SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

September 2020

The Trifid Nebula (M20) by Steve Bellavia

The Trifid was discovered by Gillaume Le Gentil, probably in 1747. This astronomer is most remembered for his epic but unsuccessful attempts to view the Transits of Venus in 1761 and 1769. Messier first saw the Trifid in 1764. It was first called “Trifid” by John Herschel, which is interesting because John’s father, William Herschel, had already catalogued it but in four separate designations. Steve made this image at Cherry Springs, PA on June 17-19; 4.6 hours of integration through a Borg 90 FL refractor, ZWO ASI183MC and MM cameras. Three different filters were used during the image acquisition.

WAA September Meeting

Friday, September 11th at 7:30 pm

Members' Night

Speakers: Your fellow WAA members

An on-line Zoom event for members

WAA members will be invited via email blast to participate in our first on-line meeting via Zoom. We have capacity for 100 participants. Look for the email from eblasts@westchesterastronomers.org.

Starway to Heaven Star parties

As of the date of this newsletter, we still don't have clearance from the park for a public event. Members are encouraged to take advantage of our Special Use Permit with the park to do individual observing on any night of their choosing. Please be sure to call in advance and bring your ID. Observe all appropriate pandemic protections.

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

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Assistant Editor: Scott Levine
Almanac Editor: Bob Kelly
Editor Emeritus: Tom Boustead

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

Also In This Issue

WAA October Meeting

Friday, October 2nd at 7:30 pm. On-line.

Intelligent Nighttime Lighting: The Many Benefits of Dark Skies

Charles Fulco

Charles is a science educator who has been involved with the International Dark-Sky Association. Light pollution is not only bad for astronomy, but it has many deleterious effects on human and animal biology.

New Members

Brian Blaufeux	Larchmont
Laura Doty	Ossining
Jason Kalmer	Peekskill
Hugh Osborn	New Rochelle
John Pasquale	Bedford
Vlad Rapoport	New York
Steven Reed	New York
Albert Sayers	Pelham
Sean Wandzilak	Yonkers
Edwin Williams	Mount Kisco
Joseph Willsen	Yonkers

Renewing Members

Liv Andersen	Westport
Leandro Bento	Mohegan Lake
Thomas Boustead	White Plains
Bill Caspe	Scarsdale
Michael & Ann Cefola	Scarsdale
Federico Duay	Briarcliff Manor
Howard Finkelstein	Greenwich
Patricia Frasier & Myrna Morales	New York
Joe Geller	Hartsdale
Parikshit Gogte	Chappaqua
Rena Hecht	Rye
Manish Jadhav	Ossining
Scott Levine	Croton On Hudson
George & Susan Lewis	Mamaroneck
Scott Nammacher	Athens
William Newell	Mount Vernon
Anthony Ortega	Scarsdale
Alfred J. Padilla	Armonk
Christopher Plourde	New Rochelle
Peter Rothstein	Hastings on Hudson
Pierre-Yves Sonke	Tarrytown

ALMANAC For September 2020

Bob Kelly, WAA VP for Field Events

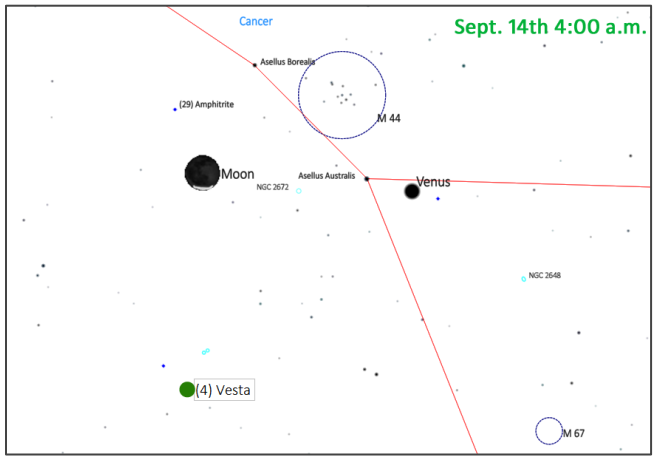

Full 9/2


3Q 9/10


New 9/17


1Q 9/23

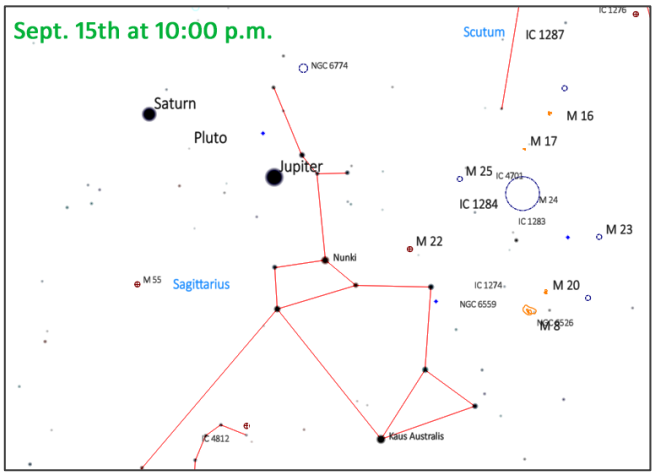
Time for the low-down on bright objects for the month of September! None of the five brightest planets, except **Mars**, gets more than 28 degrees above the horizon during the night. Thus, I give you, the low-down planets.



On the morning of the 14th, the **Moon** will sidle up to **Venus**. Compare the Moon's phase with that of Venus. You'll need a good pair of binoculars or a telescope to see Venus's phase. It's best viewed in twilight. The Moon will be thin and wan, but it has a rare showing of the ridges on our side of Mare Orientale in the days around the 14th, with the best view that morning. Venus is spectacular before, and even for a while after, sunrise. If you are up early enough, **Vesta** forms another vertex of a Moon/Venus/Vesta triangle. You'll need to be out before astronomical twilight begins at 5:01 a.m. EDT to pick up magnitude +7.9 Vesta in binoculars. While you're at it, **M44**, the "Beehive" open cluster, makes it a foursome. By the way, if you can see Vesta, you'll also be able to see Ceres, which we'll talk about later. You could get seven objects orbiting the Sun in a night. Of course, **Uranus** and **Neptune** are as bright or brighter than Vesta, so you can make it nine objects. (Increase your total further by counting moons, including ours!)

Jupiter and **Saturn** are the stars of the night, starting low in the southeast. Earth is moving away from them, so they look are a bit smaller than they were opposition in July, but they rise at a better time for evening observers. We get another occurrence of a double shadow transit (two Jovian moons casting shadows on Jupiter's disk) around 3 a.m. on Monday the 14th. It's a great way to start the workweek.

Saturn dawdles behind Jupiter, rising about a half an hour later. But it's but worth the wait. Telescopes will let you find **Titan**. **Iapetus** passes north of Saturn on the 6th.



Mars's brightness increases past magnitude -2.0, as we come up on its closest approach. By the end of the month, it is as bright as Jupiter and appears larger than every planet except Jupiter. The ruddy planet still doesn't rise until 9:30 p.m. in early September and by 7:30 p.m. at the end of month. It's worth staying up a bit late to get Mars in a higher sky to look with high magnification to see details. (See the detailed table on page 8). Mars is much higher in the sky than its last opposition in 2018. Its southern hemisphere celebrates its summer solstice on the 2nd. The southern pole is tipped toward Earth, but the summer sun is shrinking the southern polar cap. Mars is tantalizing close to the Moon on the night of the 5th/6th, so you can catch them in the same eyepiece. Compare the phase of the Moon with the phase of Mars.

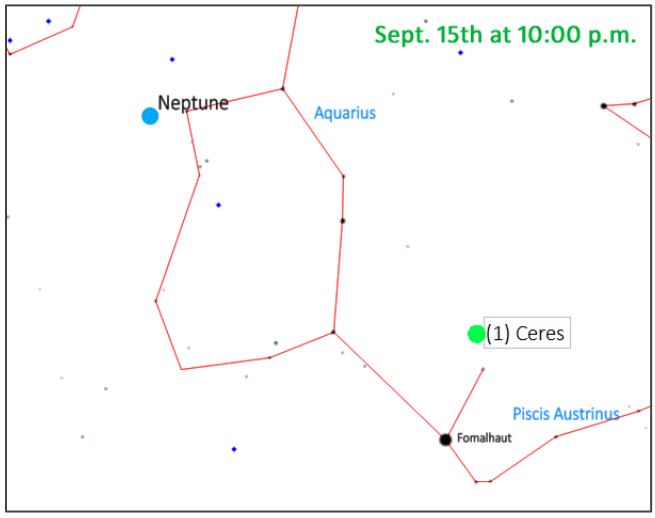
Mercury is in the evening twilight sky, but it's not a good apparition from our viewpoint in the northern hemisphere. Mercury passes less than a degree from Spica, 24 degrees from the Sun, but the pair is only 8 degrees above the horizon at sunset on the 21st and

22nd. Good luck fishing for them with binoculars, even with Mercury at magnitude 0.0 and Spica at +1.0. Mercury slides out to greatest elongation at the end of the month.

Neptune reaches opposition on the 11th. Compare its magnitude +7.8, tiny blueish disk to the closer but smaller dwarf planet **Ceres** at magnitude +7.4 on the other side of Aquarius. **Uranus** rises two hours after Neptune.

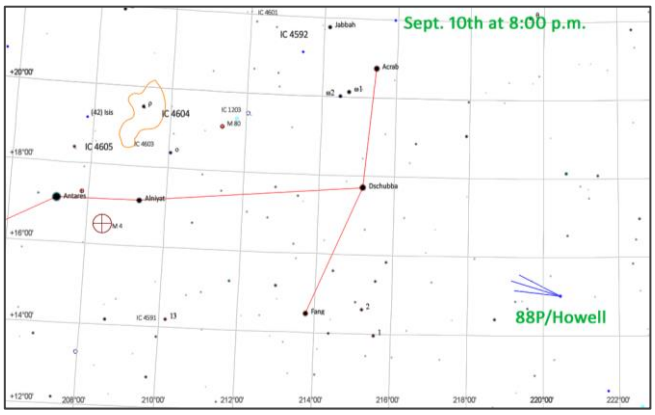
Our **Moon's** perigee is on the 18th, 28 hours after new Moon. Beware of higher than normal tides, especially if the hurricane season ramps up. October's new Moon will be even closer.

Each month, the Moon appears to tilt back and forth a bit from Earth's point of view as it changes distance from Earth and its orbital speed changes, all the while keeping its side with the dark Maria toward Earth. This effect is called *libration*.[1] The word is derived from *libra* for scales and balance, not *liberation*. After all, the Moon's situation, locked in its orbit around the Earth and keeping the same side toward Earth, is the opposite of "liberation." It's easy to imagine our Moon trying to keep its balance, wobbling like a novice skater, as it sails in its elliptical orbit around the Earth. This wobble is just from the Earth's point of view, as the Moon itself doesn't wobble appreciably. Libration gives us a peek at the nearest edges of the Moon's far side.



