SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

February 2021

The Pleiades by Leandro Bento *(see page 15)*

WAA February Meeting

Friday, February 12 at 7:30 pm

On-line via Zoom

Update on Mars Research

Br. Robert Novak, Ph.D.
Iona College & Goddard Spaceflight Flight Center

Three searches for methane in Mars' atmosphere are currently ongoing. The Mars Curiosity Rover (launched Nov. 26, 2011, landed August 6, 2012) has detected methane repeatedly throughout its time on Mars. The Trace Gas Orbiter, launched by the European Space Agency in 2016, makes solar occultation measurements at sunrise and sunset. This instrument measures gases in the atmosphere above an altitude of 10 km; no detectable methane measurements have been reported up to now. NASA's Astrobiology Group, headed by Dr. Michael Mumma, has been using infrared spectrometers attached to NASA's 120-inch Infrared Telescope on Mauna Kea. They regularly detect methane on Mars and have reported upper limits for other organic molecules (such as ethane, methanol, etc.). The methodology used to make these measurements will be described, along with the criteria used to determine if these organics originate from living or non-living sources.

The link is on www.westchesterastronomers.org.

Pre-lecture socializing with fellow WAA members and guests begins at 7:00 pm!

Also In This Issue

WAA March Meeting

Friday, March 12 at 7:30 pm

On-line via Zoom

High Performance Infrared Focal Plane Arrays for Astronomy, Earth Science, and Planetary Missions

James W. Beletic, Ph.D.
President, Teledyne Imaging Sensors

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

Starway to Heaven

Ward Pound Ridge Reservation
Cross River, NY

Saturday, March 13 (rain/cloud March 20). Weather permitting. Meadow Parking Lot.

Members (only) can observe at Ward Pound Ridge on any suitable night with prior notification to the park by calling (914) 864-7317. Bring your WAA ID card.

New Members

Eli Goldfine and Family	Larchmont
Sophia Gonzales	Mamaroneck
Melissa Sims	Ossining
Jude Stenson	New Rochelle

Renewing Members

Harry S. Butcher, Jr.	Mahopac
MaryPat Hughes	Ossining
Mayan Moudgill	Chappaqua
Bob Quigley	Eastchester

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

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

ALMANAC For February 2021

Bob Kelly, WAA VP for Field Events

If you want to see planets, you'll have to peek around the Sun a lot this month (but never look directly at the Sun, especially with binoculars or a telescope!) **Mercury** has been the closest planet to the Earth since late January and will be so through early July. A lot of that time it's between us and the Sun. This month, Mercury can be seen in the NASA/ESA Solar and Heliospheric Observatory (SOHO)'s LASCO C3 camera from the 4th through the 12th (https://is.gd/lascoC3). Mercury slides into the morning sky late in the month, but it's best seen from the Southern Hemisphere.

Like a student in extended detention, **Venus** will start the next two months in conjunction with the Sun. It won't be until late May that Venus is easily visible again, taking until late October to get farthest away from the Sun in the evening sky.

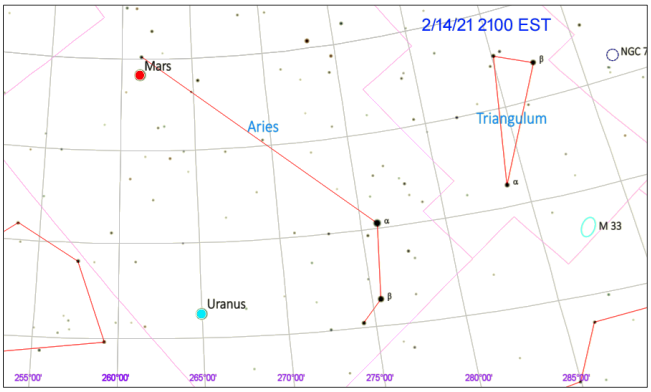
Jupiter edges out into the morning sky in late February. On the 11th, the giant planet pairs up with Venus as the Morning Star also ducks out of the morning sky. They are only 11 degrees to the right of the Sun. This will be a difficult, even dangerous observation because of their proximity. On the 10th, the sliver **Moon**, one day before New, comes close to Venus.

Venus passes **Saturn** on the 6th. Saturn is 2½ magnitudes fainter than Jupiter and 4½ magnitudes fainter than Venus, making it almost impossible to find even in a telescope. Later in the month, Jupiter, Saturn and Mercury cluster low in the east-southeast. Even as late as 30 minutes before sunrise, they are less than 10 degrees above the horizon.

The brightest comet of February, **C/2020 R4 (ATLAS),** might reach magnitude +10 (faint!) late this month, just above the Jupiter-Saturn-Mercury planetary traffic jam in the dawn twilight. We can hope for better visibility after perihelion when it makes its closest approach to Earth in late April.

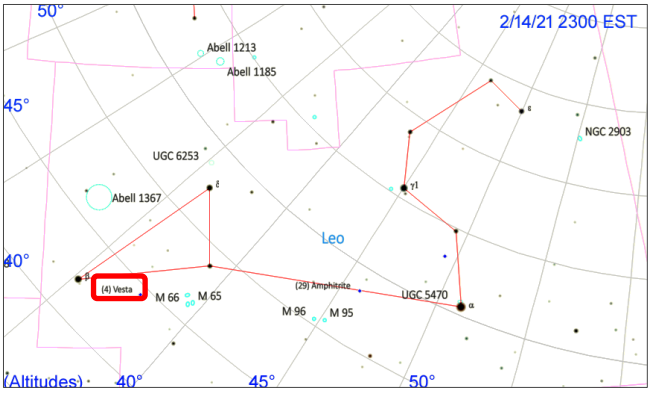
Are you a fan of the last quarter **Moon**? Luna is closest to Earth for the month on the 3rd, the day before last quarter. It's about 8% closer than its apogee at first quarter on the 19th. Comparison photos taken with the same telephoto lens or through a telescope with the same settings might show the difference nicely. Sunrise occurs over the outer rings of Mare Orientale, tilted a bit toward us, on the 25th/26th.

Mars and **Uranus** are still out in the evening sky. **Neptune** is lost in the Sun's glare.



The **International Space Station** is an evening sight through the 8th. It soars across the morning sky starting on the 18th. Have you seen a rocket launch? I hope someday to bring my grandkids to NASA's Wallops Flight Facility on the Delmarva peninsula. On or after February 20th, an Antares rocket will launch the Cygnus spacecraft from the Mid-Atlantic Regional Spaceport's Pad-0A. It will bring supplies to the ISS. Seeing a rocket that has a destination in space that we can see with our own eyes is intriguing

Here's a finder chart for minor planet **4 Vesta**, in the hind legs of Leo the Lion in February, not far from the Leo Triplet of galaxies. It's heading toward opposition in early March, brightening to magnitude +6.0.



Member Profile: Charlie Gibson

Home town: Scarsdale, NY

Family: Wife Caroline, daughters Michelle and Sherry, grandchildren Shakirra, Alexis and Elijah, great grandchildren Cameron and Leeah.

How did you get interested in astronomy? While vacationing at my aunt's house in Nassau, Bahamas in 1961, I saw a rocket launch from Cape Canaveral disappear into the night sky. I was hooked! I started looking up each night and noticed "shooting stars." Nassau was pretty dark back then.

Do you recall the first time you looked through a telescope? What did you see? It was in Yonkers in 1982. I had a 60 mm Tasco on a flimsy mount. My terrace overlooked the Hudson River, a due west view. I first saw Saturn and its rings.

What's your favorite object(s) to view? Planets, galaxies, Messier objects and bright nebulas.

What kind of equipment do you have? I have an 8" f/4.5 Dobsonian by Handmade Telescopes of PA (now sadly defunct), a Meade 90 mm ETX Maksutov that's motor-driven, a Stellarvue 80 mm f/6 APO triplet refractor on an iOptron ZE25GT mount that has a 50,000-object database, a Lunt 50 mm H-alpha telescope and a 40 mm Orion refractor also set up for H-alpha solar viewing with Lunt heat rejection and blocking filters.

What kind of equipment would you like to get that you don't have? Maybe a camera to capture digital images.

Have you taken any trips or vacations dedicated to astronomy? In Mexico, I visited Chichen Itza. In 1999, I visited the scopes atop Mauna Kea and the Bishop Museum in Hawaii. I've also been to the Lowell Observatory in Arizona and Mount Palomar in southern California. In Copenhagen I visited the Tycho Brahe Museum. I've been to several planetariums, most notably the Fleishman Planetarium in Reno, the Adler in Chicago and, since I'm a native Manhattanite, the Hayden. In November 2008, several WAA members took a trip to New Mexico Skies and visited the Apache Point Observatory, checking out the 2.5-meter Sloan Digital Sky Survey telescope. On that trip, one member of our group had a panic attack going up the ladder up to the mirror box. If he reads this, he'll remember! On a trip to Puerto Rico, I stopped by the Arecibo Radio Telescope.

Are there areas of current astronomical research that particularly interest you? Planetary exploration.

Do you have any favorite personal astronomical experiences you'd like to relate? When I was in Hawaii at Mauna Kea, I was part of a group that visited the top of the mountain. Afterwards, the guide set up an 8-inch Celestron SCT. A few people asked him questions about what we were going to observe. On a few objects he got twisted around and I volunteered to help him out. After a few more questions, the guide pointed to me and said, "Ask him, he seems to know his way around the sky better than me." Another time, when vacationing in Key West, I won a raffle to view the night skies from a schooner. As Carol and I boarded the ship, the host displayed a star map of the current night sky, local time. I immediately noticed that the chart was incorrect and look more like a mid-30 degree latitude than the 26-degree north latitude of Key West. I said to the host that the map he put up was for a more northerly location, to which he barked back, "There's always a wise ass in the group." The crowd, some 50 people, laughed, but he later admitted that I was right. Another highlight was observing the Southern Cross from Cabo San Lucas, in 2000.

What do you do (or did you do, if retired) in "real life"? I'm retired 14 years from the New York State court system. Both of my daughters are employed by the state courts.

Have you read any books about astronomy that you'd like to recommend? *Turn Left at Orion* by Guy Consolmagno and *Astrophysics for People in a Hurry* by Neil DeGrasse Tyson.

How did you get involved in WAA? I'm one of the original members of the club. Initially, we were a loosely organized group, coming together around 1986 when we set up scopes to observe Halley's

Comet at the Hudson River Museum. The club was then called the Westchester Observer's Group. We held meetings in the Andrus Planetarium. I met Sam Storch, Bill Newell and Bob Davidson there. Bill is still involved and Sam is now in Florida, but Bob sadly is no longer with us.

Charlie, Frank Jones and Darryl Ciucci at the WAA booth at NEAF, April 2017

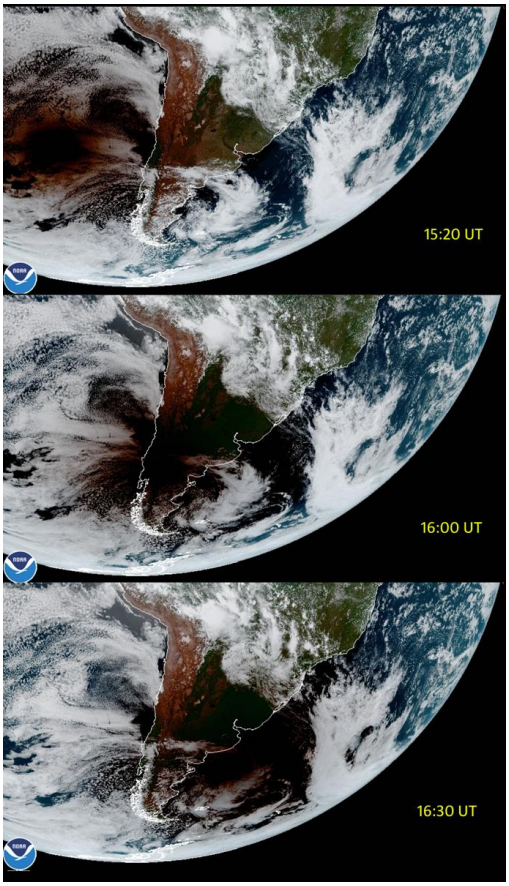
What WAA activities do you participate in? I participate in star parties and attend meetings (and now Zoom sessions).

