SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

2021 APEX® AWARDS FOR PUBLICATION EXCELLENCE

July 2022

Thor's Helmet by Olivier Prache

Ultraviolet radiation from the hot Wolf-Rayet star WR7 powers the emission nebula NGC 2359 in Canis Major. The star is visible as the brightest point in the body of NGC 2359. It also has intense winds that stir up gas in the surrounding medium, accounting for the nebula's complex shape.

Thor's Helmet (which looks to your editor more like a snail) lies almost 12,000 light years away.

Olivier made this image in February with a Celestron RASA-8 telescope. See Olivier's article on this imaging telescope in the October 2021 SkyWAAtch.

WAA July Meeting

Friday, July 8 at 7:30 pm

David Pecker Conference Room
Willcox Hall,
Pace University, Pleasantville, NY

Or on-line via Zoom

Make Plans Now to Observe the 2023 Annular Eclipse!

Charles Fulco
NASA Solar System Ambassador

The next major solar eclipse to cross the U.S. is little more than a year away. If you want to be in the path of annularity, Charles will show you how to start making your plans now. He'll also describe terrestrial landmarks along the path that can enhance your photos.

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

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

Also In This Issue

WAA September Meeting

Friday, September 16 at 7:30 pm

David Pecker Conference Room
Willcox Hall,
Pace University, Pleasantville, NY

Or via Zoom

Members' Night

WAA members are invited to give short presentations on subjects of astronomical interest to the membership: equipment, techniques, observations, trips, education experiences and research. An annual WAA tradition. If you'd like to present, contact Pat Mahon, at waa-programs@westchesterastronomers.org.

Starway to Heaven

Ward Pound Ridge Reservation,
Cross River, NY

Saturday, July 23 (Rain/cloud make-up date July 30)

Bring your own telescope or view through members' instruments.

Westchester
Amateur Astronomers

New Members

Pramod Agrawal	Bardonia
Ajay Royyuru	Yorktown Heights

Renewing Members

Brian Blaufeux	Larchmont
Anthony Bonaviso	New Rochelle
John DeCola	Mt Kisco
Michael DiLorenzo	Yonkers
Barry Feinberg	Croton on Hudson
Kim Hord	Dobbs Ferry
Daniel Intrilligator	Cortlandt Manor
Glen & Patricia Lalli	White Plains
Gene Lewis	Katonah
Anthony Monaco	Bronx
Richard Segal	Chappaqua
Michael Sheridan	Mt. Kisco
Pierre-Yves Sonke	Tarrytown
Ihor Szkolar	White Plains

Almanac For July 2022

Bob Kelly, WAA VP for Field Events


Bob Kelly


1Q July 6


Full July 13


3Q July 20


New July 28

Morning Planet Parade Progress

Mercury has been trailing along well behind the other bright planets in the morning sky parade. The innermost planet will be sliding back closer to the Sun in our skies, but brighten to magnitude -1.7 for the middle two weeks of the month. It'll be harder to find, as its elongation – its apparent distance from the Sun – drops to less than 10 degrees, but perhaps it will be easier to see once found.

Venus is starting its slow slide back into the solar glare, but actually moves its rise time back to the beginning of astronomical twilight this month. The last time it rose this far ahead of the Sun was in April. This will be the earliest rise until it disappears behind the Sun in the fall.

Mars continues to appear steadily larger and brighter, passing through magnitude +0.3 this month. Look for a reddish-tinted dot to the left of Jupiter.

Major planets slide into the pre-midnight sky

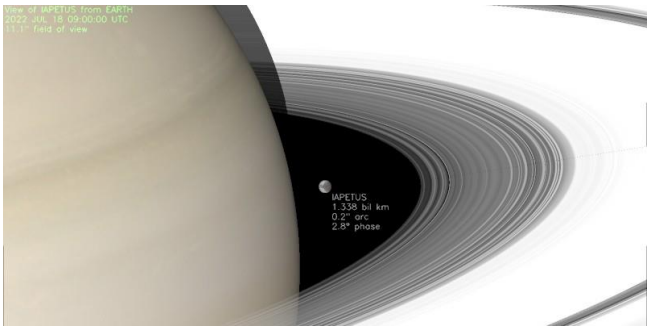
Jupiter gains membership in the evening sky club this month, rising at 11 p.m. Westchester time by the end of the month. Get a telescope on the planet to see the interactions of its four brightest moons. There will be a few shadow transits this month, but the planet is somewhat south on the ecliptic. This means you will have to observe those that are in progress just before dawn, which is around 6:45 a.m. on the 1st and 4:42 a.m. on the 31st. That's when Jupiter is higher and closer to meridian transit. The best one this month is probably a shadow transit of Io on the 15th starting at 2:50 a.m. and ending at 5:04 a.m., in morning twilight.

Saturn plays both sides of the celestial street all month, rising during evening twilight during July, and still up at dawn. It transits the meridian at 4 a.m. at the beginning of the month and 2 a.m. at the end.

Mercury joins the evening sky after mid-month. But it's barely above the horizon 30 minutes after sunset.

Saturn Gets Crossed

Iapetus crosses in front of Saturn's disc on the night of July 17/18. I would love to see it crossing Saturn's rings, but that happens in daylight. Christopher Go, planet photographer extraordinaire, caught a photo with the last transit in April, wondering aloud on Facebook what the white spot was in Saturn's atmosphere. This time, the timing of Iapetus crossing Saturn's disc favors our side of the world. I don't know how large a telescope we'll need to see tiny disk, since it's much smaller and twice as far away as Jupiter's moons.



Iapetus transit July 18, 2022 5:00 a.m. EDT. Don't expect to see it like this with a small telescope!

According to Solar System Simulator at https://space.jpl.nasa.gov/, some of Iapetus' dark terrain will be facing Earth during the transit, so the dark moon on the butterscotch-painted planet might be detectable. Get out your planetary cameras!

ISS Overflights

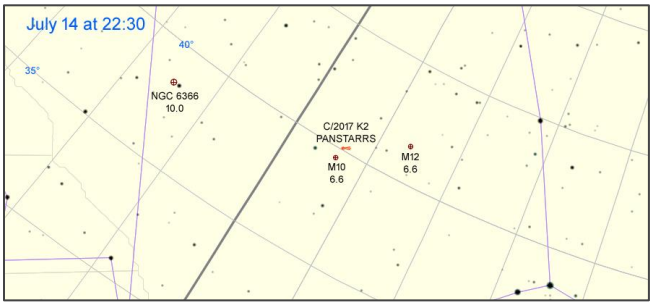
While it's all orbital mechanics and math, the many overflights of the **International Space Station** in July make it seem like the space station is making up for not being available very often in June. The month starts with ISS overflights visible after midnight. By the 11th, we are favored with overflights every 93 minutes all night long. By the 20th, most of the visible passes are before midnight.

It's a great month to see what you can catch with a camera of any kind, since the ISS often is as bright and as dazzling as Venus. I think catching all five passes on a given night is harder than the Messier

Marathon, since you can be tempted to nap between the overflights, which would really mess with my sleep cycles.