Dwarf planet **Ceres** reaches opposition on the 2nd in Aquarius. It's about a fist width above 1st magnitude **Fomalhaut**, which is called the "lonely one" for a reason. But at magnitude +7.4, Ceres is findable with binoculars and a finder chart.

Comet 88P/Howell may brighten to 9th magnitude by mid-September. It will be very low in the west, to the left (south) and a bit higher than Mercury, so it will be hard to see in the twilight. Follow the claws of the Scorpion to get into the neighborhood. 88P/Howell was discovered in 1981 by Ellen Howell as part of a project using comparisons of photographic plates taken by a 460-mm Schmidt telescope.



Get thee to a dark site and see the **Milky Way**! It's overhead after dark this month. Plan for nights with the darkest skies when the Moon is out of sight. After the 11th, the Moon rises after midnight giving you dark evening skies after astronomical twilight ends about 8:42 p.m. EDT. If you haven't seen the Milky Way from a dark site, it helps to look for strands of what looks like thin high clouds, especially near Cygnus (the Northern Cross). Look for the "blank spaces" between the delicate bands of light. That's where dust is blocking stars behind it. The Moon resumes interfering with viewing the Milky Way by the 21st. While you are checking out our galaxy behind **Cygnus**, the bright star at the tail of the swan (or the head of the Cross), **Deneb**, is the farthest away of the top 25 brightest stars as seen from Earth, around 1,400 light years. If Deneb was as close to us as magnitude +0.6 Vega over in Lyra, it would sear the sky at about magnitude -6, brighter than any of the planets in our sky. I guess it would be a swan with afterburners.

The **International Space Station** is visible in dawn sky through the 14th, and the dusk sky in the second half of the month. Experience our autumnal equinox on the 22nd at 9:31 a.m. EDT. ■

[1] [1] A very nice video is at the NASA Scientific Visualization Studio web site https://svs.gsfc.nasa.gov/4768.

From the Editor — Larry Faltz

Some years ago I purchased an Orion Apex 127 Maksutov-Cassegrain (hereinafter just " Mak") from a now-defunct astronomy store in Long Island. I was looking for something much more portable and easier to set up than my 8" Celestron CPC, but with more magnification potential than the 3-inch f/6 Stellarvue refractor that was my other scope at the time. The 127 Mak is an instrument commonly offered by astronomy vendors, often with low-cost mounts. My assumption is that the various brands are all made in the same factory in China, and although they have different markings and colors, they are fundamentally clones.

This telescope design was invented in 1941 by Russian amateur astronomer and optical designer Dmitry Dmitrievich Maksutov, founder in 1930 of the Laboratory of Astronomical Optics at the State Optical Institute of Leningrad (now St. Petersburg). Maks are rather slow scopes: the Apex 127 is f/12.1. The first Mak that was commercially successful was the Questar Standard 3.5, an f/14.4 scope first made in 1950 and still in production. Meade's 7-inch Mak was an f/15 scope, as is that company's popular ETX-125 (which is really a 127). Because the primary mirror and the thick, highly curved corrector plate are spherical, the scopes are relatively inexpensive to make in smaller apertures. The secondary is a non-adjustable silvered disc on the inside of the corrector and so collimation is maintained far better than a Schmidt Cassegrain. The narrow field of view means Maks are not great for sweeping the Milky Way or examining large open clusters. They have a well-deserved reputation for sharp, contrasty planetary views compared to an SCT. The smaller central obstruction helps in this regard. The only other disadvantage is that the thick corrector plate takes a lot more time to cool than a thin SCT corrector, but a little planning and preparation can take care of that issue.

The Apex and its bretheren usually come with a dovetail screwed into the tube, but I replaced it with tube rings and an 8" dovetail bar for better clearance from the mount and the ability to rotate the tube. I also replaced the 1.25" visual back with a 2" unit because I sometimes view with a heavy Denkmeier binoviewer and the larger circumference of the 2" back provides a more secure fit. Larger Maks are very heavy because of the thick corrector plate but the 5" is easily carried with one hand. I once observed with a 20-inch Mak in an observatory in Arizona, said to be the third-largest in the world. It had a 600-lb. counterweight! The scope at the Stamford Observatory was a 22-inch Mak, the second largest in the world. It has been decommissioned and apparently was moved to New Mexico. Somewhere out there, possibly in South America, there is said to be a 24" Mak. Big Maks are very hard to bring to thermal equilibrium.

In mid-August I took the scope out in front of my house for a look at Jupiter and Saturn. My tree-filled neighborhood doesn't have good exposure to the south, but there is a 10-degree opening through which the planets would pass that night. Using a non-motorized alt-az mount and a laser for a finder, it was easy to get each planet in the field with a 26-mm Meade Plossl (59x, 1° field) and then switch to a 9 mm Televue Nagler T6 (171x).

In spite of the two planets being only 25° or so above the horizon, there was a lot of detail. A shadow transit of Ganymede had just begun, the moon's umbra a sharp black dot over the western side of the North Equatorial Belt. Io was just off the western limb, close to the equator, and as I watched it slowly merged with the planet, remaining visible for a while as a pearly orb just inside the limb until it finally was swallowed by the planet's face. The Red Spot was transiting, and was easily visible if you knew what you were looking for.

Saturn was its usual wonderful, improbable self. The Cassini Division came and went in the variable low-altitude seeing, but when it was sharp it was very black and fully circumferential. Two bands on the planet's face were easily seen, as was the shadow on the back of the rings. Three moons were visible, and if I could have somehow turned off the accursed LED street light that was just 20 yards east of my observing position, I would have dark adapted better and perhaps picked out another moon or two.

If you are looking for a planetary or lunar scope and can't afford a fine (and big) apo refractor, consider a 5- or 6-inch Mak. ■

Member Profile: Deidre Raver

Home town: Yorktown Heights

Family: 2 dogs, 5 cats and 2 parrots

How did you get interested in astronomy? When I was very young, my father used to show us the constellations and we had a small telescope.

Do you recall the first time you looked through a telescope? What did you see? The first time I looked in a telescope as an adult was at Lake Taghkanic State Park. My nephew helped me put my new Orion Intelliscope together and someone lent me an eyepiece. With some help pointing in the right direction, I saw Saturn over the lake.

What's your favorite object(s) to view? Jupiter

What kind of equipment do you have? Orion 8-inch Dobsonian, Meade 8-inch Lightswitch 8, Antares 105-mm refractor.

What kind of equipment would you like to get that you don't have? When I retire soon, I would like to get 3-D binoviewer.

Have you taken any trips or vacations dedicated to astronomy? My favorite astronomy trip was to Astronomy Camp at Medomak in Maine.

Are there areas of current astronomical research that particularly interest you? I am especially interested in studies researching light emitted from other planets that might have life, and the recent Hubble telescope discoveries such as "Cotton Candy Planets." I am very interested in the study of radio signals in space, including research on radio beams from pulsars and possible signals that may be coming from intelligent life.

Do you have any favorite personal astronomical experiences you'd like to relate? I used to go to Fahnestock State Park by myself and lock myself in there just so I could figure out what I was doing without help. I would be there in the dark, hearing animals in the woods. I was pretty isolated and I started wondering if this was the hobby for me. Then, one night I was surprised when two amateur astronomers from NYC by showed up, leaving the gate open. I observed with them and that was when I recognized how much fun observing can be and how much drive and passion can be involved in this hobby.

What do you do (or did you do, if retired) in "real life"? I am a high school math teacher in NYC who also coaches a robotics team. I am also a retired army reserve Lieutenant Colonel.

Have you read any books about astronomy that you'd like to recommend? *Turn Left at Orion*. This book is not only useful for beginners, but for those seeking to know what they should be looking for.

How did you get involved in WAA? I researched local astronomy clubs and dragged my new telescope to a star party at Ward Pound Ridge Reservation.

What WAA activities do you participate in? I have attended Star Parties and a club picnic. I was encouraged to attend a Rockland Star Party in the Berkshires with other WAA members.

If you have a position in WAA, what is it, what are your responsibilities and what do you want the club to accomplish? I am an Advisory Board member. My goal is to support more events. I want the club to get as many people involved as possible. I find that people really want to show up and experience meet-ups with viewing through member scopes.

Provide any other information you think would be interesting to your fellow club members, and don't be bashful! When I was a teenager, I saw a UFO and was fascinated by what it could possibly be. There were some stunt pilots that ended up on *Unsolved Mysteries* but this was something different. ■

September Deep Sky Object of the Month: Messier 56

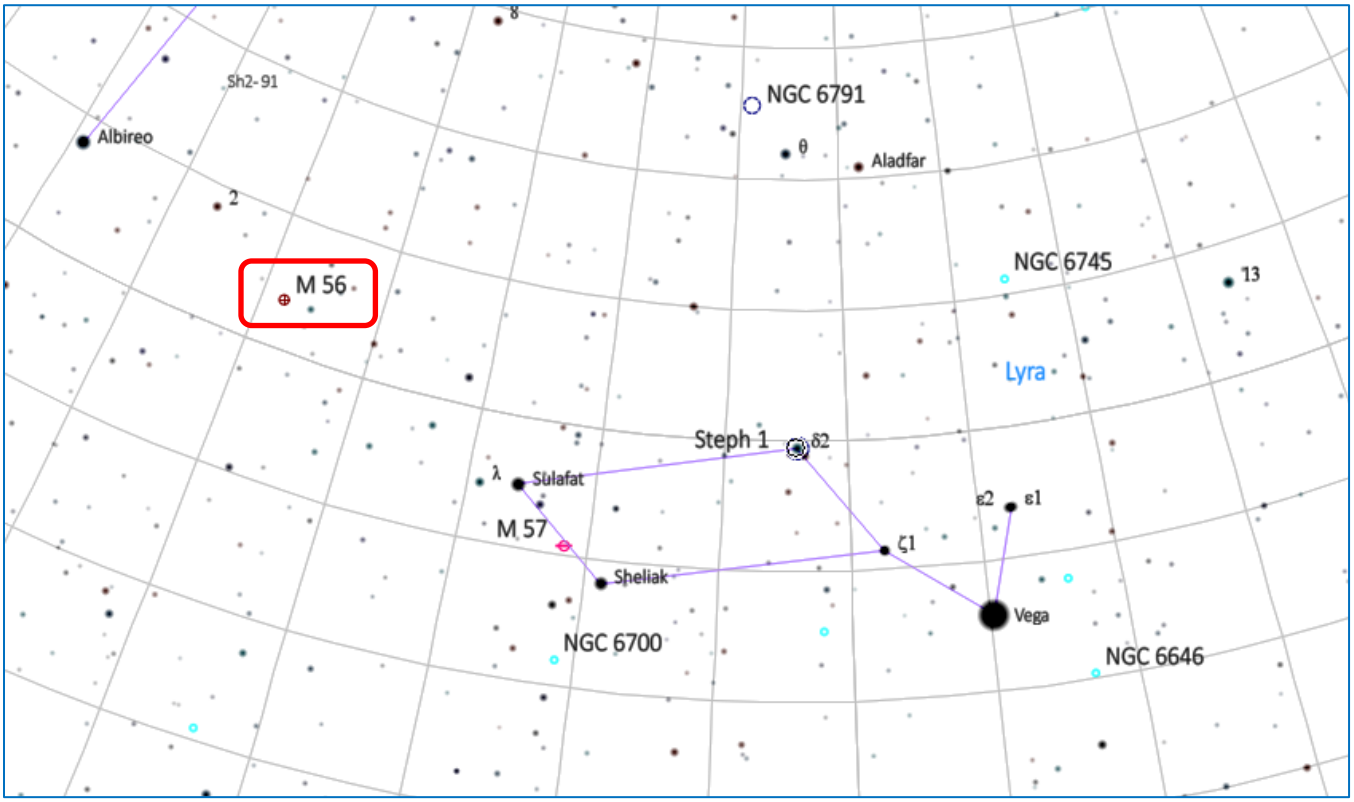
Messier 56	
Constellation	Lyra
Object type	Globular Cluster
Right Ascension J2000	RA: 19h16m 36.0s
Declination J2000	DE:+30°11'00"
Magnitude	8.3
Surface brightness	12.0 mag/arcmin^2
Size	5' arcminutes
Distance	32,900 LY
NGC designation	NGC 6779