If you have or have had a position in WAA, what is it, what are/were your responsibilities and what do you want the club to accomplish? I was Events Coordinator from 1998 to 2002, responsible for getting lecturers and planning star parties. In 1999 I arranged for John Dobson give a two-day presentation at the Hudson River Museum. I was President from 2004-2006 and now I'm Senior Vice President.

Besides your interest in astronomy, what other avocations do you have? In my local parish, St. James the Less, I'm involved with a racial outreach committee that helps struggling parishes. I'm a lay Eucharistic Minister at the parish and at the Church of the Crucifixion in Manhattan. ■

The December 14, 2020 Solar Eclipse

Not surprisingly, Covid-19 disrupted our plans to experience the total solar eclipse that crossed central Chile and Argentina. A year and a half ago, Elyse and I had signed up for the Sky & Telescope trip to view the event on the center line in Argentina. It would have been led by S&T editor Peter Tyson. Covid has ravaged Argentina, with high infection rates continuing into their summer. The Argentine government prohibited foreigners from entering the country and so the trip was canceled. It's time to start gearing up for the April 8, 2024 eclipse. Let's hope for good health and good weather.



We enjoyed WAA member and science educator Charles Fulco's *Science@Home* Zoomcast of the event. Among Charles' s guests were a number of solar eclipse experts (they are also regulars on Charles's programs) including Jay Pasachoff, Fred Espenak and Joe Rao. There was one view that we might not have seen had we been on the ground looking up. The GEOS-East weather satellite showed the umbra and penumbra crossing the Pacific, South America, and the South Atlantic. The GEOS web site animates a 4-hour loop. Here are three frames from the satellite.

There were plenty of clouds on the Chile (windward) side of the Andes but the leeward side, in Argentina where we would have been, looked pretty clear.

I've seen three total eclipses and missed two, one because of a giant cloud that screwed up the island of Hawaii, and one because of a tiny virus that's screwed up the whole world.

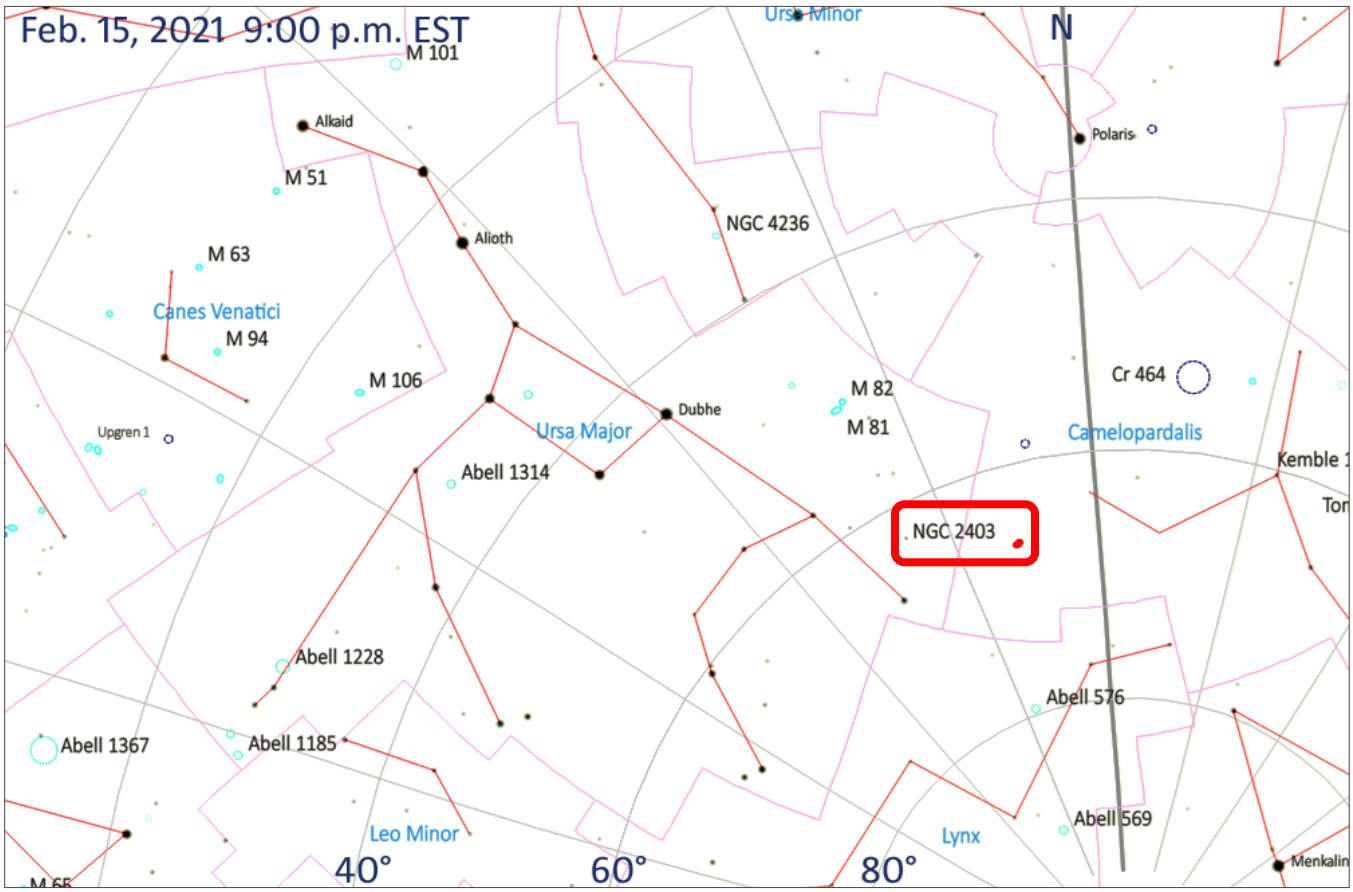
LF

Deep Sky Object of the Month: NGC 2403

NGC 2403	
Constellation	Camelpardalis
Object type	Spiral galaxy
Right Ascension J2000	7h 36m 48.0s
Declination J2000	+65° 36’ 00”
Magnitude	8.5
Size	21.9’ x 12.3’
Distance (Mpc)	3.19 (Tully-Fisher, 2017)
Other designation	Caldwell 7, UGC 3918
Discovery	W. Herschel, 1788

NGC 2403 is in the faint constellation Camelopardalis (brightest star magnitude 4.03). It was the first galaxy beyond the Local Group in which Cepheid variables were identified, using the 200-inch Hale telescope at Mt. Palomar. It Is tilted 28° to our line of sight. A large star-forming HII region in its northern arm has a separate NGC designation, 2404. Visual magnitudes given by various observers range from 7.3 to 10.2, but 8.5 seems a reasonable expectation. Look for it 13½° from M81/M82 when you are galaxy-hunting in the northern skies.

NGC 2403: Visibility for February 2021			
9:00 pm EST	2/1/21	2/15/21	2/28/21
Altitude	61°41’51.9”	64°46’47.7”	65°42’35.7”
Azimuth	22°20’10”	11°39’57”	359°12’08”



More 1950s Space Artifacts

Long-time WAA member **Mike Cefola** writes "The *Men into Space* board game is a very sought after collectible Milton Bradley game. I only had one original rocket piece at first but as I went through various boxes I found all the others. It is extremely rare to have all the Astro trivia cards and rockets that came in the box."

The National Air & Space Museum owns a copy of this game. It's not currently on display. Their web site notes:

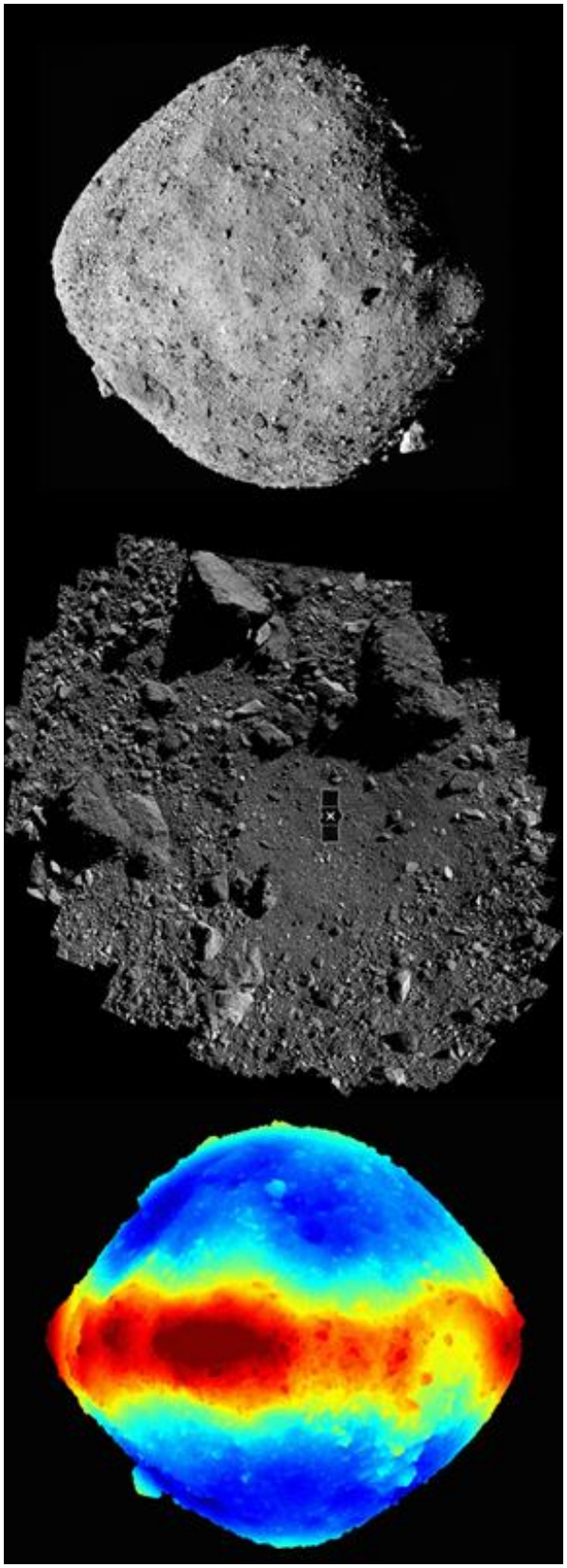
> It was inspired by the television program *Men Into Space*, which aired during the 1959-1960 season. In the game, up to four players could move colored "space cones" around the board according to the instructions on 24 cardboard cards, which also included "Did You Know" space facts on the reverse.
>
> In its one season of half hour black-and-white programs, *Men into Space* depicted the realistic adventures of Colonel Edward McCauley, head of a fictional American space program. Aimed at adults, executed with the cooperation of the Department of Defense, and aired on CBS, *Men into Space* offered a fact-based depiction of space flight in the near future of the budding space age. It was produced by Ziv Television Programs, Inc., a Midwestern company known as the leading producer of first-run syndicated programming.

The scenery for the television program and the artwork for the game were drawn by the famous space artist Chesley Bonestell. A superb documentary, *Chesley Bonestell: A Brush with the Future*, can be seen on Amazon Prime, YouTube and other services. See https://www.chesleybonestell.com/.

