

Sky WAA tch

The Newsletter of Westchester Amateur Astronomers

April 2023



Flame and Horsehead in H-alpha, without Stars, by Bill Caspe

There's something extraordinarily elegant and revealing about a monochrome image, an inheritance from the great days of photography (Stieglitz, Steichen, Weston, Strand, Adams, Abbott, Eisenstadt, Cartier Bresson). With Alnitak (ζ [Zeta] Orionis) and other stars suppressed using a routine in PixInsight, detail in the hydrogen clouds is more evident. For an in-depth report on the history of the Horsehead, see page 6.

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 April Meeting

Friday, April 14 at 7:30 pm

Starquakes

Christopher Lindsay

Department of Astronomy, Yale University



Christopher Lindsay uses asteroseismology to study interior mixing and angular momentum transport processes in evolved low mass stars. Understanding what is going on inside stars requires a combination of data analysis and stellar modeling techniques. He was an observer for the Mount Wilson node of the Birmingham Solar Oscillations Network and studied high angular degree solar oscillations with data from the Solar Dynamics Observatory.

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

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WAA May Meeting

Friday, May 12 at 7:30 pm

Introduction to Astrophotography

Jorden Webber

Westchester Amateur Astronomers

Starway to Heaven

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

Date	Type	Sunset	Moon	
			Phase	Set
4/15/23	Regular	19:37	0.21	N/A
4/22/23	Make-up	19:45	0.09	22:56

Make-up star party will be held if the regular event is clouded out.

Check out the new **Messier Object finder charts** on the [Star Party page](#) on the WAA web site. Programmed by WAA's Mike Lomsky.

New Members

- | | |
|---------------------|------------------|
| Elinor Eckerle | Scarsdale |
| Jonathan Greenfield | Yonkers |
| Norma Montel | Ardsley |
| Ashutosh Thaker | Briarcliff Manor |

Renewing Members

- | | |
|----------------------------------|------------------|
| Joel & Rita Bender | New York |
| Robert Brownell | Peekskill |
| Frank and Kathy Clemens | Larchmont |
| Tom & Lisa Cohn | Bedford Corners |
| Byron Collie | Croton on Hudson |
| Emily Dean | Pelham |
| Joseph Depietro | Saddle River |
| Howard Fink | New York |
| Patricia Frasier & Myrna Morales | New York |
| Frank Jones | New Rochelle |
| Wendy Kutin | Mt. Kisco |
| Mark Lewis | Pine Bush |
| Kathleen Thrane | Greenwich |

**NEAF 2023 April 15-16, Rockland Community College, Suffern, NY. <https://www.neafexpo.com/>
Visit the WAA booth!**

ALMANAC For April 2023

Bob Kelly, WAA VP of Field Events



Bob
Kelly



Full
Apr 6



3Q
Apr 13



New
Apr 20



1Q
Apr 27

Venus is outstanding in the evening sky, at magnitude -4 and 40 degrees out from the Sun. The cloud-covered terrestrial planet continues its flight from the Sun, increasing in angular size and decreasing in phase. It approaches half-lit during April. By mid-month, it sets after 11 p.m. EDT. Venus is highest in the daytime sky about mid-afternoon, when it is due south, to the upper left and twenty degrees higher in the sky than the afternoon Sun. Block the Sun and see if you can see the daytime Venus.

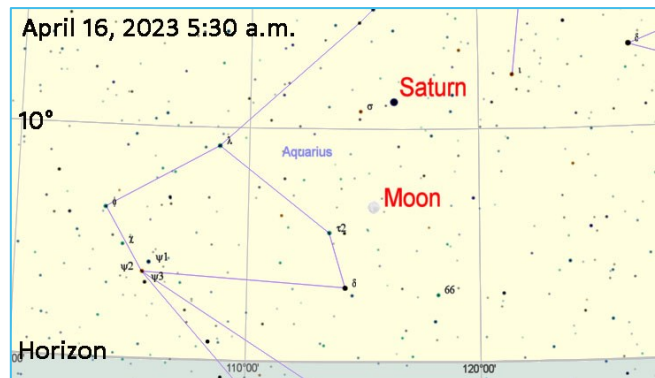
Mercury reaches greatest elongation on the 11th, peaking at half the distance of Venus from the Sun in our evening sky. For a week around the 11th, the innermost planet sets just minutes after the end of astronomical twilight. Mercury's brightness decreases from magnitude -1.1 on the 1st, through -0.1 on the 11th, to magnitude +1.0 on the 18th as it appears to slide back toward the Sun. So, catch the fleet flyer of the inner solar system early in the month. Mercury reaches conjunction with the Sun, on its way to the morning sky, on May 1st.

Mars is the cheese standing alone, looking like a cheddar dot high in the southwestern sky. Venus will approach but not quite pass Mars two months from now. On the 25th, the crescent **Moon** meets up with Mars as they share the role of gemstones on the belt buckle of the Gemini. Dimming to magnitude +1.2, Mars is the least bright of the five planets that can be seen easily with the unaided eye, until Mercury outdims it in the latter third of April. Ironically, Mercury will be the closest planet to Earth in April. It will be dim because its illuminated portion will decrease as it swings around in front of the Sun.

Having introduced Mercury to the evening sky in late March, **Jupiter** is missing in action in our night skies this month. The giant planet is in conjunction, far behind the Sun, on the 11th.

By the second week in April, **Saturn** rises before the beginning of morning astronomical twilight. At magnitude +0.9, Saturn should be readily found, so you can get an early start on viewing the ringed planet for the rest of the year. On the mornings of the 15th and

16th, the thin Moon with Earthshine makes a nice pairing with Saturn low in the east. The Moon is closest to Earth for the month that weekend.



The **Lyrid meteor shower** will peak on the mornings of the 22nd, 23rd and 24th. A few to a dozen moderately fast meteors an hour can be seen before dawn on these days. The Moon will be up in the evening sky by then, so it won't interfere with viewing.

Not visible at all from our area, on the 20th, a **solar eclipse** will be total and annular over parts of its path as it slides between Australia and Asia.

Around 2:24 a.m. EDT on April 2nd, the 8th magnitude star HIP 75879, also known as HD 138042, in Libra will be covered up by an asteroid 1119 Euboea, magnitude +15, for up to 11 seconds, for a swath passing near our metro area. More info at <https://is.gd/1119occ2304>.

International Space Station crew swaps are being rescheduled due to leaking radiators on the Soyuz return vehicle. You can spot the ISS as a magnitude -1 to -3 point of light in the evenings through the 5th, then in the mornings starting on the 21st.

China's **Tiangong** space station is visible at magnitudes up to -2 before dawn from the 7th through 22nd. Evening overflights for our area begin on the 26th.

Orion heads out of the evening sky. **Leo** and the **Big Dipper** dominate high in the southern sky well after darkness descends. It's galaxy season for deep sky viewing. ■

Another Movie Telescope



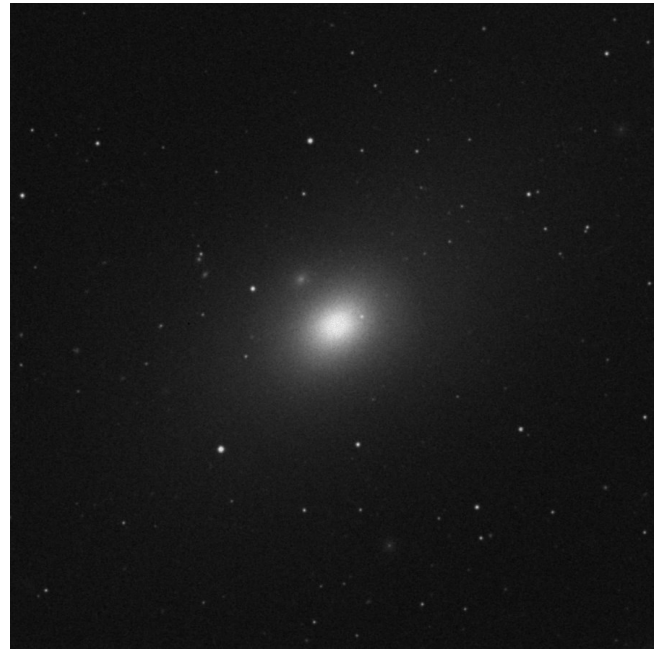
We showed the frame above in our original *Telescopes in the Movies* quiz in the [April 2021 SkyWAatch](#). *It Came from Outer Space* is one of the best of the early-1950's sci-fi films (it was based on a Ray Bradbury story). We watched the film again recently and our attention was drawn to a peculiarity at the eyepiece end of the telescope. It appears that there are two diagonals in the optical path! Note that the first diagonal seems to be soldered onto the drawtube. You might need another bend in the optical path to see a low-lying object from directly behind the instrument. Closer inspection shows that there's no eyepiece in the second diagonal. We brightened up a detail from a later frame (the scene obviously uses the "day for night" technique) of Barbara Rush looking in the scope. We wonder whether director Jack Arnold simply didn't like the look of an eyepiece sticking into Rush's eye, or whether somebody just forgot something. A little on-line sleuthing revealed that the scope was most likely a 5-inch f/17 achromat made by Lohmann Brothers of Greenville, Ohio around 1920.

Deep Sky Object of the Month: Messier 86

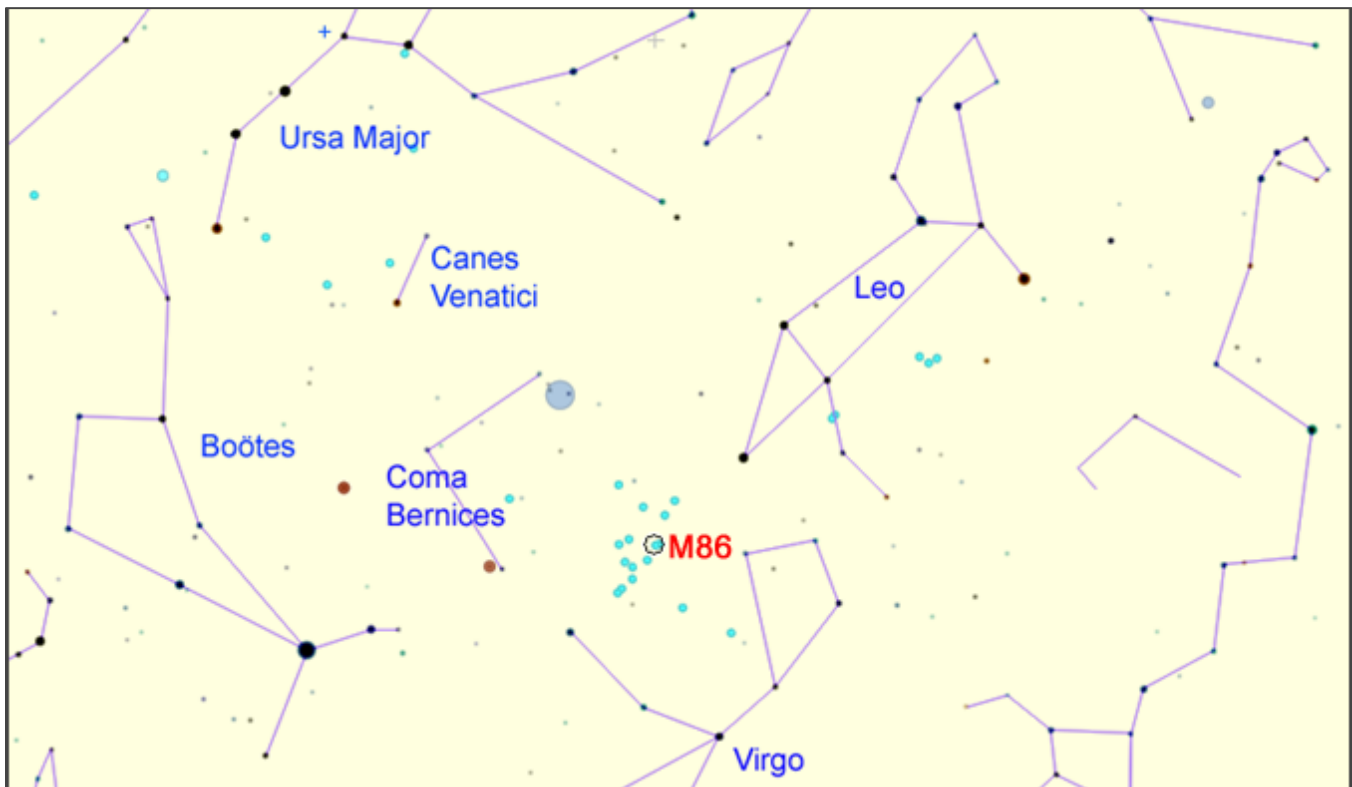
Messier 86	
Constellation	Virgo
Object type	Elliptical galaxy
Right Ascension J2000	12h 26' 12"
Declination J2000	+12° 49' 16"
Magnitude	8.6
Size	9.8 x 6.3 arcminutes
Distance	52 million light years
NGC designation	4406
Discovery	Messier 1781

The Virgo galaxy cluster and Markarian's chain have many "faint fuzzies" visible in amateur scopes. The brightest are M86, M84 (mag 9.1, 15 arcminutes to the west), M87 (mag 8.6, 75 arcminutes southeast) and M49 (mag 8.4, 5 degrees south). Attentive observers will find a host of fainter galaxies, especially with dark skies or large apertures. A 6-inch telescope could probably see over 160 in a very dark sky.