Comets

Did anyone catch **C/2017 K2 PANSTARRS** in Ophiuchus last month? The visitor traveled for millions of years to get here from its old perch 0.8 light years from the Sun. It's been seen from dark locations in binoculars. PANSTARRS should get a bit brighter than its present magnitude +9 at is comes closest to Earth, still quite far away at 167 million miles on the 14th, visible after twilight in the southern sky. On July 14th it will be close to globular cluster M2 in Ophiuchus.



Meteors

Normally, I'm not impressed by late July's **Delta Aquariids**. This year is notable because the **Moon** is a day after new, so it's thin and out of the way. This shower is better for those further south. Patient observers can catch up 10 to 15 meteors per hour from a dark site near the peak morning of the 30th.

Another Supermoon

On the 13th, the Moon is closest to the Earth for 2022, 9½ hours before full Moon at 2:37 p.m. EDT. Moonset is at 3:46 a.m., and rises again at 8:00 p.m. So, if you watch the Moon set early that morning, you'll see an almost-full Moon two hours before perigee. If you watch Moon rise that evening, it'll be 5½ hours after full Moon and 15 hours after perigee.

Earth's Aphelion

We are farthest from the Sun for the year at 3:11 a.m. on July 4th, 94,509,598 miles (152,098,454.48 km) away.

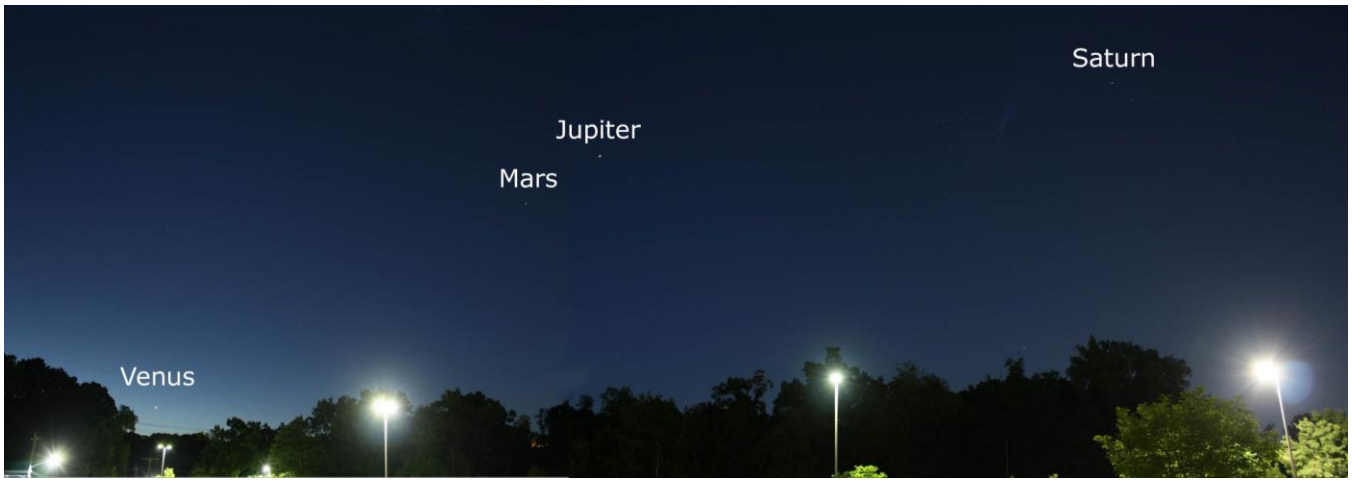
Manhattanhenge

Picturesque sunbeams will stream down the cross streets of Manhattan just before sunset through July 12th.

Unobservable Events Department

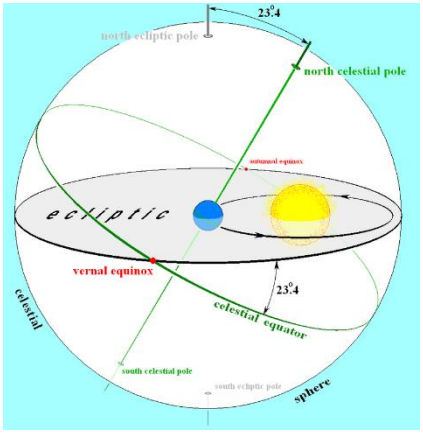
The Sun is in conjunction with the **Beehive Cluster** at the end of the month. Check the Solar & Heliospheric Observatory's C3 view at https://soho.nascom.nasa.gov/data/realtime-images.html to see for yourself.

Line-Up of the Planets in the Morning Sky, June 10, 2022, 4:20 a.m. EDT by Bob Kelly



June featured a remarkable alignment of the planets. On June 10th they were all within 92 degrees. Bob made a two-frame mosaic at the Ardsley Middle School (why do they need the lights at 4:20 a.m.?) with a tripod-mounted Canon XS, 18-mm lens, f/4, 6 seconds at ISO400. Mercury was on the horizon, so blocked by the trees at the left edge, and Uranus (near Venus) and Neptune (to the right of Jupiter) are too faint for the exposure. Magnitudes: Venus -3.9, Mars +0.6, Jupiter -2.3, Saturn +0.7.

Astronomy 101: The Ecliptic

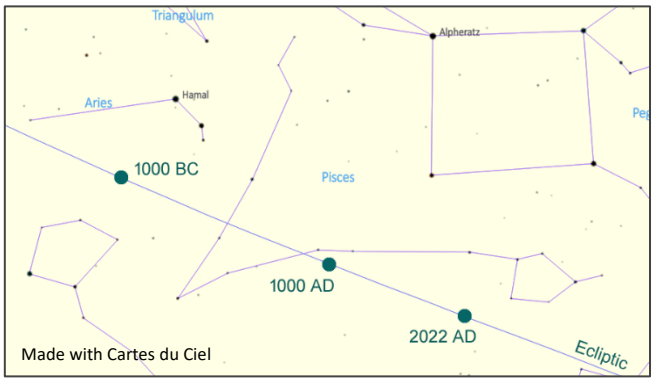


The ancient Sumerians and Babylonians knew that the Earth was round, and that even in the daytime the stars were still out there, far more distant than the Sun or the planets. They could plot which constellations were in the heavens behind the Sun, even if they couldn't see them, because they knew that six months later the Sun would be on the opposite side of the sky. The ecliptic is the path the Sun takes through the constellations in one year (even though, of course, it is the Earth that's moving). The dozen constellations through which the Sun travels are familiar to us as the Zodiac. The ecliptic is named for the phenomenon that lunar and solar eclipses can only occur when the Moon crosses it (so Sun-Moon-Earth form a *syzygy*).