Visibility for September			
10:00 pm EDT	9/1/20	9/15/20	9/30/20
Altitude	76° 54'	68° 44'	58° 03
Azimuth	215° 22	245° 56'	261° 52

Messier first noted this globular cluster on January 19, 1779. Since it's within in the Summer Triangle and not far from Albireo, he must have been observing just before morning twilight in Paris to be able to see it, low in the east. Messier's telescopes were small (4 inches or less, and with imperfect optics), but central Paris in those days was a lot darker than Ward Pound Ridge Reservation is today.

M56 is old, as evidenced by the low metallicity of its stars, and it's in retrograde orbit around the Milky Way. It may have been part of a satellite galaxy that was captured by the Milky Way. Omega Centauri might be the core of that object.

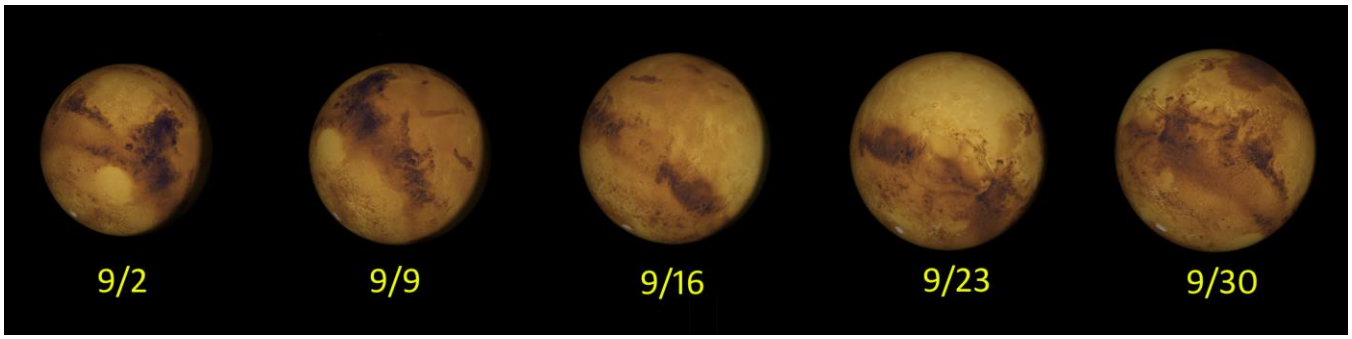
M56 has fairly high surface brightness, as would be expected of a globular cluster, so it ought to be visible in telescopes as small as 80 mm (about the size Messier used) if transparency is good. While you are in the celestial area looking at the Ring and Albireo, see if you can spot this cluster.



Observing Mars in September 2020

The Red Planet's closest approach will be on October 6th and interest in viewing the disc will grow as the time approaches and publicity increases. You'll want to start looking in September (if you haven't already). We prepared this table to show you Mars's elevation at 10:00 p.m., a convenient time for after-dinner viewing (but not great early in the month), and the time of night it crosses the meridian and is highest in the sky later that same night (nominally the next day). That's when our atmosphere will be the "thinnest" so seeing will be better.

Date	Day	Magnitude	Diameter (arcseconds)	Illumination	Elevation at 10:00 p.m. EDT	Meridian Transit (Mars at highest altitude, 180° S)
9/1/2020	Tue	-1.8	18.9	0.92	+04°31'	3:55 a.m.
9/2/2020	Wed	-1.8	19.1	0.92	+05°11'	3:52 a.m.
9/3/2020	Thu	-1.9	19.2	0.92	+05°51'	3:48 a.m.
9/4/2020	Fri	-1.9	19.4	0.93	+06°32'	3:44 a.m.
9/5/2020	Sat	-1.9	19.5	0.93	+07°14'	3:41 a.m.
9/6/2020	Sun	-1.9	19.7	0.93	+07°56'	3:37 a.m.
9/7/2020	Mon	-2.0	19.8	0.93	+08°39'	3:33 a.m.
9/8/2020	Tue	-2.0	19.9	0.94	+09°22'	3:29 a.m.
9/9/2020	Wed	-2.0	20.1	0.94	+10°06'	3:25 a.m.
9/10/2020	Thu	-2.0	20.2	0.94	+10°50'	3:21 a.m.
9/11/2020	Fri	-2.1	20.4	0.94	+11°35'	3:17 a.m.
9/12/2020	Sat	-2.1	20.5	0.95	+12°20'	3:13 a.m.
9/13/2020	Sun	-2.1	20.7	0.95	+13°06'	3:09 a.m.
9/14/2020	Mon	-2.1	20.8	0.95	+13°53'	3:05 a.m.
9/15/2020	Tue	-2.1	20.9	0.95	+14°40'	3:01 a.m.
9/16/2020	Wed	-2.2	21.1	0.96	+15°27'	2:56 a.m.
9/17/2020	Thu	-2.2	21.2	0.96	+16°15'	2:52 a.m.
9/18/2020	Fri	-2.2	21.3	0.96	+17°03'	2:47 a.m.
9/19/2020	Sat	-2.2	21.4	0.96	+17°52'	2:43 a.m.
9/20/2020	Sun	-2.3	21.5	0.97	+18°41'	2:38 a.m.
9/21/2020	Mon	-2.3	21.7	0.97	+19°30'	2:34 a.m.
9/22/2020	Tue	-2.3	21.8	0.97	+20°20'	2:29 a.m.
9/23/2020	Wed	-2.3	21.9	0.97	+21°10'	2:24 a.m.
9/24/2020	Thu	-2.4	22.0	0.98	+22°01'	2:20 a.m.
9/25/2020	Fri	-2.4	22.0	0.98	+22°52'	2:15 a.m.
9/26/2020	Sat	-2.4	22.1	0.98	+23°43'	2:10 a.m.
9/27/2020	Sun	-2.4	22.2	0.98	+24°34'	2:05 a.m.
9/28/2020	Mon	-2.4	22.3	0.98	+25°25'	2:00 a.m.
9/29/2020	Tue	-2.5	22.3	0.99	+26°17'	1:55 a.m.
9/30/2020	Wed	-2.5	22.4	0.99	+27°08'	1:50 a.m.
10/1/2020	Thu	-2.5	22.4	0.99	+28°00'	1:45 a.m.



View of Mars at meridian transit on the dates indicated. Relative sizes are accurate. (Made with Cartes du Ciel)

The disc will be 100% illuminated between October 6th and October 22nd. The planet's apparent diameter will be 22.0 arc-seconds or larger between September 24th and October 18th, so optimal viewing and imaging will be during that period, later in the night on the earlier dates.

Some Mars Viewing Tips

If you can go to the top of a mountain in clear dry weather conditions, you will have the best view (true for observing in general, of course). Schlepping your equipment to a mountain in Colorado or Arizona is probably not feasible this year, but if you're willing to go for it, I like Camp Hale in the Colorado Rockies, on US 24 just north of the Tennessee Pass.[2] It's flat, pitch black and 9,200 feet in elevation. By late September there may be some snow there, however. You'd have to camp, have an RV or drive to Vail, Avon (north) or Leadville (south) for accommodations.

Closer to home, Bailey Benchmark, at an elevation of 980 ft. (299 m.), is the highest point in Westchester County, NY. It is located within the Sal J. Prezioso Mountain Lakes Park in North Salem, NY, very close to the Connecticut state line. It's also on a hiking trail in the middle of a forest, so not good for observing. The Meadow Parking Lot at Ward Pound Ridge Reservation is at an elevation of about 300 feet, and less than five miles from North Salem.

The presence of the Moon in the sky is never a problem for viewing the bright planets, so you can observe on any reasonably clear night. Light pollution is also less of an issue.

Setting up on grass is preferable to a paved surface since there is more heat rising from the concrete or asphalt, creating disruptive thermals. Similarly, viewing over roofs adds more atmospheric heat cells in your line of sight, but may be hard to avoid. Also, check the weather report to see if the jet stream is going over our area. That usually impairs seeing. Because of the effect of the atmosphere on seeing, you need to be patient at the eyepiece and catch the rare, precious moments of steady seeing.

Your telescope should come to thermal equilibrium, which depends on the type of scope, size and the temperature difference between where it was stored and where you are observing. Be patient! For reflectors and SCT's, accurate collimation maximizes planetary detail. Dew heaters are a good idea unless the dew point is really low.

The maximum useful magnification depends on many factors, so have a range of eyepieces and perhaps a Barlow available. The image looks sharper at lower magnification, but you'll have to find your "sweet spot" between size and resolution of surface features.

Filters help when viewing Mars.

- An orange or red filter will lighten the desert regions and darken the rest of the planet and so is most useful for viewing surface markings. We like the Orange #21 (46% transmission) for general use on Mars. A light red filter (#23A, 25% transmission) is even better but will need more aperture, and the deep red (#25, 14% transmission) gives the most contrast but you will need at least 8 or 10 inches of aperture, since you are effectively dropping your telescope's speed by three f-stops with a #25, and that's a lot of light loss.
- A green filter (#56, 53% transmission or #58, 24% transmission) will enhance the overall contrast of the image and help with the polar caps.
- A blue filter (#82A, 73% transmission, #80A 29% transmission) can also enhance the icecaps.

If you are showing Mars to other people, be sure to encourage them to look for at least a couple of minutes and wait for those brief moments of clarity. Beginners, especially children, tend to look for two seconds, see a fuzzy orange ball and then if you ask them "Did you see it?" they say "Yes," not wanting to disappoint you. Some years ago at a Quaker Ridge School outreach program, Mars was in a good position. I sat next to the scope and talked each viewer, adult or child, through the observation, saying "Keep looking…wait for the view to settle…it will just be an instant and you'll see the polar cap…you'll see markings on the surface…wait for it…wait for it…" And each one, after 30 or 40 seconds, burst out with and excited "I see it!!" And they really did.

