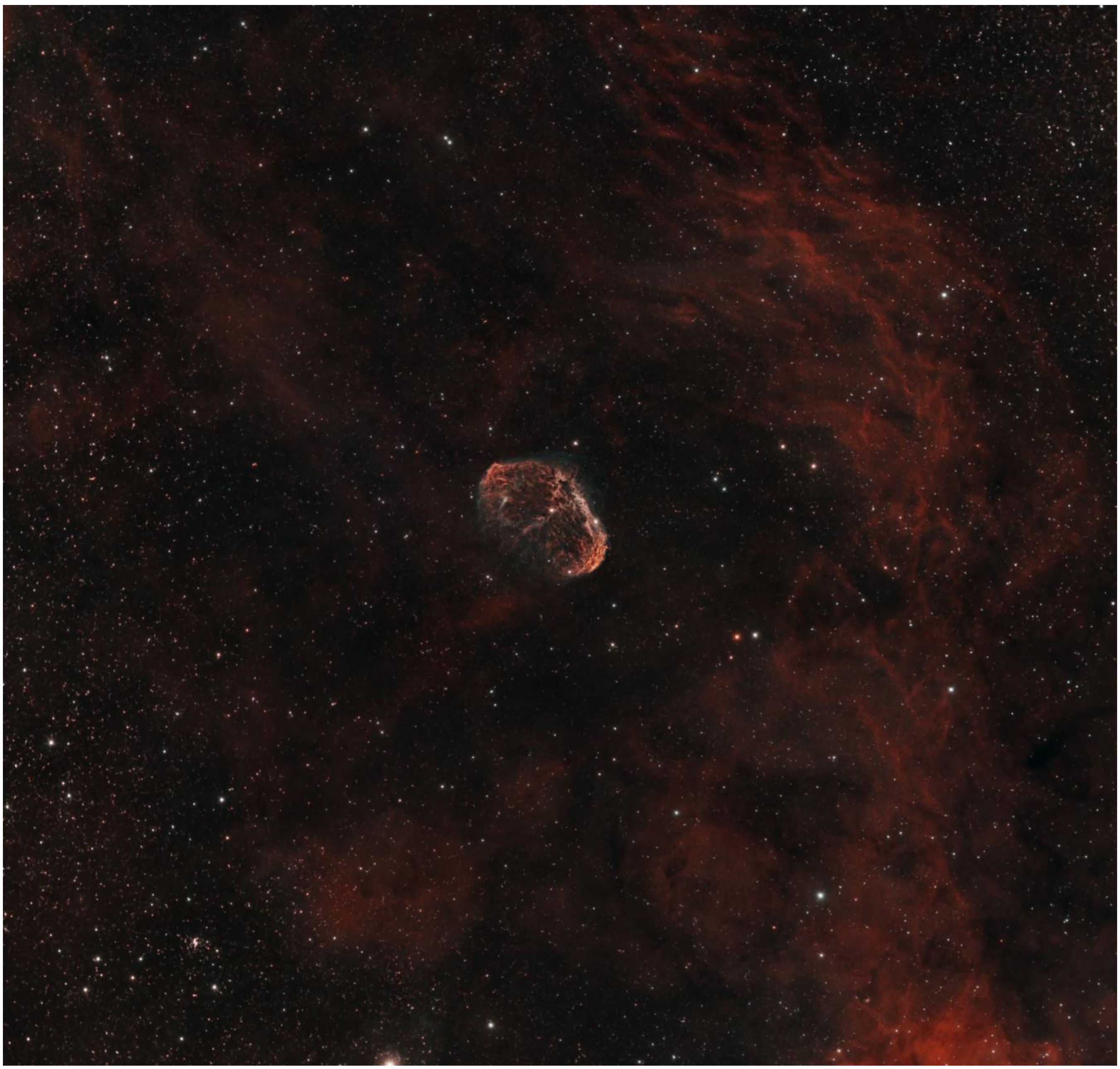
SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

November 2022



The Crescent Nebula, NGC 6888 by Olivier Prache *(see p. 18 for more information)*

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 November Meeting

Friday, November 11 at 7:30 pm

The McCarthy Observatory: A Refuge for Science

Bill Cloutier
Founding member, McCarthy Observatory

The McCarthy Observatory is the centerpiece of a community science center in New Milford, Connecticut. It was conceived, designed and constructed by volunteers from local communities with a common goal – to establish a teaching tool to promote science literacy.

The observatory is different from many other astronomical facilities in that its focus is on accessibility and educational outreach. While capable of real science, the mission of the non-profit organization that operates the facility is to encourage critical thinking and promote STEM-related learning. Over the past 22 years, the all-volunteer staff has continued to add to the observatory's educational offerings and look for new and innovative means to engage with the public.

The talk will focus on the history of the McCarthy Observatory, as well as the challenge of managing a small, all-volunteer organization with lofty goals.

Call **1-877-456-5778** (toll free) for announcements, weather cancellations, or questions. Also, don't forget to visit www.westchesterastronomers.org.

Also In This Issue

WAA December Meeting

Friday, December 9 at 7:30 pm

DART and the Dinosaurs

Dany Waller
Johns Hopkins Applied Physics Laboratory
DART Science Operations Center

Starway to Heaven

Ward Pound Ridge Reservation, Cross River, NY

Saturday, November 19 (rain/cloud date Nov. 26).

Members can observe at the park with advance notification by calling the number on your WAA ID card.

New Members

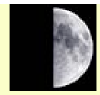
Diana Mooney	Scarsdale
Una O'Malley Petrino	Yorktown Heights
Joaquin Santana	Ossining
Lars Schneidenbach	Bedford Hills

Renewing Members

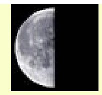
Paul Andrews	Patterson
Andrea Anthony	Yorktown Heights
Kevin Bynum	Irvington
Uziel Crescenzi	Bronx
Daniel Cummings	Croton-On-Hudson
Thomas Durkin	White Plains
Aram Fuchs	Irvington
Bob Kelly	Ardsley
Joan Indusi	Ossining
Michael Lomsky	Wilton
Tracy Ostroff	Ardsley
Ciaran O'Sullivan	Montrose
Daniel R. Poccia	Cortlandt Manor
Bruce Rights	Mount Kisco
Mauri Rosenthal	Scarsdale
Richard Segal	Yorktown Heights
Kevin Shea	Carmel
Maryellen Sinclair	Cross River
James Steck	Mahopac
Woody Umanoff	Mount Kisco

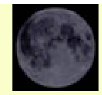
ALMANAC For November 2022
Bob Kelly, WAA VP of Field Events


Bob Kelly


1Q Nov 1


Full Nov 8

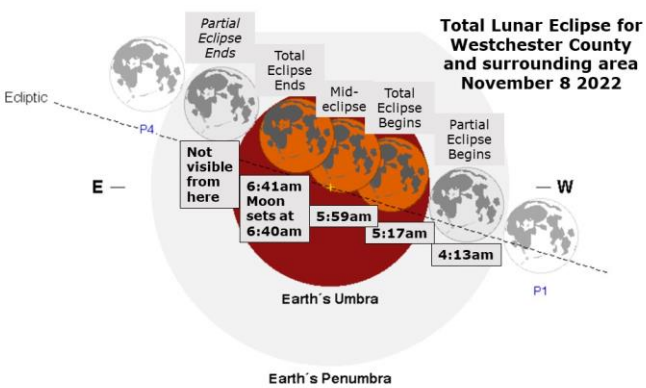

3Q Nov 16


New Nov 23

Total Lunar Eclipse Sets on New York

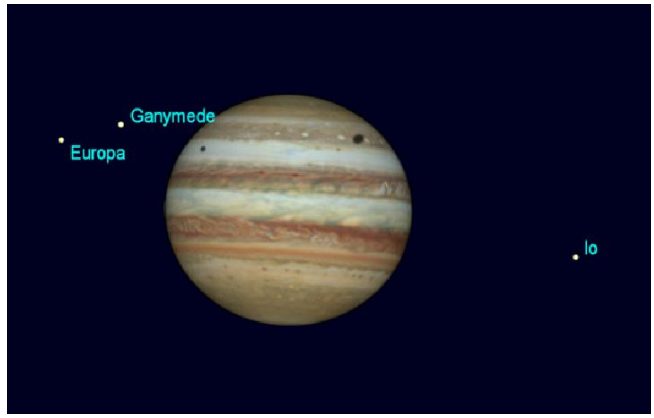
The highlight of November is the total lunar eclipse on Election Day morning, November 8.

Totality begins at 5:15 a.m. EST, and ends one minute after the 6:40 a.m., moonset in our area. As you go further west or north, moonset is later and you'll see more of the eclipse. However, in the eastern United States, there is a great opportunity for wonderful photos with terrestrial landmarks near or in front of the eclipsed **Moon,** low in the sky. The azimuth of the setting Moon will be 292 degrees from north (22 degrees north of due west). If you plan on looking from the east bank of the Hudson River, the Moon may set sooner than the predicted time due to the Palisades blocking the western horizon. Can you find **Uranus** two degrees to the upper left of the Moon as the sky darkens during the eclipse?



Jupiter Still King of the Evening Sky

At magnitude -2.7, **Jupiter** is still the brightest object in the sky, other than the **Sun** and Moon. It's been impressive in the evening sky, now rising well before sunset. Even bright **Saturn**, due south at sunset, seems dim by comparison at magnitude +0.7. There's a double shadow transit on the 2nd (see page 20).

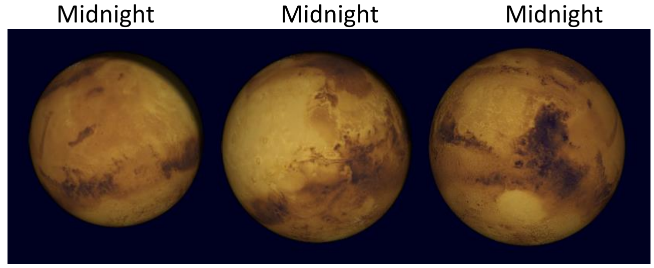


Jupiter November 2 at 20:41, showing the shadow transits of Europa and Ganymede. Callisto is out of the frame, to the right.

Mars Attacks!

Mars is sitting pretty, high on the horns of the Bull. The reddish planet will peak in apparent size at 17 arc seconds wide on the 30th, eight days before opposition. We start the month at 15 arc seconds wide (and still a slightly gibbous phase), larger than it will be until 2031, as upcoming oppositions are less favorable for us. Mars takes a while to get high in the sky in the evening. At magnitude -1.5, Mars outshines all the other bright kids in the area, like **Aldebaran**, **Capella**, **Betelgeuse** and **Rigel**. Only **Sirius**, far lower in the sky, is as bright as Mars is now. Mars is the closest planet to Earth until **Mercury** reclaims the title on January 5th, 2023.

