SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

August 2020

C/2017 F3 NEOWISE

Steve Bellavia made this telescopic close-up of NEOWISE on July 18, 2020 from Cherry Springs State Park in Pennsylvania with an equatorially mounted William Optics Redcat 51-mm refractor and ZWO ASI183MC Pro camera.

WAA September Meeting

Members' Night

Our first presentation of the academic year is always an opportunity for club members to talk about their activities over the past year. While recent astronomy trips and star parties may have been voided by the pandemic, many members have observed, imaged, read or tinkered, and your reports are always appreciated. Contact VP for Programs Pat Mahon at waa-programs@westchesterastronomers.org if you'd like to be on the program.

This may be an in-person meeting at Pace University, or an on-line event, depending on whether Covid-19 restrictions are still in effect. We will eblast members with updates as we get closer to the date.

WAA Members: Contribute to the Newsletter!
Send articles, photos, 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

Starway to Heaven

Meadow Parking Lot
Ward Pound Ridge Reservation, Cross River, NY

If Phase 4 reopening plans remain in effect, we will announce a star party for August 15th (rain/cloud date August 22nd. We will send out an announcement ahead of the date if everything is in order. Member (only) viewing under our Special Use Permit is still permitted on other nights. You must notify the park in advance and bring your ID card. Masks and social distancing are required.

New Members

Rosaria Baldari	Brooklyn
Jake Burk	Ossining
James Cooke	Scarsdale
Thomas Durkin	White Plains
Peridot Eclipse	White Plains
Trudi Fackler	Purchase
Christian Harrigan	Brooklyn
David Kaufman	Flushing
Kei Kurihara	Bronxville
Jonathan Moy	Manhattan
Charles Pevsner	Riverside
Richard Segal	Chappaqua
Kathleen Thrane	Greenwich

Renewing Members

Andrea Anthony	Yorktown Heights
Eric and Katherine Baumgartner	Redding
Anthony Bonaviso	New Rochelle
Robert Brownell	Peekskill
Kevin Bynum	Irvington
Jim Cobb	Tarrytown
Dugan Family	Sleepy Hollow
Barry Feinberg	Croton on Hudson
Daniel Intrilligator	Peekskill
Jimmy Gondek & Jennifer Jukich	Jefferson Valley
Josh & Mary Ann Knight	Mohegan Lake
Glen & Patricia Lalli	White Plains
Gene Lewis	Katonah
Patricia Mahon	Yonkers
Arumugam Manoharan	Yonkers
Mark Mayo	White Plains
Alexander Mold	Tarrytown
Anthony Monaco	Bronx
David Parmet	Mt. Kisco
James Peale	Bronxville
Arthur Rotfeld	White Plains
Ihor Szkolar	White Plains
Roman Tytla	North Salem
Cathleen Walker	Greenwich

ALMANAC For August 2020

Bob Kelly, WAA VP for Field Events


Full
Aug 3


3Q
Aug 11

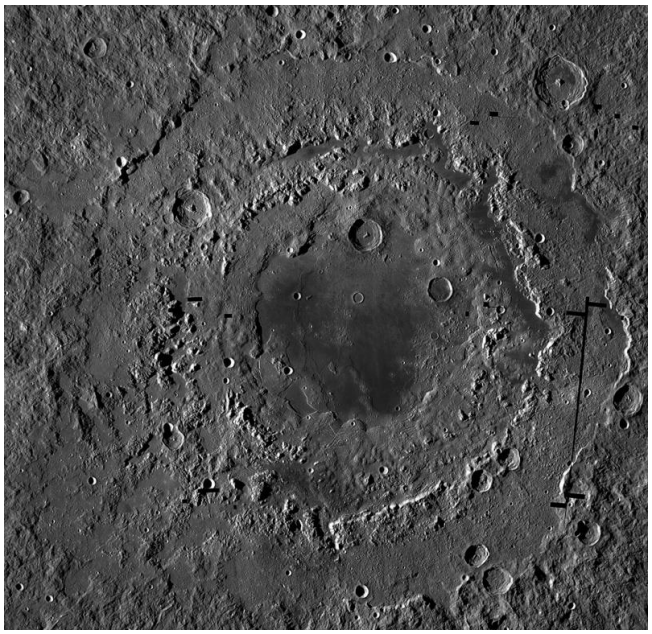

New
Aug 18


1Q
Aug 25

The Delta Aquariids officially peaked on July 27th but the shower will last a few weeks longer. Delta Aquarids are often faint and better seen from the southern hemisphere. They may be pieces of comet 96P/Machholz, discovered in 1986, which orbits the Sun every 5.29 years. Machholz has a strange inclination and is affected by Jupiter's gravity. It's been seen by SOHO during the last five orbits, but it won't be near the Earth again 2028. Sadly, the Moon will increasingly get in the way at the beginning of August.

The brighter, more frequent Perseids will peak the night of the 11th–12th. The last quarter Moon will light the post-midnight sky. Since the radiant of the meteors in Perseus rises higher into the sky during the night, the number of Perseid meteors will increase. Just as the shower is starting to get good, the Moon will rise at 12:06 a.m. EDT, washing out fainter meteors. Pre-midnight observers might see as many meteors as the moonlight-hampered morning observers.

On the morning of the 13th at 25 seconds after 2:05 a.m. EDT, magnitude +3.5 star Epsilon Tauri will pop out of the dark limb of the waning post-last quarter Moon, which rises at 12:38 a.m. EDT.


Mare Orientale from Lunar Reconnaissance Orbiter.

Mare Orientale, either a small lunar sea or giant lunar crater, is on the western limb of the Moon (eastern limb from Earth's point of view, hence its name). For the next three months, the Moon tips that section toward us more than usual (libration), so we get a view across the Mare's ring of mountains. The view will be best on the 15th, when the Moon is a waning crescent 15% illuminated. It will be even better on September 14th and October 13th. See the image on the next page.

Lunar perigee occurs on the 21st at 7 a.m., Luna appearing as a waxing crescent during the evenings of the 20th and 21st.

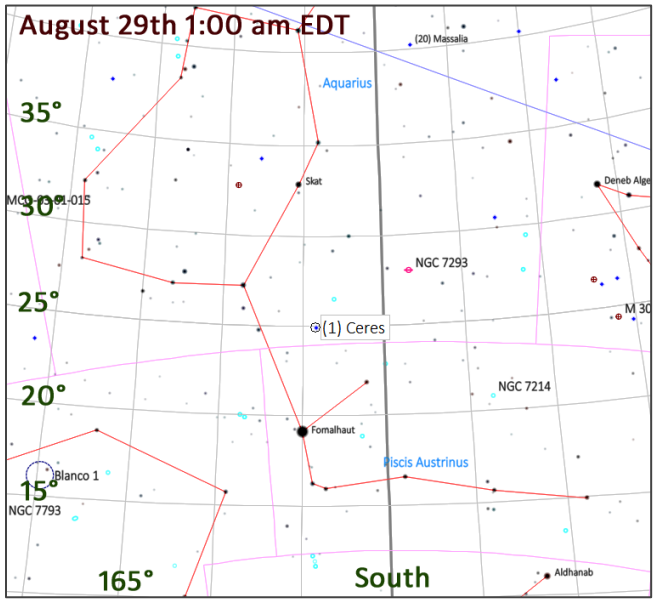
We run out of superlatives to describe Venus, our morning star, shining at magnitude -4.5 even when it is half-lit on the 12th. It's a great sight in binoculars or a telescope in twilight or daylight. Venus is at greatest elongation from our Sun on the morning of the 12th (see page 20 for more information about the elongation of Venus and viewing in daylight).

Mercury starts out at magnitude -1, quite bright in the morning sky if you can tear your eyes away from Venus. The innermost planet falls into the Sun's glare fairly quickly. After passing behind the Sun on the 17th, it eases into the evening sky at the end of the month.

In early August Mars takes the prize for closest planet to Earth. It won't give up the title for the rest of 2020. The Red Planet will get lots of attention as it brightens through magnitude -1 this month. The Moon and Mars get within two Moon-widths (one degree) on the night of the 8th-9th. Compare the 65 per-

cent full Moon with 88 percent full Mars. Mars still works the late shift, not rising until 10 p.m. EDT at the end of the month. Mars will be large enough for details to be seen in a modest telescope. The South Pole is tipped toward us. You may be able to see the polar cap, while the large desert region Hellas may be even easier to visualize.[1] The cap is shrinking as Mars heads toward its southern hemisphere's summer solstice. See page 21 for more information about Mars this autumn.

Ceres' brightness maxes out for this year at +7.4 on August 28th. The brightest it will get in the next 20 years is magnitude +6.79 on Dec. 17, 2035. Ceres is farthest from the Sun on the 18th, and closest to the Earth on the 27th. Vesta joins the Beehive on the 28th and 29th, at magnitude +8.1. It rises after Venus, about 4 a.m.



Finder chart for Ceres on August 29th at 1:00 a.m.

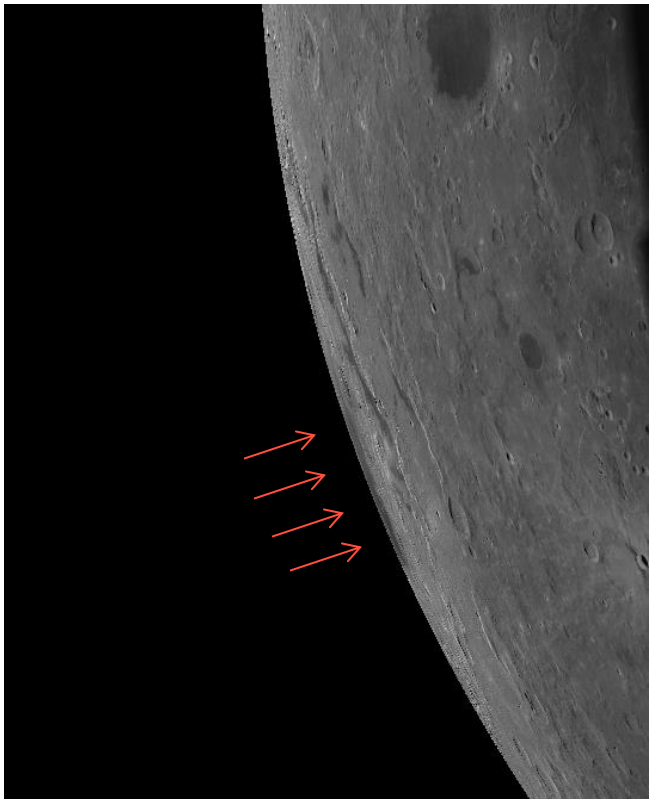
In August, Jupiter and Saturn have the best combination of large size and elevation above the horizon for this year. Io and Ganymede throw eclipse shadows on Jupiter at the same time on the night of the 14th/15th, from 12:09 am through 1:54 a.m. (on the 15th).

