

Sky WAA tch

The Newsletter of Westchester Amateur Astronomers

September 2023



LBN 310, the “Weeping Willow Nebula” in Cygnus by Steve Bellavia

Steve writes, “This is an object I have been planning and preparing to capture for quite some time. It is a region in Cygnus with many faint emission nebulae, as well as dark nebulae. When I first saw it, it reminded me of a weeping willow tree, which is my own name for it, not “official.” [The Editor notes that there doesn’t seem to be any official control of nicknames, as distinguished from catalog names, for astronomical objects. This is why some objects have multiple colloquial names and there are two galaxies that are referred to as “Pinwheel”.]

Steve made this narrowband image at Orient Point on the easternmost tip of Long Island’s North Fork. Detailed information is at <https://www.astrobin.com/vbqymx/B/>.

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).

WAA September Meeting

Friday, September 8, 2023 at 7:30 p.m.

Members' Night

Presentations by WAA members

It's one of our most popular events. WAA members will make short presentations on a variety of topics of interest to their colleagues. Contact Pat Mahon, WAA VP for Programs, at waa-programs@westchesterastronomers.org if you wish to be included on the program.

Starway to Heaven

Ward Pound Ridge Reservation, Cross River, NY

Saturday, Sept. 9, Rain/cloud date Sept. 16

WAA Members: Contribute to the Newsletter!

Send articles, photos, or observations to waa-newsletter@westchesterastronomers.org

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Also In This Issue

3	Almanac (Bob Kelly)
4	Something Completely Different
5	WAA Picnic, September 17
6	July 22 Star Party
7	August 19 Star Party
8	Eli Goldfine Wins Stellafane Award
9	DSO of the Month
10	Another Movie Telescope
11	Field Rotation (Robin Stuart)
14	Observing Report (Steve Bellavia)
16	Deconvolution (Larry Faltz)
24	Images by WAA Members
32	Research Finding of the Month
33	Member Equipment Classifieds

WAA October Meeting

Friday, October 13, 2023 at 7:30 p.m.

Space Volcanoes

Caitlin Ahrens, PhD

NASA/Goddard Space Flight Center

New Members

Justin Accetturi	Scarsdale
Lawrence Baskind	Cortlandt Manor
Laura Brengelman	Greenwich, CT
Shawn Cargil	Bronx
Matthew Casavant	Cross River
Jessica Clark	Nyack
Eva Gao	Millwood
Bob Kenison	Scarsdale
Michael Marinelli	Pound Ridge
Zubin Wadia	Chappaqua

Renewing Members

Salman Abbasi	Yonkers
Paul Andrews	Patterson
Leandro Bento	Mohegan Lake
Thomas Boustead	White Plains
Michael & Ann Cefola	Commack
Jim Cobb	Tarrytown
Kathy Dietz	Port Chester
Rick Faery	Rye
Ireneo Fante	Brookfield, CT
Joe Geller	Hartsdale
Kim Hord	Dobbs Ferry
Joe Lisle	White Plains
Patricia Mahon	Yonkers
Mark Mayo	White Plains
Alexander Mold	East Orange
Scott Nammacher	Athens (NY)
Ayumi Noda	Elmsford
Ciaran O'Sullivan	Montrose
Jeremy Pantlitz	Port Chester
Christopher Plourde	New Rochelle
Deidre Raver	Mahopac
Robert Rusinko	Tarrytown
Robin Schwartz	Riverdale
Maryellen Sinclair	Cross River
Trudy Swan	Yorktown Heights
Harry Vanderslice	Mamaroneck
Carlos Vegerano	Bronx
Thomas Venditto	Somers
Roger Woolcott	Brewster

ALMANAC For September 2023

Bob Kelly, WAA VP of Field Events



Bob
Kelly



3Q
Sep 6



New
Sep 14



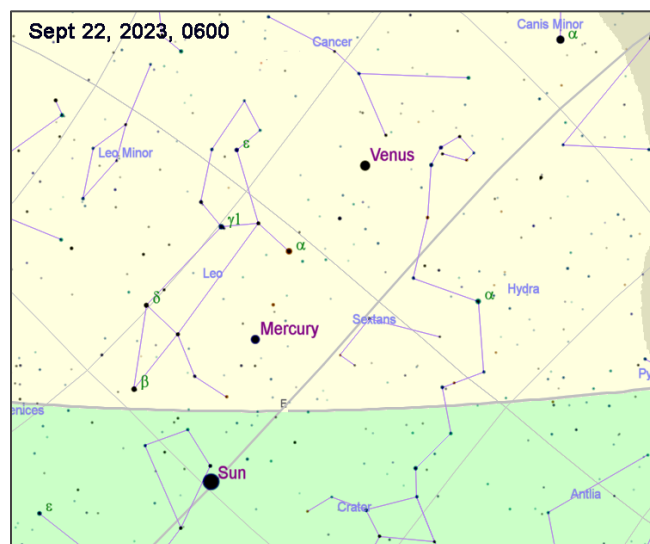
1Q
Sep 22



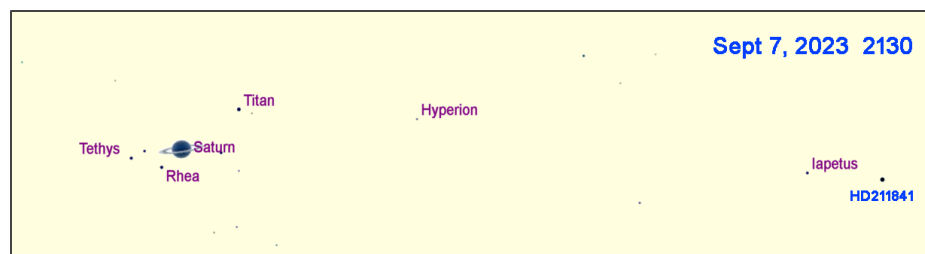
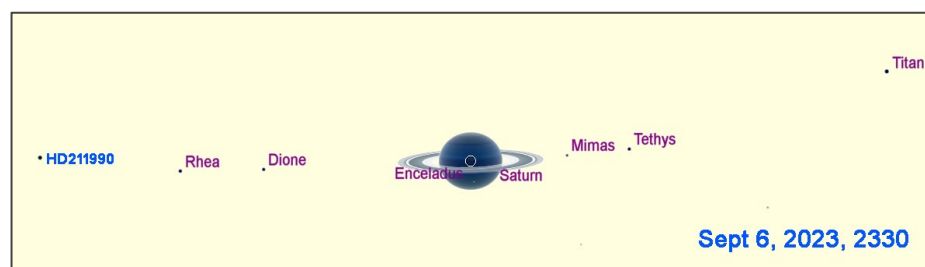
Full
Sep 29

Morning Watch

Mercury zips through inferior conjunction on the 6th to reach its greatest westward elongation at 18 degrees from the Sun on the 23rd. Catch Mercury rising at the beginning of astronomical twilight that morning. This is a good morning apparition for Mercury, even viewing in twilight, brightest on the 28th.



Venus blazes into the morning sky, peaking at magnitude -4.8 on the 18th. By mid-month, Venus rises 3 hours before sunrise. To see the crescent phase more easily, follow the planet in any telescope as the morning sky brightens.



Find the Outer Planets

Saturn is now pulling all-nighters after it reached opposition late last month. The ringed planet is perched low in the southeastern sky after sunset. It reaches its highest point in the southern sky before midnight.

Saturn's moons get some company when 9th magnitude HD 211990, almost as bright as Saturn's brightest moon Titan, appears to sail through the scene on the 5th and 6th. 8th magnitude HD 211814 passes to the northwest of Saturn from the 6th through the 10th. It is close to 10th magnitude Iapetus, then near its brightest, on the 7th. Titan and Iapetus pair up from the 19th through the 22nd.

Jupiter rises after end of twilight, getting up earlier each night as it approaches opposition in early November. Jupiter plays its usual game of hide-the-moons this month. One encounter has sparked attention at *Sky & Telescope* – Ganymede will graze the northern limb of Jupiter between 4 and 5 a.m. on the 25th. Jupiter's disk is sufficiently bright that Ganymede may be hard to pick out during this pass. But the event will occur in a dark sky, before twilight starts.

Neptune reaches opposition on the 19th, in Pisces, its 2.5 arcsecond disc shining at magnitude 7.8. Around midnight it will be above 40 degrees elevation in the south, 24 degrees northeast of Saturn.

Uranus rises about half an hour after Jupiter, also in Aries, trailing by 7½ degrees. Its 3.6 arcsecond disk shines at magnitude 5.7, making it a naked eye object in a dark sky. Both Uranus and Neptune can be resolved in moderate-sized telescopes.

Mars Plays Hard to Get

Mars will be hard to see, since it's just above the western horizon during evening twilight.

Mars is occulted by the Moon this month, but the event occurs in the middle of the afternoon on the 16th. During this event, Mars, at magnitude +1.7, will be impossible to see without a telescope as it's only 25 degrees east of the Sun. The Moon won't be easy to find either, a three percent sunlit crescent at that time.

Crewed Space Stations Sightings

The **International Space Station** is visible to the unaided eye before dawn through the 11th; and in the evening from the 11th through the end of the month.

The Chinese space station **Tiangong**, is in our skies during the morning from the 8th through the 21st, and in the evening by the end of September.

Meteor Showers

Background numbers of meteors increase in September, but there are no organized major meteor showers this month.

Comets

C/2023 P1 (Nishimura) was discovered by Hideo Nishimura in August. It is rapidly brightening as it approaches perihelion on the 18th. C/2023 P1 ends August low in the eastern morning sky as twilight increases, perhaps at magnitude +6, perhaps falling

apart, perhaps making another, larger, surge in brightness, but heading into the southern hemisphere. This is Nishimura's third comet discovery. Comet discoveries by individual observers are becoming less common now that automated observatories are finding so many comets and asteroids as a side product of looking for supernovae.

Equinox

The equinox occurs on the 23rd at 2:50 a.m. EDT. Equal day and night occurs on the 27th, if any part of the Sun above the horizon counts as 'daytime'. The width of the Sun (0.5 degrees) means the top edge of the Sun rises about a minute before the geometric center of the Sun.

One More Thought

Looking at Jupiter and Venus this month, channel your inner Galileo as you imagine (or perhaps are able to recall, from your own experience) what it would have been like to be surprised to see Jupiter's moons and the phases of Venus for the first time. Your view of Saturn through a telescope will be better than any view Galileo had. He was surprised in 1610 that planet number six had "ears" and it was not until 1659 that Christiaan Huygens figured out that the rings were distinct from the planet. ■

And Now for Something Completely Different



Hate having to pack your gear in the car to drive to an observing site? Here's a possible solution. Our friend Kelly Beatty of *Sky & Telescope* sent us a link to a story about a 9½-inch Zeiss refractor that was once mounted on top of a 1932 Ford "deuce coupe."

The full story is at <https://www.jalopyjournal.com/forum/threads/the-deuce-and-the-telescope.1246797/>.



WAA Member Picnic

Sunday, September 17, 2023 from 12 to 4 p.m.

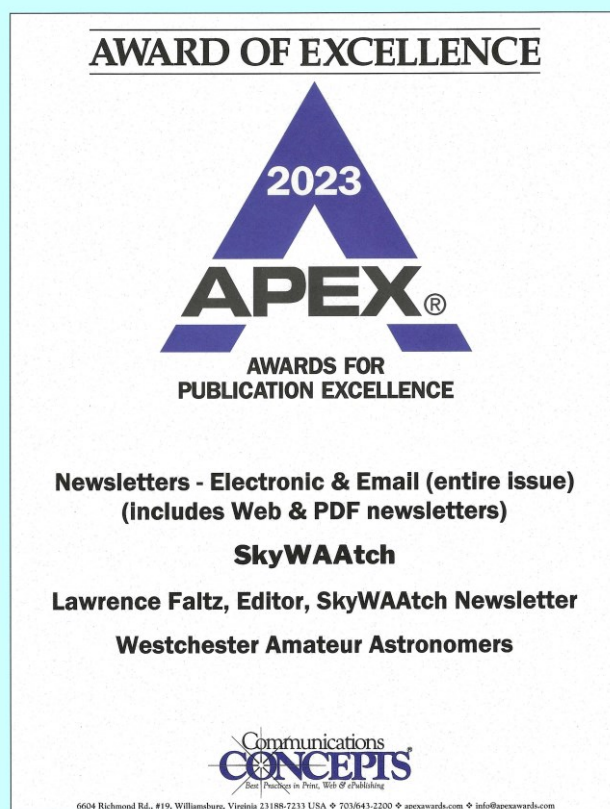
Croton Point Park, Pavilion 1. Rain or shine!

Join your fellow WAA members and their families for an afternoon of food and fun. Astronomy trivia contest, door prizes and more.

Please **RSVP by September 11th** to Eva Andersen by sending an email to andefam55@gmail.com or text to 845-803-4949 with your name(s), contact phone number and food allergies or avoidances.

SkyWAArch Wins Again!

For the third consecutive year, SkyWAArch received an Award of Excellence from Apex Communications. We're the only amateur astronomy publication to be honored.



The WAA Hotline

Call **1-877-456-5778** for announcements, weather cancellations, or questions. Also, don't forget to visit the [WAA website](http://www.waa.org).

July 22 Star Party

The July star party was scheduled for the 15th, but rain postponed it to the following weekend. Optimistic predictions all week for “clear skies” on Saturday gave way to intermittent clouds, bedeviling the viewing a bit. But early in the session, the Moon, Venus and brighter DSOs were visible, particularly in Mike Lomsky’s 14-inch motorized Dobsonian. At least a dozen members of the public stopped by.

