

Sky WAA *tch*

The Newsletter of Westchester Amateur Astronomers

October 2023



Messier 31, the Andromeda Nebula, by David Parmet

RedCat 51, ASI533MC Pro, 15x180 secs, 10 dark, flat and bias frames. August 11, 2023, Ward Pound Ridge.

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 October Meeting

Friday, October 13 at 7:30 pm

Space Volcanos

Caitlin Ahrens, PhD

Postdoctoral Fellow

NASA/Goddard Space Flight Center

A variety of both active and ancient volcanos have been found in the solar system, in environments as diverse as Earth, the Moon, Mars, Io and Pluto. Dr. Ahrens studies planetary vulcanology using remote sensing.

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

WAA Members: Contribute to the Newsletter!

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

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WAA November Meeting

Friday, November 10 at 7:30 pm

Edwards Air Force Base in the Era of Space Flight

Andy Poniros

NASA Solar System Ambassador

Starway to Heaven

**Ward Pound Ridge Reservation,
Cross River, NY**

Saturday, October 7 (Rain/cloud date October 14)

Date	Sunset	End Nautical Twilight	End Astronomical Twilight
10/7	18:37	19:31	20:03
10/14	18:16	19:20	19:52

New Members

Lucian Lipinsky de Orlov

William Meurer

Harshini Pothuganti

Goldens Bridge

Greenwich, CT

Pleasantville

Renewing Members

Linda Brunner

Christopher Bruno

Jorge and Priscilla Camino

Walter Chadwick

Keith Fliszary

Jeff Gershgor

Jimmy Gondek & Jennifer Jukich

Manish Jadhav

Chetan Karande

Mark Kleiman

Scott Levine

George & Susan Lewis

Arumugam Manoharan

Daniel R. Poccia

Richard Segal

Kevin Shea

Rita Walton

Cliff Wattley

Yonkers

Cortlandt Manor

Mt. Kisco

Cold Spring

Yorktown Heights

Wappingers Falls

Jefferson Valley

Ossining

Briarcliff Manor

Ossining

Croton-on-Hudson

Mamaroneck

Yonkers

Cortlandt Manor

Chappaqua

Carmel

Yonkers

Danbury, CT

SkyWAAatch is written entirely by human beings.

ALMANAC For October 2023

Bob Kelly, WAA VP of Field Events



Bob
Kelly



3Q
10/6



New
10/14



1Q
10/21



Full
10/28

Eclipses

There are two eclipses visible from our area in October.

• October 14 solar eclipse

On Saturday the 14th, our area gets the side-effect of the western United States annular eclipse of the **Sun** by our **Moon**. Thirty-four percent of the diameter of the Sun (23 percent of the area of the Sun) will be covered by the Moon at peak eclipse at 1:22 p.m. Think of this as a warm-up for the solar eclipse of April 8, 2024.

Oct 14, 2023 at 1:22 pm



Max View in White Plains, New York

Local Type:	Partial Solar Eclipse in White Plains, New York
Begins:	Sat, Oct 14, 2023 at 12:09 pm
Maximum:	Sat, Oct 14, 2023 at 1:22 pm 0.341 Magnitude
Ends:	Sat, Oct 14, 2023 at 2:35 pm
Duration:	2 hours, 26 minutes

All times shown on this page are local time.

Make sure you use only certified glass or mylar solar filters when viewing the Sun! Or, with your back to the Sun, you can project the image of the Sun through a hole in cardboard onto a surface. If you are using a telescope or binoculars, filters must be over the opening that lets the sunlight in. Eclipse glasses are not safe for looking through an unshielded telescope or binoculars. If there is a finder on the scope, keep it covered and don't look through it.

• October 28 lunar eclipse

In the morning of the 28th, we catch the barely-there conclusion of a just-barely partial lunar eclipse. Only 12 percent of the Moon will pass through the darkest part of the shadow, the umbra. We won't see that part, since the umbral phase ends before the Moon rises for the eastern United States. On the bright side, timeanddate.com estimates 75 percent of the Earth's population, in Europe, Africa and Asia, will see the entire lunar eclipse.

Saturday evening the 21st, is **International Observe the Moon Night** with a lovely first quarter Moon. A bonus observation will occur when the star 59 Sagittarii, magnitude +4.5, will be covered up by the dark limb of the Moon at 8:04 p.m.



Venus in the Morning

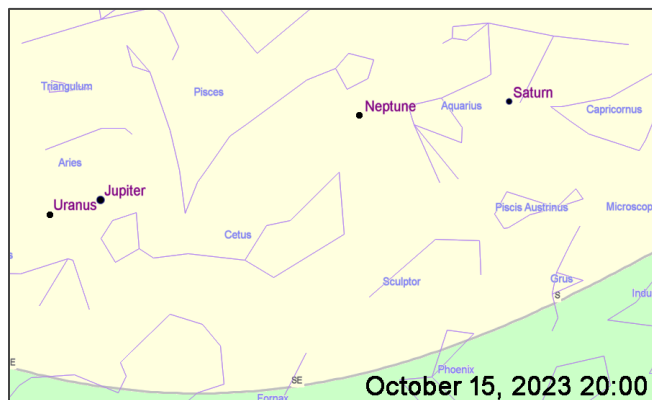
Venus is blazing at magnitude -4.5 in the pre-dawn sky. Catch it now while it's still a crescent and before it shrinks in apparent diameter. Most people need at least binoculars to see the phase. I've found the shape of the sunlit side of the planet is easier to see as dawn lights up the morning sky. Venus is at greatest elongation on the 23rd, half-lit around that date. Venus will be super-bright in the morning sky well

into 2024. Thanks to the orbital mechanics of Earth and Venus, we won't see a crescent Venus again until mid-January 2025.



Venus on September 21st. 200-mm f/5.9 Dobsonian, Canon XS DSLR at prime focus with 2x Barlow, 1/320 seconds at ISO-200.
Bob Kelly

Outer Planets



Jupiter presents itself nicely in any telescope as it approaches its opposition to the Sun in early November. It's rising time moves earlier than 7 p.m. by mid-month. It will also be visible low in the western sky before the Sun rises on clear, blue-sky mornings.

Overnight on the 19th/20th, starting at 2 a.m., the shadows of Io and Ganymede are visible on Jupiter's disk.

Saturn is already up at sunset. Get acquainted with the ringed planet in its own article this month! See page 6 for more information about viewing Saturn.

The ice giants, **Uranus** and **Neptune**, are near opposition: Uranus on the 13th of November and Neptune

having passed opposition on September 19th. Uranus is just 9½ degrees northeast of Jupiter on the 15th, with Neptune some 45 degrees to the west (towards Saturn). They are worth making detailed finder charts to be able to pick them out, or use your properly-aligned go-to scope.

Comets and Meteor Showers 2P

Comet 2P Encke makes perihelion every 3 1/3 years, this year November 22nd. It's been sighted at 9th magnitude in late-September. Its brightness may peak at magnitude +4, but it will be too close to the Sun to see. Look for it in the morning sky in Virgo as it brightens through 7th magnitude. Use big binoculars to see this comet. It has been sighted on more trips around the Sun than any other.

Orionid meteors peak from the 21st through the 23rd, best after midnight. You might see several dozen of these fragments of Comet 1P/Halley before morning twilight starts. They are some of the fastest meteors we see.

Satellites

Preliminary predictions have the Chinese space station, **Tiangong**, visible in evening twilight through the 14th, and in the morning starting on the 26th. The **International Space Station** is visible in the evening through the 5th, and the morning starting on the 17th.

Starlink satellites are visible as a train of bright dots in the days after a new set is launched. See heavens-above.com for the latest predictions. The sheer number of these internet communication satellites are annoying and disruptive to astronomers and astrophotographers.

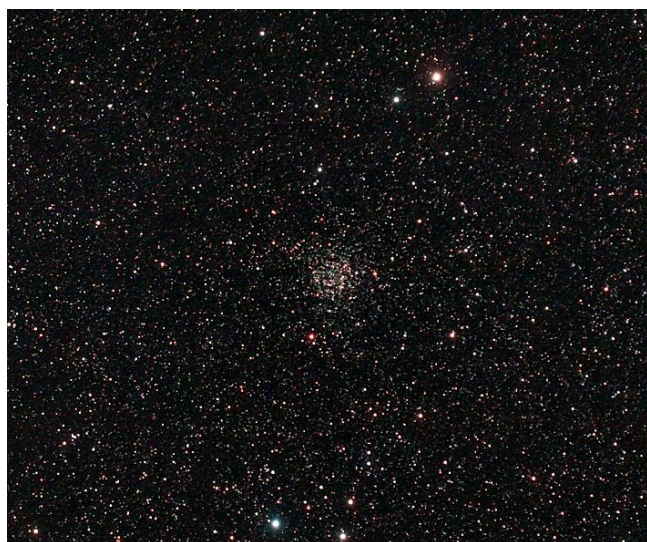
The Solar Neighborhood

The **Solar and Heliospheric Observatory (SOHO)**'s LASCO C3 camera sees a lot of traffic this month. Mercury spends most of October in its field, from the 9th through superior conjunction on the 20th. Encke passes through starting on the 25th. The Sun finally catches up with Mars, so Mars enters the scope's view for the last third of the month. It'll be there, gone from the sight of mere mortals on Earth; too close to the Sun through mid-December. The link to the live camera image is <https://soho.nas.nasa.gov/data/realtime/c3/512/> ■

