SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

May 2024

The Sun on March 25 by Rick Bria

Rick used a new Canon EOS R6 Mark II mirrorless camera on an 8-inch Meade LX-200 Schmidt-Cassegrain telescope with a solar filter to record this image of the "white light" Sun. It's a single 1/1000-second image.

Coming next month: The Eclipse Issue

Our club meetings are held at the David Pecker Conference Room, Willcox Hall, Pace University, Pleasantville, NY, or on-line via Zoom (the link is on our web site, www.westchesterastronomers.org).

WAA May Meeting

Friday, May 10 at 7:30 pm

Funding the Final Frontier

Emma Loudon
Department of Astronomy, Yale University

This interactive talk will explore the intricate dynamics of funding for space exploration, with a particular focus on NASA's profound impact on society. We'll discover how strategic investments in space missions have advanced our scientific understanding and spurred innovations that permeate everyday life. From technological advancements to fostering international cooperation, we will learn how NASA's budgeting decisions shape economic growth, technological innovation, and even the geopolitical landscape. The vast societal returns generated by funding space exploration argue for continued investment in reaching beyond our earthly confines for what some would call less practical reasons. Join astrophysicist Emma Louden (@exoplanet_emma) as she charts the course from fiscal inputs to astronomical impacts, highlighting why pursuing the unknown yields dividends far beyond the stars.

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 June Meeting

Friday, June 14 at 7:30 pm

Solving the Missing Baryon Problem with Fast Radio Bursts

Isabel Medlock
Department of Astronomy, Yale University

Starway to Heaven

Ward Pound Ridge Reservation, Cross River, NY

Saturday, May 4, 8:00 p.m.
Saturday, May 11, 8:00 p.m.
Weather permitting.

New Members

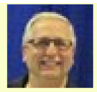
Michael Blanton	Irvington
Melissa Brown	Croton on Hudson
Katherine Macleod	Larchmont

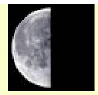
Renewing Members

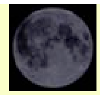
Arun Agarwal	Chappaqua
Satchi Anderson	Tuckahoe
Winston Archer	Yonkers
Christopher Auletta	White Plains
Steven Bellavia	Mattituck
Joel & Rita Bender	New York
John Benfatti	Bronx
Rick Bria	Greenwich
Chris Bubacz	White Plains
Donna Cincotta	Yonkers
Tim & Cindy Dunne	Scarsdale
Charles Fulco	Millsboro
Jinny Gerstle	Lexington
Wendy Kutin	Mt. Kisco
John Lanzetta	Tarrytown
Milagros Lecuona	White Plains
Mark Lewis	Pine Bush
Norma Montel	Ardsley
Anthony Ortega	Scarsdale
David Parmet	Mt. Kisco
Jake Sablosky	Chappaqua
Michael Sheridan	Mt. Kisco
Peter Spenser	New Rochelle
Dante Torrese	Ardsley

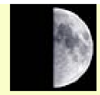
ALMANAC for May 2024

Bob Kelly, WAA VP Field Events

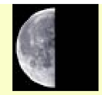

Bob Kelly


3Q May 1


New May 7


1Q May 15


Full May 23


3Q May 30

Mercury Pops Up

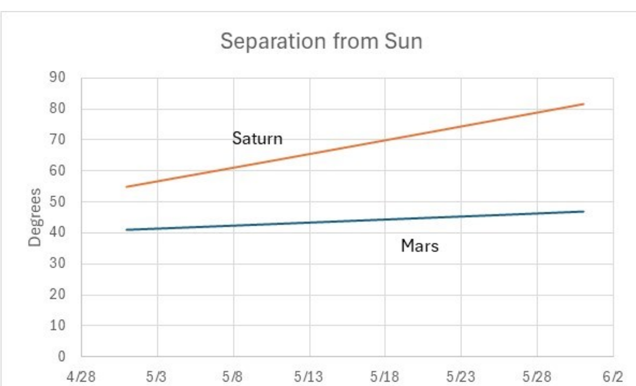
Mercury reaches its greatest elongation from the Sun in the morning sky on the 9th. It's off at a low angle in the morning sky, so the innermost planet will be hard to pick up before sunrise. The latest time of Mercury-rise will be halfway between the beginning of twilight and sunrise.

Jupiter Hides; Venus, too

Giant Jupiter goes into conjunction with the Sun this month, so there will be no sightings in our skies for a while after the first few days of the month. Jupiter will pass through the Solar & Heliospheric Observatory's viewer from the 8th to 29th. Venus will also pass through in the opposite direction, from May 6 through July 3. Got to https://soho.nascom.nasa.gov/data/realtime-images.html.

Mars and Saturn Mornings

That leaves Mars and Saturn for easier viewing among the major planets. They are in the morning sky, slowly gaining distance from the Sun in our skies. Use a telescope to compare apparent size, shape and color. Keep an eye on Mars: it seems like it doesn't want to get very far from the Sun. Mars appears to lag behind Saturn, only gaining 6 degrees of separation from the Sun while Saturn gains 26 degrees.



On the 31st, the 23-day waning Moon, 42% illuminated, passes close to Saturn. One hour before sunrise, they will be just 1¼ degrees apart. After that, the Moon takes three days to cover the distance between Mars and Saturn in our sky. It'll make for some nice wide-angle photos with foreground objects for context. The Moon makes a similar pass through that area earlier in the month, from the 4th to the 6th, but appears to steer clear of the morning planets on that pass.

Space Station Overflights

The International Space Station will be visible in the morning sky until the 9th, then for the next few days the ISS will be making overflights every 93 minutes all night (of course, not visible when it's in the Earth's shadow). For the rest of the month, this international outpost in outer space will be visible in the evening sky through midnight.

China's space station, Tiangong, will be visible every 92 minutes after 3 a.m. starting on the 20th through the end of the month. Check sites like heavens-above.com for updated times.

Meteor Shower

The Eta Aquariids peak on the night of May 4-5. As usual, they will be best just before dawn. There will be more meteors if you are in the southern hemisphere. With only an 18-percent illuminated moon, there won't be much interference for viewing the 10 to 30 meteors per hour.

Comets

C/2023 A3 (Tsuchinshan-ATLAS), a comet discovered in early 2023, is on its way to making a bright appearance this fall. It's predicted to have naked eye visibility. It's now in Virgo, magnitude around 10, visible in moderate telescopes or large astro- binoculars. It'll be well up in the evening sky in May at magnitude +9. See http://www.aerith.net/comet/catalog/2023A3/2023A3.html for updates.

Comet 13P/Olbers is a magnitude +8 evening object low in the northwest at the end of twilight. Comet Olbers should be better placed for our viewing in June, as it approaches magnitude +6 in August. Olbers was discovered in 1815. It's another comet like Comet Halley, this one returning to the inner solar system after its last pass 68 years ago. Comet Olbers will make perihelion while on the other side of the Sun from Earth, so it would be even more impressive if it had passed closer to Earth.

Moon Tries to Block Other Stars, Too

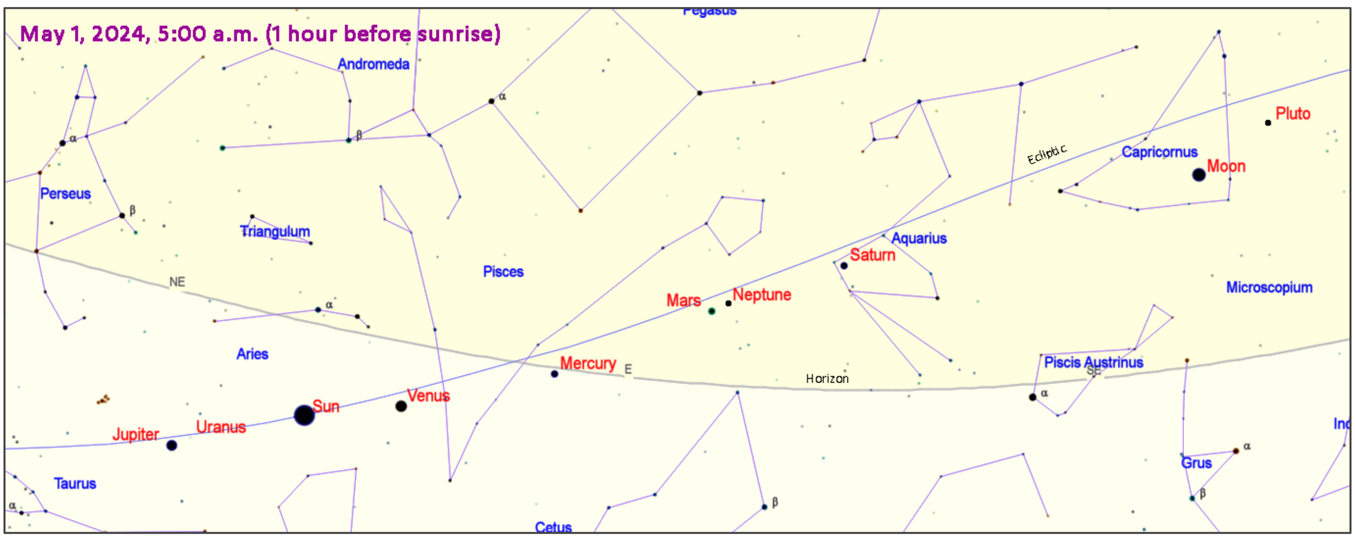
The full Moon covers the bright red star Antares on the evening of the 23rd for southern New Jersey and southward. For us, the rising Moon will look like it has a tiny red cherry on top, if we can see Antares at all through the glare of the fully-lit Moon. A telescope will help.