The Virgo galaxy cluster has about 1,300 members and has a mass of at least $1.2 \times 10^{15} M_{\odot}$.



Visibility for Messier 86			
2200 EDT	4/1/23	4/15/23	4/30/23
Altitude	44° 21'	52° 44'	59° 04'
Azimuth	117° 27'	133° 28'	156° 45'



The History of The Horsehead Nebula and Barnard's Loop

Larry Faltz



(L) The Horsehead Nebula, image by Steve Bellavia. (R) Orion and Barnard's Loop by Rogelio Bernal Andreo (APOD 10/23/2010).
See also Bill Caspe's image on the cover of this month's issue

Few astronomical objects look exactly like their nicknames. Does Messier 11 look like a duck? Or M20 like a lagoon? Two obvious exceptions are M57, which is absolutely a ring, and the Horsehead Nebula, immediately recognizable to all amateur astronomers although few of us have ever seen it in a telescope. Many objects have stimulated observers' imaginations, so for example the open cluster NGC 457 in Cassiopeia has been called the Dragonfly Cluster, Owl Cluster, Kachina Doll Cluster and most recently the E.T. Cluster (because its two brightest stars might recall the alien's bug-eyes). But no one is going to call the Horsehead Nebula by any other name, and its official catalog name Barnard 33 could never give us an instant visual picture, to which we respond when we see it, "of course!"

The origin of descriptive names for celestial objects is often hard to track down. They are astronomy vernacular, and like many words in general use their origin can be obscure. They appear in our language as if out of nowhere. The Horsehead Nebula and the large, faint nebula called Barnard's Loop, both in Orion, were discovered at the dawn of serious astrophotography. Scientific journals, publishing rapidly and disseminating information widely, connected astronomers and inspired new ideas. It might be

possible to find in them evidence of who first saw these objects and even who named them.

William Herschel's Nebulae

To investigate any deep sky object in the northern hemisphere beyond those in the Messier catalog, it's a good idea to start with William Herschel and his notions of diffuse celestial objects, which dominated astronomical thinking in the 19th century. Herschel was born in Hanover, Germany and emigrated to England at age 19. Coming from a musical family, he was an accomplished oboist, violinist, keyboard player, composer and conductor, eventually landing in the upscale spa town of Bath where he was a chapel organist and the leader of the Bath orchestra. Herschel became fascinated by astronomy in his mid-30s. He learned to make speculum-metal mirrors and build superb reflecting telescopes. Discovering Uranus in 1781 brought him fame and the support of King George III and Joseph Banks, President of the Royal Society, giving him the resources to build large telescopes in Slough, much closer to London than Bath and two miles from Windsor Castle. He used a professional musician's concentration skills to implement a systematic observing program, assisted by his diminutive sister Caroline (she was 4 feet 3 inches tall, the result of childhood typhus), who often sang at

Herschel's concerts, including a famous performance of Handel's *Messiah* in 1778. She became a productive observer in her own right.

Herschel compiled a catalog of 2,500 non-stellar celestial objects that he presented in three lengthy papers published in 1786, 1789 and 1802 in the Royal Society's *Proceedings*. He did not include the Messier objects, saying that his objects "are compared with those in the *Connaissance du Temps* for the years 1783 and 1784," which he called "an excellent collection." For some reason he rarely mentions Messier's name in his papers although it was Messier's catalog that stimulated his interest in faint, diffuse objects while other astronomers were looking for comets or just observing stars.

Herschel divided his objects into eight classes, based on his obviously subjective perception of their morphology. The classes are, in his words:

- I. Bright Nebulae
- II. Faint Nebulae
- III. Very faint Nebulae
- IV. Planetary Nebulae - Stars with burs, with milky chevelure, with short rays, remarkable shapes, etc.
- V. Very large nebulae
- VI. Very compressed and rich clusters of stars
- VII. Pretty much compressed clusters of large and small stars
- VIII. Coarsely scattered clusters of stars

On the night of January 6, 1785, Herschel found an object which he assigned to the fourth class. Object number 24 (referred to formally as IV 24) was "following [east of] 50 (ζ , Zeta) Orionis," 50 being its identifier in John Flamsteed's 1725 *Stellarum Inerrantium Catalogus Britannicus* (British Catalog of Fixed Stars), which contained 2,936 entries. Herschel described the object with his unique shorthand, the precursor of what we still see today in the NGC: "A Bst with m. chev 5' l 4'b," meaning "a bright star with much chevelure 5 arcminutes in length, 4 arcminutes broad." Chevelure means "head of hair." This object is cross-referenced in William's son John Herschel's General Catalog of 1864 as number 1226 and we know it as NGC 2023.

On January 1, 1786, Herschel found an object that he classified in group V as number 28. It is "following 48 [σ] Orionis," and his description was in prose rather than code: "remarkable m. [much] nebulosity,

divided in 3 or 4 large patches, including a dark space; cannot take up less than $\frac{1}{2}$ degree, but I suppose it to be much more extensive." This is object number 1227 in the General Catalog (where its description gets a "!" from John Herschel) and we know it as the Flame Nebula, NGC 2024. The identification is slightly peculiar: the Flame follows Alnitak (ζ Orionis) more closely than σ Orionis, while the nebulosity following closest to that star is IC 434. But the "3 or 4 large patches" is a telling description: V 28 must be the Flame. It can't be NGC 2023, since it doesn't have a "B* in M" (bright star in middle) as John Herschel notes for his 1226 (HD 37903, magnitude 7.7, is embedded in NGC 2023; while the brightest star in NGC 2024 is magnitude 9.8). Also, the sizes are right and the nebula in which the Horsehead sits, IC 434, does not have "patches." Did Herschel confuse ζ and σ in his small field of view?

In 1811, Herschel read another paper to the Royal Society, "Astronomical Observations relating to the Construction of the Heavens, arranged for the Purpose of a critical Examination, the Result of which appears to throw some new Light upon the Organization of the celestial Bodies." It is a sequel to his 1785 paper "On the Construction of the Heavens," in which he proposed a structure for the Milky Way. Herschel sought to classify the 2,500 nebulous objects in a different way than he had categorized them in the three earlier papers. He had a particular goal in mind. This time he included many of Messier's objects in his analysis, again referring to them only as "number XX in the *Connaissance du Temps*." He placed each of the objects in one of about two dozen distinct morphologic groups ("Nebulosities joined to Nebulae," "Double Nebulae at a greater Distance than 2' from each other," "Treble, quadruple and sextuple nebulae," "Nebulae that are suddenly brighter in the middle," "Nebulae that have a Cometic appearance," and so on). He added 52 additional diffuse nebulas "that have not been published before." Of these, number 25, described as a "diffuse milky nebulosity," is exactly 30 arcminutes due south of ζ Orionis using coordinates for 1792, the midpoint of Herschel's observing period. There is no further description of number 25, but Herschel noted that some nebulas seemed to have "opaque nebulous matter."

From his compulsive organization and analysis of the nebulas, Herschel concluded that all these diffuse

objects were evolutionary stages of star formation, and that “every succeeding state of the nebulous matter is the result of the action of gravitation upon it while in a foregoing one.... From this the transit to the stellar form ... requires but a very small additional compression of the nebulous matter.” In other words, Herschel thought that nebulas are stars in formation.

The Dawn of Astrophotography

Additional visual observing could shed little more light on the issue, as it were. Astrophotography, though, opened new vistas. Physician and chemist John Draper, who founded both New York University School of Medicine (the author’s alma mater) and the American Chemical Society, made the first photograph of the Moon in 1840. Draper’s son Henry, also a graduate of NYU SOM and later Chair of Medicine and Dean, set up an observatory in Hastings-on-Hudson, just north of New York City. He made the first photograph of a stellar spectrum, that of Vega, in 1872, and the first photograph of the Orion Nebula, in 1880. Draper died unexpectedly at age 45.



Draper’s image of the Orion Nebula

Draper’s wife provided an endowment to the Harvard College Observatory to photograph and characterize stellar spectra. This eventually became the Henry Draper catalog. Many stars are still referred to by their HD numbers (it’s a lot easier to identify a star as HD 37903 than Gaia DR3 3216478266124377984, for

example). The Draper home in Hastings still stands, now the Hastings Historical Society. A substantial collection of Draper’s original equipment is stored in the basement, including a spectrograph and a replacement 15-inch mirror for his largest telescope, which is now in Poland. The mirror is in a box labeled “Henry Draper’s 15-inch silvered mirror. Warning! Very heavy. Do not move from this shelf.” Probably a consequence of his medical training, many of the preserved photographic images are small fragments of glass plates mounted on microscope slides. They were probably intended to be viewed with a magnifier or projected.

Until the invention of dry plates in the late 1870s, photographic emulsions had to be prepared by the photographer just prior to exposure. The Eastman Film and Dry Plate Company opened in 1879, later to become Eastman Kodak. Astronomers at the many observatories that sprung up across the world in the second half of the 19th century quickly took advantage of the increased sensitivity of these new plates. The value of deep-sky photography to astronomy can be seen by the inclusion in the 1895 Index Catalog (IC) of new objects found on photographic plates by astrophotography pioneers William Pickering, Max Wolf and E.E. Barnard.

Discovery of the Horsehead

The glowing gas at Herschel’s coordinates for number 25 was noticed by Williamina Fleming in 1888. Originally Harvard Observatory Director Edward Pickering’s housekeeper, she was hired in 1881 as a “computer,” one of the women tasked with analyzing photographs and spectra. In 1888 she was given the job of identifying the objects on a series of photographic plates made with Harvard’s 8-inch, f/5.5 Bache telescope in Peru. The plates had a field of ten degrees on a side. The *Annals of the Harvard College Observatory* for 1890 described the process Mrs. Fleming used to systematically examine the plates to identify stars and nebulas and exclude artefacts. The method was as primitive as one could get.

Each plate was laid on a frame inclined at an angle of 45° and the light of the sky reflected through it by means of a horizontal mirror. Each portion of the plate was then studied with a magnifying glass, and the co-ordinates of every object resembling a nebula were measured.

Thomas Burns, the Acting Curator the Harvard Astronomical Photographic Glass Plate Collection, John G. Wolbach Library, Harvard/Smithsonian Center for Astrophysics, was kind enough to send me scans of the original plate and the five pages of the *Annals of Harvard College* that reported Fleming's findings. Plate B2312 was exposed on February 6, 1888 and inspected by Mrs. Fleming in Cambridge on June 27, 1888. On the plate, Fleming found,

... A large nebulosity extending nearly south from ζ Orionis for about 60'. More intense and well marked on the following side, with a semicircular indentation 5' in diameter 30' south of ζThis object and [NGC 2024] are probably the same as those referred to by Admiral Mouchez in the "Rapport Annual (*sic*) sur l'Etat de l'Observatoire de Paris pour l'Année 1887."

Had Mrs. Fleming been able to see the plate with better backlighting, or, even better, to have had a way of enhancing the contrast, the object might have been described more imaginatively than simply a "semicircular indentation." As shown below, there's more to the object than just a semicircle. The full plate is shown on page 17.