11/1/22 Midnight	11/15/22 Midnight	11/30/22 Midnight



Diameter 15.2" Altitude 39° 14'	Diameter 16.6" Altitude 61° 41'	Diameter 17.2" Altitude 72° 07'

Venus and Mercury Hide Out

Our view of **Venus** and Mercury is blinded by their passing near the Sun in our skies this month. They will migrate out from the Sun at the end of November. At only five degrees above the horizon at sunset on the 30th, seeing them in November will likely be limited to the SOHO C3 camera. Mercury and Venus will have a spectacular conjunction low in the southwest at the end of December. Yes, Venus is the brightest planet in our skies, at magnitude -3.9, but Jupiter gets the prize this month since we can't readily see Venus at the moment.

Outer Objects

Uranus comes to opposition, and closest to Earth, on the 9th. Maxing out at magnitude +5.7, it's technically visible to the unaided eye, but you'll need a good finder chart and a very dark sky. A couple of degrees to the lower left is asteroid **27 Euterpe**. It's at mag +8.9, and might be visible in binoculars, which you might use to seek Uranus. Between Jupiter and Saturn, you might spot **Neptune**, about ten degrees west of Jupiter at magnitude +7.7. **Juno** and **Vesta** are also between our two giants, visible in telescopes at magnitude +9.1 and +7.6, respectively.

Meteors

The **Northern Taurids** are a weak shower that peaks during a mostly full Moon on the morning of the 12th. Taurids produce just a few meteors an hour, but they have more fireballs than typical showers.

The more famous **Leonids** peak on the morning of the 18th with a waning crescent morning Moon. Typically, a determined observer may see six to 12 meteors an hour. Many of them are very bright with persistent trains. The American Meteor Society notes Earth could run into some dust trails from the parent, **Comet 55P/Tempel-Tuttle**, just after midnight on the 18th and 19th with a short-lived, perhaps much larger number of meteors. No one sees signs of a meteor storm like 1966 for the rest of the 21st century.

Comets?

There are a few comets that might be visible in our larger telescopes. I'm looking forward to seeing **C/2022 E3 (ZTF)**, high up in a dark sky in January, perhaps reaching magnitude +5 or better.

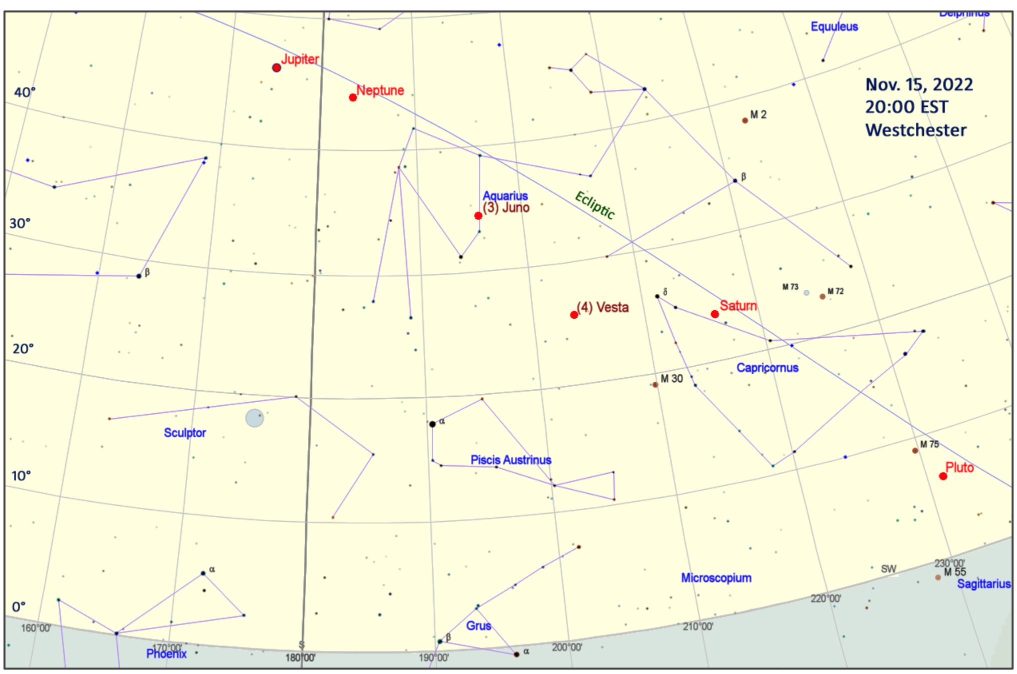
Satellites

The **International Space Station**, bustling with arrivals and departures like Grand Central Terminal, is visible in the morning through the 10th, and in the evening starting on the 13th.

Tinagong is expanding. It's visible in the morning from the 4th through 19th. Evening appearances return at the end of November.

Daylight Time Ends

We send the clocks back an hour at 2 a.m. on Sunday, November 6th. A welcome extra hour of sleep, or maybe observing or imaging?



Finder chart for Jupiter, Saturn, Neptune, Vesta and Juno in November. Relative positions change just a little during the month.

More Movie Telescopes

Although there were movies about space travel before World War II (Flash Gordon and Buck Rogers immediately come to mind) it was only after the war that the genre developed in a scientific direction. The majority of German rocket engineers surrendered to the Allies. Wernher von Braun was scrubbed free of Nazi sympathies and set about developing an American rocket program, starting by modifying the V-2. One of his goals was to create a space program that envisioned travel to and colonization of the Moon and Mars, although earthly military necessities were clearly the government's main interest.

At the same time, the new 200-inch Hale telescope, which could hardly be contaminated by alleging a military purpose, promised to unravel the mysteries of the cosmos. But lurking behind the optimism of science and discovery was the growing danger of nuclear confrontation and the specter of the annihilation of the human race.

Among the first scientific space travel movies, producer George Pal's *Destination Moon* (1950) dealt at least somewhat realistically with problems that could be encountered during a lunar voyage. Artist Chesley Bonestell's lunar backdrops were a revelation (if ultimately a bit fanciful compared to the blander reality revealed by Apollo). They were prominently displayed in the Metropolitan Museum of Art's blockbuster exhibition "Apollo's Muse" in 2019.

For his next film, Pal, a Hungarian who emigrated to the United States when the Nazis took control of Germany, combined astronomy, space travel and global annihilation in 1951's *When Worlds Collide*. The film tells the story of humanity's attempt to survive the coming impact of a rogue star. The opening scene (after a biblical quotation about God talking to Noah about the destruction of the world by a flood) takes place in the "Kanna

Observatory" in the "remotest part of South Africa." Its astronomers have discovered the star Bellus and its planet Zyra, which they think are heading towards Earth. The scene at the observatory (page 5) uses the Hale Telescope as a backdrop. We know the scene was not filmed there: there's no spiral staircase in the Hale dome.

Photographic evidence is brought to the "Cosmos Observatory" in New York. A group of astronomers assembles there because Cosmos has computer resources that can be used determine the *exact* path of Bellus (we see an old IBM tab card sorter and a flatbed X-Y plotter; then female lead Barbara Rush takes out a small slide rule!). As the astronomers examine the evidence, we see the observatory's telescope in the background (also a painted backdrop): it's the 100-inch Hooker telescope at Mt. Wilson Observatory, which saw first light in 1917 and was the instrument that Edwin Hubble used to determine cosmic expansion. For this film, Chesley Bonestell was listed as "Technical Advisor," but he also did some of the backdrops. The final scene uses an uncompleted sketch that lacks the fine detail of his major illustrations. He undoubtedly was the person who chose to use the Hale and Hooker instruments as backdrops.

Pal is best known for his cinematic adaptations of two H. G. Wells novels: *The War of the Worlds* (1953) and *The Time Machine* (1960). Bonestell was a prolific illustrator of science fiction magazines and books, most famously Willy Ley's *The Conquest of Space* (1949). In his earlier years he did architectural design, and we are indebted to him for the art-deco façade of the Chrysler Building.

The Hale telescope is still a highly productive instrument despite growing light pollution in San Diego county. It is operated by Caltech. See the September 2016 SkyWAAtch for more information about this instrument, and the October 2016 SkyWAAtch for the epic story of its construction. The Hooker is now only used for outreach, the victim of light pollution in the LA basin. You can read about Mt. Wilson in the August 2016 SkyWAAtch.

My Vacation on the Moon — Larry Faltz

This is a counterpoint to Bob Kelly's (July 2022) and Eli Goldfine's (August 2022) fantasy trips, inspired by the BBC's Sky at Night request for travelogues of Moon visits.

Taking advantage of the points on my MuskCard, I bought seats on the SpaceX Moon Express, which left from Musk Cosmodrome in the Bronx. As everyone knows, Musk bought the Bronx Botanical Garden and the Bronx Zoo when global warming killed off all the plants and effective PETA militancy liberated the animals, leaving the sites vacant. It's a terrific place for a rocket port. Just take any Musk North train to the Botanical Garden station (it used to be a limited stop, but now every train stops there) and jump on the moving sidewalk over to the departure lounge.

When we got there, the rocket was overbooked (the ad campaign "Want to go to the Moon, Alice?" has been very successful), but fortunately we had checked in early and had our seats. Then the flight was delayed because of a mechanical problem which took some time to fix (something about the interossiter not working). While we waited, we took the MuskBus over to the McMusk's on the corner of Fordham Road and Southern Boulevard. Ever since meat was officially outlawed because of its carbon footprint from all the methane-producing bovine, ovine and porcine eructations, the most appetizing dish is the McRamenburger with tofu and secret sauce (a.k.a. ketchup). We could have gotten some meat at the nearby Arthur Avenue National Historic District. One of the indigenous cultures high on the national preservation radar is *Corleone*. To keep one of its traditions alive, you can get otherwise banned products by finding Tony and giving him the secret handshake, which involves a folded-up Benjamin.

Takeoff was uneventful. The Falcon Leviathan successfully dodged all the Starlinks and the interossiter did whatever it needed to do without any problems. Our rocket, the flagship of SpaceX, was named "I Have All the Money." It was comfortable enough. There were generous servings of Musk-o-Lay chips, M&M's (you can guess) and Tang. Congress, in one of the few bits of bipartisan legislation it passed in the last quarter of a century, declared Tang the National Historic Space Food. Given a wide choice of channels on MTV (get it?) during the flight, we turned to the *Simpsons* channel. You would think that now that they've passed 2,500 episodes we'd have a good choice, but they just continuously showed episode 564, "The Musk That Fell to Earth," with guest star Elon Musk. It reminded me of the perpetual streaming of "Some Like it Hot" on the TV at the Del Coronado in San Diego.