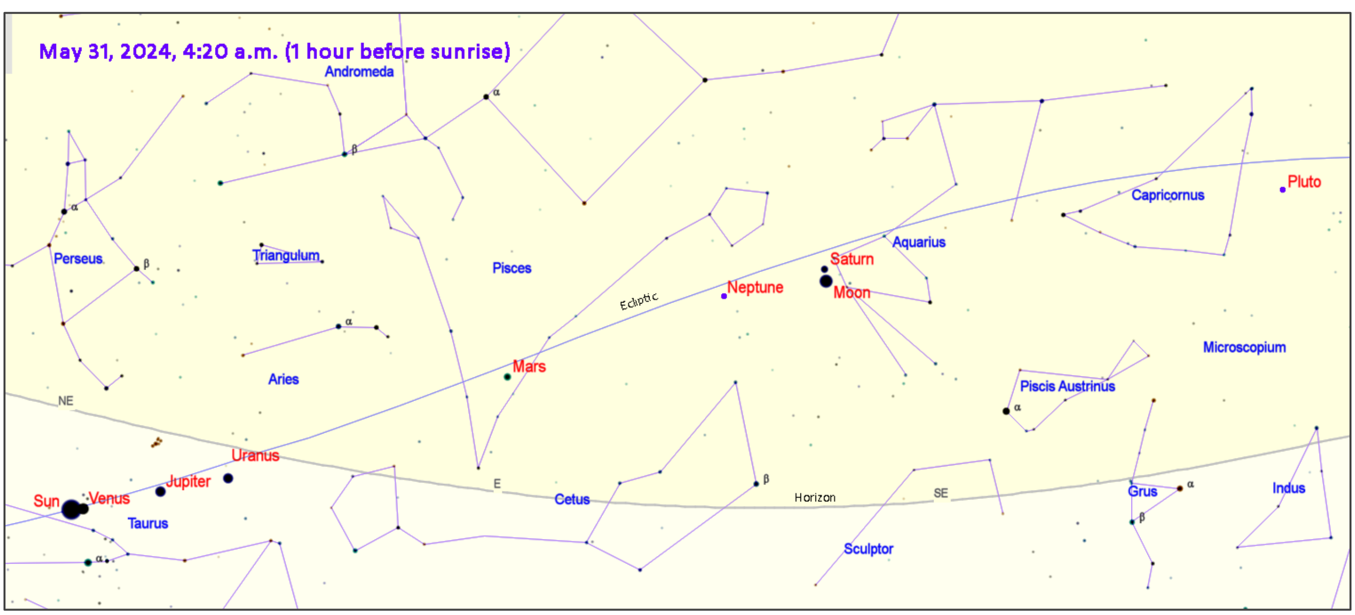
Asteroids

The second asteroid to be discovered, Pallas, is brightest for the year in May, peaking at magnitude +9.0 in the outer reaches of Hercules. It's hard to distinguish from nearby stars, even with optical aid. You might want to look for the first asteroid, Ceres, now officially a "minor planet." It's a whole magnitude brighter in the eastern suburbs of Sagittarius.

Our Starry Friends

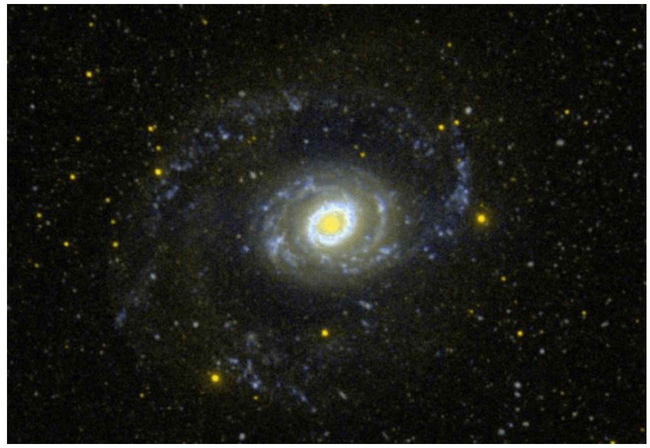
It's a good time of year to see Gemini dance on the west-northwestern horizon just after dark. It looks like Leo is chasing them off our celestial stage. The end of astronautical twilight moves from 9:30 to 10:30 p.m. The summer constellations, with the Milky Way stretching across the sky, will begin to rise around midnight. ■





Deep Sky Object of the Month: Messier 94

Messier 94	
Constellation	Canes Venatici
Object type	Barred spiral galaxy
Right Ascension J2000	12h 50m 53,1s
Declination J2000	+41° 07’ 14”
Magnitude	8.2
Size	11.2’ x 9.1’
Distance	16 million LY
NGC designation	NGC 4736
Discovery	Pierre Méchain, 1781
Nicknames	Cat’s Eye Galaxy Crocodile’s Eye Galaxy

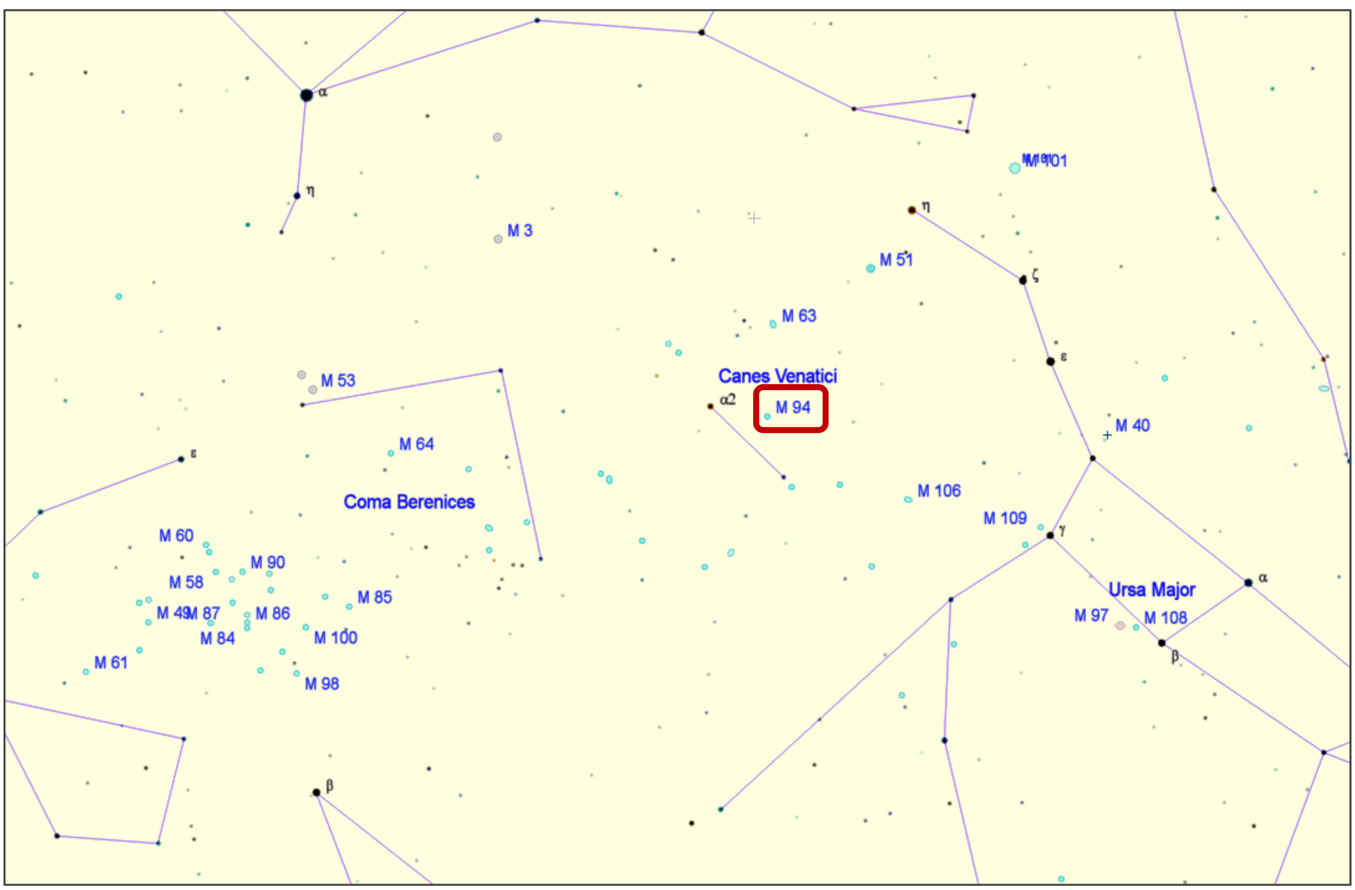


Visibility for M94			
2200 EDT	5/1	5/15	5/31
Altitude	77° 52’	88° 41’	79° 52’
Azimuth	85° 57’	98° 03’	272° 54’

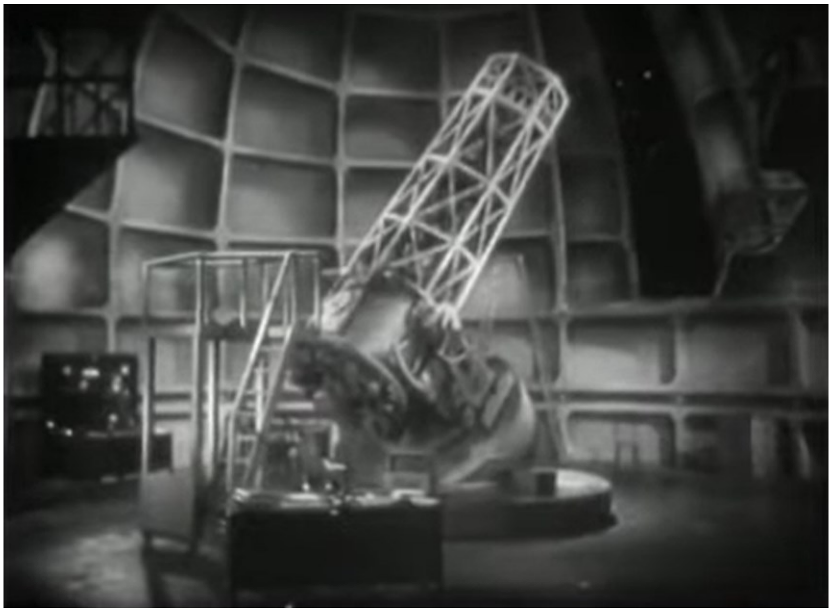
High overhead in May, M94 is an unusual galaxy with a double ring structure, which form at resonance points in the galaxy’s disk. The outer ring is actually a spiral structure containing 23% of the galaxy’s mass. The star formation occurs in both rings, but at a greater rate in the outer ring.