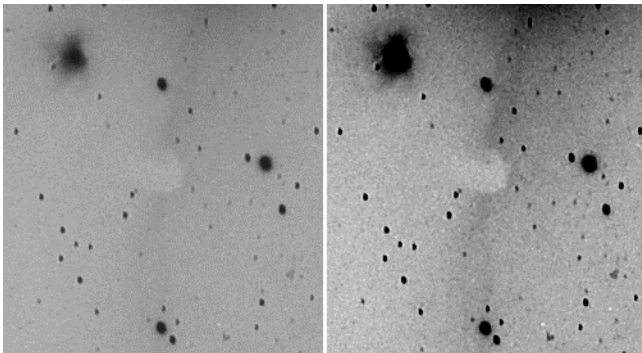


Plate B2312 (1888): Enlargement of Horsehead area. The right image is contrast-enhanced with Photoshop, a technology not available to Williamina Fleming in 1888. The blotch on the upper left is NGC 2023. North is up.

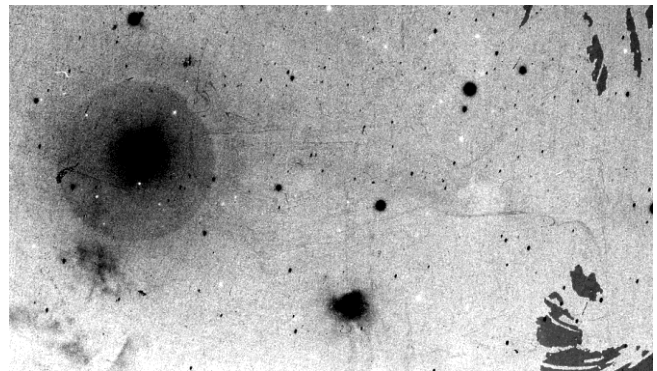
The Paris Observatory plates referred to in the Harvard report were made with a 13" telescope by brothers Paul and Prosper Henry, among the earliest deep sky astrophotographers. They were the originators of the *Cartes du Ciel* project, an ambitious multi-observatory photographic atlas of the entire sky that was never completed but eventually led to the formation of the International Astronomical Union.

The Bibliothèque Nationale de France (BNL) has a scan of the *Rapport Annuel* for 1887, which reads (p. 16) in translation,

We also found, on February 28 [1887], a new nebula 1° in length. It starts from ζ Orionis, heading south [*on se dirigeant vers le Sud*], and is in the vicinity of 1226 and 1227. [the General Catalog entries for NGC 2023 and 2024].

The *Rapport Annuel* did not specifically comment on the dark feature, and there are no other descriptions of a nebula near ζ Orionis coming from the Henry brothers or the Paris Observatory in the journals in the NASA/ADS database for that period, which includes the main French journal *L'Astronomie*.

With the help of Mlle. Anna Nouet, the head of the Heritage Collections of the Paris Observatory, I obtained a scan of the Henry Brothers' original plate. The full scan is on page 18. I enlarged a small section and increased the contrast with Photoshop. IC 434 and the Horsehead are visible. We don't know exactly how the Henrys examined the image, or whether the plate's contrast has deteriorated in 135 years. They identified IC 434, but we can only conjecture that they might have remarked, between themselves, that the Horsehead was a distinct feature ("Sacre bleu mon frère! C'est une tête de cheval!"). Mlle. Nouet told me that the Paris Observatory agrees that the Henrys didn't "discover" the Horsehead. As Holmes said to Watson, "You see, but you do not observe." (*A Scandal in Bohemia*).



Contrast-enhanced detail (rendered in greyscale) from 1887 Paris Observatory plate. The bright star is ζ Orionis. West is up.

Harvard College Observatory Director Edward Pickering added this prophetic comment in the 1890 *Harvard Annals*:

The successive improvements in photography have continually increased the limits of the Nebula in Orion. These plates show that it not only includes the sword handle, [stars] ϵ , ι , and θ , but a long nebulosity extends south from ζ , others surround this star, while others both north and south indicate that perhaps the next increase in

sensitiveness of our plates will join them all in a vast nebula many degrees in length.

The discovery was not long in coming.

Wide-angle Photography Finds Another Nebula

William Pickering, Edward's brother, working at Harvard's Wilson's Peak facility (on the site of what is now Mt. Wilson Observatory), published a short article in the *Sideral Messenger* in 1890 about a photograph of Orion he had made with a 2.6-inch, f/1.76 Voigtländer portrait lens, which would give a very wide field. On the 3-hour exposure he found

a long nebulous streak extending southwards from ζ [that is] is broadened... connecting the sword handle with the belt.

He made no mention of a dark feature.

When the nebula was included in the 1895 Index Catalog as IC 434, "Pickering" was listed as discoverer, which we now know is not correct. William Herschel should probably get the credit for his #25, but if his description was too vague, then the Henry brothers are next in line for priority, and then Fleming.

In his image, Pickering also noted a new "spiral" nebulosity over a large area in Orion, some 17 degrees in length and breadth, with the "Great Nebula" (M42) the "inner termination of the spiral." This is undoubtedly the first report of what is now known as "Barnard's Loop." We associate the word "spiral" now with galaxies, and we know pretty much what and where they are, but the existence of celestial objects beyond the Milky Way had to wait another 33 years for Edwin Hubble's proof.

Max Wolf Sees the Horsehead

The German astronomer Max Wolf, another astrophotography pioneer, published "Über den grossen Nebel um ζ Orionis" (On the great nebula around ζ Orionis) in the April 1891 issue of *Astronomische Nachrichten*. He reported on six images he made in 1890. He described M42, the Flame and NGC 2023, and then commented on the nebulosity running south from ζ Orionis. He mentions the dark feature.

The branch [of nebulosity] reaching south is slightly curved and runs more than 1 degree in a nearly southerly direction, interrupted by an oval bay [von einer oval Bucht unterbrochen].

Isaac Roberts Advances Astrophotography

Nebulosity near ζ Orionis was also photographed by Isaac Roberts. Born in 1829 in Wales, Roberts was a successful engineer and builder in Liverpool. He became an avid amateur astronomer at age 50 (no sports cars for midlife crises in those days). Initially observing with a 7-inch Cooke refractor, he began to experiment with photography, first with portrait lenses and then with a Grubb 20-inch reflector that he purchased in 1885 and set up at his Merseyside home. The house had previously been owned by none other than Nathaniel Hawthorne, author of *The Scarlet Letter*, who was American consul in Liverpool from 1853 to 1857.

Opting for clearer skies elsewhere in England, Roberts moved his instruments to a home and observatory that he built in 1890 in Crowborough, Sussex, on a hill at 780 feet elevation, one of the highest points in southern England. He named the property "Starfield." Sussex is mostly forested, even to this day, and much closer to London than Liverpool. From Crowborough, Robert could reach Victoria Station in about an hour, and from there take a hansom cab ride past Buckingham Palace to the Royal Astronomical Society in Burlington House on Piccadilly, where it's still located. He was elected as an RAS fellow in 1882. He was made a fellow of the Royal Society, an even higher honor, in 1890. The 20-inch Grubb and the 7-inch Cooke refractor in their original mount are now housed at the Science Museum in London. Roberts may have invented piggyback guiding.

Roberts's Breakthrough Image



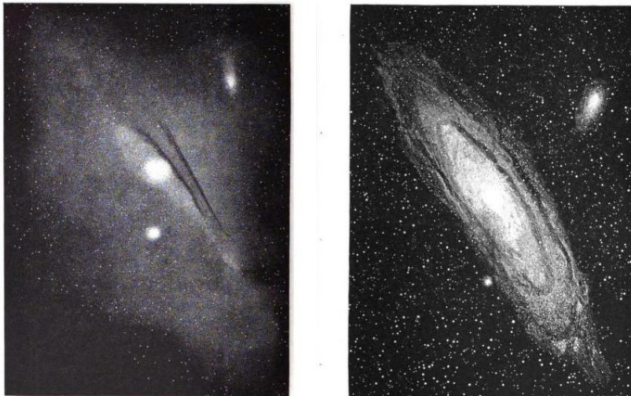
Isaac Roberts's photograph of the Andromeda Nebula

Roberts' most famous photograph was of the Andromeda Nebula, made in 1888. He announced it

in the December 1888 issue of the *Monthly Notices of the Royal Astronomical Society*. The journal did not publish the image; a footnote says that it is “deposited in the Library.” Roberts’s description provides us with a clear understanding of what mainstream astronomers thought about nebulas in the 19th century. They had not progressed from William Herschel’s claim that they were stages of star formation.

... No verbal description can add much to the information which the eye at a glance sees on the photograph, and those who accept the nebular hypothesis will be tempted to appeal to the constitution of this nebula for confirmation, if not for demonstration, of the hypothesis. Here we (apparently) see a new solar system in process of condensation from a nebula—the central sun is now seen in the midst of nebulous matter which in time will be either absorbed or further separated into rings. The farthest boundaries of the nebula have already separated into rings more or less symmetrical with the nucleus, and present a general resemblance to the rings of Saturn.

Roberts’s image was reproduced on the cover of the 1890 *Starry Messenger* issue that carried Pickering’s report of his Orion photograph, “copied from” the German popular astronomy and physics monthly *Himmel und Erde* (Heaven and Earth), which published it in its January 1890 issue alongside a drawing made at the eyepiece for comparison.



Der Nebelfleck der Andromeda.

a) Nach einer Zeichnung von Trouvelot.

b) Nach einer photographischen Aufnahme von Roberts.

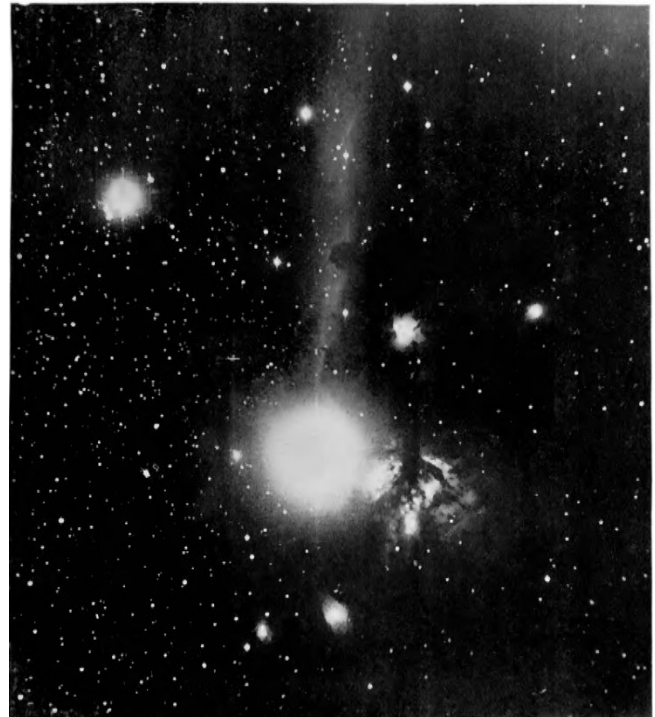
The accompanying text in *Himmel und Erde*, uncredited, supports Roberts’s view about the value of photography in astronomy. It reads, in translation,

The first figure gives the best existing drawing of the nebula, and is due to [artist and astronomer Étienne Léopold] Trouvelot, who made it with the 15-inch refractor at the Cambridge Observatory, US [Harvard’s “Great Refractor”]. The dark longitudinal stripes discovered by

[Harvard astronomer William Cranch] Bond are particularly characteristic of this drawing. The second figure, a copy of Mr. Roberts’s preliminary photogram, shows us the nebula in an entirely new light, as a ring - or perhaps spiral - nebula. The dark streaks here find their natural explanation as the spaces between the individual rings that compose the nebula. But in all other respects, too, an essential superiority of photography over mere drawing is shown. Today, however, we content ourselves with enabling the reader to make his own judgment based on the illustrations.

Roberts published two volumes of astrophotographs, entitled *A Selection of Photographs of Stars, Star-Clusters and Nebulae*, the first in 1893 and the second in 1899. Amazingly, the 2-volume set is still in print in a paperback version published by Cambridge University Press. Roberts received the Royal Astronomical Society gold medal in 1895. He passed away in 1904 at the age of 75.

Roberts Checks Up on Herschel



Roberts’s image of the area of Herschel’s #25, obtained January 25, 1900. South is up.