Orbital Inclinations	
Mercury	7.01°
Venus	3.39°
Earth	0
Mars	1.85°
Jupiter	1.31°
Saturn	2.49°
Uranus	0.77°
Neptune	1.77°
Pluto	17.14°
Ceres	10.59°
Pallas	34.83°

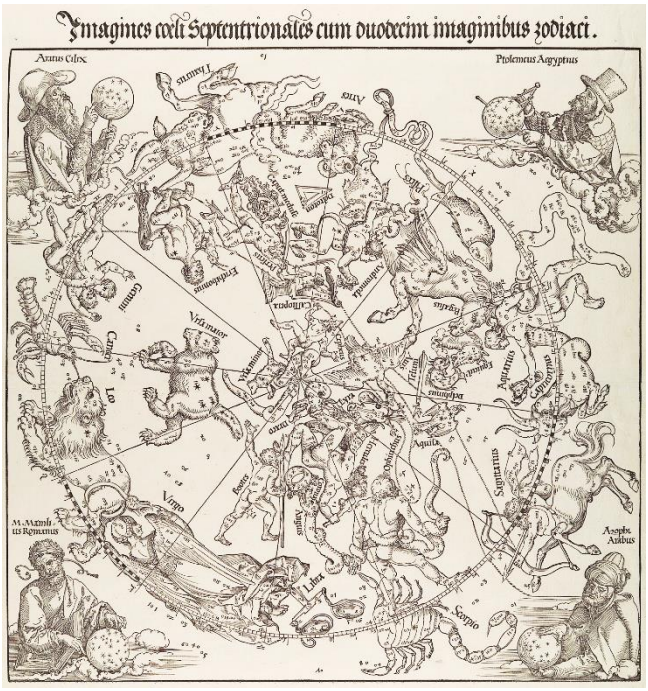
The ecliptic is the plane of the Earth's orbit around the Sun. All the planets orbit within a few degrees, because the solar system formed from a rotating disk of gas and dust. Mercury has the greatest orbital tilt. Because of these inclinations, as they travel through the constellations of the Zodiac the planets' paths vary slightly above or below the ecliptic. Many minor planets have more oblique orbits.

On June 9th the Earth's axis was tilted 23.43636 degrees to the Ecliptic pole, the point in space orthogonal to the center of the ecliptic. Due to precession, the slow gyration of the Earth's axis relative to the stars, the tilt is narrowing at a rate of 47 arc seconds per 100 years. This angulation is what gives us the seasons. The Sun crosses the ecliptic on March 21st, the vernal equinox. This point in the sky is labeled the "First Point of Aries." It is the origin of celestial coordinates (0 hours right ascension, 0 degrees declination). In antiquity, it was in the constellation Aries, but precession has moved it into Pisces. On the autumnal equinox, the Sun crosses again at "the First Point of Libra," which is now in Virgo.



The location of the "First Point of Aries" over the past 3,000 years

Many early celestial maps and globes were plotted with ecliptic coordinates, placing the ecliptic pole at the center of each celestial hemisphere. This reflects the importance of the Zodiac and the intimate historical and functional links between astronomy and astrology that only loosened in the mid-17th century after three thousand conjugal years.■



Albrecht Dürer's celestial map, 1515 (Met Museum)

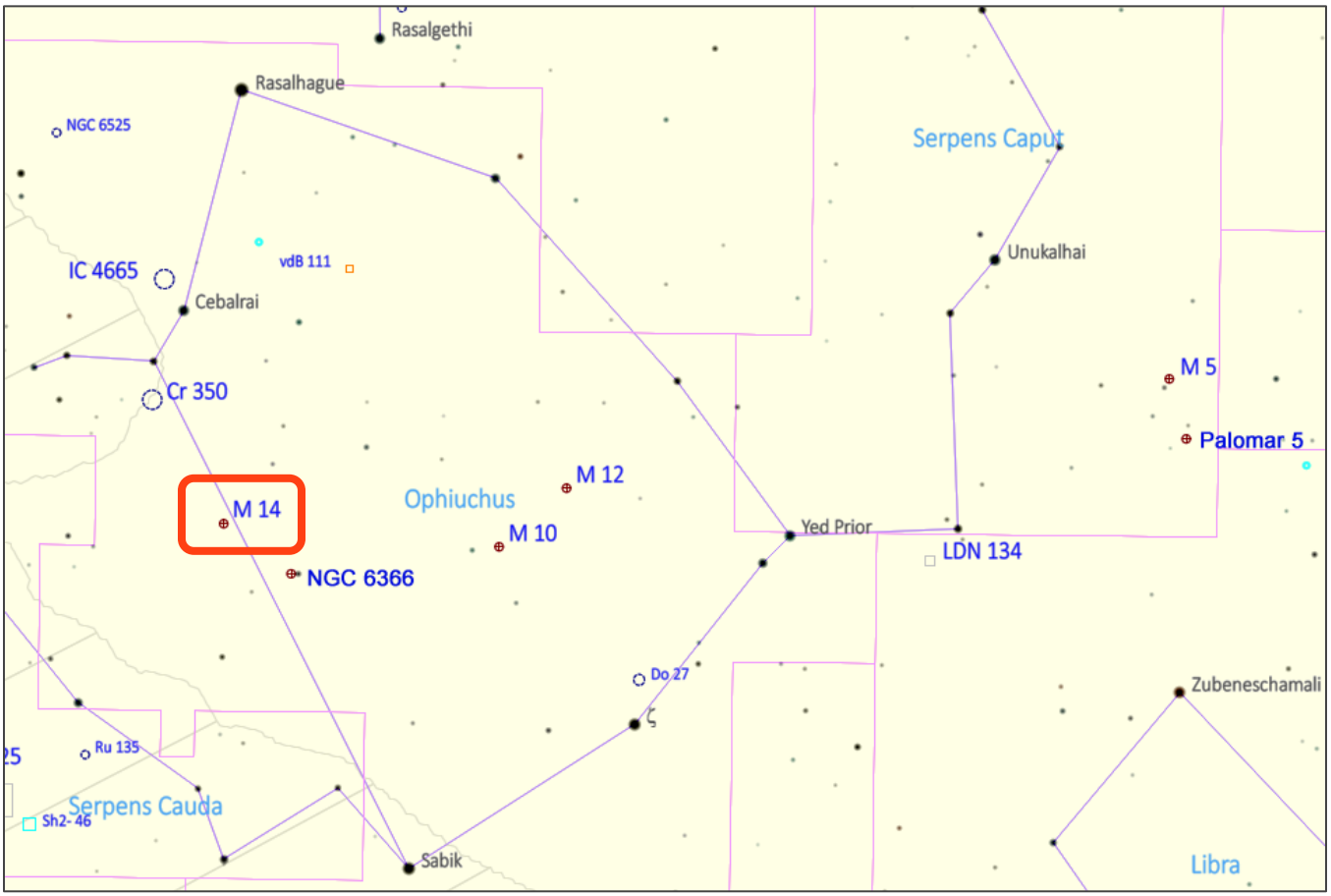
Deep Sky Object of the Month: Messier 14

Messier 14	
Constellation	Ophiuchus
Object type	Globular cluster
Right Ascension J2000	17h 37m 36s
Declination J2000	-03 14m 45s
Magnitude	7.6
Size	11 arcminutes
Distance	30,300 light years
NGC designation	6402
Discovery	Charles Messier, 1764

There are several lovely globular clusters in Ophiuchus within the reach of moderate-sized amateur telescopes. M10 and M12 are the most commonly viewed, but don't overlook this gem. M14 is composed of several hundred thousand stars, the brightest of which is just magnitude +14, but the whole cluster is bright enough to be a binocular object. If you are using a reasonably-sized telescope, also look for the fainter nearby cluster NGC 6366 (mag 9.5).