Saturn is up just before sunset, following Jupiter. The rings of Saturn get all the attention, of course. Their large tilt overwhelms Saturn's fainter moons. Titan is the brightest moon, but not as bright as Jupiter's big four. Iapetus brightens as it swings to the west (ahead) of Saturn. Its greatest elongation is on the 18th. Titan is halfway between Iapetus and Saturn on the 29th.

Neptune is hanging out in Aquarius, rising 2½ hours after Saturn. Uranus, in Aries, rises an hour before midnight. A modest telescope will show that these planets are discs and good optics will show their blue color. Uranus is magnitude +5.8, 3.5" in diameter, while Neptune is magnitude +7.8 and 2.5" across.

The International Space Station will be visible in the evening sky through the 5th, and in the morning sky starting on the 24th.

During August, a SpaceX Falcon 9 rocket may launch Starlink 10, fifty-eight satellites for SpaceX's Starlink broadband network. In the past, sets of Starlink satellites made a nice parade across the night sky, a few days after launch. [On the other hand, they're a curse for imagers and for professional astronomy, especially damaging to the work of large survey telescopes. Personally, I hope a gigantic space goat comes along and eats all of them. Ed.] ■



The Mare Orientale as it will appear on August 15th. Virtual Moon Atlas v. 6.0

[1] The Editor recommends an orange filter for Mars. It enhances the contrast of surface features. Be patient at the eyepiece and wait for the rare moments of steady seeing.

From the Editor — Larry Faltz

Last summer, WAA held a very successful outreach program at the Onatru Farm Park in Lewisboro. The park is a few miles east of Ward Pound Ridge, with similar skies. We were also asked to show the night sky a few weeks later to a small group of families who were doing a "night hike" at Pine Croft Meadow Preserve, a small open field in Waccabuc. Elyse and I set up a telescope for 15 adults and seven children. We showed them the main summer constellations, Jupiter, Saturn, and many of the summer's best telescopic highlights, all the while explaining some astronomic science. We brought a stepstool to help the small kids get a look. It was a fun evening for all.

I pointed out the two bright planetary nebulas in the Summer Triangle, the Ring (M57) and the Dumbbell (M27), easily visible on that clear August night. I explained that they were the remnants of stars that had used using up their hydrogen fuel, throwing off their outer layers and collapsing into white dwarves, whose radiation excited the atoms of the ejected hydrogen and oxygen. "This will happen to our Sun in about 5 billion years," I explained. "As it consumes its hydrogen, it will puff up beyond the Earth's orbit and fry the Earth."

All of a sudden, a little boy, maybe six years old, cried out in anguish, "What's going to happen to us? Are we going to get burned up?" He was clearly upset, and kept repeating "Are we going to burn up? Are we all going to die?" His father tried to calm him: "Don't worry, it won't happen for five billion years." He wasn't very successful. The concept of "five billion years" probably means nothing to a small child. August 2019 and August 5,000,002,019 are both just around the corner. Or perhaps this child is actually displaying some kind of pure, idealistic empathy for and connection to our entire race, believing that humanity deserves to be around in 5,000,002,019 and beyond. Although we felt badly for his anxiety, we were also amused by his innocence. Perhaps, though, I ought to find a less potentially shocking way to explain the future of the solar system when dealing with impressionable children. I immediately thought of the 8-year-old Alvy Singer, taken to the psychiatrist because he's depressed that the universe is expanding (in Woody Allen's *Annie Hall*, for those few of you who might not know the reference.)

The return of American manned space flight, with the successful SpaceX mission to the ISS in May, has increased optimism about the possibility of Martian colonization, the long-term goal of Elon Musk. We're told that we have to become a spacefaring species because Earth's future is too precarious to ensure humanity's survival, what with the inevitability of asteroid or comet impacts or our own unstoppable trashing of the planet. But even if we had complete protection from these risks, the fact is that in five billion years, or even five million years, it won't be *Homo sapiens* that will be around to occupy it. Darwinian evolution will see to that.

Random genetic mutations provide a reproductive advantage for organisms that find themselves in new "ecological niches." The organisms evolve into the niches even before it is evident (to us as sentient observers) that they exist. We can't predict evolution. Science and society can't prevent *Homo sapiens* from finding opportunities to evolve (unless, in the null case, we simply destroy ourselves). The coronavirus pandemic and climate change have created new ecological niches. There will be a survival advantage for individuals with certain gene combinations, but we don't yet know what these might be, and won't for a generation or longer. Genes for other traits lying close to those protective genes on our chromosomes benefit from the survival advantage due to "linkage", co-evolving and changing the organism in unpredictable ways. Evolution is blind: we don't know how to identify, much less know how to occupy, a new niche, so we really can't be sure what *Homo futuris* will actually look like or be capable of.

Terrestrial evolution took place in a protected world (atmosphere, magnetic field, habitable zone, water, stable Sun [see page 25]). To adapt to outer space's unique ecological niche requires not just technology, but ultimately biology. *Homo cosmos* can only exist if much more effective pathways for DNA repair evolve in order to survive intense radiation in space. With genetic engineering we could conceivably speed up the evolutionary time-frame, but only after biology teaches us how to do it. And, by the way, all the viruses and bacteria we bring along for the ride will be evolving too, and they will surely have something to say about how we adapt. ■

Member Profile: Arthur Rotfeld

Home town: White Plains, NY

Family: Married for 19 years, 15-year-old daughter.

How did you get interested in astronomy? I was interested in science as kid and got a simple Edmund Scientific reflector and acquired a whole bunch of astronomy books. I'm old enough to remember when Jupiter had 13 moons.

Do you recall the first time you looked through a telescope? What did you see? I remember finding M42 with my scope the first night out. I also remember seeing Saturn around the same time.

What's your favorite object(s) to view? I often get drawn to beauty of globular and open clusters, but I can appreciate anything, from planets to galaxies. I do try to plan an evening in advance. I'll always look at some favorites and the best a given night has to offer, but I'll embellish with something that I haven't seen before.

What kind of equipment do you have? I have a Celestron Edge 8" CPC and most often use a 31 mm Nagler, a 17 mm Explore Scientific, and a Baader 8-24 mm zoom eyepiece. I'm quite pleased with the views. I have an Explore Scientific 80 mm telescope on a simple EQ mount that I use for DSLR imaging. I'll often bring both setups.

What kind of equipment would you like to get that you don't have? I'm thinking about getting a wedge and reducer for the 8" scope. I know that it's challenging to image that way, but I'll have to give it a shot one of these nights. A wide-field 12- or 13-mm eyepiece would be nice. I'm also dreaming of a big and fast Dobsonian at some point. We'll see….

Have you taken any trips or vacations dedicated to astronomy? Nothing entirely dedicated, but I do try to add astronomy to our trips. I like to go to the Adirondacks for fishing, so when I'm up there, I certainly take advantage of the dark skies.

Are there areas of current astronomical research that particularly interest you? I do keep up with general trends and discoveries via astronomy and science magazines , but my interest in astronomy is primarily as an observer rather than the more academic side.

Do you have any favorite personal astronomical experiences you'd like to relate? I remember Hale-Bopp as a bright, naked eye object—it was incredible! Last summer I happened to see a really bright and long-lasting fireball. Those unique experiences are highly memorable. So, another spectacular comet or an incredible meteor shower are things that I hope to experience again. Events that we can't quite predict keep things exciting.

What do you do in "real life"? I'm a full-time music teacher. I have been giving guitar lessons for the past twenty years—and even teach a couple of our astronomers! I also work as a freelance writer for a variety of music book publishers and guitar magazines. I have a website at www.rotfeld.com.

How did you get involved in WAA? I joined to meet fellow astronomers and observe at Ward Pound.

What WAA activities do you participate in? I don't make it to many meetings because I'm probably at Ward Pound with my scope! I usually make it to the club nights, so when we can start again, come by and we'll take a look!■

Amalfi and the Belt of Venus (LF, 10/9/19)

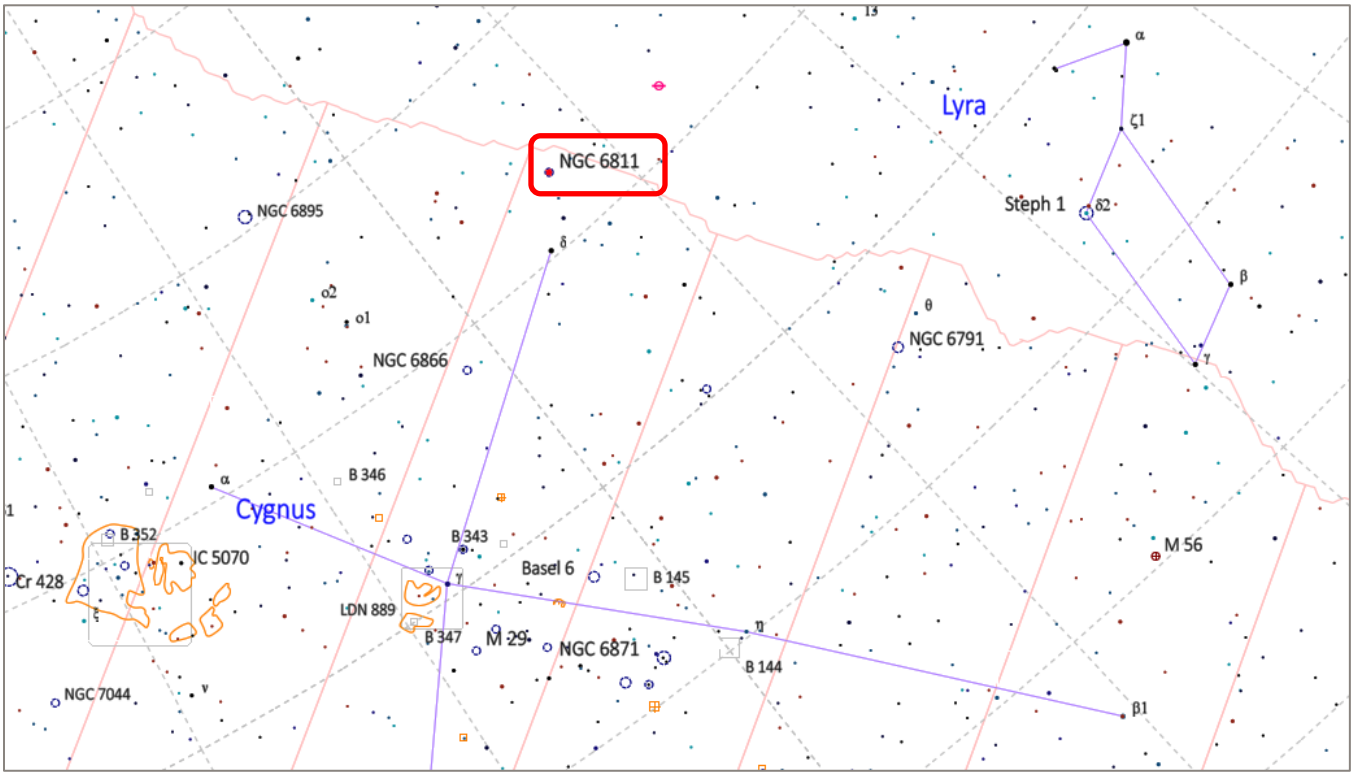
August Deep Sky Object of the Month: NGC 6811

NGC 6811	
Constellation	Cygnus
Object type	Open Cluster
Right Ascension J2000	RA: 19h 38m 12.0s
Declination J2000	DE:+46° 34' 00"
Magnitude	6.8
Size	13 arcminutes
Distance	3,285 LY
Nicknames	"Hole in the Cluster" "Smoke Ring" "The Reliquary"

This subtle open cluster is 1.8° northwest of δ (Delta) Cyg i, the western wing of the swan. Sue French, in *Deep Sky Wonders,* describes it as having "a swarm of about 40 faint to very faint stars in a nearly equilateral triangle" but with a prominent central void. The cluster actually has about 250 members. Walter Scott Houston collected reports of the cluster's morphology from other amateurs, with descriptions such as "Liberty Bell," a butterfly, a frog, clover and "Nefertiti's headpiece." In a small scope, the darker interior seems more prominent. The cluster appears to be about 1 billion years old. An optimal magnification for the object seems to be about 60x.