Clean your eyepieces with 91% alcohol between users! —LF

[2] See the August 2010 SkyWAAtch for more about Camp Hale.

The Great Mars Hoax Redux — Anne Burns

A favorable opposition of Mars is coming, and once more the Great Mars Hoax is circulating on the Internet! We are being told, with the aid of some pretty Photoshopped pictures, that Mars will have its closest approach to Earth in 50,000 years on August 27, 2020 and will look as large and bright as the full Moon.

This misunderstanding dates back to August of 2003, when Mars did in fact have an extremely favorable opposition which coincided with its closest approach to Earth. Here's an excerpt from the original news story (from Snopes.com):

> The encounter will culminate on August 27 [2003] when Mars comes into within 34,649,589 miles for Earth and will appear (next to the Moon) the brightest object in the night sky. It will attain a magnitude of -2.9 and will appear 25.11 arc-seconds wide. *At a modest 75-power magnification* Mars will look as large as the full Moon [does] to the naked eye.

According to Snopes, the crucial phrase I've italicized was dropped when the story was transcribed, leading the unwary reader to think that Mars would look as large as the full Moon to the naked eye. Of course, if it ever did we'd be in a whole lot of trouble, as it would be either on a collision course with Earth, or about to pass us so closely that the gravitational force would probably rip both planets apart.

Several of us were at the Bowman Observatory the night of the 2003 opposition, and Mars was in fact very bright and quite spectacular through the telescope. One interesting feature was that at midnight, the planet lost its usual reddish color and became bright white, like the full Moon. However, to the naked eye it still looked like a large dot.

These stories, which seem to surface whenever Mars is having a favorable opposition, must assume that Mars is always at opposition on August 27. For that to occur, Mars would either have to be stationary in its orbit – which doesn't happen to any object in the solar system, or anywhere else – or else it would have to match Earth's orbit exactly, in which case it would be constantly at opposition!

An opposition occurs when the Sun, Earth and one of the outer planets line up in a straight line. As seen from Earth, a planet at opposition acts like the full Moon; it rises at sunset, crosses the north-south meridian at midnight, and sets at sunrise. Most outer planets (Jupiter, Saturn, et al.) have an opposition every year, because they move so slowly in relation to the Earth. Jupiter, for instance, takes almost 12 Earth years to complete one orbit, so Earth passes it about every 13 months, like a race car on a circular track "lapping" a slower-moving car.

Mars, however, is closer and moves faster in relation to Earth; the Martian year is 687 Earth days long, or about 1.9 Earth years. So Mars only has an opposition about every 26 months. Most of the time Earth is slowly catching up with Mars, slowly passing it, or slowly leaving it behind. This is why Mars lingers for months in either the morning or evening twilight.

Also, not all Mars oppositions are "favorable," that is, coinciding with Mars's closest approach to Earth. If, for instance, Mars is at aphelion (its farthest distance from the Sun) when Earth passes it, it will be a lot farther away and thus small and dim. Favorable oppositions happen only every 15-17 years, and are much anticipated by astronomers hoping to study the red planet in more detail.

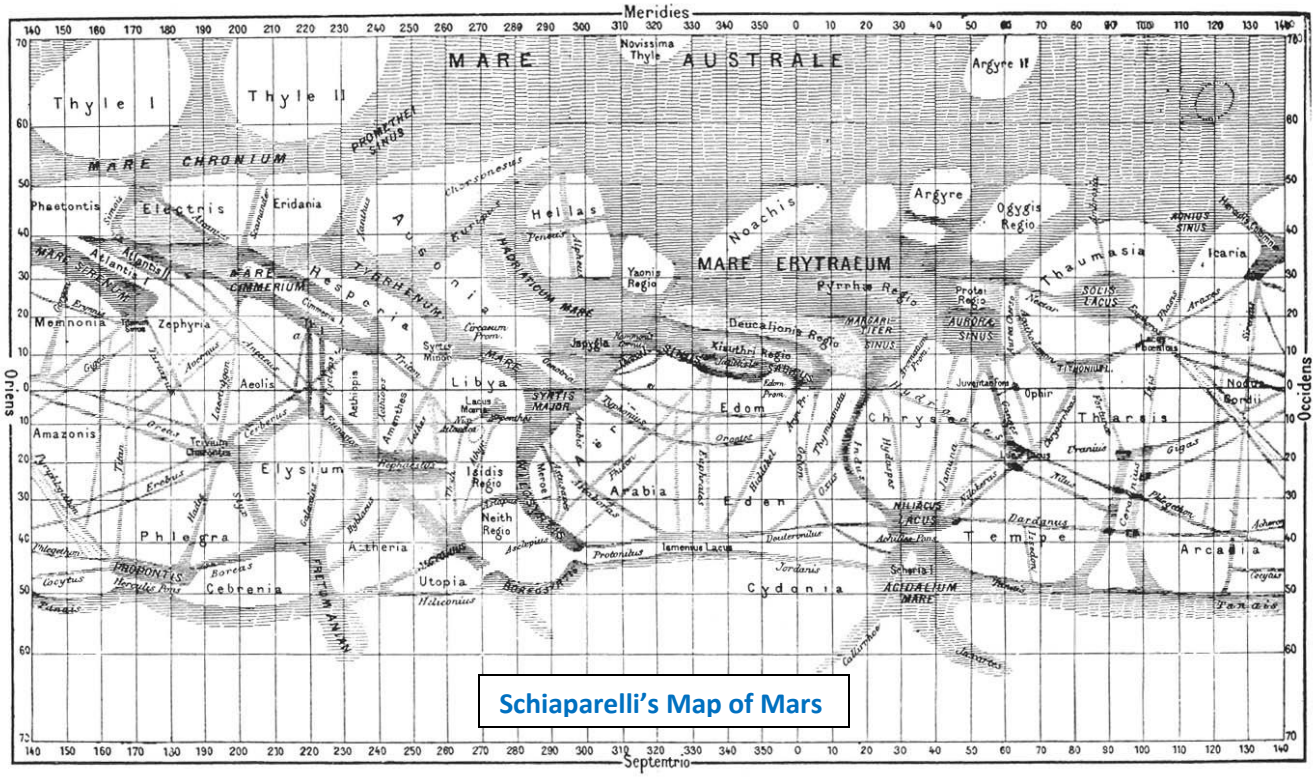
In 2020, Mars will have its closest approach to Earth at 10:19 a.m. EDT on October 6, and opposition will occur on October 13 at 7:20 p.m. It will be very bright at magnitude -2.6 – but definitely NOT the size of the full Moon! The next favorable opposition will occur in 2035 – 15 years from now, rather than 50 thousand.

So, if you know anyone who's over-excited about this, please set them straight - and encourage them to turn their telescopes or binoculars on Mars in October to see a beautiful sight – which will NOT look like this!

Anne Burns is President of the Astronomical Society of Greenwich and a member of WAA.

Victory over the Martians

Larry Faltz



> "No one would have believed in the last years of the nineteenth century that this world was being watched keenly and closely by intelligences greater than man's and yet as mortal as his own; that as men busied themselves about their various concerns they were scrutinized and studied, perhaps almost as narrowly as a man with a microscope might scrutinize the transient creatures that swarm and multiply in a drop of water….
>
> At most, terrestrial men fancied there might be other men upon Mars, perhaps inferior to themselves and ready to welcome a missionary enterprise. Yet across the gulf of space, minds that are to our minds as ours are to those of the beasts that perish, intellects vast and cool and unsympathetic, regarded this earth with envious eyes, and slowly and surely drew their plans against us. And early in the twentieth century came the great disillusionment."

So begins H. G. Wells's *The War of the Worlds*, perhaps the most influential science fiction novel of all time. Although many people have seen the 1953 film with Gene Barry and/or Steven Spielberg's 2005 version with Tom Cruise, fewer people these days have been exposed to Wells's refined prose. The novel was serialized in 1897 and published in book form in 1898 at a peak of public interest in Mars, in an era when many people, educated or not, believed intelligent life was residing on its surface.

Mars has played a distinct role in astronomical progress, its properties slowly being revealed as the field grew and matured. Kepler's determination in 1609 that the orbit of Mars was an ellipse was the first observational blow to the Ptolemaic model of the universe, dependent as it was on circular motion of the planets.

Galileo tried to see phases on Mars in 1610 after he had found them on Venus. With his crude optics he could only vaguely perceive changes in its diameter. It wasn't until 1645 that Johannes Hevelius was able to observe Mars in a distinct gibbous phase.[3] Albedo variations on the surface were noted by Riccioli and Grimaldi in the 1650's, but the first true observation of a surface feature was by Christiaan Huygens, the great Dutch lens maker and discoverer of Saturn's moon Titan. On November 28, 1659, he described what we now call Syrtis Major. He roughly determined Mars's rotation period and guessed that the planet was 60% of the Earth's diameter, not far from

[3] Mars's smallest phase, at quadrature, is about 84%.

the actual value of 53%. In 1666 Giovanni Domenico Cassini saw the south polar cap and also refined the rotational period to 24 hours, 40 minutes, just 25 seconds longer than the currently accepted value.

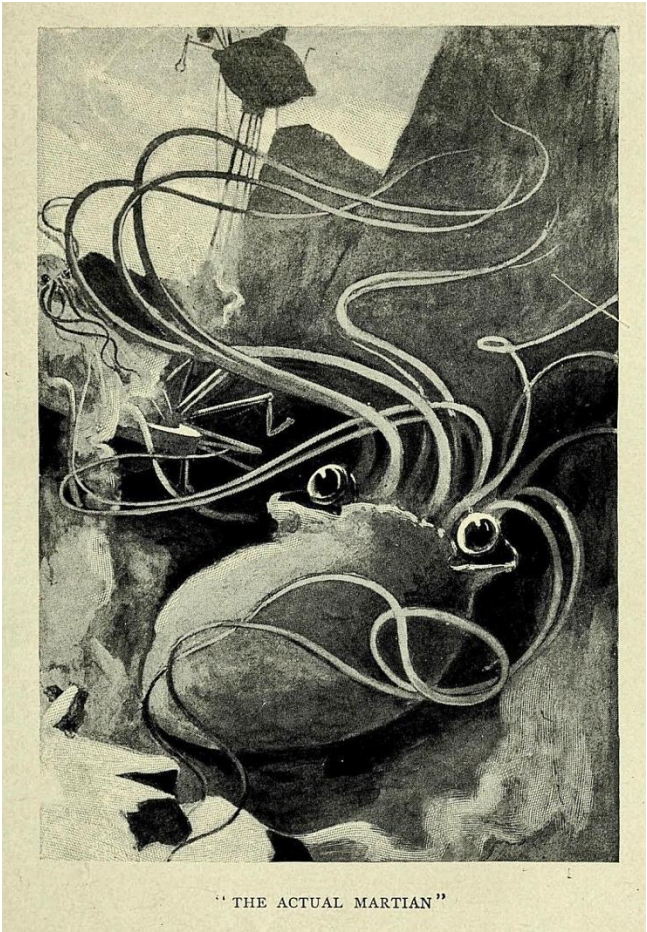


Illustration by Warwick Goble for the original serialization (1897) of *The War of The Worlds*

Mars was closely observed over the next century during its biennial close approaches. William Herschel began observing it in 1777. He saw that the polar caps varied in size with the seasons and suggested that they were made of water ice. He also determined the planet's orbital tilt to be 28.5 degrees, only a bit higher than the actual value of 25.19 degrees, impressive considering he was observing with his "7 foot" telescope, a 6" speculum-metal reflector. With his larger telescopes, Herschel noted changes in surface features, believing they were caused by vegetation varying with the seasons. He also claimed that Mars had a "considerable but moderate atmosphere, so that its inhabitants probably enjoy a situation in many respects similar to ours." Herschel's observations, which were reported to the Royal Society, strongly supported the idea of life on Mars. At that time it was a common belief that the planets harbored intelligent beings.