The highlight of the evening was John Paladini’s 230 year-old table-top brass Dollond refractor. Although we had to crouch, we had a nice look at the Moon through this historic instrument (a solar image through it is in the [August 2023 SkyWAAtch](#), page 17). When John replaced the slightly foggy original eyepiece with a modern ocular, the lunar image was impressively clear and sharp.

Among the other scopes were an 8-inch Celestron SCT on an AVX mount, an 11-inch Celestron CPC, two 8-inch traditional Dobsonians, a 92-mm Astrophysics Stowaway on a Rainbow Optic RST-135 harmonic drive mount, and my Stellarvue SVR-105 refractor on a ZWO AM5 harmonic drive, with ASI533 camera. Although the conditions were not great for making high-quality images, with wispy clouds intermittently crossing the field of view, I was able to show a few people M57 in color, the supernova in M101 and the Blue Snowball planetary nebula (NGC 7662). But it was still a lovely evening. The highlights of a star party are always the socializing, educating and enthusiasm of the attendees, not to mention a unique chance this time to look through a historic instrument.

LF



John Paladini



Chris Plourde



NGC 7662



August 19 Star Party

The regular August star party, scheduled for the 10th, was clouded out, but the make-up session on the 19th was one of the truly beautiful observing nights of the year: 100% cloud-free, pleasant temperatures, low humidity and no bugs. I arrived at the park half an hour before sunset, and already half a dozen WAA imagers were set up with their scopes pointed towards the pole, ready for alignment once it was dark enough to see Polaris. Within an hour, a total of 20 telescopes were on the field, belonging to a mix of regulars and new WAA members. A couple of people had brand-new instruments being tried out for the first time, and as is traditional, experienced WAAers offered assistance when needed: leveling mounts and working through the seemingly mystical process of aligning an alt-azimuth telescope on a go-to mount.

Twilight featured a sliver of a lunar crescent low in the west. About 45 minutes after sunset, Bob Kelly pointed out the Chinese space station Tiangong, shining at first magnitude, parading across the southern sky from west to east just above the tree line. Shortly after a string of Starlink satellites appeared low in the southwest. During the evening several very bright meteors, a couple with persistent trails, were visible to those who were not peering into an eyepiece or staring into a computer screen.

WAA Board members Karen Seiter (President), Jordan Webber (Senior VP), Eva Andersen (Membership VP), Bob Kelly (Field Events VP) and your truly (Newsletter) were on hand to welcome and assist other members and the public. Later in the evening some of the folks who were camping in the park that night came by, curious to see what was going on and amazed by the celestial sights. Mike Lomsky did a wonderful job showing deep sky objects and Saturn with his 14-inch Orion Dobsonian, which always attracts a crowd. They got a taste of the glories of amateur astronomy from Mike's enthusiasm and knowledge and the impressive views through the 14.

I was able to grab a couple of snapshots before it got dark, but they don't show the real density of telescopes and the throng of attendees once it was dark enough to view. LF



Eli Goldfine Wins Stellafane Award

At the 2023 Stellafane, WAA's youngest member Eli Goldfine (age 11) won first place in the Junior competition for his restoration of a 1950's cardboard-tubed 3½-inch reflector. It was first owned by a Grumman engineer who worked on the Apollo 11 Lunar Module; his daughter is Eli's piano teacher. The telescope was made by The SkyScope Co., Inc., 475 Fifth Avenue in New York City. The 24-story building, built in 1926, is across the street from the NY Public Library. The location was probably SkyScope's offices and showroom; the scopes may have been built in Brooklyn. The company operated from about 1946 to the late-1950s. These scopes were quite popular and a thread on CloudyNights from 2013, reports that a SkyScope exactly like Eli's was comet hunter David Levy's first telescope, and possibly Al Nagler's as well.

Screws hold the tube to its simple alt-az saddle, but the holes in the tube were worn, so Eli improvised with the tried and true Paladini technique of using hose clamps. Otherwise the scope is 100% original.



Deep Sky Object of the Month: Collinder 399

Constellation	Vulpecula
Object type	Asterism
Right Ascension J2000	19h 25m 24s
Declination J2000	+20° 11' 00'
Magnitude	3.6
Size	1 degree
Distance	235 to 1735 LY
Discovery	Al Sufi, 964 CE
Other names	Brocchi's Cluster The Coathanger

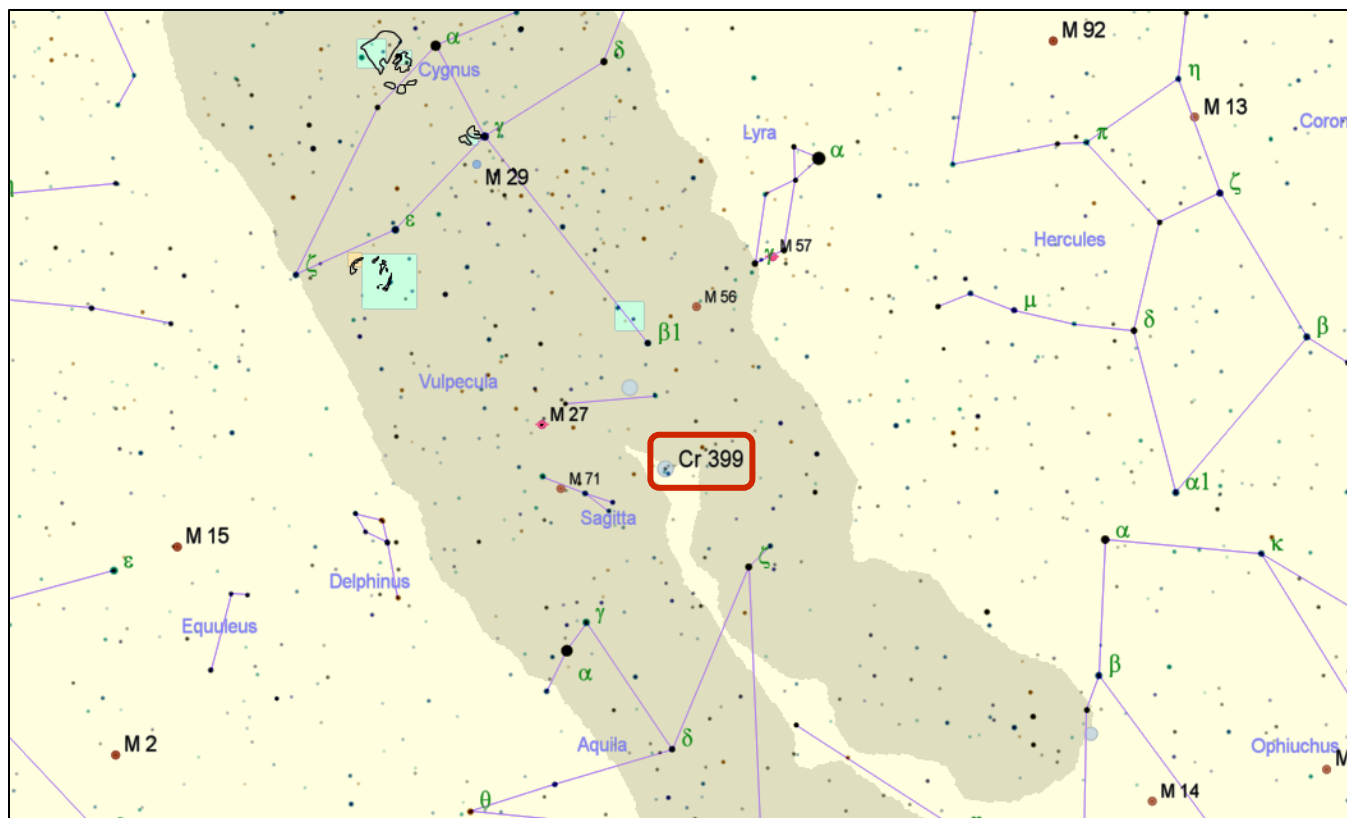
It's about time we presented one of the most viewed objects in the summer sky. Mentioned in al Sufi's *Book of the Fixed Stars*, the Coathanger was listed by amateur astronomy Dalmero Brocchi 100 years ago in an AAVSO map. It's inside the Summer Triangle and close to Albireo and the Dumbbell Nebula. The ten individual stars range from magnitude 5 to 7, but are not gravitationally related. There are 4 A stars, 3 B stars, 2 K stars and one red giant. The true open cluster NGC 6802, magnitude 8.8, lies 1° to the east but is far more distant than the stars in Cr 399.



Visibility for Cr 399			
10 p.m. EST	9/1/23	9/15/23	9/30/23
Altitude	67° 45'	62° 55'	54° 08'
Azimuth	153° 06'	222° 16'	243° 06'

You will need an eyepiece that shows at least 1 degree of field. The required formula is:

$$\text{Actual FOV} = \frac{\text{Eyepiece Field of View}}{\text{Telescope FL} \div \text{Eyepiece FL}}$$



More Movie Telescopes (and Orreries)



Three telescopes appear in the 1966 crime film noir *Harper*, a vehicle for Paul Newman that did well at the box office.

A: Robert Webber has the drop on Newman, while Shelley Winters is passed-out on the couch. An antique brass refractor is seen in the background.



B: Arthur Hill, with another antique brass refractor behind him, against the bookcase.

C: What looks like a 3-inch Unitron is pointed out the window as Newman walks by a local policeman.



D: Newman is looking at an old studio portrait of Shelley Winters, while an orrery sits on a console piano. In the film, Winters plays a once-glamorous, now washed-up alcoholic movie star whose career tanked when she “got fat,” a laughing Robert Walker says earlier in the film. A starlet in her early days, the talented (2 Oscars) Winters did gain weight, although her career never waned.

There is another orrery, properly a tellurium (Sun-Earth-Moon), in frame B, under the picture.



The film concerns a kidnapping and has a minor astrological plot element that might account for the presence of these instruments, as well as globes, an armillary sphere and sundials, in various scenes.

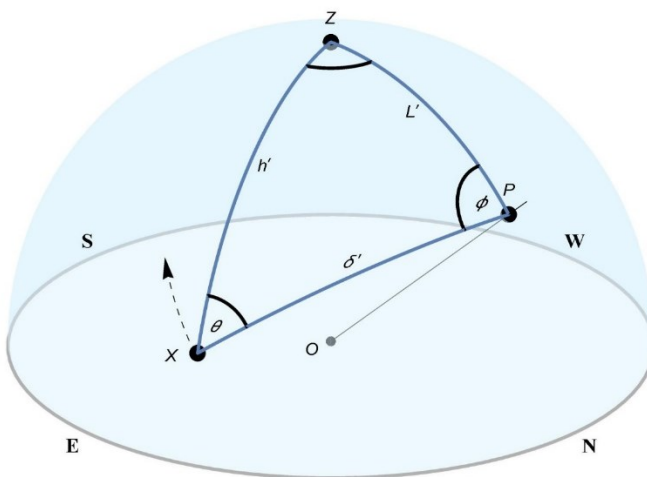
The complete story of orreries is in the [March 2023 Sky-WAArch](#).

Field Rotation

Robin Stuart

Computerized telescopes are able to track the diurnal motion of the stars across the sky, keeping a target accurately centered in the eyepiece. However, for an altazimuth mount, although the object being observed remains centered, the overall field of view will appear to slowly rotate. The phenomenon is known field rotation. Visually this is not usually a problem but photographically the stars will trail into arcs about a fixed point in the frame. To avoid this, an astrophotographer can take a series of exposures each short enough that the trails are not apparent and then stack and crop the result. Just how much of a problem is field rotation for someone wanting to use an alt-azimuth mount for imaging? In the case of a poorly aligned equatorial mount, how long of an exposure can be made before field rotation needs to be considered? This article gives some simple formulas that can provide guidance in answering these questions.

The diagram shows the state of affairs for a northern hemisphere observer, O , under the celestial sphere using an altazimuth mounted telescope to view an object, X , that is rising in the east. The telescope's "polar" axis is directed at the zenith, Z . As time progresses the object X follows the dashed arc about the north celestial pole, P , but the orientation of the line XZ remains fixed in eyepiece's field-of-view or on the camera's image plane. The direction XP of the pole, however, will change over time and the star field will be seen to rotate. The rate of field rotation is the rate of change with time of the angle θ shown in the diagram at the vertex X .



The sides of the spherical triangle PXZ connect the pole, the object being observed and the zenith. The object's altitude is h above the horizon and its declination is δ . The observer's latitude is L . A prime is used to denote complementary angles, for example, $\delta' = 90^\circ - \delta$.

The angle ϕ is the local hour angle (LHA) which advances at the sidereal rate of 1 revolution in a sidereal day ($23^{\text{h}}56^{\text{m}}4.091^{\text{s}}$) or equivalently $15.041^{\circ}/\text{hour}$ (or arcminutes/minute of time or arcseconds/second of time). This sidereal rate will be denoted ω_{\oplus} . The rate of field rotation is then,

$$\frac{d\theta}{dt} = \frac{d\theta}{d\phi} \cdot \frac{d\phi}{dt} = \left(\frac{d\theta}{d\phi} \right) \cdot \omega_{\oplus}$$

Patera (<https://vixra.org/abs/2205.0085>) derives an expression for $(d\theta/d\phi)$ using 3D vector methods. An alternative using spherical trigonometry is given in the appendix at the end of this article. Although the intermediate steps involve some hefty algebra, the final result is remarkably simple.