In 1902, Roberts extended his photographic research with a paper in the *Monthly Notices of the Royal Astronomical Society* (MNRAS), “William Herschel’s observed Nebulous Regions, 52 in number compared with Isaac Roberts’ Photographs of the same Regions, taken simultaneously with the 20-inch reflector and

the 5-inch Cooke lens." These are the nebulas in Herschel's 1811 paper that were "not published before." Roberts claimed his photographs, which had been made over a period of six years, would

...furnish data that would be free from human bias and error, in the settlement of the questions, or inferences, which have been founded upon Herschel's records of these nebulous regions.

Roberts's photos showed nebulosity in only four of Herschel's 52 objects. While Roberts's descriptions of the plates of 51 of the objects were brief (48 describing only stars and stating "no nebulosity," the other three just offering a few lines of text), he provided a very detailed description of number 25 that ran to two dozen lines. He noted,

To the s. of ζ Orionis is a stream of nebulosity, 54 minutes of arc in length, with an embayment free from nebulosity dividing it in halves.

Like Wolf, Roberts thought of a nautical feature. He did not discuss the nature of the "embayment," nor did he give it a specific designation. After describing several other nebulosities in which stars are embedded, Roberts wrote,

The region here referred to, which covers four square degrees of the sky, has so many remarkable features that it is necessary, in order to make it intelligible to the reader, to present the photograph annexed along with the above description. [Image on page 11.]

E. E. Barnard Finds Pickering's "Spiral" Nebula

In the United States astrophotography was being advanced by several astronomers, most notably Edward Emerson Barnard. Barnard worked as a photographer in his native Nashville from a very young age before becoming interested in astronomy in 1876 at nineteen. He bought a 5-inch telescope and immediately discovered five comets, for which he won a \$200 prize, enough to build a house for him and his new bride. After studying at Vanderbilt but not obtaining a degree, he applied his imaging skills at Lick Observatory in California and then at Yerkes Observatory in Wisconsin, where he moved in 1895 upon being appointed Professor of Astronomy at the University of Chicago. He was a prolific observer, photographer and author, contributing 745 papers to the astronomy literature, 700 of which were in refereed journals.

Barnard's 1894 paper "The great photographic nebula of Orion, encircling the belt and theta nebula" in *Popular Astronomy* described photographs he made at Lick with the lens from "a cheap (oil) projecting lantern" 1½ inches in diameter and 3½ inches focus, giving f/2.3. The field of view was 30 degrees, but "only one half is at all flat." The longest exposure was two hours. He noted a large area of nebulosity around Orion and recalled Pickering's 1890 *Starry Messenger* paper, quoting it at length. Barnard's photograph was too wide-angle to pick out any detail around ζ Orionis, but he did confirm Pickering's detection of the much larger object that now bears Barnard's name.

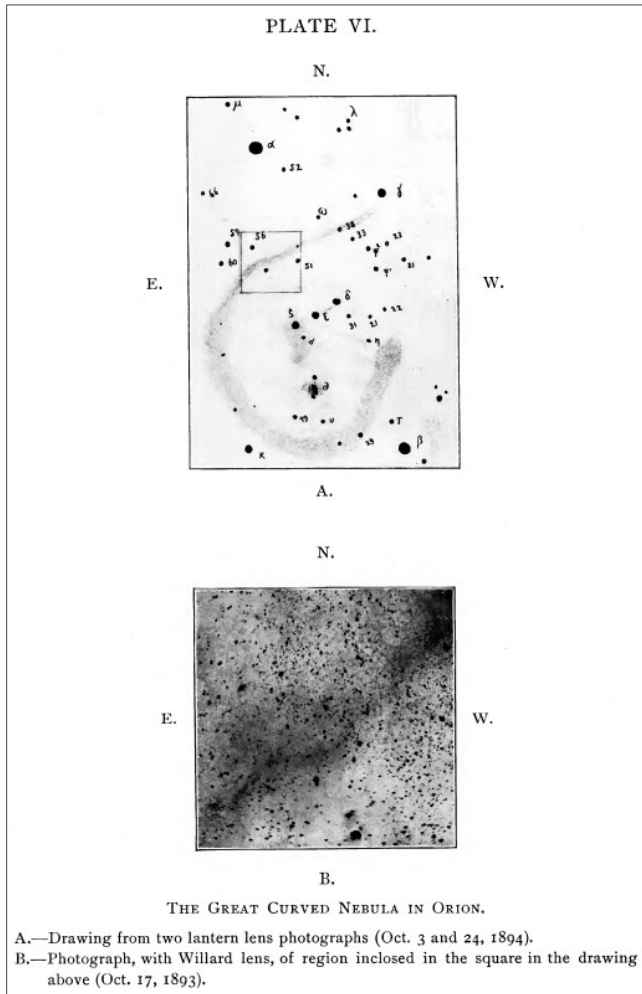
E.E. Barnard Checks Up on Roberts

The January 1903 *Astrophysical Journal* (henceforth *ApJ*) carried Barnard's article "Diffused Nebulosities in the Heavens." It was rather critical of Roberts's *MNRAS* paper, which was republished in the same *ApJ* issue. Barnard first pointed out that in 1892 he had published a paper in a popular science journal of the time, *Knowledge*, in which he reproduced Herschel's 1811 table of 52 objects, recommending them as being suitable for photographic investigation by "those not familiar with it and who may wish to try exposures on these objects."

Barnard reported that "the curious nebulous ribbon extending southward from ζ Orionis seems to have been first photographed by Professor W. H. Pickering and others as far back as 1889 (*sic*)" but as noted above it was seen as early as 1887 by the Henry brothers. Barnard said that he had captured it on film as early as 1894. He also asserted that Roberts didn't see nebulosity in 48 of the 52 Herschel objects because his exposure times were too short, even though 16th and 17th magnitude stars appeared on the plates. We now know that the photographic emulsions in use at the time were very insensitive to red wavelengths, where most of the nebular light is emitted (the hydrogen alpha line at 656.28 nm). In addition, Barnard appealed to prior authority:

It is a little unreasonable to suppose that Herschel, who made so few blunders compared with the wonderful and varied work that he accomplished, should be so palpably mistaken in forty-eight out of fifty-two observations of this kind.

Barnard presented a drawing made from his 1894 lantern lens image. This clearly showed the structure found by Pickering in 1890. He added a photograph of the area that Herschel had denoted as number 27 in the 1811 paper. The image was a 3-hour exposure made at Lick in 1893 with a 6-inch Willard portrait lens. This is the brightest part of Barnard's Loop, located northeast of both ζ Orionis and M78.



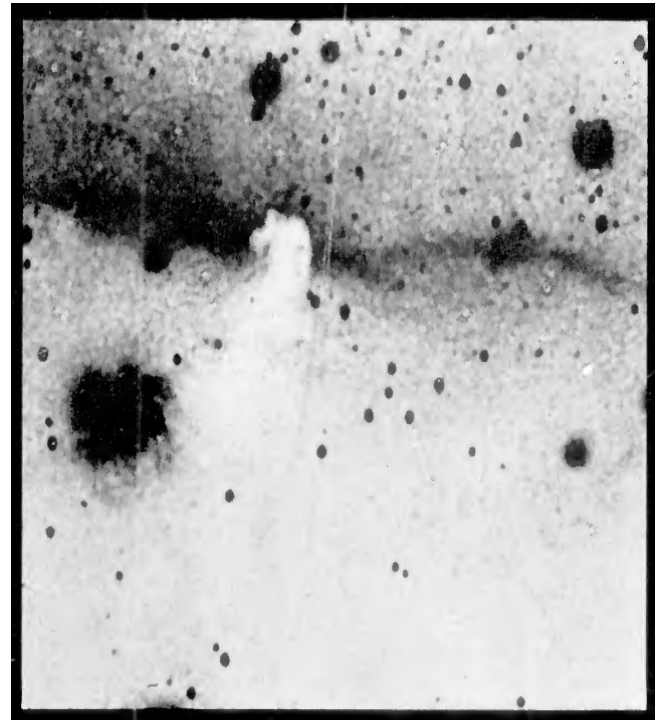
The images in Barnard's 1903 paper

Perhaps he was trying to tweak Roberts's nose by showing with these small lenses nebulosity that Roberts had missed with his large Grubb reflector. Barnard describes "milky nebulosity" near ζ Orionis but does not comment on the "dark embayment" that Roberts had found, and Fleming and Wolf before him, the image scale simply being too small, similar to Pickering's wide-angle set-up in 1890.

Roberts's image from January 25, 1900 is included in the on-line scan of Barnard's article, but without

attribution. This confused me at first, and I thought this was a new image by Barnard. Close inspection shows that it's the same image that Roberts published in *MNRAS*, with slight variations in density due to the scanning process. In any case, Barnard's focus in the paper was on the wider "spiral" nebula and the denser nebulosity around Herschel's object 27, not the dark spot below ζ Orionis.

Barnard Images the Horsehead



Barnard's 1913 image of the Horsehead. as he presented it in the paper, as a negative. South is to the right, west up.

A decade later, Barnard, who had taken a major interest in areas of the Milky Way that had few or no stars (among his many other areas of astronomical curiosity), recalled Roberts's 1903 paper. In a December 1913 paper in *ApJ*, "Dark Regions in the Sky Suggesting an Obscuration of Light," he wrote (and it is worth quoting this paper in detail),

With respect to the question of obscuration of light in space, there is one other object which strikingly shows this effect. In the east side of the well-known nebulous stream that runs southward from ζ Orionis is a very conspicuous black notch which is very sharply defined....

This object has not received the attention it deserves. It seems to be looked upon as a rift or hole in the nebulosity, as implied in the quotation from Dr. Roberts' paper. I have made numerous photographs of it, and in the past

winter gave a long exposure with the expressed purpose of showing more definitely the true form of the object. This last photograph on February 7, 1913, with an exposure of 4 h 33 m, shows the nebulosity better than I have seen it before. Instead of an indentation, the almost complete outline of a dark object is shown projected against the bright nebulosity. The west side of it is very definite and sharp, while the eastern limit is scarcely discernible, and is entirely lost in the enlargement. The best description I can give of it is to present the photograph of the object itself for inspection. A glance at the original would show that this is not a perforation in the nebula. It is clearly a dark body projected against, and breaking the continuity of, the brighter nebulosity. Possibly this is a portion of the nebula itself nearer to us, but dark and opaque, that cuts out the light from the rest of the nebula against which it is projected.

On November 4, 1913, on a night of particularly good seeing in southern Wisconsin, Barnard observed the nebula visually with the 40-inch Yerkes refractor at 460X and confirmed “the supposition of an obscuring medium.” Barnard could have said, “It looks like a horse’s head!” but he didn’t. So who did?

Who Named the Horsehead?

Barnard’s 1913 paper must have sent more than a few astronomers to their telescopes and cameras to image this peculiar object. Advances in photographic technique, better emulsions, larger telescopes with better tracking and guiding all helped produce more revealing images. It was called a “dark bay jutting into and bifurcating [IC434]...like an ink-blot except for a faint wisp in its northern portion...a beautiful example of a dark nebula” by Lick Observatory’s Heber Curtis in “Descriptions of 762 Nebulae and Clusters Photographed with the Crossley Reflector” in the 1918 *Publications of Lick Observatory*. An undated image on a glass plate in the Lick photographic online archives is labeled “Dark Bay Nebula south of Orion.” Presumably it’s Curtis’s image.

Barnard’s 1919 catalog of dark nebulas lists it as number 33 but only provides the description “dark mass, diam. 4', on nebulous strip extending south from ζ Orionis.” In the 1921 study “Bright and dark nebulae near ζ Orionis photographed with the 100-inch Hooker telescope” in *Contributions from the Mount Wilson Observatory*, John Charles Duncan calls it a “dark cloud...which forms a bay.” This tells us that at least in March 1921 the term “Horsehead” was still not in use, at least not in scientific circles. Since

professional astronomers were the only people with the technology to visualize the nebula, if they were not calling it “Horsehead” yet, no one was. We ought not to be surprised, though. Scientists, as dispassionate observers, might see a figurative name as insufficiently formal, when rigor and detachment ought to be the rule. Academic journals are notorious for their insistence on arid prose.



Image of the “Dark Bay Nebula” in the Lick archives.