Mike also sent in this photo of a peculiar rolling rocket ship with what appears to be some sort of cannon or ray gun on the top. The piece is 4 inches long, too large to be a "cereal box prize" (see the January 2021 *Sky*WAA*tch*). Mike isn't sure how he got it when he was a kid, "probably in a bag of space toys." It looks a bit like Flash Gordon's rocket ship from the 1930s series with Buster Crabbe, but that vessel had a rounder front and didn't have a weapon on top.

Teledyne Sensors at Bennu — Jim Beletic, Teledyne

Our March 12 lecturer will be Jim Beletic, President of Teledyne Imaging Systems. Teledyne provided the digital "eyes" for the OSIRIS-REx mission to the asteroid Bennu. ISIRIS-Rex successfully grabbed a sample of the asteroid's surface on October 20th and is expected to return it to Earth in September 2023. NASA is confident that over 400 grams of Bennu is now in its possession. Jim provided the following information.



OSIRIS-REx is an acronym that incorporates the mission's major concepts and goals: Origins, Spectral Interpretation, Resource Identification, Security and Regolith Explorer. The mission is helping scientists investigate how planets formed and how life began, as well as improving our understanding of asteroids that could impact Earth.

Asteroid Bennu is shown in the top image. The sample site, named "Nightingale", is shown in the middle. The image of the Nightingale site is overlaid with a graphic of the OSIRIS-REx spacecraft to illustrate the targeted touchdown site which is ringed by dangerous obstacles.

Bennu has a much more hazardous landscape than anyone envisioned. The 500-meter wide asteroid (a bit larger than the 433-meter tall Empire State Building) has very large boulders on its surface; the largest is 58 meters wide and 22 meters tall. Any sizable boulder could damage the spacecraft as it approaches the surface. A vital instrument on the spacecraft is the LIDAR system that measured Bennu in three dimensions to 10 cm accuracy and the landing site to 1 cm accuracy. Teledyne provided the two LIDARs that are on the OSIRIS-REx spacecraft.

The Teledyne instruments operated flawlessly during the entire mission, taking visible images, measuring surface topology, and using visible-infrared spectroscopy to assess surface material composition.

The bottom image shows a three-dimensional view of asteroid Bennu created from 20 million LIDAR measurements. The LIDAR system obtained these measurements by firing laser pulses at Bennu and measuring the amount of time it takes for the light to bounce off the asteroid's surface and return to the instrument. The time delay is translated into altitude data. The colors represent the distance from the center of Bennu: dark blue areas lie approximately 60 meters below the peaks indicated in red.

But where to sample? Site selection depends on the composition of the surface material. Chemical composition is determined by spectroscopy. Since every element, molecule, and mineral has a unique spectral "fingerprint", the spectrometer assessed surface composition so that the most scientifically valuable site will be sampled. Teledyne's visible-infrared image sensor detected the light in the spectrograph.

- The OSIRIS-REx Camera Suite (OCAMS) consists of three cameras that image in visible light, mapping the entire asteroid to help determine where to sample. These imagers recorded the sampling event during the critical touch-and-go maneuver. The OCAMS use Teledyne DALSA CCD image sensors (Waterloo, Ontario and Bromont, Quebec, Canada) that are sensitive to the low light levels at Bennu and impervious to space radiation.
- The two LIDAR sensors in the OLA, which were developed by Teledyne Optech (Toronto), have been optimized for the different aspects of the mission – a high-power LIDAR for mapping at a distance of 0.6 to 4.7 miles and a low-power LIDAR for distances less than 0.6 miles. The LIDAR is also used to support navigation and gravity analysis.
- The OSIRIS-REx Visible and Infrared Spectrometer (OVIRS) measures visible and infrared light from Bennu, and is sensitive to wavelengths from the blue (0.4 micron wavelength) to the mid-infrared (4.3 microns). OVIRS measures the spectrum of the asteroid surface by splitting the light into its component wavelengths. The visible-infrared detector in OVIRS was provided by Teledyne Imaging Sensors (Camarillo, California) and is similar to the detectors used in NASA's Orbiting Carbon Observatories that accurately monitor the carbon dioxide in the Earth's atmosphere.

The top image to the right shows an artist's conception of OSIRIS-Rex hovering over Bennu. The middle image shows the sample collector about to contact the asteroid. The bottom image shows the collector head hovering over the Sample Return Capsule (SRC) after the Touch-And-Go Sample Acquisition Mechanism arm moved it into the proper position for capture.

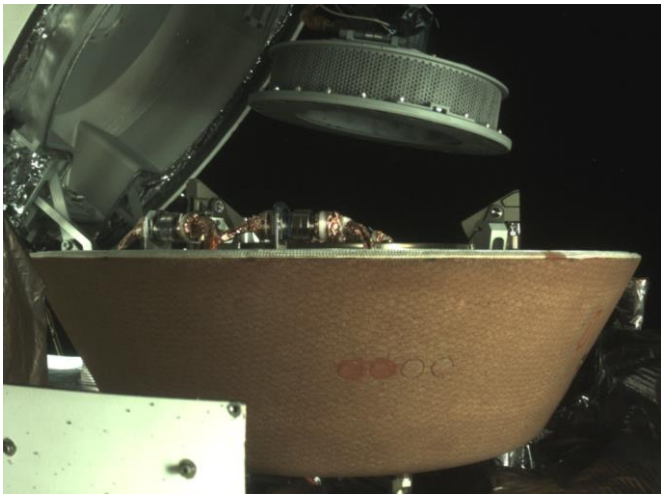


Image credits: NASA/Goddard/University of Arizona/Teledyne. The original text for this article was provided by Teledyne in the form of a press release and revised for *SkyWAAtch* by the editor. In addition to being the head of Teledyne, Jim Beletic was the college roommate of WAA President Paul Alimena.

Apollo 11's View of Moon — Robin Stuart

This photograph was taken from the Command Module of Apollo 11 of the crew began their homeward journey following the trans-Earth Injection maneuver on July 22, 1969. Any WAA member can instantly see that this is not the Moon as it appears in the sky, but it surprising how many of the general public don't recognize it as such. The photograph shows the view from almost directly above Mare Crisium, which we see from Earth near the Moon's eastern limb (west in the sky). One might therefore ask, "If they're trying to head back home, aren't they going in the wrong direction?" The Moon orbits the Earth at a little over 1 km/s and the return trip requires expending a component of the main engine's thrust to counter the orbital angular momentum by flying west. The balance is directed toward target Earth.

Maybe because of its eerie subliminal unfamiliarity, a version of the photograph featured in the opening credits of the TV series *Buffy the Vampire Slayer*.

The photograph is also seen on the NASA website https://www.nasa.gov/mission_pages/apollo/40th/images/apollo_image_25.html, where it is described as having been taken when "the spacecraft was already 10,000 nautical miles away."

The July 2019 WAA newsletter, page 8, reported my attempt to replicate the Apollo 11 photograph by transforming my own Earth-based images using code written in *Mathematica*. As noted there, to obtain a near match the spacecraft distance had to be set to 8,000 km from the Moon's center. This is obviously very different from the 10,000 nautical miles that NASA claims. At the time I supposed that there was probably a wrong factor somewhere in my code but as my aim was principally aesthetic I didn't think much more about it.

Recent favorable librations of the Moon allowed me to image more of the eastern limb than previously and to get a more complete match to the Apollo 11 photograph. This also prompted me to pursue the apparent inconsistency in the distance. Arizona State University hosts the fantastic Space Exploration Resources archive of high resolution scans of the original photographs from the US Space program. Those from Apollo 11 are at http://tothemoon.ser.asu.edu/gallery/Apollo/11/Hasselblad%20500EL%2070%20mm

The photograph in question is the last in a sequence showing the Moon's disk shrinking in the Command Module window and bears the designation AS11-44-6667. Scans are available in various resolutions from a 1.3-gigabyte raw image down to a 12-kilobyte thumbnail shown here.

Apollo 11's Photographic Equipment

The ASU archive lists AS11-44-6667 as having been taken on Kodak Ektachrome SO-368 medium speed ASA 64 color reversal film with a Hasselblad 500EL camera equipped with a Zeiss Sonnar 250 mm f/5.6 lens. This is one of two Zeiss lenses for the Hasselblad that Apollo 11 carried, the other being a Planar 80mm ƒ/2.8 lens.

The Hasselblad used 70-mm film, which is the overall width of the film strip including the sprocket holes. Since the ASU scans cover the complete film, it is possible to accurately measure the physical size of the Moon's image on the film plane.

It can be shown that the radius of the image, *r*, is related to the focal length of the lens, *f*, the Moon's physical radius, *a* = 1,737 km, and observer's distance, *d*, from the center, by

$$r = \frac{f}{\sqrt{\left(\frac{d}{a}\right)^2 - 1}}$$

The same formula applies when imaging the Moon or other spherical body through a telescope from Earth but in that case since *d* is very much greater than *a*, the approximation $r = f \times (a/d)$ is adequate for most practical purposes. The quantity a/d is the body's angular semi-diameter (radius) expressed in radians.

Conversely if the image radius is measured, the focal length of the lens that was used to take it can be calculated.

A careful measurement of the scan finds that Moon's radius on the film plane is 19.7 mm. Inverting the formula above then places the Command Module at a distance of 22,100 km from the Moon's center or 11,000 nautical miles from the surface, which is presumably where the NASA's round figure of "10,000 nautical miles away" comes from.

Apollo 11's Distance from the Moon

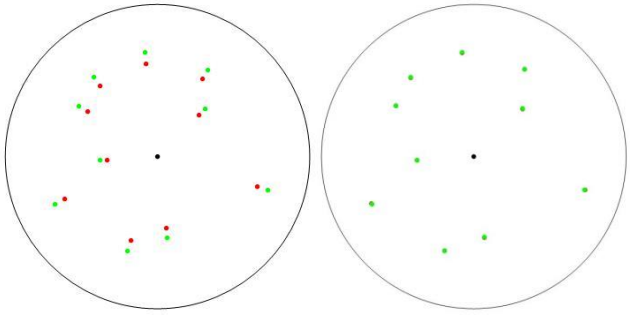
The distance at which the photograph was taken can be determined from the image itself without reference to the photographic equipment used. The higher an observer gets the more of the surface is visible. As the height changes the locations of individual features on the face of the disk also change.

Working with the medium resolution scan http://tothemoon.ser.asu.edu/data_a70/AS11/extra/AS11-44-6667.med.png I selected 10 small bright features and measured their pixel locations. The Moon's radius was measured as 992 pixels. Google Earth was then used to find their selenographic latitudes and longitudes. The coordinates of the point at dead-center of the Moon's disk is also needed and the results of these measurements are tabulated below.

Feature	Pixel Coordinates X	Y	Selenographic Coordinates	
Moon Center	1709	2226	5°40.7'N	58°19.1'E
Moltke	1632	2905	0°36'S	24°9.4'E
Mare Crisium Shore	1337	2202	22°40.3'N	54°26.4'E
Lacus Spei	1045	1916	43°26'N	65°56.9'E
Bellot	2023	2539	12°39.7'S	48°7.5'E
Dawes	1295	2744	17°10.7'N	26°15.3'E
Neper	1777	1700	8°49.4'N	84°7.8'E
Rosse	2040	2794	17°59.4'S	34°50.1'E
Humboldt	2429	2007	27°25.4'S	81°10.2'E
Hubble	1519	1613	22°0.6'N	87°10.2'E
Near Romer	1199	2557	24°23'N	33°52.6'E

For a given distance of the observer, this information, along with a little spherical trigonometry, allows calculation of the locations of these features on the image of the lunar disk.

In the plots below the red dots are pixel positions of the features as measured from the scan and the green dots are their positions calculated from their corresponding selenographic coordinates. The plot on the left is for *d* = 10,000 nautical miles and the one on the right is the best fit obtained for *d* = 7,336 km. In the latter the two sets of dots are essentially coincident.



As a check Google Earth can be used to simulate the view of Moon above any point on its surface and from any distance.