The achromatic doublet lens was invented by Chester Moore Hall around 1730. Joseph Frauenhofer improved the manufacture of glass and developed a better achromatic lens design that enhanced planetary resolution and contrast. Frauenhofer delivered a 17.5-cm diameter refractor to the Capodimonte Observatory in Naples in 1814 and then provided the famous 24-cm "Great Refractor" to the Dorpat Observatory in Estonia in 1826. With these and progressively larger instruments Mars was obsessively observed throughout the 19th century. Astronomers drew maps of its surface with ever-increasing detail.

During the particularly favorable opposition in 1877 Asaph Hall discovered Mars's two moons, Phobos and Deimos, with the 26-inch Alvin Clark refractor at the U.S. Naval Observatory in Washington, D.C.[4]

Giovanni Schiaparelli (1835-1910), who like Mark Twain was born and died in the years of Halley's Comet, was director of the Brera Observatory in Milan starting in 1860. The main instrument at Brera was a 218-mm (8.6-inch) Mertz refractor, ordered in 1862 and finally erected in 1874. Observing Mars during the 1877 opposition, Schiaparelli drew the first really detailed map of the planet, describing a series of straight lines on the surface, which he called "canali," meaning "channels" but famously mistranslated into English as "canals." Although many other astronomers did not see them, or only glimpsed doubtful hints during rare moments of steady seeing, others confirmed the observations. The influential French astronomer Camille Flammarion, who was to late 19th-century astronomy what Harlow Shapley was to astronomy in the 1930's and 40's and Neil deGrasse Tyson is today, wrote a book in 1892 about Mars (*La planète Mars et ses conditions d'habitabilité*) that further developed the "canal" thesis, claiming that the channels were made by an intelligent race needing to redistribute water from the polar

[4] It was the world's largest refractor from 1873-1883. I had a spectacular look at Jupiter through this telescope (complete with a moving observatory floor for optimal eyepiece positioning) in 1975. The Vice President's residence is on the Naval Observatory campus; tours are very infrequent and are suspended during the pandemic.

caps to a parched Mars suffering from irreversible drought. He even suggested that the Martians are more technologically advanced than Earthlings.

Percival Lowell (1855-1916), was not an astronomer by training or vocation, although he had a degree in mathematics from Harvard and had given a well-received speech about the nebular hypothesis. After reading Flammarion's book, he caught the Mars bug and used his considerable fortune to establish an observatory in Flagstaff, Arizona in time for the 1894 opposition. Eventually installing a 24-inch Clark refractor, he saw the canals. He made maps and wrote three books about the planet: *Mars* (1895), *Mars and Its Canals* (1906), *Mars As the Abode of Life* (1908).

7-inch hand-colored globe of Mars by Ingeborg Brun in the National Maritime Museum, Greenwich, UK

Ten small globes (5.5 to 9 inches in diameter) were hand-made from Lowell's map by Danish amateur astronomer, socialist and institutionalized mental patient Ingeborg Brun (1872-1929).[5] She inscribed the socialist slogan "Free Land, Free Trade, Free Men" on the base of each example. The saying was inspired by the writings of political economist Henry George. Socialist utopians of the period thought that Mars could be the ideal place to establish a new, egalitarian society. Brun gave one of her globes to Flammarion, and sent one to Lowell in 1915. It was initially stopped at customs because it was mistaken for a bomb. Lowell wrote Brun that it was "a capital piece of work." The globes are slightly peculiar in that they show the Martian south pole at the top, probably because that's the way the planet would appear in a refracting telescope (without a diagonal). Daniel Crouch Rare Books (London & New York) has both an 8.25-inch and a 5.5-inch diameter Brun globe for sale, with asking prices of £60,000 and £40,000 respectively. I was lucky to get a close-up look at these globes at Crouch's display at the 2019 Armory Antiques Show, and they are exquisite even if they only show a fantasy world. An 8.25" Brun globe sold for $50,000 at a Bonham's auction in 2012.

By 1909, the reality of the canals had faded, the final touch being observations by Eugène Antoniadi with the *Grande Lunette* at Meudon, a 32-inch refractor, then the third largest in the world. With exceptional transparency and seeing during a close opposition (the planet was 24.0" in diameter on September 18, 1909), the canals disappeared. Even Lowell had trouble visualizing them at Flagstaff by then, but he never lost his belief in a Martian civilization.

H. G. Wells was cognizant of all the scientific trends of his time, not just astronomy. His background was in biology and he was an ardent Darwinian. Many of his stories and novels have, at their core, a biologic theme. *The War of the Worlds* was born out of the problem of colonialism (Wells and his brother had discussed the catastrophic impact of the British on indigenous Tasmanians) but has a biologic resolution, Earthly microbes defeating the otherwise unstoppable invaders.

The observational background that Wells evokes fits perfectly well with the astronomy of the day.

> Men like Schiaparelli watched the red planet—it is odd, by-the-bye, that for countless centuries Mars has been the star of war—but failed to interpret the fluctuating appearances of the markings they mapped so well. All that time the Martians must have been getting ready.
>
> During the opposition of 1894 a great light was seen on the illuminated part of the disc, first at the Lick Observatory, then by Perrotin[6] of Nice, and then by other ob-

[5] At least 5 different globes based on other maps were manufactured between 1873 and 1903. See https://tinyurl.com/MarsGlobes

[6] Henri Joseph Anastase Perrotin (1845 –1904)

> servers.… As Mars approached opposition, Lavelle[7] of Java set the wires of the astronomical exchange palpitating with the amazing intelligence of a huge outbreak of incandescent gas upon the planet.... The spectroscope, to which he had at once resorted, indicated a mass of flaming gas, chiefly hydrogen, moving with an enormous velocity towards this earth.…

Wells's novel is harrowing, and the various retellings portray the vast power of the Martian invaders and the utter terror and hopelessness of their victims. The famous Mercury Theater radio broadcast was sprung on an unsuspecting public on Sunday, October 30, 1938, creating nationwide panic. Its impact was surely amplified by the absence of any visual clues to the nature of the invasion, making listeners conjure up images of the Martians and their weapons from the meager descriptions of a terrified correspondent and their own inchoate fears. We can't get that feeling now because we know it's fiction (and we know the Earth wins). If only for historical reasons, it's worth an hour of your time to listen to the broadcast if you haven't already had the experience.[8]

Both the 1953 and 2005 movie versions take liberties with the plot, relocating the action to California or New York respectively[9] and updating the action to contemporary times. The 1953 version even has the Martians using flying machines to shoot their Heat Rays rather than Wells's giant tripods.

A remarkable cinema version of the tale was released in 2012. *War of the Worlds: The True Story*, puts the action back where and when it was supposed to have occurred: in 1900 and in the southwestern suburbs of London. Woking, where Wells lived and wrote, is the first town to be destroyed by the invaders. To commemorate the hundredth anniversary of the novel's publication in book form, in 1998 the town erected a 23-foot tall replica of a Martian tripod. Not only that, this really is the true story, since the entire script is taken verbatim from the novel (with editing, but no added language). The novel's first-person narrative lends itself to a wonderful conceit in this version: it is set as a 1965 interview with the "last survivor" of the 1900 Martian invasion, one "Bertie Wells," with his verbal descriptions illustrated by filmed sequences.

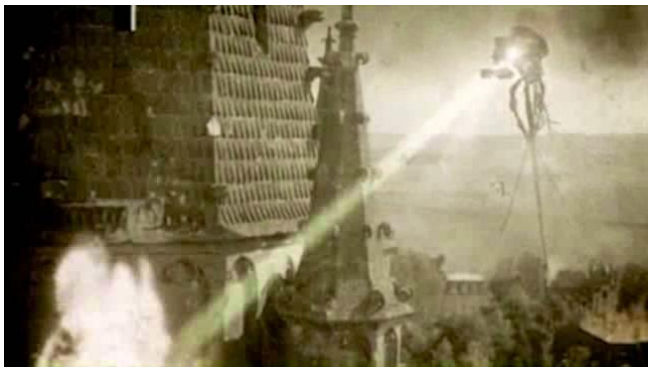
[7] Fictitious.

[8] https://orsonwelles.indiana.edu/items/show/1972

[9] The 1938 radio broadcast also relocates time to "now" and the action to Grover's Mill, New Jersey, a real place.

The Martian capsule

We saw the film listed on Amazon Prime, and with plenty of pandemic time on our hands, we watched it one evening at the end of July. As soon as I heard the first words spoken by "Bertie," "No one would have believed in the last years of the nineteenth century that this world was being watched keenly and closely by intelligences greater than man's…" I knew we would be hearing H. G. Wells's voice[10] and not that of some Hollywood screenwriter.



The Martian Heat Ray destroying Woking

The film took three years to make. It incorporates a vast amount of early 20th-century film footage, breathlessly edited, including film from World War I, to document the horrific carnage inflicted by the invaders. Some scenes were shot with actors (filmed near Seattle) in a way that makes everything look as if it was original. You are effectively transported to the time and place of the original story. Whatever is needed, fleeing crowds, crying children, Martian death machines, or people being vaporized, is cleverly incorporated into the archival footage. It's hard to tell what's old and what's new, which is exactly the desired effect.

[10] He was, as you might have guessed, called "Bertie" by his friends and family.

The narration, and the occasional dialogue between characters, uses only Wells's clear yet graceful prose. This pays homage to the novel as well as really being "The True Story." It doesn't have Cruise's scenery-chewing acting (thankfully), and the special effects aren't the slick, CGI extravaganzas of Hollywood blockbusters, but they are creative, reinforcing the conceit that we are seeing exactly what the survivor saw. It is as Wells intended: traumatic and desperate. As in the novel, there's no chit-chat, verbal byplay or jokes. There's only one bit of humor, held until the credits, when we are told that that Bertie Wells and his wife, who are reunited at the end of the story, emigrated to the United States in 1936, settling in Grover's Mill, New Jersey. An homage to an homage.

