SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

2021 APEX AWARDS FOR PUBLICATION EXCELLENCE

December 2021

Messier 33 by Robin Stuart

Triangulum Galaxy, M33, is the third largest member of the local group after M31 and the Milky Way. It lies at a distance of around 2.6 million light years. This image was taken in northern Maine on September 12 at the prime focus of a Televue NP127 refractor with a Canon 60Da DSLR at ISO1600. It consists of a stack ten 5-minute subs with dark and bias frames subtracted..

WAA December Meeting

Friday, December 10 at 7:30 pm

On-line via Zoom

Single-photon technologies for ground-based gamma-ray astronomy

Massimo Capasso, Ph.D.
Columbia University & Veritas Array

Gamma rays from space can reach energies, up to several trillion times those of visible light, from dramatically explosive phenomena that shape the universe as we know it. At these energies, the observable fluxes are so low that very large collection areas or long observing times are needed for a significant detection. For these reasons, space-borne instruments are not suited for the detection of Very-High-Energy (VHE) gamma rays. Instead, ground-based observatories can exploit the atmosphere as a huge detector to observe VHE gamma rays indirectly. The light that is emitted as a by-product of the interaction of gamma rays and the atmosphere is very faint and very fast (on the scale of billionths of seconds). Therefore, extremely sensitive detectors coupled with fast electronics are the enabling technology for ground-based gamma-ray astronomy.

In this talk, Dr. Capasso will present an overview of the physics that produces VHE gamma rays in space, how to detect them on the ground and the latest single-photon solid-state technology that enables such technique: silicon photomultipliers (SiPMs).

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

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

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

WAA January 2022 Meeting

Friday, January 14, 2022 at 7:30 pm

On-line via Zoom

Building a gravitational wave telescope out of stars

Tyler Cohen, BSc
Graduate Research Assistant & PhD Student, New Mexico Tech and Jansky Very Large Array, Magdalena, NM. Tyler is a former WAA member!

New Members

Christopher Bruno	Cortlandt Manor
Jorge Camino	Mt. Kisco
Edi Lentini	Armonk
Lillian Yousef	Katonah

Renewing Members

Harry S. Butcher, Jr.	Mahopac
Byron Collie	Croton on Hudson
Rick Faery	Rye
Carlton Gebauer	Granite Springs
Eli Goldfine and Family	Larchmont
John Higbee	Alexandria, VA
Josh & Mary Ann Knight	Mohegan Lake
Michael Lomsky	Wilton, CT
The Maida Family	Port Chester
Kevin Mathisson	Millwood
Daniel R. Poccia	Cortlandt Manor
Olivier Prache	Pleasantville
Mauri Rosenthal	Scarsdale
Kevin Shea	Carmel
Erika Soldano	White Plains
Robin Stuart	Valhalla
Cathleen Walker	Greenwich
Charles Wiecha	Hastings on Hudson

Also In This Issue

ALMANAC For December 2021

Bob Kelly, WAA VP for Field Events


New
12/4


1Q
12/10


Full
12/18


3Q
12/26

The Big Planets rush for the exits

Jupiter and **Saturn** are getting lower in the southwest each week, appearing to push **Venus** out of the sky. The **Moon** joins them on the 8th and 9th. Seeing the joy in a kid's eyes when they pick out moons around Jupiter and Saturn's rings in a small telescope is priceless. Catch them while you can.

Saturn sets by 8 p.m. at mid-month, followed by Jupiter at 9:45 p.m. Saturn's apparition is so low in the turbulent blustery near-horizon skies of winter that the planet appears to bob like a cork in the water. Saturn is the only planet with a density lower than water, so it's an appropriate simile. Here's a fun fact: If you could stand on the surface or on a cloud top of any of our solar system's planets, only on Jupiter would you would weigh a lot more than you do on Earth.

If you missed last month's double shadow transit on Jupiter, try again for a few minutes around 6:15 p.m. on the 10th.

Uranus and **Neptune** follow their larger brothers, in the constellations Aries and Aquarius, respectively. They are small and need decent magnification, but their blue color will be quite perceptible.

Lunar and Solar Stats

Lunar perigee occurs only 25 hours after the new Moon on the 4th this month, so watch for higher-than-normal tides for a few days around and after the new Moon.

The winter solstice occurs at 10:59 am EST on the 21st. Although the solstice is the shortest day, the earliest sunset is on the 7th, bringing a twinge of hope to those who commute in the evening drive-times. Earliest twilight is on the 4th. The latest sunrise is in early January. That peculiarity is due to the analemma, the stretched figure-eight path that the Sun takes in the sky.

Low in the Southwest

Mercury calls attention to Venus (or vice versa) on the 29th, passing 5 degrees to the left of the 33-times-brighter Evening Star. They are only 15 degrees from the Sun, with Mercury on its way up to see if it can tag Saturn in January.

Chips off the Ol' Asteroid

The **Geminid meteor shower** peaks after midnight on the 14th. The Moon is almost full, so only a few bright meteors might be visible. There is a window of opportunity well after the Moon sets at 2:47 a.m., when more meteors may be visible until the start of astronomical twilight at 5:33 a.m. Geminids are brought to you by the asteroid 3200 Phaethon.

International Space Station Sightings

It's great to show the kids (and their parents) the **International Space Station** passing overhead. Keep track of how many souls are aboard at https://is.gd/issnasa. This month, the ISS is visible in the evening through the 9th; then in the mornings starting on the 17th. Updates at https://is.gd/iss_pos.

Comet Leonard

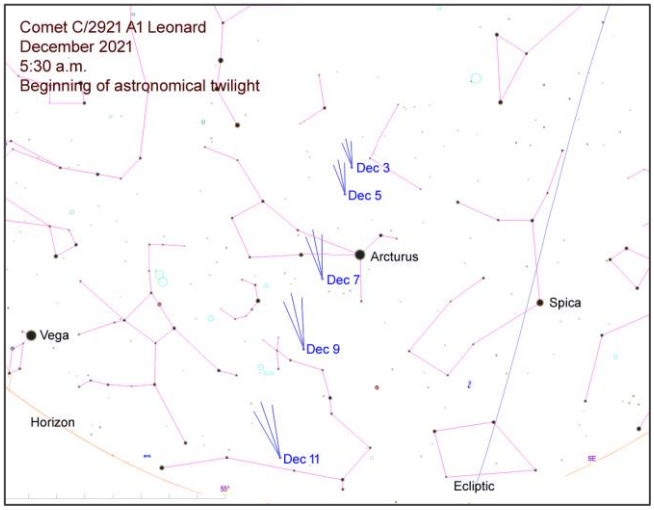
Comet C/2021 A1 Leonard starts out the month as a telescopic object in the pre-dawn sky in Boötes. We may be able to catch it in binoculars as it brightens while passing Arcturus on the 6th. By the second week in December, at its brightest, it will be visible very low in the southwestern evening sky. It is projected to reach magnitude +4, bright for a comet, but will be hard to pick up in the evening twilight sky. Closest approach to Venus in our skies (about 5 degrees) is on the 17th, but Leonard will be only 6 degrees above the horizon at the end of nautical twilight. Leonard will be closest to Earth on the 13th (21 million miles). It then passes close to Venus (2.6 million miles) and may produce a great meteor shower there, if anyone could see it from under the cloudy Venusian skies. It makes its closest approach to the Sun on January 3rd. Scattering of sunlight may brighten the comet by three magnitudes in December. Some more details and a chart for its evening appearance early in the month is on the next page. Submit any photos to SkyWAAtch. ■

Comet C/2021 A1 Leonard: Morning Visibility in Early December

Comet Leonard was discovered by Gregory Leonard at Mt. Lemmon Observatory outside of Tucson, AZ, on January 3rd, when it was just magnitude +19. It will be well-placed before dawn during the first week and a half of December and should brighten to naked-eye magnitude, about +4.0, before it drops into the Sun's glare and then into the evening twilight sky, close to the horizon, for the rest of the month. View it due east before astronomical twilight begins, which is about 5:30 a.m. EST at this time of year (sunrise is about 7 a.m. EST). Balance magnitude, tail length, sky illumination and the comet's elevation for the optimal view. And, of course, any cloud cover.

Estimated Magnitudes (IAU Minor Planet Center)

12/3	12/5	12/7	12/9	12/11
6.0	5.5	4.9	4.4	4.0



Cartes du Ciel chart by LF

WAA Shows the Sun at the Westchester Children's Museum

Saturday, November 13th dawned with a clear, sunny sky that boded well for our invitation to show the Sun to families visiting the Westchester Children's Museum for their James Webb Space Telescope Day, sponsored by NASA. The Children's Museum was selected as a site for special science outreach programs celebrating the much-delayed but now imminent launch of the Webb. We were asked to bring telescopes to view the Sun, the only astronomical object likely to be seen during the daytime program.

The morning's weather was deceptive, since the forecast predicted strong storms for the 1 to 3 p.m. window originally requested by the museum for solar observing from the Rye Beach boardwalk. I decided to flip the script and showed up at the 10 a.m. opening time with a 60-mm Orion refractor and a white light filter. I showed patrons the Sun at 47x so they would have a chance to see some sunspots, half the size of the Earth but looking tiny since they were 93 million miles away. Some intense high-altitude clouds occasionally got in the way, but with the telescope and some photos of the current state of the Sun on an iPhone, lots of people were able to learn about the Sun and understand sunspots. The museum adjusted to the time change and appreciated WAA's support for their special program. By 1 p.m. skies threatened and I got the telescope safely away just before severe storms arrived. There were even six small tornadoes in the NYC metropolitan area.

Photo by Westchester Children's Museum

Bob Kelly

Some Astronomical Events for 2022

Bob Kelly

Here's a listing of solar system events to plan for in the sky this coming year.

Lunar eclipses

In 2022 we'll have two total lunar eclipses visible from the Westchester area. On May 15-16, totality will be from 11:29 p.m. EDT to 12:53 a.m. Luna will be low in the southern sky. On November 8 the Moon will be totally eclipsed from 5:15 a.m. EDT, and will set while still fully eclipsed. Totality ends just after moonset at 6:40 a.m. Sunrise is at 6:34 a.m. (the times are given for White Plains).

Planet visibility:

Mercury is low in the morning sky in February and June, low in the evening sky early January, late April-early May, in August and starting again in December.

Venus will be visible in the morning sky starting in February and through mid-summer. It won't be an evening object all year.

Mars struggles to get out from the Sun in the morning sky, finally visible there by summer. It will be well-placed in the evening sky late in the fall, around and after opposition on December 7. It will be at its largest apparent diameter, 17.2 arcseconds, on November 29.