Both of these images are centered on 5°40′42″N 58°19′3″E. For the image on the left the altitude was set to 16,783 km (10,000 nautical miles the center) and 5,599 km (7,336 km from the center) for the one on the right. The right hand image is a close match to the Apollo 11 photograph. The one on the left is not. In it, Mare Crisium is smaller and Mare Humboldtianum, Mare Marginis and Mare Smythii are further from the limb. The shapes of Mare Nectaris and Mare Humboldtianum are clearly different.

Now that the correct distance of the Moon as seen in the photograph is known, the focal length of the lens used to take it can be calculated using the formula given above. It is found to be 80.8 mm which is consistent with the 80-mm lens and not the 250-mm as currently recorded.

Given the historical significance of these photographs I considered it important that their associated metadata be correct and reached out to the ASU archive via their 250-character limit contact form. Although fully expecting to be dismissed as a crazy person I received a brief note agreeing that AS11-44-6667 and a number of other photographs on the roll were taken with a different lens than recorded. It was indicated that they would work to the update the information. ■

WAA Member Owen Dugan Named Regeneron Scholar

One of Westchester Amateur Astronomers' youngest active members, high school senior Owen Dugan of Sleepy Hollow, has been named a Regeneron scholar in the national Regeneron Science Talent Search competition.

Owen's project, *Astronomy Will Not Trail Off: Novel Methods for Removing Satellite Trails from Celestial Images*, was one of 300 selected from 1,760 national submissions. Forty of these students will be selected as finalists, with a national winner named in March. The scholar award comes with a $2,000 grant. Owen will attend the Massachusetts Institute of Technology next fall.

Owen did original research on the double star WDS 07106 +1543, a study that was published in the *Journal of Double Star Observations*. The story is in the February 2019 SkyWAAtch. Owen presented his work at the club's September 2019 Members Night meeting.

Owen told us "I am really excited! WAA has played a critical role in fostering my love of astronomy."

The Regeneron competition is the successor to the Westinghouse Science Talent Search, which started in 1942. It was later sponsored by Intel before the Westchester-based biotechnology company Regeneron took it over. The competition "focuses on identifying, inspiring, and engaging the most promising scientists among the nation's high school seniors." Top prize is $250,000.

Owen Dugan at the 2017 Medomak Astronomy Retreat and Seminar in Maine.

Scope-Making Projects — Zane Landers

I've recently completed a 24" f/3.5 homemade Dobsonian telescope. The whole scope fits in the back of my minivan easily and can be set up by one person in about 25 minutes. I had to learn how to weld and work with metal to build it, as it uses a homemade mirror cell and significantly more metal parts than anything I've built previously. As of the time of submitting this (in mid-January), I've gotten the scope out 3 times and had great views even under partial cloud cover and without a light shroud, which finally arrived and should significantly improve contrast. The telescope is big enough to show color in brighter nebulas: the Orion Nebula appears pink under dark-ish skies.

However, I've not been content to stop there, so in the last month I've begun preliminary work on pair of slumped primary mirrors—a 16" f/3 for practice and, if successful, a 36" f/4. These mirrors are thin plate-glass menisci, basically shaped like a contact lens with a concave front and convex back. You can read more about how those work at Mel Bartels's web site http://bbastrodesigns.com/JoyOfMirrorMaking/25%20inch%20f2.6%20mirror.html. I can barely lift the 36" blank. If I could I might have sprung for a 42" instead. These will probably be multi-year projects due to the infrastructure and effort required. The finished 36" scope will be about 13 feet tall and require a trailer, assuming I even finish it in the first place.

I've also begun to teach more people the seemingly-forgotten art of making telescopes. With the shortage of new equipment that's resulted from pandemic-induced supply chain issues and the all-time high demand for telescopes, making your own instrument is an increasingly viable and worthwhile option. This week I visited my friend Jordanne who is currently working on a 17.5" Dobsonian, and we finished the mirror cell together, as shown in the next picture. You can follow her work here: https://www.cloudynights.com/topic/746807-175-f45-truss-tube-dobsonian-build-first-build/.

I have another half-dozen students working on scopes at the moment—half are even grinding their own mirrors!

Zane Landers zdlanders@gmail.com

Jordanne with her mirror and cell

Zane using the 24" scope at Ward Pound Ridge

The Pleiades: History, Art and Science

Larry Faltz

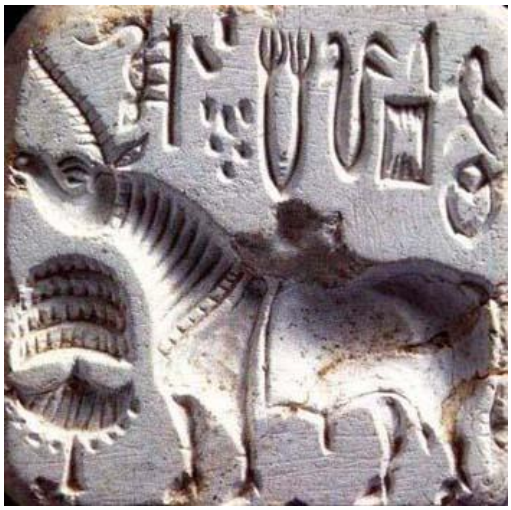
Leandro Bento's wonderful cover image was taken with his usual wide-field setup: a William Optics 51-mm f/4.9 Petzval refractor and ZWO ASI 533MC pro camera on an iOptron Skyguider tracker.

Rising in the eastern sky a few hours after dark in the early autumn, the Pleiades star cluster, fabled in astronomical and cultural history, marks the end of summer, even though the Summer Triangle still dominates the zenith.

The Pleiades has impressed itself into human consciousness as far back as we can trace. The oldest pictorial representation of the cluster may be a cave painting at Lascaux, in France. I've always felt that the Lascaux paintings look too contemporary to be really prehistoric, and I can't look at them without sniffing a potential hoax. However, the site has been certified as authentic and the paintings really are at least 15,000 years old. In one of them, sitting above the image of a bull, six dots are taken by some observers to represent the Pleiades above the constellation Taurus. Certainly the celestial bull, with the Hyades for his horns, is one of the oldest and most culturally consistent of the constellations.

Cave painting at Lascaux, France

The Pleiades may be represented on a stone seal produced by the Harrapan civilization in the Indus River Valley, which reached a mature stage of development between 2600 and 2000 BC. The Harrapan produced what appears to be a written language, the Indus Script, which has yet to be deciphered. On a stone seal one can see a bull or unicorn with 6 dots above it, perhaps representing the Pleiades.



Another ancient visual representation is the Nebra Sky Disk, a Bronze Age object housed in the Sachsen-Anhalt State Museum for Prehistory in Germany. This foot-wide bronze plaque, dated to about 1600 BC, shows gold symbols thought to represent the Sun or full Moon, a crescent Moon and stars, seven of which form a cluster that might represent the Pleiades.[1]

The Pleiades cluster is near the ecliptic, and every populated area on Earth has a view of it. It's the

[1] For more on this object, see the Science section of the *New York Times* for January 19, 2021.

brightest deep sky object in the sky, named and mythologized by every culture. To the ancient Egyptians, it represented the mother goddess Neith. To the Maori of New Zealand, a culture that evolved in complete isolation from the West until the 18th century, it is Matariki, a mother and her six daughters. The Tamil of Ceylon identify the stars as the wet nurses of the war god Skanda, one of many avatars of the cluster in ancient Indian subcontinent cultures and religions. There is a substantial (but not universal) consistency in giving the cluster and its member stars female attributes.

Pleiades (Πλειαδεσ) is their Greek name. The derivation of this word is uncertain. The writer Robert Graves suggested that the root comes from the Greek word for "to sail" or a word meaning "many," while the name used by the Greek poet Pindar (518-438 BC) is *peleiades*, meaning "a flock of doves."

The classic Greek legend (one of several variations in Greek mythology) is that they are the seven daughters of Atlas, the Titan who held up the sky, and Pleione, the protectress of sailing. The hunter Orion was enamored of them and pursued them until Zeus turned them into a flock of doves, which he placed in the heavens. The names we use for the brightest stars come from this legend. Taurus might be thought of as having been placed between Orion and the ladies to protect them from the sex-crazed hunter, but there are no references to a bull in the Orion-Pleiades myths.

A wonderful Kiowa legend parallels the Greek story. Seven maidens were threatened by giant bears. The Great Spirit created the Devil's Tower, in Wyoming, to place them beyond the bears' reach. But the bears climbed the mesa, gouging out the Tower's well-known vertical grooves with their claws. So the Great Spirit placed the maidens in the sky, permanently out the bears' reach. Among other Native American myths is a Mono Indian tale that they are a group of wives who were fond of eating onions and were thrown out of their homes by their angry husbands, subsequently wandering into the sky. To the practical and economical Japanese, they are "Subaru," not the name of beings but merely meaning "gathered together" and we are familiar with them as the name and insignia of the car manufacturer. The name was coined when five smaller companies merged to form Subaru in the mid-1950s. Appropriate for my avocation as an amateur astronomer, I've had five Subarus (following 15 years of owning Saturns, four in all).

The Pleiades' location on the celestial globe means that after sunset they rise in the fall and set in the spring, establishing a rhythm for the change of the seasons. More than one culture uses them as an alarm clock for agricultural activity. In the earliest written Greek text, the *Works and Days* of the poet Hesiod (c. 700 BC), these relationships are laid down:

> When the Pleiades, daughters of Atlas, are rising, begin your harvest, and your ploughing when they are going to set.

The Mediterranean sailing season runs from March to November, so it starts when the Pleiades are setting and ends when they are rising. This may have been the origin of the myth relating the stars to the demi-goddess Pleione and to Graves's assertion of a nautical origin for the name. In *Works and Days*, Hesiod gives this advice:

> And if longing seizes you for sailing the stormy seas, when the Pleiades flee mighty Orion and plunge into the misty deep and all the gusty winds are raging, then do not keep your ship on the wine-dark sea but, as I bid you, remember to work the land.

There are a vast number of references to the Pleiades in classical literature. In the *Iliad*, created a couple of centuries before Hesiod but existing only as an oral tradition until it was written down around Hesiod's time, Homer describes the god Hephaestus forging and decorating Achilles' shield:

> He made the earth upon it, and the sky, and the sea's water, and the tireless sun, and the moon waxing into her fullness, and on it all the constellations that festoon the heavens, the Pleiades and the Hyades and the strength of Orion and the Bear, whom men give also the name of the Wagon, who turns about in a fixed place and looks at Orion and she alone is never plunged in the wash of the Ocean.

Here's a charming fragment by the female poet Sappho (c. 590 BC):

> The sinking Moon has left the sky,
> The Pleiades have also gone.
> Midnight comes, and goes, the hours fly
> And solitary still, I lie.

In the Bible, the cluster is mentioned in Amos and twice in Job, most eloquently when Job muses on the powerlessness of man in the presence of God:

> It is God who removes the mountains, they know not how, when He overturns them in His anger;
> Who shakes the earth out of its place, and its pillars tremble;
> Who commands the Sun not to shine, and sets a seal upon the stars;
> Who alone stretches out the heavens, and tramples down the waves of the sea;
> Who makes the Bear, Orion and the Pleiades, and the chambers of the south;
> Who does great things, unfathomable, and wondrous works without number.
> Were He to pass by me, I would not see Him; were He to move past me, I would not perceive Him.
> Were He to snatch away, who could restrain Him? Who could say to Him, 'What are You doing?'
>
> (*New American Bible*, Job 9:5-12)

These passages reflect the visual prominence of the Pleiades, their near-universal recognition among the populace, and the ease in which they can carry metaphorical meaning.

In his 1835 poem *Locksley Hall*, Tennyson writes

> Many a night from yonder ivied casement, ere I went to rest,
> Did I look on great Orion sloping slowly to the West.
> Many a night I saw the Pleiads, rising thro' the mellow shade,
> Glitter like a swarm of fire-flies tangled in a silver braid.