NGC 6811 — Visibility for August			
10:00 pm EDT	8/1/20	8/15/20	8/31/20
Altitude	69° 50'	79° 00'	84° 23'
Azimuth	65° 26'	56° 23'	342° 59

Stephen James O'Meara, in *The Secret Deep,* describes the cluster as "a blowhole of stellar delight". He sees in its shape the reliquary in the Duomo di Napoli containing the clotted blood of San Gennaro, said to liquefy miraculously on the saint's day each year.



Progress on the Origin of Life? Larry Faltz

In my final undergraduate semester at Columbia in the spring of 1968, a term marked by student protests, occupations and brutal police action, I had already completed all my required coursework. With my acceptance to medical school in hand, I could lavish my remaining time on a range of oddball courses: military history, eastern religion (taken across Broadway at Barnard, because I figured it would be an opportunity to meet women, unavailable at the then men-only Columbia College) and 20th-century philosophy. I was also allowed to register for a graduate-level seminar called Theoretical Biology. Now, biology is perhaps the least theoretical of the natural sciences, but there are important biologic questions that remain solely in the realm theory, the most important of which are "What is life?" and "How did life begin on Earth?"

The biweekly seminar turned out to be just a BS session among a group of six or seven biology and biochemistry graduate students and me. The professor didn't teach; he just facilitated discussions on a wide range of topics that often went off on wild tangents. Had the classes been held outdoors under a tree in Riverside Park, someone overhearing the conversation would have assumed that we had all just shared a joint. I wasn't really disappointed, since the banter was kind of fun and anyway by that time my primary goals were to get through the spring, obtain my degree and move on. The disruptions started by Mark Rudd and the Students for a Democratic Society and completed by the New York City Police Department caused the College to announce that all courses that semester would be graded "pass-fail." The faculty let it be known, *sotto voce* of course, that they had little interest in failing anybody.

There was still the required formality of final exams; many of them were *de minimus*. Our professor just asked us one question: "What was the history of life before the first cell?"

When I saw this, I laughed, because this question is not possible to get wrong, but you can't get it right either. It was an opportunity, however, to be clever. A feasible starting point is the Miller-Urey experiment (see "Life in the Solar System" in the November 2014 SkyWAAtch) and so my answer began by placing the simple organic compounds that emerged from the Miller-Urey soup into a pond on a mineral surface. I used whatever physical chemistry that I could remember from a previous year's course, but I also recalled the fictional Max Gottlieb, bacteriology professor and mentor to medical student Martin Arrowsmith in Sinclair Lewis's 1925 novel *Arrowsmith (*one of the first serious novels I read on my own, age 14), who chides the young man for his interest in organic chemistry: "Organic chemistry? Puzzle chemistry! Stink chemistry! Drugstore chemistry! Physical chemistry is power, it is exactness, it is life."

So I argued that those mineral surfaces might harness changes in free energy to drive assembly and increasing complexity of organic molecules, accompanied by local decreases in entropy. Eventually, the amino acids created in the Miller-Urey experiment would manage to make proteins that reproduced themselves, again stressing physical chemistry mechanisms, creating an ever-growing repertoire of chemical and physical structures, then serendipitously developing enzymatic activity, with DNA, RNA, lipids and metabolism coming later, actual biology emerging with time. Who knows if it made any sense? I passed. We all passed that semester. I wonder if the professor even read the blue books.

The search for extraterrestrial life is an important endeavor of modern astronomy. The identification of so many exoplanets increases the likelihood that one of them evolved life. Detecting life still doesn't answer the question of how it began, and like my undergraduate guess 52 years ago, presumably anything is possible. But a half a century of thought and experiment has been directed at the problem since then. NASA and many universities have astrobiology programs (Columbia's is headed by Caleb Scharf, who's lectured to WAA twice and might be back again in 2021).

Living cells require the simultaneous operation of a number of interacting pathways: metabolism, small molecule synthesis, macromolecule synthesis, maintenance and reproduction of genetic information, and management of a vast number of regulatory pathways. All of these could not have evolved simultaneously. DNA carries the genetic information for all cellular processes, in the form of two interacting linear strands within which just four "bases" speak the genetic language. The bases on a given

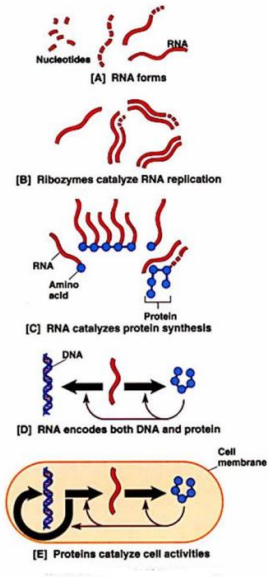
strand pair up with complementary bases on the other strand but do not interact with bases on the same strand. In the process of protein synthesis, a strand of DNA is transcribed onto a strand of RNA, which still utilizes a language of four bases (three of them the same as DNA; the sugar to which the bases are linked is slightly different). This messenger RNA is then translated to make proteins, each group of three bases providing the instructions for a single, specific amino acid to be placed onto the growing protein chain.

RNA still reflects the genetic code, but it differs from DNA not only in its chemical structure, but in the fact that RNA bases can bind with other bases on the same RNA molecule to make many different 3-dimensional structures. DNA always remains in a linear configuration. This ability of RNA to take on different forms is reflected in the existence of two other forms of RNA, ribosomal RNA, which forms a scaffold on which proteins are built, and transfer RNA, which brings each amino acid onto the growing protein.

In the 1980's, a breakthrough occurred when it was demonstrated that RNA could act as an enzyme. The first enzymatic activity detected was the ability of RNA to act as an RNA synthetase, that is, to catalyze its own reproduction, and to splice and rearrange the genetic material along the RNA strand. From this discovery came the concept of the origin of life in an "RNA World" in which the first self-reproducing molecules would be RNA with both genetic and enzymatic functions, not proteins. Biology as we know it requires proteins to catalyze and manage these processes, but at the earliest stages of the evolution of life, RNA might have taken on those roles. RNA viruses, where the genetic code is stored in RNA, might even be a little bit of the RNA World that has survived to the present.

Non-biologic chemical processes capable of synthesizing some of the purine and pyrimidine nucleotide "bases" in nucleic acids have been studied under conditions that might have been present in the Hadean (early Earth) epoch. These chemical reactions might result in the formation primitive strands of RNA, and then through the "blind watchmaker" of evolution over eons some of the RNA molecules would acquire enzymatic functions that enhance their own synthesis. The RNA molecules would then use "recombination and mutation to explore new functions and to adapt to new niches,"[2] the very definition of Darwinian evolution at the molecular level. Their enzymatic activity would eventually evolve to manage metabolic pathways, serve as a template for protein synthesis and act as RNA synthetase enzymes to maintain genetic identity. A final step would be reverse transcription: the synthesis of DNA from RNA, a process well-known in the world of virology and utilized most notably by human immunodeficiency virus (HIV). DNA is considered to be a more stable repository of genetic information, less likely to undergo mutation and easier to repair.

In the RNA World, metabolism, the harnessing and utilization of energy, would have to arise after the synthesis of the earliest macromolecules. But metabolism is need for these synthetic activities. So we are faced with a chicken-egg problem: What came first? Could metabolism have preceded the synthesis of proteins? Recall Samuel Butler's aphorism that "a chicken is only an egg's way of making another egg".



The RNA World

In 2019, a group from the University of Strasbourg described an experiment that sought to create metabolic pathways from pre-biotic precursors.[3] They took the three-carbon molecules pyruvate and glyoxylate and mixed them at 70°C with ferrous iron (Fe^{++}). Previous studies had shown that both pyruvate and glyoxalate could be formed by non-biologic processes. The early Earth was rich in Fe^{++}.

Within just three hours, they detected most of the compounds that made up the tricarboxylic acid cycle (TCA, also known as the Krebs Cycle), the critical metabolic cycle in all living cells, as well as most of the compounds in the glyoxalate cycle, present in plants,

[2] Gilbert, W, The RNA World, *Nature* (1986), 319: 618
[3] Muchowska, KB, Varma, SJ, Moran, J, Synthesis and breakdown of universal metabolic precursors promoted by iron, *Nature* (2019); 569: 104-106

bacteria, protists, and fungi. If they added hydroxylamine, a simple nitrogen-containing compound that also can be formed in a primitive abiotic environment, four amino acids were synthesized. This could lead to the synthesis of metabolic systems, in essence life pulling itself up by its metabolic bootstraps. As the authors conclude,

> An abiotic chemical pathway that resembles core carbon biochemistry is promoted by ferrous iron. Although the ability of simple reaction networks to evolve is limited in the absence of a genetic mechanism, we speculate that the incorporation of sulfur and phosphorus into this carbon-, hydrogen- and oxygen-based network could enable a primitive analogue of bioenergetics…. This, in turn, could drive dehydrative polymerization reactions, leading to the eventual emergence of functional polymers such as peptides and RNA. Thereafter, the efficiency of these primitive networks in early life would be improved through enzymatic catalysis.

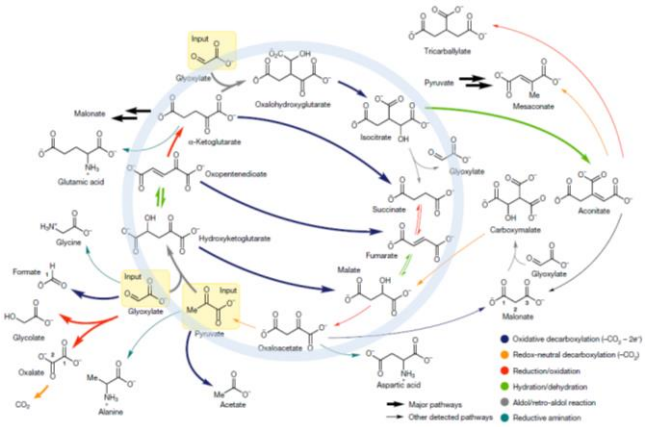


Fig. 1a from Xu *et. al* showing the reaction network synthesized from pyruvate, glyoxalate (yellow boxes) and iron. Blue circle highlights compounds in the TCA cycle (superimposed by LF).