For an altazimuth-mounted telescope,

$$\left(\frac{d\theta}{d\phi}\right) = \cos L \frac{\cos Z}{\cos h} \quad (1)$$

where Z is the object's azimuth. It can be seen that the field rotation rate is greater the higher an object is in the sky but is zero for objects that are due east or west.

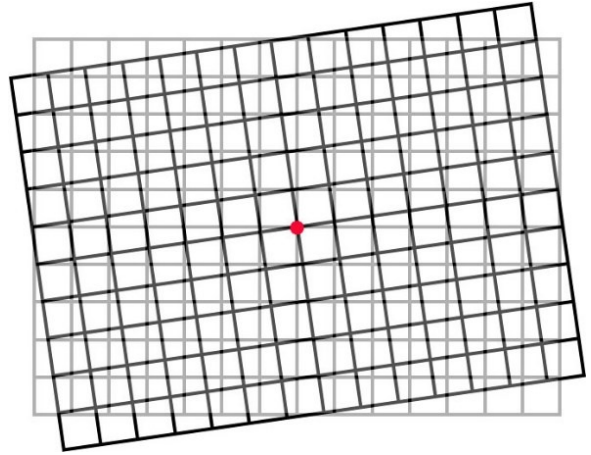
The analysis given in the appendix also derives an expression for the maximum rate of field rotation for a misaligned equatorial mount. If the telescope's polar axis is offset from the pole by some small amount Δp then for an object with declination δ_j [equation top of next page]

$$\left(\frac{d\theta}{d\phi}\right) = \frac{\sin \Delta p}{\cos \delta}. \quad (2)$$

How much field rotation is acceptable?

Field rotation is somewhat unusual in that it does not depend on the telescope's focal length or aperture. However the diameter of star images due to telescope resolution, local seeing and optical aberrations does depend on them. How much trailing of star images one is willing to accept therefore is a matter of personal preference, the specifics of the optical system and the observing conditions. To quantify this, we will compute the time needed for a star image at the edge of the field of view to trail by 1 pixel. This figure can be scaled by an appropriate factor to suit the observer's particular circumstances.

The diagram to the right shows camera's sensor array after a field rotation of angle α arc seconds that produces a 1 pixel star trail at the center of the left- and right-hand edges. It is assumed that the guide star, indicated in red, is at the center of the field of view. For a sensor array w pixels wide



$$\alpha = \tan^{-1} \frac{2}{w} \approx 3,600 \times \frac{180}{\pi} \times \tan^{-1} \frac{2}{w} \text{ arc seconds} \approx \frac{4.13 \times 10^5}{w} \text{ arc seconds} \quad (3)$$

If the guide star is at the edge of the frame then the required rotation for a 1 pixel trail is half this angle.

The time, T in seconds, needed for the field to rotate by an angle α in arc seconds is

$$T = \frac{\alpha}{(d\theta/d\phi)\omega_{\oplus}} \approx \frac{2.74 \times 10^4}{(d\theta/d\phi)w} \text{ seconds} \quad (4)$$

Examples

Suppose it is May 15th at 10:00 p.m. at the Meadow Parking Lot in the Ward Pound Ridge Reservation (latitude 41.26°N) and an intrepid WAA astrophotographer wants to shoot the Needle Galaxy (NGC 4565, Caldwell 38) in Coma Berenices. The object is nicely placed in the southwest at 70.6° above the horizon and an azimuth of 221.7°. The telescope has been set up in an altazimuth configuration and is equipped with a ZWO ASI2600MC. The camera's sensor array is 6248 pixels wide. From equation (1) $(d\theta/d\phi) = 1.70$, (meaning that the field is rotating at 25.4°/hour!). Plugging the numbers into equation (4) it is found stars at the edge of the field will trail by 1 pixel in just $T = 39.1$ seconds. Compare this to the Ring Nebula (Messier 57) in Lyra which is rising in the east at an altitude of 28.0° and azimuth 69.1°. Being lower in the sky it suffers from atmospheric extinction to a greater degree but its low altitude also means that the rate of field rotation will be less. Plugging in the numbers gives $(d\theta/d\phi) = 0.30$ and $T = 217.5$ seconds or over 3½ minutes.

Our astrophotographer decides to set up an equatorial wedge and roughly aligns the telescope's polar axis to within 5° of the north celestial pole. The Needle Galaxy lies at declination $\delta = +25.9^\circ$ and the Ring Nebula at declination $+33.1^\circ$. Plugging numbers into equations (2) and (4) gives $T = 681.5$ and 634.6 seconds respectively which are both comfortably over 10 minutes. However for objects closer to the pole such as Bode's Galaxy (Messier 81) at declination $+69.0^\circ$, things are a bit more constrained with $T = 271.5$ seconds.

Appendix

Applying the four-part formula of spherical trigonometry

https://en.wikipedia.org/wiki/Spherical_trigonometry#Cotangent_four-part_formulae to the triangle PXZ in the text gives

$$\tan \theta = \frac{\sin L' \sin \phi}{\sin \delta' \cos L' - \cos \delta' \sin L' \cos \phi}$$

and differentiating with respect to ϕ yields the general result

$$\left(\frac{d\theta}{d\phi} \right) = \frac{\sin L' (\sin \delta' \cos L' \cos \phi - \cos \delta' \sin L')}{(\sin L' \sin \phi)^2 + (\sin \delta' \cos L' - \cos \delta' \sin L' \cos \phi)^2} \quad (A1)$$

For the case an altazimuth mount, application of the cosine rule identities

$$\begin{aligned} \cos \phi &= \frac{\sin h - \sin \delta \sin L}{\cos \delta \cos L} \\ \sin \delta &= \sin h \sin L - \cos h \cos L \cos Z \end{aligned}$$

produces the result

$$\left(\frac{d\theta}{d\phi} \right) = \cos L \frac{\cos Z}{\cos h}$$

where Z is the object's azimuth measured from north.

The corresponding rate for an equatorial mount with its polar axis offset by Δp from the celestial pole can be found by setting $L' \rightarrow \Delta p$ in equation (A1). Assuming Δp is small, the result to leading order in $\sin \Delta p$ is

$$\left(\frac{d\theta}{d\phi} \right) = \cos \phi \frac{\sin \Delta p}{\cos \delta}$$

In general the direction that the mount's polar axis is offset from celestial pole, ϕ , is not known and hence setting $\cos \phi$ to its maximum value of 1 provides a safe upper limit. ■

Robin Stuart, who now lives in Eustis, Maine but remains a member of WAA, was recently awarded a Certificate of Achievement by the Royal Institute of Navigation. Robin's knowledge of celestial navigation helped find the wreck of *Endurance*, Ernest Shackleton's ship for the 1914 Imperial Trans-Antarctic Expedition, which became ice-bound in the Weddell Sea and sank in November 1915. His lecture to the Institute is on YouTube at <https://www.youtube.com/watch?v=y3sMS5p8Pgk&t=1967s>.

Robin is in the middle. Read Robin's profile in the January 2021 SkyWAArch, page 6.



A Steve Bellavia Observing Report

I had intended to go to the dark sky park at Cherry Springs, PA the weekend of August 11-13, since it was close to August's new moon. But the forecast kept deteriorating, showing clear skies all day Friday but cloudy by 11:00 p.m. Saturday showed rain and thunderstorms and then maybe some hope for a short period of clarity Sunday night. The forecast for Star Haven, in the Catskills, was very good, but by the time I decided not to go to Cherry Springs, it was too late to head to Star Haven from eastern Long Island. Orient Point is at the easternmost tip of Long Island's North Fork and is about 20 miles from my home.

So I went to Orient Point Friday night, and was joined by four fellow amateur astronomers: one imaging and the others with 12-inch Dobs.

During twilight, while I was looking down at my equipment, Bill Bradley pointed out a StarLink chain¹, that I barely captured on my cell phone:



After twilight faded, out came a splendid Milky Way, along with shooting stars (the Perseids peaking that weekend).

I imaged most of the night, and of course, just to torture myself, I checked the live cam at Cherry Springs frequently.² At 10:44 p.m. Friday, it looked gorgeous there. And 16 minutes later, at 11:00 p.m., it was overcast, just as predicted.

¹ Editor's comment: [Expletive deleted]

² The camera can be accessed at <https://csspdarkskyfund.org/current-conditions/>.



I kept checking, and it never cleared there. Did I finally make a good choice? More like dumb luck.

The 12-inch Dob owners shared views of many deep sky objects, such as the Veils, the Ring nebula, the Helix nebula, globular cluster M13, Herschel's Garnet star, etc.

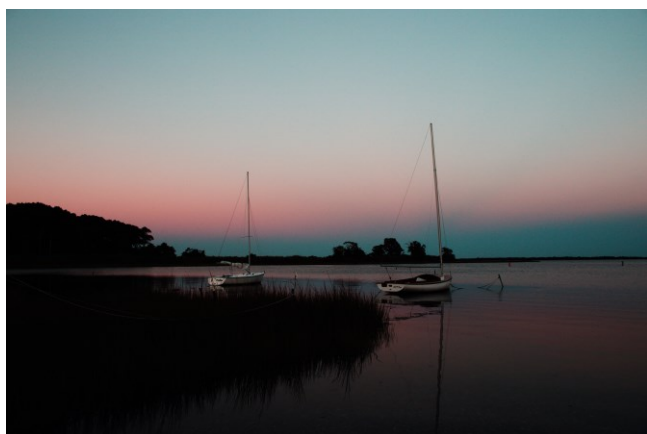
We watched a stunning crescent moonrise around 2:10 AM, which was below the Pleiades.

I stayed until 3:30 AM, when clouds started rolling in. I got almost 5 hours of data Friday night/Saturday

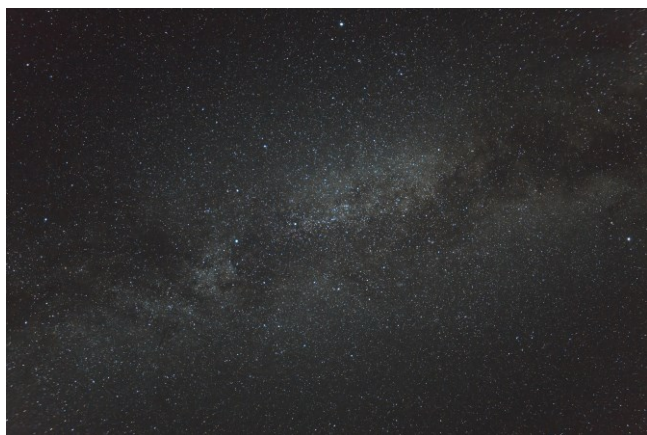
morning. As I was driving home, I saw all of Orion through breaks in the clouds. Though I have experienced it many times, seeing Orion in August is always weird.

Saturday night was mostly cloudy, and I was busy at Custer Institute with the concert and Perseid watchers. I don't think they got to see much, as there was very little clearing.

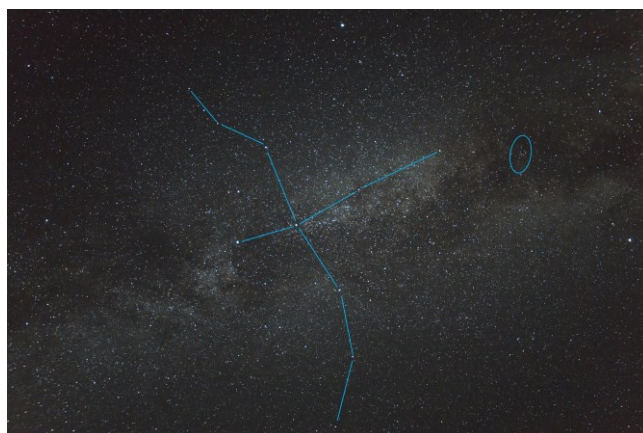
I went back to Orient Point Sunday night. I got to see the infamous homemade gondola, a sailboat coming into its mooring and a great Belt-of-Venus.



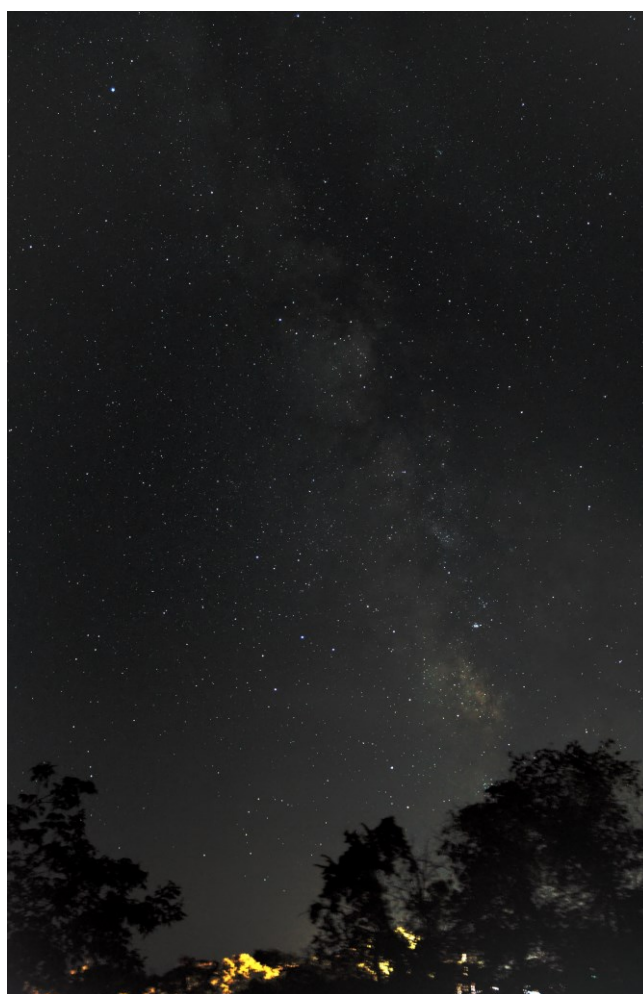
I began imaging around 9:30 p.m. I also setup my DSLR and took several shots of the Milky Way straight overhead, around Cygnus:



I love the look of the coat hanger asterism (Brocchi's cluster, also catalogued as Collinder 399, see the DSO of the Month on page 9). I made annotated image to make it to find near Cygnus.