Jupiter follows **Saturn** into the morning sky in May, and then to the evening sky after opposition on September 27. **Saturn** reaches opposition on August 14. The separation of the two planets will be much greater than the last two years. They are still relatively low in the sky, although Jupiter will climb above the atmospheric. **Neptune** reaches opposition September 17. **Uranus** is at opposition November 9.

Interesting alignments

Mars has brighter Venus and Saturn pointing out its location very low southeastern sky each morning from March 28 through April 4.

Jupiter and Venus make a close set with the Moon low in the southeast before sunrise on April 27. The two brightest planets are a spectacular close pair on the 30, 33 arcminutes apart two hours before sunrise (which is at 5:53 a.m.). They will be even closer at 8 a.m., just 24 arcminutes.

Jupiter pairs with much dimmer Mars in the mornings around May 28. That will be a good opportunity to find four planets at once, with Venus to the lower left and Saturn to the right.

Meteor Showers

The **Quadrantids** shower has a narrow peak of 25 meteors per hour on the morning of January 3, but there's no interference from the Moon.

The **Perseids** struggle to be seen in the light of a full Moon on August 11–12. The dark sky rate would be 50 to 75 per hour but the full Moon kills the event.

The **Orionids** have only an evening crescent moon in the way at the peak on October 21-22. There's a maximum of 10 to 20 per hour.

The **Geminids** peak on December 12-13 with a well-lit Moon most of the night. The Moon's glare will keep us from seeing the 75 or so per hour possible in a dark sky.

A Possible Meteor Storm?

At a club lecture two years ago, astronomy guru Joe Rao pointed out that at the end of May 2022 there is a chance of a meteor storm of epic proportions, rivalling the famous 1833 Leonid storm. Earth will be passing through the orbit of Comet 73P/Schwassman-Wachmann 3, which has been breaking up since the late 1990's. The comet is the parent body of a minor meteor shower, the Tau Herculids, which runs from May 19 to June 19, peaking on June 9. Joe thinks this coming May we might pass through a particularly large concentration of comet debris, with a potential dark-sky meteor count of 10,000 or more per hour for a short time. There's a new moon on May 30 and no moon in the sky after midnight for the following week, favorable to meteor viewing. This prediction is highly speculative. The total count could be low, like an ordinary Tau Herculid event, or it could be the greatest meteor shower in 200 years. No one will know until early June. It's a long shot, but sometimes the long shots win: 1969 Mets, Truman beats Dewey, Miracle on Ice, 2015 Leicester (for soccer fans). WAA is not responsible for any disappointment you may suffer, however.■

Member Profile: Jim Cobb

Jim submitted this biographical sketch in lieu of our usual Q&A:

I was born in 1933 in High Point, NC, where I remained in residence through high school. In 1949 I entered Iowa State College, located in Ames, Iowa. I graduated from Iowa State in 1955 with a Bachelor of Science degree in mechanical engineering. I came to the New York City area after spending two years in the U. S. Army.

In 1957, I met Mary Ethel Lane, a physician practicing in Tarrytown, NY. We were married in 1959. We have three children: Lane Leslie Cobb, an interfaith minister and social activist, Keith Hamilton Cobb, an actor and playwright, and Pamela Griffin Cobb Pettis, an obstetrician/gynecologist.

Forty nine years ago, in 1972, I founded a company for the design and construction of special or unique manufacturing machinery. The name of the company was Pilot Machine Designers. In 1999 I sold the company and retired. I created, among many other machines, two that produce commonly used products that many people are familiar with: paper sticks for lollypops and disposable paper chef's hats.

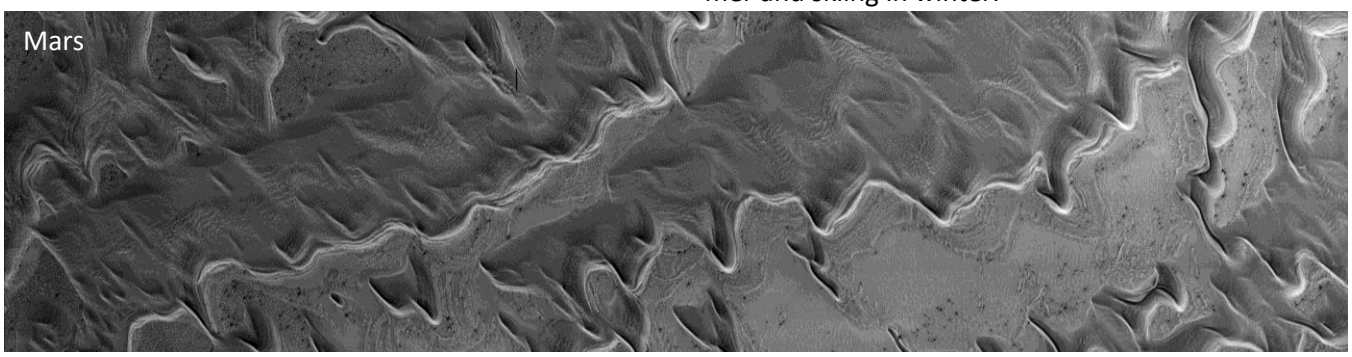
I am particularly interested in scholastic achievement in young people and enjoy community volunteer activity in that area. I have served my community as:

- Scholarship Committee chair for the New Rochelle/White Plains Alumni Chapter of Kappa Alpha Psi Fraternity;
- Scholarship Committee chair for the Westchester Black Scholars Community Partnership;
- Member of the Westchester Community College Foundation Board;
- Volunteer docent at the Maritime Center and Aquarium at Norwalk, CT;
- Volunteer docent at the Hudson River Museum in Yonkers;
- Science judge for the NAACP ACT-SO regional scholastic competition.

I have been an active member of the Community Unitarian Universalist Congregation at White Plains, NY since 1965.

I love science and contemplating our place in the universe. I don't think that I am active enough or knowledgeable enough in astronomy to call myself an astronomer but I have been a member of the Westchester Amateur Astronomers for many years. At 88 and with some mobility problems I am less active but I still think and read a lot about the universe and stars.

I also love water and snow; consequently, when active, I spent as much time as possible sailing in summer and skiing in winter.


Mars

Deep Sky Object of the Month: Messier 74

Messier 74	
Constellation	Pisces
Object type	Galaxy, type SA(s)c
Right Ascension J2000	1h 36m 41s
Declination J2000	+15° 47’ o1”
Magnitude	9.46 (V)
Size	10.5’ x 9.5’
Distance	32 million LY
NGC designation	628
Discovery	Pierre Méchain, 1780

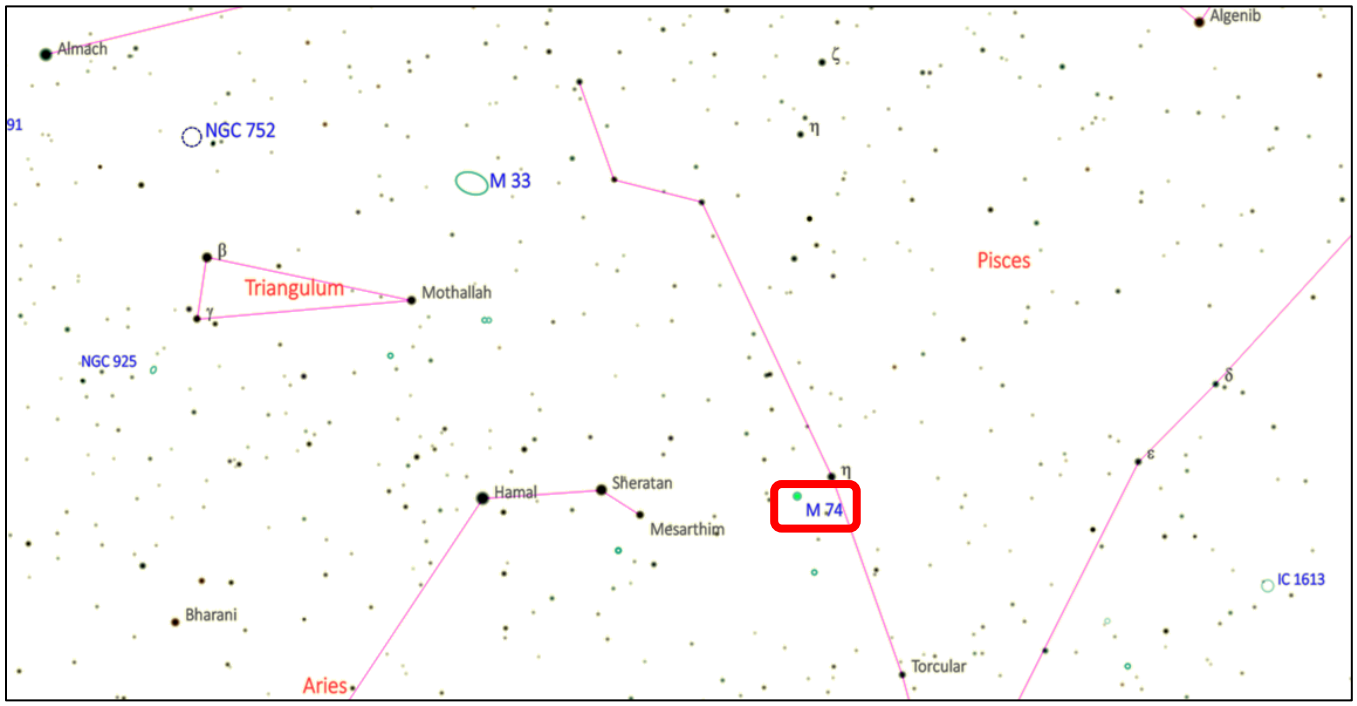
Messier 74 is a beautiful but very challenging face-on spiral galaxy. Its low surface brightness of 14.4 means that our local light pollution will make it even more difficult to see than its 9.46 magnitude suggests. Stephen James O’Meara recommends using “a small aperture instrument, low power, and a wide field of view on the finest of nights” and then going to higher power. Obviously, heading out to a darker location will help immensely.

M74 is probably the chief member of a very small physical group of galaxies, which includes the peculiar SBa barred spiral NGC 660, the peculiar Sm galaxy UGC 891 (of a mixed type between spirals and irregulars), and the irregulars UGC 1176, UGC 1195, and UGCA 20.