A recent paper in Nature[4] suggested that the emergence of nucleic acids that carry the genetic code might not have proceeded linearly from RNA to DNA, but that RNA and DNA molecules could have coexisted at an early stage. Previous work demonstrated the abiotic synthesis of ribonucleotides (the bases of RNA) but these authors showed that conditions plausible on the early Earth could also result in the synthesis of deoxyribnucleotides. Perhaps the earliest compounds to contain genetic information were mixed RNA-DNA hybrids, only later differentiating into their separate structures and functions.

If you've gotten this far, you're going to ask, "Is this astronomy?" I think it is. I've always believed that all of the sciences are connected, and astronomy is really the *ur*-science, the one that generated the approach to all the others. The logic and power of the nebular hypothesis, proposed in the 18th century, inevitably led rational thinkers to posit that if the Earth had a natural beginning, then life on it also arose naturally, and therefore there was a mechanism to be conceived and perhaps discovered. That the Moon, the planets and even the Sun were inhabited was accepted by many astronomers well into the 19th century and for some even later, Percival Lowell going to his grave in 1916 with the firm conviction that there was life on Mars. The question of whether life exists elsewhere has a more realistic chance of being answered because it is amenable to direct observation rather than extrapolation from experiment, but it's still indissolubly linked to the origin question.

The 100th anniversary of the "Great Debate" between Heber Curtis and Harlow Shapley occurred on April 26th. That debate reflected the most important astronomical question at the time. Entitled "The Scale of the Universe," it concerned the question of whether the Milky Way was the entire universe or whether the "spiral nebulae," so-called, were themselves Milky Ways. That question was definitively answered just 3 years later by Edwin Hubble. To commemorate the debate's 100th anniversary, a new debate[5] was held (virtually) on the topic of "Life in the Universe," with the specific question being "How will extra-terrestrial life be discovered?" Twenty-one astronomers (at least two of whom have lectured at WAA) weighed in, each presenting their arguments via PowerPoint and/or video. Almost everyone agreed that if life is found it will be in the water vapor plumes of Enceladus or by seeing biologic or technologic absorption signals in the atmospheres of exoplanets by spectroscopy. When we find it, the question "How did life arise?" will still remain. And while that might always be a guess, the possible answers are getting a lot more scientific and credible. ■

[4] Xu, J, Chmela, V, Green, NJ, Selective prebiotic formation of RNA pyrimidine and DNA purine nucleosides, *Nature* 2020; 582: 60-66

[5] https://apod.nasa.gov/debate/debate100th.html

The Comets of 2020 (so far)

Comet C/2017 T2 PANSTARRS on May 30th by Steve Bellavia

We haven't had a truly great naked-eye comet in our night skies for over two decades. Since C/1995 O1 Hale-Bopp in 1997, a few comet spectaculars have been promised, but none have delivered for us in the northern hemisphere. C/2006 P1 McNaught in 2007 and C/2011 W3 Lovejoy were fantastic in the southern hemisphere but poorly placed for us, McNaught visible on the dusk horizon for just a few days and Lovejoy never making it above our horizon. Comet C/2012 S1 ISON was touted as a possible "Comet of the Century" but broke up as it rounded the Sun, an event captured, as the world watched, by the Lasco C3 imager on board the joint NASA/ESA SOHO (Solar and Heliospheric Observatory) spacecraft. We eulogized it on page 11 of the January 2014 SkyWAAtch.

This year, C/2019 Y4 ATLAS, a Kreutz sungrazer discovered on December 28th, was promised to be a naked eye object and possibly visible in the daytime, but it broke up early in April when it was still around 8th magnitude. It was a fuzzy ball with a small but definite tail when your editor observed it on April 11th at Ward Pound Ridge Reservation.

Comet C/2019 Y4 ATLAS on April 11th. Hand-held cell phone shot of the Mallincam video monitor screen. 6" f/5 reflector. Colors are artifacts.

Comet C/2017 T2 PANSTARRS was discovered in 2017 by the University of Hawaii's automated 1.8-meter telescope on Mt. Haleakala in Maui. Perihelion was on May 4, 2020 when it was high in the sky in Camelopardalis. It was a fuzzy ball with a very short tail, but got no brighter than 8th magnitude.

On the other hand, Comet C/2020 F3 NEOWISE at least gave us a chance to see what a good comet can be like. It was discovered March 27, 2020 by the NEOWISE space telescope, an infrared imager launched in 2009, turned off in 2010 and then reactivated in 2013 for near-Earth object surveys. At first the comet didn't seem that it was going to give much of a show, but it brightened dramatically after emerging from behind the Sun. By early July it reached magnitude +1 and was a naked-eye object before dawn. It then passed into the evening sky, rising higher into the sky after sunset although losing brightness.

The comet's proximity to the Sun in meant that it would be visible only when low in the pre-dawn sky and thus contending with more atmosphere. Atmospheric dimming varies with wavelength but averages about 0.3 magnitudes per "airmass" unit. This parameter can be obtained from planetarium programs for an object at the given date and time.

Images of Comet C/2020 F3 NEOWISE

Rick Bria made this image at 3:44 a.m. EDT on July 14th. This is a stack of five 10-second images. The Mary Aloysia Hardey Observatory at Sacred Heart Greenwich, an independent school for girls, houses a 14-inch PlaneWave Dall-Kirkham telescope. Piggybacked on it are an 85-mm TeleVue refractor and an 80-mm Lunt solar telescope. Rick operates the observatory for the school.

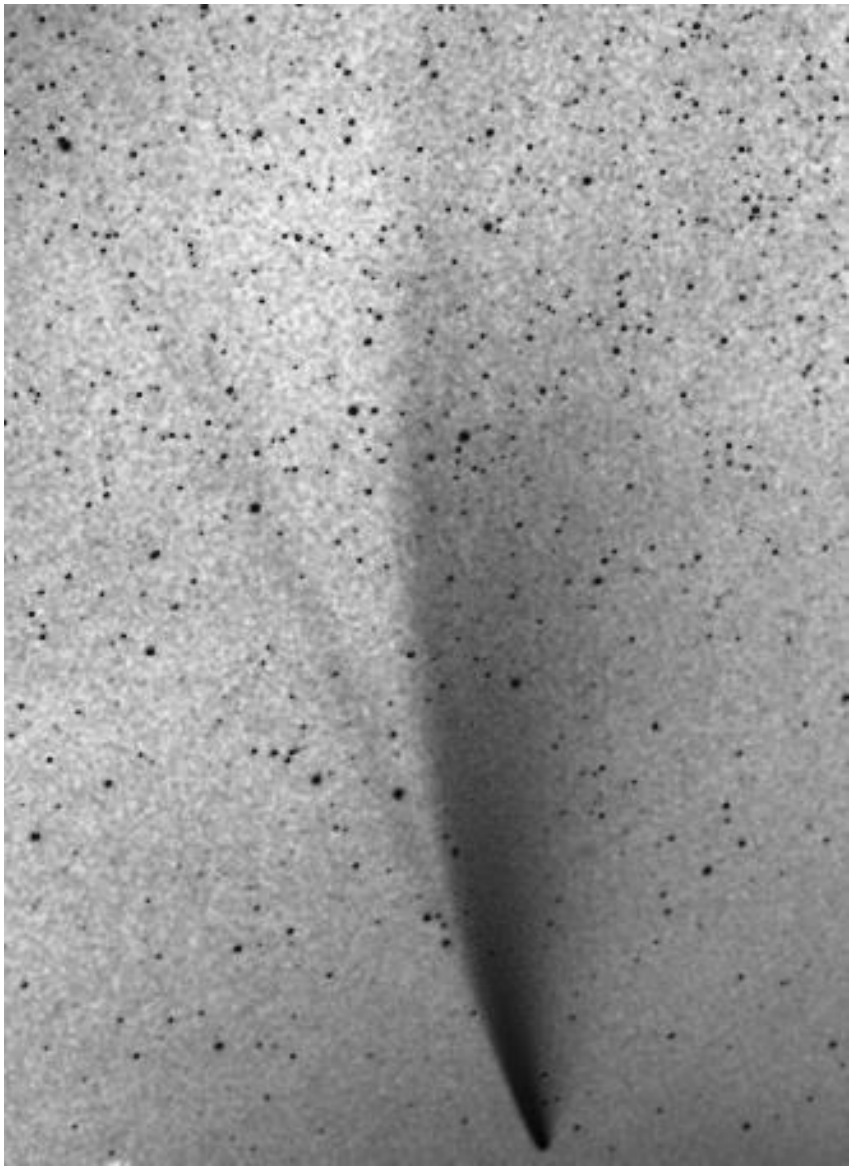
Dave Parmet's wide-angle shot of from Ward Pound Ridge Reservation at 4:12 a.m. on the morning of July 12th captured the comet just above the trees on the left, and magnitude -4.5 Venus inside the Hyades, on the far right. The Pleiades are visible in the upper right corner of the image. The bright star above the comet is zeroth magnitude Capella (α Aurigae), the sixth-brightest star in the sky. Halfway between it and the comet is magnitude 1.9 Menkalinan (β Aurigae).

Larry Faltz made this wide-angle shot at Ward Pound Ridge Reservation on July 20th at 10:29 pm to show the comet's position under the bowl of the Big Dipper. Canon T3i with 18-135 zoom at minimum focal length (35-mm equivalent 29 mm), 20 seconds at f/4, ISO 800. The camera was mounted on an iOptron Minitower so it could track, allowing a relatively lower ISO setting.

The comet was barely visible to the naked eye at WPRR that evening, when it was estimated to be around magnitude +3.5. It had faded from its peak magnitude of around +1.2 on July 5th as its distance from the Sun increased, even though it was getting closer to Earth. Airmass at the comet's position was 4.1 when this image was made, so there was further extinction of about a magnitude. In binoculars and in an 80-mm f/6 Stellarvue telescope at 16X, the tail looked to be about three degrees in length.

Two good sites for up-to-date information about comets are https://cobs.si/ and http://www.aerith.net/.

Mike Cefola grabbed this image with his iPhone 11 Pro Max from his patio in Scarsdale on the 20th at 10:20 pm. f/1.8, one second, ISO 6400.