I also got the Milky Way down to Sagittarius, just above a bright boat marina.



Clouds came in around 11:30, with another 1.5 hours of data captured on my intended object for the weekend, Sh2-126 and LBN 437, in the constellation Lacerta. The image is on page 25. ■

There's More Than Meets the Eye

Larry Faltz

In June, we received an email from a non-club member who had just purchased a Nikon P1000, an amazing new camera that sports a 28-3,000 zoom lens (35-mm equivalent). The zoom reaches its mega-telephoto limit of 3,000 mm optically, not digitally. The 16-megapixel camera has all the modern digital features, such as image stabilization, multiple video modes, in-camera image adjustments and dynamic focusing, all for a list price of just \$999. The lens is f/8 at the full 3,000-mm, fast enough to make fine single-shot pictures of the Moon, two of which were submitted with the email.

The gentleman added this to his message: "I have not seen much better pics of the moon - more clarity - than mine from any fellow amateurs. Perhaps you can send me a few if you find any? One would think that by now we would have many much closer pics of our nearest neighbor - with advances in optics, etc."

His image was very good, but nothing out of the ordinary. I sent him links to the Lunar Observing and Imaging Forum on CloudyNights.com, with its many extremely high-quality lunar images by amateurs.

Trying to be helpful, I pointed out that there are ways to make his images sharper and even more impressive. I took a tiny section of one and applied a slight adjustment of a single wavelet slider in Registax. The improvement is evident.



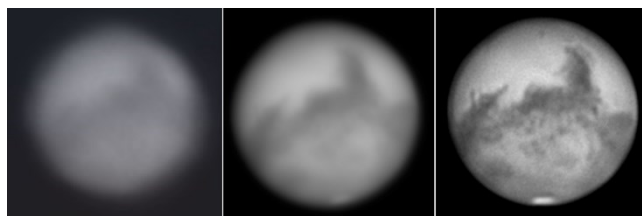
Tycho, from a larger image. Left, original; right, processed with Registax 6.1, wavelet slider layer 1, denoise 0.40, sharpen 0.150, preview 25.7.

The response I got was rather odd. "No computer app can do more for a photo than the original optics provide. One can layer a bunch of fuzzy shots but that won't create more clarity than is already there." This turns out not be true, as it would seem I had already demonstrated. But then the writer said, "I am con-

cerned that nobody seems to notice how little detail we have of the lunar surface. Is this something that you find acceptable?" A strange comment, indeed.

How could anyone think we don't have enormous detail about the Moon's surface after 400 years of observation, 180 years of photography and more than half a century of exploration? We have detailed maps of the entire lunar surface specifying its geography, magnetic and gravitational features, mineral composition, and even crustal thickness. The Lunar Reconnaissance Orbiter Camera made a lunar map at 100 meters per pixel, and captures images down to 0.5 meters per pixel, able to see the tracks the Apollo astronauts left in the lunar regolith.

To point out the value of computer enhancements and sharpening, I sent a trio of pictures of Mars that I made on October 8, 2020, two days after the planet's closest approach that year, to show how real detail can be extracted.



Mars, 10/8/20. Left: One frame from the capture video; Center: Stacked image from that video; Right: Wavelet-processed image.

The response was complete denial, with this comment: "A program cannot create details in photographs out of thin air." But, as we shall see, we are not *creating* details, but *recovering* information that's actually present in the image but obscured for discoverable reasons. The gentleman also claimed I was lying and that my Mars pictures were "fake." That is, actively and consciously faked. It was an insult that ended our correspondence.

In one sense, though, the gentleman was correct. All images are counterfeits. They are transcripts of reality but not reality itself. The photons coming from an object are converted into electrons, from which new photons are generated to give us a new representation of the object. That's even how our eyes work! It's a concept that Plato might have appreciated: there must be an ideal optical version of everything, of which we can only get a more-or-less corrupted form

in the real world. But they are not disingenuous fakes.

Imaging always has an element of art to it. We frame the subject, adjust the lighting, choose the moment of creation. There is an innate human need to make art. Pablo Picasso is reputed to have said “Art is a lie that makes us realize truth, at least the truth that is given us to understand. The artist must know the manner whereby to convince others of the truthfulness of his lies.” Of those Mars images, which is the truth: the left-hand image as picked up by the camera, or the right-hand image after stacking and processing? I would submit that the most processed version is far, far closer to the truth. Yet it was not exactly what the camera saw, and certainly not what I saw at the eyepiece that night, which looked like the middle image during the best moments of steadiness.

My correspondent, however, was not interested in the philosophical nature of image-making. From his comments I realized it was pointless to try to enlighten him further. But it did suggest the topic for this article and gave me an opportunity to learn more about a subject with which I had only the most meager familiarity. *How is it possible, and is it valid, to find detail in an image that is not evident on our first examination?*

Resolution

By resolution, we mean the smallest unit that can contain discrete information. This also means the ability to differentiate two closely spaced features. In photography resolution is expressed as “lines per millimeter” while in digital astronomical imaging we are interested in the angular dimension per pixel. For a computer monitor, it is the number of pixels per inch that are presented to our eyes.

The best fine-grain films (my favorite was Fuji Velvia transparency film shot at ISO 32) contained the equivalent of 20 megapixels in a 35-mm “full-frame” (36x24 mm) image. Nikon and Canon now make 45 megapixel full-frame cameras and the Leica Q3 has a 60-megapixel full-frame sensor.

A CCD or CMOS sensor with a larger number of small pixels will have greater resolution than a similarly sized sensor with larger pixels. Why don’t all cameras have a large number of tiny pixels? Cost, speed, file size and practicality: There may be little reason to

have an image of 20 megapixels or more if you are only going to show it on a 1920x1080 monitor that has 2 million pixels. You’ll want 20 megapixels if you make an 11x14 print at 1200 dots-per-inch, provided that your optical system can match the sensor’s resolution (see “Dawes Limit and Resolution” on page 18).

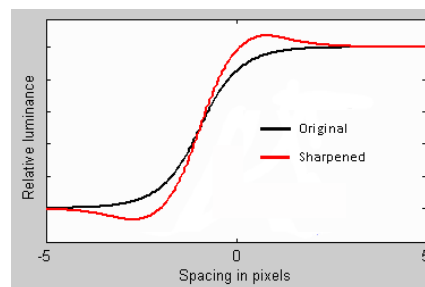
Sharpness

Among the most important characteristics of an image is sharpness. All digital images made with one-shot color sensors are slightly unsharp because the Bayer filter in front of the sensor produces red, green and blue signals that must be interpolated to produce the image.

Whether we’re shooting the Orion Nebula or our pet dog, most of us want our images to be as sharp as possible. What does it mean for an image to be “sharp?” It’s a subjective matter, a combination of resolution and “acutance,” which is the amount of contrast along edges within the image. We can’t control resolution once the image is formed: it’s set by the optic we’re using and the sensor itself. To increase sharpness, the acutance has to increase. This can be done by applying an algorithm to adjacent pixels based on the intensity of the signal in each. When the software detects an edge, it slightly boosts the intensity difference between the pixels. Most compact digital cameras, unless they have a RAW mode, apply some sharpening algorithms of this type to the images. Image processing software can be used to process images downloaded from the camera. Portrait and fashion photographers sometimes soften an image with a filter or even smear Vaseline on the lens (for effect, to hide blemishes or disguise aging) and there are even “soft focus” lenses for portrait photography. A soft image is not out-of-focus, but has reduced contrast within the image, that is, lower acutance.

A simple example is shown in the graph. The slope of the gradient between a darker area (left) and brighter area

(right) is increased, which raises the acutance and makes the boundary between those areas “sharper.”



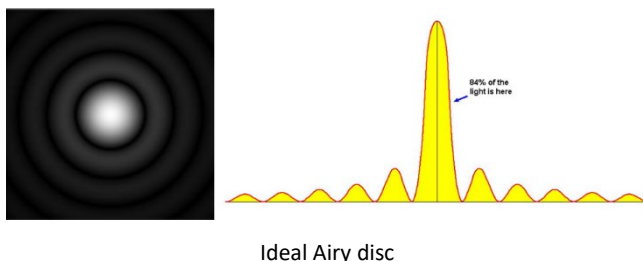
The results of this kind of sharpening can be both good and bad. Below is a photo I took some years ago in Florida. The image was scanned at high resolution from a medium format (6x7 cm) Fuji Velvia transparency. The slightly sharpened image on the right has more detail in the bird's feathers, but close inspection shows artefact on the edge of bird's beak and legs, the result of the algorithm working on areas with already strong gradients.



Another sharpening technique is the “unsharp mask.” It was originally developed as a darkroom technique with film. A slightly blurred low-contrast image is created and combined with the original image. The unsharp masking process, available in many image processing programs like Photoshop and GIMP, gives the user more control, unlike a direct sharpening algorithm for which the software usually has one setting, although it can be applied iteratively.

While these simple procedures can be used in astrophotography, they are not the best way to enhance astronomy images. For that, we need to understand what our telescopes do to incoming light.

The Airy Disc



Ideal Airy disc

If you closely examine a star in your telescope at high magnification, you will see faint rings around it. This is the Airy disc. Light passing through *any* circular opening is diffracted and the light waves will amplify and cancel depending on the length of their paths. The only way to eliminate diffraction is for the aperture to be zero, which would make for a rather use-

less instrument (or infinity, which would be useful but impossible). The wave nature of light is a discovery credited to Thomas Young, who performed the famous two-slit experiment in 1801.¹ The specific phenomenon of optical diffraction in a telescope was first noticed by John Herschel in 1826 but named for George Biddell Airy, Britain's Astronomer Royal from 1835 to 1881, after his theoretical analysis was published in 1835. Even a perfect lens or mirror, if such a thing could exist, cannot eliminate the Airy disc.

The pattern is more pronounced when out of focus and can be used as an optical test (the pattern should be spherically symmetrical with appropriately faint secondary rings on either side of focus in a perfect optical system) and for collimation (it should be spherical but will be asymmetrical if the optics are not well-aligned). Those of us with Schmidt-Cassegrain scopes are familiar with the tiny iterative adjustments of the secondary needed to get the Airy disc exactly centered.

We must live with whatever effects the Airy disc has on the stars in our image, but since the central component of the Airy disc gets 84% of the light the pattern will generally be unnoticeable, especially for extended objects. The tiny Airy discs around bright stars, when viewed with a fine refractor exactly in focus, are actually kind of pretty. They are a reminder that we live in a quantum mechanical world.

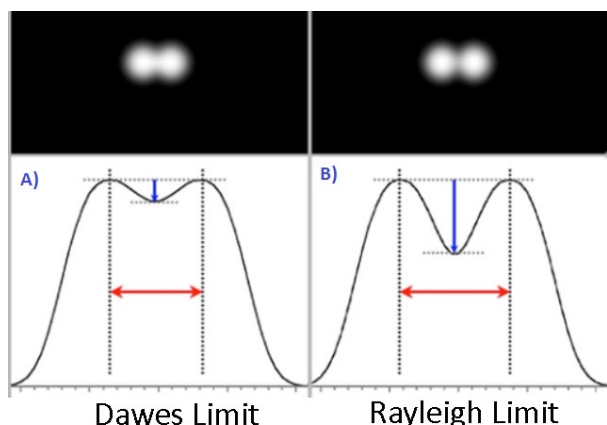
Dawes Limit & Telescope Resolution

When two point sources are close together, their Airy discs overlap. There is a point at which the overlap of the primary images is so great that the two point sources cannot be reliably distinguished. This is the *Dawes Limit*, the maximum resolving power of any telescope under ideal circumstances. It is solely a function of aperture. It was first proposed by William Rutter Dawes in 1867. When we say “aperture is king” we mean that bigger scopes not only gather more light to see fainter objects, they also resolve finer details. The Dawes Limit formula is $R=C/D$, where R is the resolving power in inches, D is the di-

¹ This year marks the 250th anniversary of Young's birth. For a very brief review of his life, see <https://www.nature.com/articles/438291a>. An appreciation of his wave experiment and its modern consequences in a recent issue of Nature is at <https://is.gd/TYNature2023>.

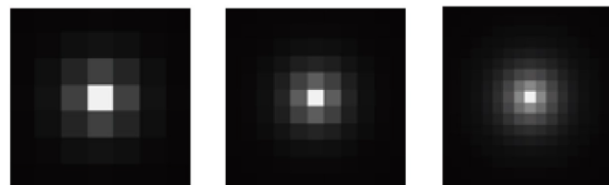
ameter, and C is either 4.56 if you are measuring in inches or 11.6 if you are using centimeters. Since we often use millimeters of aperture, C would be 116. An 80-mm refractor, regardless of its focal length, would have a resolving power of 1.45 arc seconds. An 8-inch SCT (203 mm aperture) would theoretically resolve 0.57 arcseconds. As you might expect, the Dawes limit varies very slightly as a function of the wavelength, but the differences between blue and red wavelengths is small enough for us to ignore.