The alien tripods move on to Shepperton

The Martian invasion theme has had other cinematic representations, some serious, some not. *Invaders from Mars*, also from 1953 with a remake in 1986, allows a young boy to overcome adult skepticism and heroically thwart the evil Martian invaders who are trying to conquer the Earth through mind control. Tim Burton's celebrity-laden *Mars Attacks!* (1996) is a send-up of alien invasion movies with mostly clueless humans and ruthless but funny aliens. They are defeated only because their heads explode inside their helmets when they hear country singer Slim Whitman's recording of "Indian Love Call," his (nauseating) yodeling version of a song written in 1924 by Rudolf Friml for the operetta *Rose Marie*, later popularized in the 1936 movie version with Nelson Eddy and Jeanette MacDonald. I have to admit I rather enjoyed the way *Scary Movie 4* mocked the Spielberg version of *War of the Worlds,* but I'm a sucker for all those silly Zucker-Abrahams parodies and horror movie spoofs (although I think horror movies themselves are stupid, but good comedy is never stupid).

A Martian in *Mars Attacks!*

In 1906, the English naturalist and polymath Alfred Russel Wallace, who had independently conceived of evolution at the same time as Darwin, was asked to write a review of Lowell's books. His review grew into a short book, *Is Mars Habitable?* (1907). Wallace states that the mean temperature on Mars, based on its distance from the Sun, should be minus 35° F, and so liquid water, a necessity for life, is "non-existent." Wallace concludes, "Mars, therefore, is not only uninhabited by intelligent beings such as Mr. Lowell postulates, but is absolutely UNINHABITABLE." By 1924, new observations showed that although there were a few places where surface temperatures might rise above freezing for a brief time, Mars was a very cold and dry place. Mariner 4 in 1964 confirmed the arid, frigid, asphyxiating conditions on Mars and that killed any notion that intelligent life could thrive there. Since Mercury (on its sunward side) and Venus are too hot and the outer planets too cold, every time the Earth is now invaded by aliens, the creatures come from beyond the solar system.

Wells may have intended the invading Martians to be avatars of our blacker nature, humanity's history of aggressive, selfish, technologically superior cultures obliterating indigenous peoples and trashing the environment, but the novel's epilogue speaks of a united humanity's need to protect itself. Wells offers the possibility of space travel: If the Martians can do it, so can we. In our time we routinely free ourselves from the bounds of Earth's gravity. We've explored the entire solar system and detected environments in which life is at least scientifically conceivable, even on Pluto. With all the orbiters and rovers now at or on their way to Mars, evidence of past or even present life might be found there. Fortunately, we're not going face the Heat Ray. ■

Images

Planetary Nebula Abell 39 in Hercules by Steve Bellavia

Steve Bellavia spent two full nights at Orient Point, the easternmost tip of Long Island's North Fork, to capture this very faint and rarely imaged object. Technical information on his set-up and process can be found at https://www.astrobin.com/s1qld1/.

Abell 39 is an almost perfectly spherical, low surface brightness planetary nebula (PN) in the constellation of Hercules. It catalogued in George Abell's 1966 *Catalog of Planetary Nebulae*, one of several catalogues of these objects (it is PK 047+42 in the more frequently cited catalog published in 1967 by Czech astronomers Luboš Perek and Luboš Kohoutek). Estimated to be about 6,800 light-years from Earth, it has a radius of 2.5 light-years and appears 154.8 arcseconds in diameter. Rarely glimpsed in any but the largest amateur telescopes, it might be seen using an OIII filter in a moderate (13-inch) telescope with averted vision, and continuously with direct vision in a 17½ inch scope, but it would certainly need very dark and clear skies. The central star is 15th magnitude.

The nebula was extensively studied in the late 1990's by astronomers at Kitt Peak, imaging with the 3.5-meter WIYN telescope and doing spectroscopy with the 4-meter Mayall telescope.[11] Images show some irregularity throughout the nebula, and a background galaxy can be seen through it (which is very cool!). The simple spherical shape suggested a minimum

[11] Jacoby, Ferland & Korista, The planetary nebula A39: an observational benchmark for numerical modeling of photoionized plasmas, *Astrophysical Journal* 2001;560: 272-286, on line at https://iopscience.iop.org/article/10.1086/322489/pdf

amount of interaction with the interstellar medium and similarly small effects from interior stellar winds or shocks. Abell 39 could thus serve as a model to resolve significant discrepancies in elemental abundances, which had limited the validity of then-current models of planetary nebula formation that had been derived via spectroscopy.

After presenting an extensive amount of data, the authors conclude:

> The PN A39 is a beautiful example of what a PN is supposed to look like: a nearly perfect limb-brightened circular shell with an obvious central star. Its special geometry would allow a test of various photoionization models if our spectra had gone deep enough to provide tighter constraints. Future observers may be able to test our model predictions and take advantage of the unique spherical geometry. Although we were able to reproduce the line ratios without excessive challenge, this apparently very simple nebula provided plenty of surprises to consider:
>
> 1. Galactic PN distances are always a problem. The Shklovskii[12] distance disagrees only slightly with the spectroscopic distance, but we must assume a nebular mass that is at the high end of the nebular mass distribution.
>
> 2. The presence of [Ne V][13] just outside the main nebula implies an unusual ionization structure, with a large low density extended halo. The high ionization is likely the result of the low density and resulting high-ionization parameter.
>
> 3. The "central" star is offset from the nebular center by 2". The offset does not appear to be a consequence of an interaction with the ISM. We speculate that a small asymmetric mass ejection has accelerated the star.
>
> 4. The nebula is close to, but not exactly, a uniform spherical shell. The east rim of the nebula is 50% brighter than the west rim, and irregularities in the surface brightness are evident across the face of the shell. The cause of the east-west dichotomy is not known but could be related to the offset of the central star.
>
> 5. The oxygen abundance was determined to be 3 times smaller than the ICF method would predict. This discrepancy is unexpectedly high and represents the typical uncertainty in the method when applied to a fully ionized nebula.
>
> 6. The very low surface brightness made it impossible to detect the faint emission lines that were the original motivation for this investigation.

This rarely glimpsed planetary is not mentioned in any of Stephen James O'Meara's *Deep Sky Companion* books, nor in Phil Harrington's *Cosmic Challenge*, but it does get a brief mention in Sue French's *Deep Sky Wonders*.

Abell 39 image at OIII wavelength, WIYN 3.5-meter telescope. NOAO/AURA/NSF, © WIYN Consortium, Inc.

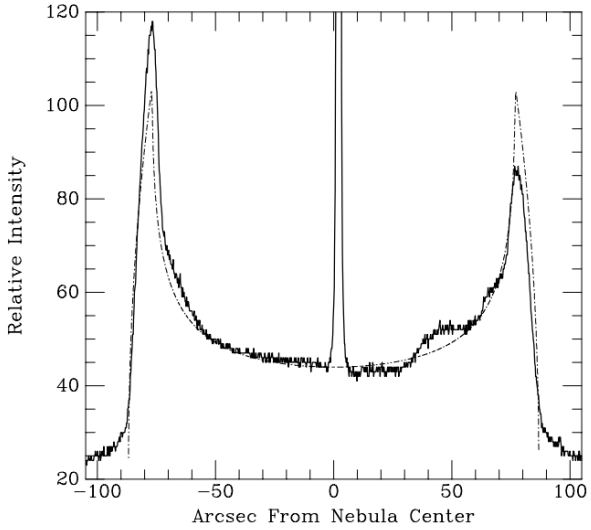
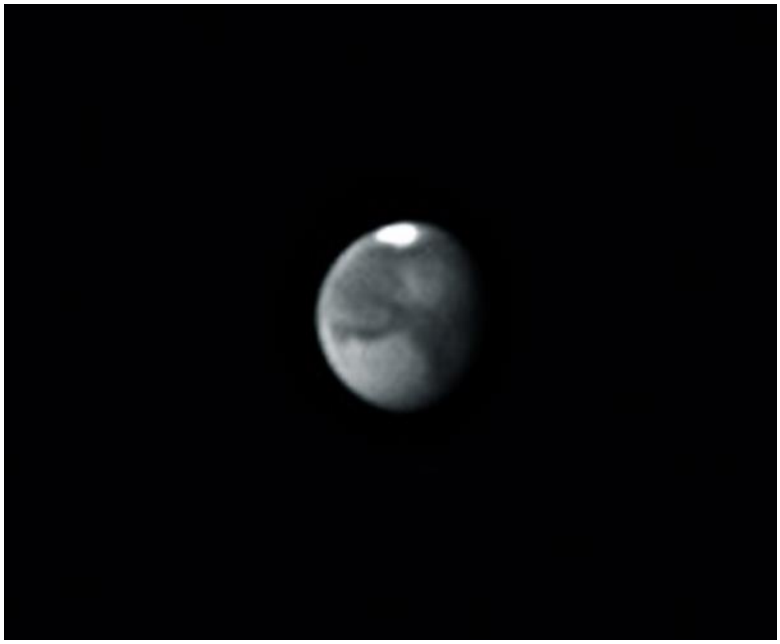


Fig. 7 from Jacoby *et. al.* Photometry across the center of Abell 39, showing the sharp peak at the central star (slightly offset from

