picnic is an annual WAA tradition and free to members and their families. All o*ur memberships are considered family memberships so feel free to bring family members. No family around? You may bring a guest.**

There is no admission fee to enter Croton Point Park but there is a **parking fee.** $5 per car for Westchester Park Pass holder, $10 per car without Park Pass.

WAA will provide hotdogs, hamburgers, veggie dogs & burgers, chips, dessert, water, lemonade, soft drinks as well as plates, cups, utensils, napkins, etc. Members are welcome to bring an appetizer, dessert or side-dish to share. You can bring your own beer and wine. We will provide coolers with ice for your beverages. Hard liquor is not permitted on Park grounds.

The WAA Astronomy Trivia contest will be held at 2PM! The WAA version of the game "Corn Hole" aka "Black Hole" will be ready to go along with a variety of board games for all ages.

Croton Point Park is a lovely 508-acre Westchester County Park located on the largest peninsula on the Hudson River. The pavilion has capacity for 200 people and includes picnic tables and cooking grills, so we will have plenty of space. The park has a sandy beach for swimming (there is a small fee). Dogs are permitted in the park but must be leashed at all times and are not allowed on the beach. Fishing is also a popular pastime. There is a **Visitor Center** that houses exhibits on local flora and fauna including Hudson River specimens, local and Native American history, and hands-on activities. Restroom, maps, and information are also available in the **Nature Center**. Go to **https://parks.westchestergov.com/croton-point-park** for more information.

As we consider the ongoing nature of Covid and the health and safety of our members, we ask you not to attend if you have any illness symptoms the day of the picnic.

Our community service event this year will benefit the SPCA of Westchester. Please click the link below for more information. I will have a drop-off box at the picnic if you wish to bring items for donation. **https://spcawestchester.org/donate/wish-list**

Please RSVP to Eva Andersen by June 10th by sending an email or text with your name(s), contact phone number and food allergies or avoidances.

Email: andefam55@gmail.com CELL: 845-803-4949.

We're looking forward to seeing you!

Eva Andersen- WAA VP for Membership and Chief Confection Officer

Another Movie Telescope

Can you name any movie remakes that are better than the original? We're not sure there are any. The 2003 version of *The Italian Job* is a fine film but it lacks the clever humor and deft touch of the original 1969 effort starring Michael Caine.

Caine plays a Cockney petty thief who is released from prison only to be recruited to steal $4 million in gold from an armored convoy in Turin, money intended to finance a Fiat factory in China. (Things cost less in those days!) The operation is bankrolled by the imprisoned genteel crime lord Mr. Bridger, who commands the total allegiance of the other inmates, the guards and even the warden. He even seems to be able to run the British government from within the prison. Mr. Bridger is played with devastating aristocratic cheek by none other than the great playwright, actor and composer Noël Coward.

The plan requires hacking the computerized Turin traffic signal system, and so a computer expert is required. In the 2003 film, a horny but fundamentally sane Seth Green is cast as the geeky IT wizard. In the 1969 film, the expert is the outrageous Benny Hill, as Professor Peach. Complicating the situation, however, is his extreme attraction to very large women. He occasionally spies on neighbors with his refractor, which is why it's pointed downwards.

Unlike Green's never-fail wireless internet connection and ability to hack into any site, Hill's reprogramming involves surreptitiously slipping a large computer tape into the Turin operations center and mounting it on one of those refrigerator-sized tape drives that were ubiquitous in the mainframe computer era.

A gigantic traffic jam is created in Turin so that the robbers' three gold-laden Mini Coopers can zip up and down stairs and through historic buildings and alleys to thwart their pursuers. The thieves not only have to outwit the police but must contend with the Mafia, a far more deadly, persistent and capable enemy. Most of the chase scenes were actually filmed in Turin.

In contrast to the inevitable victory of righteous Mark Wahlberg and company over loathsome bad-guy Edward Norton in the newer film, the 1969 version has a far more ambiguous and witty ending. ■

Deep Sky Object of the Month: Messier 104

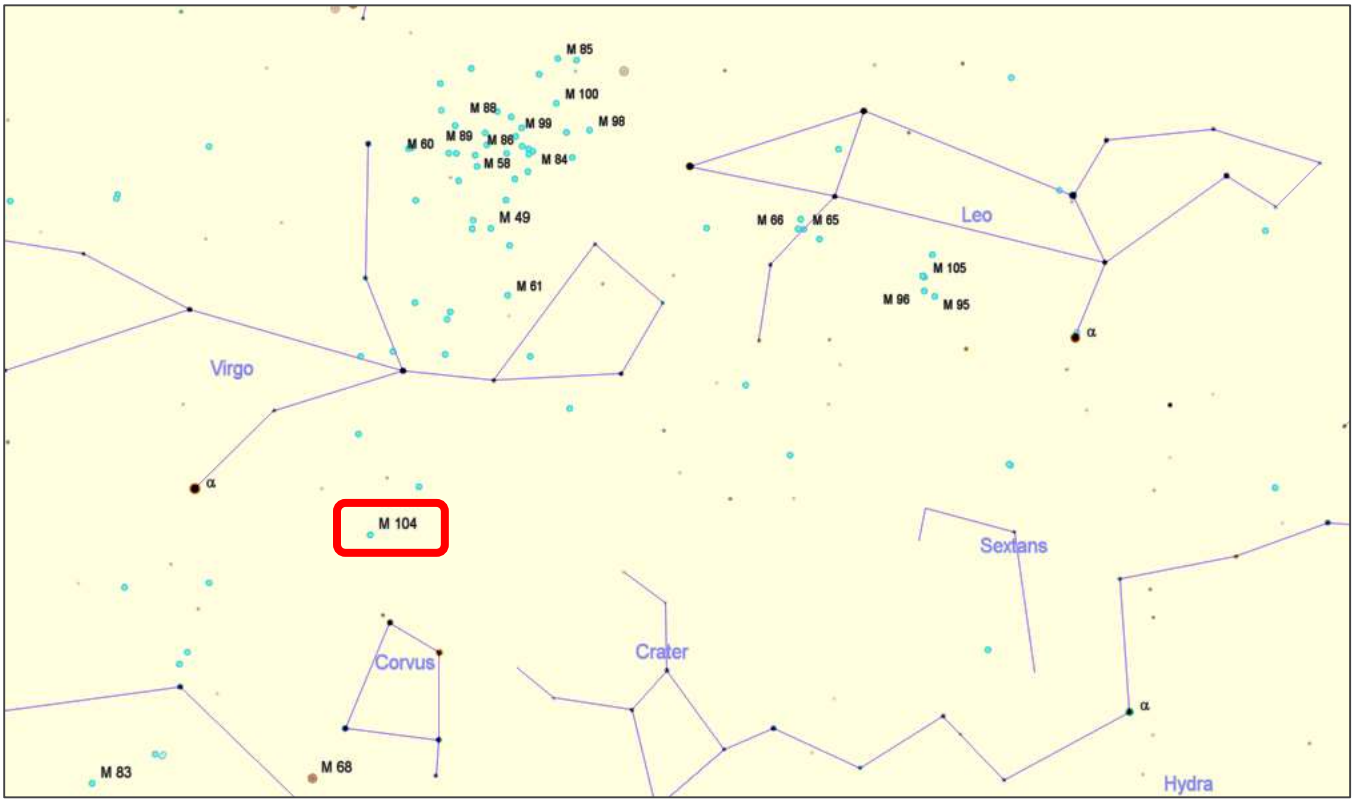
Messier 104	
Constellation	Virgo
Object type	Spiral Galaxy
Right Ascension J2000	12h 40m 00s
Declination J2000	-11° 37’ 00”
Size	8.7’ x 3.5’
Magnitude	8.0
Nickname	Sombrero Galaxy
Distance	31.1 million light years
NGC	4594
Discovery	Pierre Méchain, 1781

Because it is well below the celestial equator, the famous Sombrero Galaxy is never that far above the horizon. Spring is the time to see it. It is angled seven degrees from our line of sight, the bright core just peeking out over its dense dust lane. It’s a diffuse, elongated blob in smaller scopes but the dust lane will be visible in larger scopes and it’s easily imaged.