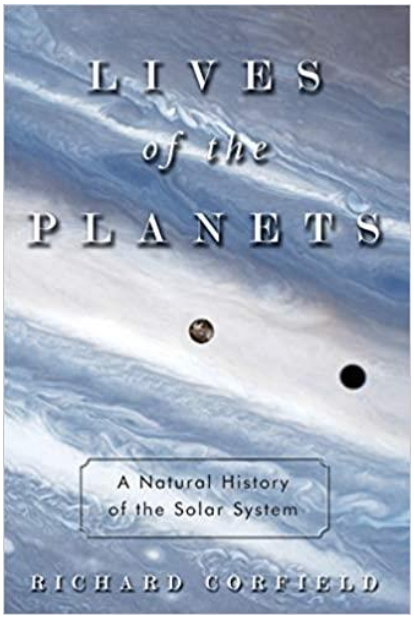
Visibility for Messier 74			
9:00 pm EST	12/1/21	12/15/21	12/31/21
Altitude	64° 30’	60° 45’	52° 08’
Azimuth	186° 53’	214° 50’	237° 41’

Messier called M74 a *nébuleuse sans étoiles* (nebula without stars). In the original NGC catalog, Dreyer listed it as a globular cluster, not surprising because galaxies as distant Milky Ways were as yet completely unknown.

Imagers should be able to capture M74 nicely.



Book Review:
Lives of the Planets: A Natural History of the Solar System by Richard Corfield.
Reviewed by Alex Mold



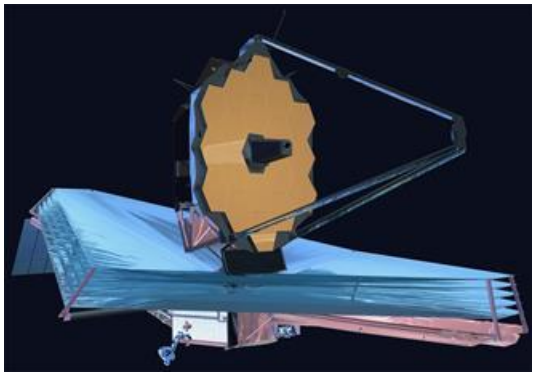
I found this book at The Strand, New York's wonderful used bookstore and one of the largest of its kind in the world. *Lives of the Planets* is a short (about 250 pages) book about the history of mankind's exploration of our solar system. It traces how we investigated the movement of the planets using the first astronomical computer at Stonehenge to actual space probes that visited them. Corfield, a British astronomy professor, discusses each planet in turn, giving the history of its discovery (for those planets that were actually "discovered"), major planetary features, and the missions were sent to explore it.

Most interesting to me is the comparison between what the various missions expected to find, based on observations from Earth, and what they actually discovered. Titan is mentioned as one of the most anticipated targets of the Voyager missions. Carl Sagan asked JPL to make a contingency to redirect Voyager 2 to study Titan if Voyager 1 failed, even though that would have prevented exploration of Neptune and Uranus. Fortunately both probes worked, but the results of the Titan visit were not as revealing as what people had hoped. In fact, Voyager 1's only real accomplishment at Titan was confirming how much they had to work on the next fly by.

The book also discusses Ceres and the formation of the asteroid belt with depth that eclipses other books I've read. This discussion really brings to life how the asteroid belt is not one continuous zone of small bodies, but due to the effects of orbital mechanics there are several bulges or concentrations of objects. I also enjoyed discovering that Ceres was originally listed as a planet after its discovery, so for a brief period the solar system had nine planets before Pluto.

The only major downside to reading the book now is the date of publication, 2012. Unfortunately, this leaves a few major holes in the history of space travel, namely the MESSENGER, Dawn, and New Horizons missions which, while mentioned, had not yet arrived at their targets.

Despite this limitation, the book effectively highlights how each mission to the solar system's planets and moons strove to achieve what those before them could not, and how our knowledge increased as a result. *Lives of the Planets* effectively tells the story of how we got to our current understanding of the solar system, and tells us what questions the next missions need to ask.



James Webb Telescope Launch Set for December 22

As of this writing, the Webb telescope is scheduled to lift off from Kourou, French Guiana on an Ariane V rocket at 7:20 a.m. EST on December 22. The long-awaited event (the original 1996 plans called for a launch in 2007) is just the beginning of a tense period for the instrument. It will take about a month to reach the L2 Lagrange point, and then three weeks to unfurl its sun shade and deploy its primary and secondary mirrors. Follow the launch and deployment progress at the NASA/Goddard web site, https://jwst.nasa.gov/content/webbLaunch/index.html

Notes from the Junkyard Astronomer

Cobbling together a "Gas Cam"

John Paladini

The dictionary defines cobbling as "assembling or putting together something from available parts or elements."

On August 11, 2021 at the WAA star party at Ward Pound Ridge Reservation I set up an old Mallincam CCD video camera with a fast wide angle lens mounted on it. I quickly drew several people over to view the hydrogen gas clouds of the Lagoon (M8) and the Trifid (M20). There were plenty of bunch of oohs and aahs from the crowd, surprised how bright the nebula images were on the OLED eyepiece I was using.

About 12 years ago, I introduced Larry Faltz to the Mallincam at one of the WAA star parties, using video "gamer glasses" as the viewer. We plugged my camera into his 8-inch SCT. I showed him Messier 16 with the "Pillars of Creation," something he could never see through the eyepiece. After I got the nebula in focus, I slipped the glasses over his eyes. He went nuts. [Yes, I did. – Ed.] As soon as he got home he ordered a Mallincam and has been using it with a 7-inch video screen display at many star parties to show faint nebulas and galaxies. In 2010 we were able to see the 17th magnitude Twin Quasar in Ursa Major, an object eight billion light years distant.[1]

A video camera outputs a "composite" analog video signal, suitable for plugging into a video screen with a two-conductor cable. A computer is not needed: any digital information from the CCD sensor is converted to analog by "D/A" chips inside the camera. Using video cameras with telescopes falls under the category of Electronically-Assisted Astronomy (EAA). It's a good method for outreach, since the astronomical objects are easily seen on monitor and are brighter than in an eyepiece. Video cameras have small chips, often just 640x480 pixels, and do not create the same lovely clean images as a good astrophotography imaging camera. Indeed some people feel it EAA with small-chip video CCDs has become obsolete. In some sense that was true for me, with my older Mallincam black and white camera sitting unused in a drawer.

A few years ago I purchased a 48-mm DGM dual-channel filter. This filter transmits the Ha line and OIII/Hb region and does a good job at suppressing other parts of the spectrum, similar to filters used by other astrophotographers using color imaging cameras. My initial intention was to use this filter on my night vision devices which use an image intensifier tube and scintillation screen rather than a CCD sensor and LCD display. I was quite surprised how well the filter worked, in most cases better than the single narrow-band Ha filter that I had been using. Some of those images have been posted in previous WAA newsletters. Keep in mind this filter works best for gas emission nebulas, which have a narrow spectral range mostly at the hydrogen alpha wavelength. It is not designed for stellar objects like galaxies and stars, which output light across the visual spectrum.

Then I wondered if such a filter would work with a video camera. Most filters do not work that well with this technology. Rock Mallin, the inventor of the Mallincam, does not recommend them. However my

[1] See the cover of the June 2010 SkyWAAtch.

thought was that they may work well on certain objects with proper lens/camera configuration.

The objects that I was interested in viewing were the larger emission nebulas such as the Lagoon, the North American and Orion. It's too bad that these objects are faint. They are quite large and if we could see them with greater intensity it would be a sight to behold. Some would extend over an angle larger than the full Moon!

The object I want to view determines what lens I should use on the camera. Most telescopes would have too narrow a field of view and even at f/4 may be a bit slow. I decided that the only way to go was to use TV camera lenses. These lenses have a wide field of view and are very fast, f/1.2-2.0. They also use a C-mount, which is the standard thread for Mallincam video cameras. I have three video lenses. A 12.5-mm focal length, f/1.3 Computar lens has a very large field of view. I use this lens for big objects like Barnard's Loop, which is almost as large as the constellation Orion itself. My second TV lens is also a Computar, a zoom of 12.5 – 75-mm, also f/ 1.2. The third is a Canon zoom lens with a focal length of 17-102-mm, f/2.0, for objects like M16 and M17. These lenses are not that expensive, running $20-90. There are a few things you need in addition to the lenses. You need to buy a filter adapter for each one so you can mount the 48-mm DGM filter on the front of the lens. You also need to register them. Registration in this case means making sure they achieve focus at infinity. I found that for the Mallincam camera I need to add a C-mount ring or thin washer to increase the distance from the back of the lens to the sensor.

The final part of my gas cam is a V780 OLED video eyepiece. This part is optional in the sense that you can display a video image to a stand-alone video monitor, a PC or video glasses. But OLED eyepiece is smaller than the other alternatives and can be mounted right on the camera using a simple bracket. I slightly modified the power input so I could use battery power (3.7 volts DC) or use an AC to DC power adapter. I purchased this OLED eyepiece on eBay The experience is more like looking into a telescope than merely seeing the image on a screen, even though what you are seeing is in fact a screen. The psychological impact seems to be that it is more "astronomical."

Once the parts were cobbled together I placed the whole lens/camera/eyepiece on a simple EQ mount that can track. You need to be roughly polar-aligned and tracking because some exposures are 7, 14 or 28 seconds long (using switches on the Mallincam) and without tracking everything would start to blur.

Power up the rig, point to an object, focus and Bingo! you will get to see some excited gas. Sometimes the image is even too bright! I use the f/stop dial on the lens to control the diaphragm and regulate the amount of light on the sensor.

When I first posted some of these images on the CloudyNights.com EAA forum, I was challenged by the moderator. They have strict rules that state only non-processed images can be posted. The moderator stated that I needed to post an avi video clip (which are harder to doctor) or my post would be removed. I posted the avi clip and the challenge was withdrawn. This project bought back to life some old technology that was fading away.

A lot of astrophotography cameras such as those made by ZWO have C-mount adaptors. I will attempt to see if I can use these TV lenses on those cameras.

Here are some facts about the V780 digital eyepiece:

- Gives the impression of a 90-inch video display at 2 meters distance
- 1024x768 active matrix color 0.5-inch OLED panel built with single crystal silicon transistor
- Small size and light weight
- Equipped with a 21-mm eyepiece
- Adjustable diopter and brightness
- 3.7V power supply can be connected to it through external socket
- Supports NTSC/PAL
- Waterproof, dustproof and shockproof
- Screen Ratio: 4:3
- Color Depth: 24-bit input
- Viewing Angle: 45° diagonal
- Power consumption: 0.1W
- See https://www.ebay.com/itm/124295483664?hash=item1cf0969110:g:jIUAAOSwfZVfM50A

Without the filter in place, the camera can be used to see the brighter large galaxies and clusters, in this case the Andromeda Galaxy, Messier 31, and its companion M110 (below M31).