We passed on the final game of the World Series, which was held while we were in transit. In an effort to keep baseball interesting for short attention span fans, MLB (Musk League Baseball, formerly Major League Baseball) starts both of the game's innings with the bases loaded. The pitch clock has been reduced to four seconds. Similarly, the NBA, oops, I meant the MBA, holds its insatiable fans with continuous scoring, using 22 baskets arranged around the court at heights between five and eight feet. I can't get interested in a game that typically has final scores of 4,120 to 4,117. Hockey too, now of course the MHL, meets fans' desires for hyper-scoring with the clever multi-puck system. Football became silly when the MFL reduced the defensive side to eight players. It's no wonder us older folks are into curling, which doggedly sticks to its leisurely traditions.

We finally landed at Musk Crater, formerly known as Copernicus, and of course they lost our bags. "Perhaps they are on the flight to Mars," the young baggage attendant cheerfully informed us. "You know space travel," she chirped. "Last week someone's poodle ended up on Saturn." Fortunately, we had purchased baggage insurance, having heard all the stories about the frequency with which Moon luggage goes to Mars and poodles end up on Saturn. We went over to the spaceport's shopping mall and its giant department store, Musk's, where we were able to find space suits and other clothes in our size. The currently popular sartorial cut known as *Kardashian* meant the waists were too tight but everything was comfortably roomy in the hips and on top. At last, we were ready for our adventure.

Our hotel room, at the Musk Suites, was spacious if undistinguished. We had paid a premium for a Moon view, and indeed the vast lunar expanse was in front of us. However, all those helium-3 wells were not a pretty sight, unless you like helium-3 wells.

Like the rest of Las Vegas, of which the Moon is an official suburb, gambling is very big. They have a special game called “Musk Roulette.” You place your bets on a bunch of numbers, all of which are even. The wheel has only odd numbers. Everyone who comes in, except a few VIPs, is obligated to play.

You can go to the shows, and, yes, Celine Dion is still a hot ticket, her career extended by the Moon’s lower gravity and the helium-3-enriched atmosphere in the Musk Palladium, which really helps her high notes. As was widely reported, Musk purchased Liberace’s remains and reanimated “Mr. Showmanship” using all the bioengineering talent he got when he bought the Salk Institute, the Institut Pasteur, the Karolinska, Harvard and Sephora. Mr. Showmanship the Undead may have been only a partial success, but it was a lot better than Musk’s first try, cloning baseball great Ted Williams from his cryogenically preserved head, which Musk obtained when Arizona’s Alcor Life Extension Foundation was thrown in as a sweetener for his purchase of the entire state. I understand his next project is to mix the remains of Elvis Presley, Frank Sinatra and Luciano Pavarotti to create a “Super Multi-Mr. Showmanship the Undead.” *Nessun dorma*, indeed!

We took the Monolith Monomuskorail to Clavius. Of course, it’s not the real Monolith, just the one from the movie set, but that doesn’t seem to stop anyone from coming to believe in super aliens once they’ve seen it. They do a great business in the gift shop selling miniature Monoliths with little thermometers or clocks in them, and black Monolith soap bars. You can also have your picture taken with the Monolith, on which they will print one of three captions: “E.T. and Me,” “What is this Thing?” or “When is the Gigantic Cosmic Fetus Coming to the Earth and Just What Was Kubrick Getting at with *That* Anyway?”

Moon Golf at the Alan Shepherd Intergalactic Golf Course was interesting. Improvements in spacesuits mean that you can actually hold the club with two hands, unlike Shepherd’s original televised shot. It’s pretty cool to drive 950 yards off the tee in the low gravity. However, golf carts have failed to keep up with all the other advances in technology. As you may know, all the golf carts in the solar system are now fitted with AARP-mandated 3 mph speed governors because of all the cart-related retiree deaths in Florida. It took the entire day to play six holes. The nearby Musk Lunar Garden was lush and intriguingly fragrant, but had only one kind of plant, a ”420.”

We flew over to the night side to do some astronomy. You have to use a specially fitted space helmet to get your eye close to the eyepiece. Viewing is awkward and somewhat uncomfortable, so most people don’t bother. They prefer to look at all the amazing images from the recently renamed RuPaul Space Telescope. It’s surprising how few people really care about astronomy these days, though. Now that we know exactly what dark matter and dark energy are, is all the mystery gone? I also can’t understand the increasing number of people who believe in a “flat Sun.” And then there’s the “ringless Saturn” conspiracy theory. Well, at least they’re looking up.

Speaking of conspiracy theories, we toured the historic Apollo landing sites. We took a selfie at Tranquility Base alongside two of the many mime Neil Armstrongs and Buzz Aldrins, but make sure you tip them a couple of space bucks lest they get mad and try to rip off your oxygen tanks. Efforts in crowd control have failed. The original footprints are obliterated and most of the artifacts have been looted. On the descent stage of Apollo 11’s lunar module, someone scratched “I never thought I’d miss Nixon,” reflecting a shockingly common feeling about recent Presidents from both parties, except for the universally respected President Snooki. People carve their names into the regolith. It’s generally harmless, if ugly, but what should we make of the word “Tesla” engraved in the Mare Imbrium in letters large enough to be seen from Earth with the naked eye? Humanity’s respect for the past, and for nature, is a tenuous thing.

It wasn’t a bad trip, but for the money, I think I’d rather be in Philadelphia. ■

SpaceX Falcon-9 Rocket Launch on September 24

Although it wasn't an official star party night, clear skies on September 24 drew some WAA observers to Ward Pound Ridge, taking advantage of the privilege extended to club members by the park. The sky was very transparent, and we could just barely sense the Milky Way, even though the best SQM reading I got was just 20.04. Mike Lomsky brought his 14-inch go-to Meade truss tube Dobsonian. Bob Kelly and Jordan Weber had 8-inch Dobs. Gene Lewis brought two scopes: a 102-mm Stellarvue refractor with a carbon-fiber tube and an exotic 8-inch Takahashi Mewlon, a Dall-Kirkham design. The scopes were mounted on a Rowan AZ100 dual (manual) mount with encoders and Nexus DSC. Jose Vega was imaging with a small refractor and had a nice capture of the North American Nebula on his screen. WAA Secretary Tim Holden and webmaster Dave Parmet also came by, as did some visitors. A group of 18 scouts were camping in the park, and we gave a laser-assisted sky tour and showed them Jupiter, Saturn, Neptune and a couple of DSOs in the scopes.

I brought my 8-inch Celestron SCT, sporting a Denkmeier binoviewer and a pair of 24-mm Televue Panoptics, specifically to view the two gas giant planets. Using both eyes makes observing much more relaxing, at the expense of making it harder for others to use your scope. They have to adjust the binoviewer's interpupillary distance and then be able to fuse the images, which some people find difficult. But several managed. There was a lot of detail on the bands of Jupiter at 180x and even a suggestion of color. I also brought a Mallincam DS287 camera (1/3" chip, 720x540 pixels, 150 fps) and imaged the two planets. Io had just poked out from behind Jupiter when I made the capture. Here's a composite of stacked and deconvoluted frames to show their relative sizes.

At 9:40 p.m., there suddenly appeared in the southeastern sky a bizarre comet-like object. Heads turned and immediately the speculation began. It was clearly not an actual comet. It couldn't be a plane unless it was dumping fuel. A few people hoped it would be ET. Then Bob Kelly suggested it might be a rocket launch, perhaps from Wallops in Virginia. We've seen some rocket trails in the southeast from launches, but nothing looking quite like this. A quick check on the Internet revealed that we were seeing the SpaceX Falcon 9 "Starlink 62 (4-32)." It launched from Cape Canaveral in Florida at 9:32 p.m., delivering a clutch of Internet satellites. What we were seeing was the second stage, whose engine was still firing over 150 miles above the Earth. The first stage landed successfully right around the time these images were made, so we could rule out that we were seeing the landing burn of the first stage engines.

Photo by Jordan Webber. Similar photos were sent in by Dave Parmet and Mike Lomsky.

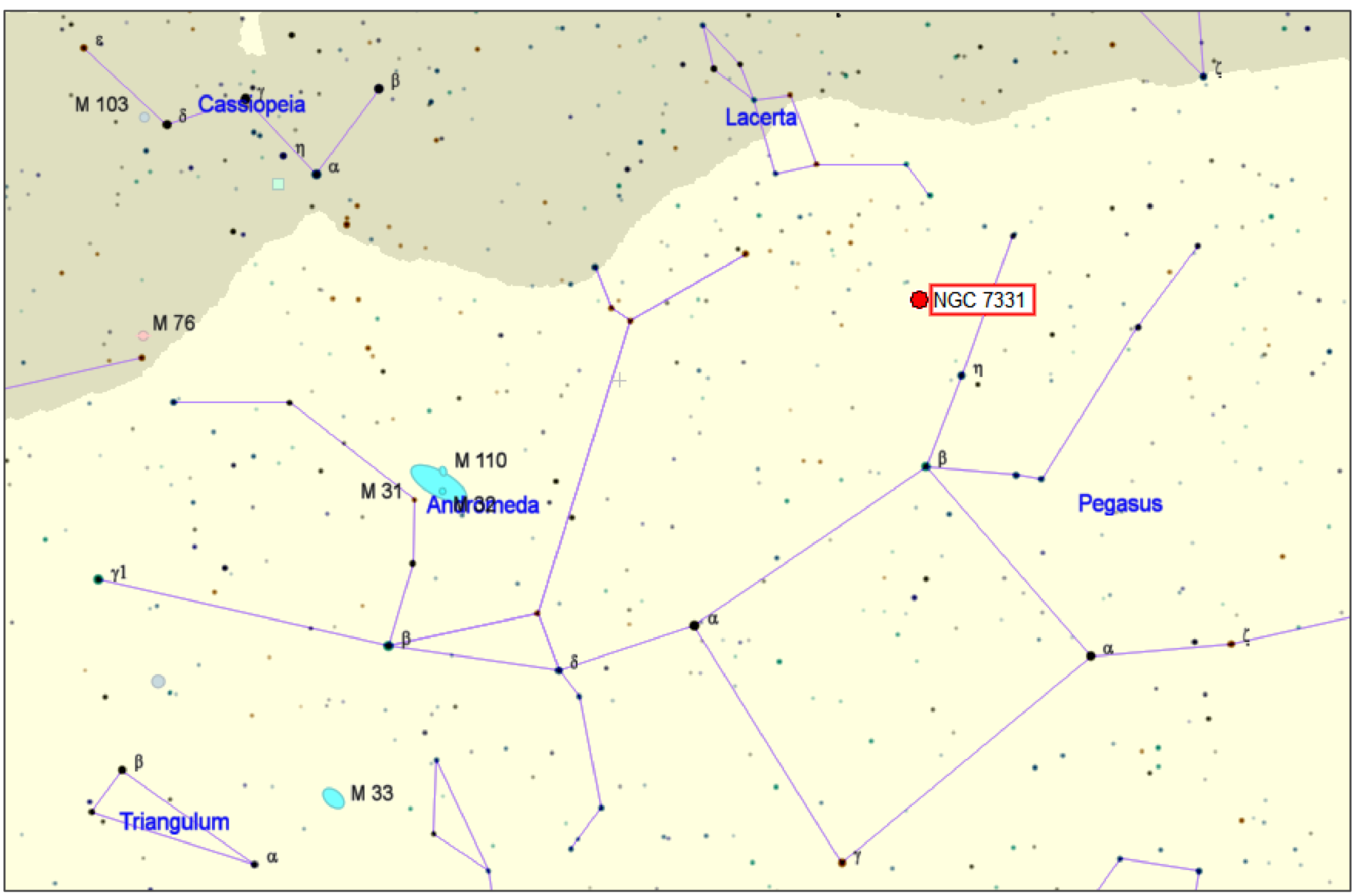
SpaceX live-streams these launches. You can see the video of this one at https://is.gd/sxf9starlink62. The actual event starts 3:12. I won't get deeply into my personal views of these satellites, but suffice it to say that I'm not happy that Elon Musk has decided to pepper the space above my head with thousands of his devices. Should space really be there for the taking, first-come, first -serve? These satellites are a misery for astrophotography and especially for ground-based research telescopes, a problem likely to get much worse in the coming years. LF ■