M94 is the brightest member of the M94 Group, which lies within the Virgo Supercluster

Various theories have been advanced for the peculiar distribution of matter in M94. One study suggested that M94 was deficient in dark matter, but this has not been confirmed.



Another Movie Telescope: Flash Gordon



The13-episode movie serial *Flash Gordon*, starring Buster Crabbe, was made in 1936. Based on a comic strip that premiered in 1934, the action is built on the discovery by astronomers that the planet Mongo is on a collision course with Earth. The opening scene shows a telescope that looks exactly like the 60-inch fork-mounted telescope at Mt. Wilson Observatory. Perhaps the scene was filmed there, although the scope's base and the inside surface of the dome look slightly different.

Happily ignoring the laws of physics and the realities of space flight, Flash, Dale Arden and Dr. Zarkov fly in the latter's rocket ship to Mongo, Dr. Zarkov claiming to know how to prevent the collision. We get to meet Ming the Merciless, his seductive daughter Princess Aura, and all sorts of peculiar denizens of Mongo, starting with the usual giant reptiles common to these kinds of 1930's films (think *King Kong*).

The telescope dome seen briefly in several episodes is Griffith Observatory in Los Angeles, which opened in 1935. The small dome houses the 12" Zeiss refractor, the most looked-through telescope in the world. See the June 2015 SkyWAAtch for more on Griffith.

We love the sound made by the rocket ships, which reminds us of an electric sander. The primitive technology was not a barrier to enjoying how Flash and Dale extract themselves from so many peculiar and seemingly inescapable crises.

Clarence Linden "Buster" Crabbe (sometimes listed as Larry "Buster" Crabbe) won the 400-meter freestyle swimming event at the 1932 Olympics, and immediately turned to acting. He played the three most famous comic-strip heroes in movie serials in the 1930s: Tarzan, Flash Gordon and Buck Rogers, although another Olympic swimming gold medalist, Johnny Weissmuller, was the more famous Tarzan, making 12 full-length films. Crabbe made two more Flash Gordon serials: *Flash Gordon's Trip to Mars* (1938), and *Flash Gordon Conquers the Universe* (1940).

Charles Middleton, in his role as Ming, largely created the archetype of evil that still inhabits fantasy movies today. We recall his appearance as the prosecutor in the Marx Brothers' zany classic *Duck Soup* (1933). He appeared in 200 films, including *Showboat*, *Abe Lincoln in Illinois* and *The Grapes of Wrath*.

Thanks to WAA member **Joe Geller** for sending in this movie telescope after going to a screening of the serial at the Museum of Modern Art in January. All the episodes are on YouTube. ■

NEAF Report Steve Bellavia

NEAF 2024, Sunday at 2 p.m. Photo by L. Faltz

I attended the North East Astronomy Forum, (NEAF) 2024, Saturday and Sunday, April 20-21.

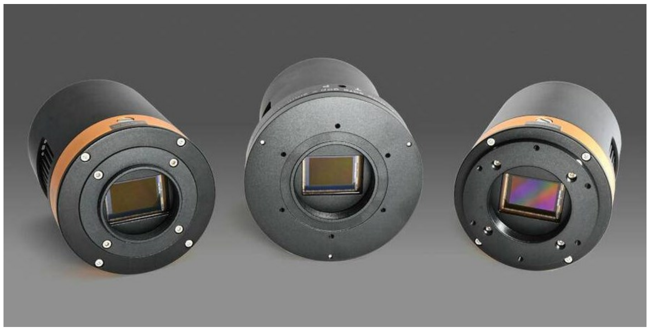
Let me start off by stating that this is not meant to be fully comprehensive. These are just my overall takeaways:

1. Many of the past vendors were not there, with many new (or new to me) vendors/manufacturers to take their place:

Sightron of Japan: They are apparently known for their rifle scopes, but they had a gorgeous refractor there on a Sightron strain-wave mount, as well as binoculars, etc.

Spectrum Optics Instruments/MirroSky: I never heard of them. They had a large selection of telescopes, mounts, etc., and a really nice 110mm, f/5.7 doublet apo refractor:

Ogma cameras and accessories: A new company making astrophotography equipment, using Sony sensors (much like ZWO) in an attractive, solid-feeling package, with great prices.



Airy Disk: Absolutely stunning refractors. I am very interested in their 96mm and 106mm triplet FCD-100 apo's.

2. There has been an explosion of strain-wave mounts.

Everyone seems to have one now. iOptron has seven models, with and without high precision encoders.

3. It was great to see so many familiar faces from near and far.

Of course, a couple of selfies with Al Nagler, Pac Sun Glatter, Cecilia Detrich, Ted and Mia Ishikawa, Dan Davis...

Steve with Al Nagler

4. On Saturday I showed about 20 people Venus, in between the clouds.

It was too cloudy Sunday to do anything.

5. Shopping

My main "goal" (besides outreach and to have fun) was to investigate the many new light and compact strain-wave mounts, as well as image-capture-computers (like ASIAir). ZWO now has an ASIAir Mini built into a camera, the ASI2600 MC Air. That's clever.

However, I did not have any revelations, and might just stick with my massive EQ6R-Pro and bulky laptop for a little while longer. I don't need any more telescopes, but I really liked the Explore Scientific 152mm, f/12.5 Mak-Cass. It's white, has a handle, a beefy focuser, and small secondary obstruction.

And I loved all the refractors there including what seems like a new Vixen line. Refractors are a small compulsion that I have, with no cure in sight.

But the only thing I purchased during the show, both days, was a Pepsi from the cafeteria. But after the show, I thought about that ED 152 Mak and decided to buy one, taking the extended Explore Scientific NEAF discount. I plan to use it primarily for planetary viewing and imaging.

I only attended one talk. Time goes by too fast to do it "all" at NEAF, but I have no complaints. I had a great time and can't wait until next year. A full album of my 2-day adventure is here. https://www.flickr.com/photos/125134422@N06/albums/72177720316419623

The Editor comments:

I was only able to come for a short time on Sunday this year, missing both days for the first time in a decade. The show was clearly smaller and less well-attended than in the past. Lunt apparently opted out because of “eclipse fatigue” (they provided scopes for NASA’s public event and broadcast from Carbondale, Illinois). Many stalwarts of the past were also absent, including Markus Ludes (Baader), AstroPhysics and Stellarvue. CCTS was the only full “retail” vendor. I didn’t see Woodland Hills although they were listed in the program). As usual, Celestron, Explore Scientific and SkyWatcher had full displays.

The presence of new camera and small refractor companies is a tip-off to the change in the hobby that I described in my article in the November 2023 SkyWAAtch (“Amateur Astronomy Evolves. Should It?”, p. 9). It wasn’t that long ago that the stars of NEAF were large Dobsonians (Teeter, we miss you).

Never again to be seen at NEAF? A scene from 2018. 30” Dob.

As in the past, high-end makers like Takahashi, PlaneWave and PrimaLucieLab displayed their fantastic products. The ZWO booth was a hub of activity, the SeeStar clearly a super-hit in today’s astronomy business. And there were still many interesting exhibitors with a vast range of offerings, among them meteorites, lens cleaning systems, filter makers, and remote observing hosting sites.

As Steve notes, the real attraction of NEAF is meeting the many astronomy friends that we’ve made over the years. It was also great to see WAA members at the booth, which was right next door to Televue, which we viewed as an honor. Like Steve, I didn’t buy anything there except food: a pretzel and a Diet Coke. Unlike Steve, I didn’t succumb afterwards.