The WAA Club Picnic, October 16th

The annual picnic is a club tradition. For many years we held it at the Ward Pound Ridge Reservation, cooking franks and burgers on a portable grill. For the past four years (excepting no picnic in 2020 for Covid reasons), Eva and Erik Andersen have hosted it on the property of the Danish Home in Croton. The event took on magnificent new proportions, courtesy of the Andersen's incredible organizational skills and generosity and the availability of a large gazebo, complete with tables, chairs, utensils, condiments and decorations. The Danish Home was a senior living facility but shut down last year due to Covid.

We held the 2021 picnic indoors in the now-empty but nevertheless elegant building, pictures of the King and Queen of Denmark and a 1928 ivory-keyed Mason & Hamlin A piano among its contents. Eva, her sister and some staff members made a memorable feast, with astronomy-themed decorations, a life-sized image of Neil Armstrong and a vast amount of elegant food and desserts, complemented by some edibles, wine and beer brought by the 35 or so (all vaccinated) attendees. There were door prizes and a wonderful team trivia contest with all sorts of challenging questions, like naming the two Chinese astronomers who were executed for failing to predict the total solar eclipse of 2136 BC (Xi and He, in case you forgot), completing a series of insults from the original Star Trek, knowing astronomy references in popular songs and correctly matching evil computers with the movies in which they were featured. Here are some photos of the event.

Elyse Faltz at the entrance to Danish Home


Door Prizes


Appetizers, with John Paladini

Dining area

The Main Room at Danish Home

Courtyard

Getting ready for the Trivia Contest

Group photo

Eva emceeing the Trivia Contest

Note the portraits of the King and Queen!

The property, near Croton Dam, is up for sale, so this is very likely the last of the WAA picnics there. We'll figure out a convenient spot for next year's event. We still have the old grill!

Thanks to Frank Jones, Lori Wood and Larry Faltz for the photos. And most of all thanks to Eva and Erik Andersen, truly generous and enthusiastic party-givers.

Johann Schöner:
The Man Behind the Man Behind the Man Behind Heliocentrism

Larry Faltz

Johann Schöner, from his *Opera Mathematica* (Mathematical Works), a 932-page volume published in Nuremberg in 1551, four years after his death (Lessing J. Rosenwald Collection, Library of Congress)

Of all the sciences, astronomy is most connected to its history. Over time, humanity has perceived the universe with increasing veracity because our species developed rational, objective thinking. And vice versa: wrestling with the challenges of astronomy, the nature of planetary movements, the changing length of the day, stimulated intellectual maturity that extended beyond astronomy. When we're very young (as children, as a civilization) we notice that the Sun and Moon circle the Earth, but as we mature (as people and as a civilization) we learn that while their paths through the sky seem identical the Moon circles the Earth yet the Earth that circles the Sun. Then the planets, and out to the stars.

Most new students of astronomy would summarize this history by saying "Aristotle put the planets in crystalline spheres; Ptolemy wrote the *Almagest* to permit their orbits to be defined mathematically (using a whole bunch of epicycles and equants) and that was accepted for 1,400 years by uncurious humanity until Copernicus figured out the right order of the solar system, which Galileo then proved." In the very broadest sense this is true, but it is far too much of a generalization to say that between 150 AD, when the *Almagest* was written, and 1543 AD, when Copernicus published De *Revolutionibus*, no one was perturbed by inconsistencies in Ptolemy's clever theorems.

Claudius Ptolemy was a resident of Alexandria, the intellectual capital of the Roman Empire, famous for its library. The library's greatest days were in the third and second century BC, when it was overseen by the great scholar and geographer Eratosthenes. It had already begun to decline by the time it was partially burned by Julius Caesar in 48 BC (ostensibly by accident) and eventually ceased to function in the second century AD. Some scholars prefer to think there was a single cataclysmic firestorm, a poetic triumph of the barbarians so to speak, burning and pillaging and putting philosophers, poets, scientists and scrolls to the torch, but it didn't happen that way. Nevertheless, in the second century AD the city of Alexandria, a Roman city in Egypt in which Greek was the primary language, was still hospitable to intellectuals like Ptolemy.

Ptolemy, like many figures in the early history of astronomy as late as the Renaissance and Reformation, was a true polymath. He was interested in and knowledgeable about astronomy, astrology, mathematics, physics, optics, harmonics, chronology, and geography. He wrote several texts that survive today. Most famous is the *Mathēmatikē Syntaxis* (Μαθηματικὴ Σύνταξις, literally the "Mathematical Systematic Treatise"), better known as the *Almagest*, the English corruption of its Arabic nickname, al-majisṭī (المجسطي), meaning "the greatest." We think of the *Almagest* as a description of the mechanics of

planetary orbits, but the title gives away its main purpose: to develop and explain mathematical and geometric techniques for the calculation of those orbits. Using its Arabic name implies that the work was only rediscovered through Arabic translations, but this is not entirely correct.

Around 330 AD, the Emperor Constantine reorganized the Roman Empire, moving its capital to the city of Byzantium on the Bosporus, renaming it Constantinople and making Christianity the official state religion. Although Rome fell in 476 AD, the Eastern Roman Empire, colloquially known as the Byzantine Empire, persisted for nearly a thousand years. Greek was its primary, if not official, language. Greek manuscripts of the *Mathēmatikē Syntaxis* were kept at Constantinople and perhaps other places in Byzantium. The proximity of Constantinople to Persia on the one hand and the penetration of Islam into Spain to interact with western societies (both militarily and civilly) meant that there were cultural and intellectual exchanges from just after the time of Mohammed until those two epic events of the 15th century: the fall of Constantinople in 1453 and the end of Moorish occupation in Spain in 1492.

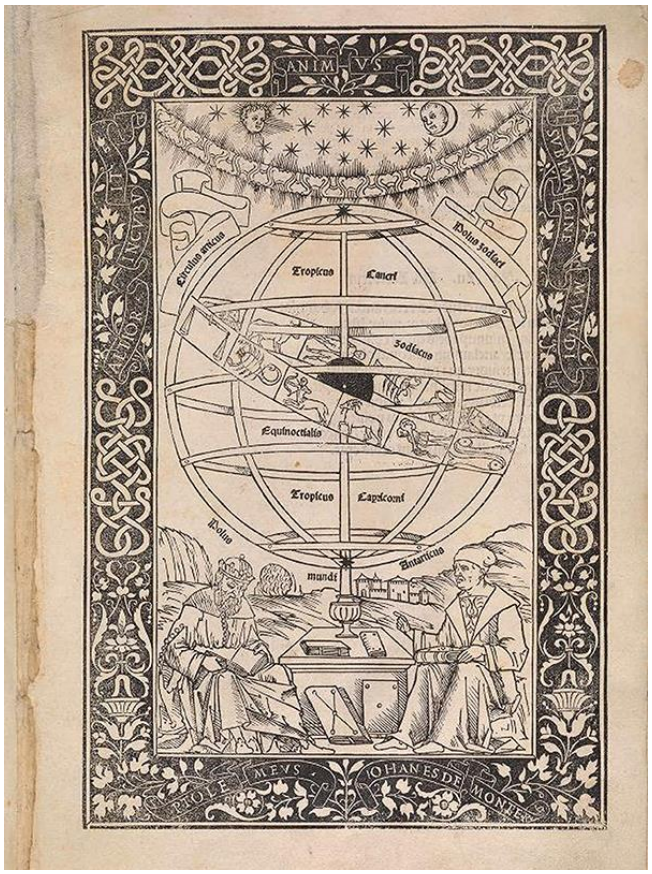
In the 9th century, the first Arabic translation of the *Almagest* appeared. A translation from Greek to Latin was made in southern Italy by Henry Aristippus in the 12th century and from Arabic to Latin by Gerard of Cremona in Toledo in 1175. Gerard was a member of Toledo School of Translators, established after that marvelous city fell to Christian forces in 1085.

A parallel development helped spread the influence of the *Almagest* and other Greek, Latin and Arabic works on a wide range of topics: the creation of the university, first in Bologna in 1088, then Paris in 1150 and Oxford in 1167. The curriculum in medieval universities consisted of the *trivium* and the *quadrivium*. The *trivium* was taught first: grammar, logic, and rhetoric formed the basis of all subsequent intellectual pursuits. The *quadrivium* consisted of arithmetic, geometry, music, and astronomy. These “liberal arts” were distinguished from more vocational educational programs such as law and medicine. While these subject areas had their origin in Plato and were adopted at least in part in monastic education as early as the 6th century, it was in the university that they created an intellectual ecosystem that would grow and evolve. Professors read and wrote commentaries on older texts, using them for teaching. Astronomical textbooks written by medieval scholars covered the calendar, the nature of celestial spheres, planetary theory and the use of instruments such as the astrolabe and quadrant. These works included methods of calculating orbits, conjunctions and eclipses, but being based on Gerard’s translation, which lacked a true understanding of Ptolemy’s mathematical and geometric details, they were shadows of the original *Almagest*. Examples of medieval astronomy texts are Robert Grosseteste’s *De sphaera*, from 1215, Johannes de Sacrobosco’s (John of Holywood) *De sphaera*, *De computo eccliastico* and *De algorismo*, often bound together, dating from around 1240, and Campanus of Novara’s *Theorica planetarium* from 1264. The census of scholars who were actually able to read the hand-written copies of these books was naturally small, but in the university environment lectures would spread the knowledge. Students paid attention in those days I suspect, not having cell phones and Facebook accounts to distract them.

In the 13th century, King Alfonso X of Castile and Leon sponsored additional translations into Latin and Spanish of Arabic versions of Greek texts, as well as translations of original Arabic astronomical and mathematical works. This effort culminated in the creation of the *Alphonsine Tables*, which used Ptolemaic methods to calculate solar, lunar and planetary positions starting on January 1, 1252. The *Alphonsine Tables* were an update of the *Toledan Tables* of 1080.

There wasn’t any profound theoretical progress in astronomy during the medieval and early Renaissance periods. Astronomy served to support the casting of horoscopes. Planetary and terrestrial positions and time-keeping (using positions of the fixed stars and the length of the day) needed to be accurate. Translations and commentaries circulated slowly through the intellectual nexus of western Europe. But in the middle of the 15th century, a new invention changed everything. Johannes Gutenberg invented printing with moveable metal type. In 1440, he began to print poetry, and in 1455 he made the first Bible, the “42 line” edition of which 180 copies were made and 49 are known to exist now, but only 21 are complete (the Morgan Library has one).

Gutenberg's invention, while it didn't seem to make much money for him, spawned a new industry in Europe. Presses arose all over the continent in just a few years. A particularly important site was Venice, undoubtedly because of its position as the trading portal to the east. There, the Byzantine Greek philosopher, diplomat and later Roman Catholic cardinal Basilios Bessarion deposited his large library of manuscripts that is still housed in the *Biblioteca Marciana* on St. Mark's Square. In 1460, Bessarion went to Vienna, whose university had become a center of astronomy and mathematics. Among the scholars there were Georg Peurbach and his pupil Johannes Müller von Königsberg, better known by the name given to him by Bessarion, Regiomontanus.