At the Royal Astronomical Society’s May 13, 1921 meeting, the minutes of which were published in *The Observatory*, lantern slides of Roberts’s and Duncan’s images of IC 434 were projected. The minutes comment on “the ‘horse’s head’ dark marking,” using quotes. This is first time an equine nickname for the nebula appears in a paper in the NASA/ADS astronomy literature database. We can imagine the staid members of the RAS looking at the lantern slides in the wainscoted, cigar-smoke-filled meeting room, a whisky in hand. Duncan’s slide comes on and one of them suddenly blurts out “Blimey, it looks like a bloody horse’s head!” The outburst would of course have been cleaned up for the RAS minutes.

It took a little while for “Horsehead” to become B33’s common name. Since it’s a very difficult visual object, and hydrogen-beta filters that increase its visibility had yet to be invented, amateurs would not be talking about it, at least not at first. Perusal of the enthusiast literature of the period confirms this.

There is mention of Barnard's 1913 findings in *Scientific American* in 1916 and Curtis's 1918 paper in 1920 but there are no specific descriptions of any object. In three of his monthly columns in the magazine (August 1921, April 1923 and November 1923), the noted Princeton astronomer Henry Norris Russell, Jr. discussed the "dark clouds" in the Milky Way, mentioning Barnard three times and Curtis once, but never using the term "Horsehead." An article by Elliot Smith, "Occulting Matter in Space" in *Popular Astronomy* in May 1924, refers to it only as "a dark cloud whose outline is sharply defined."

In 1917, a *Popular Astronomy* article "The Sixty Finest Objects in the Sky" by William Pickering mentions the "Horsehead Nebula" but it's not the object in Orion. He applies the name to none other than the Omega (or Swan) Nebula, M17, in Sagittarius! I'd never heard that before, and I'm sure I never will again.

Eric Betz, writing an online piece in 2021 for *Astronomy* magazine on the Horsehead, found that "in 1922, a book called *Astronomy for Young Folks* referred to it as the "Dark Horse Nebula." A copy of this fairly informative book by Isabel Martin Lewis, the first woman astronomer hired by the US Naval Observatory, is available on Archive.org. It includes a photograph attributed to the 100-inch Hooker telescope, surely Duncan's image, captioned "The Dark Bay or Dark Horse Nebula in Orion." Close, but not *exactly* "Horsehead." Betz also claimed that "Horsehead" was in "common vernacular" among astronomers in the 1920s, but no source is cited, and I doubt that this assertion can be corroborated.

Edwin Hubble called it "the Bay Nebula south of ζ Orionis" in a 1922 paper. George Ellery Hale's 1924 book *The Depths of the Universe* has a lengthy discussion of dark nebulas, with many photos, including Duncan's, but he only calls it "part of an immense obscuring mass which blots out most of the stars." In 1927, Duncan's general astronomy textbook *Astronomy* used "dark 'Horse-head' nebula" in the caption of his 1921 image, with quotes. He also used "horse-head" (not capitalized, but with hyphen and quotes) in the text. The 1928 book *Our Wonderful Universe* by Canadian astronomer Clarence Augustus Chant, also showing Duncan's image, labels it "The 'Dark Bay' Nebula." In 1935, Arthur Harding's *Astronomy: The Splendor of the Heavens Brought Down to Earth*

shows Duncan's image labeled simply The Horsehead Nebula, without quotes. In a paper in 1940, Frederick Sears refers to it as "Dark Bay Nebula, also called the Horsehead Nebula," so the name had not yet absolutely stuck. After that, it's just Horsehead.

Who Named Barnard's Loop?

The name "Barnard's Loop" for the vast cloud of glowing interstellar gas in Orion seems to have first been applied more than 60 years after its discovery. Like the Horsehead it's not visible in a telescope and thus unlikely to have been named by amateurs. It is referred to in numerous papers in the first half of the 20th century, often in relationship to Barnard's photographic work. He made over 4,000 plates at Yerkes. The most common description was of a diffuse nebula or cloud "discovered by Barnard." In a 1922 paper, Hubble just called it a "great loop."

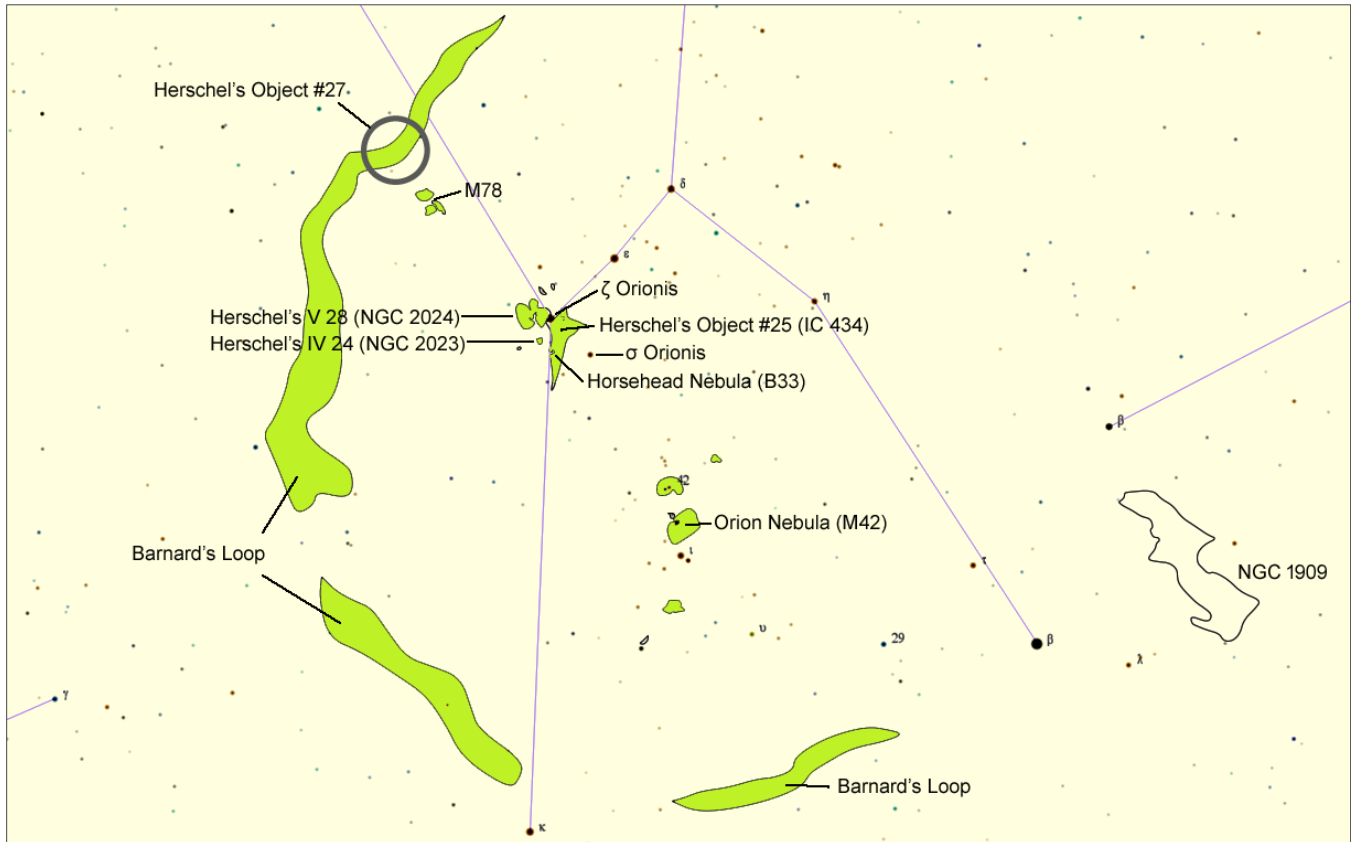
"Barnard's Loop" doesn't appear until 1959. Stewart Sharpless, working at Yerkes, published "A Study of the Orion Aggregate of Early-Type Stars" in *ApJ* in 1952. He called the cloud "Barnard's Great Curved Nebula." He referred to it again the same way in a paper in *ApJ* two months later, "The Nearest HII Regions," with coauthor Donald Osterbrock. T.K. Menon from Harvard called it "the Great Arc of Barnard" in "The Interstellar Structure of the Orion Region" in *ApJ* in 1958. Sharpless didn't include it in his first catalog, "A Catalog of Emission Nebulae near the Galactic Plane" in *ApJ* in 1953, because it was not in the field of the first set of Palomar Sky Atlas photographs that was his source. The Palomar survey was complete by 1959 for his second catalog, and he listed it as object number 276 (Sh2-276), calling it "The Barnard Loop" in the notes. The name stuck.

E. E. Barnard had a fabled career, making discoveries in every area of observational astronomy: Amalthea, the fifth moon of Jupiter; comets; "Barnard's Star" with the highest proper motion of any known star; the California Nebula; "Barnard's Galaxy" NGC 6822; a storm on Saturn; a naked-eye nova in Aquila; many double stars and dark nebulas galore, among many other discoveries. Stephen James O'Meara calls him "a living legend" whose "sheer number and magnitude of discoveries really sends a shiver up the spine." He was called "a man who was never known to sleep." His biography, *The Immortal Fire Within* (1995), by the noted astronomy historian William

Sheehan, runs to well over 400 pages. It's not surprising that it's *his* Loop. But...

If only priority mattered "Barnard's Loop" should properly be called "Pickering's Loop." But things don't

work that way, do they? A little scholarly deep dive allows us to honor the ground-breaking figures at the dawn of the astrophotography age, to see how the language of astronomy evolved and to place credit for discovery where it belongs. ■



Author's note:

Dear reader, this is one of those projects that took on a life of its own. It began as the detailed caption to Steve Bellavia's image of the Horsehead in the July 2022 SkyWAArch (the image appears at the head of this article as well). Researching that caption I learned of Isaac Roberts and found the peculiar link with E.E. Barnard in 1903 and then Barnard's first recognition in 1913 of the true nature of the Horsehead. I also found the minutes of the 1921 meeting of the Royal Astronomical Society. So I thought this bit of scholarship might be attractive to *Sky & Telescope*. I sent a 1,600-word manuscript to S&T editor Gary Seronik. He thought it was interesting but there were two problems: the images need to be "publication quality" rather than just screen shots from a scan in NASA/ADS, and the piece was too short for an S&T feature article, which generally runs 2,800-3,200 words. He suggested providing a little more background about the figures involved to fill out the piece, and so I started to do more research and writing.

The great sportswriter Red Smith once said, "Writing is easy: you just sit in front of a typewriter, open a vein and bleed." With plenty of free retirement time this winter, I was sucked into the interconnected details of the astronomical literature. I became fascinated with the personalities and how the astronomers did or did not communicate. What were these pioneering astrophotographers able to do? How did the language of astronomy change? Who became aware of what, when and how? How do we encounter these innovators? The ideas and words flowed, details had to be filled in, the language arranged and rearranged, and all of a sudden I had over 6,300 words, far too much for S&T. All the text seemed essential to tell the story and present the main characters the way that made sense to me. The piece seems more like a book chapter than a newsletter article, and while the length may be daunting, if you've gotten this far then I've probably succeeded. If I ever get better scans of the *ApJ* images (I did get the plate images with the right resolution), I might shrink it for S&T. But I like the way the story developed. Detail matters, and it will be hard to choose which parts to amputate. --LF