Deep Sky Object of the Month: NGC 7789

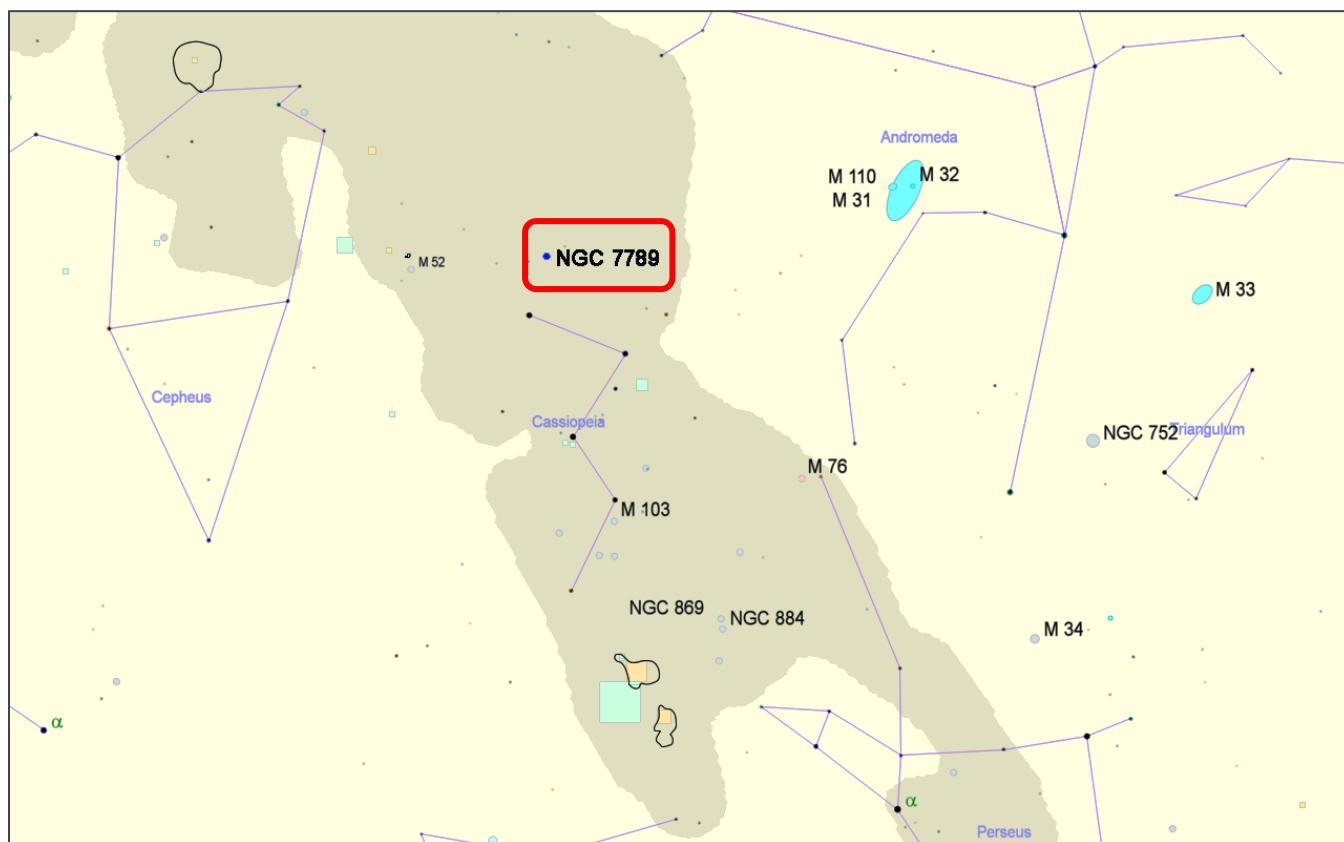
NGC 7789	
Constellation	Cassiopeia
Object type	Open Cluster
Right Ascension J2000	23h 57m 24s
Declination J2000	+56° 42' 30"
Magnitude	6.7
Size	18 arcminutes
Distance	6,000 LY
Other designation	Caroline's Rose Herschel VI.30
Discovery	Caroline Herschel 1783

Although she spent much of her life at the base of the telescope writing down what her brother William called down from the eyepiece high overhead, Caroline Herschel gets credit for this object, which her son John called "a most superb" cluster. In his second catalog (1789), William Herschel reported that he viewed it on October 18, 1787, noting "C.H. discovered it 1783." Stephen James O'Meara reports that there are exactly 583 stars in the cluster, which is estimated to be 1.7 billion years old.



Visibility for NGC 7789			
22:00 EDT	10/1/23	10/15/23	10/31/23
Altitude	64° 14'	70° 40'	74° 55'
Azimuth	43° 17'	32° 58'	07° 17'

NGC 7789 is a fine binocular object in a dark sky.



Viewing Saturn in October



8/27/23 02:57 UT, 8" SCT/2x Barlow/Mallincam DS287. LF

Saturn will be well placed for evening observers in October. The ringed planet (it's not the *only* ringed planet, but it's the only one whose rings we amateurs can see) reached exact opposition on August 27, 2023 at 08:20 UT, rising at sunset and culminating (crossing the meridian) at midnight. Its southerly position now means it doesn't get very high in the sky (the maximum altitude this fall is 35°). As the year progresses, culmination will be earlier but still in a dark sky.

Date	Sunset EDT	Altitude @20:00	Meridian crossing	Mag	Disk (")
10/1	18:37	25°	22:31	+0.6	18.6
10/15	18:14	31°	21:32	+0.6	18.3
10/31	17:51	34°	20:28	+0.7	17.9

The ring plane, the angle of the rings with respect to the line between Earth and Saturn, is 8° and decreasing. (See page 27). Eventually it will become zero and we won't be able to see the rings for a short while.

The ring plane will be aligned with the Earth on March 25, 2025, and then on May 6, 2025 the rings (and Saturn's equator) will align with the Sun. These events aren't simultaneous because of the inclination of Saturn's 29.4-year orbit, 2.79° from the ecliptic. The rings will not be visible from Earth for a total of 44 days in 2025. Saturn will be less than ten degrees from the Sun, near solar conjunction, so observing the rings near their minima will be difficult, if not impossible. The next ring crossing when the planet is near opposition will be a triple crossing beginning in October 2038 and ending in April 2039. A good discussion is at <https://is.gd/SatRings>.

While Saturn is a delight in any telescope, magnification will help. There are few details to see on the

disk, although a northern hemisphere cloud band may be visible. The goal is to see sharply defined rings and a visible Cassini division, as well as getting a sense of depth. There's a sweet spot between the size of the planet in the eyepiece and its sharpness. If you have really great seeing, you can push the magnification, remembering Dawes' limit (see the [September 2023 SkyWAArch](#), p. 18). With my 8-inch SCT in Westchester, where the seeing is always limited by thermals from roads and rooftops, I don't view at more than 225x (9-mm eyepiece). With great seeing in rural Maine in 2021, I was able to get sharp views at 400x (5-mm eyepiece). A yellow or blue filter can sometimes help, but the advantage gained is fairly small as compared with Mars or Jupiter. SCTs and Newtonians need to be well-collimated.

People seeing Saturn for the first time are always awed and delighted by its improbable appearance. Half of them seem to remark something like "It's not real" or "You put a picture in front of the telescope." Many people recall their first telescopic view of Saturn and for some it started a life-long appreciation of astronomy. Consider doing a "pop-up" outreach this fall. A fine example is reported in an August 25th *New York Post* story about an enthusiastic Brooklyn amateur who blocked traffic in Park Slope because the middle of an intersection afforded the only good view. Read it at <https://is.gd/saturnbrklyn>. (Try not to block traffic at your outreach event!)

Saturn now has at least 145 moons, of which the brightest five might be seen with an 8-inch telescope in a good sky. *Sky & Telescope* has an app on its web site (<https://is.gd/satmoons>) and offers a fine one for iOS and Android for \$2.99.

Imaging Saturn with a planetary camera is not difficult. A 2x or 3x Barlow is usually needed to get the image large enough on the sensor to show detail. Use "lucky imaging" techniques, with stacking and wavelet processing, but be careful not to overdo it. You can determine the resolution of your system using the very useful FOV calculator in Imaging Mode at https://astronomy.tools/calculators/field_of_view/.

LF

Astronomy in Ancient India

Eli Goldfine

Introduction

Astronomy in India has a rich and complicated history. The ancient Indians started observing the stars in about 2000 B.C.E., but some archaeoastronomers (people who study the history of astronomy) believe that it could have been even earlier. Astronomy in India is often linked to Indian-originated religions such as Hinduism and Buddhism. Indian astronomers in the first millennium C.E. tended to be interested in astrology (the study of how the movement of planetary objects are connected to human actions and fate) and formed many theories about how the heavens worked. Most people, even amateur astronomers, don't know much about archaeoastronomy though it is a very interesting topic.

A Brief History of Astronomy in India

Around the beginning of the first millennium, three Indian astronomers, Aryabhata, Varahamihira, and Brahmagupta, wanted to separate astronomy from astrology. They founded the Siddhantic Era. They still included astrological ideas but their work was much more heavily centered around astronomy. To start this new era of Indian astronomy, Aryabhata, Varahamihira, and Brahmagupta used concepts from earlier Babylonian and Greek astronomy. They also used Babylonian arithmetic procedures to calculate astronomical phenomena such as eclipses and solar years. The Siddhantic era included early ideas of equinoxes, solstices, eclipses, lunar periods, and planetary objects. One of the practices during the Siddhantic era was to calculate astronomical data on special stones called Zij tablets. One Zij tablet included the Indian numbering system, which is still used today. The Siddhantic era and other Indian astronomical ideas heavily influenced other cultures, as different civilizations encountered their ideas about astronomy on trading routes such as the Silk Road.

The Vedanga Jyotisha

The first significant Indian astronomical text was titled *Vedanga Jyotisha*. Most historians of astronomy believe it was first written before 1000 B.C.E. by an ancient Indian astronomer called Jyotisha. It was then built upon by other Indian astronomers throughout the years. Vedanga Jyotisha recorded most astronomical phenomena from 1100 to 650 B.C.E.

Important Astronomical Discoveries in India

Indian astronomers and mathematicians have made extremely important discoveries and suggested ideas that other astronomers have built upon. For example, an Indian astronomer was the first to predict that a year is 365 days long. Indian astronomers were also some of the first to deeply research that planets were spheres, not flat discs. They also were the first to come close to predicting the approximate size of Earth and also suggested that Earth spins on its axis. Keep in mind that Indian astronomers were not necessarily the originators of these concepts. They were usually building on other people's ideas, or suggesting vague partially-true ideas.

The Three Most Iconic Indian Astronomers of the Siddhantic Era

As mentioned earlier, the Siddhantic era was perhaps the most important and influential period in the history of Indian astronomy. However, this era of important astronomical discoveries would not be possible without the original mathematicians, astronomers, and astrologers who founded it.

Aryabhata

Aryabhata, perhaps the most famous Indian scientists of all time, lived from 476-550 C.E. He studied various sciences including astronomy, mathematics, and physics. He

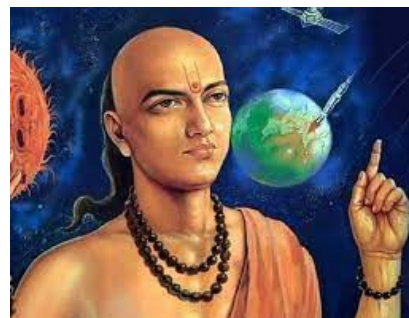


Image credit: discoverwalks.com

composed two significant works, the *Aryabhatasiddhanta*, and the *Aryabhatiya*. The *Aryabhatasiddhanta* greatly influenced Islamic astronomy and as well as other Indian astronomers such as Varahamihira, Bhaskara, and Brahmagupta. It was also one of the first texts to state that the day starts at midnight. The *Aryabhatasiddhanta* is now lost.

The *Aryabhatiya* was famous, especially in South India. Many mathematicians throughout history have written commentaries on the *Aryabhatiya*. It was

written in verse. It covers not only astronomy but also mathematics. The *Aryabhatiya* is divided into 3 sections, the introduction, Gantia (which translates to “Mathematics”), Kala-kriya (“Time Calculations”), and Gola (“Sphere”). The introduction contains astronomical tables and a system of notating numbers. In the Gantia, Aryabhata makes many important mathematical discoveries. He gives algorithms for calculating square and cubic roots. To do this, he uses the decimal number system, invented by his predecessor Bhāskara II. He estimates π at 3.1416 (rounded), which is correct to 4 significant digits. He also used the Pythagorean theorem to figure out a method for building his table of sines.

Aryabhata extended his work with sines to make many other mathematical discoveries. The Kala-kriya chapter presents methods for calculating planetary positions along the ecliptic, including mentions of epicyclic and eccentric models of planetary motion. This built on the work of earlier Greek astronomers. Another subtopic included celestial navigation (sometimes called astronavigation). This chapter also included an astrological theory called Lords of the Hours and Days, used for figuring out favorable times for action. The last chapter in *Aryabhatiya*, Gola, combines spherical geometry and plane trigonometry in a method that projects lines and points on a sphere. This was used to predict eclipses and to justify the claim that the stars appeared to move westward because Earth rotates on its axis. He also predicted the luminosity of many planetary objects. In his honor, the Indian Space Research Organization (ISRO) named their first satellite, Aryabhata.