Visibility for M14			
10:00 pm EDT	7/1/22	7/15/22	7/31/22
Altitude	38° 37'	43° 36'	45° 28'
Azimuth	142° 52'	159° 57'	181° 57'

Not far away, in Serpens Caput, are bright M5 and the fainter Palomar 5 (mag 11.8).



Another Movie Telescope

We've seen plenty movies with telescopes, but so far the 1949 romantic comedy *A Kiss in the Dark* is the only one that shows a mirror being figured. The film stars David Niven and Jane Wyman and was directed by Delmer Daves. Niven plays a world-renowned but high-strung concert pianist whose manager buys him an apartment building in Morningside Heights as an investment, without telling him. He reluctantly goes to inspect the building and meets the manager, Mr. Willoughby, played by the kindly but bumbling Victor Moore. One of the first tenants they encounter is young Willie. Here's the scene's dialogue:

Willie: Hello Mr. Willoughby.
Willoughby: Well, hello, Willie. This is Mr. Phillips, Willie.
Willie: I'm polishing a reflector *(sic)* for a six-inch telescope with a focal length of 40 inches. An ellipsoid parabolized to 97% correction.
Phillips: That must be fine. [Niven's quizzical expression is priceless.]
Willie: I can also give the distance in light years between Earth and Arcturus, Vega, Polaris and Altair.
Willoughby: That's fine, Willie. I'm sure you'll be finished within eight or nine months. [Willie leaves.]
Willoughby: This will be the only apartment building in Morningside Heights that has its own observatory for the tenants.

The film has a poignant scene with Maria Ouspenskaya as Niven's old piano teacher. It was her last film role.■

My Vacation on the Moon — Bob Kelly

The BBC Sky at Night asked people on Facebook to describe a vacation at a future Moon Base. In fifteen minutes, I wrote out some highlights of my wonderful lunar vacation. So, here goes a somewhat expanded version, written on my way home from the Moon.

I'm on my way back from my vacation at a lunar outpost. I'm old enough to remember the excitement of the Moon missions of the 1960s and 70s, so I was afraid I would age-out before I could take this trip.

My wife and I love to travel together, but she didn't think an airless, dusty Moon would be an exciting destination. I decided to pump up the fun by taking the grandkids! Three days in a car seat on the way to the Moon is a bit tough for the young ones. But lots of time floating about in zero gravity more than made up for it.

We landed at the new lunar base at Shackleton Crater near the Moon's South Pole. This way, we didn't have to bring our own water.

Our first excursion was to Hadley Rille for the towering, scenic mountains and the deep, sinuous rille valley made by flowing lava several billion years ago. Looking across the rille, we could see the lunar module decent stage, the lunar rover and other equipment left behind by the Apollo 15 mission. The lunar parks have a very strict 'look, but don't touch' policy, so we couldn't get any closer. But seeing the footprints and wheel tracks left behind by those early explorers was fantastic.

Another trip was to nearby Tycho Crater, to the Surveyor 7 landing site. Surveyor 7 was the last of the USA's uncrewed landers before Apollo. We each took selfies with the lander. Mine matches the selfie I took in the reflection of the camera's mirror using an engineering model of the Surveyor spacecraft long ago at the National Air and Space Museum.

Tycho's crater walls and the central peak are fantastic from this site. You can see this crater from earth, especially at full Moon when its rays stretch out across the moon's disk. We could pick out large boulders atop the central peak, so tiny from our vantage point, looking like some toddler dropped their blocks atop the peak.

One of our fellow passengers brought a vintage lunar rover, all folded up in their luggage, like the version packed in the descent stage of the lunar module. I took turns with each of the grandkids, driving the rover in a dedicated area in a nearby crater, the ultimate off-road experience.

Wallace and Gromit vacationing on the Moon in Nick Parks's stop-motion short *A Grand Day Out* (Aardman Animation, 1989). The Moon is revealed to be made of Wensleydale cheese, Wallace's favorite.

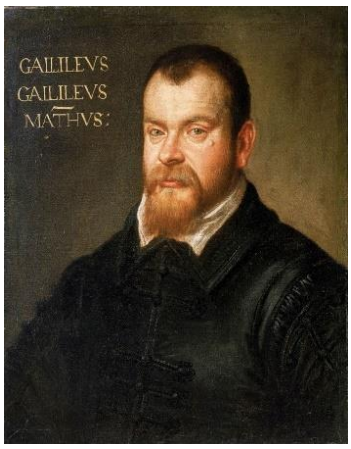
In the evening, we watched the swirling clouds of Planet Earth. A small spotting scope helped me give the best weather talks I've ever given as we discussed seeing the dynamics of the Blue Marble's atmosphere with our own eyes.

Nothing beats seeing it live!

I'll be back home in a few days! ■

In the Footsteps of Galileo: Part 1 — Rome

Larry Faltz



If you ask anyone for the name of the first astronomer that comes to mind, the odds are pretty good that they will say "Galileo." It's often overlooked that his interests extended far beyond the telescope. Scientifically, he was particularly fascinated by mechanics: he studied and quantified motion, inertia and acceleration, and he was first to conceive of relativity. In our focus on his celestial discoveries and his battle with the Roman Catholic Church we tend to forget, or may never have learned, how diverse were his talents. He was a mathematician, a teacher, an engineer, an inventor, an experimenter, a philosopher, a fine lute player, an artist, a wit, a literary critic, a playwright and a poet. He was said to be able to quote long passages from Dante's *Divine Comedy* and Ariosto's *Orlando Furioso* from memory. He even cast a few horoscopes (like almost everyone else interested in astronomy in those days, most notably Johannes Kepler). His often-irritable personality got him into more trouble than he expected. Much of his life can be tracked on an almost daily basis from extant civil and church records, his letters (although most of the ones in his possession were destroyed after his death) and those of others (particularly those from his daughter, which were saved), the observations of contemporaries and in his own books and pamphlets. All amateur astronomers encounter Galileo at the commencement of their interest in the subject. When he turned his telescope towards the sky in the fall of 1609, humanity made a huge leap, reluctantly in some quarters, but irreversibly.

Sky & Telescope's tour division put together a 9-day trip to Italy called "In the Footsteps of Galileo." It was originally scheduled for April 2021, but the Covid pandemic forced postponement for a year. Fully vaccinated and boosted, a supply of N-95 masks and Paxlovid in hand, we were eager to return to Italy, anticipating the special opportunities arranged by Kelly Beatty, the Senior Editor of S&T, who developed the astronomical part of the itinerary. Like all trips to Italy, history, art, food and wine were a substantial part of the syllabus.

Galileo was born in Pisa in 1564. He grew up and was educated in and near Florence, went back to Pisa to go to medical school but switched to mathematics, returned to Florence to teach, then accepted a mathematics position at Pisa. In 1591 he moved to Padua where he spent "the happiest eighteen years of my life." After learning to make telescopes a year after Lippershey claimed to have invented them, he made a trip to Venice[1] to market his new telescopes to the Doge, returned briefly to Padua, where he made his pioneering observations, and then went back to Florence, with intermittent trips to Rome, some successful, others harrowing. After the Inquisition found him "vehemently suspected of heresy" in 1633, he spent the rest of his life in a villa in Arcetri, just outside of Florence, where he died in 1642.