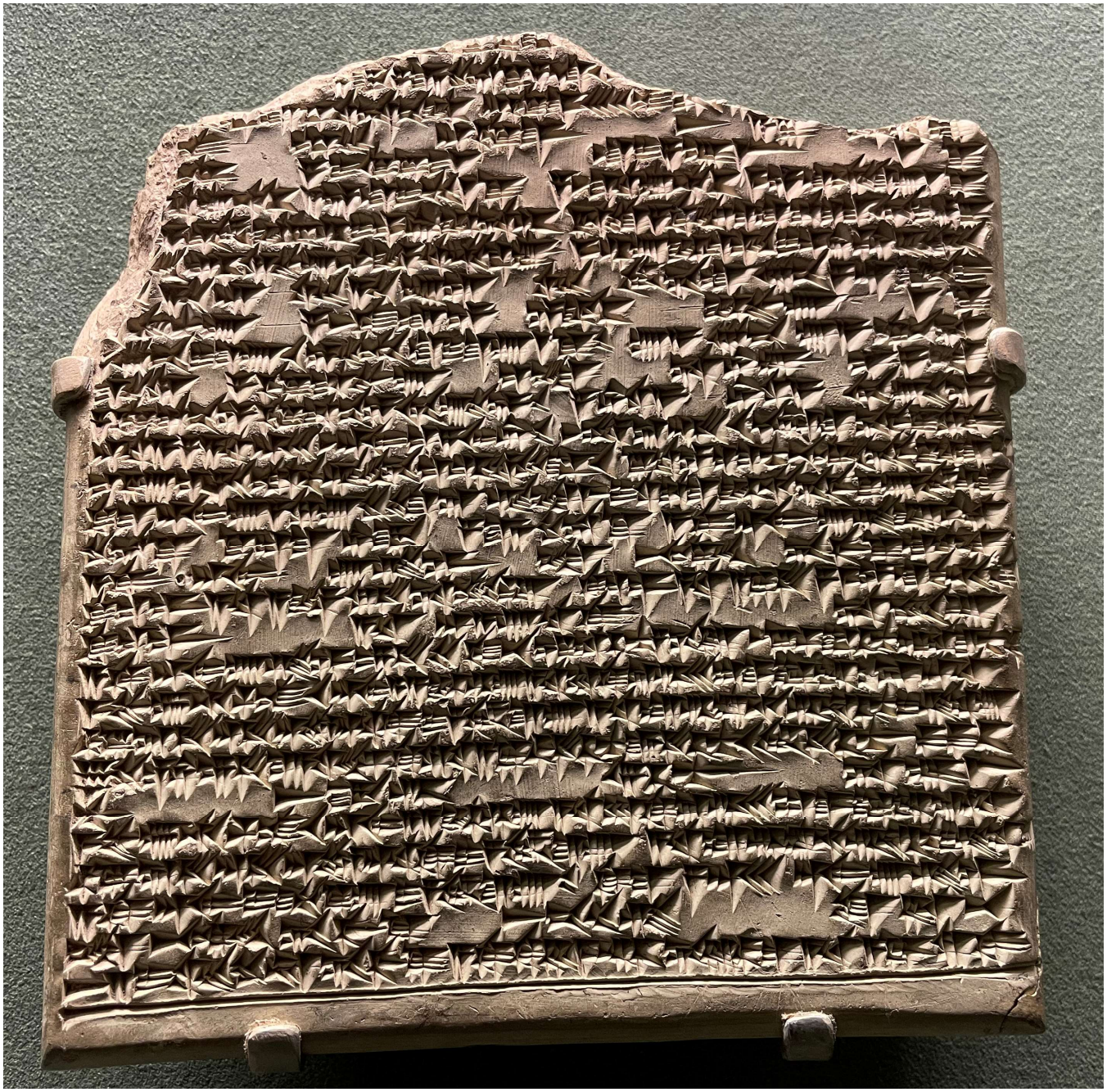
M104 is located on the Virgo-Corvus border, 25 degrees south of the main mass of galaxies in the Virgo cluster. There are many fainter galaxies to the east, but it is not clear whether M104 is part of that group.

Visibility for M104			
22:00 EDT	5/1/23	5/15/23	5/31/23
Altitude	34° 42’	36° 19’	34° 54’
Azimuth	162° 40’	179° 00’	198° 01’

M104 was the first galaxy in which rotation was detected, by Vesto Slipher at Lowell Observatory in 1913. With spectroscopy he showed that the whole galaxy was receding at 700 miles per second, but that one side was moving toward us relatively, compared to the other side.



The Astronomer at the Museum: A Babylonian Lunar Eclipse Ritual



We saw this 6-inch wide tablet at the Morgan Library in Manhattan. It is inscribed in Akkadian and dates from the end of the Seleucid period (first to third century BC), later than many of the Babylonian tablets on view in various museums. It describes the ritual to be undertaken during a lunar eclipse. Babylonian astronomers had tremendous observing and data organizing skills and by the time this tablet was inscribed had been accurately predicting eclipses for at least 1,500 years, if not longer.

As the eclipse begins, the …priest shall light the torch, and attach it to the altar…. As long as the eclipse lasts, the fire upon the altar thou shalt not remove. A dirge for the fields thou shalt intone; a dirge for the streams that the water shall not devastate, thou shalt intone…. As long as the eclipse lasts, the people of the land shall remove their headgear; they shall cover their heads with their garments, that catastrophe, murder, rebellion, and the eclipse approach not…. They shall cry aloud; for a lamentation they shall send up their cry.

NEAF 2023 Larry Faltz

After a three-year hiatus (we can't count the lame on-line events in 2021 and 2022) the Northeast Astronomy Forum, sponsored by the Rockland Astronomy Club, was back. The event took place on Saturday, April 15 and Sunday, April 16. For the eighth consecutive NEAF, WAA had a booth.

CCTS (Camera Concepts & Telescope Solutions) of Patchogue, NY, was there with new and used scopes and a complete range of accessories. Merchants who had been prominent at past shows, like OPT (Oceanside, California), Astronomics (Normal, Oklahoma) and High Point Scientific (Montague, New Jersey) were absent, and Woodland Hills Camera and Telescopes (Woodland Hills, California) only had a small footprint this year. Whether this is a trend reflecting the dominance of on-line astro-commerce, the impact of manufacturers selling directly to consumers, increased costs of bringing inventory to the show or just a slow start in the post-Covid environment won't be clear until next year.

On the other hand, gear manufacturers displayed a plethora of beautiful instruments and innovative accessories. There were large displays from Celestron, Lunt, DayStar, iOptron, SkyWatcher, Stellarvue, Explore Scientific, Unistellar, ZWO, Software Bisque and Televue. Among other exhibitors who caught our eye were manufacturers of cameras (Starlight Express), scopes (PlaneWave), mounts (PrimaLuce Labs, 10 Micron, AstroPhysics) and filters (Chroma, Andover). Among other interest booths were: two Chilean remote-telescope hosting facilities; a very high-end observatory construction company; makers of optics cleaning products; our friends Holly, George and Bruce from MARS (the Maine Astronomy Retreat and Symposium); Kevin Schindler from Lowell Observatory; Ruskin Hartley from the International Dark Sky Association (soon to be rebranded just "Darksky");
Sky & Telescope and Astronomy magazines; Andy Poniros doing his radio show; and even a toffee (the confection) company. And lots more. WAA members Roman Tytla (Big Bang Prints) and Dan Cummings (Star in a Star) had their own booths, displaying their fine products.

I set up the WAA booth early Friday afternoon, arriving before most of the large vendors had set up their displays. A "Welcome, Vendors" table had donuts, coffee and a specially decorated cake. I was tempted, but was unwilling to make the first cut before others had seen it. It was pristine when I left around 2:30 p.m. but I suspect it was gone before dinner time.

Thirty-six WAA members signed up to staff the WAA booth, and many more stopped by during the show. I brought my home-made, square (wood) tube 5¼-inch f/5 reflector, a project that rescued the peculiarly sized optics from the first telescope I owned. It helped generate conversation among members and passers-by.

You can see all the WAA'ers who staffed the booth in the photos (plus some guests). They were:

Alex Mold	Chetan Karande	Evan Bender	Karen Seiter	Mike Lomsky	Sal Abbasi
Ayumi Noda	David Parmet	Everett Dickson	Larry Faltz	Noah Bender	Scott Levine
Bill Caspe	Dede Raver	Hans Minnich	Lydia Maria	Olivier Prache	Sri Srinivasan
Bruce Rights	Eli Goldfine	John Higbee	Marcy Cohen	Pat Mahon	Steve Bellavia
Byron Collie	Elyse Faltz	Jordan Webber	Mark Lewis	Paul Alimena	Tim Holden
Charlie Gibson	Eva Andersen	Josh Knight	Maury Rosenthal	Rick Bria	Woody Umanoff

WAA VP for Field Events Bob Kelly made it on Sunday, fresh from grandfather duty in Pennsylvania the previous night. Thanks to everyone who was there. The best astronomy club members this side of the Oort Cloud!

There were some fine talks, concentrating this year on spaceflight. Fred Haise, the Apollo 13 astronaut, was a featured speaker, speaking via Zoom to a large audience in the auditorium. I was too involved with the goings-on inside the Rockland Community College field house to attend any of the lectures. Too many old friends to catch up with and new ones to make, and lots of great gear to ogle (although I bought nothing this year).

John Higbee (center) and the 6-inch Saturn, with long-time club members Mike Virsinger (left0 and Mike Cefola (right).

Elyse got a lesson on Foucault testing at the Springfield Telescope Maker's booth. Mirror-making lives on, although just barely.