Varahamihira

Varahamihira, lived from 505-587 C.E. He authored a book called the *Pancha-siddhantika* (which translates to “Five Treatises”). This book was a compilation of all Greek, Egyptian, Roman, and Indian astronomical sciences. His work was influential in Western astronomy. He used Ptolemaic mathematical charts and tables to calculate astronomical data. He was also very interested in astrology.

Brahmagupta

Brahmagupta (598-668 C.E.), focused on predicting circumferences and shapes of planetary objects. He was very influential in forming methods for calculating the position of astronomical objects. He also

helped form methods for calculating the times that astronomical objects would rise and set, and when conjunctions and eclipses would occur.

Conclusion

As you can see, Indian archaeoastronomy is an extremely complicated and interesting topic. Most people don’t realize that Indian culture has contributed so much to astronomy. Aryabhata and the other founders of the Siddhantic era have made extremely important contributions to science. These scientists, mathematicians, and astronomers are undervalued in the West for their extraordinary contributions to our modern world.

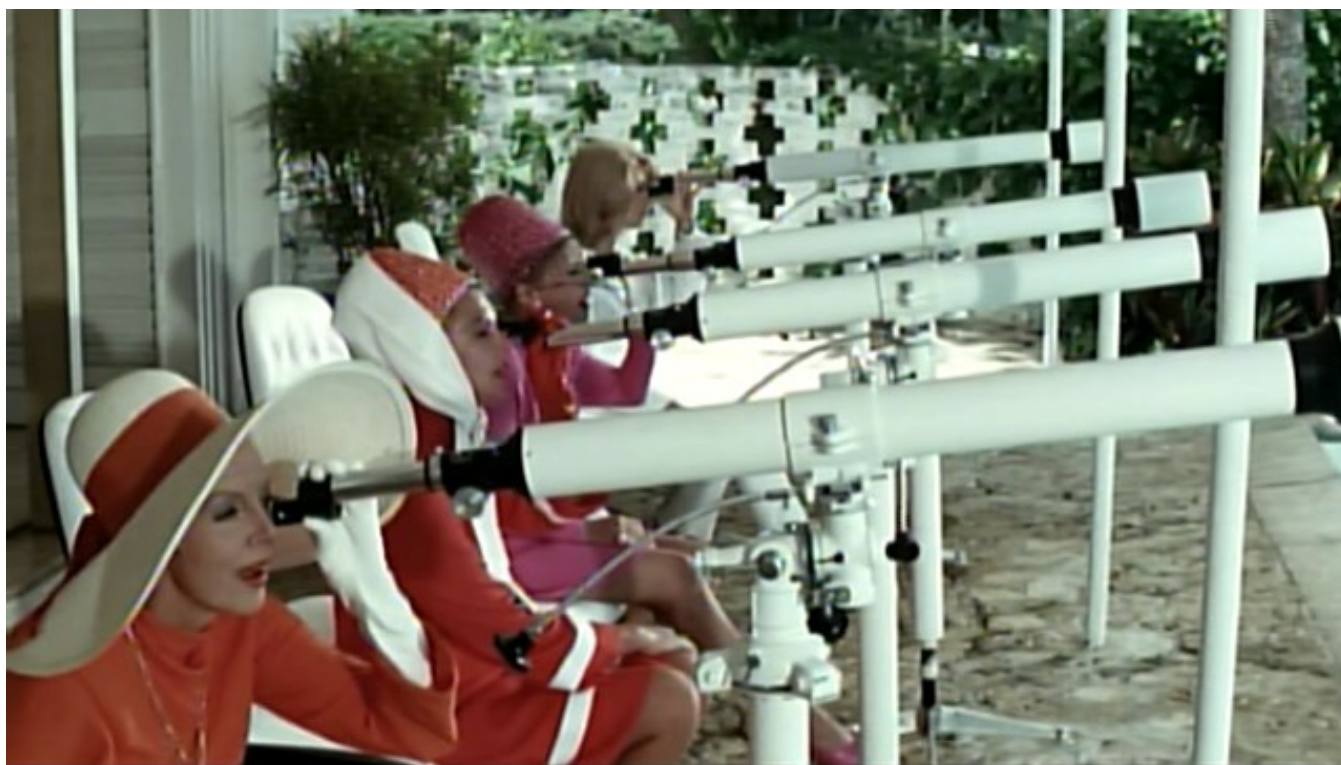
Works Cited

- “Aryabhata.” Wikipedia, 22 Feb. 2023, <https://en.m.wikipedia.org/wiki/Aryabhata>.
- “Astronomy - Ptolemy, Arabic, and Chinese | Britannica.” <https://www.britannica.com/science/astronomy/India-the-Islamic-world-medieval-Europe-and-China>. Accessed 1 June 2023.
- “Celestial Navigation.” Wikipedia, 17 Feb. 2021, https://en.wikipedia.org/wiki/Celestial_navigation.
- Frey, Wendy, et al. History Alive! The Ancient World. Palo Alto, Ca, Tci, 2004.
- “Indian Astronomy.” Wikipedia, 1 June 2023, https://en.m.wikipedia.org/wiki/Indian_astronomy. Accessed 1 June 2023.
- Martyn Shuttleworth. “Indian Astronomy - History of Astronomy.” Explorable.com, 2019, <https://explorable.com/indian-astronomy>.
- “Varahamihira | Indian Philosopher and Scientist | Britannica.” Encyclopædia Britannica, 2020, www.britannica.com/biography/Varahamihira.

अधिकाग्रभागहारं छिन्द्यादूनाग्रभागहारेण ।
 शेष परस्परभक्तं मतिगुणमग्रान्तरे क्षिप्तं ॥
 अध्वउपरिगुणितमन्त्ययुगूनाग्रच्छेदभाजिते शेष ।
 सधिकाग्रच्छेदगुणं द्विच्छेदाग्रमधिकाग्रयुतम् ॥

■

More Movie Telescopes



The James Bond phenomenon in the 1960s, which we mentioned in the [August 2023 SkyWAArch](#) movie telescope segment, spawned a whole bunch of imitators, some serious and some comedic, many of the latter being rather campy (camp, I was told at an early age, is “something so bad that it’s good”). Among the silliest of these send-ups were two films starring James Coburn as super-agent Derek Flint, *Our Man Flint* (1966) and *In Like Flint* (1967). He’s an agent of Z.O.W.I.E. (Zonal Organization World Intelligence Espionage), a secret government spy organization run by a seemingly clueless Lee J. Cobb, who really must have needed the money. We’re a long way from Cobb’s Academy Award-nominated performance 13 years earlier as malignant union boss Johnny Friendly in Elia Kazan’s monumental film *On the Waterfront*.

The evil organization in *In Like Flint* is a feminist conspiracy called Fabulous Face, which seeks to overthrow the American government and replace it with a matriarchy. Headquartered at a spa in the Virgin Islands, they brain-wash female adherents by planting tape recorders in hair dryers. They’ve kidnapped the President and replaced him with a compliant double. When I first saw this movie on TV in the early 1980s during the Reagan administration, I got a kick out of a line given to a shocked Coburn when the switch is discovered: “An actor? In the *White House*?” As Oscar Wilde put it, “Life imitates Art far more than Art imitates Life.”

In this scene, the ladies of Fabulous Face are observing a rocket launch. Close inspection shows that the scopes have old-style straight-through erecting prisms, a realistic touch if they are to observe terrestrial objects. Once a common accessory, this version of the erecting prism is apparently no longer made, all modern erecting prisms being angled at either 45 or 90 degrees. The scopes clearly have equatorial mounts configured for alt-az use with the counterweight shafts and weights removed. They look like good 3-inch f/15 Japanese refractors.



The plot of *In Like Flint* climaxes in outer space. Flint, who plays every scene with ultra-exaggerated coolness, gets out of all sorts of impossible scrapes, kills the bad guy, gets the girl(s) and all is right with the world. Both Flint movies did well at the box office, but they can only be watched now as a celebration of the power of camp to entertain in spite of, or more likely because of, being utterly ridiculous.

Finding Our Way Among the Stars: Plate Solving

Larry Faltz

The first star catalogues come down to us from the Sumerians and Babylonians. Greek astronomers, notably Eudoxus, Aratus, Timocharis, Aristillus and Eratosthenes, studied and wrote about star positions, describing their locations in relation to the constellation figures they inhabit.¹ Hipparchus' 129 BCE catalogue of about 850 stars established the magnitude system and was adopted by Ptolemy in the *Almagest*. In the late 16th century, Tycho Brahe accurately measured the positions of 1,050 stars, which were plotted in Johannes Bayer's *Uranometria* (1603), the first full-sky atlas. Some of its beautiful constellation figures grace the ceiling of Grand Central Terminal (see the [May 2020 SkyWAArch](#), page 12). Bayer included 200 previously uncatalogued stars from southern regions, the booty of the first century of European sea-going

exploration. By the early 18th century, with better telescopes and more accurate measuring devices, John Flamsteed provided positions and magnitudes for 3,000 stars in his *Historia Coelestis Britannica* (1712). In 1801, Joseph Jérôme Lefrançois de La-lande listed 47,390 stars visible from Paris in the *Histoire*

This is a page from Joseph Jérôme Lalande's *Histoire céleste française* (1801). It contains a table of stars with columns for 'NOM DE L'ÉTOILE' (Star Name), 'DROITE ASCENDANTE' (Right Ascension), 'DECLINAISON' (Declination), 'MAGNITUDE' (Magnitude), and 'REMARQUES' (Remarks). The stars listed include Alpha Centauri, Sirius, and others, with their positions and magnitudes recorded in French.

A page from Lalande's catalog

céleste française. In the 1850's the *Bonner Durchmusterung*, also mostly listing northern hemisphere stars, identified 320,000. It was supplemented over the next half century by southern observers with another two hundred thousand or so entries. The 1924 Henry Draper Catalog, compiled at Harvard, was a whole-sky catalog with 225,000 entries specifying position, magnitude and spectral class. Supplements grew the number to the current 359,083. The SAO (Smithsonian Astrophysical Observatory) catalog of stars down to ninth magnitude and with known proper motion at

the time it was compiled (1966), totals 258,997 entries.

As we see deeper and deeper into space with larger and more sensitive telescopes, the listings have grown. The first Hubble Guide Star catalog (1989) had 20 million stars, while GSC-II, published in 2008, has 945,592,683 stars. The US Naval Observatory B1.0 catalog (2003) has over a billion objects (1,042,618,261 to be exact) but it lists both stars and galaxies. The Gaia Data Release 3 catalog (2022) has 1.8 billion objects, about 1.4 billion of which are stars, down to a limiting magnitude of 21 (but none brighter than 3, a limit set by its CCD detector).

This image shows two consecutive pages from the SAO Star Catalog: Positions and Proper Motions of 258,997 Stars for the Epoch and Equinox of 1950.0. The pages are filled with dense tables of star data, including names, positions, magnitudes, and proper motions, organized by constellation and star number.

Two consecutive pages from the SAO Star Catalog: Positions and Proper Motions of 258,997 Stars for the Epoch and Equinox of 1950.0 (published 1966 in 4 volumes). A bit dense?

In printed form or as displayed on a computer, these catalogues are just page after page of dense tables with columns of numbers, as shown above. Newer ones, like Gaia, aren't shown that way at all: they are databases to be searched and we see only an input screen.² What's the use of all this information? How can we use it to find our way around the cosmos?