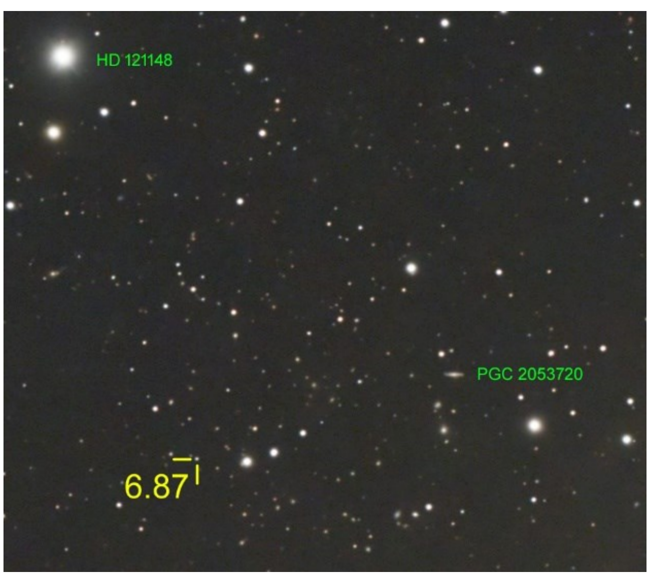
LF

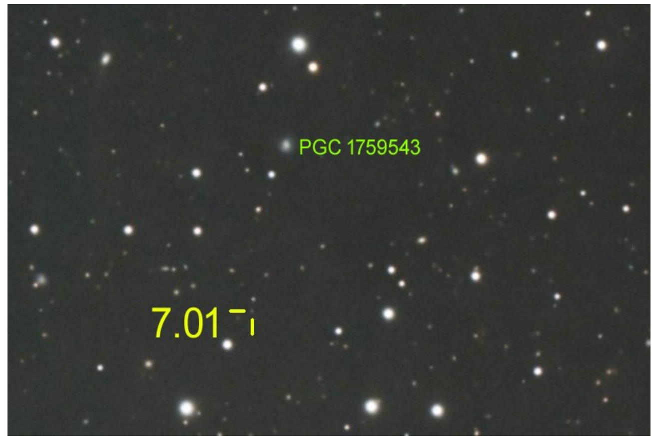
From the Editor: To Be a Quasar, or Not to Be? Larry Faltz

Light from astronomical objects takes its time getting to us. From the Moon, one and a quarter seconds, from the Sun 8 minutes, from Voyager 1 22½ hours, from Sirius 8 years, from M31 2½ million years, and from the nearest quasar Markarian 231, 600 million years.[1] In the March 2024 SkyWAAtch, we found distant quasars on images made by WAA members Robin Stuart and Bill Caspe. Bill's image contained a quasar with a redshift of 3.32 (compared to Markarian 231's meager 0.04147). The light from a z=3.32 quasar was emitted 11.7 billion years ago.

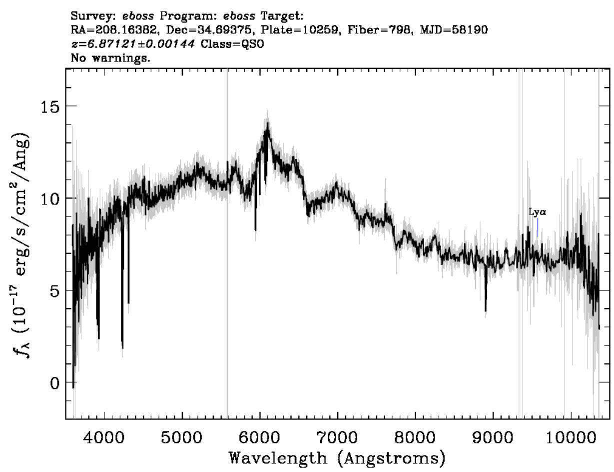
We challenged the two intrepid astrophotographers to go deeper. Available quasar catalogs can be linked to various planetarium programs to make quasar hunting a little easier, as we mentioned last month. Although not a planetarium program per se, the image processing software PixInsight also uses these catalogs to label objects it finds on images.

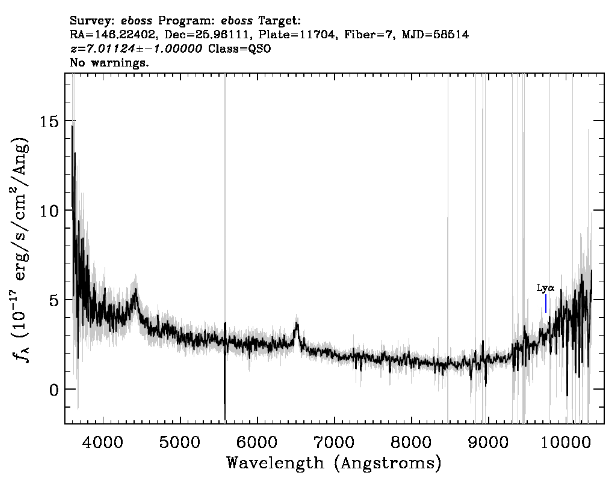
Rising to the challenge, Robin sent in a couple of deep sky images with objects identified by the Sloan Digital Sky Survey (SDSS) as quasars with redshifts of 6.87 and 7.01. The images shown here are cropped sections, with a minimum of identifiers for clarity. The z=6.87 object is magnitude 18.96 SDSS J135239.31+344137.5 in Coma Berenices. The z=7.01 object is SDSS J094453.76+255740.0 in Leo, magnitude 20.34.





I expected to find Lyman-alpha (Lyα) emission peaks at 9567 Å and 9737 Å respectively in the two new quasars, but when I looked at the spectra on the SDSS SkyServer, there were no peaks where the Lyα line was annotated to be. It seemed odd.





[1] 3.3 nanoseconds for a person standing 4 feet from you.

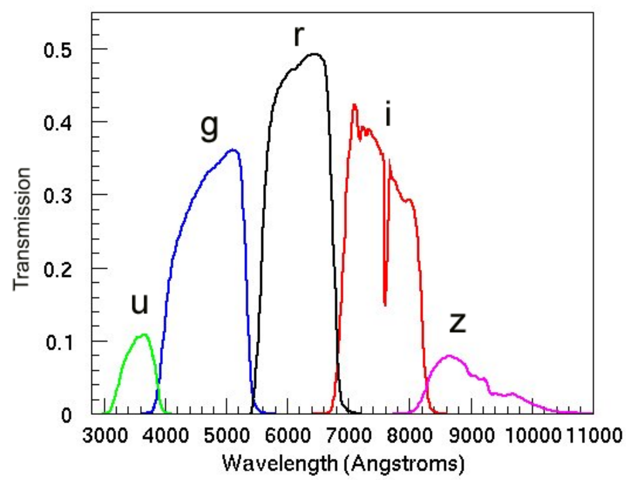
Are these the true redshifts? Could there be some kind of error? The data on the professional web sites CDS, Simbad and NED were consistent; they use the same links to the SDSS catalog that our own software uses. So we did some exploring on the SDSS web site, and we learned a lot about the remarkable SDSS and some of its potential limitations.

Sloan Digital Sky Survey

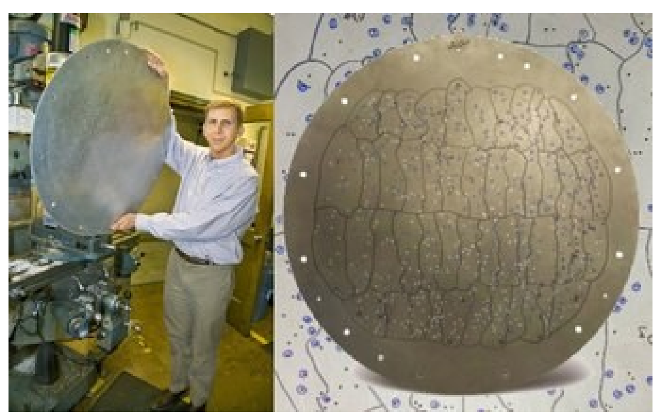
The SDSS was conceived in 1991 and began operations in 2000. It is an observing program designed to accurately measure the redshifts of a large number of galaxies. Astronomers could use these data to map the distribution of matter in the universe, informing and testing a variety of cosmological assumptions. As mentioned in the January 2024 and February 2024 SkyWAAtches, beginning with Shapley and Ames' pioneering study in 1926 astronomers began to appreciate that galaxies were not randomly scattered in the cosmos. Glimpses of grand structure were evident in the Palomar Sky Survey and other observational programs in the second half of the 20th century: galaxy groups, clusters, superclusters, the Boötes void, the Great Wall. By the end of the 20th century, both theory and technology were ready for a grand observational assessment of cosmic structure.

The Sloan Digital Sky Survey is based at the Sloan Foundation's 2.5-meter f/5 Ritchie-Chrétien telescope at Apache Point Observatory in New Mexico, not far from Alamogordo. The alt-azimuth mounted instrument is housed in a roll-off roof observatory. The 3° field of view is achieved with an f/2.25 hyperbolic primary, 1.08-meter hyperbolic secondary and two corrector lenses, giving a highly corrected flat field that can detect objects down to magnitude 23. Its first goal was to examine fields over 35% of the northern sky, making images for photometry and then spectroscopy. The photometric images utilized the now familiar *u,g,r, I* and *z* filters, collecting photons with a unique camera and tracking technique that would allow a single pass to collect five filtered images for each field, which can be independently assessed or combined to a full-color image. The filters cover specific arrays of pixels rather than being rotated into place by a filter wheel.

Although the filtered images could give a general assessment of an object's spectral energy distribution in the visible range and near infrared, it was not a real spectrum. For true spectroscopy, an aluminum plate was drilled with holes in the position of each object to be examined in a specific field. Optical fibers were meticulously placed in each hole through which light was delivered to a spectrometer. The tedious task of connecting the fibers was apparently assigned to undergraduate astronomy majors at participating universities. There were 640 optical fibers per plate. The prepared plate with its fiber bundle was placed at the telescope's focal plane for another observing run and the light fed to the spectrograph. The SDSS database records the observing run, plate numbers and optical fiber number for each object.



SDSS filter transmission



David Schlegel, Principal Investigator of SDSS-III, with one of the plates

There were multiple projects within each of the overall SDSS programs, not limited to finding ultra-distant objects. SDSS-I's initial photometric and spectrophotometric survey was followed by SDSS-II , which carried out three distinct programs: the Sloan Legacy Survey of 230 million celestial objects with spectra of 930,000 galaxies, 120,000 quasars, and 225,000 stars; SEGUE (the Sloan Extension for Galactic Understanding and Exploration) which imaged and took spectra of a quarter of a million Milky Way stars; and the Sloane Supernova Survey, which found 500 Type Ia supernovas over a three month period.