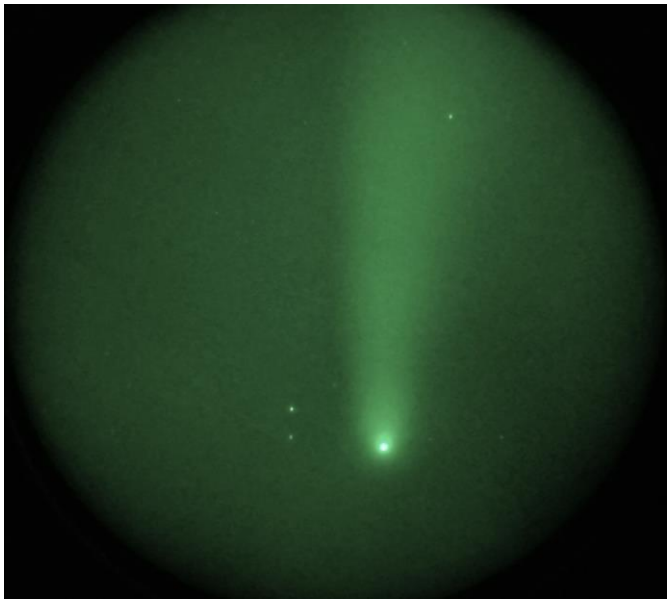


Rick Bria made a negative grayscale image of the comet on July 14th from his color photo on the page 12. It shows the faint ion tail projecting straight out from the coma to the upper left, while the brighter dust tail arcs directly upward. If you look closely on the color image, you can make out the very faint blue ion tail, but it's far easier to see with this technique.

The dust dail is caused by solar radiation pressure, while the ion tail follows magnetic field lines.

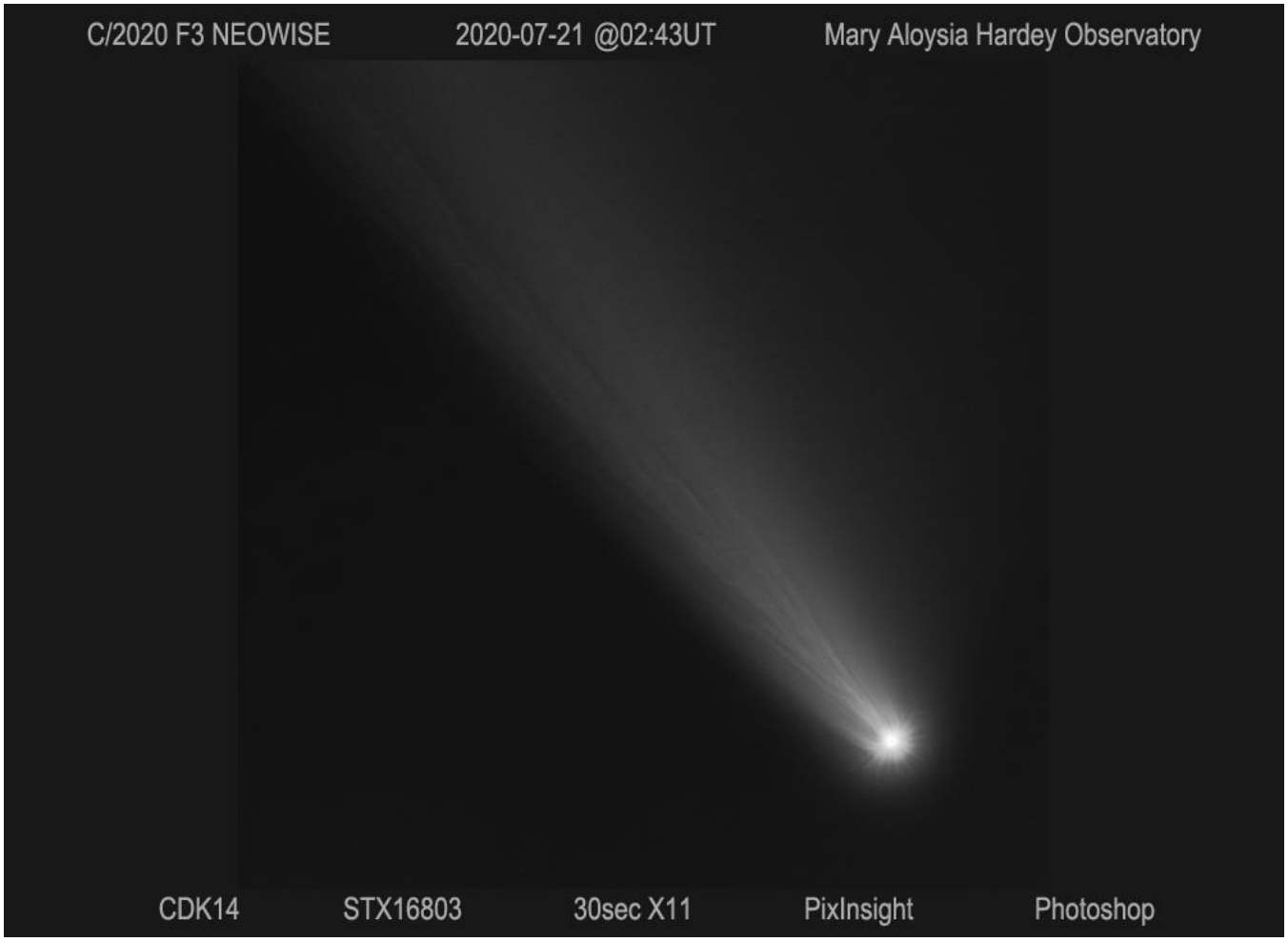
Steve Bellavia also caught the ion tail in this image from Cherry Springs, Pennsylvania on July 18th.

Alex Mold used his cell phone to capture the comet through a 127-mm f/12.1 Maksutov.



John Paladini imaged through his home-made 3rd-generation image intensifier eyepiece on a 10-inch f/4.5 Newtonian. Hand-held cell-phone image.

About a dozen club members were at Ward Pound Ridge Reservation on Saturday evening, July 18th for general stargazing and comet viewing. (Left) **Arthur Rotfeld** grabbed this image of the comet with a DSLR on an 80-mm ED refractor. The ion tail is clearly visible on close inspection. (Bottom, left and right) **Jordan Webber** contributed a close-up view through an Orion XT8 and a wide-angle DSLR image.



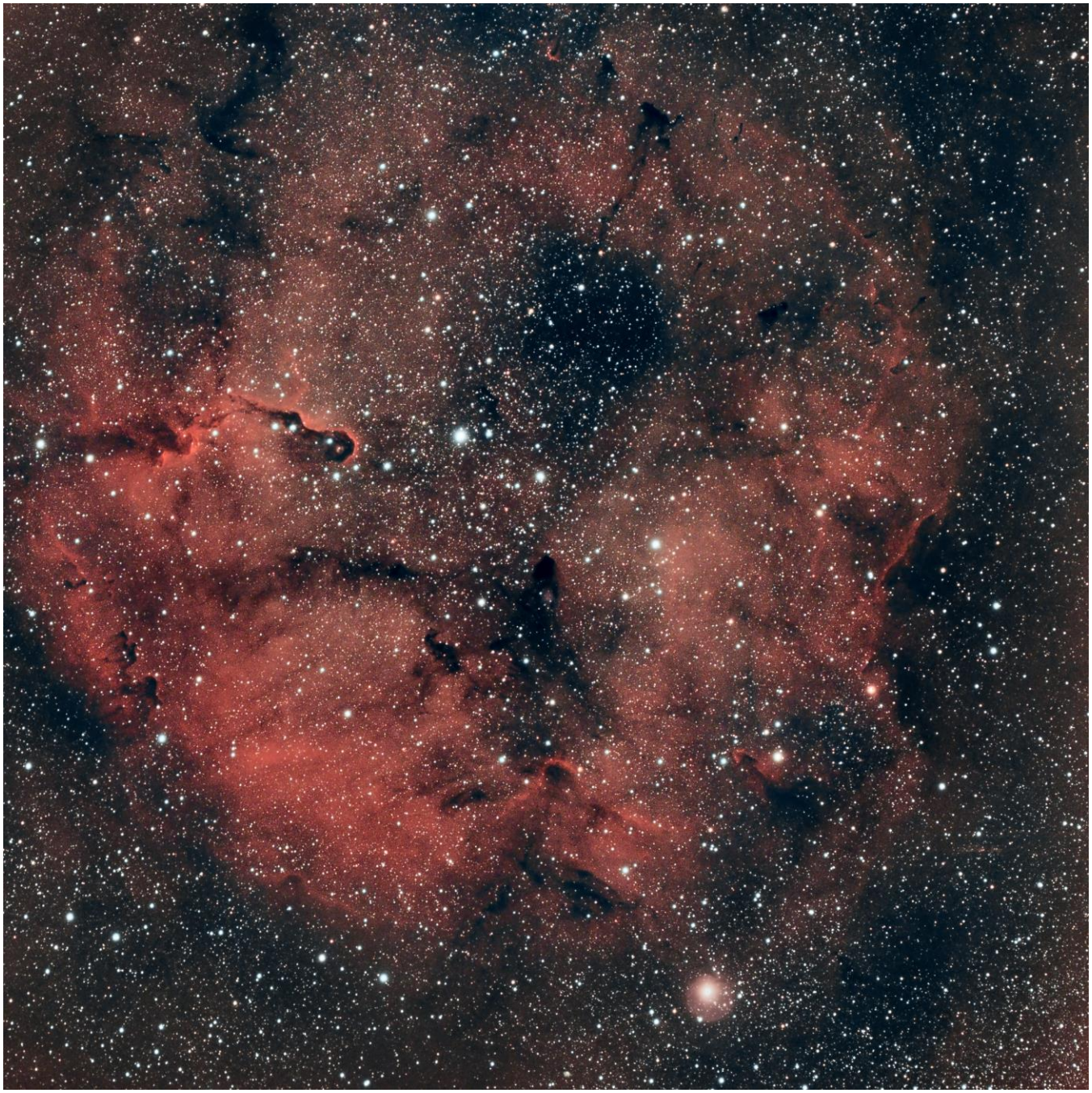
And what happens if you happen to have a 14-inch PlaneWave at your disposal (and you know what you're doing)? You can make an utterly spectacular image of the coma and the tail. Here's **Rick Bria's** close-up of the comet on July 21st when NEOWISE was at magnitude 3.6 and just 14 degrees above the horizon. Rick notes, "Delicate streamers of dust can be seen in the tail. I have seen those before in other comets. The streamer features are real. I'm not yet sure if the spike features in the coma are real. They may be software or instrumental artifacts. I'm waiting to see if telescopic images produced by others also show them." The picture was processed to remove the background stars.

And now for something completely different…

Always trying new ways of seeing things, **John Paladini** used a filter to see if he could detect sodium in the comet. This image was made through an Andover filter that passes the sodium D-lines (doublet) at 589.0 and 589.6 nm with a 3 nm bandpass. John used a 66-mm APO refractor and a black-and-white video camera. Sodium tails were first extensively studied in Hale-Bopp. They appear to have a distinct formation mechanism and don't just follow the dust that boils off due to the solar wind, nor do they track with the ion tail.