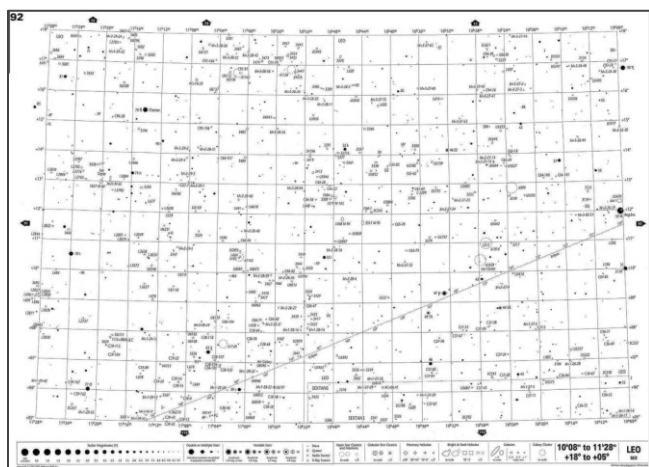
Lists and Maps

The tables can be used to create star maps. Since Bayer's time celestial maps are ever more detailed and sophisticated, if perhaps less artistic (no mythological characters floating among the stars on proper

¹ For example, Hyginus tells us that "Aries has one star on his head," which in Arabic is رأس الحمل (ra's al-ḥamal meaning "head of the ram") and so we call that star Hamal (Alpha Arietis).

² The Harvard web site that refers to the UNSO-B1.0 catalog gives a link to the search engine, but also has this note: "The catalog's size is about 80 GBytes and the only way to get it is to make a copy from someone who already has it."

star maps these days). Printed maps, whether simple ones like in the *Norton Star Atlas* (to magnitude 6.5), or more detailed ones like the *Uranometria 2000* (to magnitude 9.75) and *Millennium Star Atlas* (to magnitude 11), are impressive, beautiful in their own way and a testament to cartography, but they have been replaced by computer programs such as *Cartes du Ciel*, *Stellarium*, *TheSky* and *SkySafari*. These programs aren't just passive drawings of star positions. They can show the appearance of the sky at any time, date or locality, have look-up functions, display stars and deep sky objects with limiting magnitudes of the user's choice, link to image and research sites, and can even control telescopes. Unlike printed maps, they include the Sun, Moon, planets, asteroids and comets at their real-time positions, with the ability to update the ephemerides for new discoveries and orbital changes. Users can upload and display all sorts of specific catalogs from professional databases. They are colorful, and they are either free or fairly inexpensive.³



A page from *Uranometria 2000.0* (stars to mag 9.75)

Progress at the Telescope

The personal computer came on the scene in the late 1970s (the Apple 2 was introduced in 1977) and inevitably impacted amateur astronomy. In 1985, Celestron offered the first computer-controlled "go-to" Schmidt-Cassegrain telescope, the Compustar, followed by the Ultima in 1996 and the Nexstar in 1999.

³ *TheSky* is substantially more expensive than the other programs mentioned. The *Millennium Star Atlas* shows all the stars in the Tycho and Hipparchus catalogs to magnitude 11. Now out of print, one is being offered on Amazon, as of this writing, for \$1,429.99. But you can download the

The Compustar was expensive and a major power hog, requiring 12 amps (a typical modern 8" SCT draws around one amp when slewing and less than 0.5 amps when tracking). The earliest fork-mounted scopes required a wedge for tracking. Celestron quickly phased out their non-go-to fork mounted telescopes, replaced stepper motors with servos, and implemented polar tracking in the alt-az configuration so a wedge was no longer mandatory. Other scope and mount manufacturers jumped into the "go-to" world.



A Celestron Compustar (in someone's garage). From a YouTube video.

Another solution for way-finding is the optical encoder, which uses light source, photosensitive detectors, and an optical grating (or more recently magnetic sensors) to convert rotary motion to an electrical signal. Attached to the mount's axes, they feed microprocessors that have encoded sky catalogs, such as the SkyCommander, ArgoNavis and Nexus DSC. They are often used on large Dobsonians. A two-star alignment is all that's needed for the sky model to work. They usually display arrows to direct you to move the telescope in each axis, counting down as you get closer until you reach 0,0, when you're on the selected object. Not "go-to," but "push-to." Celestron

entire Tycho catalog (to magnitude 12), the UCAC-4 catalog (to magnitude 16) or even the Gaia DR2 catalog (to magnitude 21) for free to display on a planetarium program.

now has StarSense, in which a cell phone and its camera do the job of the encoders.

The new computerized devices obviated the time-tested (and time-intensive) practice of “star hopping” to find a faint celestial object. We don’t see anyone at our star parties peering over maps of the sky preparing to hunt for faint-fuzzies by plotting out a path among the stars finder field by finder field. Set up your scope, polar align if it’s an equatorial mount (alt-az mounts only need to be leveled) and align on one or two bright stars (you can even use planets) and you’re set. The scope’s computer has a model of the sky and a catalog of objects. Once you give it the necessary information, it knows where it’s pointing and can calculate exactly where to go when instructed.

Celestron has offered “SkyAlign” for two decades with their computer controlled mounts. The user doesn’t have to know the names of any stars at all. After setting the date, time and location, select three bright stars, align on them, and the scope figures out which they are. This works because there are not going to be too many choices: stars will most likely be second magnitude or brighter and there are not so many of those⁴ and the scope also knows which ones are above the horizon. A crude look-up function that compares the offsets (distance and relative angles) of the objects with a table of star positions in the hand control’s firmware will quickly identify the objects to establish the pointing model. However, any owner of a telescope with that capability ought to learn the names of enough stars to be able to pick two bright stars on any night and go directly to a two-star align. Once learned, it’s faster and just as accurate. Anyway, I think it would be embarrassing if you had a sophisticated \$2,500 telescope and someone came up to you and asked “Which star are you pointing at?” and you answered “I have no idea, but then I’m going to look at the 12th magnitude Blue Pimple planetary nebula.” Basics first!

Every star and deep sky object is located at a given right ascension and declination. Planets, asteroids and comets move in orbits whose elements are specified to great accuracy. Fortunately stars and deep sky

objects stick to their places in the heavens. We allow them a little leeway for proper motion and the precession of the equinoxes, but software can compensate for that too.

But now consider that astronomy is not just about going outside and looking up. It’s a science whose goal is to learn how things work in the cosmos.

Where Are We in the Sky?

Imagine you are not at the telescope and you’re asked to identify the exact location in the sky of an object on an image made by another astronomer with an instrument about which you know nothing, nor do you know the date, time or location when the image was made. What part of the sky is shown in that image? Astronomers need to be sure they are talking about the same place in the sky when they compare data. Telescopes and other astronomical devices don’t all have the same field size. Images differ in left-right and up-down orientation, depending on the number of lenses and mirrors in the optical train. The brightness of an object in an image is dependent on a variety of technical choices. A system that could derive location information from an image would have to be independent of these details.

We can scan the image and use software to specify the stars relative to each other, but we still have no idea where in the sky they are.

Taking a list of star positions in an image and iteratively comparing it, object by object, magnification by magnification, orientation by orientation, to a stellar database of millions of objects would be ridiculously inefficient and time consuming. Fortunately some very smart people have figured out how to solve this problem.

Rapid data indexing and searching was one of the primary concerns of computer technology since the early days of data processing, achieving astonishing speed and capability. Think about how quickly you get relevant information in a Google search. Put in any term, no matter how sophisticated, and within a second you can get thousands of links, sorted by relevance.⁵ I entered “plate solving” and got 151,000

⁴ The SAO catalog lists 19 stars brighter than magnitude 1.0, 39 stars between 1.0 and 1.99, and 131 stars between 2.0 and 2.99. That’s in the entire celestial sphere, both northern and southern hemispheres In Westchester,

SkyAlign doesn’t have to worry about Canopus or Alpha Centauri..

⁵ Ignore the paid links at the top!

links in one second, with the first page or two containing almost everything I needed to know to get started on this article: informative Wikipedia entries, links to an on-line plate solver, scientific papers, useful discussions and videos on vendor and enthusiast web sites. The software does not look at web site #1 for the words “plate solving” and then go on to site #2 and site #3 and eventually get to all 1.3 billion web sites (and all their billions of subsidiary pages). I’ll leave the science of modern search engines for your own investigation. Suffice it to say that identifying the locations of cosmic objects benefits from all the progress computer science has made in indexing and searching.

But what should we search for? The answer is not individual stars, but patterns of stars, useful patterns among myriads of actual patterns that we could possibly construct, anywhere in the sky, at any scale we might need. But there are millions of potential patterns and many possible scales. How do we find ones that we can use, and use efficiently?

One way of doing this might be to require all the astronomers to provide their imaging data at the same scale, so the patterns themselves had absolute dimensions. Early in the astrophotography era, 56 delegates convened in Paris on April 16, 1887 for the International Astrophotographic Congress.⁶ They wanted to ensure that astrophotography would become a truly scientific technique. The Congress’ main goal was “To prepare a general photographic chart of the heavens...to determine with the greatest accuracy the positions and the brightness of all the stars down to a given magnitude.”⁷ Among its recommendations:

- The telescopes would all be 0.330-meter (13-inch) refractors with a focal distance of 3.43 meters (giving $f/10.4$). That means they would have a resolution of 1 arcminute per millimeter on the photographic plate.⁸
- The objectives should be corrected with light of the Fraunhofer G line (the calcium and iron lines at 430 nm; undoubtedly reflecting the fact that early films were primarily blue-sensitive).

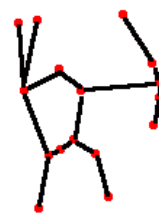
- Plates would be exposed to show 14th magnitude stars.
- Plates would be prepared, processed and oriented in the same way by all of the participating observatories.

But this kind of standardization can inhibit the progress of science. At the time of the Congress, little was known about astrophysics. A star’s brightness on a blue-sensitive film might very well be misleading, especially since we know now that so many stars are dim red dwarfs. Anyway, brightness ultimately proved less important to the progress of astronomy than spectra. One of the major goals of the Congress was “To be able to utilize in the best way, both at the present day and in the future, the data obtained by photographic means.” Locking people into one way of doing things won’t do that. Innovation is the key to progress.

Patterns in the Sky



If you look at this pattern of stars, after some thought you might be able to identify it as the constellation Orion. It’s obvious when we connect the dots in a familiar way.



It doesn’t matter how big the picture is. The pattern has the same proportions and gives us the same information. This is the concept behind plate solving (also called astrometric solving). Stellar positions need to be converted to patterns that can be

⁶ A summary of the minutes are at <https://articles.adsabs.harvard.edu/pdf/1888MNRAS..48..212>.

⁷ This was the famous and never-completed *Cartes du Ciel* project.

⁸ This probably accounts for some of the turn-of-the - (20th)-century telescopes of this peculiar size that are preserved at historic observatories around the world.

compared quickly, and in a way that allows for differences in dimension and orientation of the image.

One of the nice things about geometry is illustrated by the fact that a small square and a large square are both still recognizably squares. Any geometrical object that is enlarged or shrunk without distortion retains the same proportions of its sides, nor are they changed in a mirror image. How can geometry be translated into a database that can be searched quickly and with few or no errors?