His biography has been written many times, first by his adoring student Viviani, whose *Vita di Galileo* was published in 1654, and then by many others. Among the more recent are Dava Sobel (*Galileo's Daughter*, 1999) and J. L. Heilbron (*Galileo*, 2010). The drama of Galileo's struggles with the Church dominate any survey of the great man's life.

Elyse and I had already been in Italy for a week by the time the tour began, spending three days in Umbria (Perugia, Assisi, Spello and Bagnoregio, with wine and chocolate tastings) and four days in and around Rome (visiting the ancient port city of Ostia, the Lateran and St. Paul Outside the Walls, revisiting the stunning Borghese Gallery, going out to Tivoli and the Villa D'Este, and catching a very fine performance of Bellini's opera *I Puritani*). Rome was packed with people luxuriating in the warm spring weather, making the most of the opportunity to escape from the confines of the pandemic. Covid-19 hit Italy particularly hard in 2020, with many weeks of total lockdown, vast disruption of the tourist economy and an overwhelmed health care system. We had been staying at a hotel near Santa Maria Maggiore, moving over to the tour hotel, just across the Tiber from the

[1] Padua was part of the Venetian Republic in those days. As the crow flies, the two cities are just 20 miles apart.

Piazza del Popolo, on Sunday, May 1. It was a holiday in Rome with the city seemingly as busy as any other day. We met up with the other tour participants: Kelly Beatty and his wife Cheryl, with whom we've traveled before, Betsy Hight and Gary Salisbury from southeastern Maryland, Janeil and Richard Hill from Huntsville, Alabama and Dan Eagle Eye from Easton, Maryland (Dan had been on our trip to Chile in 2017). We also met Natalia (pronounced Nat-al-*eee*-a) Mandelli, who was our energetic Italian tour factotum and cheerleader, constantly on the phone making sure everything ran smoothly, teaching us Italian (language and gestures) and trying to get us to roll our r's in the proper Roman style (we had to repeat "trenti tre Trentini" over and over, rolling the r's as dramatically as possible. Kelly couldn't do it.) Meals were pre-arranged in good restaurants although we did have a couple of lunches and dinners on our own during the week.

In each city (Rome, Florence, Pisa, Padua and a non-astronomical extension to Vence) we had a walking tour, full of fascinating information about the city, its history, customs, and art. We also learned about the lives of our guides, who were universally knowledgeable and thoroughly prepared. They all had advanced degrees and spoke English well. Specific venues also supplied docents. For this report, I'll focus on the astronomical (but keep in mind how important the gastronomical is in Italy!)

Kelly's lecture and demonstration

Kelly Beatty lecturing

Although we all knew something about Galileo, Kelly Beatty wanted to make sure we did not harbor any misconceptions. Our first tour activity was a wine-fueled lecture providing insights into Galileo's life, his discoveries and his battle with the Jesuits and the Inquisition. Since we were going to see (but not look through) his actual telescopes in Florence, Kelly showed us how they worked. He made an optical bench out of 2" lenses mounted on Styrofoam coffee cups, recreating Galileo's telescope (convex objective and concave eyepiece) as well as a modern refractor with convex lenses at both ends, so we could compare their properties. The concave eyepiece provides a much narrower field of view, although the image is upright. Modern refractors, developed in the mid-17th century, achieved wider fields of view and had fewer aberrations, at the expense of inverting the image. Galileo's choice made sense, considering that his first goal was to sell telescopes to the Doge of Venice for military purposes, where an upright image is needed.

Angelican Library

After a visit to the Vatican gardens, we were driven across the Tiber and then walked a short distance near the north end of the Piazza Navona to the oldest public library in Italy, and one of the first in Europe. The Biblioteca Angelica is tucked into what looks like a small building (but isn't) next to the Basilica di Sant'Agostino, the mother church of the Augustinian order. The church, completed in 1483, boasts a lovely Caravaggio, the Madonna of Loreto. (We later went to the nearby San Luigi dei Francesci which has three spectacular Caravaggios). Rome, by the way, has 800 churches.

The Angelican Library was founded around 1604 and moved to the present location in 1659. It contains over 200,000 volumes, including many original manuscripts and first editions. It's a public facility, so any-

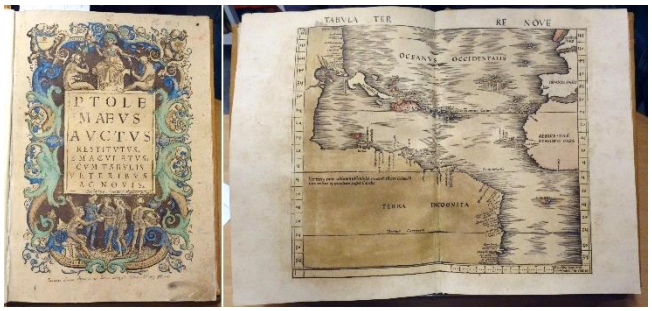
one can study there.[2] The large reading room has three tiers of books, just a small part of the collection. A pair of terrestrial and celestial globes by the important Dutch cartographer Willem Blaue, dating from 1623, is prominently displayed.

We noticed two enormous, inflated bags, looking like huge mattresses, at one end of the reading room. Old manuscripts and early editions, subject to attack by insects and mold, are fumigated inside them. The earliest treasures of the library need this treatment every few years.

Galileo's *Sidereus Nuncius*

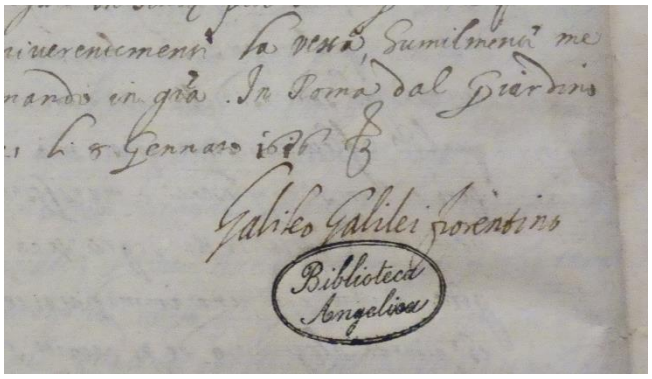
After a brief tour, one of the librarians showed a 13th century illuminated manuscript and several rare, printed works from the dawn of printing (late 15th and early 16th centuries). The astronomical highlights were an original copy of Galileo's *Sidereus Nuncius*, the March 1610 pamphlet reporting his telescopic discoveries (I actually got to touch it) and a first edition (1619) of Johannes Kepler's *Harmonices Mundi*, the treatise in which he tried to fit the orbits of the planets into ratios determined by musical intervals, a thoroughly Pythagorean approach to astronomy.

There was also a 1529 edition of the geographical works of Ptolemy with a hand-colored title page, saying that the books were "enlarged, restored and renewed with old and new illustrations." The practice, beginning with the first Latin printing of Ptolemy's *Geographia* in 1482, was to include newly drawn maps, and this edition even had a map that showed the coast of North and South America and islands in the Caribbean.