Frontispiece of *Almagesti Ptolemaei* showing Ptolemy and Regiomontanus in a discussion (Smithsonian Library)

Peurbach had written a textbook about planetary motion, *Theoricae Novae Planetarium* (New Planetary Theories) left two unfinished works, *Tabulae Eclipsum* (Table of Eclipses) and *Almagesti Ptolemaei* (Epitome of Ptolemy's Almagest). They were completed by Regiomontanus at Bessarion's request after the death of Peurbach at age 38 in 1461. Regiomontanus traveled in Italy with Bessarion for four years on a hunt for more ancient Greek manuscripts. During that time, he wrote *De Triangulis Omnimodis* (On Triangles of Every Sort), a mathematical treatise that uses algebra and trigonometry to analyze plane and spherical triangles, an important skill in cartography. His sine and tangent tables are the model for those used today.

In 1471 Regiomontanus moved to Nuremberg and set up an observatory and a printing press. He published Peurbach's *Theoricae Novae Planetarium*, which was widely read. Regiomontanus' *Ephemerides* were the first planetary tables to be printed, and it has been said that they were used by Christopher Columbus on his fourth voyage to predict the lunar eclipse of February 29, 1504.[1] Regiomontanus also published the completed *Epitome Almagesti Ptolemaei*, more than just a summary of the *Almagest* since it included later observations and critical analyses. There is some speculation that Regiomontanus toyed with heliocentrism in spite of his focus on Ptolemy.

Regiomontanus died in 1476 at age 40. Copernicus read Peurbach's *Theoricae* and Regiomontanus' *Epitome* when he was a student in Bologna in the first decade of the 16th century. Regiomontanus' critique of inconsistencies in Ptolemy, variances between prediction and observation of eclipses and planetary motion, must have provoked Copernicus' dissatisfaction with Ptolemy's construction. Copernicus was particularly troubled by the use of the equant, an arbitrary non-circular feature Ptolemy invoked to account for discrepancies in the observed speed of planetary motion (while "actual" motions must remain circular and of constant speed). Copernicus' heliocentric theory took form before 1515. We know that because that year he wrote a short summary of his ideas, now known as the *Commentariolus* (Little Commentary). It was circulated to a few of his friends in manuscript copies (it was not printed until the 19th century). Were it not ultimately for the influence of a somewhat obscure German scholar, Copernicus might have stopped with the *Commentariolus.* In that case, *De Revolutionibus Orbium Cœlestium* (On the Revolution of the Heavenly Spheres) might never

[1] Columbus used the eclipse to scare the natives of Jamaica into submission

have seen the light of day and Copernicus would have simply been a footnote to astronomical history.

Johann Schöner (1477-1547) was born in Karlstadt and educated at the University of Ehrfurt. He was ordained as a priest in 1500 in Bamberg. Most of his early life is known from marginal notes he made in a copy of Regiomontanus' *Ephemerides*. He reported his activities and domestic relations, even the birth of his children (in spite of being an ordained priest), until 1506 when the notes cease. For the next quarter of a century he seemed to divide his time between Karlstadt and Bamberg, where he had set up a printing shop specializing in maps and globes. In 1526 he was called to Nuremburg to teach at a gymnasium, essentially a preparatory high school. He became a Protestant around that time, the Reformation sweeping across a turbulent Germany. In Nuremberg he connected with Johannes Petreius, who was interested in establishing a scientific press. Petreius would eventually published 11 Schöner titles, including works on astronomy, astrology, mathematics and instrumentation, and in 1543 he printed Copernicus' *De Revolutionibus*.

Schöner was esteemed for his skills as an astrologer, and probably in pursuit of that expertise had become an adept mathematician, cartographer and scientific instrument maker, as well as a bibliophile and collector of mathematical, astronomical and geographical manuscripts and, in particular, maps. He was the first person to make printed (rather than hand-figured) globes, both terrestrial and celestial. He was a prolific author, editing and publishing the works of other astronomers and mathematicians. He was extremely well-known in the 16th century and corresponded with Philip Melanchthon, a professor of Greek at the University of Wittenberg who was Martin Luther's chief collaborator and the main theologian of the Reformation, as well as many other notable scientists, humanists and religious figures.

Particular important in the development of Schöner's expertise in cartography and mathematics was Ptolemy's *Geographia*.

Geography and mapmaking were important to ancient Rome. By the time of the Empire (Octavian assuming the title of Augustus in 27 BC), Rome's enormous sphere of influence required maps for management, communication, commerce and military control. A reliable way of accurately defining locations and routes was needed. The *Geographia* was a revision and expansion of an atlas by Marinus of Tyre, now lost. Like the *Almagest*, it was substantially a mathematical treatise, providing formulas that would convert the length of the day at various locations into latitudes. It also included instructions on map-making and globe-making. It was translated into Arabic in the 9th century; the oldest extant manuscript is in the Vatican Library and dates from the 12th century. The first Latin translation appears to have been made in 1406. Some of the manuscripts contain maps, but these are thought to have been added by subsequent commentators and were not copies of the original maps that Ptolemy had drawn.

A Latin edition of the *Geographia* was printed in Ulm in 1482 and Schöner bought a copy on October 16, 1507, as revealed in copious marginal notes. It had a profound influence on him. Schöner made detailed drawings that helped him work out Ptolemy's mathematical and geometrical methods for determining latitudes on the globe and converting them for placement on flat maps that could be printed.

In 1533, Schöner edited and Petreius printed an edition of Regiomontanus' *De triangulis omnimodis*. In the preface to this edition, Schöner mentions Regimontanus' *Index*, a listing of medieval and classical works that Regiomontanus had hoped to publish, but could not because of his untimely death. Schöner published several mathematical works that Regiomontanus had completed before his death as well as some of the other works on the Index.

As a result of his fascination with scientific publications and cartography, and in addition to his own publications, Schöner put together a collection of manuscripts and maps and bound them together in a volume that has come to be known as the *Sammelband*, which directly translates to "anthology." This collection was discovered in 1901 in the library of Prince Johannes Waldburg-Wolfegg at the Castle of Wolfegg, in Württemberg, Germany by Jesuit historian Josef Fischer. It had somehow been separated from the rest of Schöner's works, which had remained together after his death in 1547. They were ultimately purchased in 1656 by Emperor Ferdinand III of the Austro-Hungarian Empire and now reside in the Austrian National Library in Vienna.

The *Sammelband* is now part of the Kislak Collection in the Library of Congress, which purchased it in 2003 for $10 million. The main treasure in the *Sammelband* is the only surviving copy of possibly the most important map ever published, Martin Waldseemüller's 1507 map of the world (*Universalis cosmographiae*). It was the first map to show the Pacific Ocean and to use the term "America."

The 1507 Waldseemüller map (Library of Congress)

It should not be surprising that cartography and geography were important at the beginning of the 16th century. Just as the conquests of Rome enlarged its world, the "discovery" of America in 1492 and the rounding of Cape of Good Hope in 1497 expanded the Renaissance world. Oceanic trade (and conquest) demanded accurate specification of the previously unknown parts of the Earth's surface.

The first terrestrial globe,[2] called the *Erdapfel* (Earth Apple) was made in 1492 by Martin Behaim for the city of Nuremberg, where it still resides in the German National Museum. Hand-painted, it does not include the continents of North or South America, not surprising since Columbus had not yet returned from his first voyage when the globe was presented to the Nuremberg town fathers. Schöner must have seen this globe. In 1515, he made a terrestrial globe based on Waldseemüller's 1507 map, two examples of which survive. He used woodcut-printed "gores," sector-shaped strips 30 degrees wide extending from pole to pole, pasting them onto a wooden sphere. He later published a book about globe-making. Several of Schöner's terrestrial map gores were bound in the covers of the *Sammelband;* they have since been removed and put in mountings.

Schöner also made a celestial globe in 1515 using the figures in Albrecht Dürer's printed map of the same year.[3] Images of both hemispheres can be seen in the May 2020 SkyWAAtch, page 14. He must have gotten these maps right off the press. Dürer was a Nuremberger and was famous throughout Europe by 1515. We know about this celestial globe from a letter written by Lorenz Beheim (no relation to Martin Behaim), a Bamberger who bought a celestial globe from Schöner for two and a half guilders for astrological use. Perhaps a stimulus for this purchase was that Beheim was a friend of Dürer.

Johann Schöner's 1515 terrestrial globe, in the Historical Museum of Frankfurt.

Schöner bound Dürer's southern hemisphere celestial map into the *Sammelband*. Fragments of gores from the celestial globe were also bound into the volume's covers, just like the terrestrial map gores. The two printed Schöner celestial globes that currently exist date from 1532. Schöner's globes must have been popular. A pair of them appears in Hans Holbein the

[2] While there are instructions in Ptolemy for making globes, no ancient globes have ever been found. The earliest Arabic celestial globe dates from 1085, but there are no Arabic terrestrial globes prior to the 16th century.

[3] The first printed celestial map, it was in ecliptic projection and "God's eye" view, so designed for a celestial globe. A pair of hand-colored Dürer maps, one of three in existence, was sold at auction at Sotheby's in 2011 for £361,250.

Younger's most famous painting, *The Ambassadors* (National Gallery, London), a work from 1533.

Hans Holbein the Younger's *The Ambassadors*, a portrait of two French diplomats at the court of the English King Henry VIII. The distorted figure at the bottom is a skull in anamorphic projection.

Detail: Schöner's celestial (L) and terrestrial globes (R).

While busy writing, editing, globe-making and horoscope-casting, Schöner was also teaching. One of his students in the 1530s was Georg Joachim de Porris, better known as Rheticus. Like Schöner and Copernicus, he was broadly educated, with expertise in mathematics, medicine, instrument-making, astronomy, astrology and cartography. Although he started out in medical practice, he was brought by Melanchthon to the University of Wittenberg, where he received his M.A. degree in 1536. He was immediately appointed to a professorship in mathematics, arithmetic and astronomy. Two years later, Melanchthon granted him a sabbatical, which may have had something to do with Rheticus' homosexuality. He went to study with Schöner in Nuremberg . This was a fateful connection for astronomy.