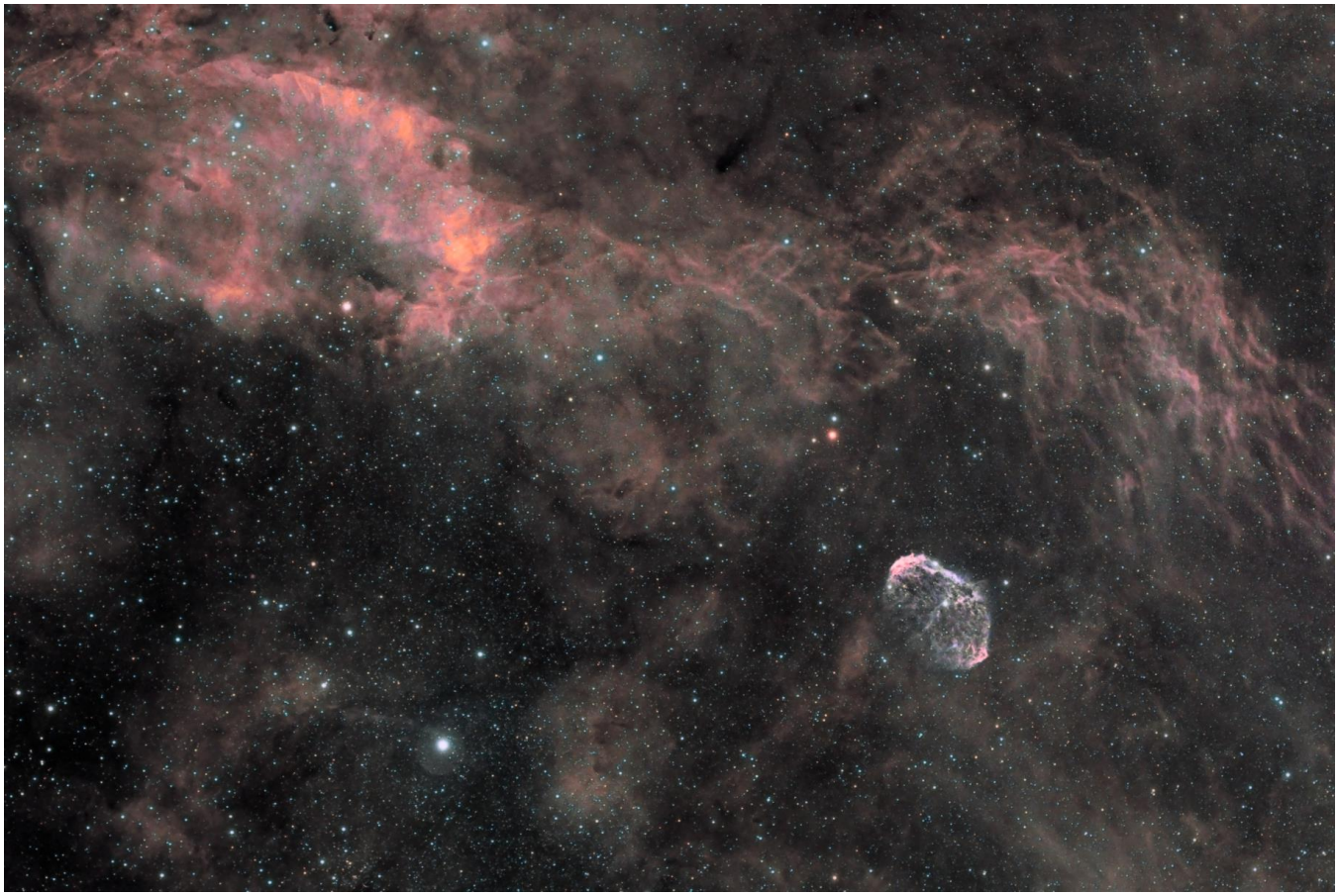
[12] Ukrainian astrophysicist Iosif Shklovskii (1916-1985) proposed that planetary nebulas were the transition stage between red giants and white dwarfs and created a distance scale for these object.

[13] The ion Ne^{+4}, with four electrons stripped away.

the geometric center and the different intensities of the rim on each side.



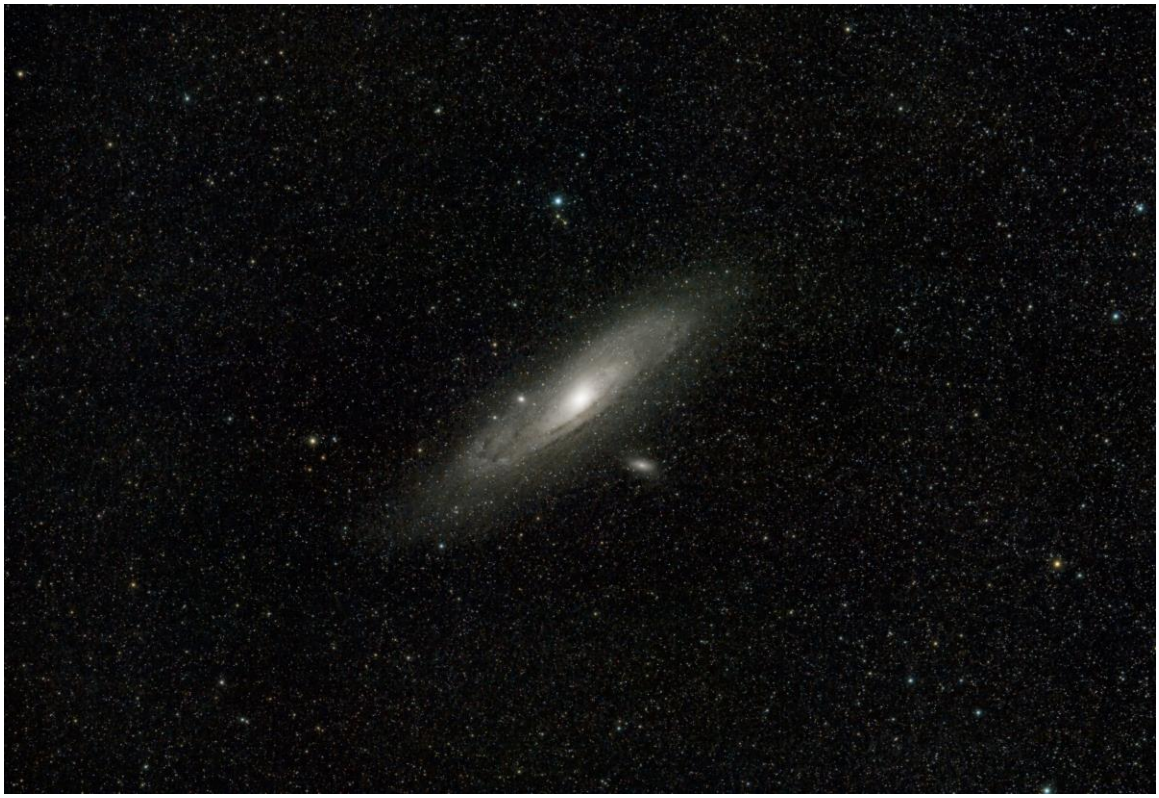
John Paladini used a 7" Orion f/15 Maksutov and ZWO ASI120MM camera for this monochrome image of Mars on July 20th. The large south polar cap is at the top. The planet was shining at magnitude -0.9, with a 13.3" disc 85.3% illuminated. Distance from Earth 65,582,000 miles.



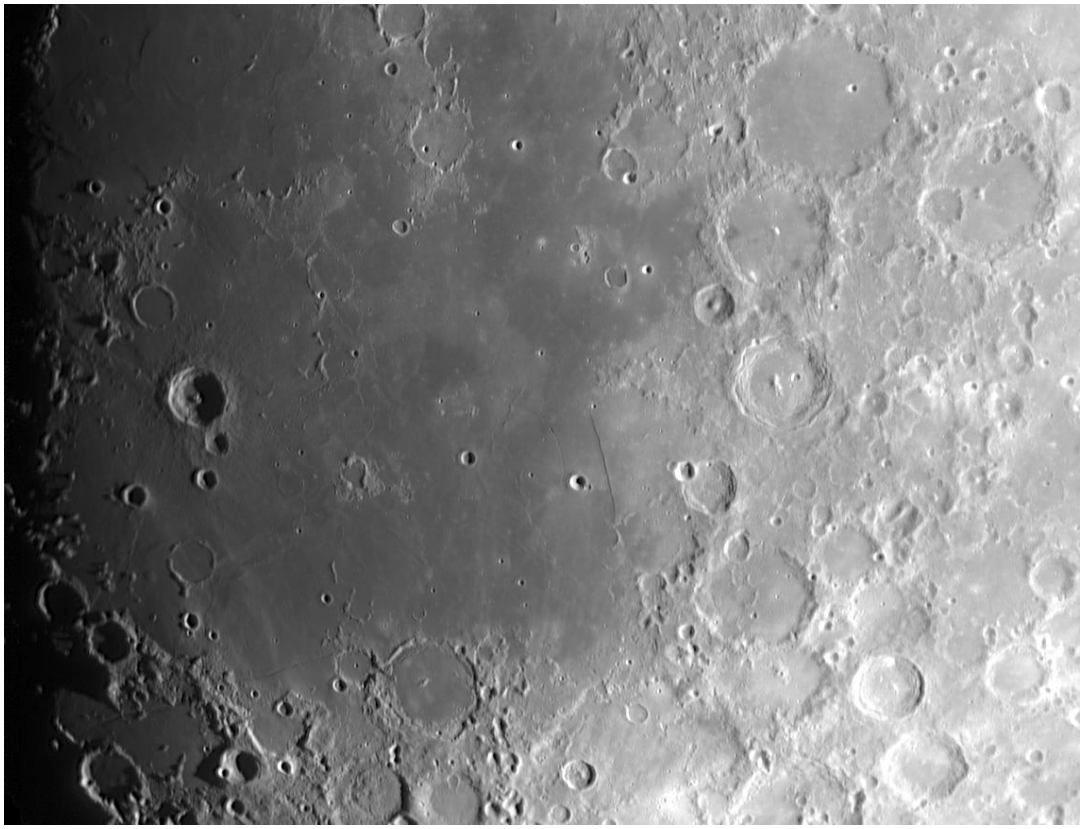
Steve Bellavia went to the very dark skies of Cherry Springs, Pennsylvania in June and captured this terrific image of NGC 6888, the Crescent Nebula in Cygnus, sitting within a larger but fainter nebula of hydrogen gas. The bright star in the lower left is the B1 star P Cygni, magnitude 4.77.

Near and Far: Two Images from Gary Miller

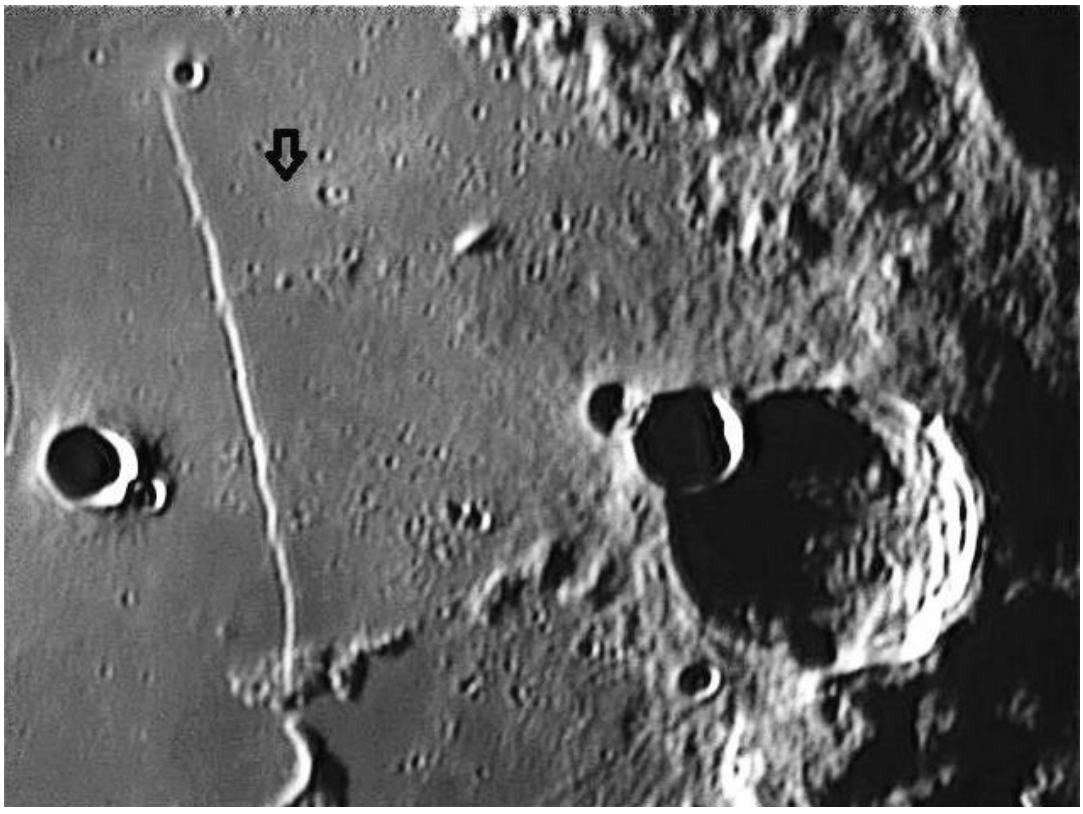
Comet C/2020 F3 NEOWISE was 5.80 light-minutes from Earth on July 20th when Gary imaged it from Ward Pound Ridge Reservation with a Rokinon 135-mm lens on a Canon DSLR. Twenty 20-second exposures.