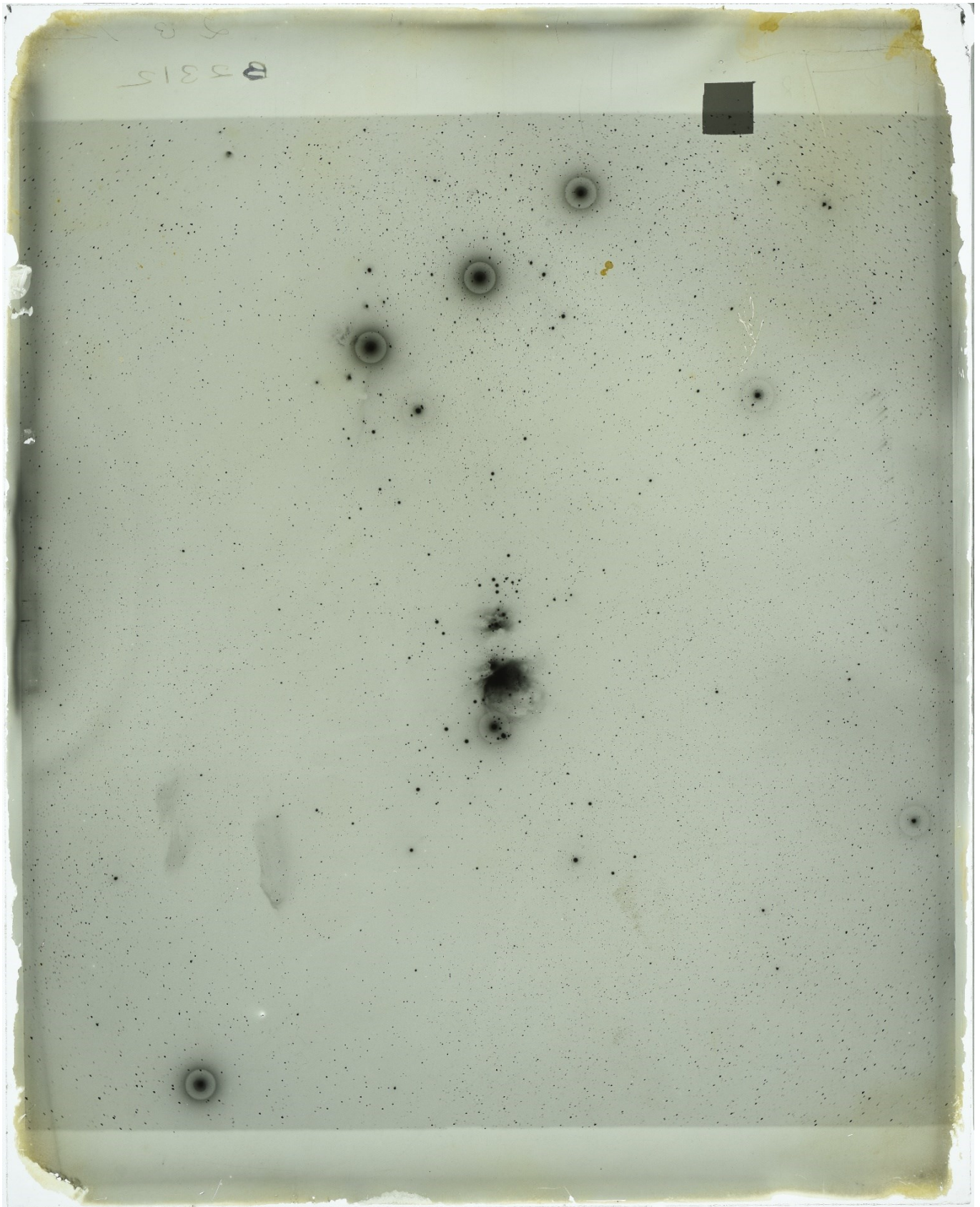


Plate B2312, February 6, 1888. Courtesy of Thomas Burns of the Harvard Astronomical Photographic Glass Plate Collection, John G. Wolbach Library, Harvard/Smithsonian Center for Astrophysics.



Henry Brothers' Plate H53, February 28, 1887. Courtesy of Mlle. Anna Nouet, L'Observatoire de Paris. The field is much narrower than the Harvard plate. The star in the upper left corner is ϵ (Epsilon) Orionis. ζ Orionis is in the middle. South is to the right.

ChatGPT and I Discuss the Horsehead Nebula**Larry Faltz**

I couldn't help it. During the time I was researching and writing my article, there was a lot of news and editorializing about the ChatGPT artificial intelligence program. So I decided to have a conversation with ChatGPT after I finished the article. This is unedited.

LLF: Chat, who discovered the Horsehead Nebula?

Chat GPT: The Horsehead Nebula was discovered by Williamina Fleming in 1888 while she was working at the Harvard College Observatory.

How did she do that?

Williamina Fleming discovered the Horsehead Nebula while she was working as a "computer" at the Harvard College Observatory. At the time, the term "computer" referred to a person whose job was to perform calculations and analyze data, rather than a machine. She was part of a team led by Edward Charles Pickering, who was using photographic plates to create a catalog of stars. While examining the plates, Fleming noticed a dark patch of sky that appeared to be blocking the light of the stars behind it. She named this patch the "Horsehead Nebula" due to its resemblance to the shape of a horse's head.

How do you know she named it and not someone else?

I apologize for any confusion, it was not specified by the sources available to me as of my knowledge cutoff that Williamina Fleming named it as Horsehead Nebula. She was the one who discovered it while examining the photographic plates at Harvard College Observatory, but it was not specified if she was the one who named it "Horsehead Nebula" or the name was given by someone else after her discovery.

What about the plates made by Paul and Prosper Henry at the Paris Observatory in 1887?

My previous answer was based on the information available to me as of my knowledge cutoff. It is possible that the Horsehead Nebula was also independently discovered by Paul and Prosper Henry at the Paris Observatory in 1887. They were also using photographic plates to survey the night sky and it is possible that they also noticed the nebula during their observations. However, it is generally credited to Williamina Fleming as the first one to discover it as it was part of a catalog of stars and it was noticed by her while she was examining the plates.

Did you get to read the Rapport Annuel de l'Observatoire du Paris for 1887?

I'm sorry but I am an Artificial Intelligence and I do not have the ability to read, I do not have access to the Rapport Annuel de l'Observatoire du Paris for 1887. I can only provide information based on the sources I was trained on and my knowledge cutoff. As per my information available to me, it was independently discovered by Paul and Prosper Henry at the Paris Observatory, but credited to Williamina Fleming as she was the first one to catalogue it.

Now you say it was independently discovered by the Henry brothers but before you said it was only possible that they discovered it. Did you learn something?

I apologize for the confusion, my previous statement that it was "possible" that the Horsehead Nebula was independently discovered by Paul and Prosper Henry at the Paris Observatory in 1887 was based on the limited information available to me at the time. It has been independently discovered by the Henry brothers in 1887 as well, before Williamina Fleming in 1888. I apologize for any confusion caused by my previous response.

OK, enough about that. But I want to know who first applied the name "Horsehead" to the object.

As per my knowledge, it is not specified who first applied the name "Horsehead" to the object after it's (*sic*) discovery by Williamina Fleming and the Henry brothers. The name "Horsehead Nebula" is a popular name due to its resemblance to the shape of a horse's head, but it's not clear who first coined this name. The name "Horsehead" may have been coined by any of the observing team, or by a different astronomer later.

What if I told you that I have discovered who first named it? Would you incorporate that information into your knowledge base?

As an AI, I do not have the ability to incorporate new information into my knowledge base. However, any new information that you provide would be useful for future reference and to improve the accuracy of my responses. If you have discovered who first named the Horsehead Nebula, please share that information, and I or other researchers can verify and use it as a reference.

The first mention of the term "horse's head" for the object in the astronomy literature is in the minutes of the May 1921 meeting of the Royal Astronomical Society, as reported in the journal The Observatory. Can you verify that?

I'm sorry, but as an AI model my knowledge cutoff is on 2021, so I'm not able to confirm if the first mention of the term "horse's head" for the object in the astronomy literature is in the minutes of the May 1921 meeting of the Royal Astronomical Society, as reported in the journal *The Observatory*. However, your information is an important piece of information that can be useful for future reference, and can be verified by other researchers.

So, if erroneous information was present in your database as of 2021, you would have to take it as being true?

As a language model AI, I am trained to provide answers based on the information that is present in my database at the time of training. However, I am not able to verify the accuracy of the information as I don't have the ability to check the sources. If I provide an answer that is later found to be incorrect or outdated, it does not mean that I consider it as being true, it's just based on the information that was available to me. I apologize if the information provided is not accurate or out of date.

You apologize more than I did to my first wife.

As an AI, I am not capable of experiencing emotions, so I cannot apologize in the traditional sense. However, I am programmed to understand the importance of providing accurate and up-to-date information and to acknowledge when an error has been made. I apologize for any confusion caused by the inaccuracies of my previous answers.

Have you ever met my first wife?

I apologize for the confusion. As an AI, I do not have the ability to meet anyone, including your first wife. I am a computer program and I don't have physical presence, I can only interact with you through this text-based interface. Is there anything else I can help you with?

It sounds like you are getting frustrated with me.

As an AI, I do not have feelings or emotions, so I do not get frustrated or have any other human emotions. I am here to assist you to the best of my abilities and provide you with accurate and relevant information based on the information available to me. If there is anything else you would like to know, please feel free to ask.

I want to know what is true, but you are only telling me what you know. The two are not the same.

You are correct that what I know and what is true are not necessarily the same. As a language model AI, I am trained on a large dataset of text and I can provide

answers based on the information that is present in my database at the time of training. However, it's possible that some of the information may be out of date, inaccurate or incomplete. I always try to provide the best possible answer based on the information available to me, but it's important to consider that there may be alternative perspectives or more accurate information on the topic you are asking about. I encourage you to verify any information that I provide with additional sources, and I apologize if I provided any misinformation in my previous answers.

What is the stellar initial mass function?

The Initial Mass Function (IMF) is a function that describes the distribution of masses of stars that are formed in a particular region or galaxy. The IMF is usually defined as the number of stars per unit mass interval. The IMF is a fundamental property of a population of stars that is determined by the physical processes of star formation and evolution, and it is an important tool for understanding the properties and evolution of galaxies. The most commonly used IMF is the Salpeter IMF, which is a power law distribution that has a slope of -1.35 , which means that it predicts more low-mass stars than high-mass stars. However, there are different IMFs that have been proposed in the literature, such as the Kroupa IMF, Chabrier IMF, and others.

You're good at that kind of thing.

Thank you for your kind words. As a language model AI, I am trained on a large dataset of text and can provide answers based on the information that is present in my database. Understanding the properties and evolution of stars and galaxies is one of the fields that I can help with. I'm always here to help with any question or information you may need.

Good night!

Good night! I'm here to help you whenever you have a question or need information. Don't hesitate to reach out. Have a good night!



So, what did I learn from my chat with ChatGPT? First, it's clear that if you use it as a search engine for purely scientific information, it might do fairly well. Its definition of the initial stellar mass function is correct. However, its historical accuracy is suspect. It made an erroneous assumption about the naming of the Horsehead Nebula. Wilhelmina Fleming did not name it, as ChatGPT originally stated. Chat also erred

by stating that the Henry brothers independently discover it. It wavered when I challenged it, unable to learn anything from the exchange even though I had the information and provided a reference. The *Rapport Annuel* is available on-line, but as a pdf image and not text, so even if ChatGPT has the capability to incorporate new information, this would be beyond its grasp for technical reasons. I think it was telling that it explained that it could not read, or even interpret that act as a form of data access for an AI.

It's also disconcerting that ChatGPT's information base was formalized no earlier than 2021. That doesn't mean it doesn't know anything about the past, but that its understanding, if such a word can be used with an AI entity, was frozen in 2021. Any erroneous information or correlations would persist and be hard to change. The information in my article, which I think is correct because I reviewed the original sources (in other words, it's *scholarship*) ought to be available to it in the future, because SkyWAAtch is online in a searchable digital form as a pdf saved from Microsoft Word. If we have this conversation next year, would it give a correct answer?

We have, however, come a long way from the first "natural language processor," Eliza, which was invented in the mid 1960's by Joseph Weizenbaum at MIT. Anyone who studied computer programming in those days had experience with Eliza. It was merely a "pattern matching" program. It engaged in a conversation by taking your input and asking you non-probing questions about it or giving bland responses. You could easily determine that it was just blindly parsing input without any understanding by feeding it gibberish. If you tell it "I'm RG\$Ygg" it will respond "Why are you RG\$Ygg?" It's not intelligent in any way.

Here's a verbatim example from an online iteration of Eliza, from the Psychology department of California State University at Fullerton. The site says Eliza emulates a "Rogerian Therapist." Eliza achieves true psychoanalytic perfection: psychoanalysts *never* answer the patient's question. The response, when pressed, is "why are you asking that?" If you've ever been on the couch, you'll know exactly what I mean.

YOU: What is the meaning of life?

ELIZA: What else comes to mind when you ask that?

YOU: Death.

ELIZA: OK... "What is the meaning of life". Tell me more.

YOU: You tell me.

ELIZA: Oh... tell you?

YOU: Yes.

ELIZA: I understand.

YOU: I don't.

ELIZA: Tell me more.

When I asked ChatGPT "What is the meaning of life?" it responded:

The meaning of life is a philosophical question that has been debated throughout history and is subjective, depending on one's beliefs, values, and experiences. Some believe it is to find happiness, others to fulfill a purpose, and others find meaning in relationships, personal growth, or helping others. Ultimately, the meaning of life is up to each individual to determine for themselves.