Deep Sky Object of the Month: NGC 7331

NGC 7331	
Constellation	Pegasus
Object type	Galaxy
Right Ascension J2000	22h 37m 04s
Declination J2000	+34° 32′ 05″
Magnitude	10.35
Size	9.3 x 3.8 arcminutes
Distance	39.8 million LY
Caldwell	30
Discovery	William Herschel 1784

In the galaxy-rich constellation of Pegasus are two famous clusters, the “Deer Lick Group,” of which NGC 7331 is the largest and brightest member, and the fainter but more compact Stephan’s Quintet, just half a degree to the southwest. NGC 7331 can be glimpsed in an 8-inch scope, perhaps in a 6-inch in darker, clear skies. Its companions are in the 13th magnitude range (as are the galaxies of the Quintet) and so need a larger scope for visual appreciation.

Westchester Visibility for NGC 7331			
22:00	11/1 (EDT)	11/15 (EST)	11/30 (EST)
Altitude	74° 11′	52° 44′	41° 47′
Azimuth	250° 45′	275° 18′	283° 09′

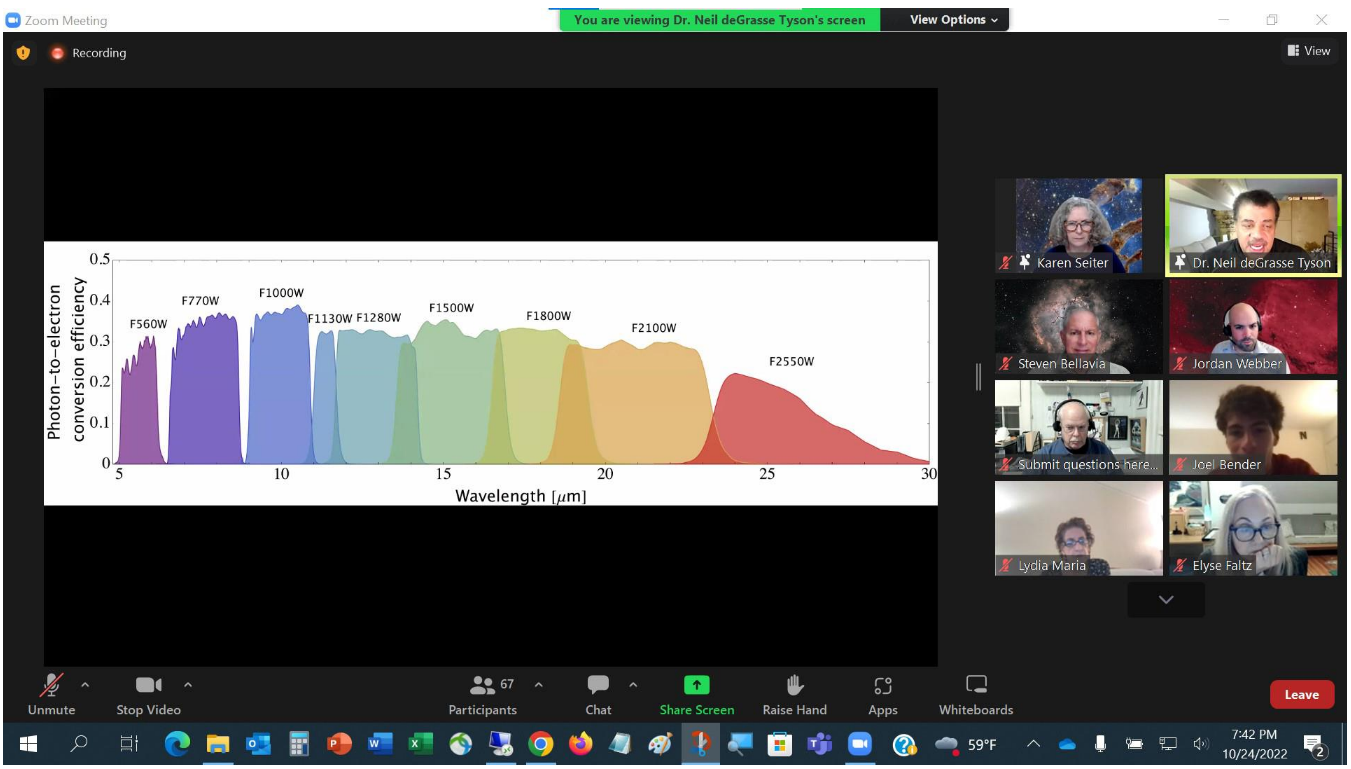


WAA's Conversation with Neil deGrasse Tyson on October 24th

On October 24th, WAA members were privileged to spend over an hour and a half, via Zoom, with Neil deGrasse Tyson, the Director of the Rose Center for Earth and Space at the American Museum of Natural History and surely the world's most recognizable astrophysicist and champion of science. WAA member Lydia Maria, who volunteers at the Rose, spontaneously suggested to Dr. Tyson that he speak to our club, and he graciously agreed. She had piqued his interest in WAA by sending him several copies of Sky*WAA*tch.

Although initially he suggested a "conversation" with WAA President Karen Seiter and then audience questions, he opted to start a prepared presentation. After Karen's wonderful introduction, he described his new book *Starry Messenger: Cosmic Perspectives on Civilization* and then gave a highly informative report on the James Webb Space Telescope. He started with its initial appearance in the 2000 Astronomy and Astrophysics Decadal Survey, described its construction, showed videos and animations of its launch and deployment in space, reviewed its instrumentation (with particular detail about the heat shield that allows it to function a few dozen degrees above absolute zero). The JWST's most recent scientific results and images were also presented. His talk was full of information and perspective, given at a level perfect to the range of knowledge of our club members and of course presented in his engaging, passionate and lucid style. After the lengthy presentation, he answered questions from club members, whose images we were able to spotlight to make the Q&A fully interactive.

Here's a screen grab by Steve Bellavia. Dr. Tyson was describing the spectral range of the Webb and how the invisible infrared wavelengths are translated into visual wavelengths that allow us to see the fantastic objects in space.



There were 67 WAA members who logged on to the presentation. Thanks go out to Paul Alimena for organizing the Zoom (we had several practice sessions to make sure that we would know exactly how to manage the live session), to Karen Seiter for being the host, to Jordan Webber for managing the Zoom waiting room, and Larry Faltz who oversaw the Q&A. Most of all, WAA thanks Lydia Maria, without whom this special event never would have happened.

From DSLR to OSC

Robin Stuart

A while ago I made the transition from Canon 60Da digital single-lens reflex (DSLR) camera to a ZWO ASI2600MC one shot color (OSC) camera for astrophotography. In addition to smaller pixels and a larger sensor area, an important advantage that the ZWO camera offered was that it was thermoelectrically cooled, so its temperature could be set to a predetermined value and I wouldn't need to maintain a dark frame library that depended on both temperature and exposure time.

Image processing is relatively simple with a DSLR. Downloaded images are generally natural-looking and in full color. Processing OSC images introduces a few additional steps which the DSLR takes care of in the background. Fortunately there are many helpful YouTube videos and other sources available to guide the newbie through these processes. Unfortunately, however, some of the background information provided by well-meaning pundits can simply be wrong and lead to confusion or misunderstanding. This article briefly describes the extra things that need to be done in processing OSC images and highlights some of the misconceptions that have been propagated.

After taking my first images with the ZWO ASI2600MC, I eagerly downloaded the FITS files. Even after quite long exposures, deep sky objects produce rather dim images. To see them the image needs to be *stretched*. Simple scaling of the pixel values by a multiplicative factor can render the image visible but generally better results are achieved by a non-linear stretch in which pixels of lower brightness are mapped to a wider dynamic range than the brighter ones.

Most early stages of processing require a linear image, hence stretching is usually one of the last steps performed. On doing a stretch I was surprised and a bit disappointed when I saw something like the blocky grayscale image in the next column.

The image needs color to be assigned to the individual pixels in a separate process known as *debayering* which will be discussed in more detail later. After debayering and stretching the result is a 3-color RGB image shown below but again the things were not as expected.