SDSS-III encompassed APOGEE (APO Galactic Evolution Experiment) which surveyed 100,000 red giant stars in the Milky Way; MARVELS (Multi-object APO Radial Velocity Exoplanet Large-area Survey) which looked at radial velocities of 11,000 stars to search for exoplanets; SEGUE-2 (a follow up to SEGUE, looking at 120,000 stars); and BOSS (Baryon Oscillation Spectroscopic Survey (which measured redshifts of 1.5 million luminous galaxies to $z = 0.7$ and the Lyman-α forest spectra of 160,000 quasars at redshifts $2.2 < z < 3$) to derive the characteristic scale imprinted by baryon acoustic oscillations in the early Universe.

SDSS-IV encompassed three programs: APOGEE-2, which extended APOGEE with additional data from the 2.5-meter DuPont telescope at Las Campanas in Chile; eBOSS (Extended Baryon Oscillation Spectroscopic Survey) with more data; and MaNGA (Mapping Nearby Galaxies at APO) which made spatially resolved spectra of 10,000 brighter galaxies.

SDSS-V will gather even more data. The tedious manual drilling of plates and placing of fibers has been replaced with an automated fiber system that positions 1,000 fibers in a manner of minutes, vastly increasing the throughput. Other surveys, such as the Dark Energy Spectroscopic Instrument at Kitt Peak, which has 5,000 automated fibers in a 4-meter telescope, are addressing similar cosmological issues.

Data analysis

SDSS relies on a connection to the world of particle physics. Particle accelerators, neutrino detectors and cosmic ray telescopes need advanced computer hardware and software to detect and analyze large amounts of data. For example, the Large Hadron Collider can generate and potentially detect 600 million collisions a second. Computers analyze these collisions in real time and filter out the very small number that are of real interest. This is a paradigm useful for analyzing the gigabytes of data generated each night by the various SDSS observing programs. Although not quite as time intensive as the accelerator data, there is still a large amount of photometric and spectral information that needs to be classified, and with the large number of objects, the process needs to be rapid and accurate. Is the object a star? A galaxy? A quasar? A cosmic ray? An asteroid? A satellite? A firefly? United Airlines flight 635? Doing this manually is impossible. SDSS has a funding and governance link to the US Department of Energy, which operates Fermilab in Illinois, where there is expertise to develop high-throughput real-time computing programs. In SDSS-1, data was even shipped to Fermilab on magnetic tape and analyzed there.

There is a personal link between the two facilities. John Peoples, PhD, was the director of Fermilab from 1989 to 1999. He was responsible for upgrading and increasing the power of the Tevatron, Fermilab's accelerator, which discovered the top quark in 1995. From 1998 to 2003 was also the director of SDSS. Peoples began his academic career at Columbia, and in another personal link, this one to the author, he taught my undergraduate physics course in 1966-67.[2]

The computer "pipeline" analyzes, classifies and validates photometry and spectra. The information is automatically entered into SDSS database, an enormously complex data structure. The data is publicly available, and programmers familiar with Python can use it for their own research purposes. For more detail, go to the SDSS web site sdss.org and its many sub-pages. Suffice it to say that the data is generally not subject to human inspection until it is utilized.

The Early Universe

After the Big Bang, the universe consisted of a hot plasma of hydrogen and helium nuclei and electrons, with trace amounts of lithium and deuterium nuclei. Photons could only travel an infinitesimal distance before encountering a charged particle. The universe was opaque to light. But as it expanded, the matter

[2] I'm happy to report I aced both semesters.

cooled. At a temperature of 3,000 Kelvin, 380,000 years after the Big Bang, the plasma underwent a phase transition into electrically neutral atoms. The universe became transparent to radiation. We see that radiation now as the Cosmic Microwave Background, a thermal (blackbody) spectrum which through further expansion of the cosmos has redshifted to a temperature of 2.7 Kelvin, its peak in microwaves. The redshift of the CMB is approximately 1,096. Over the next half billion years or so, the universe continued to expand. Dark matter and slight variations in the density of regular matter from baryonic acoustic oscillations resulted in localized matter "overdensities," which further condensed due to gravity. The regular matter was heated as the local pressure increased. Eventually, the first stars and galaxies formed (exactly which came first, and the exact details of how they formed, is still unclear).

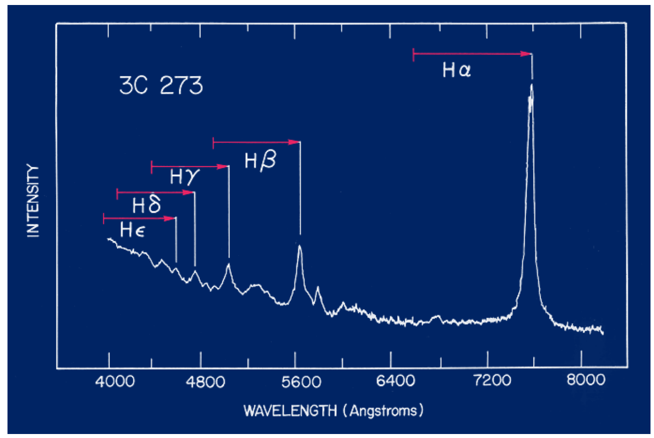
Young stars emit ultraviolet radiation energetic enough to strip the electrons from hydrogen atoms. This process "reionizes" the atomic matter surrounding the newborn stars and galaxies, but clouds of neutral hydrogen still remain. The process of reionization is thought to have started around z=20 and petered out by z=6. Although there are charged particles in the intergalactic medium, the universe has expanded enough that in general photons do not encounter them, so the universe remains transparent, and we can see distant objects. Recall that the average density of matter in the cosmos is only about six protons per cubic meter and in intergalactic space only one-sixth of that.

The clumps of atomic (neutral) hydrogen in intergalactic space far from sources of intense ultraviolet radiation can be thought of as persistent structures from the "dark era," although they too will be modified by local gravity and thinned by the expansion of space.

Quasars

Quasars are active galactic nuclei in which a hot, dense plasma orbits a supermassive black hole at the center of a galaxy. They emit prodigious amounts of energy, particularly in the X-ray and ultraviolet bands. Their spectra are characterized by emission lines of ionized nuclei, redshifted to longer wavelengths depending on their distance (which correlates with their recession velocity, the source of the redshift).

The first quasar detected was 3C 273, a star-like object first found as a radio source in VIrgo. Its visible light spectrum shows the characteristic pattern of hydrogen lines of the Balmer series shifted towards the red end of the spectrum, consistent with a redshift of 0.158. With a visual magnitude of 12.9, 3C 273 can easily be imaged and its spectrum obtained by amateurs with a StarAnalyzer, or, if you are willing to spend some real money, one of the sophisticated spectrographs from Shelyak Instruments.



Electrons in atoms occupy discrete, quantized energy levels. An electron either absorbs or emits a photon to change levels, according to the formula ε=hv, where h is Planck's constant and v (the Greek letter nu) is the frequency, related to the wavelength (λ) by λ = c/v (c=speed of light). At low redshifts like that of 3C 273 the strong H-alpha peak (the 3 → 2 transition of hydrogen) is displaced towards the visible-infrared border. At higher redshifts it is displaced beyond the sensitivity of earth-based cameras. When looking for high-redshift objects, the strong Lyα line of hydrogen (the 2→1 transition) is often the strongest signal.

The Lyα radiation are photons with wavelengths (λ) of 1215.67 Ångstroms, in the ultraviolet, far outside the range of our eyes or our cameras and fully blocked by the Earth's atmosphere. The redshift required to move this line into the visual range (say, a very blue 4000 Å), can be calculated from the redshift formula

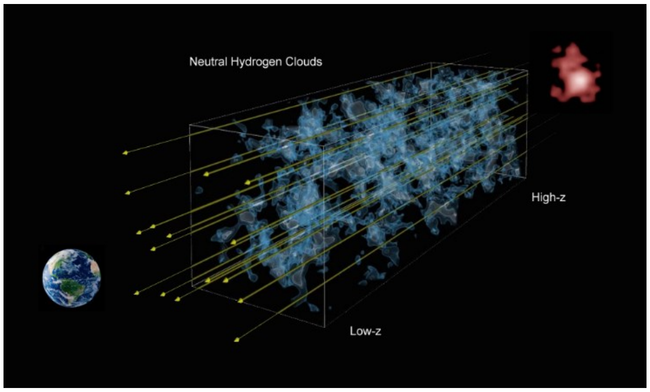
$$z = \frac{\lambda_{observed} - \lambda_{emitted}}{\lambda_{emitted}}$$

Solving for z we get

$$z = \frac{4000 - 1215.67}{1215.67} = 2.29$$

Quasars at higher redshifts would show Lyα emission peaks at visible wavelengths. At a redshift of around z=5.6 the Lyα peak passes into the near infrared. Lyα is of course not the only emission line that can be used to determine redshifts, since quasars can have strong signals with carbon, magnesium and other ionized nuclei.