A similar measure is the *Rayleigh limit*, which measures the ability of a telescope to completely separate two stars of equal magnitude (that is, show the images distinctly separate, not just perceptibly a pair). The formula for the Rayleigh limit, for an aperture in millimeters, is $R=138/D$.



Of course, there are other factors that affect the image: quality and design of the optics (the central obstruction of SCTs and Newtonians increases the amount of light in the secondary peaks, reducing contrast), tube currents, atmospheric conditions, focusing, and the resolution of the detector. The zone in the retina that a telescope image would fall on may be the equivalent of at least 112 megapixels, perhaps a bit more. Taking 112 million pixels with an average rod/cone size of 2 microns (cones, for photopic vision, are between 0.5 and 4 microns in diameter, and rods, for scotopic vision, are all 2 microns in diameter), and then plugging that information into an imaging mode field-of-view calculator,² I come up with a resolution of 0.34 arcseconds per pixel, far below the telescope's Dawes limit of 1.45 arcsecond. We are vastly "oversampling" the image when we use our eyes, but that's not a problem.

² <https://astronomy.tools>



under sampling suitable sampling over sampling
Single star image on a sensor. From cosgrovescosmos.com.

Knowing the resolution per pixel helps to choose the right camera-telescope combination. You want to match the size of pixels with the resolving power of the optic (and the seeing, which reduces resolution from the ideal value). A slight bit of oversampling, perhaps 2X, is usually recommended. It's easier to correct oversampling than undersampling.

Convolution

Convolutions, in the vernacular, are simply twists. The mathematical definition is very precise: A convolution is an integral that expresses the amount of overlap of one function³ as it is shifted over another function. Convolution "blends" one function with another.

Convolution is an important process in several mathematical realms, particularly probability. A fine explanation is given by 3Blue1Brown, a beautifully illustrated math education site on YouTube.⁴

When you apply a "blur" in Photoshop while doing graphic design with an image, you are using a convolution function. The program uses information from a specified range of adjacent pixels and applies the values from that range across the entire image.

The light from a distant telescopic field comes to us as a "wavefront" that can be described by a mathematical function. It encounters the atmosphere, the telescope and the sensor, each with properties that are potentially describable by a mathematical function. What we see with our eyes, or what is recorded on a sensor, is a convolution, the object's wavefront acted upon by all the distorting functions on its passage through the atmosphere and our apparatus. Convolution is an actual mathematical operator, denoted by a (non-superscript) asterisk $*$.

³ A mathematical function, for example the parabolic function $f(x)=x^2$.

⁴ See the 23-minute video on convolution at <https://www.youtube.com/watch?v=KuXjwB4LzSA>.

Deconvolution

If we knew exactly what the distorting functions were, we could reconstruct, or *deconvolve*, the image, removing the effects of the unwanted distortions and restoring the original wavefront.

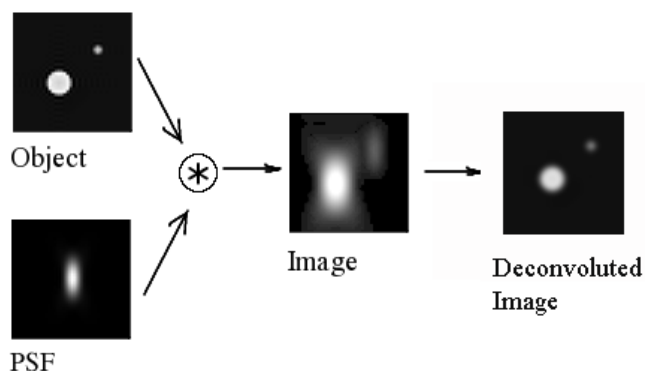
During World War II, the brilliant (and notoriously absent-minded⁵) MIT mathematician Norbert Wiener developed the Wiener filter, a mathematical function which reduces the amount of noise in a signal by comparison with an estimate of the desired (noiseless) signal. This was not a theoretical undertaking, however. Wiener was trying to direct antiaircraft fire automatically against German planes by real-time analysis of radar signals (radar having been studied and improved at the MIT Radiation Lab). The process was particularly effective against the unmanned V-1 “flying bomb,” which had no human control once launched, so its trajectory was reasonably predictable. Ninety-nine percent of the V-1s were shot down once the filter was employed. Eventually Wiener’s work led to advances in information theory and human-machine interaction, resulting in the science of cybernetics, a term he invented for his 1948 book *Cybernetics: or, Control and Communication in the Animal and the Machine*. When his signal processing advances were declassified, he wrote about deconvolution in *Extrapolation, Interpolation, and Smoothing of Stationary Time Series* (1949).

The Wiener filter lies at the root of more sophisticated deconvolution techniques that are now used in fields as varied as optical and radio astronomy, microscopy, seismology and medical imaging.

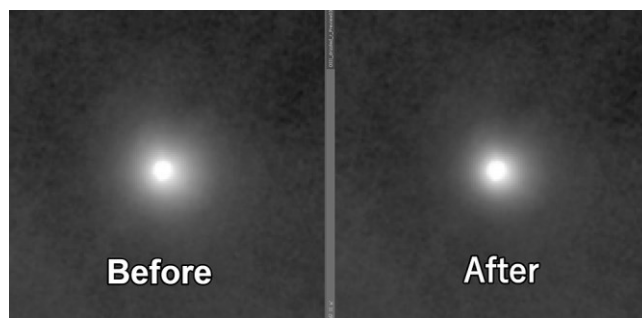
To deconvolve an astronomical image, we need to know the *point spread function* (PSF), which as you might guess describes the distribution of the diffracted light from a theoretical point source. For practical purposes, it can be considered the average of an Airy disc at each point in the image. The point spread function, when convolved with the image, acts as a

“low pass filter,” reducing the contrast of high frequency signals, that is, the finer details of the image. The detail is still there, but there’s just not enough contrast to see it well. How and why this works is very nicely explained by Russell Croman at a recent on-line session of the Astro Imaging Channel, a YouTube site for imagers which meets weekly. The video is entitled “AI-Powered Deconvolution” (only the last bit of the talk is about AI-driven deconvolution software) and is at

https://www.youtube.com/watch?v=5_Dg7bYu-E8.



Convolution & Deconvolution. An acquired image (center) is made up of the actual perfect image convolved with the point spread function (PSF). Deconvolution applies mathematical operations to reverse the process. Since the exact PSF is not known exactly, the resulting recovered image is not perfect, but it’s much closer to the actual object than the acquired image.



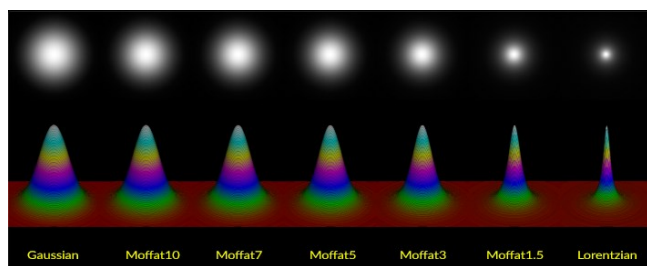
Moderate deconvolution of a single star. The effect is subtle but the light is clearly more concentrated. (Matt’s Astro, UK)

If the point spread function could be determined exactly, its inverse could be calculated. When the PSF is convolved with the acquired image, the result would be reconstruction of the original image. Deconvolution is in fact just another convolution step, but one under our control. As Croman explains, there are limitations that prevent a perfect reconstruction, but a substantial amount of the original signal can be recovered.

⁵ Among the anecdotes related by colleagues about Wiener’s absentmindedness are the time he reported the theft of his car to the police, only to discover that he had driven it to Providence for a talk and had taken the train back to Boston; and the conversation in an MIT hallway that he concluded by asking his colleague which way he had been heading when he stopped to chat, greeting the answer with “Good! That means I’ve already had lunch.”

A star is a point source, and so the pixel values surrounding the star could be used to solve the PSF. Then the image can be deconvolved by applying the PSF to every pixel. In practice this is still an estimate, and there are a variety of formulas that are used, the most common being the Lucy-Richardson deconvolution, first proposed in 1972. This is basically an iterative matrix operation, which makes sense in this setting since you can naturally think of a CCD or CMOS sensor as a matrix.

On the sensor, the shape of the central peak of the Airy disc (that is, the distribution of signal on the sensor's pixels) is related to the star's brightness. Very bright stars that are not oversaturated may have a Gaussian probability distribution, while dimmer stars have a Moffat or even Lorentzian distribution, with a slightly different shape to the brightness curve. Moffat is the most commonly encountered. The curve's shape is important when calculating the PSF.



Distribution of light cones (John Rista, *Nature Photography*)

PixInsight, the program most often used by accomplished deep-sky astrophotographers these days, provides several methods for deconvolution. The user has substantial control over the outcome. Skilled astrophotographers (which I'm not) spend a lot of time deciding on the workflow, choosing parameters, tweaking controls, and sometimes creating and applying contrast masks that reduce star intensity in order to emphasize diffuse nebulosity. The process is ultimately artistic, but art in pursuit of reality. Software is the astrophotographer's paintbrush or crayon. Just as DaVinci, Raphael or Velasquez had to know the properties of pigments, bases, solvents, brushes and canvas, the imager needs to know the intricacies of image capture and the utility of software tools. The imager/artist tries different procedures and makes subjective decisions about the image until it looks the way he/she thinks the object "actually" looks. How does any artist know when the work is finished? I always wonder if his assistant said,

"Leonardo, she was smiling a little more" to which the master would have responded, "This is the lady as she really is." The goal of computer processing is to bring out the reality that was obscured.

An example of two PixInsight deconvolution routines on the same image was sent to me by Rick Bria and is shown at the end of this article on page 23. There is a vast amount of information on the web relating to deconvolution in PixInsight, and a simple search will bring up some very useful and well-done presentations on YouTube.

PSFs can vary in different parts of an image. In addition to the contributions of diffraction by the optics, atmospheric and sensor structure to the PSF, images can show tracking irregularities, field rotation (from inexact polar alignment) that varies across the frame, motion artefacts from wind, and coma (giving non-round stars in the corners of the image, especially with wide-field optics). Croman's AI-based BlurXTerminator add-on for PixInsight claims the ability to correct for these problems, at least partially.

What if there's no star to use as a source? One can always guess. Since we know stars are round (or should be on our images) an arbitrary but reasonable initial PSF could be chosen for "blind deconvolution" as a starting point. What about deconvolution for solar system imaging? A new free program, imPPG, applies the Lucy-Richardson deconvolution to monochrome solar and lunar images. My first crude attempt adjusting an image with this software is shown on page 31, comparing it to an image processed with wavelets, the more common method for bringing out details in solar system images.

Even in a perfectly deconvolved image (if that were possible), the side lobes of Airy disc still contribute to the fuzziness of the image. These can be partially prevented by a process called *apodization*, which can be achieved through lens design, diaphragms and other techniques. A mask made with a special filter or even a ring of mesh placed in front of the telescope can reduce the intensity of the first diffraction ring. This can improve planetary contrast and split close double stars, but at the expense of color distortion and other undesirable artefacts. Frankly, apodization would not be useful for deep-sky imaging. See the [November 2020 SkyWAArch](#), p. 11, for John Paladini's article on apodizing masks.

Wavelets

One can consider the detail in an image as the sum of signals of different dimensions. As noted in a review,

Wavelet algorithms process data at different scales or resolutions. If we look at a signal with a large “window,” we would notice gross features. Similarly, if we look at a signal with a small “window,” we would notice small features. The result in wavelet analysis is to see both the forest and the trees, so to speak. (A. Grpas, Introduction to Wavelet Processing, *IEEE Computational Science and Engineering*, Summer 1995)

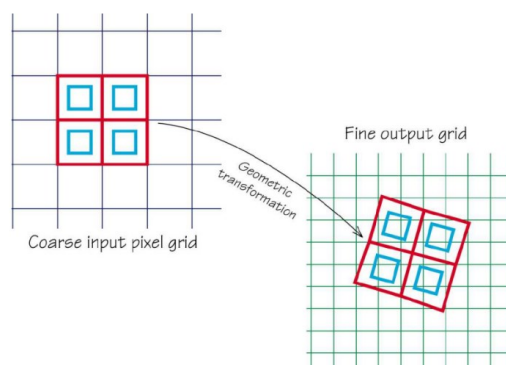
Wavelets isolate details of a certain dimensional range and increase the contrast of those features. Wavelet processing works very well to bring out details of planetary surfaces (including the Sun and Moon). It is an empirical, trial and error process. One has to resist the temptation to over-sharpen or bring up too much noise, both giving ugly results. Registax 6.1 is the most frequently used wavelet software, but AstroSurface has been gaining adherents.

Wavelets essentially apply a Fourier transform to the data. You’ve already used a form of wavelets when you compress an image, such as making a jpeg file from an uncompressed RAW or tiff file. Once compressed, though, you can’t bring back all the original detail in the image. For most screen-presentation purposes, though, compressed files such as jpeg look as good as the much larger originals unless you enlarge to an excessive degree.

Increasing Resolution: Dithering & Drizzling

Most modern mounts and guiding software can implement a process called dithering, in which the telescope is offset by a few pixels in a random direction for each new frame. Stacking software can still register the images, but hot pixels can be diluted and transients, like satellite tracks, may be suppressed. Most importantly, the camera’s fixed pattern noise can be reduced and thus the signal-to-noise ratio is increased. If you don’t dither, the inherent noise from the camera gets stacked along with the image, reducing contrast. Dark frames can eliminate a lot of it, but dithering itself might obviate the need for dark frames in some cameras. In addition, dithering can increase the resolution of the image at the sensor level. It’s a process that newer smart phones use in their cameras.