There's no doubt that these days amateur astronomy is substantially about imaging. One of the old hands at the show, who now sells high-quality used equipment, muttered to me "No one looks through eyepieces anymore." That of course is not true: a couple of WAAers bought 110° field of view Ethos eyepieces that Televue offered at a considerable discount. Catching cosmic photons directly with one's retina is still the central experience of amateur astronomy. Astrophotography can enhance the excitement of the hobby, adding a degree of creativity, not to mention fostering perseverance, now that mirror-grinding and scope building, once central experiences for amateurs, is mostly gone. But that's the nature of progress.

Here are a few more photos from the show.

Comet C/2022 E3 (ZTF) – A Tale of Tails

Robin Stuart

My first opportunity to observe comet C/2022 E3 (ZTF) came around 2 a.m. on January 22, 2023. At the time it was at an altitude of 42° in the constellation Draco, just below the Big Dipper. I don't have a great deal of experience imaging comets and have yet to decide what works best. On this occasion I elected to take 90 second exposures and have my Paramount MyT track at a custom rate that followed the comet's motion. As it was moving at 6.7 arcminutes per hour this would make the stars appear as trails 10 arcseconds long. When the first images came in it was apparent that, along with a slender ion tail, Comet ZTF was sporting a rare *anti-tail*! Over the next several days reports and images of the anti-tail rolled in, making this a very interesting comet indeed.

Keplerian Orbital Elements

Let's look first at its orbit. As described in my previous article in the October 2022 SkyWAAtch, page 7, the orbital properties of an orbiting body can be summarized by 6 Keplerian Elements. These can be obtained using the Jet Propulsion Laboratory (JPL) Horizons system https://ssd.jpl.nasa.gov/horizons/app.html#/. For Comet ZTF, on 2023-Jan-22 00:00:00.0000 (UT) the elements were

e (Eccentricity)	1.0002557
q (Perihelion distance) (AU)	1.1122396
i (Inclination)	109.16882°
Ω (Longitude of ascending node)	302.55580°
ω (Argument of perihelion)	145.81459°
T (Time of perihelion passage) (JD)	2459957.28398

These are *J2000 heliocentric ecliptic osculating elements*, meaning that the coordinate origin is located at the center of the Sun and they are specified with reference to the plane of the J2000.0 ecliptic. Due to the presence of perturbing forces, no orbiting body follows an exact Keplerian conic section trajectory. On a given date the osculating elements together provide the best fit for an object's actual motion and can be used to compute its position around that time. The values change slightly from one day to the next.

The orbital inclination, i, for Comet ZTF is listed as 109.2° meaning that it is very steeply tilted to the plane of the ecliptic. Indeed since it exceeds 90°, a distant observer looking down on the invariable plane of the solar system would see the comet moving retrograde relative to the planets. An excellent interactive representation of the orbit in 3D can be found at http://astro.vanbuitenen.nl/comet/2022E3. The high orbital inclination indicates that Comet ZTF originated in the *Oort Cloud* and is not a *Kuiper Belt* object. The icy bodies in the Kuiper Belt mainly lie at 30–55 AU within about 10° of the plane of the ecliptic. They are the source of short-period comets with low orbital inclinations. The Oort Cloud is believed to be a spherical shell extending from around 2,000 to 50,000 AU. Comet ZTF was reported as having made its last appearance 50,000 years ago. Kepler's Third Law can be used to estimate the aphelion distance. It states that for the semi-major axis, a, in units of AU, is related to the period, P, in years by the relation, $a^3 = P^2$ giving $a \approx 1400$ AU and aphelion distance of $2a \approx 2800$ AU.

An object that is gravitationally bound to the solar system will follow an elliptical orbit characterized by an eccentricity $e < 1$. Objects with sufficient energy to escape the solar system follow hyperbolic orbits with $e > 1$ and never return. For Comet ZTF in the table above $e = 1.0002557$ but this alone does not unambiguously make it an interstellar visitor. As noted this value is obtained by approximating the comet's motion via a best fit with the 6 Keplerian orbital elements and, as it will be subject to error bars, it is too close to call. Compare this to 'Oumuamua, a known interstellar object, for which $e = 1.20113 \pm 0.00002$.

The Anti-Tail

Despite their relative rarity, anti-tails are well understood[1,2,3] and have been previously observed in Comets Arend-Roland (C/1956 R1), Kohoutek (C/1973 E1), Bradfield (C/1975 V2) and Hale-Bopp (C/1995 O1)

[1] Finson, M. L. and Probstein, R. F. (1968). A Theory of Dust Comets. I. Models and Equations. *Astrophysical Journal*, **154**, p 327-352 https://ui.adsabs.harvard.edu/abs/1968ApJ...154..327F/abstract

[2] Sekanina, Z. (1974) The Prediction of Anomalous Tails of Comets. *Sky & Telescope* **47** p 374-376.

[3] Sekanina, Z. and Pansecchi, L. (1977). The Anti-Tail of Comet Bradfield (1975p). *Astrophysical Letters* **18** p 61-63. https://ui.adsabs.harvard.edu/abs/1977ApL....18...61S/abstract

among others. Sometimes described as an optical illusion, they are really just a matter of geometry and viewing angle. In his *Sky & Telescope* article, Sekanina (1974) gives a list of conditions needed for an anti-tail to appear. One key requirement is that the Earth be close to the plane of the comet's orbit. For Comet ZTF with its large orbital inclination this condition only lasted for a relatively short period of time and the apparition of the anti-tail was correspondingly brief. How can one determine, in practice, when the Earth crosses the orbital plane?

The so-called *line of nodes* is the line along which the orbital planes of the comet and the Earth (the ecliptic) intersect. It passes through the comet's descending node, ☋, the center of the Sun and the ascending node, ☊. When the Earth passes through the comet's orbital plane, it will also lie on this line. At such times the Earth's ecliptic longitude will be equal to either the comet's longitude of the ascending node, Ω, or longitude of the descending node, $\Omega \pm 180°$. The ecliptic longitude of the Sun is the opposite of the Earth's. From the table of orbital elements above, Ω = 302.55580°. Clicking on the Sun in the program *Stellarium* lists, among other things "Ecl. long./lat. (J2000.0):". By adjusting the time it is found that the Earth crossed Comet ZTF's orbital plane around 4:18 UT on January 23, 2023.

Although there are some quite good articles available explaining the origin of anti-tails (e.g. https://skyandtelescope.org/astronomy-news/understanding-the-tails-of-comet-ztf-c-2022-e3/) they tend to be rather general in nature. I wanted to get a handle on the specifics of Comet ZTF and, in particular, try to develop a better understanding of what I was seeing in my own images.

Dust Tail Dynamics

Comets are often seen wearing two distinct types of tail – an ion tail and a dust tail. The ion tail consists of charged particles, ions, that stream out in the direction away from the Sun at around 400 km/s. As this is much faster than the speed at which the comet itself is moving, the ion tail is long, straight and slender. Its visible structure is influenced by the contortions of the magnetic fields permeating the solar wind that may produce a *disconnection event*, in which a break or gap forms in the otherwise continuous ion tail. Such a disconnection event was observed in Comet ZTF on January 19, 2023 and has been attributed to a coronal mass ejection from the Sun.

Dust particles of varying sizes are also ejected from the comet's nucleus and are acted on by gravity and the radiation pressure of sunlight. Both of these forces follow an inverse square law, but whereas gravity is attractive and directed toward the Sun, radiation pressure is directed away from it. The net effect is that a dust particle effectively experiences a reduction in the force of gravity and will follow its own independent orbital trajectory.

The radial acceleration produced by radiation pressure is inversely proportional to the size of the particle. Smaller particles experience a greater acceleration. The ratio of the force of radiation pressure to that of gravity acting on a particle is denoted μ.

Conceptually the motion of a dust particle in the tail is therefore quite simple and is just like any other body subject to an inverse square law. To simulate it I took an equally simplistic approach. Dust particles are assumed to originate at the nucleus with zero initial velocity relative to the comet. After calculating the magnitude and direction of the net acceleration produced by gravity and radiation pressure the particle is propagated for a short time interval, Δt, assuming that the acceleration is constant. The position, velocity and acceleration are then updated and the procedure is repeated. It can be summarized as

$$\vec{r}_{i+1} = \vec{r}_i + \vec{v}_i \Delta t + \frac{1}{2}\vec{a}_i \left(\Delta t\right)^2$$

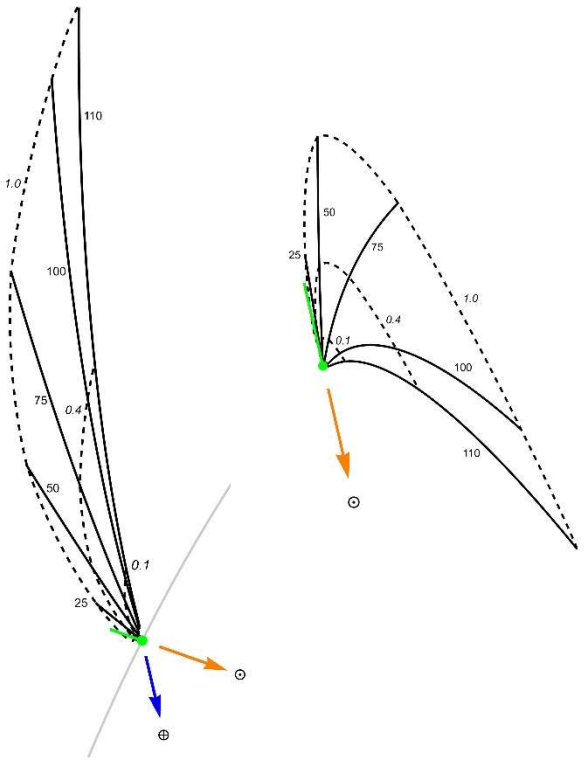
$$\vec{v}_{i+1} = \vec{v}_i + \vec{a}_i \Delta t$$

where

$$\vec{a}_i = -\frac{GM\left(1-\mu\right)}{\left|\vec{r}_i\right|^3}\vec{r}_i$$

Here G is universal gravitational constant and M is the mass of the Sun. For this simulation it is convenient to work in terms of astronomical units (AU) and days (d). In these units GM = 2.96×10^{-4} AU^3 d^{-2}. For Δt, 0.01 day was used but the results are quite insensitive to the actual value chosen. This is as it should be since as noted previously (March 2021 SkyWAAtch, page 8) "… things should not depend on things they are not dependent on."