Images by WAA Members

IC 1396 by Leandro Bento

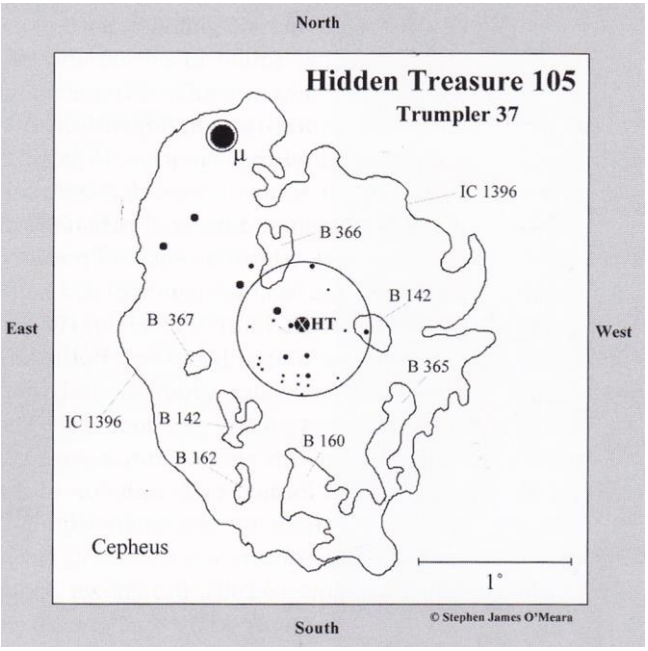


IC 1396 is an often-photographed emission nebula in Cepheus, although generally we are just shown parts of this enormous (over two degrees) expanse of ionized hydrogen. On its northern border (north is down in this image) is the red supergiant star Mu Cephei, better known as “Herschel’s Garnet Star.” In the middle of the nebula is the open cluster Trumpler 37, one of the youngest star clusters in our galaxy. The nebula is energized by emissions from HD 206267 (type O) in its center.

The dark Elephant Trunk nebula bores into IC 1396 from the left. It is a star-forming area analogous to the “Pillars of Creation” in Messier 16. In 2003, the Spitzer Space Telescope found protostars within it, some just 100,000 years old. The Elephant Trunk gets

its own IC number, 1396A; its central area has a reflection nebula catalogued as vdB 142 by the Canadian astronomer Sidney van Bergh.[6] The whole IC1396 nebula was first noticed by E.E. Barnard in the mid-1890's. It is 2,400 light years distant, with an expanse of over 100 light years.

Stephen James O'Meara, in *Hidden Treasures*, describes this nebula under the listing for the Trumpler 37 cluster. He says it "is visible to the naked eye under a dark sky as an enormous round glow three Moon diameters in extent. It looks like a blossoming flower in a moonlit garden covered in frost."

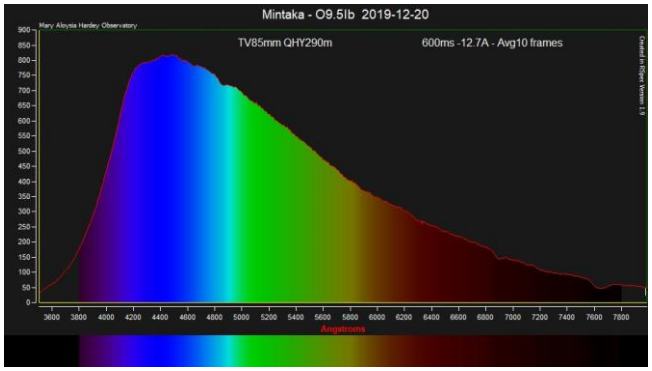


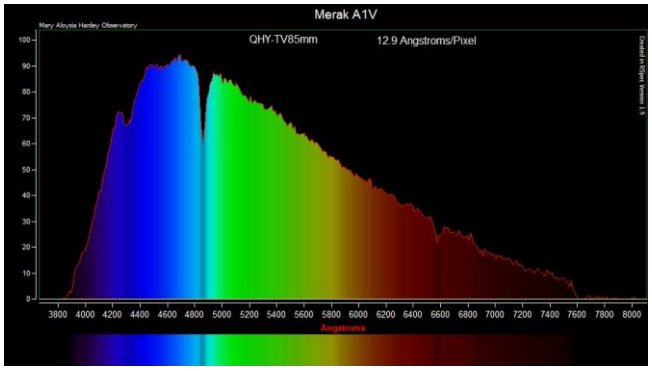
Mu Cephei is always a treat: its deep red color is easy even in small instruments. It is a variable type M star, its magnitude cycling between 3.43 and 5.1 over an irregular period, ranging from 860 to 4,400 days.

IC 1396 can only be glimpsed visually in the darkest areas, but it is frequently imaged. Its hydrogen glow can be enhanced with filters. Leandro obtained this image at Ward Pound Ridge on June 13th with the diminutive William Optics Redcat 51-mm f/4.9 (focal length 250 mm) refractor, a ZWO ASI533MC-Pro color camera, Optolong L-Enhance dual band filter, iOptron Skyguider Pro mount. Fifty three-minute subs with darks, flats and bias taken at 100 gain.

[6] All of the vdB objects are nicely displayed at http://www.emilivanov.com/CCD%20Images/Catalog_VdB.htm

Two Stellar Spectra





Rick Bria used a StarAnalyzer 100 and RSpec software to capture the spectra of the hot type O9 star Mintaka (Delta Orionis , the right-most star of Orion's belt), and Merak, in the cup of the Big Dipper, a somewhat cooler type A1 star (recall OBAFGKM). Type A stars have more absorption from hydrogen in their atmospheres, as shown by the deep line of the hydrogen-beta wavelength (486.13 nm) and a line at the hydrogen-alpha wavelength (656.28 nm). Type O stars generally have more distinct helium absorption but this is weakest in subtype O9, and so Mintaka's spectrum is relatively featureless.

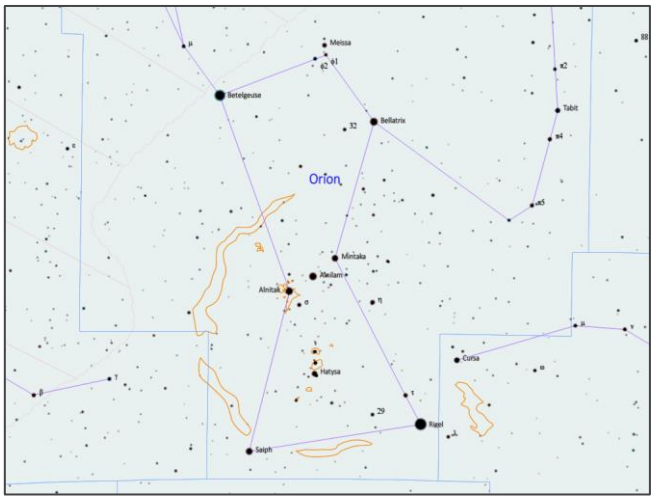
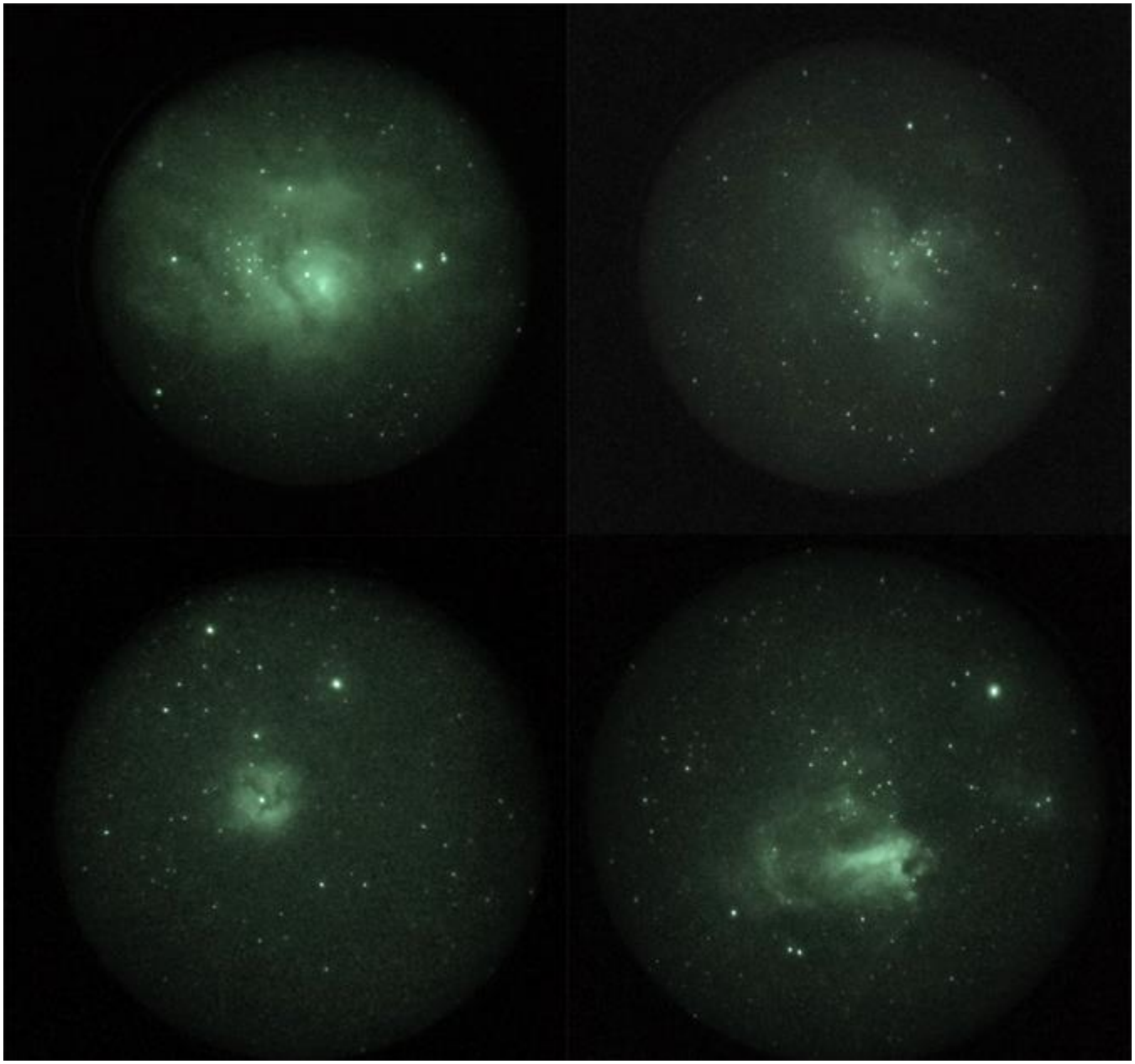