Two more recent cultural references are in opera. At the end of Act I of Verdi's *Otello*, the Moorish admiral and his wife, the ill-fated Desdemona, share what turns out to be their last happy moments. To transcendentally beautiful music, Verdi sets these lines:

> **OTELLO**
> Un bacio. . .ancora un bacio,
> Gia la pleiade ardente al mar discende.
> **DESDEMONA**
> Tarda e la notte.
> **OTELLO**
> Vien. . .Venere splende.
>
> [Othello: A kiss, another kiss. The fiery Pleiades descend toward the sea. Desdemona: The night is late. Othello: Come. Venus is shining.]

In Benjamin Britten's 1946 opera *Peter Grimes*, the tragic story of a misfit English fisherman (and undoubtedly the greatest opera in the English language), the misunderstood Grimes sings an aria reflecting on man's helplessness, perhaps echoing Job:

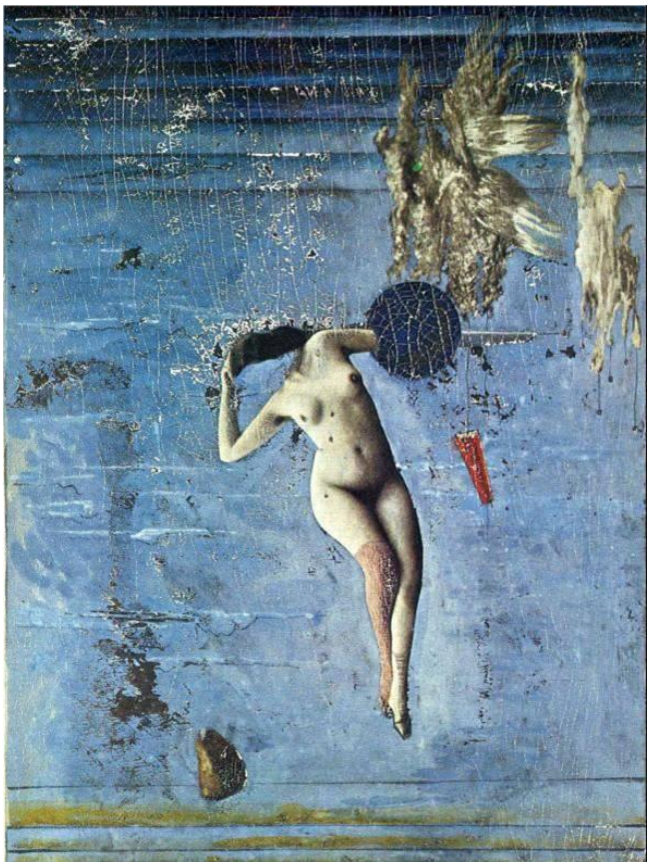
> Now the great Bear and Pleiades where earth moves
> Are drawing up the clouds of human grief,
> Breathing solemnity in the deep night.
> Who can decipher,
> In storm or starlight,
> The written character
> of a friendly fate –
> As the sky turns, the world for us to change?
> But if the horoscope' s bewildering
> Like a flashing turmoil of a shoal of herring,
> Who can turn skies back and begin again?

Henry Howard, *Night with Pleiades* (1834) (13x68 in.)

Needless to say, so prominent an astronomical feature as the Pleiades interests artists as well as poets. The figurative representation of the Pleiades as a group of women can be seen in a number of paintings. British artist Henry Howard portrayed them as weightless in the clouds, while American painter Elihu Vedder showed the seven sisters in a wild, erotic dance, spinning the stars overhead on lanyards, echoing Tennyson. Howard's painting is in Sir John Soane's Museum in London, an odd and fascinating venue that's kept exactly as architect and collector Soane left it when he died in 1837. The Metropolitan Museum of Art owns Vedder's painting; it's on display in the museum's American Wing.

Elihu Vedder: *The Pleiades* (1885) (24x37 in.)

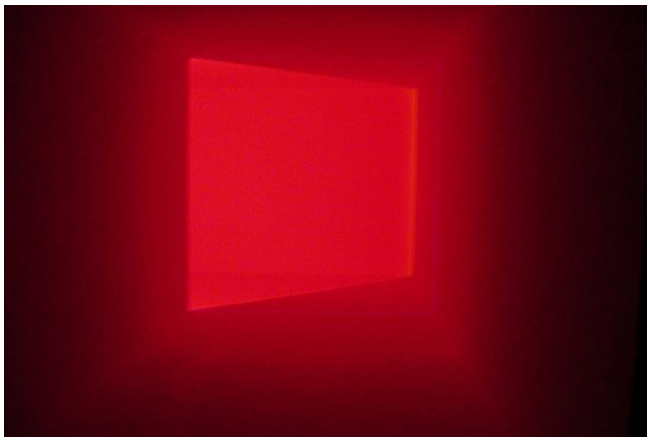
German dadaist and surrealist artist Max Ernst reflects on the sexuality of these young women in a disruptive and violent way that was clearly influenced by the devastation of World War I.



Max Ernst, *Approaching Puberty, or the Pleiades* (1920) (collage, 7x12 in.), private collection

Ernst has another connection to the Pleiades through his 1964 graphic work *Maximiliana, or the Illegal Practice of Astronomy*, the subject of which is the German astronomer Ernst Wilhelm Tempel, who discovered the Merope nebula. See the January 2018 SkyWAAtch for an in depth look at the intertwined lives of a 19th century astronomer and a 20th century artist.

Contemporary artist James Turrell creatively explores the interaction of light and space. His "dark pieces" explore human vision at night, with the goal of creating "a space in which the viewer experiences a blurring of the boundary between what is seen outside oneself and what is seen in the mind's eye." These installations consist of darkened rooms with almost invisible projections. The viewer enters and adjusts to the dim light over time. His first one was called "Pleiades." It doesn't bear much resemblance to either the star cluster or its mythological avatars, but it provokes recall of the sensation of getting accommodated to the glow of the stars on a dark night.



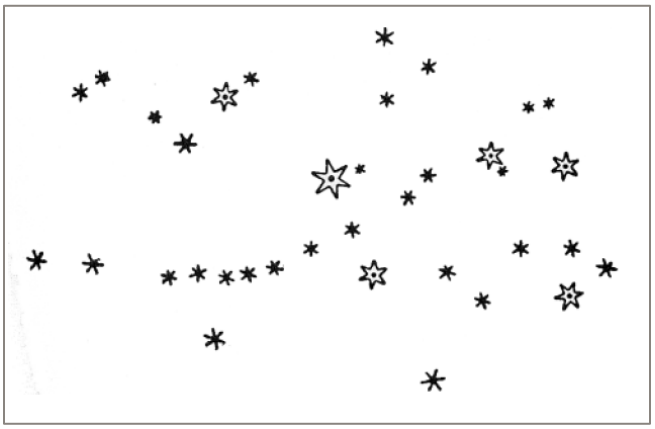
James Turrell, Pleiades

Turrell's use of dark adaptation as an artistic tool may have achieved its zenith in the remarkable *Open Sky* at the Chichu Art Museum on Japan's Naoshima Island. More of an experience than an object, *Open Sky* is a square room holding a total of perhaps 40 people on concrete benches along each of its sides. The roof is open. You assemble at sunset and simply look up in complete silence for 45 minutes as the sky darkens. When Elyse and I were there in October 2018, clouds gently passed by, Vega appeared and the color of the sky changed infinitesimally from blue to violet to nearly black. It is a work of art that takes place entirely on your retina, and it was spectacular. There are two other Turrell dark-adaptation installations on Naoshima Island, one at the Chichu and another in a specially constructed house in the town.

Perhaps the most important graphic representation of the cluster was not by an artist but by Galileo Galilei. Galileo published the *Sidereus Nuncius* (Starry Messenger) in March 1610. This pamphlet describes his telescopic observations of the Moon, the stars and Jupiter. His view of the Pleiades in late 1609 showed more than the seven stars of history and legend. This helped disprove the ancient and theologically orthodox concept that the heavens were perfect and unchanging.

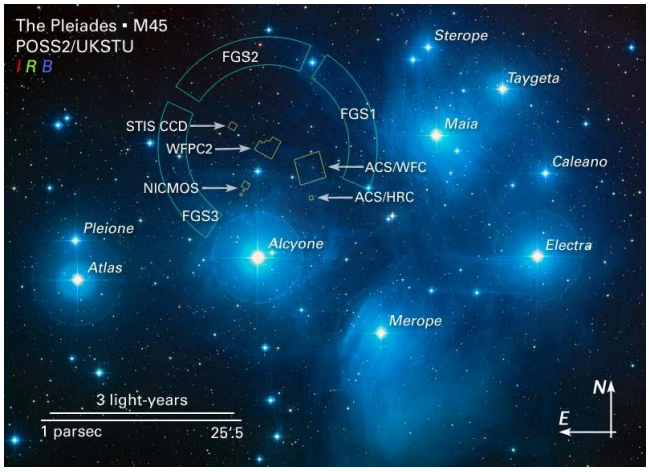
Galileo describes his view with the absolute objectivity of a scientist, avoiding any speculation about his observations. He knew his findings would speak for themselves.

I have depicted the six stars of Taurus known as the Pleiades (I say six, inasmuch as the seventh is hardly ever visible) which lie within very narrow limits in the sky. Near them are more than forty others, invisible, no one of which is much more than half a degree away from the original six. I have shown thirty six of these in the diagram; as in the case of Orion I have preserved their intervals and magnitudes, as well as the distinction between old stars and new.



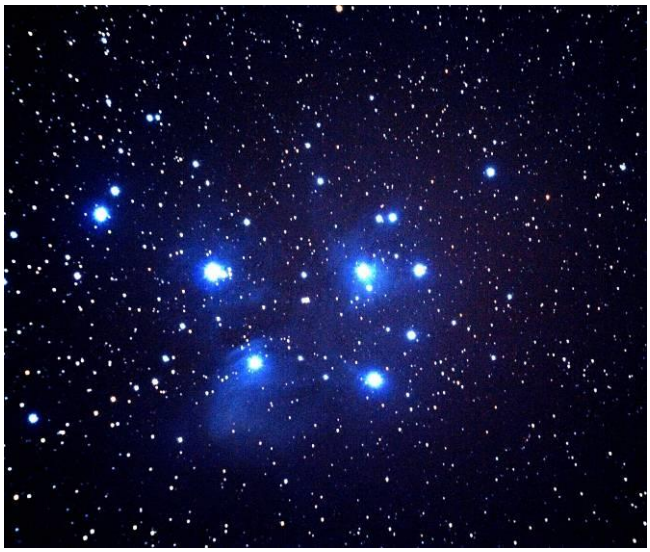
Galileo's drawing of the Pleiades (1610)

The visible stars in the cluster are hot, blue B-type stars (surface temperatures between 10,000 and 30,000 degrees Kelvin) that are 75 to 150 million years old. Many brown dwarfs have been detected in the infrared. The reflection nebula is actually a band of dust through which the stars are passing, not the material from which the stars condensed. Stellar radiation pressure would have by now dispersed any material left over from the stars' birth. The nebulosity around Merope was first glimpsed in 1859 by Tempel using a 4-inch Steinheil refractor, so at a truly dark site telescopes owned by amateurs ought to be capable of reproducing this observation. The nebulosity is invisible in our area because of light pollution, which was not a factor when Tempel observed in oil-lamp and candle-lit Venice. But even a small telescope with a properly used camera can image the dust, as shown by WAA member John Paladini, who photographed the cluster in 2008 from his home in Mahopac, NY using an 80 mm refractor and a DSLR. Of course, a deep image made with a high quality telescope and sensitive CMOS camera, like Leandro Bento's cover image, can rival the output of large, professional telescopes. And for visual appreciation of the rich star patterns, good binoculars will do quite well.