Carrying out this simulation over a range of μ values and time intervals produces a representation of the dust tail's expected structure. As there are no forces acting on the particles that would move them out of the comet's orbital plane, the dust tail will tend to form a flat fan-like structure concentrated in the plane. An observer located within the orbital plane will see the fan edge-on and the line of sight will encounter higher concentrations of dust particles. The visibility of diffuse regions of the tail will be enhanced.



To perform the simulation I first downloaded from the JPL Horizons system the barycentric 3D vector positions for the comet, the Earth and Sun and the velocity vectors for the comet and Sun at daily intervals for the time period of interest. These were converted to the required heliocentric equivalents by subtracting the position and velocity of the Sun. The calculations were performed and diagrams drawn using code written in *Mathematica*. Having convinced myself that I could accuracy reproduce the diagrams that had appeared in *Sky & Telescope* for Comets Arend-Roland and Kohoutek (Sekanina 1974) I turned my attention to C/2022 E3 (ZTF). There is also an online application (https://www.comet-toolbox.com/FP.html) that can do this but it is limited in that it only produces the view of a geocentric observer.

The diagram on the left shows the view on January 25 at 10:19 UT for an observer located high above the north pole of the comet's orbit (indicated by the grey curve). From this vantage point the comet moves counter-clockwise around the Sun. The tail is a flat fan below seen broadside-on. The direction of the Earth is indicated by the blue arrow and the orange arrow shows the direction of the Sun. At the time they were 0.37 AU and 1.34 AU from the comet respectively. The comet's head and ion tail are represented in green. As a reference scale the length of the ion tail is 6.1 million km and was set to be 5° as reported by some observers. The distance from the comet's head to the farthest point drawn in the dust tail is 0.8 AU.

In the diagram the dashed curves are *syndynes* which represent streams of particles of the same size emitted at different times in the past. They are labelled in italics with their value of μ. Points on a syndyne that are closer to the nucleus were emitted more recently than those further out. The solid curves are *synchrones* which trace out the positions of particles that were all emitted at the same time in the past. They are labelled with the time since their emission in days. Smaller particles, with larger μ, lie further from the nucleus. Synchrones tend to be straighter than syndynes. Note that each point in the tail is associated with a unique pairing of particle size, as given by μ, and time since emission. Each syndyne and synchrone represents the trajectory of particles emitted from the nucleus with zero initial relative velocity. In the real tail, variations in these initial conditions will lead to some dispersion around the plotted paths.

The right-hand diagram, sometimes called a Finson-Probstein diagram, shows the corresponding view as seen from the Earth which has just passed through the plane of the comet's orbit and for that reason the dust tail is offset to one side. Regions of the dust tail clearly project forward of the nucleus in the sunward direction. The dust particles concerned are "old dust" emitted fairly long ago in the past. They are spread over a relatively large area within the tail but are concentrated and rendered visible by the nearly side-on viewing angle.

Compare the right hand Finson-Probstein diagram with the image to the right taken at the corresponding time from Eustis, Maine. The general characteristics and location of the dust tail are reproduced. Had the image been taken 2.6 days earlier when the Earth passed through Comet ZTF's orbital plane, the anti-tail would appear as a narrow spike extending directly sunward. For scale the distance from the nucleus to the point where the ion tail meets the top of the frame is 1.1°. In the right hand diagram the ion tail is and is drawn 5° long.

Shown on page 15 are images taken on January 22 around 7:06 UT and February 11 around 23:56 UT along with their corresponding Finson-Probstein diagrams. Note that in the January image the anti-tail lies to the left of the comet's nucleus while on the image from the 25th (above) it lies to the right. Between the times when these images were taken the Earth passed through Comet ZTF's orbital plane. In the second image, taken much later, the anti-tail has disappeared and the dust grains that now make up the visible tail are no longer concentrated along the line of sight. They were emitted more recently than those that constituted the anti-tail.

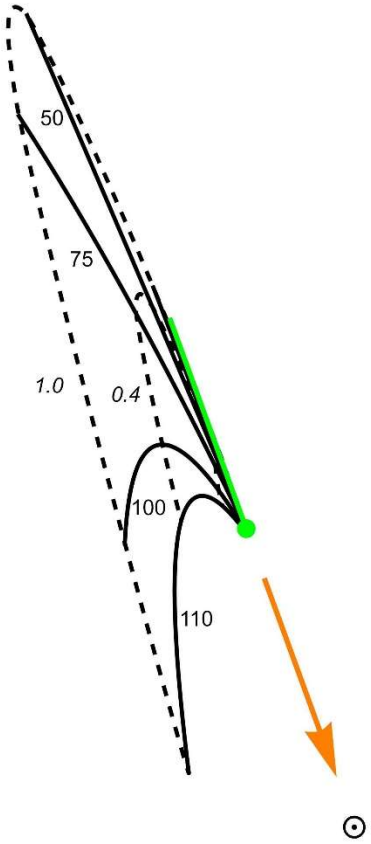
Imaging Notes

The image of January 22 was made from 22 × 90 second exposures using a ZWO ASI2600MC through a TeleVue NP 127 with the telescope mount tracking the motion of the comet. Those of January 25 and February 11 were constructed from 30 × 60 second exposures tracking the stars.

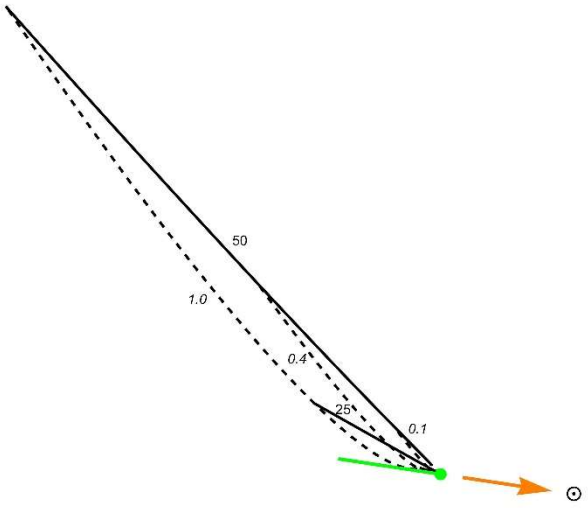
None of images shown here are scientifically accurate because, although they were all taken over a 30 minute period, both the comet and the stars appear to be fixed. They have been constructed to produce an aesthetically pleasing result. The sets of images were aligned on the comet using PixInsight's CometAlignment process and the stars were removed with Starnet2 before stacking. The same set of images were then aligned on the stars and the trailed comet was removed with Starnet2. After separate enhancement, the two images were recombined.

Removing the stars can help to make fainter regions of the tail more readily visible. For example, in the starless image from February 11 (the last image below) the ion tail can be traced across the whole width of the frame. On the other hand removing the stars is an imperfect process and always leaves some artifacts, especially in slightly hazy conditions. Attempts to enhance fine details in the comet's tail may also enhance the artifacts requiring hands-on removal.