A seminal paper was published in 2010⁹ that described the solution to the problem. The technique uses the following steps when given an unknown “query image”:

1. Identify stars in the image (a fairly easy process for a computer)
2. Analyze subsets of four stars (“quads”) among the brighter stars, creating a “hash code” for each one based on the stars’ positions relative to each other.
3. Search a large, pre-computed index for “almost identical” hash codes.
4. Find the best match(es) and rank them.
5. Test, using Bayesian methods, whether the hypothesized alignment is correct.

In practice, many quads are tested, but advances in searching algorithms (not to mention the increased speed of processors) makes the search very efficient. The main computing overhead only occurs once, when making the pre-computed index, since that has to measure the entire sky. Once that’s done and the index prepared, the only new hash codes are those generated in the query image.

The process of determining a hash code is quite clever. Four stars are identified and the longest distance between them is established as the diagonal of a unit square. One star is thus at the origin (0,0) and the other at 1,1. The coordinates of the other two stars within a circle circumscribed by the first two are then computed, and the hash code is generated based on the positions.

The choice of four stars rather than three or five (or more) is based on practical considerations. With three stars there is a possibility of making more false matches that would need to be rejected by the Bayesian step. For quintuples of stars, the matching overhead is greater and the possibility that all the stars in a geometric figure are somewhere within the query image goes down (and more so for sextuples, etc.). Four seems to be the best choice.

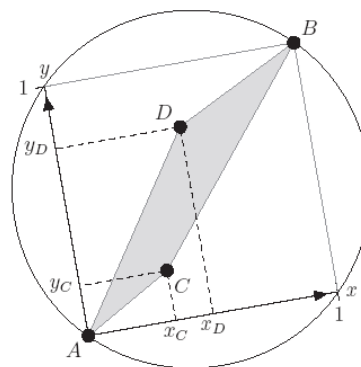


Figure 1 from Lang, et. al. Geometric hash code for a “quad” of stars A, B, C and D. Stars A and B define the origin and (1,1), respectively, of a local coordinate system, in which the positions of stars C and D are computed. The coordinates (x_C, y_C, x_D, y_D) become our geometric hash code that describes the relative positions of the four stars. The hash code is invariant under translation, scaling and rotation of the four stars.

Hash codes generated in the query image are compared to hash codes in a pre-computed index made from an all-sky survey. This does not have to be a visual survey. Although USNO-B1 was used initially, the Two Micron All Sky Survey (2MASS) and the Galex survey (ultraviolet) have been used and other catalogs, particularly Gaia, are available.

However, there is one more important consideration when developing the reference index: how to lay out the range of reference quads and their hash codes across the sky so that there is some regularity in the distribution of data and an orderly process for comparing query image quads to the reference quads. How can the sky be divided into regular, equal-sized sections. It’s more complex than you might think.

⁹ Lang, DL, Higg, DW, Mierle, K, Blanton, M, Roweis, S, Astrometry.Net: Blind Astrometric Calibration of Arbitrary Astronomical Images, *Astronomical Journal* 2010; 139: 1782-

1800, online at <https://iopscience.iop.org/article/10.1088/0004-6256/139/5/1782>.

Dicing the Sky

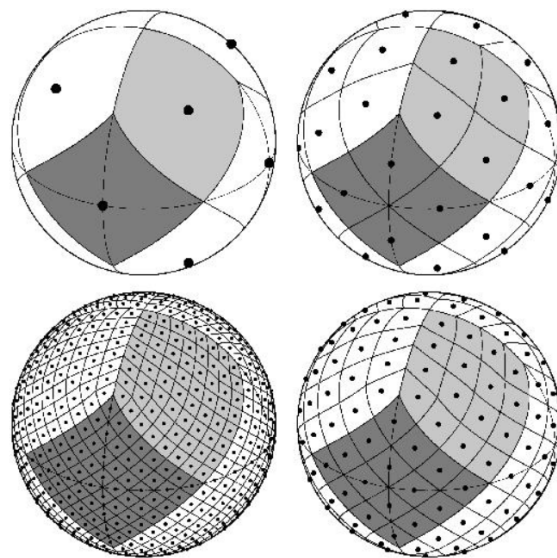
We map the sky as being spherical. We're used to dividing a sphere along lines of latitude and longitude (or, for astronomical purposes, right ascension and declination). We can't use that method if we want the areas of all the divisions to be equal. As a crude example, consider an area with sides of one degree along latitude and longitude. At the equator, we get a square one degree on a side, with an area of one square degree, or 4,774.8 square miles. At the poles, it's a triangle one degree on a side, but it's not an equilateral triangle because at the pole the base of the triangle would be much smaller than the sides even though all would be one degree. While one degree of latitude is always 69.1 miles, a degree of longitude at 89° latitude is just 1.21 miles, giving the triangle an area of about 41.8 square miles. How do we divide a sphere into *equal* areas?

The solution was developed to support analysis of WMAP and Planck cosmic microwave background satellite data. It's called HEALPix, an acronym for Hierarchical Equal Area isoLatitude Pixelization of a sphere. The sphere is divided into curvilinear quadrilaterals. All the quadrilaterals have the same area, but not necessarily the same shape, nor are the sides perfectly straight lines. The lowest resolution partition is comprised of 12 base "pixels." To get more detailed, the tessellation increases by dividing each pixel into four equal new ones, and each subsequent step does the same division by four. No matter how fine the sphere is divided, the areas of each pixel are always the same. At very high orders of division, the sides look straight.

The centers of each pixel align on constant latitudes, facilitating indexing and applications involving spherical harmonics. This property of the grid was used to analyze WMAP and Planck data to find the angular distribution of temperature differences in the CMB, showing that the most common mode is at one degree.

The differences in shape of the individual pixels can be appreciated in the examples on page 16 taken from the Aladin Sky Atlas. I centered on Polaris (close to the pole), Beta Aurigae (near 45 degrees right ascension), and M78 (near the celestial equator) on the CDS site, <https://cds.unistra.fr//>. CDS shows an image of the object (you can choose which telescope to

display) and you can zoom in or out. You can select to show the HEALPix grid. Its dimensions are correlated with the display magnification. I zoomed out to the maximum extent possible, at which CDS shows a sphere with 768 equal areas. You can see the different patterns among the three images, reflecting the regular, but not strictly orthogonal, distribution.

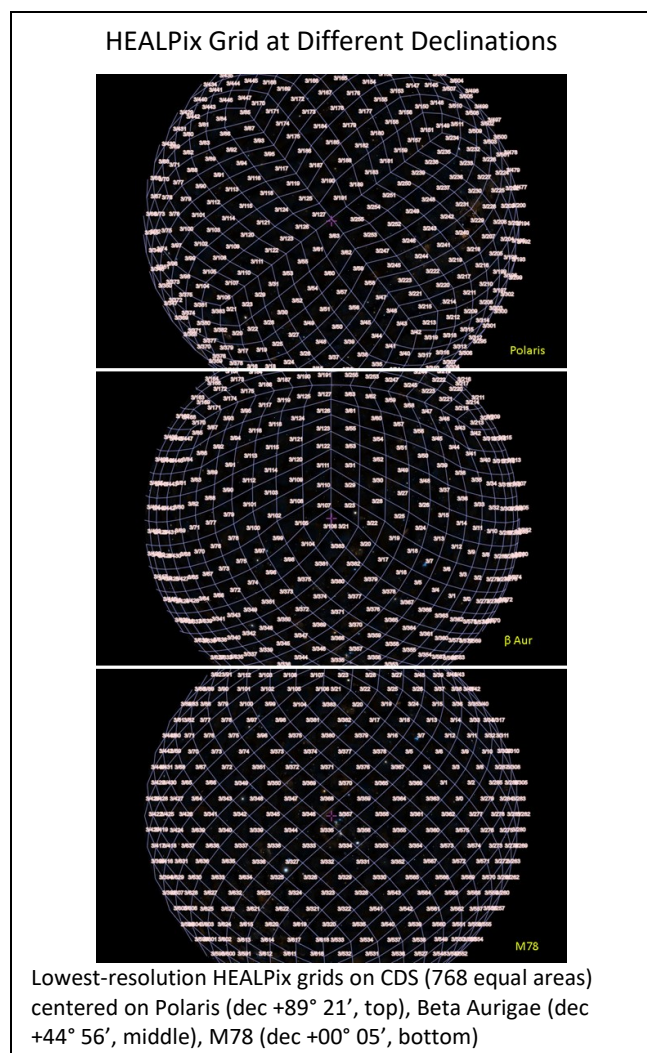


The four lowest-order HEALPix grids. Clockwise from upper left:: 12, 48, 192 and 768 pixels (NASA)

To build a library of reference quads for the index, software selects the five brightest stars in each HEALPix grid element in an all-sky catalogue and makes quads. There are some rules about how to construct the quads: they must have a diameter (the distance between stars A and D) within a certain range relative to the HEALPix grid cells, and the midpoint of the line AD should be within the grid cell. Not all stars end up being used, and some are used more than once (as part of other quads) but essentially all the grids have at least part of a quad within them, at least on the first pass. If a grid lacks a quad, the restrictions are relaxed: dimmer stars are used, and some stars may be used multiple times in new quads.

Once the index is completed, the geometric hash codes are formed into a list which is organized as a "k-d-tree," a data structure that facilitates rapid retrieval. On an unknown query image, the stars are detected and measured, hash codes are generated and then compared to the index. The tree is searched for hash codes in the "neighborhood" of the ones on the query image. A small range is required since there

may be slight variations during imaging (noise, distortion, etc.). If a match is found, a verification process

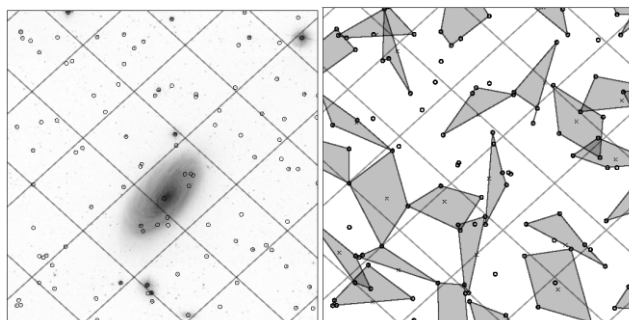


tests whether it's a true match. Many false alignments have to be examined, but since a false positive is worse than a false negative, the conditions of the validation are constructed to eliminate them. Better to not get an identification at all than to ascribe the location erroneously.

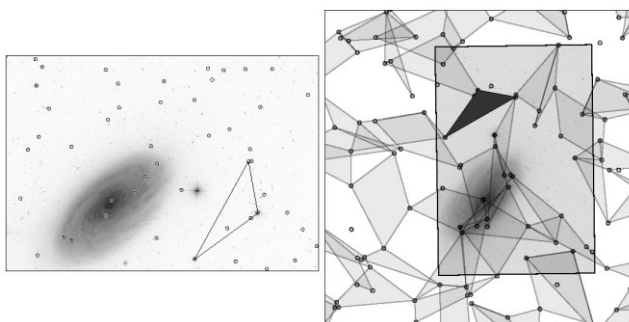
The authors tested the system on 182,221 high-quality SDSS images. They achieved 100% correct image recognition, and did so with a total of 80 minutes of computing time (running some parallel processors). In addition, tests on the Hubble Legacy Archive also resulted in 100% performance.