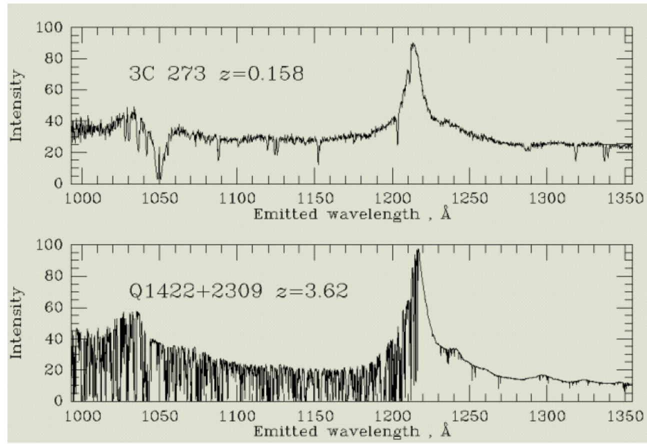
The Lyman-alpha Forest



Gas clouds forming the Lyman-alpha forest, adapted from Khee-Gan Lee (MPIA) and Casey Stark (UC Berkeley)

Radiation from quasars and galaxies that formed early in the universe has to pass through clumps of molecular hydrogen at lower redshifts in the as-yet incompletely reionized universe. These clumps of gas absorb the Lyα radiation at lower redshifts by kicking their electrons to higher orbitals, resulting in a thicket of absorptions lines at shorter wavelengths. This is the "Lyman-alpha forest," discovered in 1970 by Roger Lynds in the spectrum of what was then the most distant quasar, 4C 05.34, z=2.877.

An example, consider the spectrum of 3C 273 at z=0.158 and that of a very distant quasar, such as Q1422+2309 at z=3.62. There will not be much hydrogen between 3C273 and us, the clouds having been dispersed through expansion of the universe or congealed into stars and galaxies during cosmic maturation. On the other hand, the light from the z=3.62 quasar will pass through the younger, denser clouds on its way to us. If the spectra are "normalized" (aligned so that the Lyα peak is placed at its emitted wavelength of 1215.67 Å), the difference between the amount of absorption at shorter wavelengths can easily be seen. There is very little absorption in the 3C 273 spectrum until we get to the extreme left of the tracing, where gas in the Milky Way absorbs some of the photons. But in the z=3.62 quasar, innumerable absorption bands, beginning at the Lyα peak, extend to shorter wavelengths.



"Normalized" quasar spectrum showing the Lyman-alpha forest (bottom quasar)

Looking at the spectra of the z=6.87 and z=7.01 on page 11, we should have expected to see a distinct Lyα peak as well as a Lyman-alpha forest. Admittedly sensitivity of the detector is not great at those long wavelengths, but we ought to see *something*. There's no peak and the baseline for sure doesn't look like a Lyman-alpha forest.

There didn't seem to be any specific information on the SDSS web site that I could use to understand what I was looking at in these two spectra, so I wrote to Michael Blanton, Professor in the Department of Physics at NYU and a member of the Center for Cosmology and Particle Physics. He was the Director of the SDSS-IV collaboration, which was responsible for the 16th quasar catalog data release. I sent him the images and spectra of the two high-z objects that Robin found, basically asking him "What gives?" Although he was on vacation, he responded in just 2½ hours with this information:[3]

> Most SDSS spectra are not visually inspected. But the quasars ARE, partly because of the issues that occasionally arise. Indeed a z=7 quasar is USUALLY a mistake.
>
> The z=6.87 one is a bit inexplicable why the pipeline failed, since it sure is a quasar but clearly a lower redshift one. My guess is you are seeing CIV and

[3] See my article on generosity in astronomy in the April 2024 SkyWAAtch, p. 9.

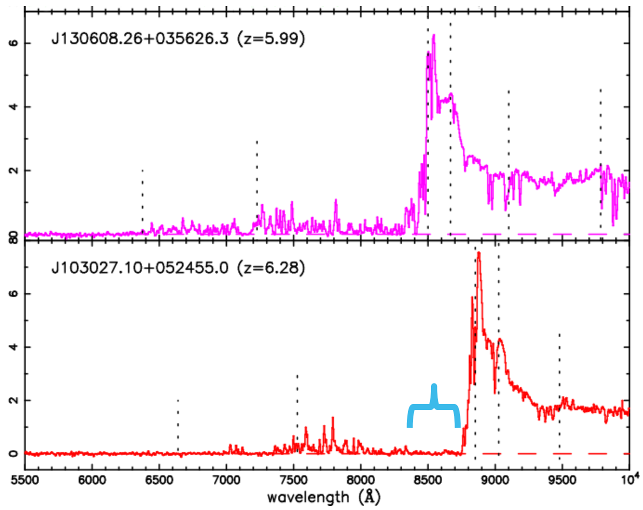
> MgII on the left and in the middle, and either bad sky subtraction or a host galaxy on the right.
>
> The second I am not sure what it is but surely not a quasar. I've asked one of my colleagues who does stare at quasar spectra a lot to look at these.

Prof. Blanton sent the spectra to Prof. Patrick Hall, Chair of Astronomy at York University in Toronto. He wrote,

> Yes, there's a long-standing shortcoming of SDSS-III/IV/V quasar redshift determination when a spectrum shows pronounced curvature, and that's what's happening here. It's on my [to do list] to help create a sanity check that overrules obviously incorrect z~7 redshifts.
>
> The [7.01] spectrum is a reddened quasar at z~2.15; the big bump is Mg II + Fe II and the other bumps are Fe II emission.
>
> The [6.87] spectrum shows C III 1909 and Mg II 2800 at z~1.3, plus bad sky subtraction as you noted.

The complex process of assigning and analyzing spectra, and how the accuracy is statistically validated, is discucssed on the SDSS web site at https://www.sdss4.org/dr17/algorithms/redshifts/. While some of the spectra are rejected, or warnings given on the display, some clearly end up with misclassifications. Nevertheless, the overall error rate is extremely low and the scientific findings that depend on the SDSS databases seem solid. The impact of rare errors is compensated by the statistical treeatment of the data in scientific studies and new machine-learning programs.

For quasars formed prior to the "end" of reionization, their light would begin its path towards us through purely molecular gas. All of the Lyα photons encounter the gas and kick electrons to a higher orbital, leaving a flat baseline blue-ward of the Lyα peak, until a lesser redshift when the gas has thinned and the Lyman-alpha forest begins. This spectral phenomenon is called the "Gunn-Peterson trough" and its extent measures the time between the quasar and the onset of reionization along that light path.[4]



Quasars without (top) and with (bottom) Gunn-Peterson trough (bracket.)[5]

We probably should have been a litle more skeptical right off the bat about a quasar with a red shift as high as 7.0. We were naively but not surprisingly credulous about information in SDSS, taking every measurement as true. It's not really SDSS's fault. there aren't many quasars with red shifts over 6. After a couple of decades of diligent searches, by 2019 only about 50 quasars with redshifts between 6.5 and 7.0 were catalogued. A quasar at z=7.0 will have the Lyα line shifted into the near-infrared at 9725.6 Å, which may be very challenging for a visible light CCD camera to record. In addition, contaminants, primarily galactic cool dwarfs and early type galaxies, are far more numerous than quasars. In fact, as of 2021, only seven quasars with redshifts greater than 7 were known. In 2021, Wang et. al. reported a luminous quasar at redshift 7.642. utilizing data from telescopes and spectrographs with high infrared sensitivity in Hawaii, Chile and Earth orbit. This object, J0313-1806, has a bolometric luminosity of 1.4 ± 0.1 10^{47} erg s^{-1} (equivalent to 36 trillion Suns) and hosts a supermassive black hole of 1.6 ± 0.4. billion solar masses.[6] It was only the third quasar with

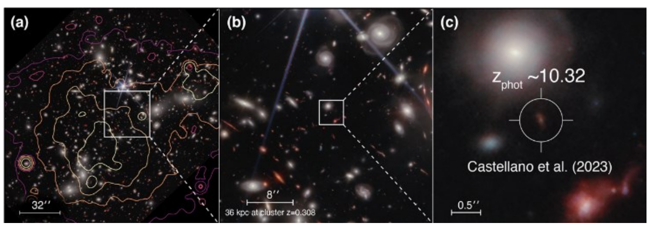
[4] The photons of the Cosmic Microwave Background are thermal (blackbody spectrum) and much lower energy than Lyα photons, so they don't cause these transitions.

[5] Becker, R. H.; et al. Evidence For Reionization at z ~ 6: Detection of a Gunn–Peterson Trough in a z = 6.28 Quasar. *Astronomical Journal* 122: 2850–2857 (2001)

[6] Wang, F, A Luminous Quasar at Redshift 7.642, The Astrophysical Journal Letters, Volume 907, Issue 1, id.L1,7 pp.. Online at https://iopscience.iop.org/article/10.3847/2041-8213/abd8c6.

a redshift above 7.5 to be found as of the date of the paper.

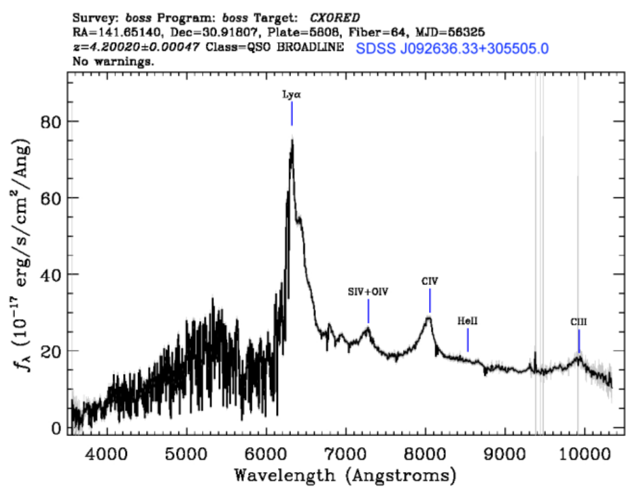
Quasars at super-high redshift can contribute to our understanding of the mechanism of formation of supermassive black holes in early galaxies. The James Webb Space Telescope's survey of very early galaxies has intriguingly shown that they are more numerous and massive than cosmological theory predicted. A recent paper[7] found UHZ1, a prodigous X-ray source identified as a quasar, at z=10.3. It appears to be embedded in a gravitationally-lensed galaxy. Its supermassive black hole is estimated as having a mass of 10^7-10^8 M⊙, equal to the stellar mass of the host galaxy. The authors suggest that the formation of so massive an object at such an early cosmic time is evidence for "heavy seeding," massive agglomerations of dark matter at the end of the "dark ages" that caused direct collapse of giant pristine gas clouds into supermassive black holes. Simulations suggest that such collections of dark matter could exist in the early Universe.