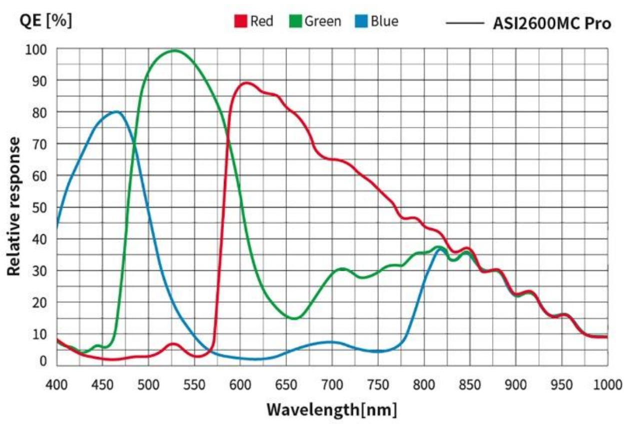
Stretched image

Debayered image

There is obviously a strong green cast present which needs to be removed by performing color calibration. In its simplest form this involves scaling the overall brightness of the red, green and blue layers individually to give a more natural appearance. As no camera's sensor responds to colors in exactly the same way as the human eye, the calibrated image can only ever be an approximate representation of what a person might see. Applications such as *PixInsight* provide several ways of doing color calibration. One method adjusts the color balance so that the average color of stars in the image is white. The Photometric Color Calibration process performs plate-solving and adjusts the color balance so that the stars identified in the image match their catalogued B-V and B-G values.

One Shot Color Imaging

The ZWO ASI2600MC camera that I use consists of a 6248×4176 matrix of identical square CMOS sensor elements or *sensels* that are 3.76 microns on a side. The sensels are all capable of detecting photons (light) over the full visible spectrum, 380 to 750 nanometers, and beyond. On the telescope side of the sensels sits a Color Filter Array (CFA) known as a Bayer filter. This is a mosaic of tiny red, green and blue filters. Although the underlying sensels themselves are all identical, the presence the filters means that only light from a limited range of the spectrum falls on any particular one. The graph below for the ZWO ASI2600MC shows the combined effect of the filters' transmissivity and the sensor's spectral sensitivity as a function of the wavelength of the incoming light.



In order to mimic the physiology of the human eye, in 1976 Bryce Bayer patented the CFA arrangement that now bears his name. There were twice as many green sensels as red or blue. The configuration of the filters can vary but the most common one is denoted RGGB. In it the filter of the top left hand corner sensel is red and the 2x2 pattern  is repeated across and down the CFA. Even for an RGGB CFA the arrangement could be offset one unit in the horizontal or vertical directions making the top left hand corner sensel green or blue. It is obviously crucially important to use the correct arrangement when adding color to the image in debayering.

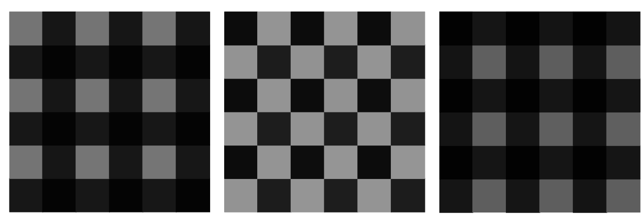
There are some lengthy online discussions where participants worry about getting the correct Bayer mosaic pattern for their cameras. Some resort to trial and error in both the pattern and offsets and then try to judge by eye which one gives the most natural looking result. This not something that can or should be done this way.

Fortunately, things do not need to be this confusing or ambiguous. The FITS header metadata produced by ZWO ASI2600MC contains the entries

Name	Value	Comment
BAYERPAT	'RGGB'	Sensor Bayer pattern
XBAYOFF	0	Bayer pattern X axis offset
YBAYOFF	0	Bayer pattern Y axis offset

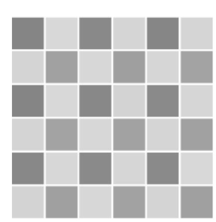
which leaves no doubt what the correct pattern Bayer mosaic pattern is. The information is available to be read by image processing software.

Alternatively, the Bayer pattern can be determined experimentally. With your favorite paint program generate a plain red image on your laptop screen. Then sit the camera on it and take a properly exposed snapshot. No optical elements are needed. Upon zooming in to the pixel level on the raw grayscale image, the sensels under red filters will be seen to be brighter compared to the others. Do the same for green and blue or infer the latter from what is left over. The images below show from left to right the top left hand corners of images produced in this way respectively from red, green and blue laptop screen images. In each case the brightest pixels are in their expected locations for an RGGB Bayer pattern with (0, 0) offset.

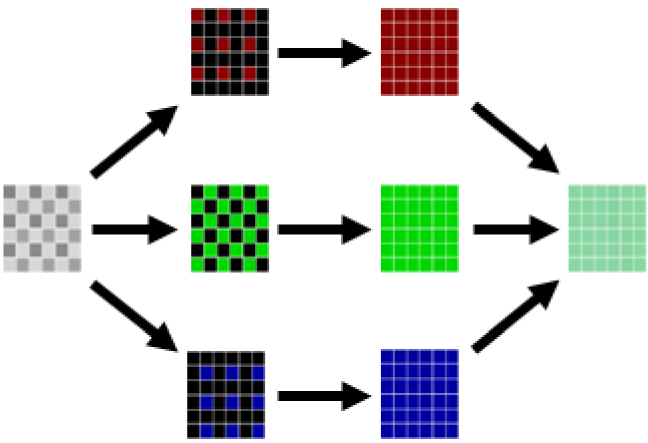


Debayering

There is at least one internet pundit who confidently asserts that the reason for the green cast in the debayered image is that there are twice as many green pixels as red or blue. This betrays a profound misunderstanding of how debayering works. It is true that if you were to look through a CFA it would appear to have a greenish tint due to the greater number of green filters but this is irrelevant when it comes to constructing the final color image.



The image above shows the top left-hand corner of a flat frame that was generated by stretching a white tee shirt over the objective lens of a refractor telescope pointed at the blue sky. The Bayer pattern is RGGB meaning, as mentioned previously, that the top left hand group of CFA filters form the pattern  which is repeated across and down the frame. Note that the positions corresponding to green sensels tend to be somewhat lighter than those of red and blue and therefore the final color image is expected to have a green hue. This is purely a consequence of the specific response of the camera to the color of the subject being recorded.



Debayering takes the grayscale mosaic of red, green and blue sensel output values and produces an RGB image where each pixel is associated with three numerical values – one each for red, green and blue. The process is illustrated above. Strictly speaking, all but the final image on the right are grayscale images but color has been added to others for the purposes of explanation. Starting from the initial grayscale image at left, the pixels are separated according to color. The black pixels in the next column represent unknown values that need to be filled in. Clearly there are 50% more holes that require filling in the red and blue pixel sets as there are for the green but this in no way affects the relative brightness of the color channels in the final image. Filling the holes involves some sort of interpolation method applied separately in the red, green and blue channels. There are several choices for this, from simple bilinear interpolation to the Variable Number of Gradients (VNG) demosaicing method which gives superior performance when boundaries are present. Once the missing pixels have been filled in, each of the three now-complete color layers are combined into a single RGB color image. As expected the final image does have a green cast to it because the green sensels were responding more strongly compared to the red and blue sensels.

Finally, lest there be any remaining doubt about the origin of the green cast, a simple experiment can be performed. On the left below is a 100×100 pixel grayscale image in which all the pixels have the value 0.7. If this image had been produced by an OSC camera then it would contain the output from twice as many green sensels as red or blue. When the grayscale image is debayered by PixInsight it produces the RGB color image on the right. Each pixel in the RGB image has the value (R, G, B) = (0.7, 0.7, 0.7). The two images appear identical and no green cast has been introduced.

Finally, after calibrating ten 10-minute subframes with dark and flat frames, debayering, registering (aligning), stacking, applying Photometric Color Calibration and stretching the resulting image is shown below. Further processing is always possible.

Calibrated and processed image

■

WAA member Robin Stuart is a physicist, amateur astronomer and expert in celestial navigation. His recent talk to the Royal Institute of Navigation on Ernest Shackleton's *Endurance* expedition is at https://www.youtube.com/watch?v=y3sMS5p8Pgk.

Beyond the Red-Dot Finder: Saving Your Neck

Larry Faltz

There are a few “star hoppers” still out there, manually going from field to field to find celestial objects and enjoying the hunt immensely. They are atavists, rebels against the modern computer-controlled, wi-fi-enabled astronomy era whose ultimate expression is the “smart” video-image telescope like the Unistellar eVscope or those made by Vaonis, that require no effort from the observer beyond placing the instrument in an upright position and flicking a switch. Most of us are not Luddites, but we want computerized visual instruments (better for lunar and planetary viewing anyway) that can identify and track objects. For that, we have to start the evening with an alignment.

Some Celestron telescopes come with, or can have added on, the *StarSeek* automatic alignment camera. Modern equatorial mounts can use an imaging camera on the mount or on the telescope itself to perform a software-assisted polar alignment, usually assisted by “plate solving.”

Those of us with computerized instruments (go-to’s or push-to mounts fitted with encoders) in the alt-azimuth configuration need to manually align the telescope at the beginning of an observing session by sighting on one or two stars (or solar system objects). Two stars gives a more accurate model of the sky, but you can start with a planet in twilight and then add a star for the second object. Celestron has a 3-star alignment process, SkyAlign, which doesn’t require the user to know any of the star names. For any of these alignment processes, a finder is needed.

The formula for true field of view is:

$$FOV_{true} = \frac{Field\ stop\ diameter}{Telescope\ focal\ length} \times 57.3$$

As an example, take a 32-mm Plössl. A 32-mm eyepiece has a 27-mm “field stop” at the bottom of the barrel and gives the widest true field of view of any eyepiece in a 1¼-inch focuser. The Plössl probably has a 52° apparent field of view. Let’s assume you are using a 6-inch f/10 SCT (a Celestron 6SE for example). With a focal length of 1,500 mm, the 32-mm eyepiece gives 46.875x. The actual field of view is 52/46.875=1.28 degrees, about three full Moons. A 25-mm Plössl eyepiece, standard equipment for the 6SE, gives 60x and an actual field of view of 0.86 degrees (52 arcminutes), less than two full Moons. If you try to find a particular star just by sighting along the tube and then looking through the telescope at 60x, the odds are good that it won’t be in the telescope’s field. It will usually take much longer than you’d like to find the star by pushing hand control buttons. We need some kind of “finder” to get us closer to the alignment stars.

Consumer telescopes today come with either a “zero-power” red dot finder or a low-power straight-through telescopic finder. The latter are often, but not always, “correct image” scopes, making movements of the telescope logical when centering an alignment star.

Many newcomers to telescopes find that sighting through a red-dot or straight-through finder is more difficult than they anticipated or that the user manual implied, and they often fail at aligning the telescope.