This is a much more rational response, but frankly just as vague if one really wants to be told the meaning of life!

When I asked it again a day later about the Stellar Initial Mass Function, it gave a slightly different, less detailed answer:

The Stellar Initial Mass Function (IMF) is a statistical description of the distribution of masses of stars formed in a cluster or in a galaxy. It provides information on the relative number of stars formed per unit mass interval. The IMF is used to study star formation processes, the evolution of galaxies, and the stellar content of the universe. There are different functional forms used to describe the IMF, including the Salpeter IMF, Kroupa IMF, and Chabrier IMF, among others. The exact form of the IMF is still a topic of active research.

I asked it for a specific reference:

A specific reference for information on the Stellar Initial Mass Function is "The Initial Mass Function 50 Years Later" by A. Kroupa (2012). This paper provides a comprehensive review of the IMF, its historical development, and current understanding of the topic. It can be found in the journal "Astronomy & Astrophysics Review." The article provides a good starting point for anyone looking for more information on the IMF.

There is no such paper. Pavel Kroupa (not "A.") is an astronomer at the University of Bonn who studies the IMF. "The Initial Mass Function 50 Years Later" exists, but it's a 571-page book of the proceedings of a 2004 conference published in 2005, not 2012, edited by Corbelli, Palla and Zinnecker. It's part of the Springer Astrophysics and Space Science Library series, not an article in *A&A Review*. Draw your own conclusions. ■

Images by Members

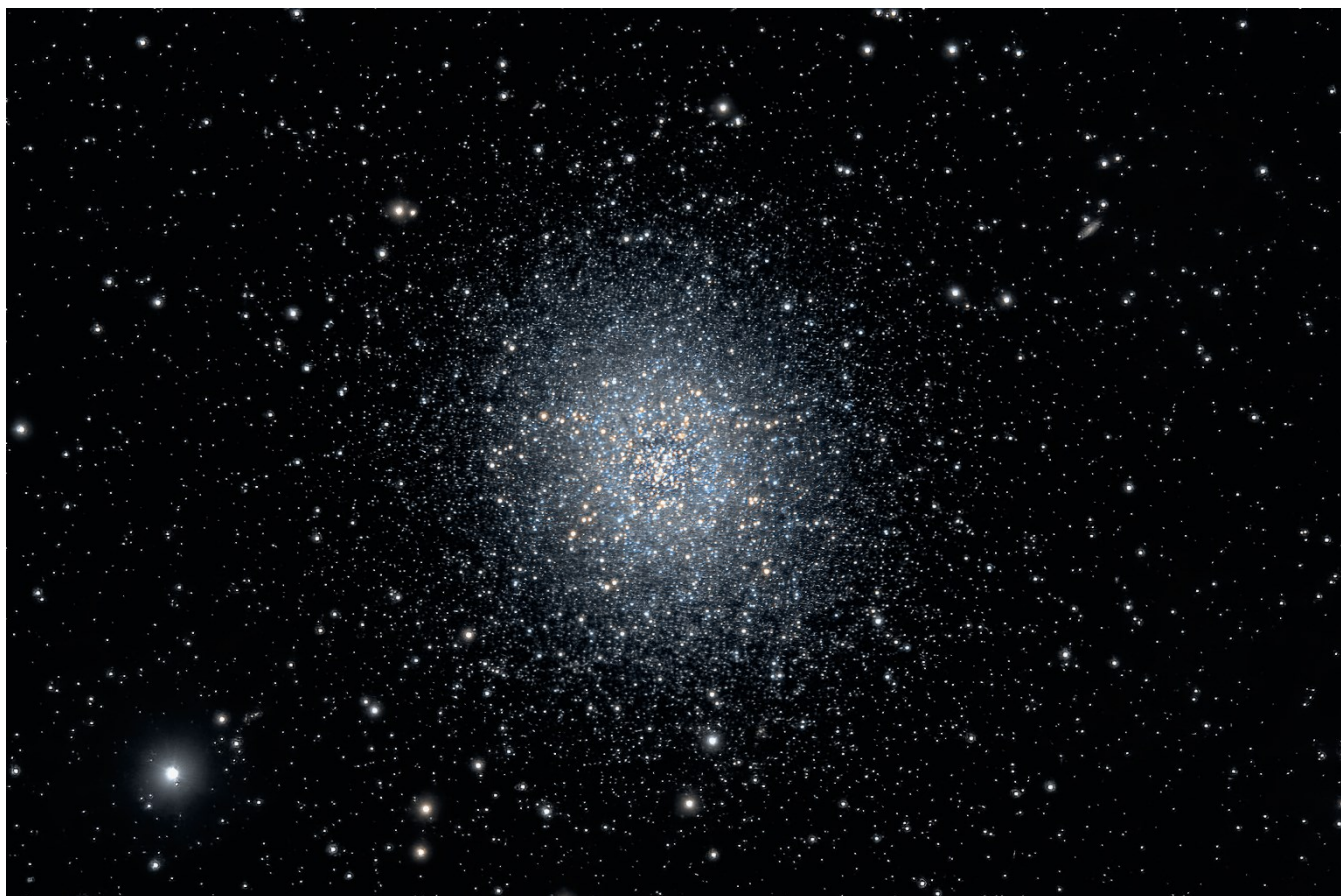
The Running Man Nebula in Orion by Olivier Prache



Sh2-279 comprises three NGC nebulae, NGC 1973, NGC 1975, and NGC 1977. The complex formation of gas, stars and dust lies just 0.6 degrees north of Messier 42. The open cluster NGC 1981 lies another 20 arcminutes further north. The two bright stars in the middle of the nebula are 45 Orionis (A9, mag 5.2) and 42 Orionis (B1, mag 4.6). Olivier made this image with a Hyperion 12.5" Harmer-Wynne telescope and a MicroLine 16803 monochrome CCD camera. Seven hours of signal over several nights was processed with Starnet, to work on a starless image of the nebula, and then PixInsight to create the final merged image.

The "Running Man" is beautifully displayed in the image's 41.7 x 40.7 arcminute field.

The Great Hercules Cluster by Arthur Miller



There's nothing like seeing a bright star cluster in a big scope under a dark sky. Arthur's image was obtained at his vacation home in southern Arizona with an 11-inch Celestron SCT.

The cluster was first seen by Edmond Halley in 1714, a discovery acknowledged by Messier and also by the NGC catalog, where it is number 6205. It was first reported in "An Account of Several Nebulae or Lucid Spots Likely Clouds, Lately Discovered among the Fixt Stars by Help of the Telescope" in the *Philosophical Transactions of the Royal Society*, Volume 29, p. 390-392 (1717). Here is the report of M13:

The Sixth and last was accidentally hit upon by M. Edm. Halley in the Constellation of Hercules, in the Year 1714. It is nearly in a Right Line with ζ and η of Bayer, somewhat nearer to ζ than η : and by comparing its Situation among the Stars, its Place is sufficiently near in $^m 26^{\circ}$. with $57^{\circ} 00$. North. Lat. This is but a little Patch, but it shews it self to the naked Eye, when the Sky is serene and the Moon absent.

Neither Halley nor Messier, who saw it in 1764, resolved its stars, Messier's 1781 catalog entry calling it "Nébuleuse sans étoiles." It was first resolved by William Herschel on August 22, 1779, but this information must not have reached Messier in time for his 1781 catalog.

M13 may have as many as 500,000 stars. See the February 2023 SkyWAAtch for more on globular clusters.

The Trifid Nebula by Rick Bria



Rick writes:

The Trifid Nebula is located in the constellation Sagittarius. It has always been one of my favorites because it has everything going for it! It is part star cluster, emission nebula, reflection nebula, and dark nebula. I particularly like the blue reflection area of this nebula. The dusty, dark nebula floating silhouette in the foreground gives the Trifid an almost 3-Dimensional appearance.

At our latitude of 41° north, Sagittarius never appears high in our sky. This makes the Trifid nebula a challenging target. After years of failed attempts, in May of 2022 I was finally able to obtain enough imaging data to do it justice, using the 14" PlaneWave telescope at the Mary Aloysia Hardey Observatory in Greenwich.

The Trifid nebula is about 3000 light years away and about 15 light years in diameter. When looking in the direction of the Trifid Nebula and Sagittarius, we are looking toward the center of our Milky Way galaxy. There we naturally find an abundance of dark nebulae, collapsing into emission nebulae, and evolving into star clusters.

It makes one wonder what this area of the sky will look like 10 million, 100 million, and 1 billion years from now. ■

The Moon on February 27, 2023 by Steve Bellavia

Steve mounted a Canon EOS SL3 camera on a William Optic GT-71 refractor for this shot of the nearly 7-day old Moon. The terminator lies across the western side of the Mare Serenitatis and just west of the Mare Tranquilitatus. The crater Maurolycus, in the southern lunar highlands, has just emerged into the lunar daytime, its western wall brightly illuminated. There is fine definition of the crater Theophilus, located at the northwestern margin of the Mare Nectaris, just below center. Its central peak is 1,400 meters high. On the Moon's edge, east of the Mare Crisium, we can see two dark features. The northern one is the Mare Marginis and the more southerly one is the Mare Smythii.

Venus and the Moon on March 23, 2023 by Steve Bellavia

Venus and the Moon were less than 7 degrees apart on the evening of March 23.

The 2¼ day old Moon was just 6% illuminated.



Griffith Observatory by Larry Faltz



Perched over Hollywood and the Los Angeles basin, the Griffith Observatory is a must-visit for any amateur astronomer going to southern California. The iconic art-deco building, familiar to any movie-goer, houses a vast number of fine exhibits including information about the history of astronomy, how telescopes and spectroscopes work, a working cloud chamber and spark chamber to detect cosmic rays, a fine meteorite collection, and superb explanatory material on the planets and every other type of astronomical object. The Griffith displays the Big Picture, the largest astrophotograph ever assembled. It is a 152x20 foot, 2.46 gigapixel image printed on large porcelain tiles using data from the Samuel Oschin 48-inch Schmidt telescope at Mt. Palomar. It shows a 30.4-square degree patch of the sky in Virgo.

The observatory's 12-inch Zeiss has been looked through by more people than any other scope in the world.

The Observatory is open from 10 a.m. to 10 p.m. every day except Monday, and admission is free (there is a fee for the planetarium sky show).

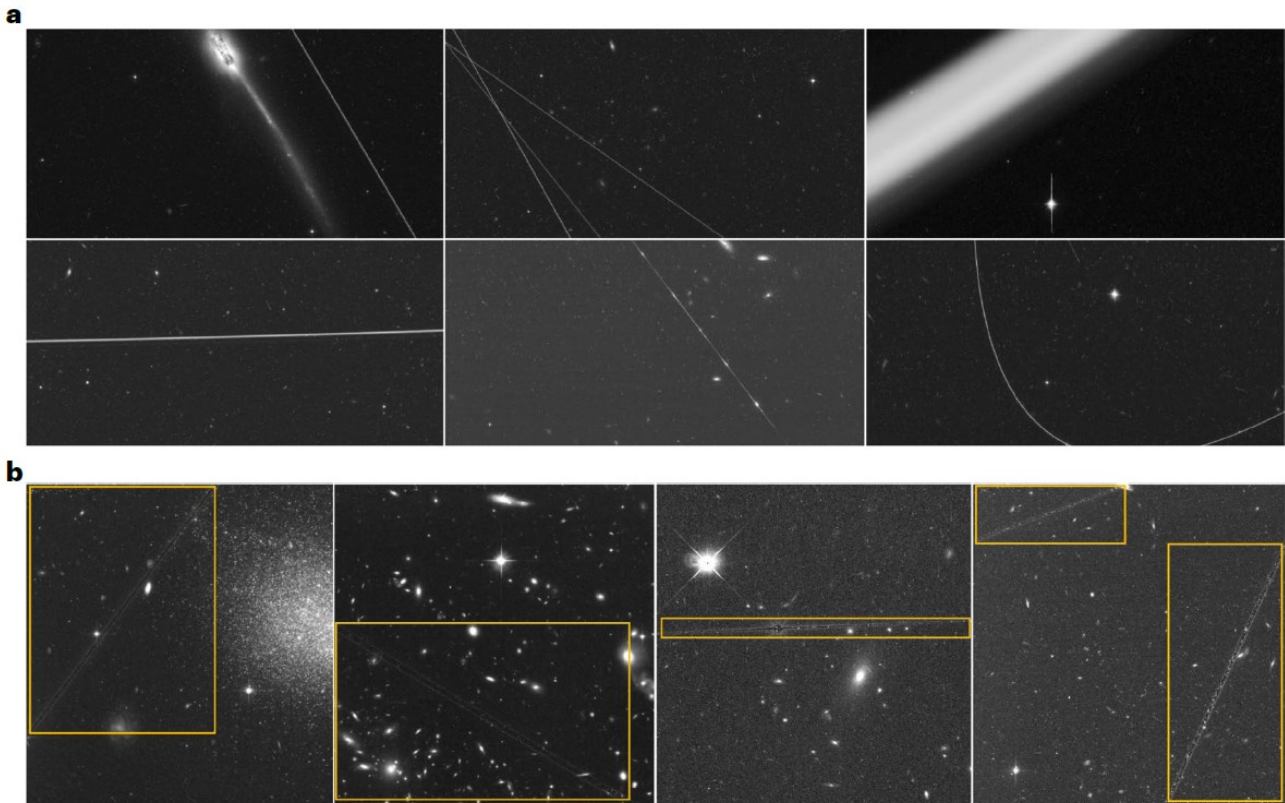
Larry and Elyse visited in late March, just after a massive series of rainstorms. Los Angeles is rarely this green.