The true value of dithering comes when the sub-frames are stacked and processed through drizzling. This technique was invented for the Hubble Deep Field. The Hubble’s camera is significantly under-sampled, so how is it going to distinguish all those distant, tiny, high red-shift galaxies? Drizzling uses a mathematical routine to remap small groups of rotated and shifted pixels from the original image onto an output image. Formally called “variable-pixel linear reconstruction,” drizzling preserves photometry and resolution, weights input images according to the statistical significance of each pixel and removes the effects of geometric distortion both on image shape and photometry.



Basic idea of drizzling (from Fruchter, A, Hook, RN, Novel image reconstruction method applied to deep Hubble space telescope images, *Proc. SPIE* Vol. 3164, p. 120-125 (1997))

The result is an image with greater resolution than the sensor can naturally provide. Is it a lie? If it is, it’s a lie that shows a greater truth.

Noise

An inherent problem in all images is noise. Once noise is in your image, it’s basically impossible to remove it without negatively affecting the good parts of the image. Deconvolution, being an iterative process, may increase the amount of noise if it’s not minimal to begin with. You want to have as high a signal-to-noise ratio as possible when you start out. For deep sky images, that means gathering photons for as long as you can, using a cooled camera, and making calibration frames. The length of your individual sub frames is less important than the total duration of your stack, and there are many astrophotographers, like WAA’s Maury Rosenthal, who get good results by stacking a very large number of very short frames,

particularly in light-polluted environments. You'll have to experiment here as well.

In "lucky" planetary imaging, where a video of several thousand frames is recorded and software selects the best ones for stacking, the objects are bright, so the individual frames can have very short durations, sometimes as little as a thousandth of a second. Since the goal is to have frames short enough to minimize

atmospheric distortion, there's a temptation to reduce the exposure length and to hike up the gain, but then the noise will be greater. You have to strike the right balance between gain and exposure. Trial, error, experience and taste.

The bottom line is that astronomical images can be improved and detail can be increased, completely honestly and scientifically. It's no lie. ■

Same Image, Two Convolutions



Rick Bria's excellent image of M101 appeared on the cover of the [July 2023 SkyWAArch](#) (left). He subsequently processed the image further (right). He told me "The earlier version used deconvolution from the EZ Processing suite. It is more or less automatic, but not the best application of deconvolution, in my view. You are not in full control of deconvolution in EZ Processing suite. The last version used what I call 'real' deconvolution." The enlarged sections from each image show the improvement in star diameters, contrast and especially detail in the darker regions of the galaxy's spiral arms. Ignore the brightness variance, an artistic choice.

Images by Members



More images from Arizona by **Arthur Miller** using an 11-inch SCT in very dark skies not far from the Fred Whipple Observatory (Smithsonian Astrophysical Observatory) south of Tucson.

Messier 104 in Virgo
Magnitude 8.6
Distance 9.55 Mpc (31 million light years)



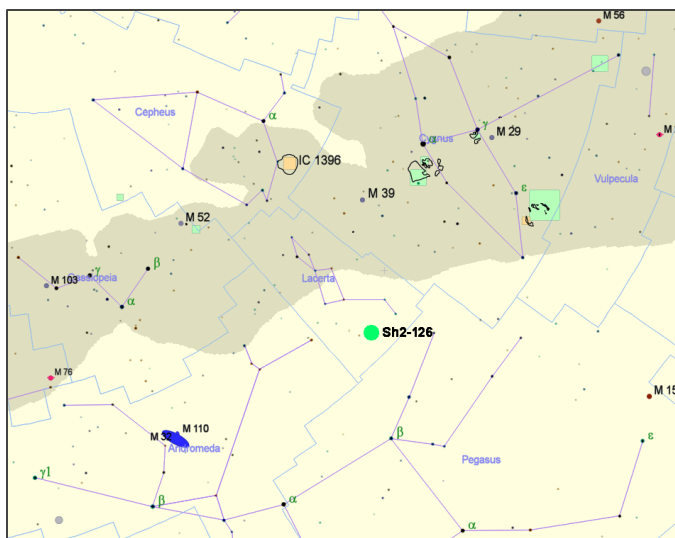
Messier 106 in Canes Venatici
Magnitude 8.4
Distance 7 Mpc (23.5 million light years)

Two Nebulas for the Price of One by Steve Bellavia



Sh2-126 is the “Great Lacerta Nebula.” It is part of Lacerta OB1, a giant star-forming region about 1200 light-years from Earth. The source of its ionization is the intense ultraviolet radiation from the star 10 Lacertae, a blue main sequence star.

The whitish portion in the center is designated LBN 437, the “Gecko Nebula.” It is a molecular cloud whose densest part is associated with some bright young stars. The field is 3.12 x 2.1 degrees.



Steve made this image over two nights in August. Williams Fluorostar 91, Starizona Apex-ED-L 0.65X reducer-flattener that brings scope to f/3.8, 350mm focal length, ASI294MM camera, RGB, luminance and H-alpha filters. Full technical information at <https://www.astrobin.com/xzt8k9/>.

Lacerta, the Lizard, is a faint constellation added to the celestial vault by Johannes Hevelius in 1687. It's brightest star is magnitude 3.8. It sits at the edge of the northern Milky Way, surrounded by Cepheus, Cygnus, Pegasus, Andromeda and Cassiopeia.



Lacerta in Hevelius' *Firmamentum Sobiescianum sive Uranographia*

Northern Sights Redux by Robin Stuart



Page 6 of the March 2023 SkyWAArch showed my image of M81 (Bode's Galaxy) and M82 (Cigar Galaxy) in Ursa Major that had been affected by an unanticipated auroral glow. Closer examination also shows faint traces of another type of glow revealing itself in the nonuniformity of the dark background. This is the Integrated Flux Nebula (IFN) which has only been identified relatively recently. Clouds of gas and dust sitting high above and below the plane of the Milky Way are illuminated, not by a single star as would normally be the case, but by the combined light from the stars of our galaxy as a whole. This is the Milky Way equivalent of Earthshine! The pole star, Polaris, is surrounded by a particularly dense region of the IFN.

Taken over the nights of 8, 9 and 10 May, the image shows the IFN in the region around M81 and M82. It represents a 25 x 10 minute exposures (4h 10m total) taken through a 70mm Televue Pronto with a 0.8X focal reducer using a ZWO ASI2600MC.

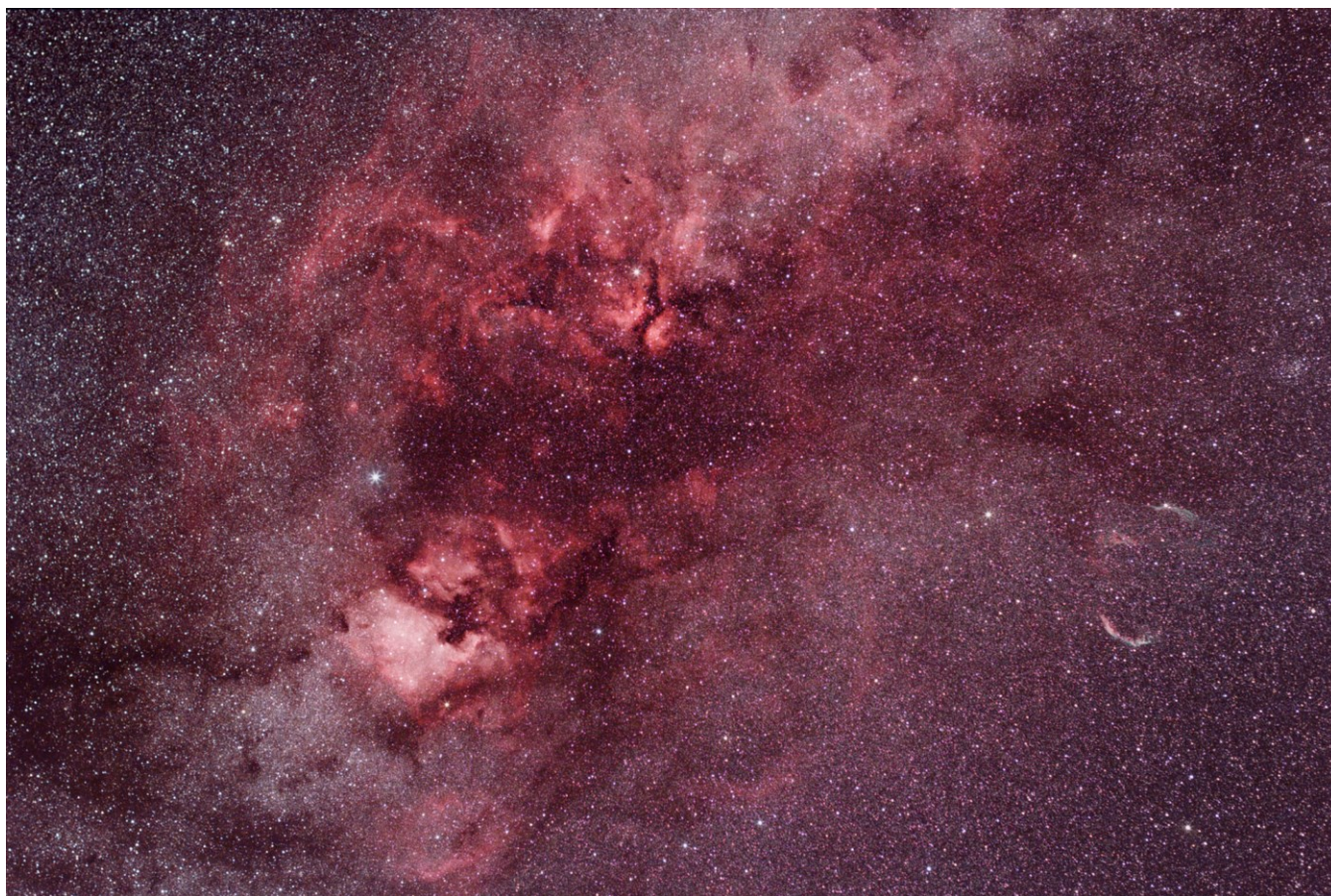
Robin Stuart

Editor's note:

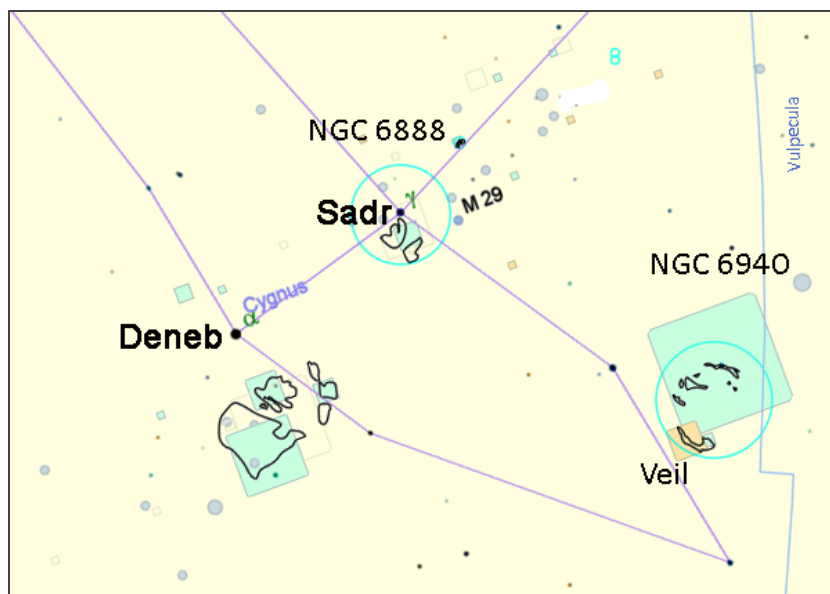
The IFN was first noticed on plates of the Palomar Sky Survey. The full extent wasn't known until the 1990s when infrared satellites were able to construct a whole sky map in the IR. The term "Integrated Flux Nebula" was coined by Steve Mandel, who noted the glow surrounding M81 and M82 on images made in 2004. Mandel created the "Unexplored Nebulae Project." There are eight objects in the "The Mandel-Wilson Catalogue of Unexplored Nebulae." The project seems to be dormant,¹ but the site is archived and available for review at https://web.archive.org/web/20170325074450/http://www.galaxyimages.com/UNP_IFNebula.html.

¹ Anyway, by simply being listed, they are no longer exactly "unexplored," right?

The Heart of the Swan by Robin Stuart



This image shows a 25°x 16.5° view of the center of the constellation of Cygnus the swan. The bright star on the left is Deneb and below it the North America Nebula lies west coast down. The star in the upper center is Sadr (Gamma Cygni), the swan's chest. To the right, the east and west arcs of the Veil Nebula can be seen with Pickering's Triangle between them. Above the Veil and near the edge of the frame is the open cluster NGC 6940. The Crescent Nebula (NGC 6888) is near the center top.