A 1529 Ptolemy, with map showing the coast of the western hemisphere

Then we had a special treat. The library owns an original written manuscript, dated January 1616, of Galileo's "Discourse on the Tides," a lengthy letter to Cardinal Alessandro Orsini. Although the text is not in Galileo's hand (a scribe was clearly employed), the great man's signature is affixed to it.



Galileo's signature

After Galileo had revealed in 1613 that he agreed with Copenicus' heliocentric organization of the solar system, he was increasingly criticised by conservative churchmen, particularly Jesuits. Galileo was helicentrism's most visible and voluble partisan, but he was unable to counter the growing power of orthodoxy. He arrived in Rome in December 1615 to confront the opposition to his Copernican views. He spent the next two months visiting Church officials, trying win them over to his view of the cosmos. He was worried that denying it would bring "scandal to Holy Church."[3] Galileo thought his theory of the tides[4]

[2] Our Italian travel agent Laura did research there for her advanced degree in philology.

[3] Galileo to Curzio Picchena, Jan. 23, 1616, quoted in Heilbron, p. 216. Picchena was Secretary of State to Grand Duke Cosimo Medici, Galileo's patron for whom he named the satellites of Jupiter ("Medicean Stars")

would be proof of the Copernican construction of the cosmos. Orsini did present the theory to Pope Paul V, alas to no avail.

On February 26, 1616, Galileo was told "to abandon completely ... the opinion that the sun stands still at the center of the world and the Earth moves, and henceforth not to hold, teach, or defend it in any way whatever, either orally or in writing." Copernicus' *De Revolutionibus* was placed on the Index of Forbidden Books "until corrected." All books teaching Copernican theory were also banned. The announcement was published on March 5, 1616, and we saw a copy of it the next day at the Copernican Museum.


DECRETVM

The Inquisition's order in 1616 banning Copernicus

Copernican Museum

The museum is housed in the former Monte Mario Observatory atop a hill on the right bank of the Tiber. From it there's a spectacular panorama of the Eternal City.

The building also serves as the headquarters of the Istituto Nazionale di Astrofisica (INAF), the coordinating body for astronomy research in Italy. There are 20 Italian research observatories (one of them is on the Canary Islands). INAF played a role in the construction and ongoing activities of the Large Binocular Telescope in Arizona.[5] There's a dome on top of the building, but it no longer hosts a telescope. A solar tower is also on the property, but it was not operating. Two of the institute's astronomers met us at the gate of the observatory and guided us through the museum's collection of astronomical instruments, many of historical importance.

Astronomical Observatory of Rome/Copernican Museum

The many items on display included astrolabes, armillary spheres, celestial and terrestrial globes, telescopes, quadrants, sextants, clocks, compasses, handheld sundials and spectroscopes.

Islamic astrolabe from 1096 AD; a wooden-tube refractor made by Simon Plössl in Vienna, c. 1850

Of particular interest and value is a large cache of equipment used by the Jesuit astronomer Angelo Secchi, who is called the "father of astrophysics." He was the first to observe and classify stellar spectra and one of the first to assert that the Sun is a star. His

[4] The theory implied that the tides would only occur once a day, and they don't.

[5] See the October 2011 SkyWAAtch.

observations were the seed for the OBAFGKM ranking that was fully developed at the Harvard College Observatory. We saw his drawings of sunspots and the instruments he used for solar observing. Secchi was the first to describe *canali* ("channels") on Mars, even before Schiaparelli. Like Schiaparelli, he did not believe they were artificial. He was also a double-star observer, discovered three comets and invented meteorological equipment.

Wooden and cardboard 17th century telescopes.

Instruments used by Angelo Secchi, and his solar drawings

Collegio Romano

St. Ignatius of Loyola founded the Society of Jesus, better known as the Jesuits, in 1540. Eleven years later he created the Roman College, dedicated to both religious and secular education. In 1584 the college moved to a large building in the heart of Rome, which it occupied until 1870. The facility is now the Ennio Quirino Visconti Liceo Ginnasio, the most prestigious high school in Rome, but the building is still referred to as the Collegio Romano, and the square that it is on bears that name.

After his telescopic discoveries, Galileo corresponded with Christopher Clavius, professor of mathematics at the Roman College and author of the most widely used astronomy textbook (*De Sphaera*)[6] of the late 1500s. By 1610, the Jesuits had obtained a telescope, but they found it hard to use. Galileo traveled to Rome with a better instrument, a trip in the grand style organized and financed by his patron, Cosimo II de Medici. He arrived on March 29, 1611. The Jesuits viewed astronomical objects with him from the roof of the Roman College. They could not doubt what they saw, but many disagreed with Galileo's interpretations, some going so far as to assert that the "Medicean stars" (Jupiter's satellites), the phases of Venus and other discoveries were at best optical illusions. The eminent Clavius, firmly Aristotelian in his thinking, was unconvinced that the Moon's surface was rough, attributing its telescopic appearance to disparities in density rather than shadows cast by the varying height of lunar features. For some Jesuits, the observations, particularly Venus, fit Tycho's model of the universe, which had the planets orbiting the Sun, but the Sun orbiting the stationary Earth, a requirement consistent with Scripture.

Courtyard of the Roman College.

Nevertheless, on May 18, 1611, the Roman College, with faculty, students, nobility and religious figures in attendance, gave Galileo an enthusiastic reception and awarded him an honorary degree. Seminars on a variety of philosophical and historical topics were

[6] Astronomy textbooks in those days were basically extended commentaries on Sacrobosco's *De Sphaera*, which was written about 1230 and itself was an elaboration of Ptolemy's *Almagest*, which was first translated into Latin in 1175.

presented in his honor. As Heilbron puts it, "Everywhere Galileo was the lion of the season." This was the height of the Jesuits' comfort with Galileo; after that it was pretty much downhill. Galileo did not formally declare his belief in heliocentrism until 1613. By that time, Clavius had died, and conservative forces in the church were increasingly strident.

The former Roman College building is entered from the Piazza del Collegio Romano (now packed with small cars). A large interior courtyard is the site of Galileo's celebration. The small dome in the photograph on page 13 is not an observatory but is part of the baroque *Chiesa di Sant'Ignazio di Loyola in Campo Marzio* (Church of Saint Ignatius Loyal at Campus Martius),[7] which was built to be the college's chapel. The church was designed by Orazio Grassi, a Jesuit architect who was also a mathematician and astronomer. In 1618, three bright comets appeared. Grassi looked for, but could not find, any parallax. He concluded (as Tycho Brahe had done with the comet of 1577) that the comets were located beyond the orbit of the Moon. Galileo took offense. Although by then a confirmed heliocentrist, he peculiarly still held to the Aristotelian belief that comets were atmospheric phenomena, plus he was apparently irked that someone other than him had the temerity to claim discovery of something new in the heavens. In his copy of Grassi's lecture, Galileo scribbled insults (*pezzo d'asinaccio* [piece of utter stupidity], *bufolaccio* [buffoon], *villan poltrone* [wicked idiot], *balordone* [bumbling idiot]). Galileo wrote a *Discourse on Comets* that tried to refute Grassi's (and Tycho's) views. But he was wrong.