Comet C/2022 E3 (ZTF)



January 22 7:06 UT

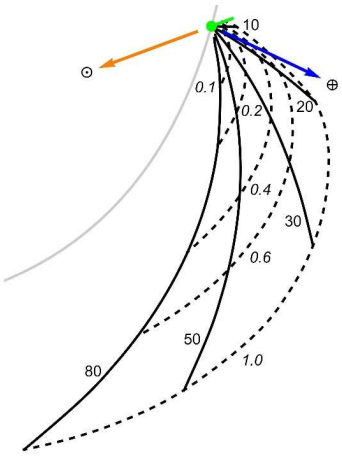


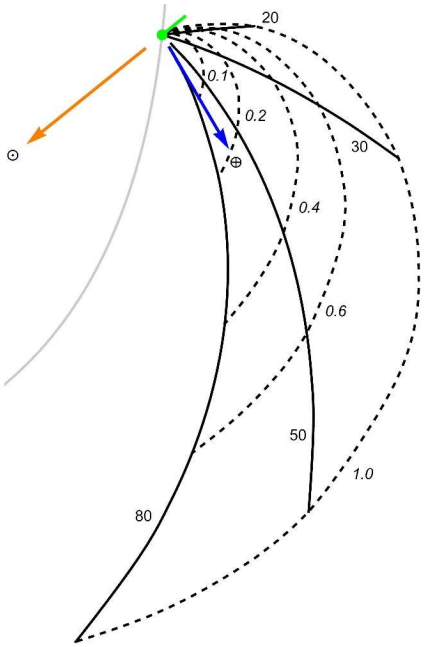
February 11 23:56 UT

Future Prospects – Comet C/2023 A3 (Tsuchinshan-ATLAS)

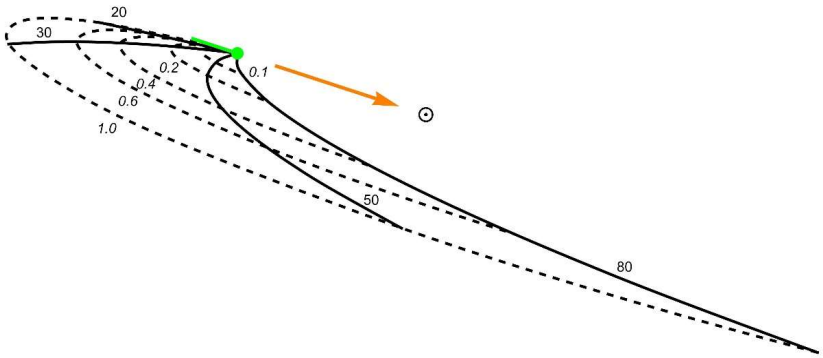
Another recently-discovered visitor from the Oort cloud is currently inbound. Predicting the behavior and brightness of comets is a difficult and uncertain business but chances are that Comet C/2023 A3 (Tsuchinshan-ATLAS) will attain naked eye visibility in October 2024 (see https://is.gd/comettsuch).

The comet will reach perihelion on September 27 at 12:51 UT at a distance 0.39 AU and 17 days later on October 14 at 18:36 UT the Earth will pass through its orbital plane. At that time it will be 0.48 AU from the Earth and 0.60 AU from the Sun. Its (solar) elongation will be just 25.4° making it not an easy target. The diagram on the left shows the view from the direction of the north pole of the comet's orbit using the same conventions used previously. A Finson-Probstein diagram for an Earth-based observer represents the dust tail as a single line extending no more than 4° in the direction away from the Sun and the bulk of the tail being directed sunward from our viewpoint. The geometry is reminiscent of Comet Arend-Roland (C/1956 R1) (Sekanina 1974).





The diagrams above right and below show the situation 10 days after the plane crossing. By this time the elongation will be a more comfortable 51.7°. In the Earth-based view (below) the locations of the individual syndynes and synchrones can be seen. North is up in this diagram. As seen from the Earth much of the dust tail remains sunward of the comet's nucleus. A great deal will depend on precisely how the comet performs but from a geometrical perspective the chances of an anti-tail appearing seem very good. ■

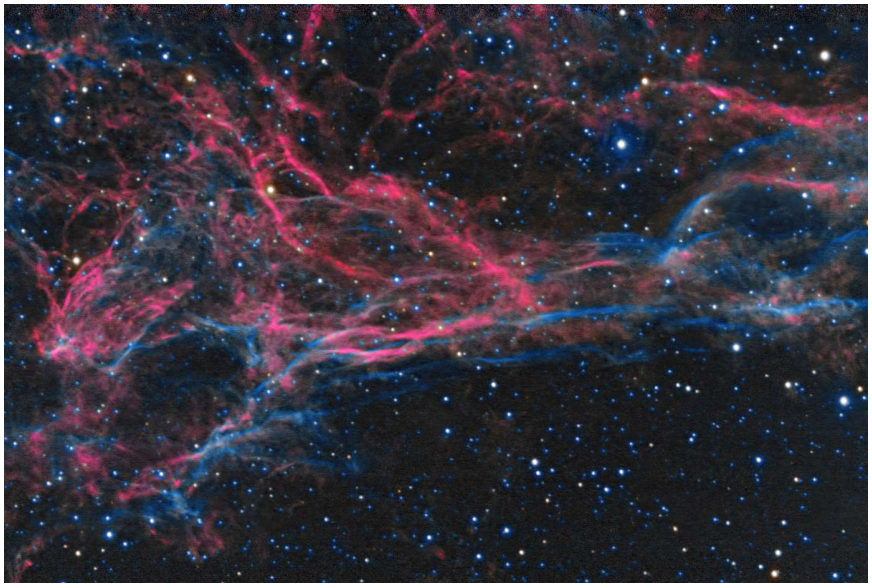


Images by Members

The Monkey Head Nebula by Steve Bellavia

NGC 2174 is a n emission nebula associated with the star cluster NGC 2175. Although formally within the boundary of Orion, it is just below the "feet" of the more northern twin of Gemini (i.e. Castor). It may have been seen as early as 1654 by Giovanni Batista Hodierna (see the January 2023 SkyWAAtch, p. 16), but discovery is credited to Carl Christian Bruhns in 1857 at the Berlin Observatory. It does appear in John Herschel's General Catalogue in 1864 as GC 1366. Sometimes the NGC designations for the cluster and the nebula are confused and the object is often referred to as NGC 2175. Stephen James O'Meara, in *Hidden Treasures*, insists that the nebula be called NGC 2175, and reserves NGC 2174 for some diffuse nebulosity a little further north. Steve Bellavia sent this image in labeled "NGC 2174" and so we have used that designation. The whole issue is compounded by doubts that there even is a cluster associated with the nebulosity! Sharpless includes it within the extended HII region Sh2-252.

The object is fairly bright, magnitude 6.9, and quite large, 40x30 arcminutes, just slightly larger than the full Moon. The class O star HD 420888, magnitude 7.6, is responsible for the radiation that excites the nebula's hydrogen gas. The distance is 7,200 light years. O'Meara notes that if this nebula had been as close to us as the Great Orion Nebula M42 (1,344 light years) it would cover more than three degrees and shine at magnitude 5.



Veil Nebula Details
by Arthur Miller

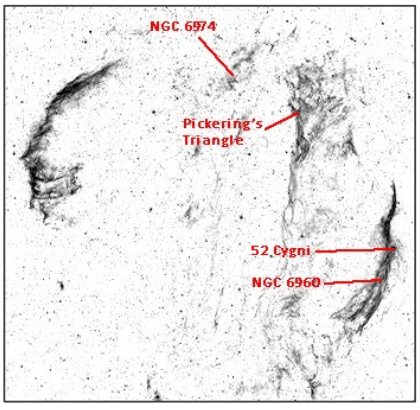
Top: Pickering's Triangle (sometimes called Pickering's Triangular Wisp) is a bright knot of gas in the northwestern part of the supernova remnant known as the Veil Nebula. Like the Horsehead in Orion (see the April 2023 SkyWAAtch) it was first noted on a glass plate image by Williamina Fleming at the Harvard Observatory but the discovery was credited to William Pickering. It does not have a specific NGC or IC number, but it is catalogued as Simeis 3-188.

Center: NHC 6974 is also in the northern part of the nebula, just 37' northwest of Pickering's loop.

Bottom: NGC 6960 is the western side of the nebula. The bright star is 52 Cygni, a helium-fusing class K of magnitude 4.2. It is much closer to us than the Veil (291 vs. 2,400 light years)

North is to the left in all three images.