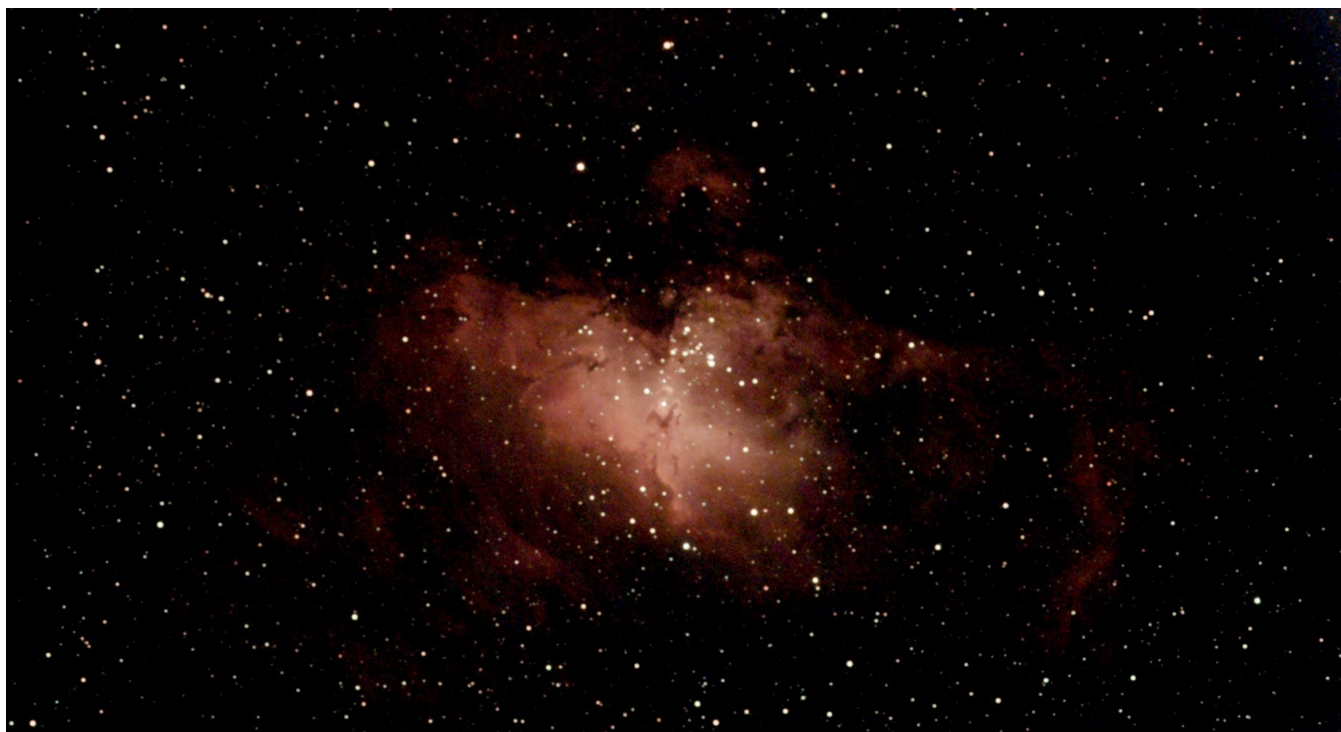


The image was made using a Canon 60Da at ISO 1600 with a 50mm lens, on two nights in mid-July 2023. It is a composite of 36 x 2 minute exposures (1h 12m total) and 11 x 10 minute exposures (1h 50m total) through a Radian Triad Quadband Filter. Although the lens can operate at f/1.4, these unguided exposures were made at f/3.5 to reduce aberrations in the star images. Focusing was done with the N.I.N.A. Lens AF plugin.

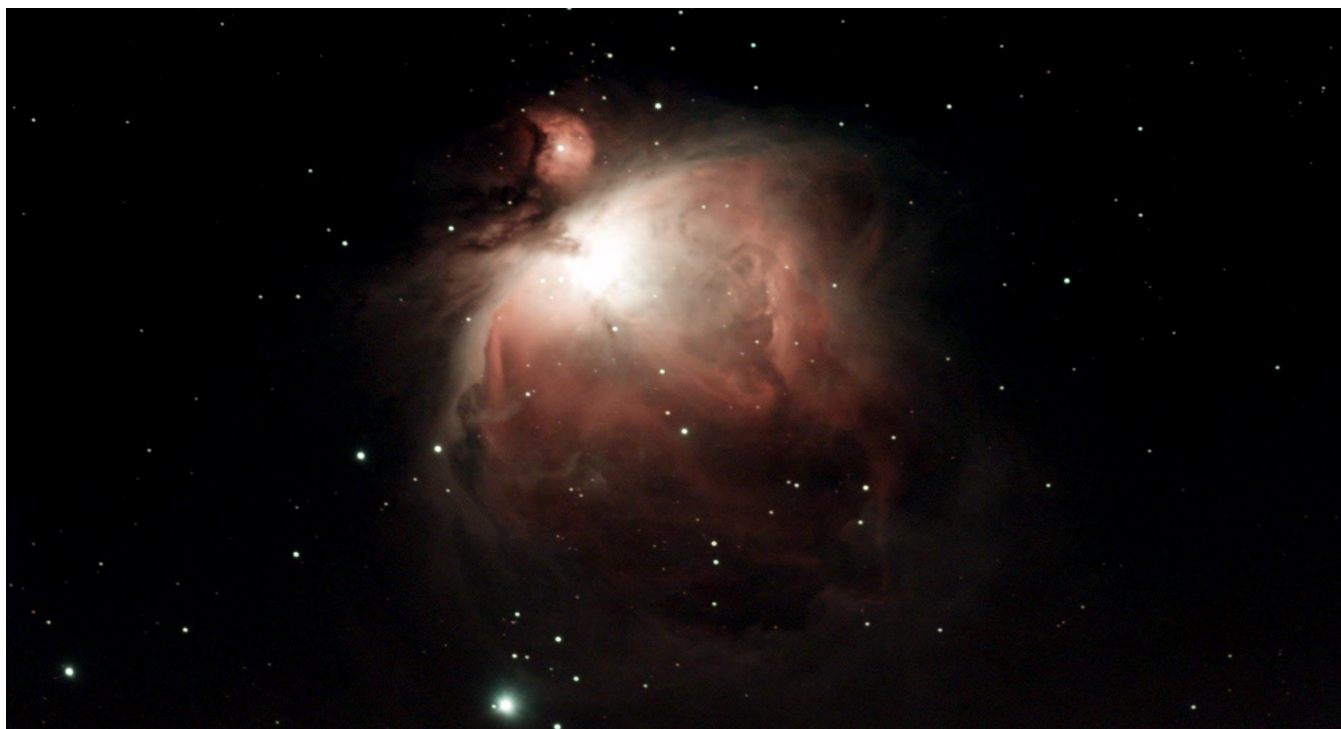
Robin Stuart

More Vaonis Expera Images by Jordan Solomon

The field of view of the Expera (200-mm f/4 scope, IMX 462 sensor) is 92x50 arcminutes.



Messier 16 (Eagle Nebula) from Cherry Springs, PA



Messier 42 (Orion Nebula) from Ward Pound Ridge Reservation

First Light from a New Imaging Setup by Manish Jadhav



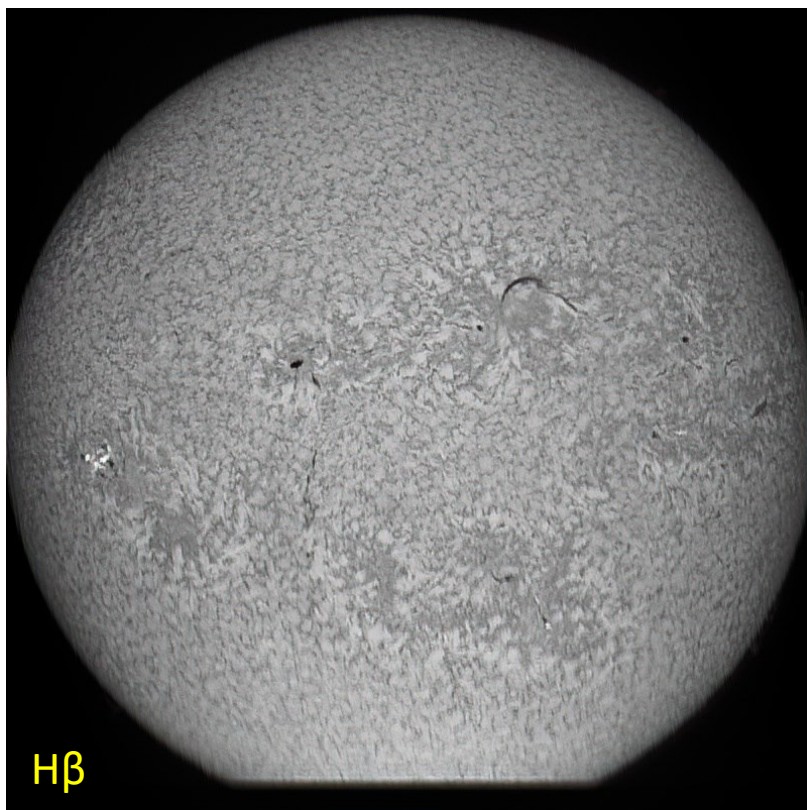
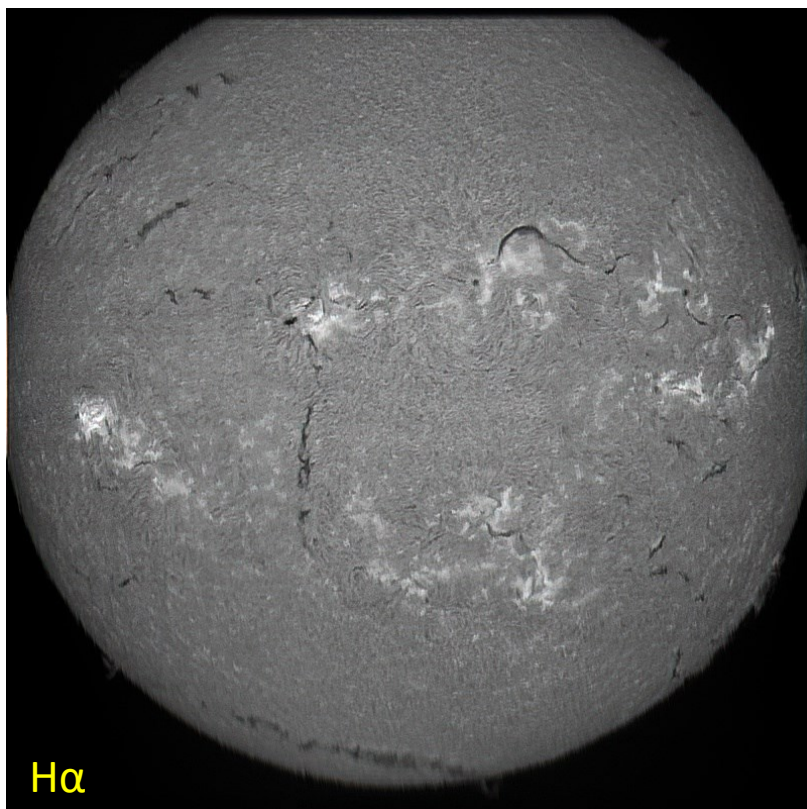
Manish made this image of Messier 31 in Andromeda on August 18th. He wrote:

[August 18th] was predicted to be cloudy, but it cleared out by 11-11:30, so I tried to set up my ZWO ASIAIR Plus for the first time. I did not bother to collimate the RC after mounting. I realized that my SVBONY auto-guider camera is not recognized by ASIAIR Plus, so I was dependent on a good polar alignment. I spent around half an hour on the polar alignment using the ASIAIR, and then I was able to capture the Andromeda Galaxy in relatively windy conditions, under a very annoying (but unavoidable) bright white LED street light. No auto guider meant the exposures had to be limited to 30-seconds, to get as close to pin point stars as possible.

Manish mounted the Orion RC (f/8) on a Celestron AVX mount. The camera was a Canon EOS-RP, a full-frame DSLR. He made 100 30-second light frames and 30 30-second dark frames, stacking with Lynkeos, a stacking program that runs on a Mac.

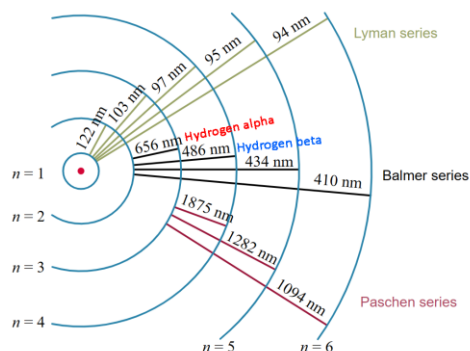
This image points out a few peculiarities encountered in the world of astronomical imaging. For one thing, DSLRs, once dominant in the field, are disappearing in favor of cooled monochrome cameras fitted with filter wheels. But they are still useful. Another is the relative rarity of Macintosh computers for scope control and image processing. Some of the most capable imaging software suites are PC-only. The ASIAir's app, a very well thought-out program, runs on Android and iOS (so presumably a Mac as well) but not on Windows, except that recently Windows 11 has been tweaked to host an Android subsystem, although it's complicated to install and you have to join the [free] Windows Insider Program. ZWO, makers of the ASIAir, have limited its functionality to ZWO ASI cameras and DSLRs. Fortunately, the guide camera can be an inexpensive bottom-of-the-line planetary camera. It's slightly selfish on ZWO's part, but from their point of view a proper business decision. The ASIAir is a Raspberry Pi device. There are competing devices for wireless scope/camera control and guiding, such as those made by PrimaLuceLab and Software Bisque. They have faster Intel or AMD processors and enhanced capabilities and will accept all cameras, in exchange for being larger and more expensive.

The Sun In H-alpha and H-beta by John Paladini



Observing the solar chromosphere at the hydrogen alpha wavelength of 656.28 nanometers with special narrow-band telescopes is an increasingly popular branch of amateur astronomy. John also can look at the Sun at other wavelengths with his home-made spectroheliograph.