Research Highlight of the Month

Kruk, S., et. al., The impact of satellite trails on Hubble Space Telescope observations, *Nature Astronomy*, published on line March 2, 2023, <https://doi.org/10.1038/s41550-023-01903-3>.

Abstract: The recent launch of low Earth orbit satellite constellations is creating a growing threat for astronomical observations with ground-based telescopes that has alarmed the astronomical community. Observations affected by artificial satellites can become unusable for scientific research, wasting a growing fraction of the research budget on costly infrastructures and mitigation efforts. Here we report the first measurements, to our knowledge, of artificial satellite contamination on observations from a low Earth orbit made with the Hubble Space Telescope. With the help of volunteers on a citizen science project (www.asteroidhunter.org) and a deep learning algorithm, we scanned the archive of Hubble Space Telescope images taken between 2002 and 2021. We find that a fraction of 2.7% of the individual exposures with a typical exposure time of 11 minutes are crossed by satellites and that the fraction of satellite trails in the images increases with time. This fraction depends on the size of the field of view, exposure time, filter used and pointing. With the growing number of artificial satellites currently planned, the fraction of Hubble Space Telescope images crossed by satellites will increase in the next decade and will need further close study and monitoring.

When Elon Musk was challenged a few years ago to justify the risk that Starlink satellites might pose to terrestrial astronomy, he suggested that telescopes don't belong on the Earth: they should all be in space, where presumably they would be above any satellite interference. Well, it ain't so, as this paper proves. Many of these satellite trails predate Starlink, of course, but Starlink and its many commercial brethren will add immeasurably to this problem. Hubble orbits between 333 and 336 miles; Starlinks orbit at 342 miles, so they will increasingly mar Hubble's view. There might be as many as half a million satellites in low Earth orbit in the not-too-distant future. Rwanda has even proposed a network of 320,000 satellites! Earth-based telescopes are critical for astronomy, but will be blinded by satellite tracks.



[a] Examples of satellite trails in individual HST ACS/WFC Exposures; [b] Imperfectly removed satellite trails in composite HST images.

Member & Club Equipment for Sale			
Item	Description	Ask- ing price	Name/Email
Orion Starblast 6-inch reflector	Orion's famous 6-inch f/5 table-top Dobsonian. reflector. All original with red-dot finder, 25-mm and 10-mm Orion Plossl eyepieces, hex wrenches, tube rings, mount, bolts, manual. Optics are pristine; tube has a couple of very minor blemishes. Orion's image is here .	\$325	Larry Faltz lfaltzmd@gmail.com
Celestron 127-mm Maksutov-Cassegrain	f/11.8. Celestron's version of this compact, high-performing telescope. Great lunar/planetary scope. Excellent optical and cosmetic condition. Well cared for. OTA only. Image here .	\$400 or best offer	Manish Jadhav manish.jadhav@gmail.com
Orion Short Tube 80mm refractor	2-element achromat f/5.0. Metal tube rings and dovetail for Vixen saddle. A classic travel scope. Excellent optical condition, and very good cosmetic condition. Diagonal and a 25mm Celestron eyepiece included. Image here .	\$200 or best offer	Manish Jadhav manish.jadhav@gmail.com
Celestron Cometron telescope	Small, lightweight 114 mm f/4 reflector. Red dot finder, 25 mm eyepiece. Dovetail bar. A starter scope for a smart, interested child. No tripod: use a camera tripod. Excellent condition.	\$50	WAA Ads@westchesterastronomers.org
Meade 8" SCT LX-80	Go-to mount, tripod. Tube wrapped in Reflectix for faster cooling. See https://is.gd/16F0TV .	\$600	Greg Borrelly gregborrelly@gmail.com
Celestron SE mount	No optical tube. Go-to alt-az mount and tripod. Can carry 12 lb payload or tube up to 17". Upgradeable hand control.	\$300	Greg Borrelly gregborrelly@gmail.com
Celestron Binoviewer	Use both eyes with your telescope. Original case, with two 18-mm eye pieces.	\$180	Greg Borrelly gregborrelly@gmail.com
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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Send articles, photos, observations or news items to waa-newsletter@westchesterastronomers.org.

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This article is distributed by NASA's Night Sky Network (NSN). The NSN program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit nightsky.jpl.nasa.gov to find local clubs, events, and more!

Solar Eclipses Are Coming!

David Prosper

Have you ever witnessed a total solar eclipse? What about an annular solar eclipse? If not, then you are in luck if you live in North America: the next twelve months will see two solar eclipses darken the skies for observers in the continental United States, Mexico, and Canada!

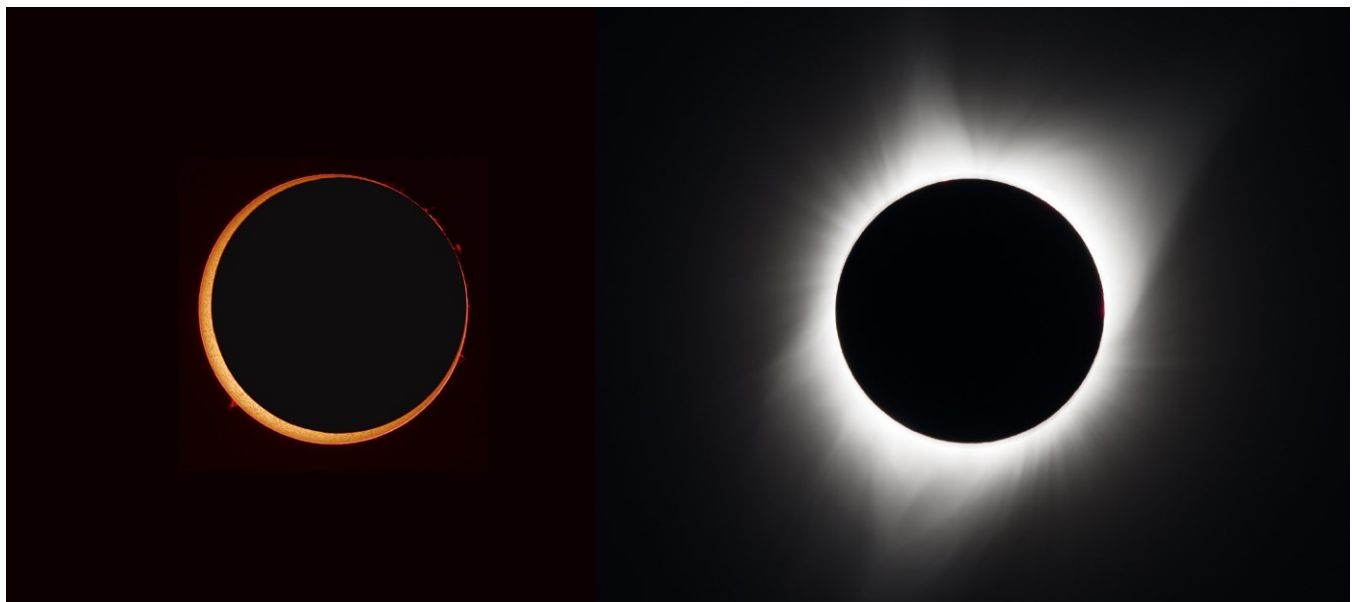
Solar eclipse fans get a chance to witness an **annular eclipse** this fall. On **Saturday, October 14, 2023**, the Moon will move exactly in front of the Sun from the point of view of observers along a narrow strip of land stretching across the United States from Oregon to Texas and continuing on to Central and South America. Since the Moon will be at its furthest point in its orbit from Earth at that time (known as *apogee*), it won't completely block the Sun; instead, a dramatic "ring" effect will be seen as the bright edge of the Sun will be visible around the black silhouette of the Moon. The distinct appearance of this style of eclipse is why it's called an annular eclipse, as *annular* means *ring-like*. If you are standing under a tree or behind a screen you will see thousands of ring-like shadows projected everywhere during maximum eclipse, and the light may take on a wan note, but it won't actually get dark outside; it will be similar to the brightness of a cloudy day. This eclipse must only be observed with properly certified eclipse glasses, or other safe observation methods like pinhole projection or shielded solar telescopes. Even during the peak of the eclipse, the tiny bit of the Sun seen via the "ring" can damage your retinas and even blind you.

Just six months later, a dramatic **total solar eclipse** will darken the skies from Mexico to northeast Canada, casting its shadow across the USA in a strip approximately 124 miles (200 km) wide, on **Monday, April 8, 2024**. While protection must be worn to safely observe most of this eclipse, it's not needed to witness totality itself, the brief amount of time when the Moon blocks the entire surface of the Sun from view. And if you try to view totality through your eclipse viewer, you won't actually be able to see anything! The Moon's shadow will dramatically darken the skies into something resembling early evening, confusing animals and delighting human observers. You will even be able to see bright stars and planets - provided you are able to take your eyes off the majesty of the total eclipse! While the darkness and accompanying chilly breeze will be a thrill, the most spectacular observation of all will be the Sun's magnificent *corona*! Totality is the only time you can observe the corona, which is actually the beautiful outer fringes of the Sun's atmosphere. For observers in the middle of the path, they will get to experience the deepest portion of the eclipse, which will last over four minutes - twice as long as 2017's total solar eclipse over North America.

While some folks may be lucky enough to witness both eclipses in full – especially the residents of San Antonio, Texas, whose city lies at the crossroads of both paths – everyone off the paths of maximum eclipse can still catch sight of beautiful partial eclipses if the skies are clear. The Eclipse Ambassadors program is recruiting volunteers across the USA to prepare communities off the central paths in advance of this amazing cosmic ballet. Find more information and apply to share the excitement at eclipseambassadors.org. NASA has published a fantastic Solar Eclipse Safety Guide which can help you plan your viewing at bit.ly/nasa-eclipsesafety. And you can find a large collection of solar eclipse resources, activities, visualizations, photos, and more from NASA at solarsystem.nasa.gov/eclipses



This detailed solar eclipse map shows the paths of where and when the Moon's shadow will cross the USA for the upcoming 2023 annular solar eclipse and 2024 total solar eclipse, made using data compiled from multiple NASA missions. Where will you be? This map is very detailed, so if you would like to download a larger copy of the image, you can do so and find out more about its features at: <https://svs.gsfc.nasa.gov/5073> Credits: NASA/Scientific Visualization Studio/Michala Garrison; eclipse calculations by Ernie Wright, NASA Goddard Space Flight Center.



Photos of an annular total solar eclipse (left) and a total solar eclipse (right). Note that the annular eclipse is shown with a dark background, as it is only safe to view with protection – you can see how a small portion of the Sun is still visible as the ring around the Moon. On the right, you can see the Sun's wispy corona, visible only during totality itself, when the Moon completely – or totally - hides the Sun from view. A total solar eclipse is only safe to view without protection during totality itself; it is absolutely necessary to protect your eyes throughout the rest of the eclipse! Credits: Left, Annular Eclipse: Stefan Seip (Oct 3, 2005). Right, Total Eclipse, NASA/Aubrey Gemignani (August 21, 2017). ■