The system was used to process the half-million plates of the Harvard Observatory for the DASCH (Digital Access to a Sky-Century at Harvard). By 2009, over 14 million images of the Palomar-QUEST sky

survey and the Nearby Supernova Factory were also successfully processed.



Stars in a field surrounding a galaxy (reference image), and the quads in that image. (Figs. 2, and 3 from Lang, et. al.).



A quad query image (left). The quad selected for matching is shown. Right: The final match. The darker rectangle is the query image, which has been rotated and scaled to show the quad match. The quad looks like a triangle because two of the stars are almost on the same line. (Figs. 5 and 6 from Lang, et. al.).

To their credit, the authors have made the code publicly available with extensive documentation. To do it yourself is a bit complicated and requires some programming skill and experience. But they didn't leave digitally-challenged end-users in the lurch.

The authors set up the web site [astrometry.net](https://nova.astrometry.net/) to make the underlying code available. The page <https://nova.astrometry.net/> is the place where anyone can upload images and have them quickly analyzed and solved. I use it to find the dimensions and exact location of deep sky images sent by WAA members. The plate solver accepts images in several file formats (not tiff, however). I uploaded an image I made of an undistinguished star field that included the small globular cluster NGC 6760. The field was 55.4 arcminutes square and the file size was 18 megabytes. From starting the upload to the solution took 33 seconds. Field size and location information were provided, the brightest stars and the cluster were labeled, three levels of maps show the field's location

Images by Members

The James Webb Space Telescope by Robin Stuart



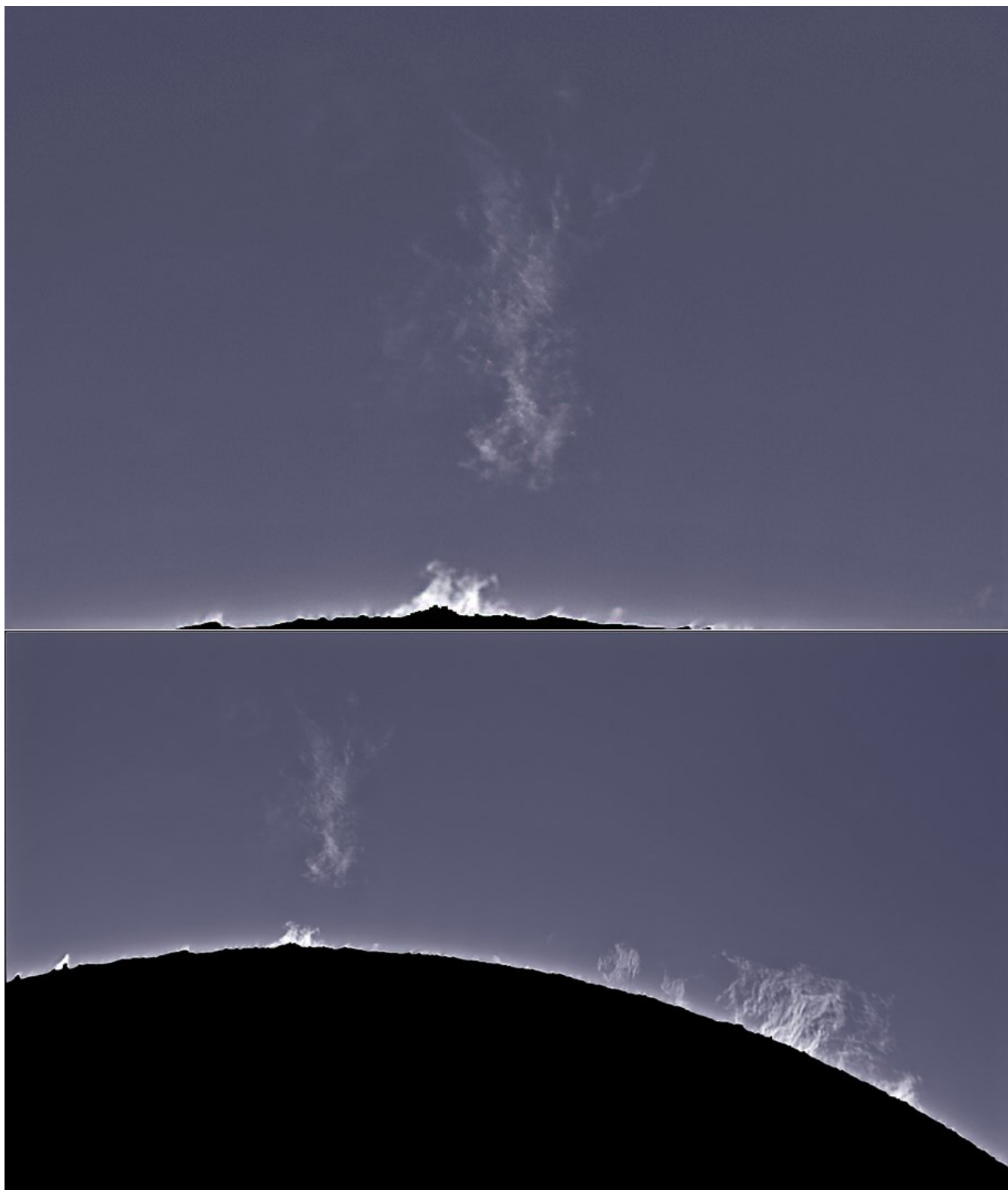
The image shows the trail of the James Webb Space Telescope (JWST) making a close appulse to the 14.2 magnitude galaxy UGC 12178 over a 1^h40^m period starting around 11pm on 20 September. The imaging session was interrupted by a passing cloud that is responsible for the gap. The lower trail represents a 20 minute period and the upper trail, 3.24 arc minutes in length, is one hour. At the time the JWST was in the constellation of Pegasus at an altitude of 51° above the horizon, at a distance of 1.23 million kilometers (780,000 miles) from Earth. For reference this is 3.26 times the average Earth-Moon distance.

The JWST executes a six month highly elliptical orbit about the Sun-Earth L2 Lagrange point, located at around 1.5 million km in the direction opposite to the Sun. It can reach a distance of 520,000 km above or below the plane of the ecliptic. A 3D animation can be found at <https://is.gd/jwstorbit>. Ephemerides for JWST's position can be obtained from the JPL Horizons system <https://ssd.jpl.nasa.gov/horizons/app.html#/>. The JWST is currently heading north. For an observer in the Meadow Parking Lot in Ward Pound Ridge Reservation, it will reach its maximum declination of 28° on 21 October. On that date it will rise to an altitude of 77° above the horizon.

The image is a combination of eight 10 minute subframes using a ZWO ASI2600MC camera through a Televue NP127 refractor in Eustis, Maine. The JWST position was found using the Orbitals plugin in N.I.N.A. The field of view is 25.5×19.1 arcminutes. The bright star just below and to the left of UGC 12178 is HD 215460, class F0, magnitude 8.39.

--Robin Stuart

August 9, 2023 Solar Prominences by John Paladini.



Hydrogen-alpha wavelength using a spectroheliograph. ASI 290MM camera.

Messier 11, the Wild Duck Cluster by Robin Stuart

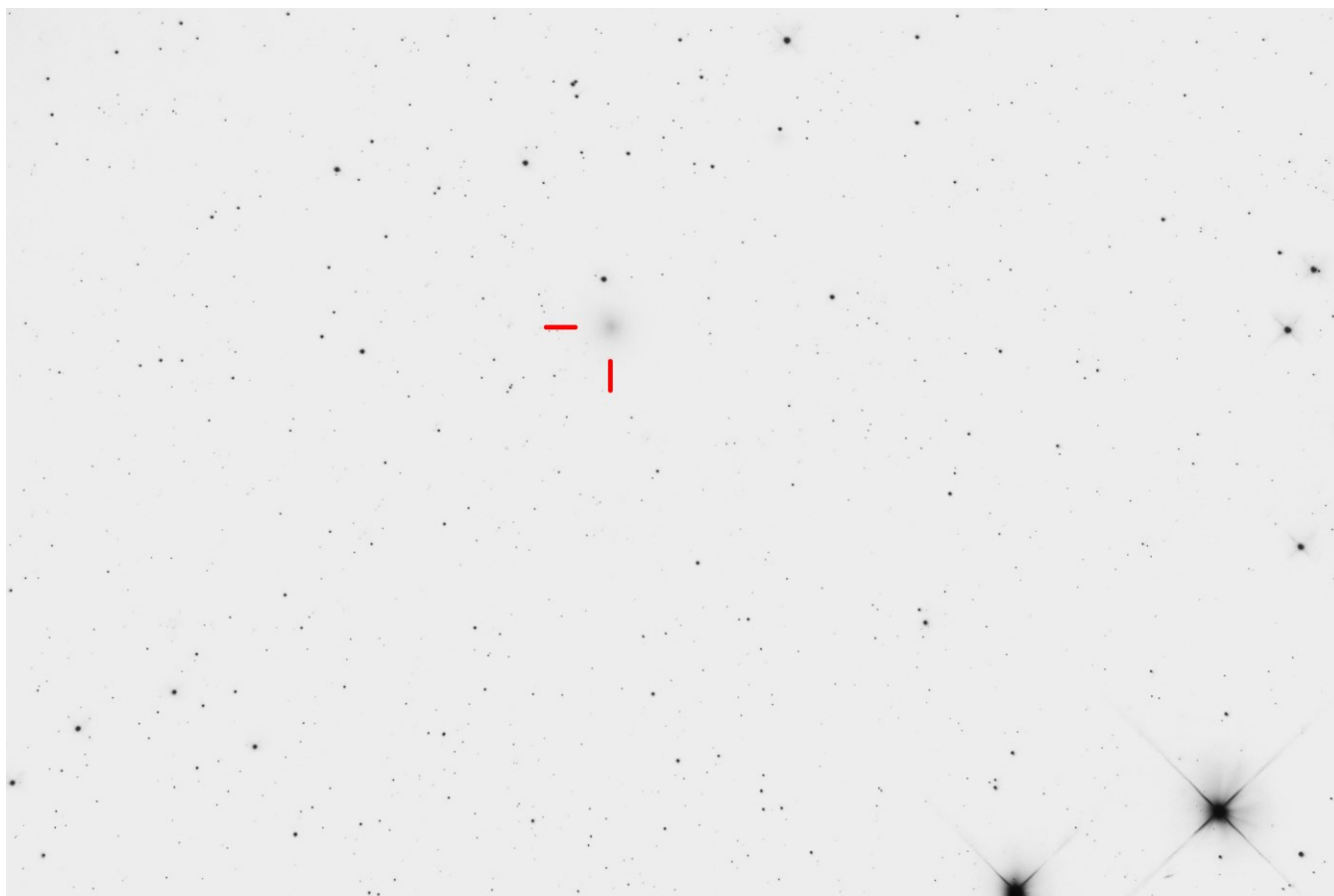


Robin writes:

The Scutum Star Cloud is actually a sucker hole in the Milky Way's gas and dust clouds which we can peer through to view the distant stars that inhabit the spiral arms beyond. Within the cloud sits the open cluster Messier 11, also known as the Wild Duck Cluster since its blocky, somewhat triangular shape is thought to resemble a flock of flying ducks. The leader of the flock is a visually striking magnitude 8.5 star at the apex. The cluster is at a distance of 6,120 light years and is one of the largest and most compact open clusters in the sky.