JWST imaging of UHZ1[7]

We were primed to believe that whatever the SDSS database told us had to be true at face value. Had we been professional astronomers, we might have known more about the database's imitations and how it goes about making educated guesses. If you want computers to put quasars in your database, ringers are bound to creep in. It will be interesting to see if our attention to the two pseudo-high-z objects results in a correction in the SDSS database, or will it always be *Caveat astronomus* and emails to the experts?

Robin did send an image with a z=4.20 quasar, SDSS J092636.33+305505.0 in Leo. Robin's image and the SDSS spectrum are shown below. SDSS did not throw us a curveball this time. It's clearly a quasar with a very typical spectrum, the Lyα line shifted from 1217.67 Å to 6300 Å and the Lyman-alpha forest clearly visible at shorter wavelengths. If you enlarge the image, you can see that it has a reddish tinge, not surprising since most of its radiation is in the Lyα peak that is sitting in the red part of the visible spectrum.



The light from a quasar at z=4.20 has taken 12.3 billion years to reach us. The object is receding from us at 92% of the speed of light because of expansion of the cosmos. That it can be detected by an amateur astronomer is simply amazing!

Now that we have some idea how to separate the real distant quasars from the ersatz ones, here's the next challenge. Can Robin find a real one at z=5?■

[7] Bogdan, A, et. Al., Evidence for heavy-seed origin of early supermassive black holes from a z ≈ 10 X-ray quasar, Nature Astronomy, 8: 126-133 (2024). Preprint at https://arxiv.org/pdf/2305.15458.pdf.

Images by Members

Hickson 44 by Arthur Miller

Arthur made this image with his C11 in Quail Creek, Arizona. NGC 3189 in Leo is the central member of Hickson Galaxy Group #44. The 39.9 x 26 arcminute field shows four major galaxies (plus faint ones in the background). The spiral arms of NGC 3187 are distorted from gravitational interaction with the larger NGC 3189. Above NGC 3189 is the elliptical NGC 3193, and to the lower left is spiral NGC 3185. To the right is the star HD 89224.

William Herschel discovered a "faint nebula" on March 11, 1784. He catalogued two objects at the same coordinates, II 44 and II-45, in his first catalogue of 1,000 objects (1789). He described them (in his shorthand) as "both faint, extended, a little brighter in the middle, resolvable." His son John assigned II 44 as #692 and II 45 as #693 in his first catalog (1833) but *three* objects are described within each entry. In his 1864 General Catalog he assigns #692 as GC 2058 but also catalogs the earlier 692a, b and c, each getting separate GC identifiers. II 45 gets GC 2061. A diagram by Lord Rosse, not available, is identified as a source. In the New General Catalog of 1888, Dreyer assigned NGC 3190 to GC 2058 and noted a separate NGC 3189, which he cross-references to GC 2057, which is 692c. GC 2061 is assigned NGC 3193. Dreyer says NGC 3189 is "parallel to h 692" with the notation "very very faint, much extended."

We get no help from O'Meara, French or Harrington, none of whom cite this lovely galaxy cluster in their books. But it seems clear that NGC 3189 and 3190 are the same and not separate celestial objects. The galaxy's dust lane may have fooled visual observers.

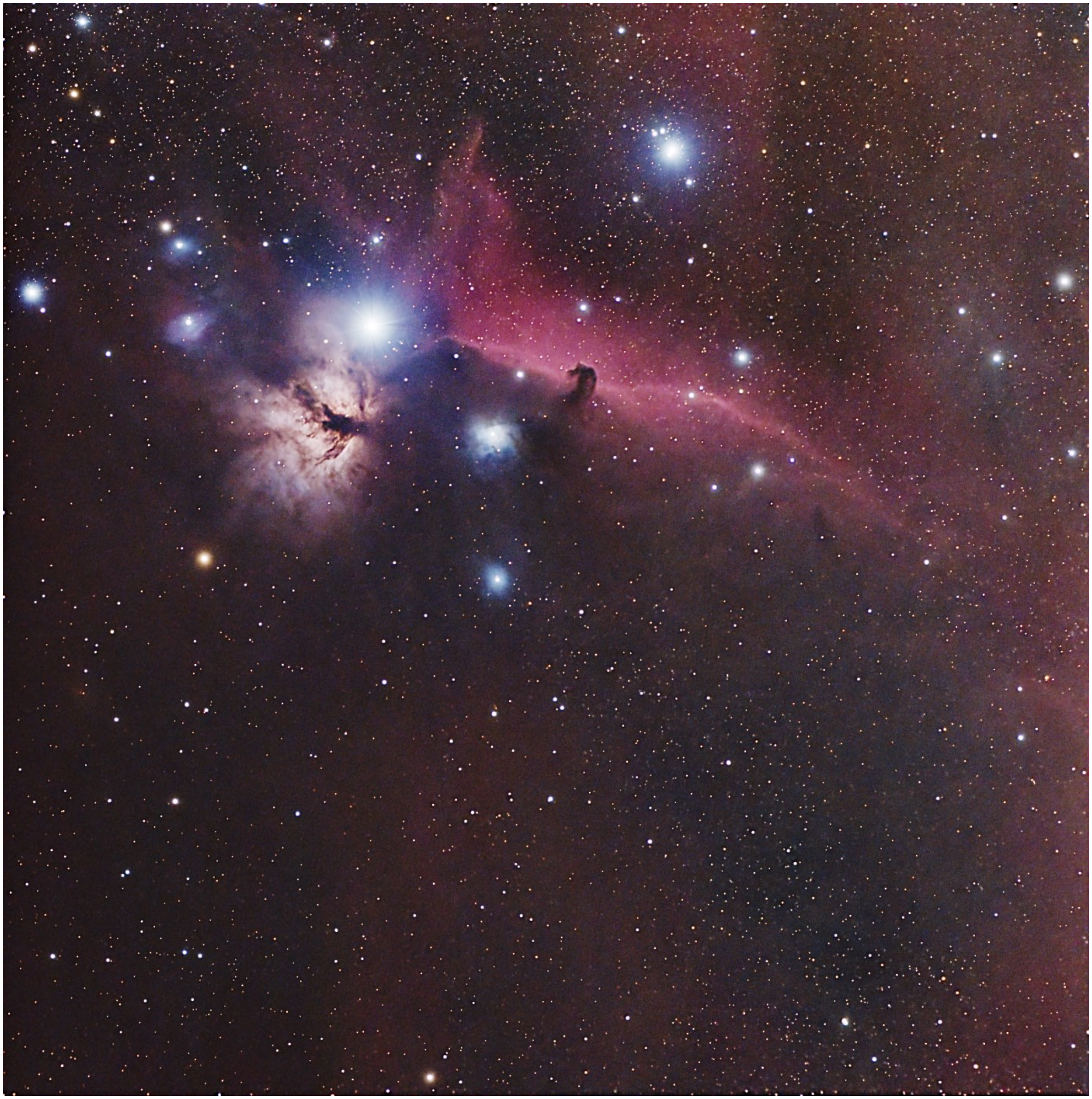
Wm. Herschel

44 45	—	20 Leonis	f	28 15	n	0 48	1	Two. Both. F. E. lbM. r.

NGC

3189	2057	...	...	Ld R, d'A	10 10 18	3·32	67 28	17·9	vvF, mE, parallel to h 692
3190	2058	692	II 44	...	10 10 22	3·32	67 28·2	17·9	B, pS, E, psbMN