The first task is to align the finder to the scope’s optical axis. Red-dot finders have one knob to adjust vertical position and one to adjust horizontal position. Telescopic finders are usually held in brackets that have thumbscrews to position the front and rear of the finder. Before it’s fully dark, point your scope at a distant object such as a tree-top, streetlight or something else at least a quarter of a mile away. Center it in the main scope and adjust the finder so the optical axes are parallel. You should adjust the alignment again when you have the first alignment star centered in your telescope’s eyepiece. That will eliminate the parallax caused by the fact that whatever earthly object you sighted on is much closer than the star. Alas, the plastic low-end red-dot finders often have imprecise movements, and for six-point brackets the movements can be counterintuitive.

The logic of a zero-power red-dot finder is inescapable. Using both eyes, look along the scope with the finder in your field of vision. Find a bright star and line up it up with the red dot, then look in the telescope, press the appropriate buttons on your hand control (or on a smartphone app if connected via wi-fi) to center the star in the eyepiece field, then press the whatever buttons that tell the electronics you've centered the star. If you are doing a two-star alignment, and you should, repeat for star #2. That usually gets you close. You can refine the alignment during a viewing session. To learn more, RTFM.[1]

On low-end telescopes, the supplied red-dot finder aperture is often quite small. There are red-dot finders with larger windows that make viewing a bit easier, but they all pose the same physical problem. If you align on a star that's at least 30 degrees above the horizon, which is the minimum altitude you should use for an alignment star, you have to crouch or kneel behind the telescope and crane you neck to a position that might provoke some cervical strain. The older you are, the more likely your neck has some underlying arthritis, making the risk of strain or even outright injury greater. When the scope is mounted on a tripod whose legs are not extended, say because you want children to be able to look through the scope, the contortions required can be quite extreme. After helping two new scope users align their instruments at the July 23rd star party, I had to take a bunch of Aleve when I got home and had neck discomfort for several days afterwards.

Straight-through telescopic finders require the same contortions. On reflectors, they are mounted near the focuser at the front end of the telescope. That's helpful, but unless the finder is mounted a significant distance away from the scope, you end up banging your head into the body of the scope when you try to sight through the finder. And you have to twist and extend your head anyway unless the star is near the horizon, which means it's not a good alignment star and you shouldn't be using it. My advice is to replace the finder with something that is easier to use and doesn't challenge your anatomy.

Some red-dot finders are mounted on a small rail with undercuts on either side. The finder clamps onto the rail with two compression screws. The mounting rail is attached to the telescope with screws. Other telescopes have a standard "Orion/Vixen" dovetail mount for the finder. If you have the former attachment and want to upgrade, a dovetail shoe with the right hole spacing is available from scopestuff.com. You may need slightly longer screws than the original (they are usually M4 or 8x32 in SCTs). These can be obtained at a local hardware store. Make sure you choose the right screw head so that it doesn't stick above the bottom of the shoe.

There are variations of the red-dot finder with larger apertures that can make sighting a little easier with a bit less strain. A good one is the William Optics red dot finder (also made by others). This is a little more substantial than a basic red-dot, with a larger window and all-metal construction, The window is higher off the scope than a generic red-dot, which is advantageous. You can switch between several different reticles. These devices cost about $80. If you want to stay small, this is a good investment.

A red dot finder that many people like is the Telrad ($46). A substantial plastic box, its viewing window is much larger than other red-dots. The reticle has rings delineating fields of ½, 2 and 4 degrees. It comes with a detachable base that can be mounted on the optical tube with two-sided adhesive, although I recommend a large hose clamp (I try to avoid putting sticky stuff on my scope.) You can get risers that lift the Telrad two or four inches above the tube for ease of sighting. The reticle can fog in high humidity; a dew heater is available for it. Three small knobs make aligning it with the telescope very easy.

A smaller version of this device is the Rigel QuikFinder ($50), which has 1 and 2-degree circles. There are adapters to mate the QuikFinder with a dovetail base.

A decent red dot finder can be effective in initiating the alignment. You get a good look at the sky with your natural eyesight, and then line up the scope with a red-dot if your neck can stand it, then center the star in the scope.

Higher-end telescopes, such as large Celestrons of various types, come with a straight-through finder, usually 50-mm diameter, with a field of about 5 degrees. But sighting along the tube at high elevation is just as difficult as with the red-dot. Replacing the straight through finder with a wide-angle right-angle/correct-image (RACI) finder is an effective neck-sparing solution. An illuminated reticle is a helpful feature.

Celestron makes a illuminated 9x50 RACI finder with 5° field of view ($160) that fits on its proprietary finder base. You can also replace the Celestron finder

[1] Contact author if you don't know what RTFM means.

base with an Orion/Vixen quick-release shoe, and then mount another company's illuminated finder with its own bracket. You can get 50, 60 or even 80 mm finders. Several makers sell compact non-illuminated 6x30 ($50) and 8x50 ($80) RACI finders with a clever alignment system consisting of two orthogonal thumb screws and a tensioning spring on the bracket, rather than a six-point system.

There is another way to achieve the benefit of your eyes' natural field of view to find the star without an optical (lens) device and without much risk to your neck: a laser.

Thin, "pencil"-type green 5 mW lasers are inexpensive. They can be mounted on a telescope using a six-point bracket that fits into a standard Orion/Synta dovetail shoe (combo laser+bracket runs about $70). You have to depress the button on the shaft of the mount to see the laser beam, which is not a problem since you only need the beam on for an instant to see where in the sky you are pointed. There are two issues with a laser: you must make sure there are no airplanes in the area, and you can't use them once the night gets started if anyone on the field is imaging. Even better than the pencil-type laser is a laser for a firearm that can easily be adapted for a telescope. See the July 2017 SkyWAAtch, page 10 for instructions. In the current tight supply-chain world, the required AgenaAstro mounting bracket is currently out of stock. Alternatives from other vendors are more expensive and anyway they too are back ordered. A viable solution is to have one custom made from high-density plastic via 3D printing. For a laser alignment bracket, this material is sufficiently rigid. Joel Short, an astrophotographer who also fabricates 3D-printed parts for telescopes, recently made one for me for about the same price as the AgenaAstro part. He can be reached at https://buckeyestargazer.net/Shop.php.

One caveat for illuminated finders: make sure you turn off the power to the reticle when you've finished aligning. The batteries will run down quickly. Always keep spare batteries on hand (two AA for Telrads, button cells, 123A for the laser, 2032, 2025 or LR-44, for the other types). I take out the AA batteries from my Telrad after each observing session to avoid any possibility of leaking. Button cells rarely leak.

In general, if your scope is large enough (six inches or bigger) you can mount both a laser (or red-dot) *and* a RACI finder to make the job of finding and centering the alignment stars even easier. With a small red dot alone you might have to get the star within 1° (or less) to be able to see it in the scope and then center it; but if you also mount a RACI finder, you only need to be within 5° to get it in the RACI field. Center it in the RACI crosshairs and it will be in the scope's field, ready for the final centering adjustments. ■

Typical generic red-dot finder

William Opics type red-dot finder

Rigel QuikFinder

Telrad

Green pencil-type laser pointer on bracket

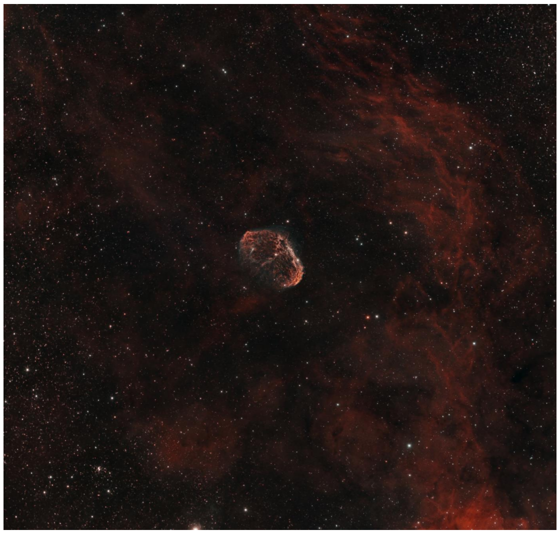
Orion non-illiumated 7x50 RACI finder on dovetail

Celestron illuminated 9x50 finder on Celestron bracket

Finder dovetail shoe for an SCT

Images by Members

Cover Image: NGC 6888 by Olivier Prache



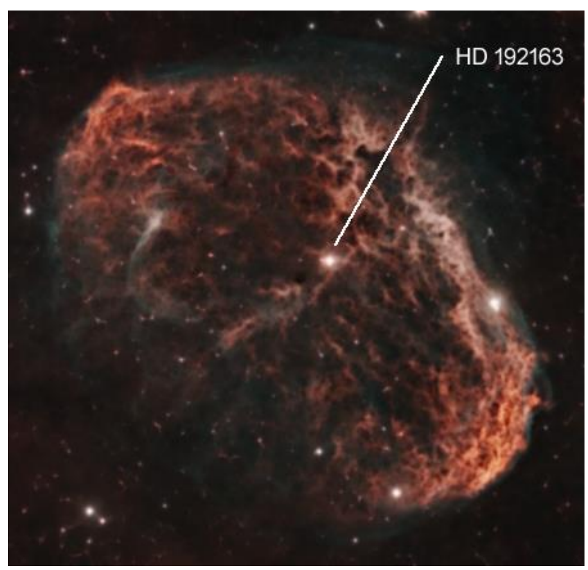
The image was made in late August at the 2022 Medomak Astronomy Retreat and Seminar (MARS) in Washington, Maine. Olivier and his wife Marine attended, along with WAAers Larry and Elyse Faltz, Eric and Katherine Baumgartner, Peter and Kate Rothstein and Bill Caspe, among the 36 or so participants.

The exposure was 2 hours 15 minutes with a Celestron RASA8.

Olivier used an IDAS NBZ filter this time instead of the Optolong L-Enhance. Olivier said "Being partially color blind does not really help me decide whether this is better or not but an analysis by Jim Thomson showed the NBZ should be better than the L-Enhance at *f*/2 in the blue part of the spectrum."

NGC6888, also listed as Caldwell 27, is another William Herschel discovery. It is a fairly large (18x12 arcminutes) emission nebula in Cygnus quite close to Sadr (Gamma Cygni), the heart of the swan and central star of the "Northern Cross" asterism. It's magnitude 8.8 but not easy to glimpse in light-polluted skies. When you can resolve it, it appears crescent-shaped due to the brighter shell on its northwest side, and thus its eponym.

The Crescent is illuminated by the Wolf-Rayet star HD 192163 (also catalogued as WR 136), the bright (magnitude 7.5) star in the center of this enlargement of Olivier's image (below). WR stars begin life as type O stars with masses greater than 20 M⊙, and are usually members of a binary. Wolf-Rayet stars have evolved and passed through a supergiant phase. They are extremely luminous, and shed mass at prodigious rates. The matter plows into gas and dust previously ejected during the star's evolution, creating the complex structures such as NGC 6888. The shocked material is heated and emits X-rays.