Schöner was familiar with Copernicus' theory. We know they corresponded, because Schöner sent Copernicus observations of Mercury made before 1504 by another Nuremberg astronomer, Bernhard Walther, who had bought Regiomontanus' instruments after the latter's death. Copernicus used three of the 41 observations in *De Revolutionibus*.[4] There is no evidence that the *Commentariolus* manuscript circulated in astronomy circles, but over the next 20 years. Copernicus had several opportunities to be heard. Just after he finished *De Revolutionibus* in 1530, he wrote to Pope Paul III commenting that calendar reform, a big issue for the Church because of the date of Easter, which depended on the accurate determination of the equinox, could not be accurately established unless the motions of the Sun and Moon were properly understood. We do know that in 1533 Johann Albrecht Widmannstetter, secretary to Pope Paul III, presented the theory to the pontiff, who approved of it and requested that Copernicus publish. He didn't. On November 1, 1536, Cardinal Nicolaus Schoenberg, another of Pope Paul III's advisors, wrote to Copernicus begging him "most emphatically to communicate your discovery to the learned world." Both Martin Luther and Philip Melanchthon made disparaging comments about Copernicus' theory in the early 1530s, arguing that heliocentrism is against scripture, although Melanchthon didn't object to the mathematics. It is rather remarkable that one hundred years later the Catholic Church, which seemed willing to consider the proposition in the 1530s, determined heliocentrism to be heretical,[5] while Galileo and Kepler were widely read in Protestant Europe.

So the theory was being circulated, yet Copernicus was reluctant to publish. The reasons are still debated. What role did the shifting sectarian allegiances in Germany and Poland play during the two and a half decades after Martin Luther nailed the *Ninety-Five Theses* to the door of the All Saints' Church in Wittenberg on October 31, 1517? Did Copernicus

[4] Mistakenly attributing them directly to Schöner.

[5] *De Revolutionibus* was placed on the *Index of Forbidden Books* in 1616, at the time of Galileo's first trial.

perhaps think that if the Protestants ended up supporting the theory the Catholic Church would turn against him in spite of the Pope's evident support? Was he perhaps not totally sure of his own ideas, theorems and calculations?

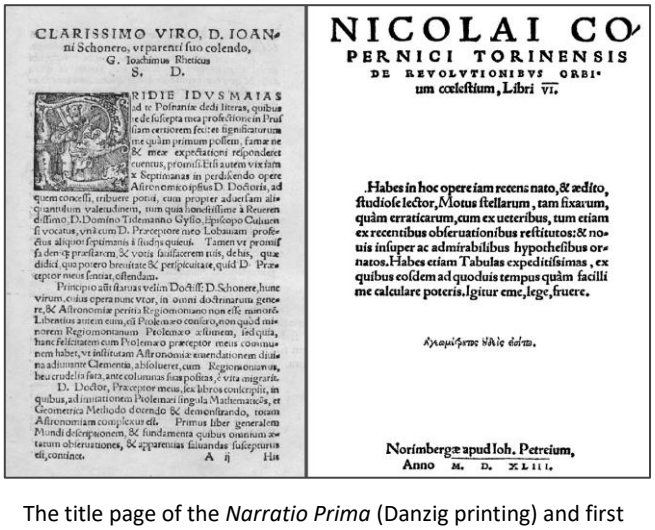
I would have thought that that the percolation of new ideas in 16th century Europe would be slow, even after the advent of printing, but that doesn't seem to be the case. Presses exploded across Europe. Printed materials circulated quickly and there must have been a rich and rapid exchange of perspectives. Arthur Koestler, in *The Sleepwalkers*, writes,

> News travelled fast and far in the sixteenth century. The pulse of all humanity was quickening as if our planet, after traversing, on its journey through space, somehow somnolent and bemused zone of the Universe, were now emerging into a region bathed in vivifying rays, or filled with cosmic benzadrine in the interstellar dust. It seemed to act on the higher as well as on the lower centres, as a stimulant and aphrodisiac, manifesting itself as a thirst of the spirit, an itch of the brain, a hunger of the senses, a toxic release of passions. The human glands seemed to produce a new hormone which caused the sudden surge of a novel greed: curiosity—the innocent, lecherous, creative, destructive, cannibalistic curiosity of the child.
>
> The new machines —type foundry and printing press— ministered to this devouring curiosity by a flood of broadsheets, news letters *(sic)*, almanacs, *libellea*,[6] pasquils,[7] pamphlets and books. They spread the news at a hitherto unknown speed, increased the range of human communication, broke down isolation. The broadsheets and brochures were not necessarily read by all the people on whom they exercised their influence; rather, each printed word of information acted like a pebble dropped into a pond, spreading its ripples of rumour and hearsay.

Schöner, clearly intrigued by what he heard about Copernicus' theories, sent Rheticus to Copernicus in the spring of 1539. As the crow flies, Nuremberg, in Bavaria, and Frombork, in northern Poland, are 500 miles apart; Copernicus was on the outskirts of intellectual Europe (reminding me of the location of the planet Terminus in Isaac Asimov's *Foundation*). In his first ten weeks with Copernicus, Rheticus studied the manuscript of *De Revolutionibus*, and he summarized its contents in the *De libris revolutionum Copernici narratio prima*, called the First Account. The *Narratio Prima* is in the form of a (long) letter to Schöner. It was published in Danzig in 1540 and Basel in 1541.

It begins "To the illustrious Johann Schöner, as to his own revered father, G. Joachim Rheticus sends his greetings." Rheticus calls Copernicus "my teacher."

> I wish you to be convinced, most learned Schöner, that this man whose work I am now treating is in every field of knowledge and in mastery of astronomy not inferior to Regiomontanus. I rather compare him with Ptolemy, not because I consider Regiomontanus inferior to Ptolemy, but because my teacher shares with Ptolemy the good fortune of completing, with the aid of divine kindness, the reconstruction of astronomy which he began, while Regiomontanus—alas, cruel fate—departed this life before he had time to erect his columns….My teacher has written a work of six books in which, in imitation of Ptolemy, he has embraced the whole of astronomy, stating and proving individual propositions mathematically and by the geometrical method.



CLARISSIMO VIRO, D. IOANni Schonero, vt parenti suo colendo, G. Ioachimus Rheticus S. D.

RIDIE IDVS MAIAS

NICOLAI COPERNICI TORINENSIS DE REVOLVTIONIBVS ORBIum cœlestium, Libri VI.

Habes in hoc opere iam recens nato, & ædito, studiose lector, Motus stellarum, tam fixarum, quàm erraticarum, cum ex veteribus, tum etiam ex recentibus obseruationibus restitutos: & nouis insuper ac admirabilibus hypothesibus ornatos. Habes etiam Tabulas expeditissimas, ex quibus eosdem ad quoduis tempus quàm facillime calculare poteris. Igitur eme, lege, fruere.

Norimbergæ apud Ioh. Petreium, Anno M. D. XLIII.

The title page of the *Narratio Prima* (Danzig printing) and first edition of De Revolutionibus (Nuremberg)

After those fateful 10 weeks and the composition of of the *Narratio Prima*, Rheticus stayed with Copernicus for another two years, during which time he published several of his own works. The *Narratio Prima* was well received in scientific circles. After what must have been continual prodding by Rheticus, Copernicus agreed to publish the full text of *De Revolutionibus*. Rheticus was called back to the University of Wittenberg in 1541, and was elected Dean of the Faculty of Arts. He brought the manuscript of *De Revolutionibus* to Johannes Petreius in Nuremberg in May 1542. The printing was initially

[6] Literally "little books." Perhaps similar to the cutesy volumes about kittens or puppies you see at a bookstore counter while waiting to pay.

[7] Satirical verses, named for Pasquillis, a fictional author of such poems.

under Rheticus' supervision, but he accepted a position at the University of Leipzig in October 1542[8] and left the oversight to Andreas Osiander, a Lutheran theologian who was also interested in astronomy. Osiander took it upon himself to write a preface without indicating his authorship. It argued that the heliocentric arrangement of the solar system was merely intended as a mathematical device and that the author was not really claiming that the Earth was not the center of the universe (thus not contradicting the implications of Scripture). The preface says,

> Since [an astronomer] cannot in any way attain to the true causes, he will adopt whatever suppositions enable the motions to be computed correctly from the principles of geometry for the future as well as for the past…. So far as hypotheses are concerned, let no one expect anything certain from astronomy, which cannot furnish it, lest he accept as the truth ideas conceived for another purpose, and depart from this study a greater fool than when he entered it.

Without attribution to another author, the preface was naturally assumed to be by Copernicus, until none other than Johann Kepler, reviewing Osiander's letters in the first decade of the 17th century, realized that Copernicus was not the author. Copernicus is said to have only seen (maybe only touched) the printed *De Revolutionibus* on his deathbed, barely conscious and possibly blind after a stroke, but there is also evidence in a 1609 letter by mathematician Johannes Praetorius, who was an acquaintance of Rheticus, that Copernicus had indeed read the preface while *compos mentis* and was unhappy about it.

Perhaps the biggest mystery is why Rheticus did not ask Schöner rather than Osiander to supervise the publication. Had that happened, the preface might have said something completely different. Koestler argues that Rheticus actually had washed his hands of *De Revolutionibus* by late 1542 because he took offense that he was not mentioned anywhere in the book. Copernicus dedicated the work to Pope Paul III, and in the dedication credited his friend and mentor Tiedemann Giese, the Bishop of Kulm, with convincing him to publish. Giese, Rheticus and Copernicus had spent time together during the two years of Rheticus' sojourn in Poland. After publication (thus after Copernicus' death), Giese wrote a letter of apology to Rheticus, calling the omission "an unpleasant oversight." Koestler suggests that mentioning a Protestant in a dedication to the Pope would not have been well-received. Rheticus wrote a biography of Copernicus, but it was never published and the manuscript was lost. It was a sad conclusion to their relationship, but history, as it usually does, puts things in perspective.

Were it not for Schöner, Rheticus would not have been in Frombork to nag Copernicus to publish *De Revolutionibus*, and humanity would have had to wait, for who knows how long, until the universe was put in proper order. Johann Schöner is an important but underappreciated character in scientific history. His decision to send Rheticus to Copernicus was a critical step in the birth of heliocentrism. And he's also the man behind modern globe-making.

Some recommended sources:

Arthur Koestler, *The Sleepwalkers* (1959). A monumental study of the history of astronomy with particular focus on how Copernicus, Kepler and Galileo made their breakthroughs. Scholarly, thorough, provocative, full of rich and surprising detail. I think it's one of the greatest works of astronomy history ever written.

Dava Sobel, *A More Perfect Heaven* (2011). The intertwined lives of Copernicus and Rheticus, telling the story as text and as a two act play. (Before becoming a science writer, Sobel studied playwriting.)

John Freely, *Before Galileo* (2012). The history of astronomy and physics from the time of the Greeks to Newton, with particular emphasis on Arabic, Byzantine and Medieval sources.

John W. Hessler, *A Renaissance Globemaker's Toolbox* (2013). A lavishly illustrated exploration of Schöner's *Sammelband* and his works on astrology. Published by the Library of Congress.