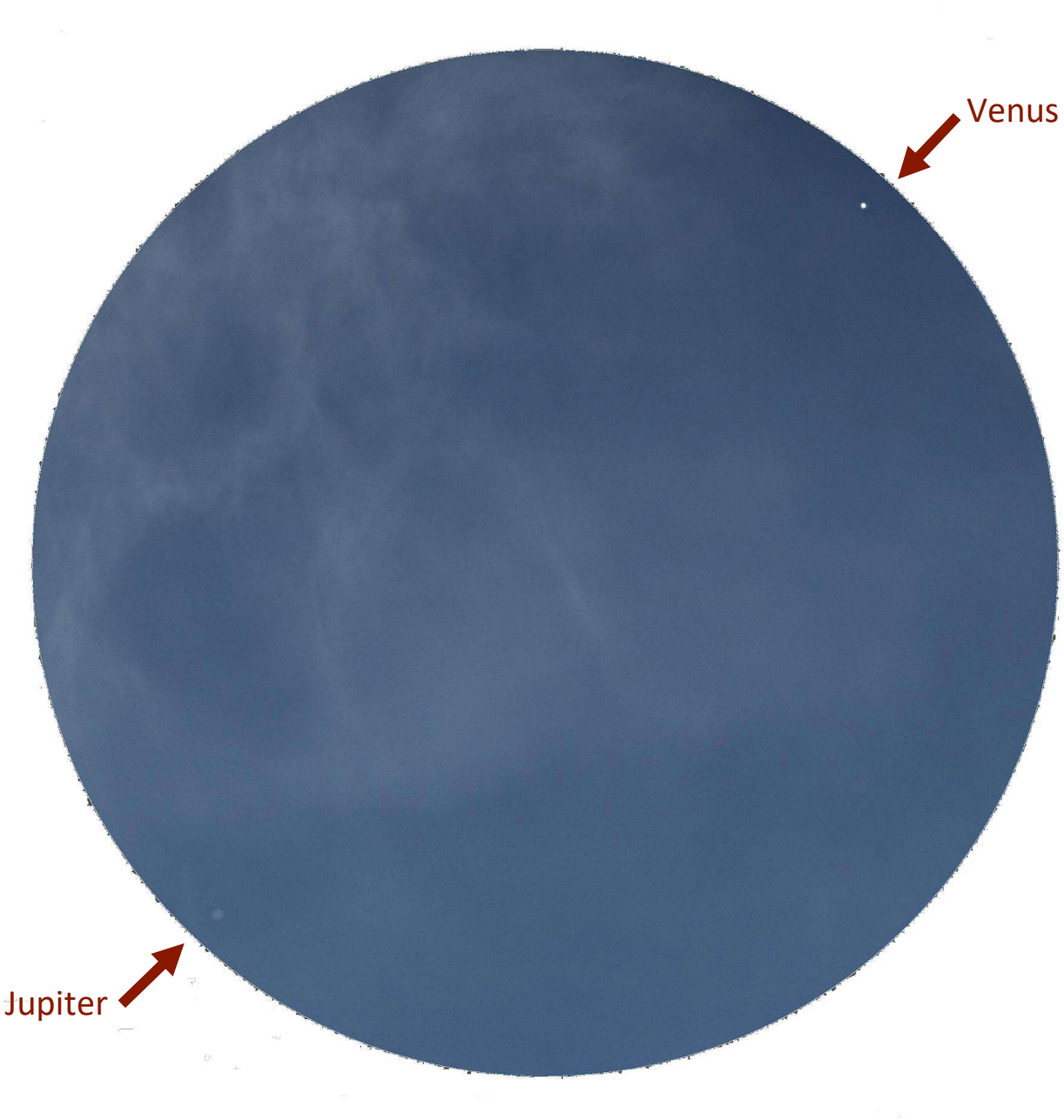
Here's a map for orientation.



The Eagle Nebula by Rick Bria

Rick Bria sent this image of Messier 16. The famous "Pillars of Creation" are in the center, beautifully outlined by glowing hydrogen gas. The Pillars were made famous by a Hubble Space Telescope image, but Rick used a different color palette. He writes "The color palette at the Aloysia Hardey Observatory is different from the colors used by the Hubble Space Telescope. The Hubble palette maps sulfur, hydrogen and oxygen to red, green and blue. Our color scheme only uses filters for hydrogen and oxygen. This palette is referred to as "HOO" and attempts to produce more natural colors at the expense of sacrificing some details brought out by sulfur emission. Testing has shown the HOO palette works well with our equipment." The image was made using two hours of exposure with the 14-inch CDK instrument at the Mary Alysia Hardey Observatory in Greenwich.

Daylight Planets by Steve Bellavia



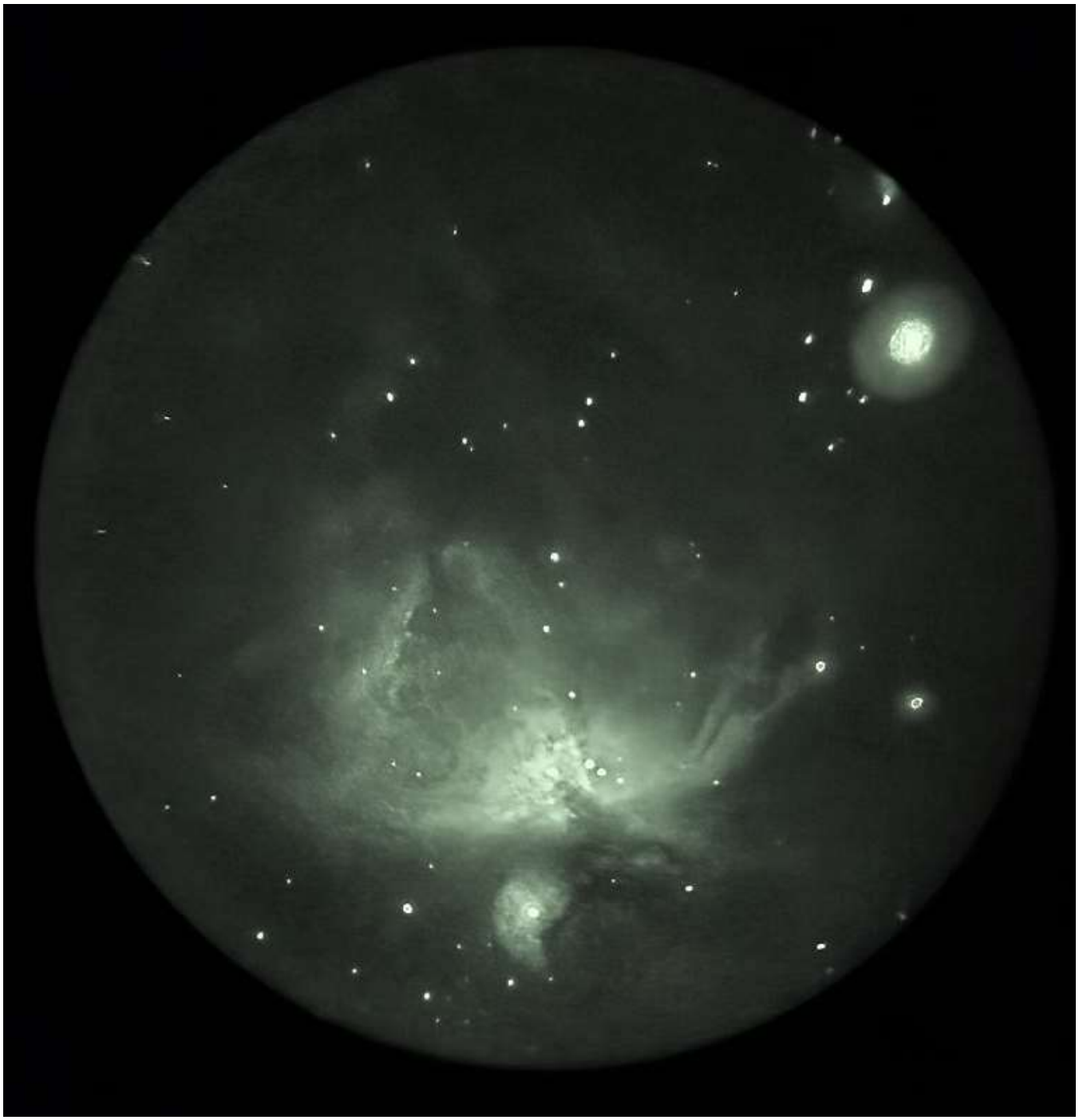
Steve has done some daylight planet-hunting this winter, and sent us a few images. Here's an image of Venus and Jupiter in the field of a 90-mm APO refractor, using a Canon DSLR. The exposure is 1/1600 second at ISO 100. The image was made on March 1, 2023 at 12:05 p.m. when the two planets were just 41' 54" apart. The pair were 30 degrees from the Sun. Venus was magnitude -4.0 and Jupiter magnitude -2.1.

The Inner Planets in Detail

Steve Bellavia periodically images Mercury's sodium tail, using an Edmund Optics 589 nm sodium-line filter. His latest image was made on April 10th when the innermost planet was about 5 degrees above the horizon an hour after sunset. Sodium atoms are blasted from the planet's surface by the solar wind and micrometeorites.