The image above is a stack of six 10 minute exposures with a ZWO ASI2600MC camera through a TeleVue NP127 telescope. It was processed with PixInsight's Photometric Color Calibration before the image was stretched and its color saturation strongly enhanced. An obvious feature of the image is the preponderance of red-tinged stars. Moreover, fainter and therefore likely more distant stars generally appear redder while brighter stars tend to show a much whiter hue. This is presumably a consequence of interstellar reddening. As the starlight passes through tenuous clouds of gas and dust to reach us, shorter wavelengths are preferentially scattered leaving the longer red to predominate. A similar phenomenon is responsible for the red color of sunrise and sunset. The effect is even more pronounced in starlight that has penetrated the regions of dark nebulosity near the top of the image. The two relatively bright 6th magnitude stars in the upper right quadrant of the image are both spectral type K which are naturally orange to red in color.

Editor's note: Messier 11 was first described as resembling "a flight of wild ducks in shape" by Admiral William Henry Smyth in his Bedford Catalog, the second part of his very influential A Cycle of Celestial Objects: For the Use of Naval, Military, and Private Astronomers (1844). He located it in the now-defunct constellation Antinous, which was created by the Roman emperor Hadrian in 132 CE. Antinous was split between Aquila and Scutum by the IAU in 1930.

Comet C/2023 E1 (ATLAS) by Steve Bellavia

This comet was discovered on March 1, 2023 at magnitude 19. Passing perihelion on July 1, it brightened to about magnitude +9.5. Steve imaged the comet on June 5, when it was in the constellation Draco and shined at about magnitude +10.5. He used a home-made 114-mm reflector with a focal length of 450-mm. The two bright stars in the lower right corner are Kappa Draconis (B5, Vmag 3.85) and 6 Draconis (K4, Vmag 4.95, on the bottom edge). The field of this image is 1.58 x 1.05 degrees. Full technical information at <https://www.astrobin.com/me6cv8/>. We're showing this as a negative image to enhance the comet's visibility for our readers.

**Venus at Inferior Conjunction**

Steve sent this daytime image of Venus, taken on August 13th at 3:28 p.m. with a Celestron C5. The disc was just 0.9% illuminated, but had it been night-time, it would be shining at magnitude -3.9.

Venus was only 7° 44' from the Sun when this image was made. It passed inferior conjunction just six hours earlier when it was just 2 arcminutes closer to the Sun. Venus' orbit is tilted 3.4° from the ecliptic, making many conjunctions visible (with appropriate precautions) but are transits very rare. If you missed the 2004 and 2012 transits, you'll have to wait until 2117 for the next one.

More Images from Arizona by Arthur Miller

NGC 6992, part of the Eastern Veil Nebula in Cygnus



NGC 4565, the Needle Galaxy in Coma Berenices. The small fuzzy patch to the right is IC 3571. (g_{mag} 17.1)

Messier 16 from Dark Skies by David Parmet

David was at the Cherry Springs State Park in Pennsylvania and made this wide-field view of the Eagle Nebula on August 19. He used a William Optics RedCat 51 ($f/4.9$), a SkyWatcher GTi mount, ASI 533MC Pro camera and ASIAir Plus, with guiding and a UV/IR cut filter. Forty 180-second light frames (a total of 2 hours of light frames), 20 darks, flats and bias frames. Processed with PixInsight. The field of view is 1.73×1.73 degrees.

Most astrophotographers shooting M16 focus, understandably so, on the “Pillars of Creation,” so they show the brighter central area in a smaller field of view. (See, for example, Gary Miller’s images on page 22 of the [August 2023 SkyWAArch](#)). David’s image, made with a shorter focal length instrument and in darker skies, shows us the vast extent of the nebula. The Pillars are still beautifully resolved in the heart of the nebula.

The Whale, the Pup and the Hockey Stick by Jordan Solomon

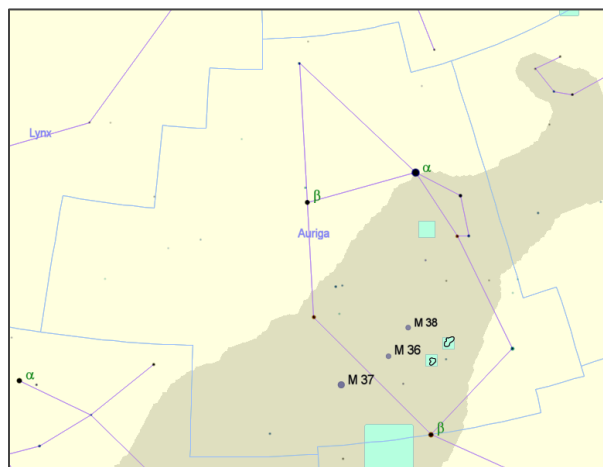
Made with a Vaonis Vespera (50 mm f/4 quadruplet “smart telescope”) at Cherry Springs in June. The galaxies are in Canes Venatici. The Whale is NGC 4631, magnitude 9.78. The tiny Pup, NGC 4627, is a dwarf galaxy associated with NGC 4631. It is magnitude 13. Half a degree to the southeast (down in this image) is NGC 4656, a magnitude 13.57 spiral that is warped from its interactions with its nearby neighbors. The object at the tip of the Hockey Stick’s blade is given its own NGC number, 4657, and may be a separate small galaxy.

Messier 37 by Rick Bria



The bright open cluster Messier 37 in Auriga is almost as wide as the full Moon. At magnitude 6.7 it is a fine sight in binoculars or a small telescope. It is made up of over 500 stars, of which 150 are brighter than magnitude 12.5. It lies almost directly opposite the galactic center and may be in the same spiral arm as the solar system, even at its distance of 4,500 light years. A planetary nebula was found in M37 in 2022.

Rick made this image with the 14-inch PlaneWave CDK telescope at the Mary Aloysia Hardey Observatory at Sacred Heart School.



Messier 37 is one of three prominent open clusters that are close to each other in the constellation Auriga. They are potentially naked-eye objects for good eyes in a very dark sky and are excellent sights in binoculars.

Object	Magnitude	Diameter	Distance (LY)
M35	5.3	28'	2,800
M36	6.3	10'	4,340
M37	6.2	15'	4,511

Philippe Loys de Chéseaux discovered M35 in 1754. Giovanni Batista Hodierna discovered M36 and M37 around 1650 (see the [January 2023 SkyWAArch](#), p. 16).

Effect of a Mild Light Pollution Filter by Larry Faltz



With filter

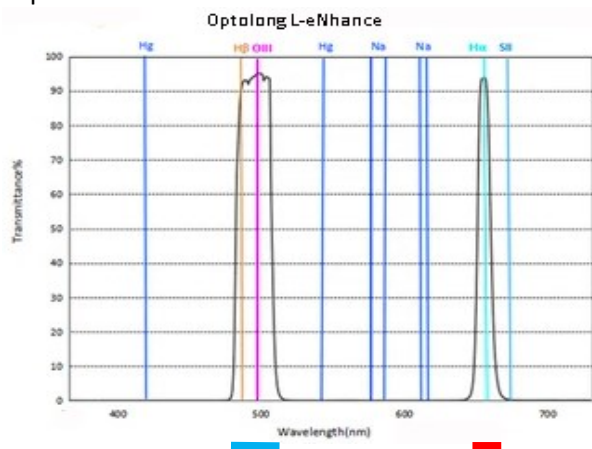
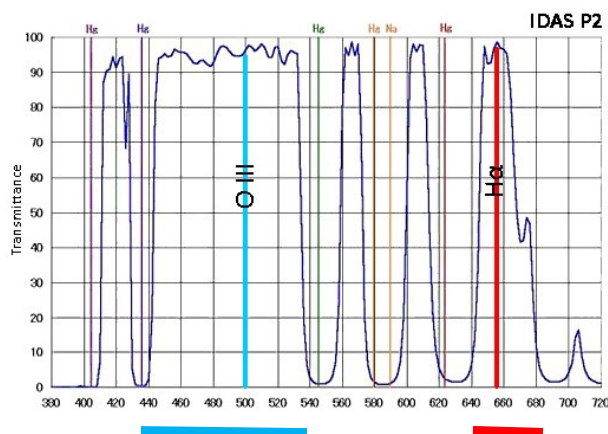


Without filter

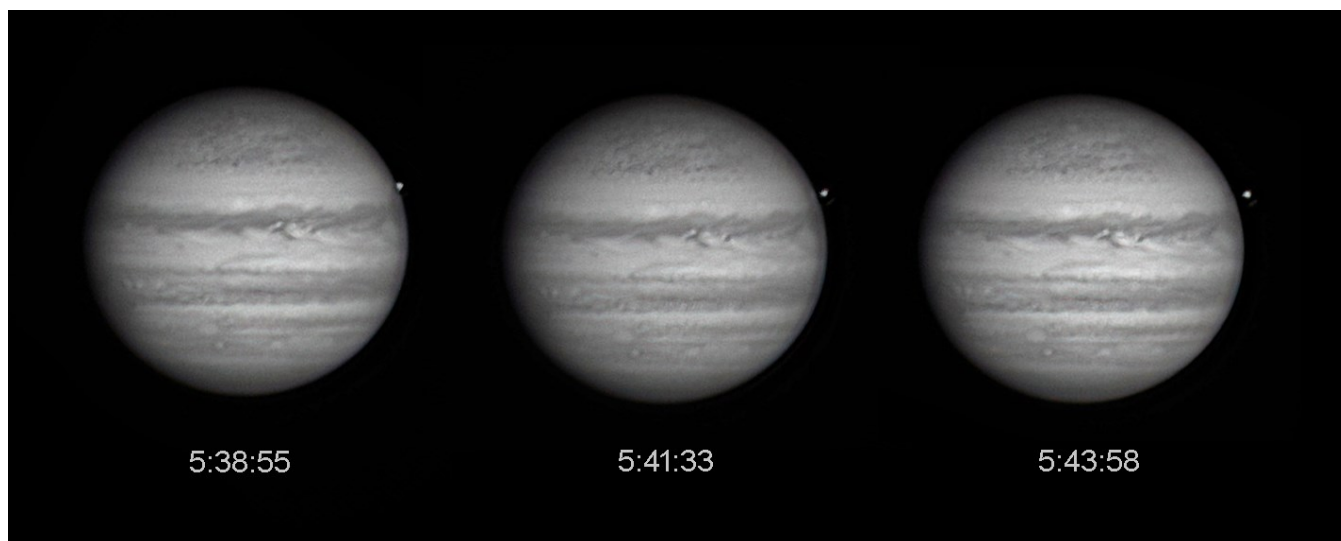
These are uncropped images of NGC 6888, the Crescent Nebula in Cygnus, made on July 11 with a Stellarvue SVR-105 f/7 triplet refractor and ASI533 MC Pro camera, on a guided ZWO AM5 mount. I used an old IDAS P2 filter for the image on the left. The P2 passes hydrogen alpha and oxygen III but with much broader bandpasses than more aggressive modern filters like the Optolong L-eNhance. Older light pollution filters were designed to block emission wavelengths from sodium and mercury streetlamps, but since 2011 almost all of those lamps have been replaced by panchromatic LEDs. Many filters now offer bandpasses for just H-alpha and OIII with full-width half-maximum (FWHM) spreads as low as 3 nanometers. We recall the “gearhead’s mantra”: “There’s always something else to buy.” The images, identically processed, are each a stack of nine 120-second subs with dark frames applied, but probably not needed much for images with the cooled, low noise, no amp-glow 533. I didn’t quite get the camera rotated to the same position after I removed the filter, accounting for the slight variation in alignment. A filter drawer would solve that problem. “There’s always something else to buy.”