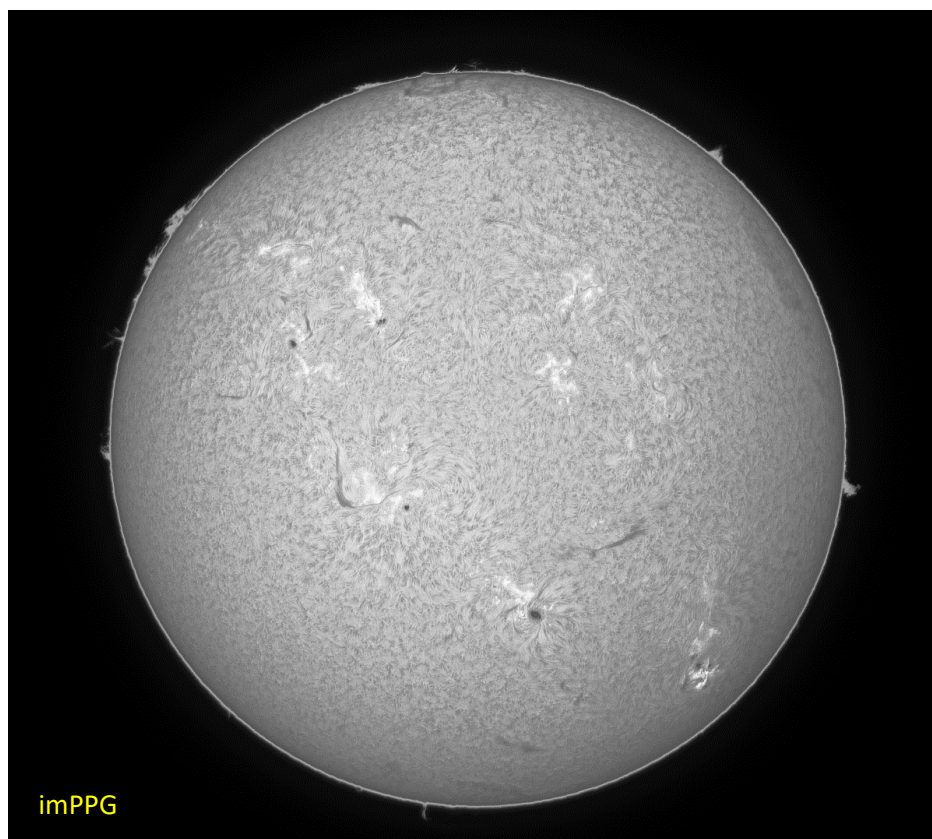
The H-beta signal arises from the transition of an excited electron in atomic hydrogen from the $n=4$ orbital to the $n=2$ orbital. (We represent them symbolically as orbits, but they are really probability densities. See the April 2014 *SkyWAArch*, p. 5). Since the energy difference between the two orbitals is greater than for the H-alpha transition ($n=3$ to $n=2$), the emitted photon has a shorter wavelength (recalling the fundamental formula for the energy of radiation $E=h\nu=hc/\lambda$, where h is Planck's constant, c is the speed of light, ν (nu) is the frequency and λ (lambda) is the wavelength). Transitions to the $n=2$ orbital form the Balmer series; these are the only hydrogen emission lines in the visible spectrum.



Emission in the two wavelengths has been used to study radiation transport and dissipation in the solar atmosphere.

The images were made on August 1, 2023.

Deconvolution vs. Wavelet Processing by Larry Faltz



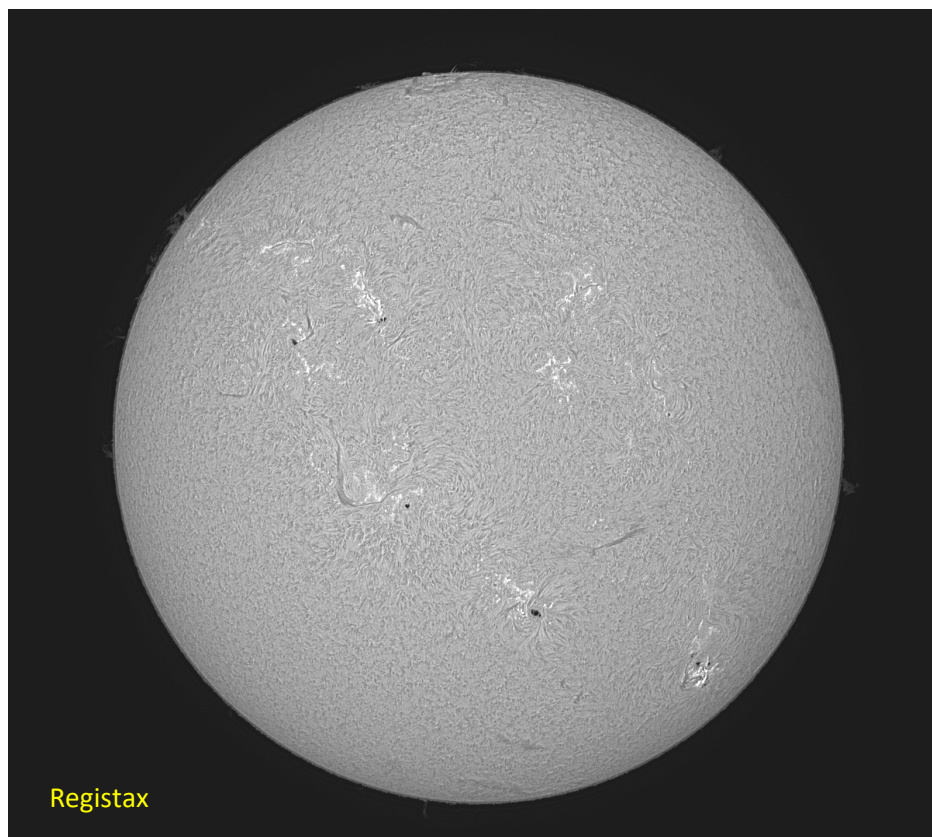
As mentioned on page 21, the free software **imPPG** applies user-controlled deconvolution and unsharp masking to monochrome solar and lunar images.

This full-disk image was made on August 2 with a Lunt 60-mm hydrogen alpha telescope, 0.5X focal reducer and ASI290MM camera. The frames were adjudged high-quality by AutoStakkaert!3, so I stacked 75% of 5000.

Then I ran the resulting tiff image through either **imppg** or **Registax**. **imPPG** is not complicated, but the manipulation is a bit arcane. You can make an inverse image, which is how some advanced solar imagers like to show their work, but I don't think a "first light" image should be so intensely altered. Nor did I spend an excessive amount of time making fine adjustments.

It's much easier to bring out prominences with **imPPG**, perhaps at the expense of some loss of contrast circumferentially inside the limb. This could probably be corrected with a gradient mask, which is as yet beyond my abilities. Overall contrast is more intense without making the surface details overly sharp. Like **Registax**'s wavelet processing, you can make the images very ugly or bizarre.

imPPG is probably worth spending some time learning.



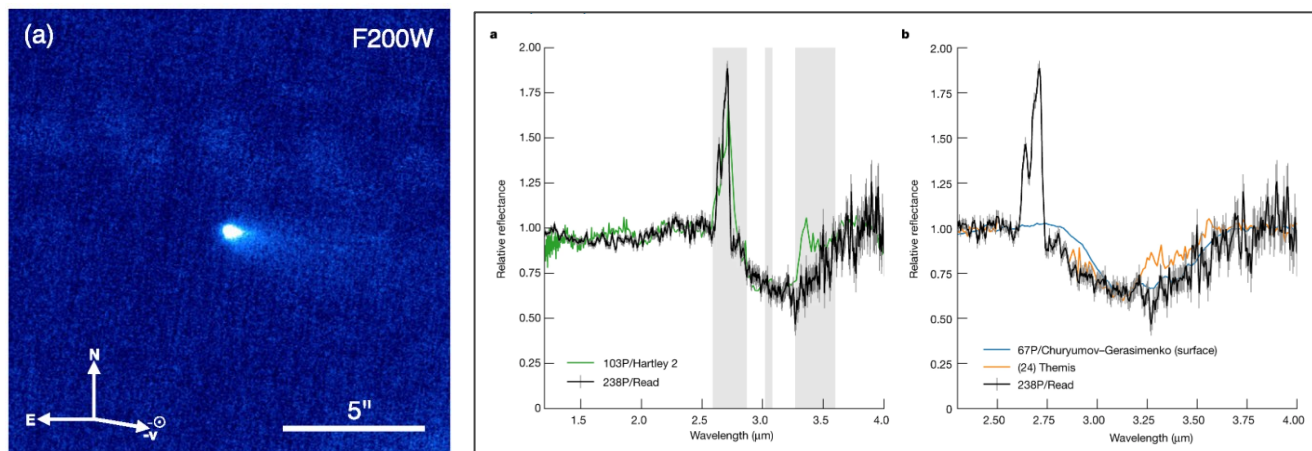
Research Highlight of the Month

Kelley, MSP, et. al, Spectroscopic Identification of Water Emission from a Main Belt Comet, *Nature* 2023, 619:720-723 (July 27, 2023)

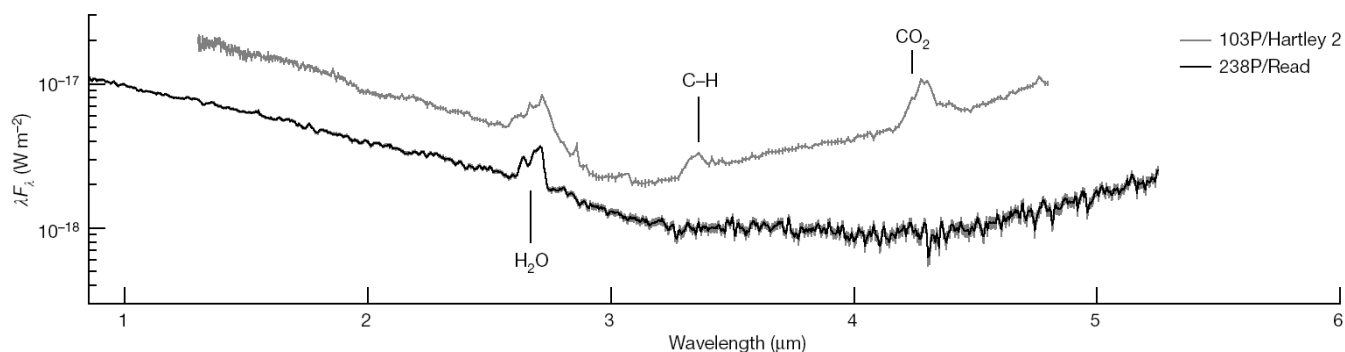
There is some confusion over the nomenclature of a group of comet-like objects that orbit within the asteroid belt. Originally called “main belt comets,” an appellation which this paper uses, some of them are now designated as “active asteroids.” These bodies orbit interior to Jupiter and have low eccentricity, meaning their orbits are relatively circular. Active asteroids are thought to show a tail due to impacts, while main belt comets form tails in the traditional cometary manner by sublimation of surface ices. Some of the bodies were given asteroid names, only to be renamed with a cometary appellation. The prototype object, asteroid 1979 OW7, was found to be a comet by Eric Elst and Guido Pizarro in 1996 and renamed Comet 133P/Elst-Pizarro. These objects suggest a third reservoir of water-bearing bodies in the solar system, forming at a temperature of 150 K as compared to the Kuiper Belt (50-100K) and Oort Cloud (<50 K). Perhaps these bodies were (or share their origin with) the source of Earth’s water, which differs isotopically from water in the “true” comets.

Comet 238P/Read has an orbital period of 2,060 days (5.64 years), a perihelion of 2.37 AU and aphelion of 3.96 AU. It was discovered in 2005. It’s core is only 0.6 km in diameter. NASA considered sending a probe to 238P/Read but the target was shifted to the near-Earth asteroid Eros.

Although we are now used to seeing JWST images of distant galaxies, spectacular nebulae, exoplanets and the solar system’s gas and ice giants, the telescope has some other objects in its sights. The JWST made images and spectroscopic measurements a few weeks after the comet’s 2022 perihelion, from a target-telescope distance of 2.086 AU. Water vapor, but not carbon dioxide, was detected, unlike what has been found in comets to date.



Left; JWST image of 238P/Read. Right Reflectance spectra details compared to other comets



JWST spectrum of 238P/Read (bottom) vs. 103P/Hartley 2, a Jupiter family comet, obtained from the Deep Impact spacecraft.

Member & Club Equipment for Sale			
Item	Description	Asking price	Name/Email
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, Far-point lifting straps, 1 lb magnetic counterweight, Bob's Knobs installed. Apertura collimator. Original boxes with foam packing.	\$500	Mark Lane jmarklane@gmail.com
Orion 6-inch f/5 reflector on EQ mount	Little used, if at all. Solid EQ4-type non-go-to equatorial mount with an electric RA drive as well as slow-motion stalks. The setting circles are large and very readable, unlike most EQ mounts for scopes of this size. An image of the mount head is here . 9 and 25 mm Plössl eyepieces, polar alignment scope with reticle, Orion flashlight, finder, counterweights, gold-colored aluminum tripod (missing tripod tray, but you can make one easily enough). Good intro scope for a bright young person. A 6" f/5 OTA alone costs at least \$300. Donated to WAA.	\$150	WAA ads@westchesterastronomers.org
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
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.			
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