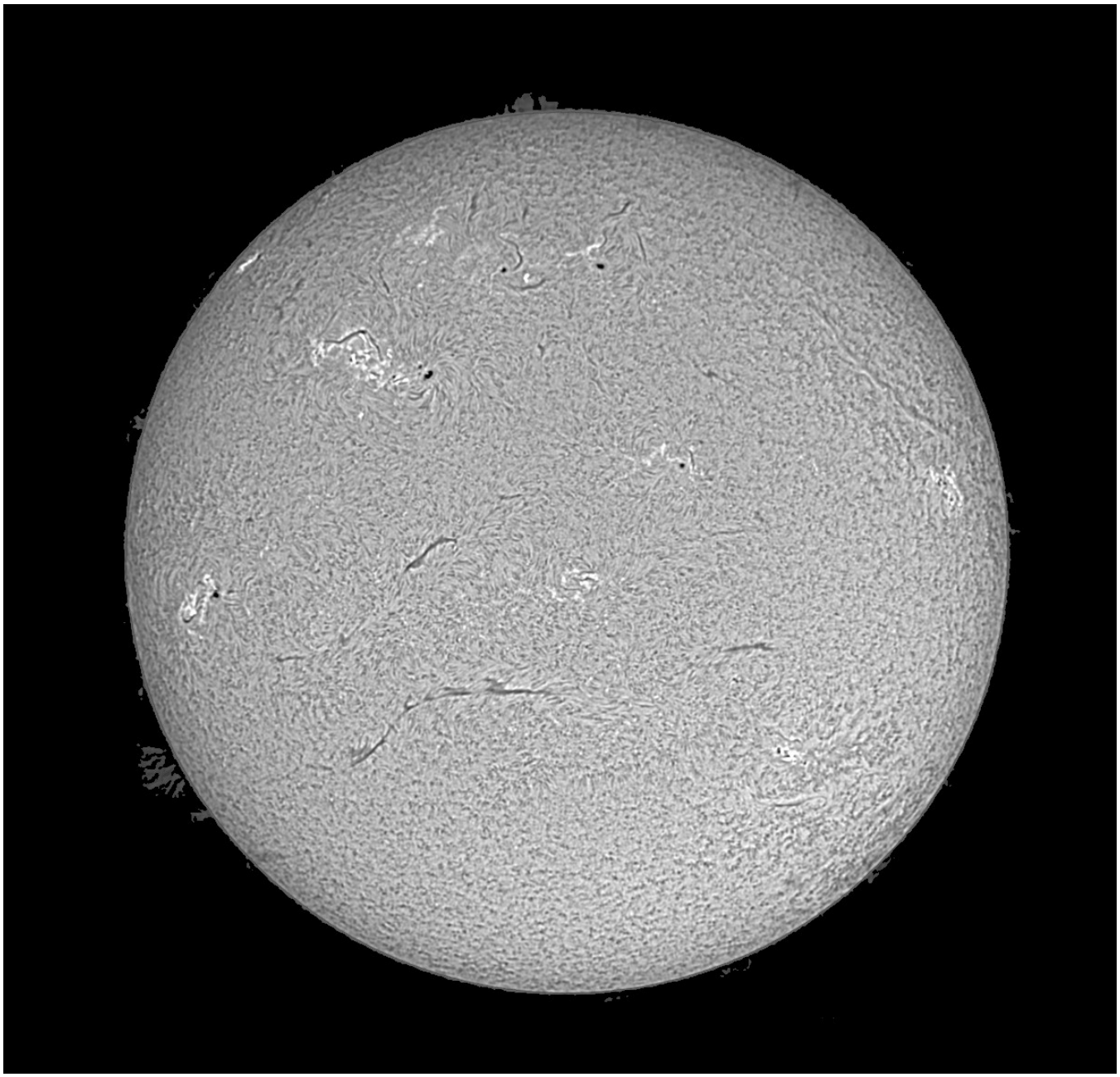
John Paladini imaged Venus on two occasions in April, using a Baader Calcium K-line filter to show structure in the Cytherean clouds. The filter passes ultraviolet wavelengths at 395 ± 8 nm. The difference between the two images has a lot to do with the telescopes: unlike an SCT, a classical Cassegrain has no corrector plate. The SCT's glass plate blocks some of the UV wavelengths. Seeing was probably a tad better on 4/20.

Messier 42 through an Image Intensifier by John Paladini



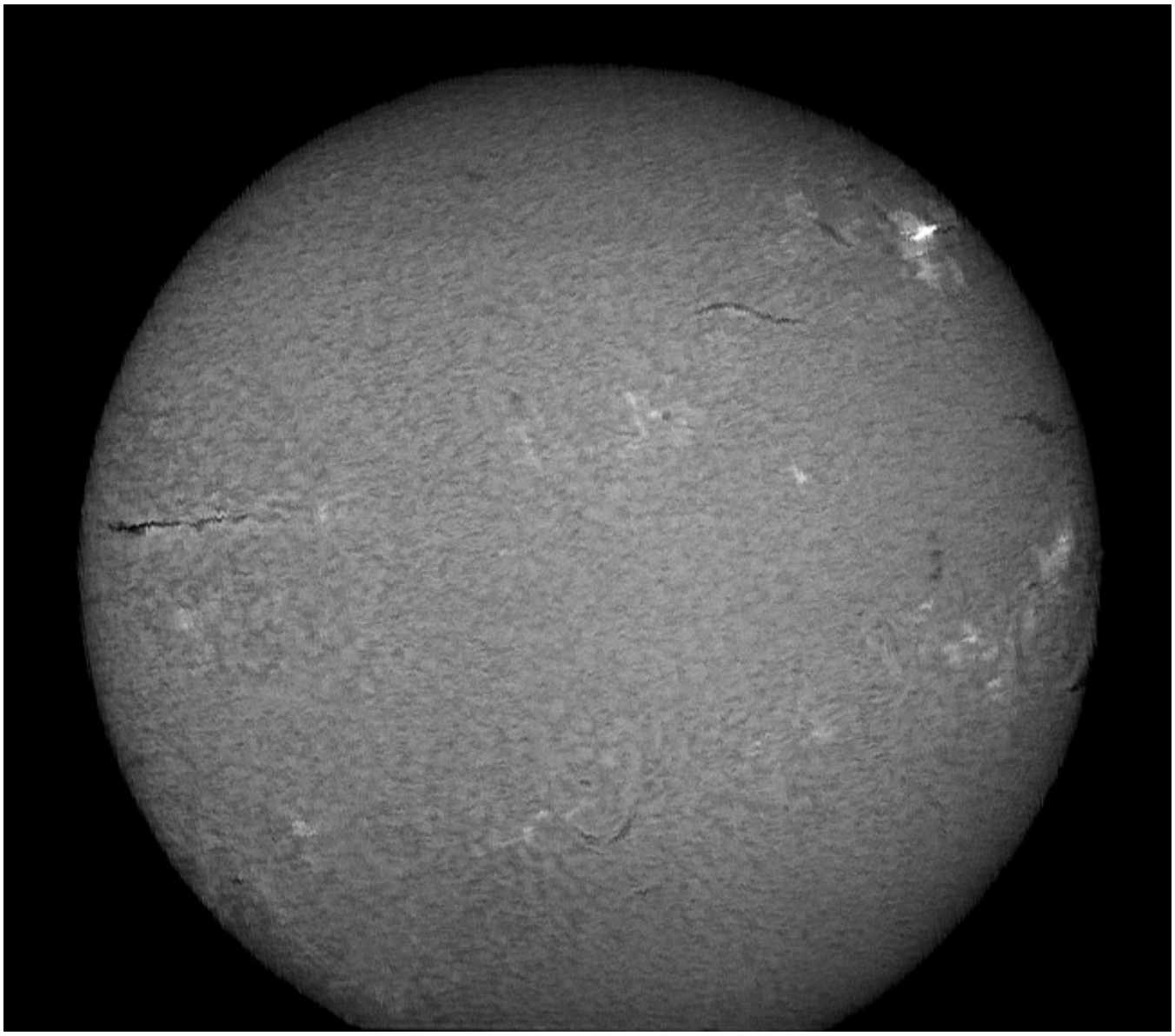
John mounted his image intensifier eyepiece on a 10-inch f/4.5 refractor and made this image with a hand-held Samsung cell phone camera. It is difficult not to wash out the images of the stars at the core of the nebula with a regular astrophotography set-up, but the image intensifier shows them while still preserving a lot of the nebula's gas and dust. The overexposed star on the upper right is HD37303, a sixth magnitude class B star. It is surrounded by some image artifact from slight tilting of the camera's sensor to the image plane.

The Sun on March 5 by Larry Faltz

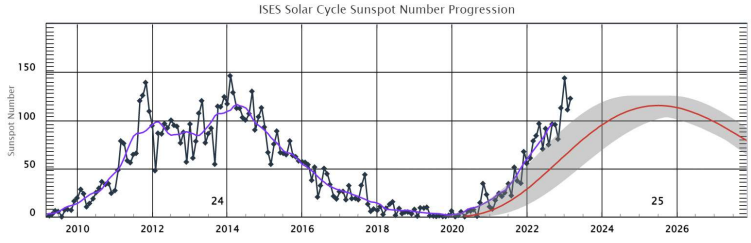


Lunt 60-mm hydrogen-alpha telescope with single etalon (0.7 Å bandpass), Skywatcher AZ-GTI mount, ZWO ASI290MM camera, processed with the latest version of the ASIStudio software, the latest version of which (1.8.1) now includes stacking and wavelet functions. Some hit-and-miss finagling in the (free) image-processing program Gimp 2.10 using layers and a transparency mask brought out the prominences, which are never as bright on an image as they are in the eyepiece. This was my first attempt at this technique, and it's definitely not perfect: the prominences are a little "blocky." But it's better and more realistic than making two separate exposures, one for the disk and one for the prominences, and trying to scale and combine them properly. -- **LF**

John Paladini Captures an X-Flare



Using his home-made spectroheliograph, which is capable of narrow-band solar imaging at any visible wavelength, John Paladini captured what appears to be an X-class solar flare on March 29, 2023. Solar flares are ranked from weakest to strongest as B, C, M and X, in a logarithmic scale. So a class X flare is 1,000 times stronger than a class B flare. Within each class there's a logarithmic breakdown denoted by a number, such as C4 or M6. X is not the limit: there are X1 and X2 flares and so on, each ten times stronger. The strongest flare to date was in 2003, and was measured to be X45. This flare was bright enough to overload the sensor on John's ASI290MM camera.