Owen Gingerich, *The Book Nobody Read* (2004). Harvard astronomy professor Gingerich tracked down every single extant copy of the first and second editions of *De Revolutionibus*, studying annotations and even pinholes in the figures to learn how astronomers received and used Copernicus' famously difficult text.

Nicolaus Copernicus, *On the Revolution of the Heavenly Spheres*, in Stephen Hawking, ed., *On the Shoulders of Giants* (2002). It's 381 difficult pages, but at least it's not in Latin. ■

[8] Although there is a strong possibility that the move was the result of another sexual indiscretion, it may have actually been for pecuniary reasons: Rheticus had negotiated a 40% salary increase at Leipzig.

Images by Members

The Iris Nebula by Steve Bellavia

The Iris Nebula (Caldwell 4, NGC 7023) is a bright reflection nebula in the constellation Cepheus. NGC 7023 actually designates the open cluster within the nebula, while the nebula itself is LBN 487 (LBN for Lynds Catalog of Bright Nebulae, a 1965 list of objects found on plates of the National Geographic-Palomar Observatory Sky Atlas). The gas is illuminated by radiation from the Herbig Ae/Be star star SAO 19158, spectral class B2Ve. Herbig stars are named after their discoverer, George Herbig, an astronomer at the University of Hawaii, who identified their unique properties in 1960. They are hot, young (less than 10 million years old) and are undergoing gravitational contraction while still embedded in their dusty nebulas. They are often surrounded by circumstellar disks. They weigh between two and eight solar masses. Herbig Ae/Be star emit a lot of radiation in the infrared, and display spectral lines of silicates, iron oxide, polycyclic aromatic hydrocarbons and crystalline water ice.

The red star near the upper left corner of the image is T Cephei, also catalogued as HD 202012. It is a class M6 Mira variable that ranges in magnitude from +5.3 to +11.3 over a period of 388.14 days. Distance 612 LY. The AAVSO web site reports that on the dates of this image (October 6 -7, 2021), the star was around magnitude 8.8.

NGC 7023 lies 1,300 light-years away and the reflection nebula spans six light years. The faint brownish areas throughout the image are photoluminescence from interstellar dust. Lynds Bright Nebula LBN 468, along with LBN 475 and 483, are larger areas of interstellar HII regions that straddle the constellations Cepheus and Draco.

Steve acquired this image at Cherry Springs State Park in Pennsylvania. Steve posted technical information and a full-size image at https://www.astrobin.com/iuio4g/.

More Experiments with a Monochrome Planetary Camera by John Paladini

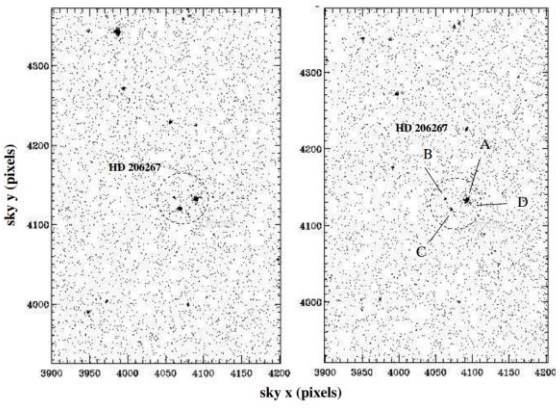
Last month we presented three images John made with a Celestron Comet Catcher 5-inch f/3.8 Schmidt-Cassegrain and ZWO ASI290MM "planetary" camera on a Meade LX-55 equatorial mount. John has been busy with this combination of equipment, shooting from his driveway in Mahopac. These are all unguided 28-30 second frames, a stack of ten for each image. Substantial detail can be seen in John's image of the Crab Nebula, M1 (upper left), as well as the Dumbbell, M27, both using a DGM dual-band filter (H-alpha and OIII). The image of the Horsehead Nebula in Orion is without a filter. The image shows NGC 2023, a hydrogen cloud surrounding the 7.8-magnitude star HD 37903. The Horsehead is formally catalogued as Barnard 33.

The Schmidt-Newtonian telescope

The Schmidt corrector cancels spherical aberration of the spherical primary. Coma, astigmatism and field curvature are all lower than a comparable Newtonian, which has a paraboloidal primary (a harder surface to figure). While the corrector is very forgiving to miscollimation, it does complicate adjusting the flat. Maksutov-Newtonian designs have also been made for the mass market.

The Elephant's Trunk by Jordan Webber

A favorite of astrophotographers, the HII region IC 1396 in Cepheus contains the sinuous Elephant's Trunk (IC 1396A) , a region of interstellar dust whose edges are enhanced by glowing hydrogen-alpha light. IC 1396A is located on the western edge of the open cluster Trumpler 37. Sicilia-Aguilar et. al. (*Astronomy & Astrophysics* 562: A131, 2014) found evidence that new star formation is still occurring within the Elephant's Trunk.



The shape is the results of the interaction of compressive radiation and stellar winds from the massive triple star system HD 206267 (the bright star above the tip of the Trunk, V mag. 5.7) counterpoised by stellar winds from new young stars within Trunk pushing gas outward. The forces meet and a sharp but sinuous boundary is formed. The stellar wind of HD 206267 has been measured at 3,225 km/s, among the highest velocities on record. The system has been described as "Trapezium-like," because three other hot stars in close proximity: B, C and D in this labeled image from Wojdowsky et. al., The Hot Star Triplet HD 206267A, 2002, at https://tinyurl.com/IC1396A.

Jordan used an Orion ED80 telescope, ZWO ASI1600MM PRO, guiding, 12x600 second subs, and flat, bias and dark frames. He attributes some of his success in making this fine image to a thermos of hot coffee.

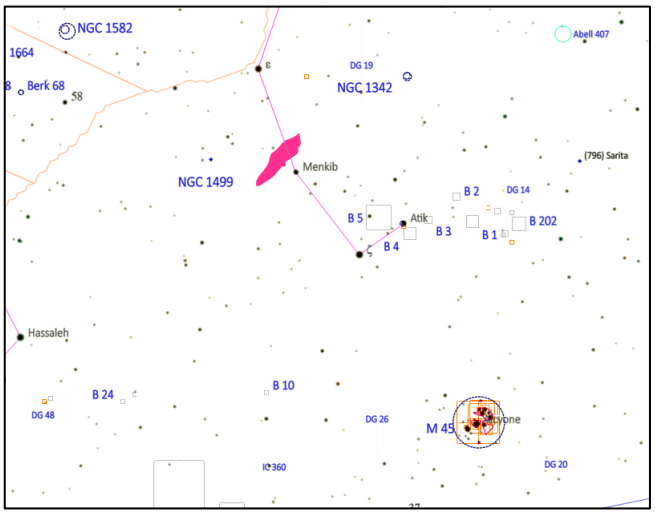
The Eagle Nebula (Messier 16) by Rick Bria

Rick made this image during a "Zoom Around the Galaxy" on-line observing session with students from the Sacred Heart School. He used a monochrome camera with a luminance filter on the 14-inch PlaneWave scope at the school's Mary Aloysius Hardey Observatory. Twenty-three 90-second exposures were live-stacked to make the image. Rick writes: "Normally I would guide for minute-long exposures. In this case, using live stacking, exposures were unguided. Transparency wasn't what it should be for a proper effort. The school's Zoom nights are by chosen by day of the week, not by quality of sky. I had to do some trickery to get the image where it is.

The Eagle Nebula has become a special favorite of imagers ever since the iconic Hubble "Pillars of Creation" image. In the *New General Catalogue* (1888) the object is identified as NGC 6611 with the notation "Cl, at least 100 st L & E" meaning, in J.L.E. Dreyer's abbreviation scheme, "Cluster, at least 100 stars, large and extended." However, the 1784 edition of Charles Messier's catalog described object #16 as *amas de petites étoiles, mélé d'une foible lumière... avec une foible lunette cet amas paroît sous la forme d'une nébuleuse* ("cluster of small stars, mixed with a weak light ... with a weak [low-power] telescope this cluster appears in the form of a nebula.") This suggests that Messier may well have glimpsed the glowing gas. Did Dreyer assume everyone knew about the nebulosity, so he only noted the prominent cluster in his listing of NGC 6611? Did he intend his cryptic "L & E" to apply to the interstellar gas making up the Eagle's body and wings? Or was he not convinced about the nebulosity? Dreyer gave dual NGC numbers to other nebula/cluster combinations, such as the Lagoon (cluster NGC 6530, nebula NGC 6523), but he waited to list the Eagle's nebulosity in the later *Index Catalog* (1908) as IC 4703. It is described as "B, eL, Cl M16 inv" meaning "bright, extremely large, cluster M16 involved."

There are actually over eight thousand stars in M16's cluster, which is just 1-2 million years old.

The California Nebula by Tony Bonaviso

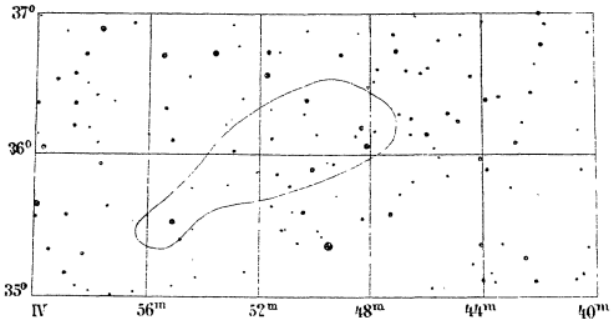


Ostensibly resembling the state of California (although to your Editor looking more like a California wildfire), NGC 1499 in Perseus is a very large HII region some 2.5 degrees in extent. Its low surface brightness makes it a difficult visual object. The hydrogen is excited by radiation from ξ (Xi) Persei (Menkib), a 4th-magnitude blue giant O7 star 1,200 light years from us. Menkib is the bright star above the nebula.

The name Menkib derives from the Arabic for "shoulder of the Pleiades." The California Nebula is just 13 degrees north of the cluster. Menkib is one of the hottest stars that can be seen with the naked eye, with a surface temperature of around 35,000 K.

The nebula was discovered on November 3, 1885 by Edward Emerson Barnard with the 6-inch Cooke equatorial telescope at Vanderbilt University Observatory in Nashville, Tennessee. The first edition of the New General Catalog (1888) credits Barnard as the discoverer. Barnard published a photograph of NGC 1499 in the December 1895 issue of the *Astrophysical Journal*, commenting on a report by the German astronomer Friedrich Simon Archenhold, who photographed the nebula and mapped its outline in 1892. Archenhold later built the *Großer*

Refraktor (Great Refractor) a 26.77-inch diameter f/30.9 telescope that's the world's longest refractor. Also called the *Himmelskanone* (Celestial Cannon) it's still in place in Berlin in the observatory/museum that bears his name (read about it in the August 2018 SkyWAAtch).