48" Schmidt telescope (Palomar) image overlaid with the names of the brightest stars and the Hubble Space Telescope imaging fields, to serve as a reference guide.

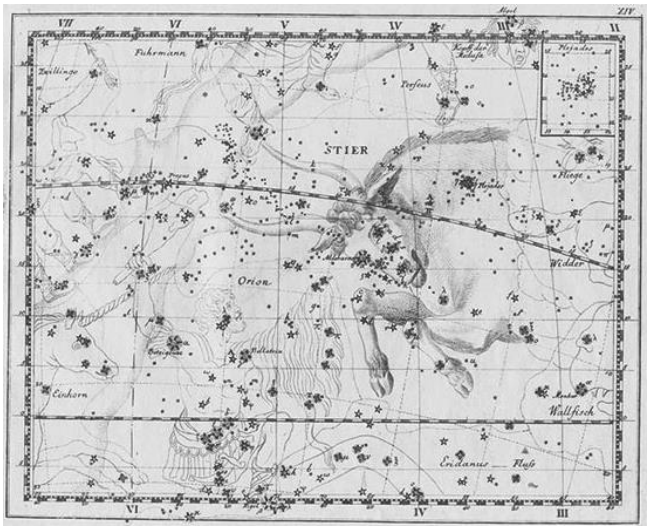
The brightest star, Alcyone, is magnitude 2.86 but the entire cluster registers on our eyes as magnitude 1.6. It's not dark enough, and older adult eyes are usually not good enough, to resolve all of the brightest members of the cluster. In fact there are nine stars brighter than 6th magnitude and there are probably over 1,000 stars gravitationally bound in the group. The brightest part of the cluster is over a degree in diameter, 8-10 light years across at its distance of 136.2 ± 5.0 light-years, according to the second (2018) Gaia data release.



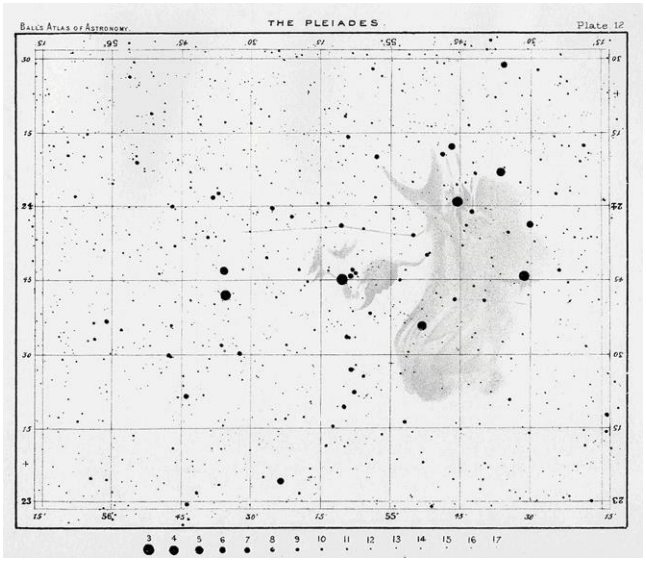
John Paladini 80-mm refractor

Star maps are another form of astronomy-art (see my article in the October 2013 newsletter). Johann Bayer's *Uranometria* (1603), the first full-sky atlas, presents the Pleiades in the plate for Aries, since they

are closer to the ram's tail than to the head of Taurus. Constellation boundaries were not formalized until 1930, so exactly which one the Pleiades belonged to was up for grabs, and on occasion it was said to be a constellation in its own right. Hevelius' *Firmamentum Sobiescianum sive Uranographia* (1687) shows it as a tiny cluster of stars on Taurus' neck, without any specific identification. Bode's influential *Vorstellung der Gestirne,* first published in 1782, shows the cluster *in situ* as well as featuring an inset map at higher magnification, apparently the first time this detail appeared in a celestial map.

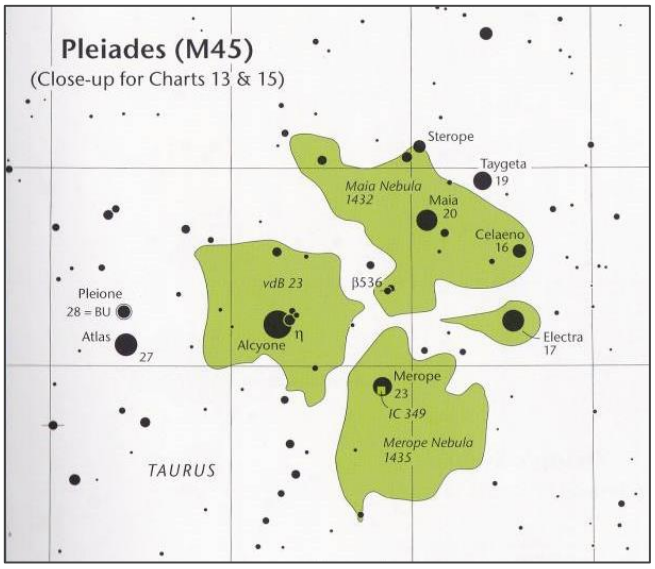


Taurus, from Bode's *Vorstellung der Gestirne* (1782). Note the Pleiades inset in the upper right corner.



Ball's Atlas of Astronomy

Celestial cartographers have taken two approaches to the representation of the nebulosities on star maps. *Ball's Atlas of Astronomy (1892)* tries to show some detail in the clouds. Many modern maps just outline the extent of the nebular regions, such as this scanned example from Roger Sinnott's excellent *Sky and Telescope Pocket Sky Atlas*.



S&T Pocket Sky Atlas detail map of the Pleiades

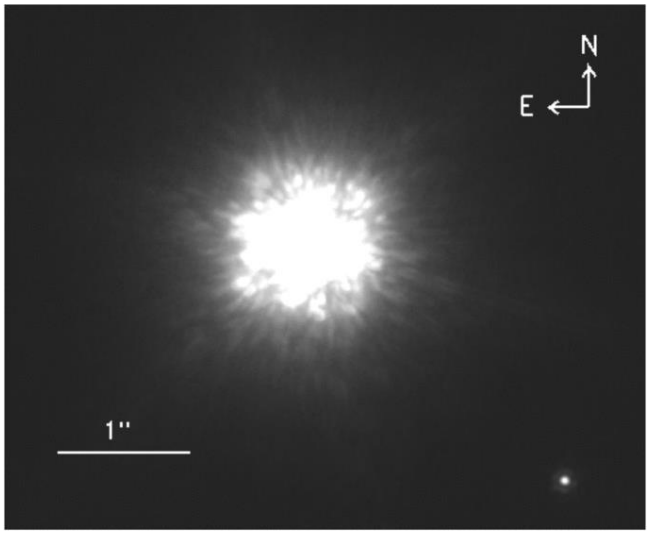
Modern telescopes have been trained on the cluster for research purposes, revealing detailed spectra of both bright and faint stars.

Spitzer Space Telescope (Infrared) (NASA)

Other space telescopes with spectral ranges outside the visual have captured photons from the Pleiades. Spitzer shows an intense amount of infrared radiation

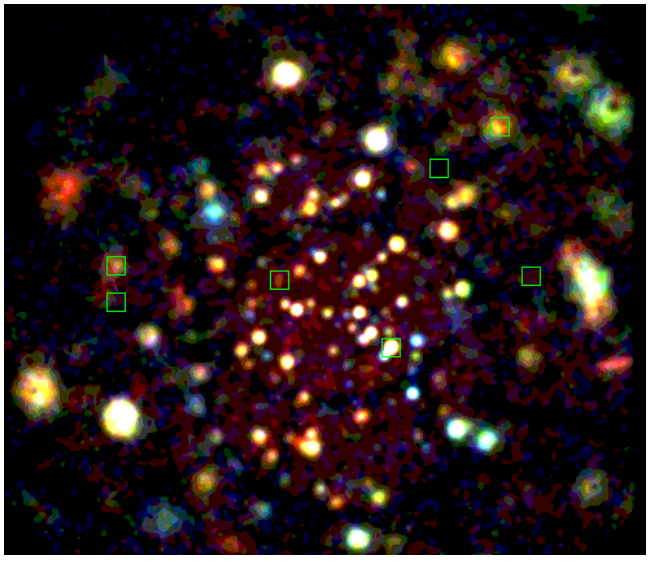
from the dust as well as a large number of smaller stars and even some brown dwarfs.

The class F7 star HD 23514, considered a member of the cluster but not located within its central part, has been shown to be surrounded by orbiting dust. A brown dwarf companion was visualized by Keck.[2]



Brown dwarf (lower right) and HD 23514

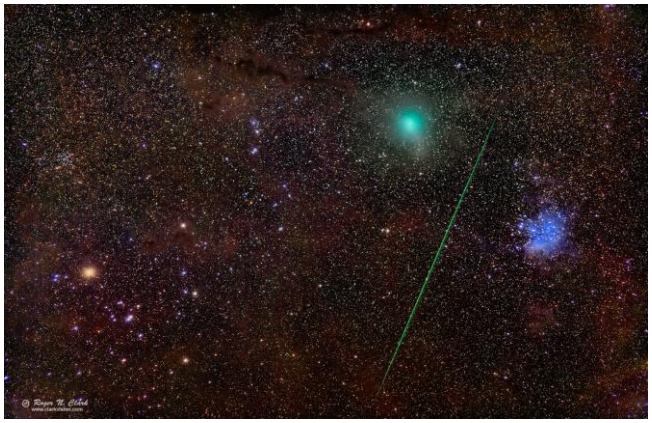
In the 1990's, the ROSAT X-ray space telescope found over 170 X-ray emission sources in the cluster. These are very hot, young stars that must be rotating rapidly. They are clearly distinct from the optically bright members of the cluster.



ROSAT X-ray (green squares=7 optically brightest stars)

Several massive white dwarfs have been associated with the Pleiades as well as the Hyades and other nearby clusters and stellar associations. Dobbie *et. al*.[3] argue that the massive white dwarf GD 50, M>1.1$M_{\odot}$, arose by single-star evolution from a progenitor of mass >6.0$M_{\odot}$ that was formed within the Pleiades 60 million years ago. They believe that another massive white dwarf, PG 0136 + 251, M=1.2$M_{\odot}$, was also an original member of the cluster. To evolve so quickly, these stars probably shed mass as the result of high rotational speeds. Perhaps some of the stars detected by ROSAT will follow similar evolutionary paths. Most white dwarfs that we observe are older, forming from smaller stars after billions of years of stellar evolution.

The Pleiades are just north of the ecliptic and the Hyades just south. The pair of clusters has been known since antiquity as the "Golden Gate of the Ecliptic." Planets and some comets pass through them on their orbital journeys around the Sun. From 4500 BCE to 1500 BCE, the equinox ("The First Point of Aries") was within the Gate.



Comet 46P Wirtanen about to pass through the Golden Gate of the Ecliptic accompanied by a meteor. December 2018. Image by Roger N. Clark, www.clarkvision.com, used with permission.

Proximity to the ecliptic means that conjunctions with the Moon, planets and even comets occur, and lunar occultations may be observed from time to time. Because of the cluster's 2-degree extent, a lunar occultation takes several hours, since the Moon travels about one arc-minute for every two minutes of time. The tilt of the lunar orbit relative to the ecliptic (which determines the Saros cycles of solar eclipses) means that occultations do not occur evenly but

[2] https://iopscience.iop.org/article/10.1088/0004-637X/748/1/30

[3] Mon. Not. R. Astron. Soc. 373, L45–L49 (2006)

come in groups. The next series will take place between 2023 and 2030.