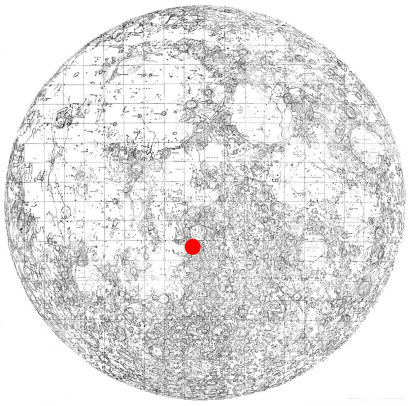


Current sunspot numbers (as of 4/18/23)

NOAA Space Weather Prediction Center
https://www.swpc.noaa.gov/products/solar-cycle-progression

Alphonsus by John Paladini

The 118-km (71-mile) diameter crater Alphonsus is quite flat but has a high central peak (2,730 km, 8,300 ft). It is the middle crater in the famous trio with Ptolemaeus to the north and Azrachel to the south, sitting along the eastern edge of the Mare Nubium.



The crater is named for King Alfonso X, who reigned over Castile in Spain in the middle of the 13th century. Known as "Alfonso the Wise," he established an environment of intellectual and cultural progress that, at least temporarily, productively united Christian, Jewish and Islamic scholars. He inherited the efforts of the Toledo School of Translators, who made translations of works in Greek and Arabic into Latin, most notably Gerard of Cremona's translation of Ptolemy in the 12th century. Alfonso had many of these works translated into the secular Castilian language. He was an avid believer in astrology, and sponsored the Alphonsine tables, the first planetary tables since Ptolemy. The tables listed planetary positions beginning in 1252. Copernicus used them in *De Revolutionibus*. While the 1551 Prutenic tables were an improvement, they remained in use in some parts of Europe until 1627, when Johannes Kepler's Rudolphine Tables were published.

John made this image on March 30 with a Meade 10 inch SCT, a 1.6x+ Barlow and an ASI290MM camera. It's a stack of 500 images.

Research Highlight of the Month

Williams, H, et. al. (24 authors), A magnified compact galaxy at redshift 9.51 with strong nebular emission lines, *Science* April 13, 2023 (https://www.science.org/doi/epdf/10.1126/science.adf5307)

Abstract:

Ultraviolet light from early galaxies is thought to have ionized gas in the intergalactic medium. However, there are few observational constraints on this epoch, due to the faintness of those galaxies and the redshift of their optical light into the infrared. We report the observation, in James Webb Space Telescope (JWST) imaging, of a distant galaxy that is magnified by gravitational lensing. JWST spectroscopy of the galaxy, at rest-frame optical wavelengths, detects strong nebular emission lines due to oxygen and hydrogen. The measured redshift is $z = 9.51 \pm 0.01$, corresponding to 510 million years after the Big Bang. The galaxy has a radius of 16.2 (+4.6,−7.2) parsecs, substantially more compact than galaxies with equivalent luminosity at $z \sim 6$ to 8, leading to a high star formation rate surface density.

The astonishing capabilities of the James Webb Space Telescope are no better illustrated than by this article. The international team, led by Patrick Kelly of the University of Minnesota, and including Alex Filippenko of UC Berkeley, detected an incredibly faint and distant gravitationally lensed galaxy. The JWST NIRCam and NIRSpec provided enough information to predict the galaxy's size, mass and star formation rate. Sophisticated software packages are used to tease the information out of the raw data.

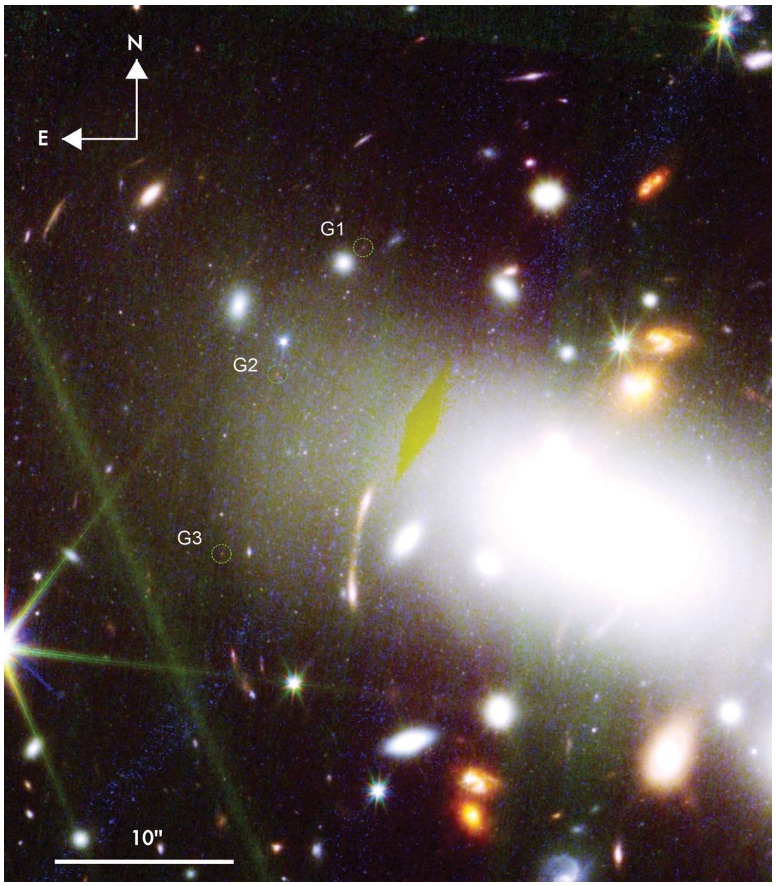
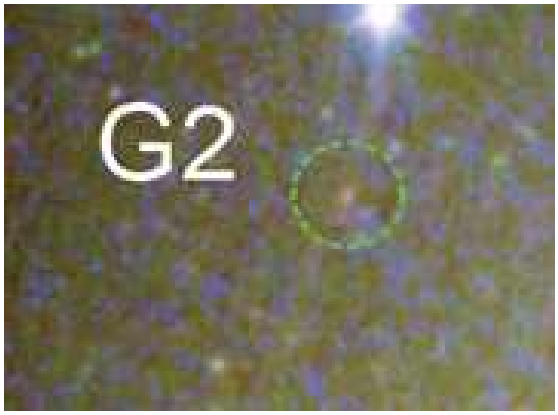


Fig. 1. Color-composite image of part of RX J2129.
JWST NIRCam + HST ACS color-composite image of galaxy cluster RX J2129, with three images of the *z* = 9.51 galaxy circled in green. We obtained spectroscopy of image G2. Filters were assigned to RGB colors as: red JWST F277W+F356W+F444W; green JWST F115W+F150W+F200W; blue HST F606W + F814W. The broad blue and green bands are diffraction spikes caused by foreground stars. The yellow diamond is an artefact caused by a chip gap in the HST ACS camera.

The mass, brightness and star formation rate of this young galaxy (only 512 million years after the Big Bang) are greater than predicted by simulations of early galaxy formation based on the generally accepted ΛCDM model. This undoubtedly means we will soon encounter some new theoretical proposals about fundamental aspects of cosmology and creative new ideas about of the structure and evolution of the universe.



Enlargement of a portion of Fig 1 to show one appearance of the galaxy more clearly.

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
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 Plossl eyepieces, hex wrenches, tube rings, mount, bolts, manual. Optics are pristine; tube has a couple of very minor blemishes. Orion's image is here.	$325	Larry Faltz lfaltzmd@gmail.com
Celestron Cometron telescope	Small, lightweight 114 mm f/4 reflector. Red dot finder, 25 mm eyepiece. Dovetail bar. A starter scope for a smart, interested child. No tripod: use a camera tripod. Excellent condition.	$50	WAA ads@westchesterastronomers.org
Eyepiece holder for Dobsonian	Anodized aluminum. Bolts on to side of rocker box. Very solid. Holds three 2" and two 1½" eyepieces. Bolt to side of rocker box. 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

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!*

It was a particular pleasure to see Televue's Al Nagler once again at NEAF. Here he is with WAA member Mike Cefola, who is looking through a Televue 3.7-mm Ethos eyepiece on a Televue NP-101 telescope. Photo by Angela Virsinger.

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

Editor: Larry Faltz
Almanac Editor: Bob Kelly
Editorial Consultant: Scott Levine
Proofreader: Elyse Faltz
Editor Emeritus: Tom Boustead