The Church of Saint Ignatius played another odd role in astronomy. The Jesuits ran out of money and couldn't afford to build the large dome over the crossing (where the transepts meet the nave), although the foundation for it was in place. To compensate, a faux dome[8] giving the illusion of height and perspective was painted on the flat ceiling by Jesuit artist Andrea Pozzo. It is considered to be the masterpiece of *quadratura*, three-dimensional ceiling painting. The Roman College eventually established an observatory in the late 18th century. When Angelo Secchi became its director in 1850, he realized that the foundations in Sant'Ignazio that weren't used to support a dome could be used to support telescopes. He put several there, the largest being a 24-cm (9.4-inch) Merz refractor. There's no trace of the observatory today. In one more link to Galileo, Cardinal Robert Bellarmine, Chief Theologian of the Holy Office, judge in the trial of Giordano Bruno and the person who delivered Pope Paul V's decision to Galileo in 1616 that he abandon professing or teaching heliocentrism, is buried in Sant'Ignazio.

The Roman College was the site of the first museum in the world, established in 1651 by the redoubtable Jesuit polymath and altogether fantastic character Athanasius Kircher. The Museum Kircheranium was an expansion of the personal "cabinet of curiosities" (also called "cabinet of wonders") that wealthy, educated, acquisitive and curious individuals began to assemble towards the end of the 16th century. One of the first and most famous was that of Rudolf II, the Holy Roman Emperor who employed Tycho Brahe and Johannes Kepler. A "cabinet of curiosities" would contain natural specimens, including rocks, fossils, bones, stuffed animals, and pinned insects but it might also include artworks and found objects. Kircher's museum even included fanciful items that came more from his imagination than the real world: a mermaid's tail, the head of a unicorn, faux Egyptian obelisks with a version of hieroglyphics of Kircher's invention. Over the centuries its specimens were distributed to other Italian museums. The Ennio Quirino Visconti Liceo Ginnasio has reconstituted it in spirit, mostly with modern specimens (lots of minerals, insects, animals, skeletons, and fossils). Just a few of Kircher's original specimens were there, as well as some scientific instruments, two of his books, two of the faux obelisks and that marvelous and hardly believable unicorn head.

Exhibits at the Visconti high school recalling Athanasius Kircher

[7] Campus Martius is an area of central Rome. Its most famous structure is the Pantheon.

[8] https://is.gd/StIgdome

Castel Gandolfo & Brother Guy Consolmagno

In the last decade of the first century AD, the Roman Emperor Domitian (reigned 81-96 AD) built a vast palace overlooking Lake Albano, a volcanic lake 16 miles southeast of Rome. By the 13th century the area passed to the Savelli family, and in 1590 a palatial "summer home" with extensive gardens was built there. The Church bought it in 1596, and it was remodeled by Pope Urban VIII in 1626, becoming the Apostolic Palace. Born Maffeo Barberini and educated by the Jesuits, Urban met Galileo in 1611 during the festivities at the Roman College honoring Galileo's telescopic discoveries. Maffeo was elected pope in 1623. He was fully committed to the doctrines of the church as ratified by the Council of Trent,[9] and despite their initially cordial relationship, Galileo could never turn him to modern, scientific cosmology. Galileo's provocations wore on Urban, and he ultimately called Galileo to Rome in 1633 to face the Inquisition.

While Castel Gandolfo is best known as the pope's summer retreat, that's not its only function.

The Papal States covered a substantial area and exercised civic and military power for over a millennium. Italy was unified in 1861, but Garibaldi did not liberate Rome until 1870, at which time the Papal States ceased to exist and the Vatican shrunk to its current 121 acres within Rome. Most church property was seized, including the Roman College. Uneasy relations between the Italian state and the Vatican persisted until a truce was finally forged in the Lateran Treaty of 1929. At that time, the palace and gardens at Castel Gandolfo were returned to the papacy. Just as the Vatican is not officially part of Italy, neither is the Apostolic Palace. When you walk through its gates from the town, you are leaving Italy, just as when you enter the Vatican. The total size of the property is 135 acres, of which 75 acres is a working farm.

[9] The Council met from 1545 to 1563, in response to the Protestant Reformation in Germany. It clarified church doctrine to oppose Luther's theology, which was spreading quickly in northern Europe. Among its determinations were that the Church is the ultimate interpreter of Scripture, and that the Bible and church tradition were equally authoritative. This prevented asserting as truth any scientific theories that would conflict with certain biblical events, or even just represent a change in "tradition."

Although the Italian government confiscated the Collegio Romano, they permitted Angelo Secchi to continue to operate its observatory out of respect for his achievements and international stature. When he died in 1878, the observatory was disbanded. There had been an observatory in the Tower of the Winds (adjacent to the Vatican Museum, closed to visitation at the time of our tour) from 1572 to 1821. During the uneasy period of relations between the Italian government and the Vatican, Pope Leo XIII sought almost any form of secular international recognition that might bolster the idea of the Vatican as a distinct sovereignty. In 1891 he established his version of a "national observatory" on the grounds of the Vatican. The new Vatican Observatory was recognized by other national observatories, and it participated in astronomical research projects, particularly the "Cartes du Ciel." Initiated in 1887 in Paris, the goal was to make a detailed photographic atlas of the night sky. Eighteen national observatories participated. The project underestimated the amount of work required and was never completed, the first World War providing the *coup de grace*. It did however lead to the formation of the International Astronomical Union in 1919, and many of the plates were used in other research projects.

Until the mid-19th century, there was no real conflict between science and religion. Most of the greatest scientific minds, Galileo and Newton among them (OK, not Descartes), held strong religious beliefs and saw no inconsistency. Geologic discoveries that put the age of the Earth far beyond the biblical timeline and Darwin's work on evolution created a schism that persists for many to this day. The Jesuits have evolved a balance that permits them to be religiously conservative yet scientifically liberal. It wasn't that way in the 17th century, and Galileo suffered for it.

Because of increasing light and soot in Rome, the Vatican moved the observatory to Castel Gandolfo in 1935. New telescopes were installed. Astronomers were housed in a floor of the Apostolic Palace. It was not infrequent for them to run into the pope during his summer residence there. During World War II, in which the Vatican was neutral, 12,000 refugees, many of them Jews, were housed in the palace and on the grounds. Unfortunately, an errant bomb from an American airplane landed in the gardens and 500 lives were lost. But the rest survived the war.

The astronomy staff consists of a dozen Jesuit astronomers of international stature. They are engaged in a wide variety of research, ranging from gravity theory to galaxy formation to meteorite study. They are led by Guy Consolmagno, who many readers will know from his popular book *Turn Left at Orion*. Brother Guy first came to the observatory in 1993 and was appointed to a ten-year term as Director in 2015. He divides his time between Italy and Tucson.

The Vatican Observatory operates the Vatican Advanced Technology Telescope, a 1.8-meter Gregorian with the first spin-cast mirror ever made by Roger Angel's University of Arizona Mirror Lab. The mirror is 1.8 meters in diameter and has a focal length of 1.8 meters, meaning it's *f/*1. The Gregorian design uses a convex secondary mirror beyond the mirror's focal point. It has to be focused with 0.1 micron. It provides a sharp image across the entire field. The whole instrument operates at *f/*9.1. The telescope is located on Mt. Graham, next door to the Large Binocular Telescope. The Universities of Arizona (UA, ASU and Northern Arizona University) get a quarter of the telescope time, in exchange for having made the mirror.