Since Mercury is never more than 28 degrees and Venus never more than 47 degrees from the Sun, visible conjunctions of these planets can only occur in spring or fall when the planet is on the night-time side of the rising (fall) or setting (spring) Sun and in the optimal position in its orbit. For Venus, this occurs about every 8 years. The last Venus conjunction was on April 3, 2020 and the next one will be on April 3, 2028. Visible Mercury conjunctions are far less frequent. Conjunctions of the outer planets occur relative to their orbital periods, and visibility obviously depends on where the Sun is when the planet lines up with the cluster. Mars arrives in the area every 1.9 years and will be there on March 3, 2021, low in the west, passing about 2½ degrees south of the cluster. Jupiter will be about 5 degrees from the Pleiades in late May 2024 but the Sun will wash out the view at closest approach. A month earlier, when the Pleiades will still be visible just after dusk, the planet will be 12 degrees away, not much of a conjunction either visibly or photographically. Saturn will be arriving in the area in early 2030 and but will be south of the ecliptic, making a close approach of only about 6 degrees in early April. It will go past and then retrograde early in 2031, getting within 7 degrees. Uranus will pass slowly through the area within 4 degrees of the cluster between 2025 and 2027. Neptune won't be around until in May 2053, when it will be within 3 degrees, but visibility will be difficult because of the Sun. It will be a little further away the following winter, but will be viewable in darker conditions.

The Pleiades has inspired poets and composers, intrigued scientists and artists, and excited even casual observers but like many other celestial objects it also has stimulated a lot of ridiculous astrological and New Age babble. On the proofofalien.com web site, (Proof? Really?) we learn that "Pleiadians…are believed to share common ancestry with humans as Lyrans from Lyra are the common ancestors." An entry in "RationalWiki" tells us that "The Pleiadian diet and digestive system are arguably 'exotic.' Food is ingested from the mouth, broken down by an organ that vaguely resembles a stomach and transported through millions of capillaries to the skin, since Pleiadians accomplish excretion through their pores. The intestines are still present but vestigial in most races, to the extent that they can be up to 6 to 8 feet shorter. Fortunately, their clothing can reabsorb waste and convert it into lubricant. What selection pressure caused them not to use the anus for excretion and being constantly lubricated is anyone's guess." Another particularly silly example is LightConnection.org, which claims, "Although we live on Earth, many of us originated on other planets, in other parts of the Universe. This is why many of us feel 'out of place' or like we belong somewhere else…. Those who have Pleiades as their planetary origin are sensitive, loving and kind. There is a deep, abiding desire for peace and happiness for all." All of this stuff would be entertaining if it wasn't so profoundly stupid, contributing to the public's disdain for science. In any case, although there might be some planets surrounding some of the stars in the cluster, they would not be old enough to have evolved life in any form that we might understand, including crapping through one's skin, given the estimate that it took about half a billion years for even the simplest life form to have developed on the Earth after its formation.

The Pleiades is one of four Messier objects not to be included in the New General Catalog (NGC) although the nebulosity surrounding Maia is catalogued as NGC 1432, with reference to M45. The others are M24, M40 and M73. M24 is the Small Sagittarius Star Cloud, just a patch of the Milky Way. M40 was first sighted by Hevelius in 1660 and for some reason, probably relating to substandard optics, he thought it was a nebula. Messier clearly perceived it as two stars, but decided to put it in his catalog anyway. As a double star, M40 certainly doesn't deserve an entry in the NGC, nor does the simple asterism of four unrelated stars that is M73. It's a little harder to figure out why Dreyer chose not to list the Pleiades. Was it simply too big and too obvious? Philibert Jacques Melotte, a British astronomer with a French name (his heritage was Belgian) listed it in his catalog, published in 1915, as Melotte 22. The Melotte catalog is a peculiar list, containing 161 open clusters, 81 globular clusters, 2 asterisms, and 1 galaxy.

The Pleiades will be visible throughout the winter until early April, when it finally gets too low in the west after sunset. That's the time to plow and plant, and to start sailing the Mediterranean. ■

Images by Members

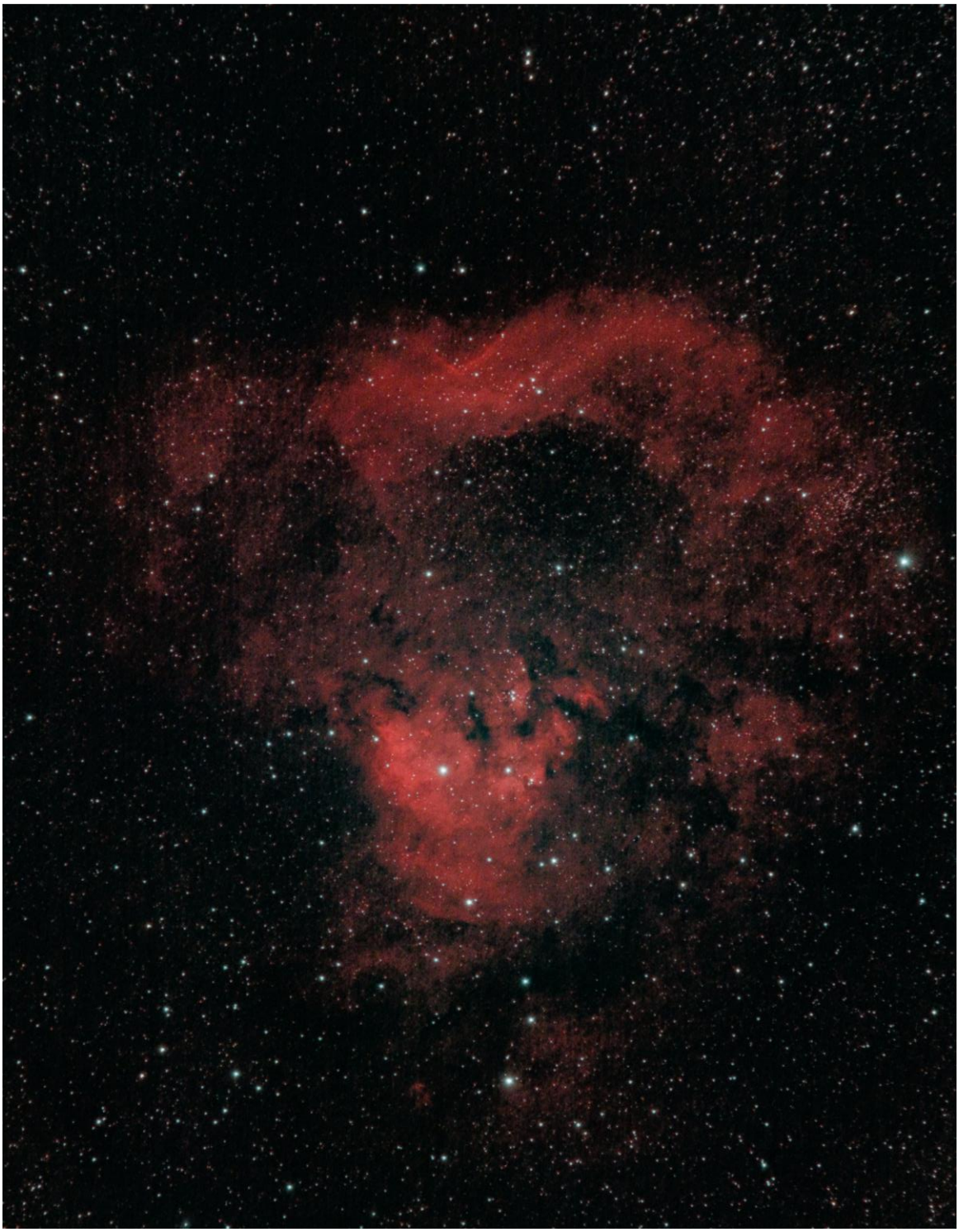
NGC 7822 by Steve Bellavia

Much younger than the Pleiades and still containing its original gas, emission nebula NGC 7822 in Cepheus is actively making new stars. The nebula, also catalogued as Sharpless 171 and Cederblad 214, takes its shape from stellar winds from the Berkeley 59 star cluster embedded within it. The hydrogen gas is energized by radiation primarily from BD+66 1673, which is the bright star near the bottom of the image (and not BD+66 1675 inside the nebula).[1] It's a class O5V star with an eclipsing binary companion. Its visual magnitude is given as 10.3. The Gaia Early Data Release 3 (published December 3, 2020) gives its G-band magnitude (a slightly different spectral distribution than the visual magnitude) as 9.331973 (yes, six significant digits!) and its parallax as 0.9829854265481166 milliarc-seconds (yes, 16 significant digits!). Its surface temperature is about 45,000 K and its luminosity is about 100,000 times that of the Sun. It is one of the hottest stars within three thousand light-years of the Sun. The nebula is about 3,000 light-years distant and no more than a few million years old.

Imaging Details:
Location: Mattituck, NY, and Orient Point NY, USA
Dates: November 29, 2018 and October 14, 2020. Total Integration: 5.5 hours
Borg 90mm f/4 refractor, SkyWatcher EQ6-R Pro mount, ZWO ASI83MM Pro camera, cooled to -15C
Optolong 7-nm Ha filter: 36 x 300 sec, Gain 100 (1.14 e/ADU), Astronomik 6-nm OIII filter: 30 x 300 sec, Gain 100 (1.14 e/ADU).

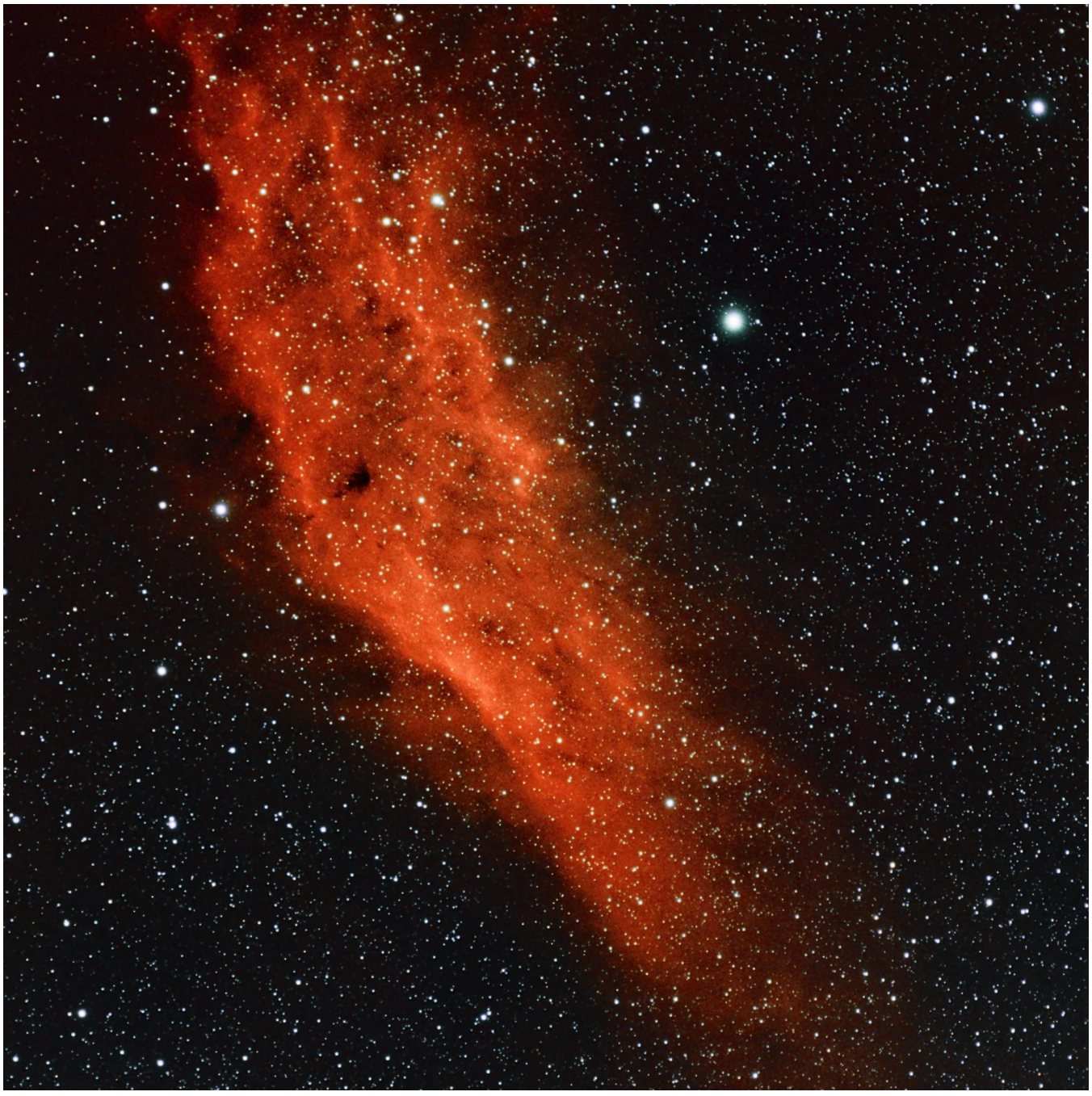
[1] Majaess, D, et. al., The Exciting Star of the Berkeley 59/Cepheus OB4 Complex and Other Chance Variable Star Discoveries, JAAVSO 2008; 36: 90-109, on line at http://articles.adsabs.harvard.edu/pdf/2008JAVSO..36...90M