The Horsehead and Flame Nebulas by David Parmet

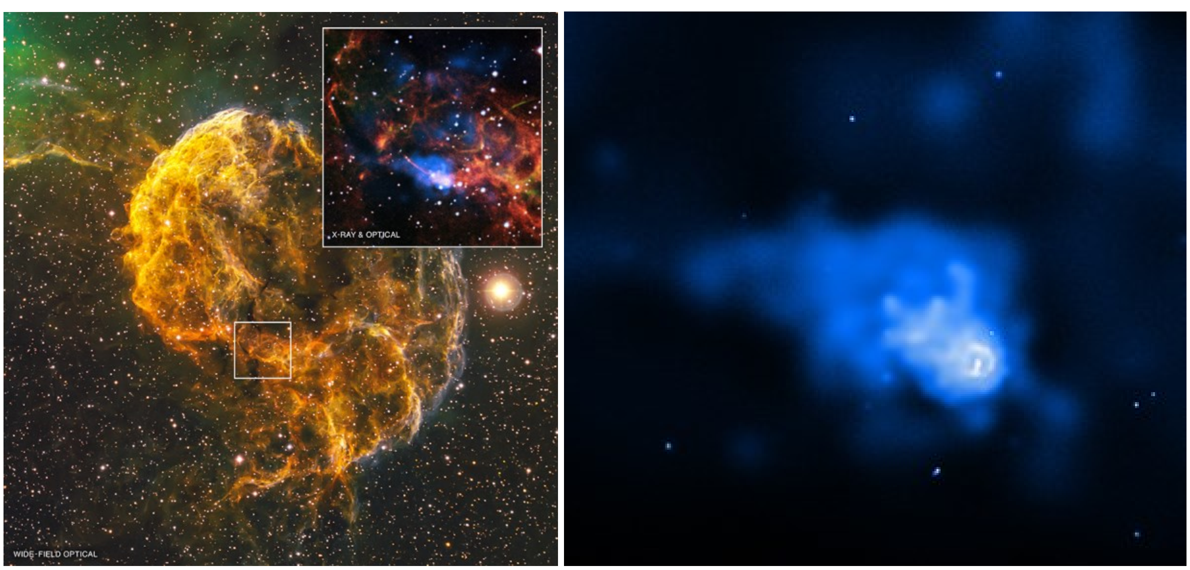


David captured this image at Ward Pound Ridge on March 12, 2024. One hour of 3-minute subs plus darks and flats. Although it was a remarkably temperate night for early March, David said “I didn’t dress for the weather and was getting cold.” Your Editor was also at WPRR that night doing visual observing. There was a sliver of a Moon, just 9% illuminated, setting in the west. The SQM measured 19.79 around 9 p.m. Since the constellation Orion is in the south, it competes with the light dome from New York City, Nassau County, southern Westchester, Greenwich and Stamford, which David overcame with a fast scope, sensitive camera and effective processing with PixInsight. William Optics RedCat 51-mm f/4.9 and ASI 533MC camera.

For the complete story of the discovery and naming of the Horsehead Nebula, see the April 2023 SkyWAAtch.

IC 443 by Steve Bellavia

IC 443 is a supernova remnant in Gemini, not far from the star Eta Geminorum, which is seen to the right of the nebula. For somewhat obvious reasons it has acquired the appellation “Jellyfish Nebula.” The supernova explosion is estimated to have occurred 30,000-50,000 years ago, leaving behind the neutron star, which is peculiarly located at the edge of the nebula and moving at 800,000 km/h away from the nebula.



Chandra X-ray images

Research Highlight of the Month

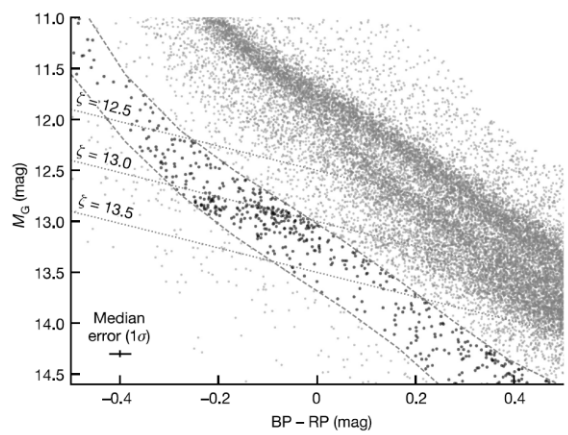
Bedard, A, Louin, S, Chemg, S, Bouyant crystals halt the cooling of white dwarf stars, *Nature* 2024; 627: 286-288 (published March 24, 2024)

Ninety-seven percent of stars will end up as white dwarfs, stars the diameter of the Earth with masses greater than the Sun. They form when the star's core temperature is insufficient to fuse carbon and oxygen, which happens when the mass of the evolved star is below about 1.44 $M_\odot$. The interior is a plasma of carbon and oxygen (sometimes with neon and magnesium). The nuclei behave like a liquid while the electrons are a Fermi gas. Gravitational collapse is opposed not by nuclear fusion but by electron degeneracy pressure, due to the Pauli exclusion principle, which states that no two electrons can occupy the same state. Remarkably, the higher the mass of a white dwarf, the smaller its radius.

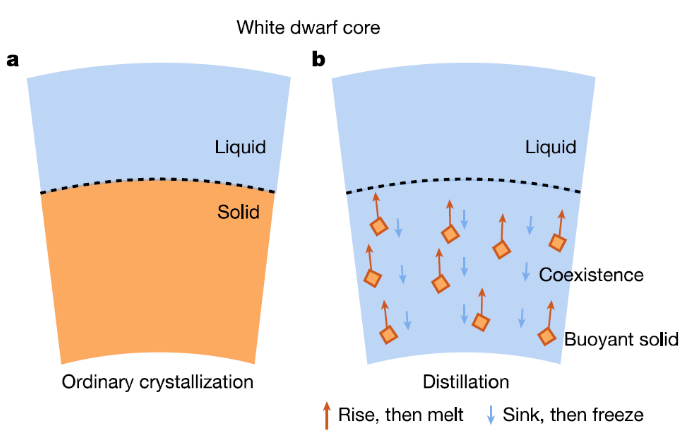
White dwarfs are hot but have small surface areas, so they have low luminosity (they are dim) and radiate heat slowly. Eventually they will cool completely and become "black dwarfs," with internal temperatures in equilibrium with the cosmic microwave background (which will decrease further over cosmic time) , but since cooling takes a very long time, far longer than the current age of the universe, there are no black dwarfs yet.

The center of the star can become cold enough to crystallize. Crystallization is a phase transition that liberates heat because the crystalline state has lower energy than the liquid state. For example, water and ice can both exist at 0 C; when heat energy of 80 calories per gram of water is liberated, the water crystallizes into ice, still at 0° C. Similarly in a white dwarf, crystallization in the interior releases heat, slowing cooling. Another process that creates heat is that the center of the white dwarf does not crystallize in bulk, but different nuclear species can form crystals within the buoyant liquid in the star's interior. Being less dense than the liquid, the way ice is less dense than liquid water, these crystals can rise, displacing the denser liquid, which falls. This releases gravitational energy, which is converted to heat.

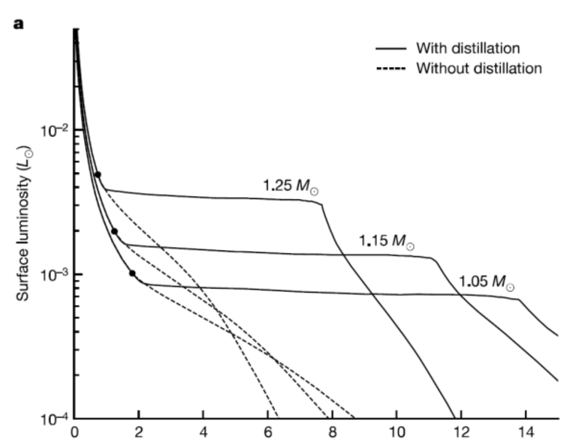
White dwarfs whose cooling is delayed forma distinct group on the Hertzsprung-Russell diagram. Many have large transverse velocities as seen by the Gaia satellite, which correlates with age. The authors modelled the "distillation" process in these stars and showed it retards the cooling of white dwarfs for billions of years.



H-R diagram showing the "Q branch" of delayed-cooling white dwarfs.



Ordinary crystallization (a) compared to the "distillation" process where crystals form and float, displacing denser liquid (b).



Cooling times for white dwarfs of various masses.

Member & Club Equipment for Sale			
Item	Description	Asking price	Name/Email
Celestron Nexstar 5SE	Mint condition white Celestron 5-inch f/10 (1250-mm) Schmidt-Cassegrain. Go-to alt-azimuth, single fork arm. Only used a couple of times. Complete with hand control, tripod, finder, eyepiece, diagonal. Picture here. Celestron lists this instrument for $799. Weight 17.8 lbs complete, including tripod. Runs on 8 AA batteries or external 12-volts. A fantastic telescope for lunar, planetary and bright DSO observing.	$400	Heather Morris heathermorris4381@gmail.com
Celestron StarSense auto-alignment	Automatically aligns a Celestron computerized telescope to the night sky. Includes finder camera, hand control (substitutes for the original HC), two mounting brackets, cables. Works with any computer controlled Celestron scope that has a hand control. Like new condition, in original box. Image here. Celestron's description and FAQ are here.	$220	Manish Jadhav manish.jadhav@gmail.com
Orion 6-inch f/5 reflector on EQ mount	Little used, if at all. Solid EQ4-type non-go-to equatorial mount with an electric RA drive as well as slow-motion stalks. The setting circles are large and very readable, unlike most EQ mounts for scopes of this size. An image of the mount head is here. 9 and 25 mm Plössl eyepieces, polar alignment scope with reticle, Orion flashlight, finder, counterweights, gold-colored aluminum tripod (missing tripod tray, but you can make one easily enough). Good intro scope for a bright young person. A 6" f/5 OTA alone costs at least $300. Donated to WAA.	$150	WAA ads@westchesterastronomers.org
ADM R100 Tube Rings	Pair of 100 mm adjustable rings with large Delrin-tipped thumb screws. Fits tubes 70-90 mm. You supply dovetail bar. Like new condition, no scratches. See them on the ADS site at https://tinyurl.com/ADM-R100. List $89.	$40	Larry Faltz lfaltzmd@gmail.com
Tiltall photo/spotting scope tripod	TE Original Series .Solid professional aluminum tripod with 3-way head, center stalk. Very solid. 3-section legs. Height range 28.5"-74". Can carry up to 44 lbs. Folded length 29.6". Weighs 6 lbs. Carry bag. Image here. List $199.50. Great for a spotting scope, camera. Donated to WAA.	$75	WAA ads@westchesterastronomers.org
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 offer only serious and useful astronomy equipment. WAA reserves the right not to list items we think are not of value to members.			
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