Archenhold's map of NGC 1499 (Archenhold, F.S., Ein ausgedehnter [extensive] nebel bei ξ Persei, *Astronomische Nachrichten*, 1892; 129, 153-158)

Barnard made his image at Lick Observatory with a six-inch portrait lens on the night of September 21, 1895. The exposure was six hours (a single manually-guided frame, no stacking in those days!).

Barnard's image of NGC 1499. East is up, north to the right.

Barnard remarks,

> It will be seen from the photograph that this is a very remarkable nebula. There are a number of angular condensations in it—especially in the north preceding and north following edges. Indeed the outlines everywhere seem to be brighter and unequally condensed. In its northern part is a very small, very dark spot, about 6' in diameter—doubtless a hole in the nebula. It will be noticed that this object lies on the edge of a region comparatively devoid of small stars. This is a very suggestive fact noticeable in the case of most of these large diffused nebulae, as shown in photographs of the large nebulous regions of Cygnus, Monoceros, Cepheus, Scorpio and the present one of Perseus, where the nebulosity either lies in or on the edges of a vacancy among the stars.[1]

The "hole" in the nebula is easily seen in Tony's excellent image, so it's not a dust mote contaminating Barnard's photograph.

By 1895, Barnard was associated with the Kenwood Observatory in Chicago, which started out life in 1890 as George Ellery Hale's home observatory, a college graduation gift from his wealthy father, complete with a Warner & Swasey 12" refractor. It was acquired by the newly-established (1892) University of Chicago to create their astronomy department. Hale was appointed professor of astronomy as part of the deal, and shortly thereafter built Yerkes Observatory in Williams Bay, Wisconsin, with which Barnard was associated for the remainder of his life (for a tour of Yerkes, see the September 2018 SkyWAAtch).

E.E. Barnard is primarily remembered today for his catalog of dark nebulas, first published in 1919 with 182 objects.[2] It has since been expanded to 369 dark regions. He also discovered "Barnard's Star," a red dwarf that is the fourth-closest star to the Sun and closest in the northern hemisphere. It has the largest proper motion of any star (10.3 arcseconds/year). He discovered 17 comets. His bibliography on the NASA ADS site returns 744 articles, observing reports and commentaries. Barnard was surely one of the most prolific observers of all time. LF■

[1] Barnard, E.E., Photograph of the Nebula N. G. C. 1499 near the Star ξ Persei., *Astrophysical Journal*, 2: 350 (1895)
[2] https://is.gd/barnard1919

The Moon and Venus in the gloaming on November 6 at Ward Pound Ridge Reservation, a nice way we started the final star party of 2021. **Larry Faltz** made this image with a hand-held iPhone 12 at 6:13 p.m. EDT, 30 minutes after sunset. The crescent moon was just 6% illuminated and 8.2 degrees above the western horizon. Venus was 14 degrees above the horizon, shining at -4.5 magnitude, nearly bright as it ever gets. Its disc was 27.8 arcseconds in diameter, 45% illuminated. Venus' maximum brightness is magnitude -4.7.

Steve Bellavia took this photograph in Mattituck, Long Island on November 8. The 21% illuminated Moon has moved past Venus and is now east of the planet, which is just above the tree line on the right. Canon DSLR.

A telephoto image of the Moon on October 24, also by **Steve Bellavia**.

Research Highlight of the Month

Mangold, N, Gupta, S., Gasnault, O, et. al., Perseverance rover reveals an ancient delta-lake system and flood deposits at Jezero crater, Mars, Science 374:711-717, November 6, 2021

Jezero crater was selected as the landing site for the Perseverance rover (originally called Mars2020) because images from orbiters showed that it had a fan-shaped formation that looked like a river delta. This would make it a likely place to find more evidence that water was once present in that area.

Analysis of the first images returned from Perseverance show inclined rock outcrops consistent with river deltas that fed into a lake. The top-most strata feature boulders that are apparently due to periodic flooding.

The authors identify boulders that would be most likely to have information about the geologic and hydrologic history of Mars that could be collected by Perseverance's sampling technology. The fine-grained bottom strata, also likely to be collected, "have high potential to preserve organic matter or potential biosignatures."

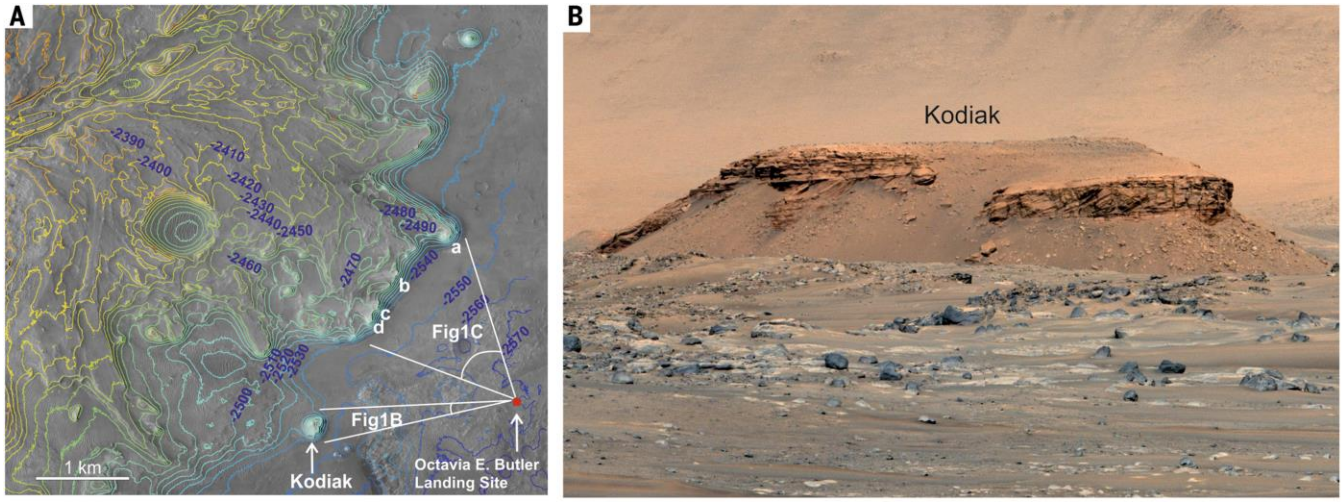


Fig 1 (A&B) showing Jezera Crater and Kodiak butte, the feature that was studied in detail.

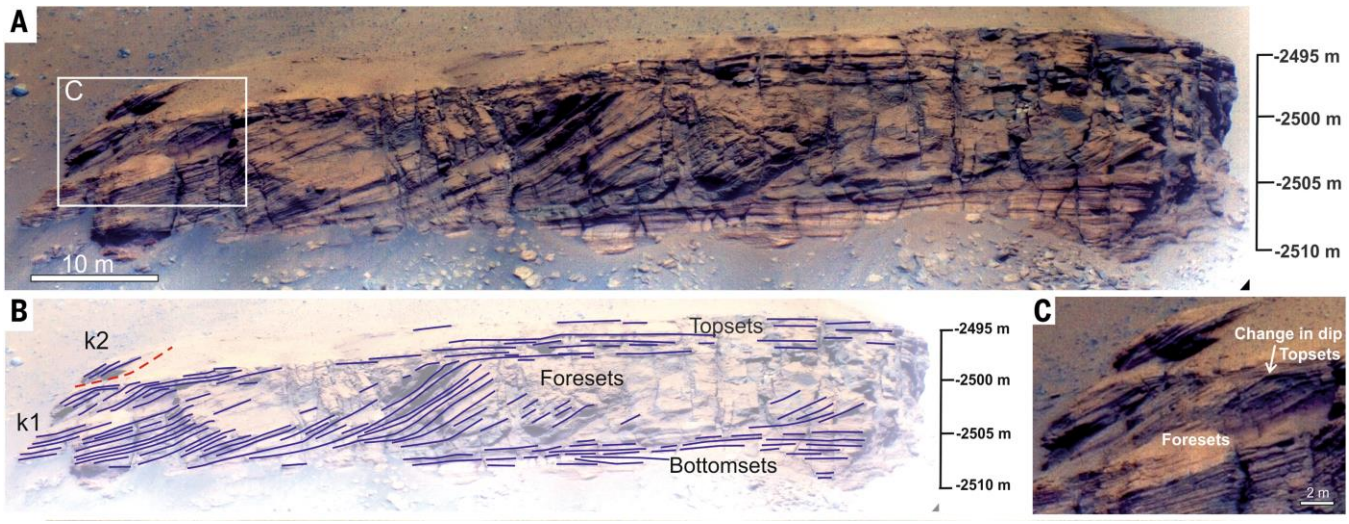


Fig. 2 (A-C) showing right-hand scarp of Kodiak butte. B shows the visible rock strata.

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
NEW LISTING Stellarvue 90-mm triplet refractor	90 mm f/7 triplet refractor, aluminum tube, 2½-inch Stellarvue focuser, clam shell mounting ring with standard Vixen dovetail, soft case. Excellent condition.	$400	Thomas Boustead bousteadtom@gmail.com
NEW LISTING Meade 390 refractor	90-mm f/11 doublet refractor in very good condition with several eyepieces, Barlow, aluminum tripod, accessory tray, straight-through finder. The alt-az mount head is very solid. An image of the mount head is here. Proprietary Meade interface between tube rings and mount (two thumb screws). Slow-motions with flexible stalks. A few minor blemishes on the tube. A great lunar/planetary scope.	$100	WAA ads@westchesterastronomers.org
Celestron CPC 800	8-inch f/10 SCT, complete with tripod, Telrad finder, dew shield and power supply. Like new. Updated to latest firmware. Align on two stars and you're good to go.	$750	David Parmet david@parmet.net
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
75-mm Tube Rings	Pair of 75-mm inside diameter rings with 3-point nylon centering screws. Can accommodate tubes between 40 and 75 mm. On fine slotted 200 mm dovetail bar. Great for finder, guide scope, small camera lens. Photo https://is.gd/75mmrings.	$50	Larry Faltz lfaltzmd@gmail.com
Celestron X-Cel 5-mm eyepiece	60-degree field, 6 elements, fully coated. Retractable rubber eye guard. Excellent condition, unmarked. Lists at $99.95. Donated to WAA.	$40	WAA ads@westchesterastronomers.org
Laser Collimator	Orion LaserMate Deluxe II Telescope Laser Collimator (for Newtonian reflectors). Donated to WAA. It works. Uses CR2032 battery. Manual and instruction video on line on Orion's web site.	$35	WAA ads@westchesterastronomers.org

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

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