NGC 7822 by Gary Miller



Here's Gary's wider-field view of the nebula, showing the band of hydrogen gas 1¼ degrees north of BD+66 1673, which is catalogued as Cederblad 215. Gary used a stock Canon EF-S 55-250 mm lens at full-telephoto on a ZWO ASI2600MC Pro camera with an Optolong L-enhance filter in the optical train. 54 light frames 2 minutes each, processed in Pixinsight. Calibrated with flats, darks, and bias frames.

California Nebula (NGC 1499) by Leandro Bento



NGC 1499, the California Nebula in Perseus, is 2½ degrees long. Visually it needs large aperture and filters to isolate the Hα line because of its low surface brightness. Its hydrogen atoms are excited by radiation from the 4th magnitude star ξ (Xi) Persei (Menkib), to the right of the nebula. Class O7, mass 30 $M_{\odot}$, surface temperature 35,000 K. It is one of the hottest stars that can be seen with the naked eye. Distance 1,200 light-years, age about 7 million years. It is a member of the Perseus OB association of hot young stars, but has a high radial velocity and is separated from the center of the association by over 200 light-years. It is considered a "runaway" star, which is what can happen to you if you hang around supernovas when you're young.

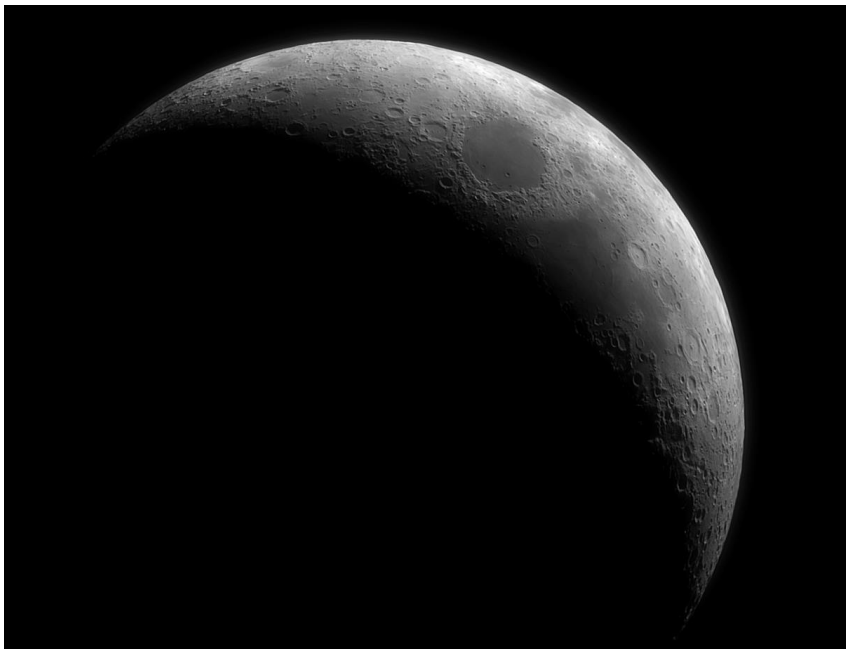
Leandro made this image on November 20, 2020 at Ward Pound with William Optics RedCat 51 mm refractor and ZWO ASI533mc Pro camera.

Orion Below the Belt in H-alpha by Steve Bellavia

Steve used a Canon EF 100mm f/2 lens on a ZWO ASI183MM monochrome camera with an Astronomik hydrogen-alpha filter with 6-nm bandpass, guided for a total of 2½ hours of integration time to capture the swirling masses of hydrogen in the center of Orion. The Flame Nebula and the Horsehead are on the upper left, with M42 and M43 towards the bottom.

The Orion Nebula in Color by Olivier Prache

Olivier used an HDR technique in mid-December to preserve detail in the nebula and show the hot stars at its core. Borg 101-mm refractor. Ten second exposures and 3-minute exposures for a total of 1.5 hours.



Larry Faltz made this image of the 4¼-day old Moon (20% illuminated) on December 18th.

Stellarvue 80-mm f/6 achromat refractor, Skyris 445 camera. Best 500 of 2,000 frames. Software: FireCapture, AS!3, Registax, Photoshop Elements.

Research Highlight of the Month

Hollands, MA, Tremblay PE, Gansicke, BT, Koester, D, Gentile-Fusilo, NP, Alkali metals in white dwarf atmospheres as tracers of ancient planetary crusts, arXiv:2101.01225v1, posted 4 January 2021

In five billion years, after using up its nuclear fuel, the Sun will become a red giant, swelling well beyond the orbit of the Earth. Then it will blow off its outer layers and become a white dwarf inside of a planetary nebula. What will happen to the Earth's atoms? Will they be blown into space, or fall into the white dwarf?

Some 540 white dwarfs in the northern hemisphere within 40 parsecs of the solar system detected by Gaia have been analyzed spectroscopically. A group from England and Germany measured the relative abundance of lithium, potassium and other planetary crust elements in the atmosphere of four of these cool (<5000 K), old (5-10 billion years) stars. Spectra were obtained using large telescopes in Hawaii, Chile and the Canary Islands. The relative abundances of the Li and K with respect to sodium and calcium strongly suggest that all four white dwarfs have accreted fragments of planetary crusts. The minimum mass of crust fragments accreted into these compact stellar remnants was calculated to be between 5 x 10^{17} and 3 x 10^{20} g. This compares with 4 x 10^{25} g for the Earth's continental crust. This means that the observed level of atmospheric contamination requires only relatively small splinters of the crust of an Earth-like planet to fall into the white dwarf.

An excess of infrared emission surrounding the star WD J2317+1830 suggests that accretion from a circumstellar debris disk is on-going. This would further mean that main-sequence stars as heavy as 4.8±0.2 $M_{\odot}$, corresponding to relatively short-lived (40 million years) B-type stars, form planetary systems and that the systems survive to white dwarf stage. WDJ2317+1830 is the coolest and oldest white dwarf with a debris disk yet detected.

A peer reviewed report in *Science* on January 8th by another group showed planetesimal accretion in a different white dwarf by measuring lithium, sodium, calcium and potassium abundances (Jaiser, BC, et. al, *Science* 2021; 371:168-171). The presence of these elements in the atmosphere suggests that they were recently accreted.

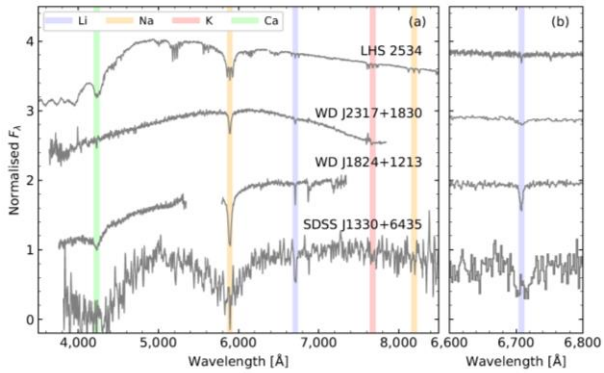


Fig. 1: Optical spectra of the four white dwarfs with photospheric lithium. The wavelengths of the most important transitions are indicated by the colored bars. The spectra in the left-hand panel have been smoothed by a Gaussian with a full width half maximum of 3A for clarity, with the exception of SDSS J1330+6435 where 8A was used instead. The spectra of the lithium line region in the right-hand panel are not smoothed.

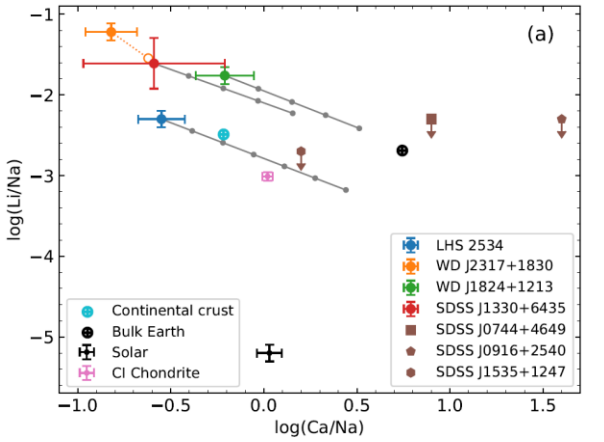


Fig 2a:. The log(Li=Na) vs. log(Ca=Na) ratios of the four white dwarfs with lithium detections (blue, orange, green and red symbols) are enhanced with respect to the Earth's continental crust. The hollow orange point indicates the composition of the planetary body accreted by WDJ2317+1830 assuming accretion-diffusion equilibrium. The gray lines illustrate the evolution of the photospheric abundances of the other three stars due to differential diffusion if accretion has stopped in the past. The dots on these tracks indicate steps of 1 Myr for LHS 2534, and 10 Myr for WDJ1824+1213 and SDSSJ1330+6435. Shown for comparison are solar system benchmark compositions, as well as three white dwarfs that lack a lithium detection (brown symbols).

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
NEW LISTING ADM R100 Tube Rings	Pair of 100 mm adjustable rings with large Delrin-tipped thumb screws. Fits tubes 70-90 mm. You supply the dovetail. Like new condition, no scratches. See them on the ADS site at https://tinyurl.com/ADM-R100. List $80.	$50	Larry Faltz lfaltzmd@gmail.com
Losmandy G11G mount	Pristine condition observatory-quality yet portable German equatorial mount. 2018 model. 60 lb. weight capacity. Heavy-duty tripod. Includes brand-new Gemini II go-to system new in box (never mounted). See http://losmandy.com/g-11.html.	$2800	Dante Torrese torresedds@optonline.net
Explore Scientific 40 mm eyepiece	68° field of view. argon-purged, waterproof, 2" eyepiece. New in original packaging, only used once. Lists for $389.	$340	Greg Borrelly gregborrelly@gmail.com
Atco 60-mm f/15.1 refractor	A classic Japanese refractor from the early 1970s. Obtained from the original owner about five years ago. It had been used only a few times, then stored for 40+ years. Current owner used it maybe seven times. Very good condition. Comes with three eyepieces and a 1.25" eyepiece adaptor star diagonal. Straight-through finder. Equatorial mount with slow-motion adjustment knobs (screws). Wooden tripod, metal tube. Everything is original.	$150	Robert Lewis lewis@bway.net

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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The Milky Way in Centaurus, Crux and Carina by **Larry Faltz**, taken in March 2017 at Andacollo, Chile. Canon T3i, 22 mm lens @ f/2.8, 20 sec @ ISO 6400, fixed tripod.