The Crescent was recently studied by a group of astronomers from Mexico and Spain using Wide-field Infrared Survey Explorer, Spitzer IRAC, MIPS and Herschel PACS IR imagers.[1] They were able to test several models of the origin of the nebula and concluded it consists of an outer shell of gas and dust and an inner shell of just gas. They determined that "the current mass of NGC 6888 is purely due to material ejected from WR 136, with a negligible contribution of the swept up interstellar medium. The total mass of this model is 25.5 (+4.7, −2.8) M⊙, a dust mass of 0.14 (+0.03, −0.01) M⊙, for a dust-to-gas ratio of 5.6×10^{-3}." Dust at the outer edge of the nebula is being destroyed by the expansion of the nebula.

From Olivier's image, you can see that there is a good deal of hydrogen emission farther away from the nebula. It was suggested in the 1990's that this material may be the detritus of a supernova that exploded 100,000 years ago, but there's no firm evidence for the hypothesis.

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[1] Rubio, G, et. al., Unveiling the stellar origin of the Wolf-Rayet nebula NGC 6888 through infrared observations, Monthly Notices of the Royal Astronomical Society, Volume 499, Issue 1, pp.415-427 (2020). On line (full text) at https://academic.oup.com/mnras/article/499/1/415/5908399.

The Helix Nebula by Robin Stuart

The Helix Nebula (NGC 7293) is one of the closest and largest planetary nebula in the sky. However, at a declination of -21° it never rises very high above the horizon for northern observers. This, along with its low surface brightness and extraordinarily large size, can make it a challenging object to spot visually. On occasion I have looked straight at it through a large telescope, but it took some time before I become aware that it was there. Dark skies and an OIII filter help. Since it's around 2/3 the size of the full Moon, one can only wonder what ancient humans would have made of it had they been able see this object staring down at them.

The Helix nebula sits distance of 650 light years from Earth and is around 0.8 light years across. The central star is on its way to becoming a white dwarf and its fierce radiation causes its previously expelled gaseous envelope to fluoresce.

This image is a stack of 32 10-minute subframes taken over three nights in August and September giving a total exposure time of 5 hours, 20 minutes through a Televue NP127 using a ZWO ASI2600MC camera.

Robin Stuart

For more on planetary nebulas, see the October 2015 SkyWAAtch, page 6.

Double Shadow Transit of Jupiter by Steve Bellavia

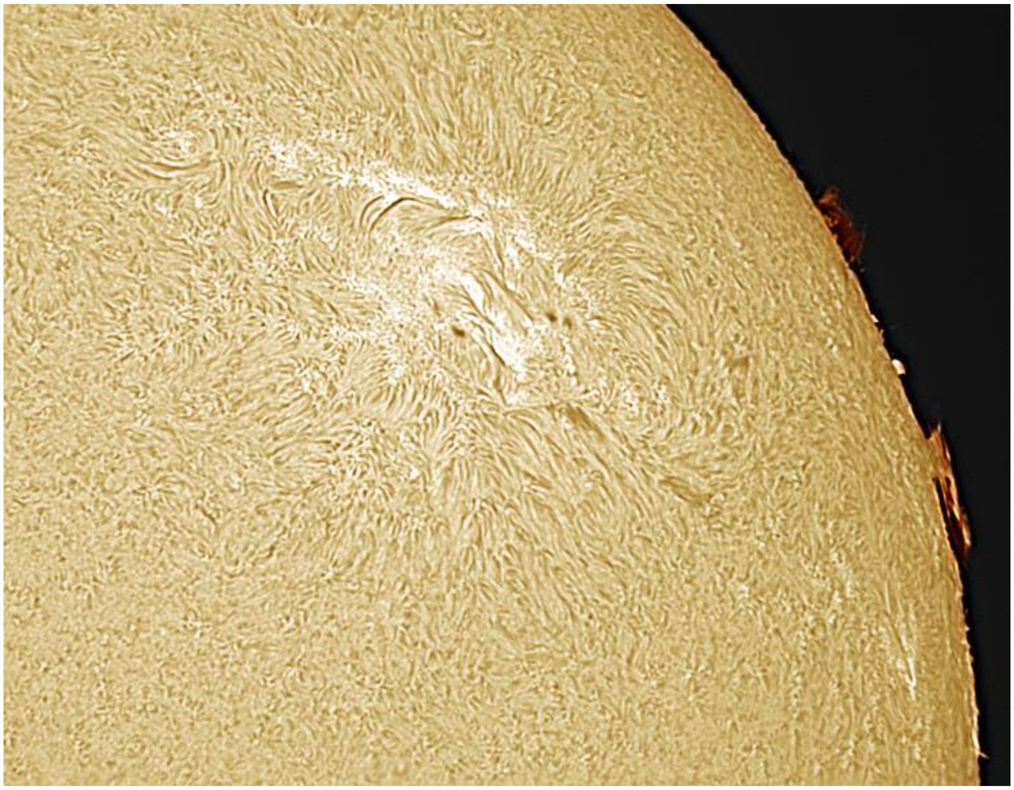
Io and Ganymede cast their shadows onto the face of Jupiter on the night of August 15-16, 2022. The shadow on the right is from Io, and the larger shadow on the left is from Ganymede, which is visible to the upper left of Jupiter. The Great Red Spot made an appearance too. Steve made this image with a 6-inch Celestron SCT and 2X tele-extender under less-than-optimal seeing (3/10) at 1:10 a.m. on August 16.

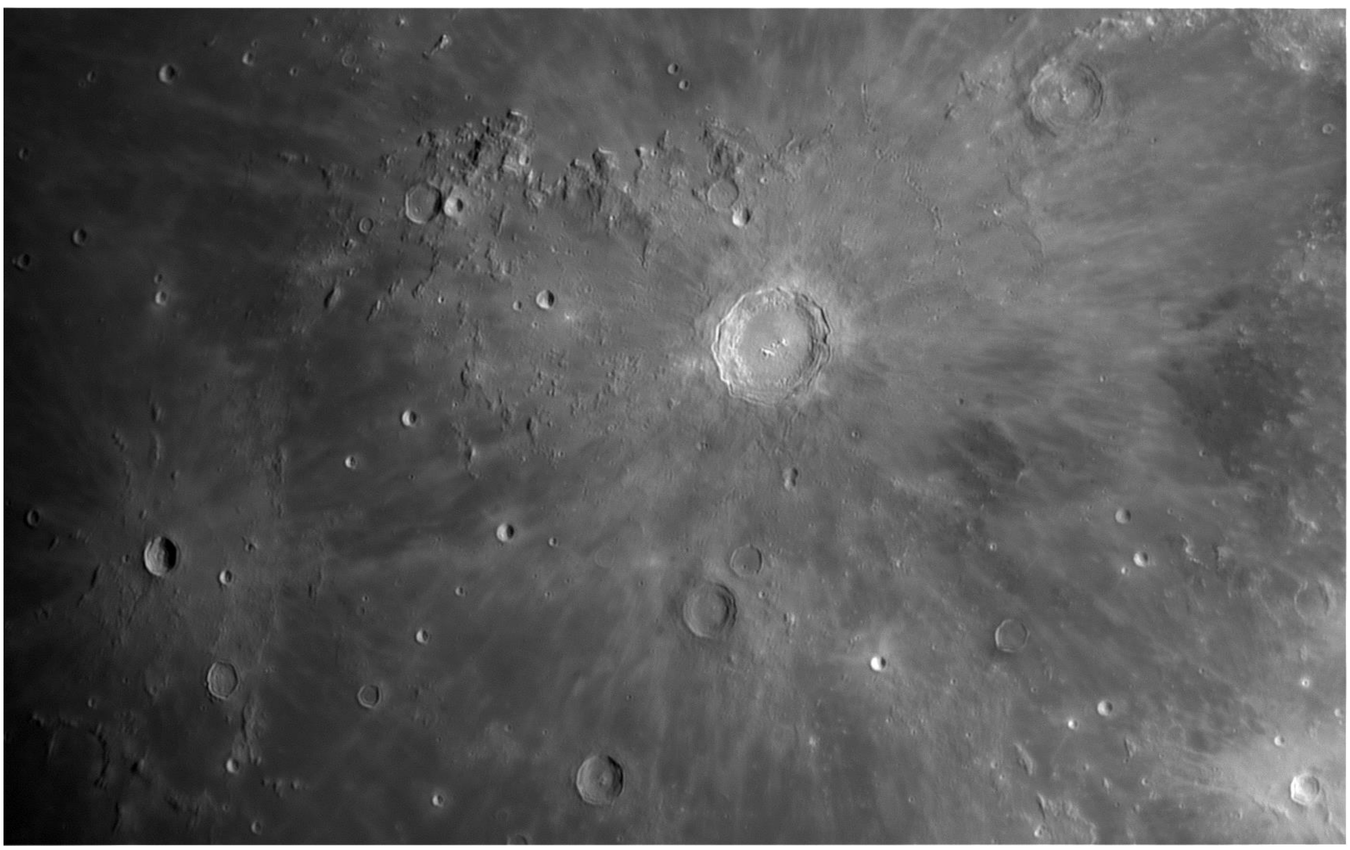
Shadow Transits of Jupiter for November 2022

Here are the evening transits during which Jupiter will be above 25 degrees altitude for at least part of the transit. Times are EDT for 11/1 and 11/2, EST for all other times (daylight savings time ends at 2 a.m. on 11/6).

Date	Moon	Starts		Ends		Notes
		Time	Altitude	Time	Altitude	
11/1	Io	20:30	41	21:01	44	
11/2	Europa	18:30	25	21:01	44	**Double shadow transit** from 20:22 to 21:01. Nautical twilight ends 18:53.
	Ganymede	20:22	41	23:08	45	
11/8	Io	20:25	45	23:39	31	
11/9	Europa	20:06	46	22:36	39	Separate transits this evening.
	Ganymede	23:25	32	02:09 (11/10)	4	
11/15	Io	23:21	29	01:35 (11/16)	6	
11/16	Europa	22:42	34	01:12 (11/17)	9	
11/17	Io	17:50	37	20:04	47	Nautical twilight ends 17:40.
11/24	Io	19:46	47	22:00	36	

Rick Bria sent in this fine hydrogen-alpha image of the Sun taken on September 21 at the Aloysia Hardey Observatory in Greenwich.