Image Intensifier Photos by John Paladini

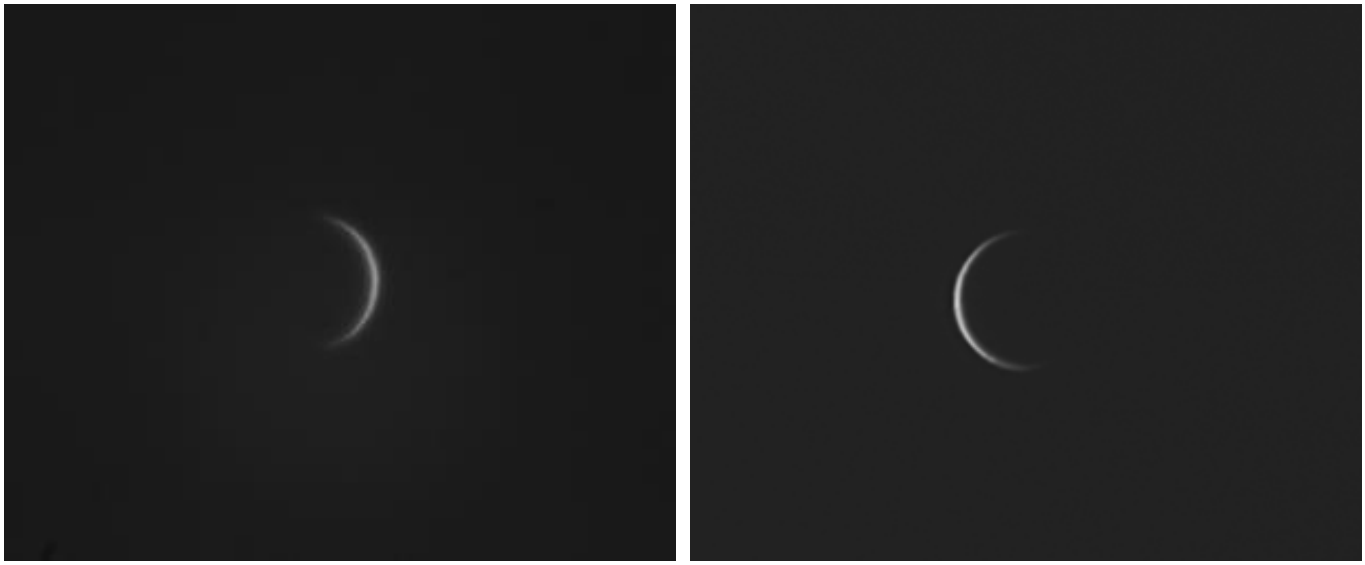


John took advantage of the clear night of June 13th in Mahopac to capture some nebulas with his home-made 3rd-generation image intensifier eyepiece and a cell phone for afocal imaging. When the Editor asked him whether he used one of those cell-phone-eyepiece-mating gizmos, John replied, "No. I'm getting better at holding my breath." John uses a multi-channel DGM filter that passes hydrogen-beta, oxygen III and hydrogen-alpha wavelengths. The telescope was a Meade 10" f/4.5 Dobsonian. These images show what you would see in the eyepiece.

Clockwise from the upper left the objects are M8 (Lagoon), M16 (Eagle), M17 (Omega or Swan) and M20 (Trifid).

Image intensifier tubes are very expensive, but they offer an option for viewing dim objects (a.k.a. "night vision astronomy") without resorting to "electronic assisted astronomy" with CCD or CMOS cameras (needing power supplies, and video screens or computers) or giant scopes. Ultimately, the cost may not be so different.

Venus in Daylight Before and After Conjunction



Left: **Robin Stuart** imaged Venus (Hesperus, the evening star) on May 24th when its disk was just 3.6% illuminated. Venus was at inferior conjunction (between the Earth and the Sun) on June 3rd and passed into the morning sky to become Lucifer, the bringer of light. Right: **Steve Bellavia** imaged it on the morning of June 8th when it was just 0.9% illuminated.

Robin sent us the following:

This picture (left image above) of the thin crescent Venus was taken in broad daylight from Valhalla at around 3:30 p.m. on the afternoon of May 24th as it approached inferior conjunction on June 3rd. Venus was 65° above the horizon and 15° elongation from the Sun, the equivalent of a thirty-hour old Moon. Even though just a sliver with an apparent diameter of 55 arcseconds, Venus was shining at magnitude -4.2. The image was taken with a Canon 60Da DSLR through a Televue NP127 refractor and a 5X Powermate. The daytime seeing was extremely poor and the image is a stack of just three hand-selected subs from a total of about 100.

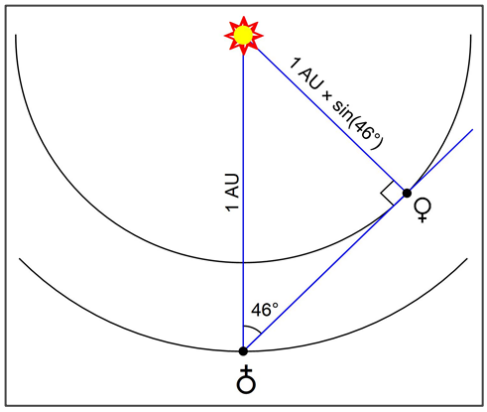
In fact you don't need a GoTo mount or even a telescope to see Venus during the day. It just requires a good compass. Binoculars are helpful but not essential. With Venus reaching its maximum elongation of 46° from the Sun and shining at magnitude -4.4 on August 13th, it's a good time to try to spot it.

Get the altitude and azimuth for the time you plan to observe from any number of popular astronomical programs or websites. From here in Westchester County add 13° to the azimuth to get the compass bearing for Venus measured from north in an easterly direction. This 13° adjustment is the local difference between true and magnetic north and is called the magnetic declination or variation as sailors know it. Face the direction indicated by the compass. It can be convenient to note some landmark lying in that direction. Start with your eyes or binoculars on the horizon and then slowly raise them, paying particular attention as the expected altitude of Venus is approached. The brilliant white planet should "pop" out of the azure blue background. The effect is striking and not something you'll soon forget!

And now for something else to think about. As stated above, the maximum elongation of Venus from the Sun as seen from Earth is 46°. From that fact, can you estimate the radius of the orbit of Venus in astronomical units (AU)?

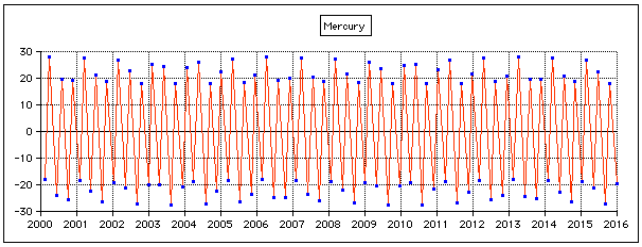
Recall the geometry we learned in high school. Assume that the orbits of the Earth (♁) and Venus (♀) are circles. This is a pretty good approximation, since Venus's orbit is closest to a circle of any of the planets. In this approximation the orbital distance of the Earth to the Sun is a constant 1 AU. In the figure on the next page the locations of the Earth and Venus are shown when Venus is at its maximum elongation

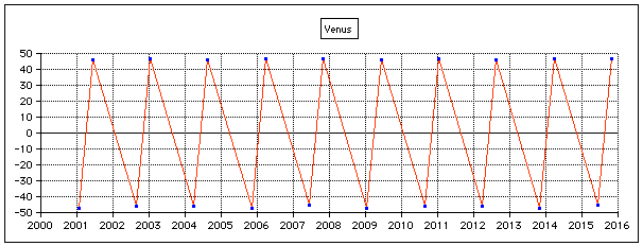
from the Sun. From simple trigonometry, the radius of Venus' orbit is 1 AU x sin(46°) = 0.72 AU or around 67 million miles. For a right triangle, the sine of each of the acute angles is the length of the opposite side divided by the length of the hypotenuse. Since we know the angle, we solve for the opposite side.



The Editor adds:

You can do a similar calculation for Mercury, but it's a little more complicated. Mercury's orbit has a much greater eccentricity (0.205) than Venus (0.007) or the Earth (0.017). It's almost as eccentric as Pluto (0.244). So its maximum elongation from the Sun as seen from the Earth varies quite a bit, depending on where each body is in its orbit. The average elongation is 22.7° (range 17.9° to 27.8°), so its average distance from the Sun is 0387 AU (range 0.307 to 0.466). You can see the substantial variation in Mercury's position at maximum elongation, and the constancy of Venus', from the graphs below.



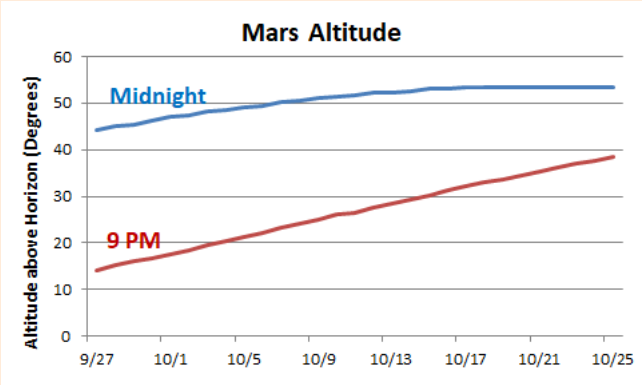


Greatest elongations of Mercury and Venus, 2000-2016
(negative values eastern elongation, positive western)

Start Planning for Mars

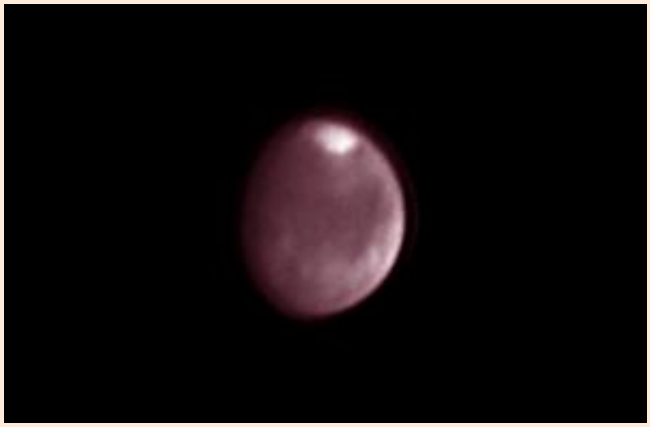
Mars will have a moderately close opposition this fall, making its closest approach to Earth on October 6th at 14:19 UT (3:19 p.m. EDT). It will appear 22.6 arcseconds in diameter, 90% of its maximum possible size (25.1") and about one half the diameter of our usual views of Jupiter at its opposition. It will be 38,568,243 miles (62,069,571-km) from Earth. The next time it will be this close is July 2033, so don't miss it!

On nights surrounding the closest approach, Mars will be favorably placed in our night sky, shining at magnitude -2.6. The graph below shows its altitude at 9 pm and midnight.



The disc will be 100% illuminated between October 6th and October 22nd. The planet's apparent diameter will be 22.0 arcseconds or above between September 24th and October 18th. Observing should be excellent until early November.