Even this mild filter clearly darkens the background and enhances the H-alpha color saturation.

Here are the transmission spectra for the IDAS P2 and L-eNhance, with some of the important spectral lines indicated. Note the difference in the width of the transmittance peaks around the OII and H α lines.



“To the Egress, 10¢” by John Paladini



Io emerges from behind Jupiter in this sequence of images taken about 90 seconds apart. John used a 7-inch Orion Maksutov telescope and an ASI290MM camera from his home in Mahopac.

Although the *Sky & Telescope* Jupiter Moon app describes this event as an “exit,” the word “egress” is also apt, and that’s how John titled the email that sent these images.

We’ve always loved the word “egress,” and not just because it sounds like the stately wading bird whose patience and concentration is a fine model for an astronomer at the eyepiece. The great showman P.T. Barnum capitalized on people’s limited vocabulary. He posted a sign in his museum (on Broadway and Park Row, across from City Hall, on the block that subsequently housed the main store of the now defunct music and electronics giant J&R) that read “To the Egress, 10 Cents” with an arrow pointing to a door. The marks bought a ticket, went through the door, and found themselves in the street! Barnum’s Museum operated from 1841 to 1865, when it burned in a spectacular fire.

The Tilt of Saturn’s Rings by Larry Faltz



After writing the article on Saturn on page 6, I realized that I had two earlier images and could show the change in the ring plane over four years. The 2019 image was made with a NexImage 5 color camera under suboptimal seeing in Larchmont; the 2021 image was in near-perfect seeing in Maine using an ASI290MM monochrome camera, and the 2023 color image is the same one that’s on page 6. All made using CPC800 with 2x Barlow.

Two Attempts at An Emission Nebula in Cygnus Created by a Wolf-Rayet Star, by Steve Bellavia

At Orient Point in Long Island in early September, Steve imaged a blue arc of glowing gas in Cygnus that is an emission nebula shaped by the intense stellar winds and prolific radiation from the Wolf-Rayet star WR 134, also known as V1769 Cygni. Wolf-Rayet stars have exhausted their hydrogen fuel and fuse helium or heavier elements. They are massive, hot and extremely luminous. Most are on their way to becoming supernovas. WR 134 is 5,700 light years distant, has a mass of $18M_{\odot}$, a surface temperature of 67,000 K and has a luminosity 407,000 times more than the Sun.

Steve used a Celestron 6-inch SCT fitted with a Starizona Hyperstar to give a focal length of 300 mm (f/2). A ASI533MC Pro camera was fitted with an Antlia ALP-T Dual Band 5-nm Highspeed 2" filter. The field is 2.11 degrees on a side.

Any of us would have been proud to have made the image on the previous page, but Steve is always striving more. He commented in his email "I am actually not that happy with this image. There is a larger portion of the nebula that makes a full circle. I hope to gather more data, perhaps with a monochrome camera and an OIII filter, to better reveal it."

And so he did. Just two days later he sent another image of the object, also from Orient Point but this time with a William Optics Fluorostar 91 f/5.9 triplet refractor, a 0.65x focal reducer and an ASI294MM Pro camera, imaging with H-alpha and OIII filters. A few days later he added four more hours of data acquired at Star Haven in the Catskills. The image below shows emission, faintly but perceptibly, around the entire circumference. You may have to enlarge the page to see it clearly. The field is 2.95 x 1.97 degrees (six full moons across!).



As usual, Steve gives detailed information about his images on [astrobin.com](https://www.astrobin.com), which also provides detailed mapping of the various bits of nebulosity in the field. This busy part of Cygnus contains several Lynds' Dark Nebulas and Lynd's Bright Nebulas, as well as many variable stars.

For the ASI533 image: <https://www.astrobin.com/34635w/>

For the ASI294 image: <https://www.astrobin.com/w42166/C/>

In 1867, Charles Wolf and Georges Rayet observed WR 134 and two other stars in Cygnus (now WR 135 and 137) through a spectroscope on the 40-cm telescope at the Paris Observatory (a visual observation, since the first photograph of a stellar spectrum was not made until 1872). They noticed distinct, broad emission lines. Only absorption lines had been seen before in stars. The lines turned out to be helium, which was not discovered until the following year, and not linked to the WR stars for several decades. The broadening was due to the Doppler shift caused by the gas moving at very high velocities along the line of sight.



Research Highlight of the Month

Rapin, W., et. al, Sustained wet-dry cycling on early Mars, *Nature* 620: 299–302 (Aug. 9, 2023)

It is generally agreed that there was substantial water on ancient Mars. At Gale Crater, the Mars Science Laboratory (the Curiosity Rover) investigated a formation of sulfate-rich rock that had a hexagonal pattern ranging from 1 to 7 centimeters on a side. The results suggested that the morphology and chemistry of the rock was due to a periodic wet-dry cycle (flooding and groundwater recharge) during the early Hesperian period, 3.6 billion years ago. In other words, it used to rain on Mars.

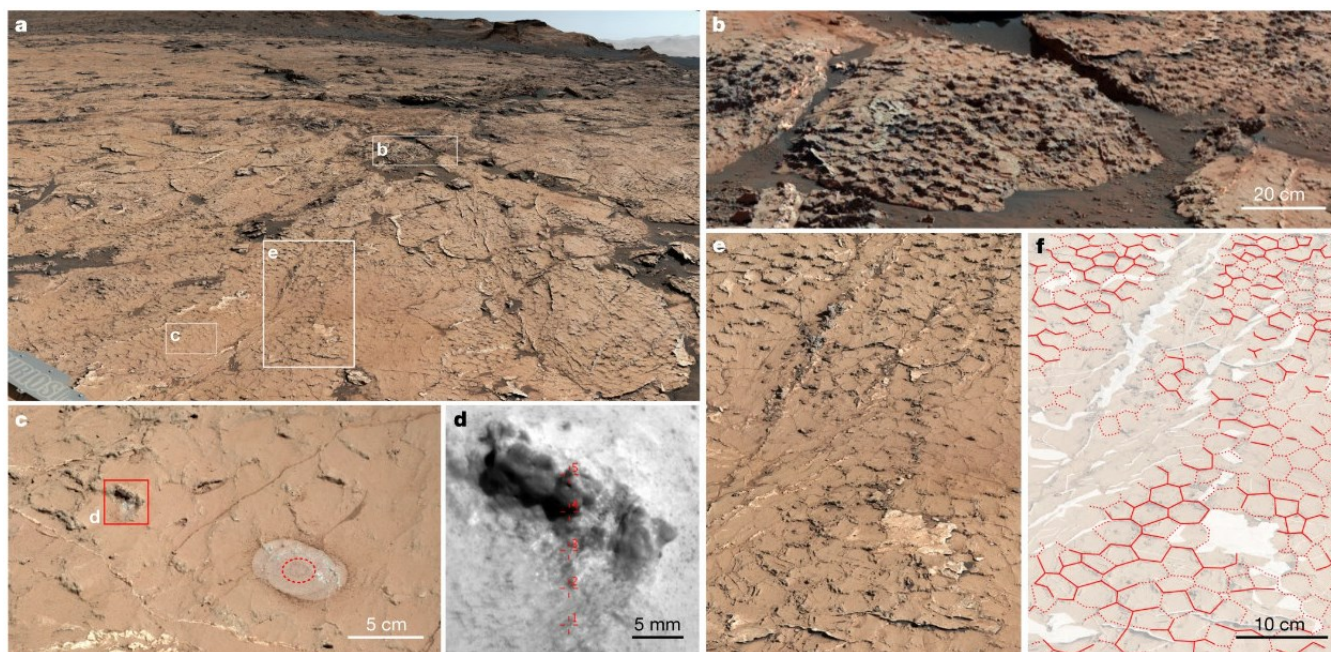


Figure 1 from the paper. In situ observations of polygonal ridges. a, General view of bedrock surrounding the rover on sols 3,154 to 3,156 showing widespread polygonal ridges. b, Close-up showing 'stepped' exposure of polygons within large bedrock blocks. c, View of bedrock with polygons and locations of ChemCam analysis on ridge (red rectangle) and APXS analysis on smooth host bedrock (dotted circle). d, Remote micro-image of cemented ridge with spots analyzed by ChemCam, highlighting details of nodular texture. e, f, Bedrock with polygonal pattern (e) and interpretative overlay (f) that shows prominent ridges (solid red lines), less certain ridges (dotted red lines) and cross-cutting later-stage Ca-sulfate-filled veins (white areas).

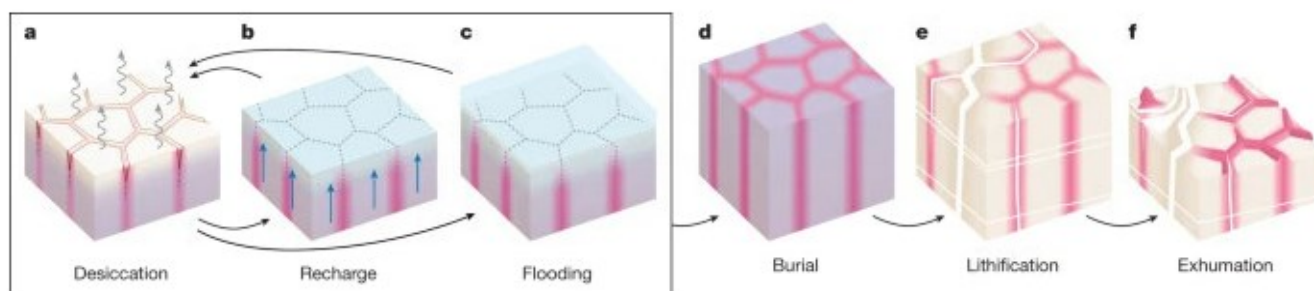


Figure 3 from the paper: a–c, Repeated cycles of desiccation (a), recharge (b) and flooding (c) form a vertically propagating hexagonal pattern of sulfate enrichment. a, Evaporation (grey arrows) desiccates and cracks near-surface sediment, triggering salt crystallization (red) at and near cracks where the subsurface brine (purple) concentrates. b, Water recharge heals cracks by sediment hydration. c, Flooding dissolves excess salts at the surface but subsurface brine and intrasediment sulfate salts are preserved and siliciclastic sediment is deposited on top. d, Sediment is buried with saturated brine in pore spaces and sulfates are mostly preserved. e, Later diagenesis partially dissolves intrasediment sulfate salts and late diagenetic fractures are filled with Ca-sulfate (white). f, Sulfate-cemented polygonal ridges become visible during exhumation as the softer host bedrock is preferentially removed during weathering.

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, Farpoint 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
Celestron Nexstar 114 GT telescope NEW LISTING	Computer-controlled go-to reflector, 114 mm f/8.7 (1000-mm focal length). Nexstar hand control, finder, 25-mm eyepiece. Excellent condition. Good beginner scope. Image here .	\$125	Eli Goldfine emgoldfine@gmail.com
Celestron Cometron telescope	Small, lightweight 114 mm f/4 reflector. Red dot finder, 25 mm eyepiece. Dovetail bar. A light travel scope or a wide-angle starter scope for a smart, interested child. No tripod: will fit on a camera tripod. Excellent condition. Donated to WAA.	\$40	WAA ads@westchesterastronomers.org
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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