In April, **Larry Faltz** imaged Copernicus and Kepler (lower left) on the 12½-day old Moon, using an Orion Apex 127-mm Maksutov and ASI290M camera.

Research Highlight of the Month

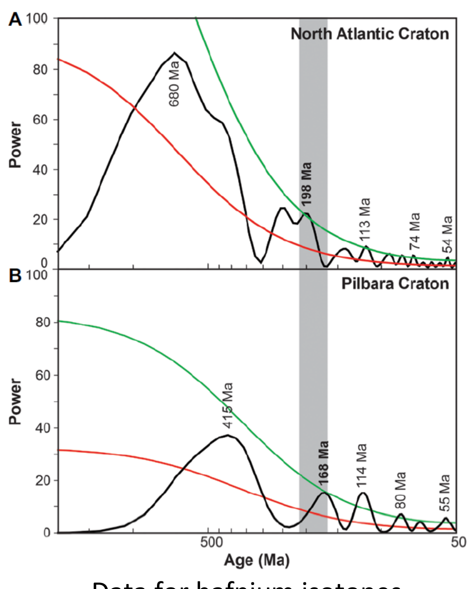
Kirkland, CL, Sutton, PJ, Erickson, T, et. al., Did transit through the galactic spiral arms seed crust production on the early Earth? *Geology* 2022; https://doi.org/10.1130/G50513.1 (accepted for publication, posted on-line August 23, 2022)

The Earth is unique in the solar system because it has continents. The Earth's crust is dynamic. The evolution of the crust is generally thought to be the result of internal processes substantially driven by circulation of the Earth's magma. The existence of plate tectonics is a consequence of these processes.

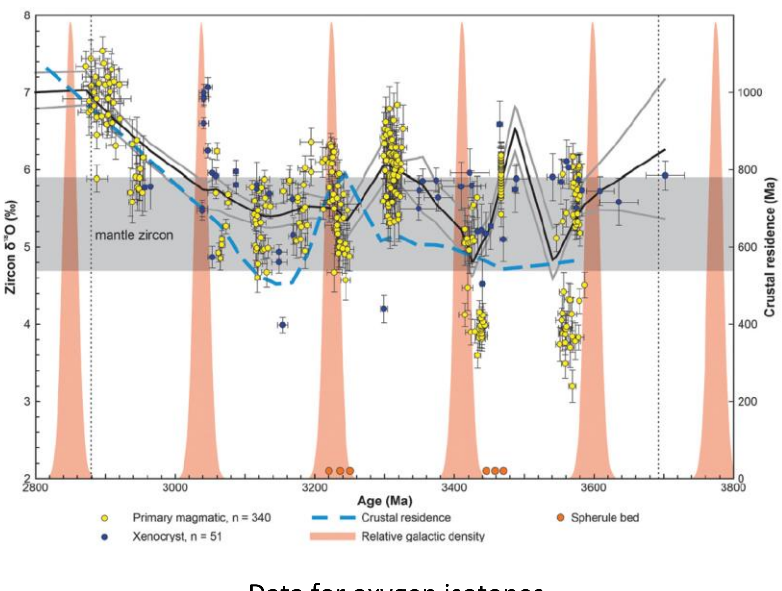
Geologists can look back in time by analyzing the isotopic composition of residual crustal formations that have survived the remodeling by more recent plate tectonics. There are just a few of these ancient formations left. The North American craton in Greenland and the Pilbara craton in Australia were formed during the Archean eon, some 2.8-3.8 billion years ago. Geologists are not sure that plate tectonics operated during that era. It has been known for about 25 years that there is a periodicity in the isotope composition of the crust.

The four spiral arms of the Milky Way orbit the Sagittarius A* black hole at a rate of 210 km/sec while the Sun revolves at 240 km/sec. The spiral arms are not constant structures: they are actually "gravity waves" of higher density. Individual components (gas, dust and stars) pass through these waves, experiencing changes in local mass density. The Sun, with the solar system, passes through a spiral arm every 200 million years. When it does so, there is an interaction between the Oort cloud and the relatively higher density of matter in the spiral arms. The planetoids in the Oort Cloud are perturbed at a higher rate. Some crash into the Earth with significant energy, resulting in changes in the structure and composition of the crust.

By analyzing the uranium, lead, lutetium, hafnium and oxygen isotope composition in zircon crystals extracted from the two ancient cratons and other, more recent, crustal formations, the authors discovered a periodicity of about 200 million years in the composition of the minerals.



Data for hafnium isotopes



Data for oxygen isotopes

Harvard physics professor Lisa Randall argued in her book *Dark Matter and the Dinosaurs* (see the March 2018 SkyWAAtch) that the density of matter in the spiral arms was not sufficient to dislodge Oort cloud objects, and suggested that there is a disk of dark matter in the galactic plane. Either way, there is now evidence that the Earth's crust has been bombarded by Oort cloud objects with a periodicity consistent with galactic rotation.

From the NASA Night Sky Network

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

Cepheus: A House Fit for a King

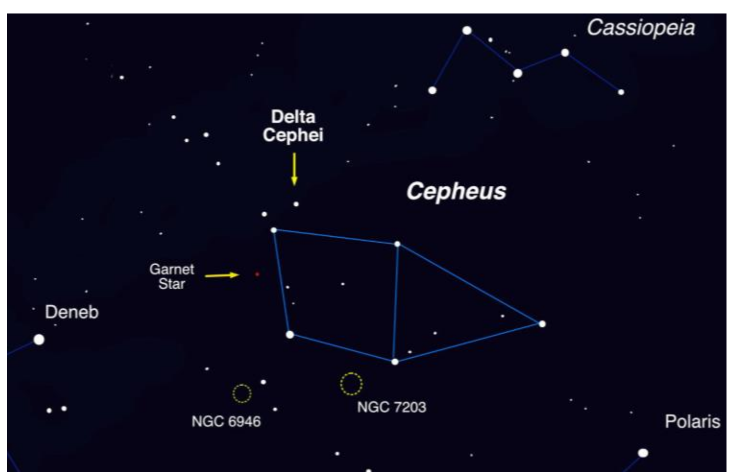
David Prosper

Sometimes constellations look like their namesake, and sometimes these starry patterns look like something else entirely. That's the case for many stargazers upon identifying the constellation of **Cepheus** for the first time. These stars represent Cepheus, the King of Ethiopia, sitting on his throne. However, many present-day observers see the outline of a simple house, complete with peaked roof, instead – quite a difference! Astronomers have another association with this northern constellation; inside its borders lies the namesake of one of the most important types of stars in modern astronomy: Delta Cephei, the original **Cepheid Variable**.

Cepheus is a circumpolar constellation for most observers located in mid-northern latitudes and above, meaning it does not set, or dip below the horizon. This means Cepheus is visible all night long and can be observed to swing around the northern celestial pole, anchored by Polaris, the current North Star. Other circumpolar constellations include Cassiopeia, Ursa Major, Ursa Minor, Draco, and Camelopardalis. Its all-night position for many stargazers brings with it some interesting objects to observe. Among them: the "Garnet Star" Mu Cephei, a supergiant star with an especially deep red hue; several binary stars; several nebulae, including the notable reflection nebula NGC 7023; and the "Fireworks Galaxy" NGC 6946, known for a surprising number of supernovae.

Perhaps the most famous, and certainly the most notable object in Cepheus, is the star **Delta Cephei**. Its variable nature was first discovered by John Goodricke, whose observations of the star began in October 1784. Slightly more than a century later, Henrietta Leavitt studied the variable stars found in the Magellanic Clouds in 1908 and discovered that the type of variable stars represented by Delta Cephei possessed very consistent relationships between their luminosity (total amount of light emitted), and their pulsation period (generally, the length of time in which the star goes through a cycle of where it dims and then brightens). Once the period for a Cepheid Variable (or **Cepheid**) is known, its luminosity can be calculated by using the scale originally developed by Henrietta Leavitt, now called "Leavitt's Law.". So, if a star is found to be a Cepheid, its actual brightness can be calculated versus its observed brightness. From that difference, the Cepheid's distance can then be estimated with a great deal of precision. This revolutionary discovery unlocked a key to measuring vast distances across the cosmos, and in 1924 observations of Cepheids by Edwin Hubble in what was then called the Andromeda Nebula proved that this "nebula" was actually another galaxy outside of our own Milky Way! You may now know this object as the "Andromeda **Galaxy**" or M31. Further observations of Cepheids in other galaxies gave rise to another astounding discovery: that our universe is not static, but expanding!

Because of their importance as a "standard candle" in measuring cosmic distances, astronomers continue to study the nature of Cepheids. Their studies revealed that there are two distinct types of Cepheids: Classical and Type II. Delta Cephei is the second closest Cepheid to Earth after Polaris, and was even studied in detail by Edwin Hubble's namesake telescope, NASA's Hubble Space Telescope, in 2008. These studies, along with others performed by the ESA's Hipparcos mission and other observatories, help to further refine the accuracy of distance measurements derived from observations of Cepheids. What will further observations of Delta Cephei and other Cepheids reveal about our universe? Follow NASA's latest observations of stars and galaxies across our universe at nasa.gov. .



The Astronomer at the Museum

Leaf from a Beatus Manuscript at the Cloisters

This illuminated manuscript page is from the Book of Revelation, the strange and often terrifying conclusion to the New Testament.

“At the Clarion of the Fifth Angel's Trumpet, a Star Falls from the Sky; the Bottomless Pit is Opened with a Key; Emerging from the Smoke, Locusts Come Upon the Earth and Torment the Deathless.” (Revelations, Chapter 9)

This particular version of the text is attributed to Beatus of Liébana, an eighth-century monk from the Asturian region of northwestern Spain. The image of the falling star might suggest that the unnamed illustrator, working around 1180, had seen a comet.

The Cloisters, the medieval division of the Metropolitan Museum of Art, is located in Inwood Park in northern Manhattan. Among its treasures is a small collection of illuminated manuscripts, each of exceptional quality and considered to be among the finest in the world.

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Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
Meade 8” SCT LX-80	Go-to mount, tripod. Tube wrapped in Reflectix for faster cooling. See https://is.gd/16F0Tv.	$600	Greg Borrelly gregborrelly@gmail.com
Celestron SE mount	No optical tube. Go-to alt-az mount and tripod. Can carry 12 lb payload or tube up to 17”. Upgradeable hand control.	$300	Greg Borrelly gregborrelly@gmail.com
Celestron Binoviewer	Use both eyes with your telescope. Original case, with two 18-mm eye pieces.	$180	Greg Borrelly gregborrelly@gmail.com

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