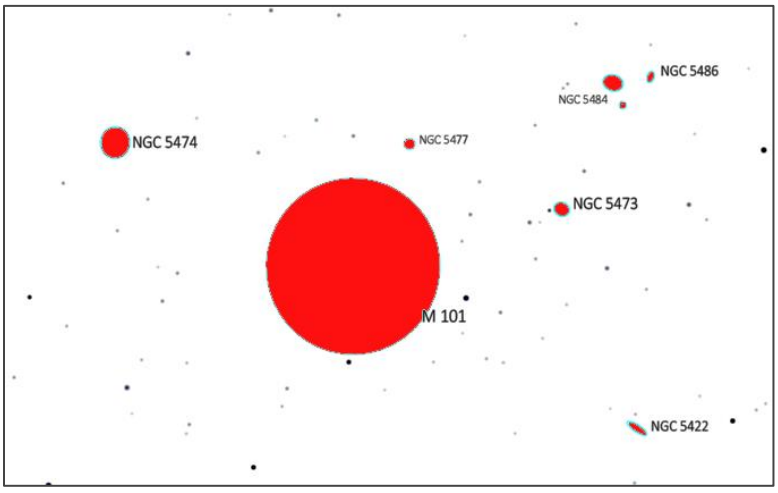
John Paladini got a jump on things in the wee hours of July 19th, imaging with a Celestron 9.25-inch SCT and a ZWO ASI120MM camera. Mars was magnitude -0.8 with a disc diameter of 13.1 arcseconds.



Messier 101 and Friends by Arthur Rotfeld

A wide-field view of Messier 101 in Ursa Major, sometimes called the "Pinwheel Galaxy" for obvious reasons. In the field are a number of other galaxies as shown on the map below. It's a challenge to see M101 visually from Westchester even with a medium-size telescope because of its low surface brightness.

M101 is a very large galaxy. Its diameter is 170,000 light-years, perhaps 70% larger than the Milky Way, and it is estimated to have twice as many stars, nearly one trillion. It has a large number of H II regions where star formation is occurring, and some of these actually get their own NGC listings.



Map of the galaxies visible in Arthur's image

M101 is asymmetric because of tidal interactions with galaxies in the so-called M101 group: NGC 5474 NGC 5477, NGC 5205, NGC 5585, UGC 8837 and UGC 9405. The first two of these are visible on the image, along with some more distant galaxies

Object	Mag	SB	Distance (Mpc)
M101	7.9	14.9	5.34 ± 0.40
NGC 5474	10.8	13.9	5.84 ± 0.45
NGC 5477	14.0	14.7	6.24 ± 0.46
NGC 5473	11.4	12.8	31.56 ± 2.21
NCG 5422	11.8	12.8	28.86 ± 2.03
NGC 5484	11.4	12.9	31.65 ± 2.32
NGC 5486	13.3	14.0	22.20 ± 1.56

M101 is a fine binocular object in a very dark sky. It's about as large as the full Moon.

NGC 5907 by Gary Miller

NGC 5907 in Draco is also known as the Splinter Galaxy or the Knife-Edge Galaxy. It's a 10.3-magnitude edge-on spiral 36 million light-years distant. It was discovered by William Herschel on the night of May 5, 1788. It's 11.5 arcminutes across but only 1.2 arcminutes wide, inclined to our line of sight by just two degrees. It's a large galaxy, 120,000 light-years in diameter. The disc is slightly warped, similar to the Milky Way, as we've recently learned. The warping is the result of interactions with a satellite galaxy some four billion years ago. The smaller satellite was disrupted and evidence of that interaction remains in the form of star streams looping around NGC 5709. These were found on deep images obtained from a 0.5-meter robotic telescope in New Mexico.[7] In addition, it is made up almost entirely of dwarf stars, most likely another result of the interaction.

Gary used a DSLR and 127 mm ED refractor. He was able to get a total of three hours 18 minutes of exposure time over two nights.

NGC 5907 is just 1½ degrees from NGC 5866, a magnitude 9.9 lenticular galaxy. NGC 5866 is sometime thought to be the "missing" Messier 102.

[7] Martinez-Delgado, D, et. al., The Ghost of a Dwarf Galaxy: Fossils of the Hierarchical Formation of the Nearby Spiral Galaxy NGC 5907, *Astrophysical Journal* 2008, 589: 184-193. On line at https://iopscience.iop.org/article/10.1086/592555/pdf.

Moon & Sun

Greg Borrelly's image of the 99.1% illuminated Moon was taken at 11:49 pm on July 5th from Yonkers. The Moon was just 23 hours after full. Orion 80ED f/7.5, Canon T6i 1/1250 sec, ISO 800.

On July 2nd, **John Paladini** captured this prominence with a classic Edmund 3" f/15 refractor and a Quark Chromosphere H-alpha filter. Point Grey Chameleon camera. Stacked with Registax and manipulated with Photoshop and PaintBucket to give it the final color touch.

Research Highlight of the Month

Reinhold, T, *et. al*, The Sun is less active than other solar-like stars, *Science* 2020; 368:518-521

The 11-year solar cycle is measured by the number of sunspots, changes of which reflect the waxing or waning of solar magnetic activity. When activity is high, there are many sunspots and an increased possibility of solar flares and coronal mass ejections. CME's have the potential to disrupt electrical technology on the Earth. The Carrington event of September 1, 1859, created auroras and caused telegraph operators to get electric shocks. A similar event now would also cause auroras but would destroy satellites and trigger widespread power system failures. With so many power transformers destroyed, it would take a very long time to restart the electrical grid. Even the weather could be affected. There would societal disruption on a massive scale, although it would be dark at night around the world and at least we'd see the auroras much better, small compensation for total chaos. Can we get any idea of how the magnetic activity of our Sun compares with that of similar stars?

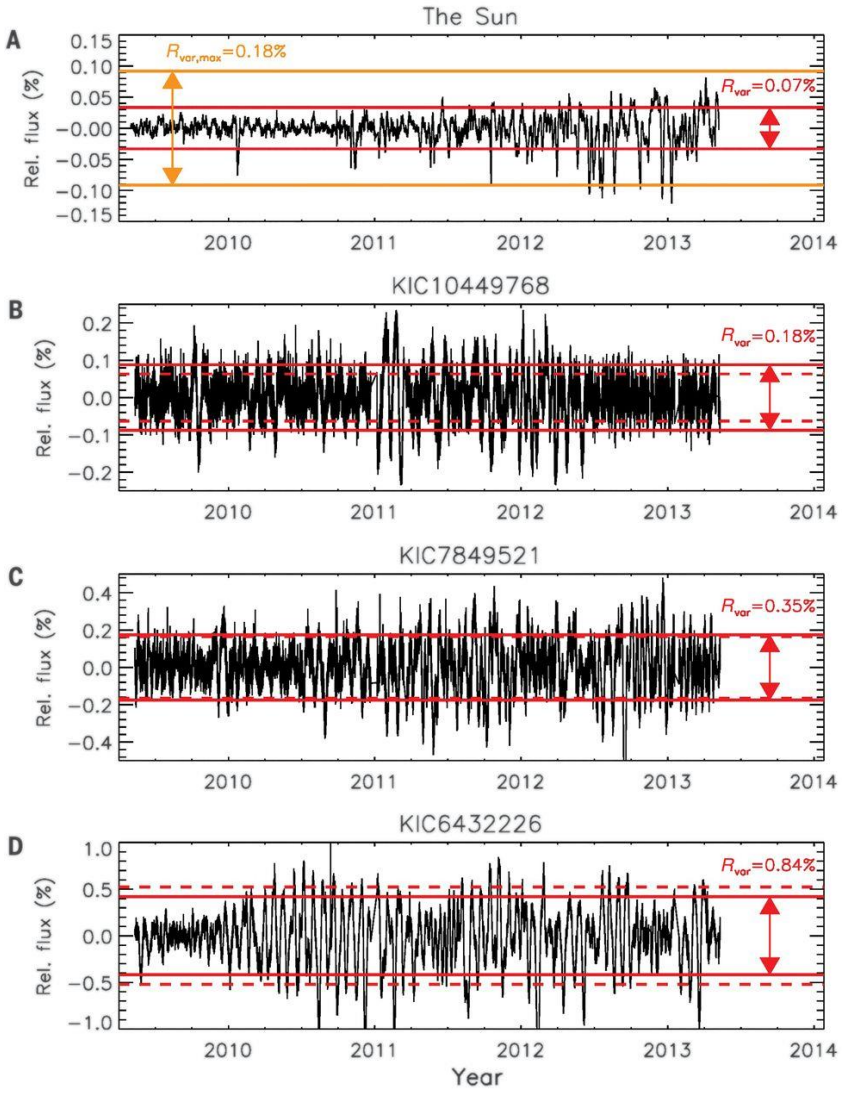


Fig. 2 from Reinhold, *et. al*. Light curves from the Sun and three of the stars studied by the Kepler and Gaia missions.

An international group based at the Max Planck Institute in Germany studied the light curves of 2,898 Sun-like stars using data from the Kepler and Gaia missions. They showed that the Sun has much less variability than stars with a similar surface temperature, age, surface gravity, metallicity and other parameters.

Previous theories suggested that stars slow down and get less active as they age, but this scenario is now being questioned. The middle-aged Sun may be transitioning and its rotation not slowing, meaning its variability may increase in the future. That's in spite of predictions that the coming solar cycle 25 will be less intense that the last few.

The prediction of a future increase in solar activity might provide the impetus to find better ways of protecting our technology and the global society that depends on it. Also, it's possible that this is evidence that, for reasons that we don't yet understand, the Sun is actually special when compared to other seemingly identical G stars. Perhaps its relative stability is why life could evolve on our planet, since a more frequent and more intense bombardment of charged particles might overwhelm the protective effects the planetary magnetic field has for our biology.

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
Meade 395 90 mm achromatic refractor	Long-tube refractor, f/11 (focal length 1000 mm). Straight-through finder. Rings but no dovetail. 1.25" rack-and-pinion focuser. No eyepiece. Excellent condition. A "planet killer." Donated to WAA.	$100	WAA ads@westchesterastronomers.org
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.	$195	Eugene Lewis genelew1@gmail.com
Celestron 6-inch f/5 reflector OTA	Same tube as the Orion 6" StarBlast. 1¼" rack-and-pinion focuser, Celestron 25 mm EP, tube rings, dovetail plate. 5x30 straight through finder. Dark canvas carrying case with compartments, room for accessories. Excellent condition, unblemished optics. This size OTA is hard to find without a mount. An Orion StarBlast 6 with 1¼" focuser and table-top Dobsonian mount lists for $379. Meade's 6" f/5 OTA, admittedly with a 2" Crayford focuser but no case, lists for $339. Donated to WAA.	$175	WAA ads@westchesterastronomers.org
Celestron Orange Tube C8	A gem from the 1970's! WAA has had this scope in storage for a long time. Serial #25778-6, labeled "Celestron Pacific," so it was made before Tom Johnson changed the company's name to "Celestron International" in 1978. Perfect condition, unblemished optics, comes with 110 volt power cable, finder and wedge, lacks only the tripod. Includes several eyepieces and other paraphernalia. You could also de-fork it and use the optical tube on a go-to GEM, which actually makes the most sense, although you might feel bad about getting rid of the iconic Celestron fork mount. Current Celestron 8" SCT optical tubes list for $679-$800.	$300	WAA ads@westchesterastronomers.org
WANTED	One of our members, 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!*