The Andromeda Nebula, Messier 31, is attended by its two satellites, M 32 and M110. M31 is 2.54 million light-years (1.34 trillion light-minutes) from Earth. Same imaging setup, 120 x 30 sec exposures



Larry Faltz imaged Mare Nubium with a 127-mm Maksutov on May 31st (9-day Moon) when it was just east of the terminator. Bullialdus is the well-defined crater on the left. The Rupes Recta (Straight Wall) is in the center with its face in shadow. It is a fault 65 miles long and about 900 feet in height. It's not that steep: an intermediate skier could manage it, if it had snow, if you were on the Moon, if you brought your skis.



John Paladini used an 8" SCT and 2x Barlow on August 11th (22-day Moon) for this close-up of craters Thebit (R)and Birt (L) and the Rupes Recta with its face illuminated. The arrow points to a tiny nameless rille that John was excited to resolve. It's seen on this enlargement of a Lunar Reconnaissance Orbiter image.

Research Highlight of the Month

Becker, H., *et. al.*, Small lightning flashes from shallow electrical storms on Jupiter, *Nature* (2020) 584: 55-58

Lightning has been observed by a number of missions that visited or flew by Jupiter over the past several decades, with a flash rate of about 4×10^{-3} flashes per sq. km. per year. The spatial extent of flashes seen by Viking was about 30 km (half-width at half-maximum intensity, HWHM), but its cameras were unlikely to have detected the dim outer edges of the flashes, given their weak response to the brightest spectral line of Jovian lightning emission, the 656.3-nm Hα line. The spatial resolution of other cameras, particularly on Galileo, allowed confirmation of 22 flashes with HWHM greater than 42 km, and to detect one with an HWHM of 37 to 45 km. These flashes, with optical energies comparable to terrestrial "superbolts" (0.02-1.6 × 10^{10} joules), have been interpreted as tracers of moist convection originating near the 5-bar level of Jupiter's atmosphere. Previous observations of lightning have been limited by camera sensitivity, distance from Jupiter and long exposures, meaning that some measurements were probably superimposed flashes reported as one. Becker *et. al.* report optical observations of lightning flashes by the Juno spacecraft with energies of approximately 10^5- 10^8 joules, flash durations as short as 5.4 milliseconds and inter-flash separations of tens of milliseconds, with typical terrestrial energies. The flash rate is about 6.1×10^{-2} flashes per square kilometer per year, an order of magnitude greater than hitherto seen. Several flashes are of such small spatial extent that they must originate above the 2-bar level, where there is no liquid water. This implies that multiple mechanisms for generating lightning on Jupiter need to be considered for a full understanding of the planet's atmospheric convection and composition.

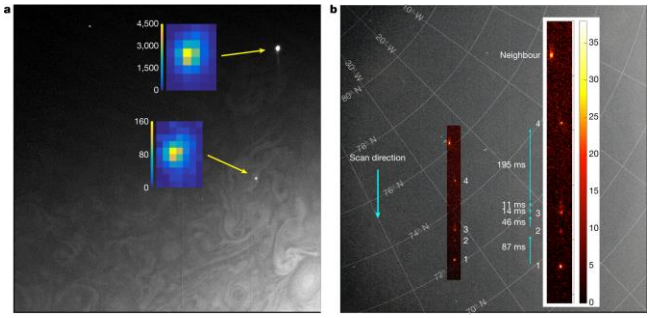


Fig: 1: Images from Juno SRU Jovian lightning survey.

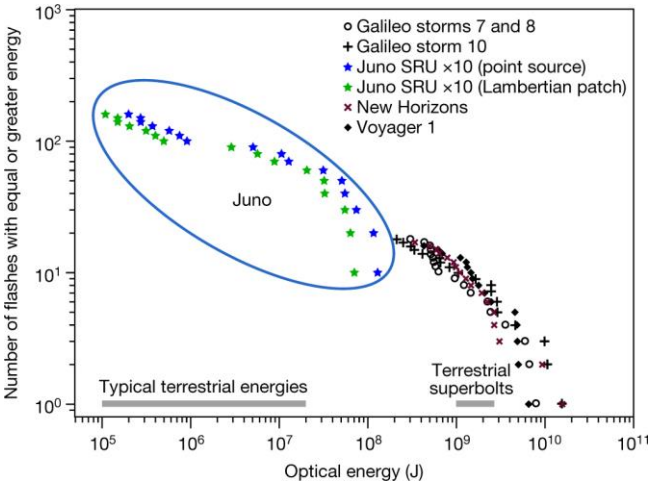
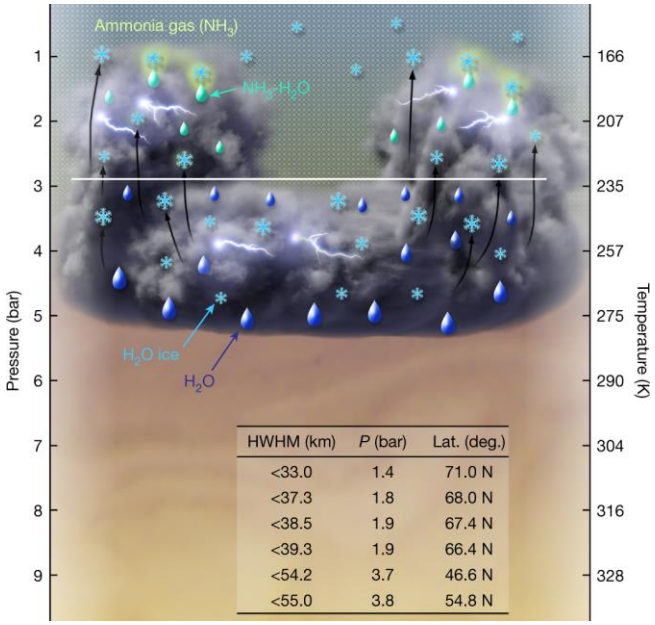


Fig. 2: Optical energies of lightning flashes observed by the Juno SRU and past broadband visible-light imagers. (SRU=Stellar Reference Unit, a camera originally designed to record dim stars for orientation of the spacecraft)



HWHM (km)	*P* (bar)	Lat. (deg.)
<33.0	1.4	71.0 N
<37.3	1.8	68.0 N
<38.5	1.9	67.4 N
<39.3	1.9	66.4 N
<54.2	3.7	46.6 N
<55.0	3.8	54.8 N

Fig. 3: Conceptual illustration of lightning generation in Jupiter's atmosphere. Energetic updraughts (black arrows) loft water-ice particles to altitudes between 1.1 and 1.5 bar, where adsorption of ammonia gas onto ice particles melts the ice, creating falling liquid ammonia–water (NH_3–H_2O) particles (green drops). Charge separation occurs as the NH_3–H_2O particles collide with upward moving water-ice, followed by lightning. At pressures greater than about 3 bar, temperatures are above the limit for supercooled water (white line, about 233 K) and lightning is generated in pure water clouds. Table: radial half HWHM intensity distances, estimated maximum depths of origin (P, pressure level) and latitudes (lat.) of observed lightning flashes.

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
Meade LX-70 Equatorial Mount	Dual Axis Drive and Polar Scope - Brand New. Bought during the closeout sale of these mounts. Owner thought he might like to have a light GEM, but decided to stick with alt-az mounts. Set up once in the garage to be sure it all works, and it does, but never saw first light in the field. Price paid: $365.	$170	Eugene Lewis genelew1@gmail.com
Celestron 6-inch f/5 reflector OTA	A steal at this price. Same tube as the Orion 6" Star-Blast. 1¼" rack-and-pinion focuser, Celestron 25 mm EP, tube rings, dovetail plate. 5x30 straight through finder. See the complete description in the August 2020 SkyWAAtch.	$150	WAA ads@westchesterastronomers.org
Celestron Evolution single arm go-to mount for 6, 8 inch or 9.25 inch SCT or Maksutov	Celestron doesn't sell these separately from the optical tube. Built-in wifi for connection to tablet or phone with SkySafari or Celestron SkyPortal. High-performance worm gears and motors for excellent tracking accuracy and reduced gear backlash. Includes rechargeable lithium-ion battery for 10 hours of continuous observing.	$400	Eugene Lewis genelew1@gmail.com
Celestron rolling case	Fits SCT OTA's up to 11 inches and 8" NexStar or Evolution with single-arm fork mount. Excellent condition. Celestron item #94004, lists for $400 on their web site.	$150	Eugene Lewis genelew1@gmail.com
Celestron Orange Tube C8	A gem from the 1970's! WAA has had this scope in storage for a long time. Serial #25778-6. OTA, fork mount, 6x30 finder, 110v power cable. Perfect condition. See the complete description in the August 2020 SkyWAAtch.	$300	WAA ads@westchesterastronomers.org
GSO 6'' reflector OTA	f/5 Newtonian. Tube rings and dovetail. 6x30 straight-through finder.	$200	Anthony Maida lvam1521@yahoo.com
Explore Scientific 102 Refractor OTA	Tube rings and dovetail. Finderscope.	$250	Anthony Maida lvam1521@yahoo.com
Vixen f/11 80mm Refractor OTA	Dual speed focuser. Tube rings and dovetail, no finderscope.	$75	Anthony Maida lvam1521@yahoo.com
WANTED	One of our members, a retired professional frustrated by the ever-increasing light pollution in Westchester, wants to know whether there are any other WAA'ers who might be interested to participate in a group purchase of property somewhere in upstate New York to build a small observatory with warm room and living facilities.		Contact Bill Caspe wbcaspe@mindspring.com

Want to list something for sale in the next issue of the WAA newsletter? Send the description and asking price to ads@westchesterastronomers.org. Member submissions only. Please submit only serious and useful astronomy equipment. WAA reserves the right not to list items we think are not of value to members.

Buying and selling items is at your own risk. WAA is not responsible for the satisfaction of the buyer or seller. Commercial listings are not accepted. Items must be the property of the member or WAA. WAA takes no responsibility for the condition or value of the item, or for the accuracy of any description. We expect, but cannot guarantee, that descriptions are accurate. Items are subject to prior sale. WAA is not a party to any sale unless the equipment belongs to WAA (and will be so identified). Sales of WAA equipment are final. *Caveat emptor!*