Clockwise from upper left: The entrance to the Apostolic Palace, an interior hallway, the dome of the dual astrograph, Elyse looking out over Lake Albano.

After a guided tour of the beautiful palace, we met Brother Guy. A brilliant storyteller, fond of word play and full of scientific, historical and even ecclesiastical information, he told us about the history of the palace and the observatory, the current staff members and their research programs, and he even related a few of his interactions with recent popes (he was particularly fond of Pope Benedict XVI's sense of humor). Then we took a small elevator to the top level. After seeing a short video about the facility, we walked out onto the roof, where there are two telescopes. The view over Lake Albano is breathtaking.

The larger instrument is the equatorially mounted "double astrograph," a 24-inch Cassegrain, carrying a plateholder, paired with a 16-inch Cassegrain that has an eyepiece. There are two smaller finders/guiders. The 24-inch scope can be configured as a Newtonian, and there's a moveable platform inside the dome for the observer if that configuration were to be used (which has not been the case in many years). The optics were made by Zeiss.

The Zeiss dual astrograph. Can you find the Telrad?

When the telescope was made in 1935, the power in Italy was 120 volts while the power in Germany was 220 volts. So as a compromise the mount was designed to run on DC power. Brother Guy fired up the telescope and it made an unholy racket, which was mostly coming from the speed governor. It's a typical "conical pendulum" design dating as far back as the steam engine. To keep the motor's rate constant, a pair of weights swing from a vertical spindle, conservation of momentum maintaining a constant rotation rate. It's just loud! The telescope must be manually guided for imaging. It's been employed most recently for spectroscopy using giant prisms that were moved into the light path with a small crane. The dome is made of wood, but unfortunately it was warped just enough that it wasn't able to be opened.

The other dome houses a 40-centimeter (16-inch) Zeiss refractor on an equatorial mount. The optics in this scope are not the original ones by Zeiss Jena. These were removed during World War II. Replace-

ments were made by the Zeiss facility in West Germany, the original Zeiss Jena factory being off limits in East Germany at the time. The scope uses a chain drive, but the motor is new, and the dome works. The instrument was primarily used for double-star work. Brother Guy said that astronomers using this telescope in 1994 were among the first to see the dark spots of Comet Shoemaker-Levy's impacts in the Jovian atmosphere.

The 40-cm refractor; Brother Guy Consolmagno with a gift of coasters from Kelly Beatty; Gary Salisbury is on his right.

There are a couple of smaller telescopes in domes in the gardens that are used for outreach, but we didn't visit them. We went to lunch at a lovely restaurant overlooking the lake, during which Brother Guy continued to regale us with amazing stories and insights into astronomy, its practitioners and its history.

Our group, with Brother Guy (3rd from right).

Santa Maria degli Angeli e dei Martiri

The baths built by Emperor Diocletian (ruled 284–305 AD) were the largest in Rome, even larger than the famous baths of Caracalla. The complex is located in what is now central Rome on the Piazza della Repubblica, close to the main train station. In 1561 Pope Pius IV ordered that a church be built in the frigidarium of the baths, a large building that was still in reasonable shape. The main designer was none other than Michelangelo, who worked on it until his death in 1564. The large church, dedicated to the Virgin, was completed in the 1600s. It has no façade. From an unpresuming entrance, just two smallish doors in a curved, narrow wall, you enter a large open space quite unlike other Roman churches.

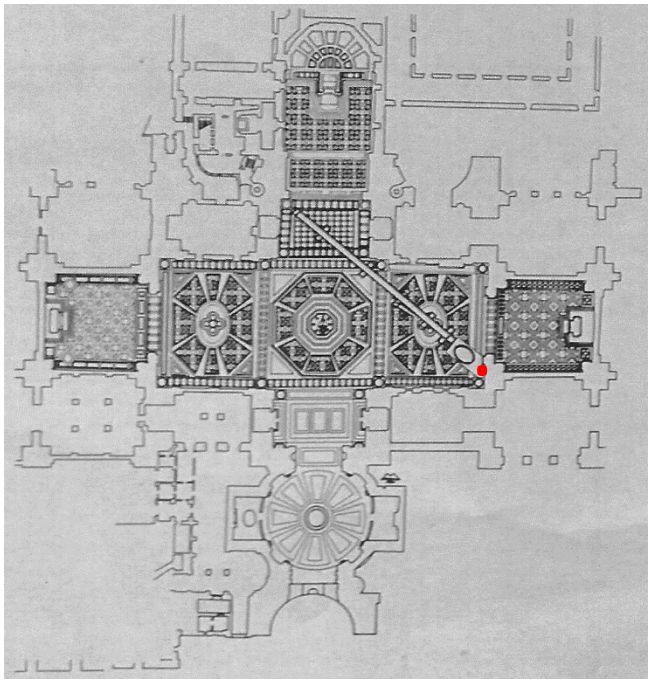
This church was included in our tour for its astronomical significance. Pope Clement XI commissioned the multi-talented Francesco Bianchini to build a meridian line in the church. Completed in 1702, the 45-meter-long meridian was more precise than the 65-meter line built in 1655 in Bologna's San Petronio by Gian Domenico Cassini.[10] Because Diocletian's baths have been around for 2,000 years, its massive walls and thick floor have completely settled, providing the stability needed for an astronomical instrument, which is essentially what a meridian line is.

Two views of the meridian line at Santa Maria

A meridian line is a type of sundial, combined with a pinhole camera. Rather than a gnomon casting a shadow, an oculus (hole) high up in the wall of the building projects an image of the Sun on the floor. The meridian line is laid down, as you would expect from the name, on the local projection of the meridian. The image of the Sun reaches its most northerly point at local noon on the winter solstice and its most southerly point on the summer solstice. The transit of the Sun across the meridian defines local noon. The

[10] Elyse and I visited San Petronio in Bologna on our own after the S&T tour was over. We photographed the Sun's image at local noon. You'll see this in a coming Sky*WAA*tch.

device can be used to determine a number of important astronomical parameters, including local time, the length of the year, the precession of the equinoxes, the obliquity of the ecliptic, solar diameter and parallax and the dates of Easter. It's a precision instrument: a lot of planning and engineering went in to ensuring that the surface is flat and the orientation is exact. Recall that the orbit of the Earth is influenced not only by the Sun but also by the Moon, and so it is not truly fixed. The line of apsides (the aphelion-perihelion axis) is slowly changing, something known to Arabic astronomers. So it's not "one and done": a meridian line can still be an active astronomical instrument.



The diagonal feature is the track of the meridian line. The oculus is 20 meters high in the wall at the red dot.

The meridian line at Santa Maria (at 12° 30' E) is a ribbon of bronze set into marble slabs with bronze lettering for the days, the Sun's declination, the names of some stars and the constellations of the zodiac. Along the path are inlaid marble figures of zodiacal constellations appropriate to the date, based on those in Bayer's *Uranographia*. The southern end has concentric circles that demonstrate the precession of the equinoxes. Bianchini also set bronze stars into the floor of the church offset from the meridian line, indicating the diurnal paths of Sirius and Arcturus.

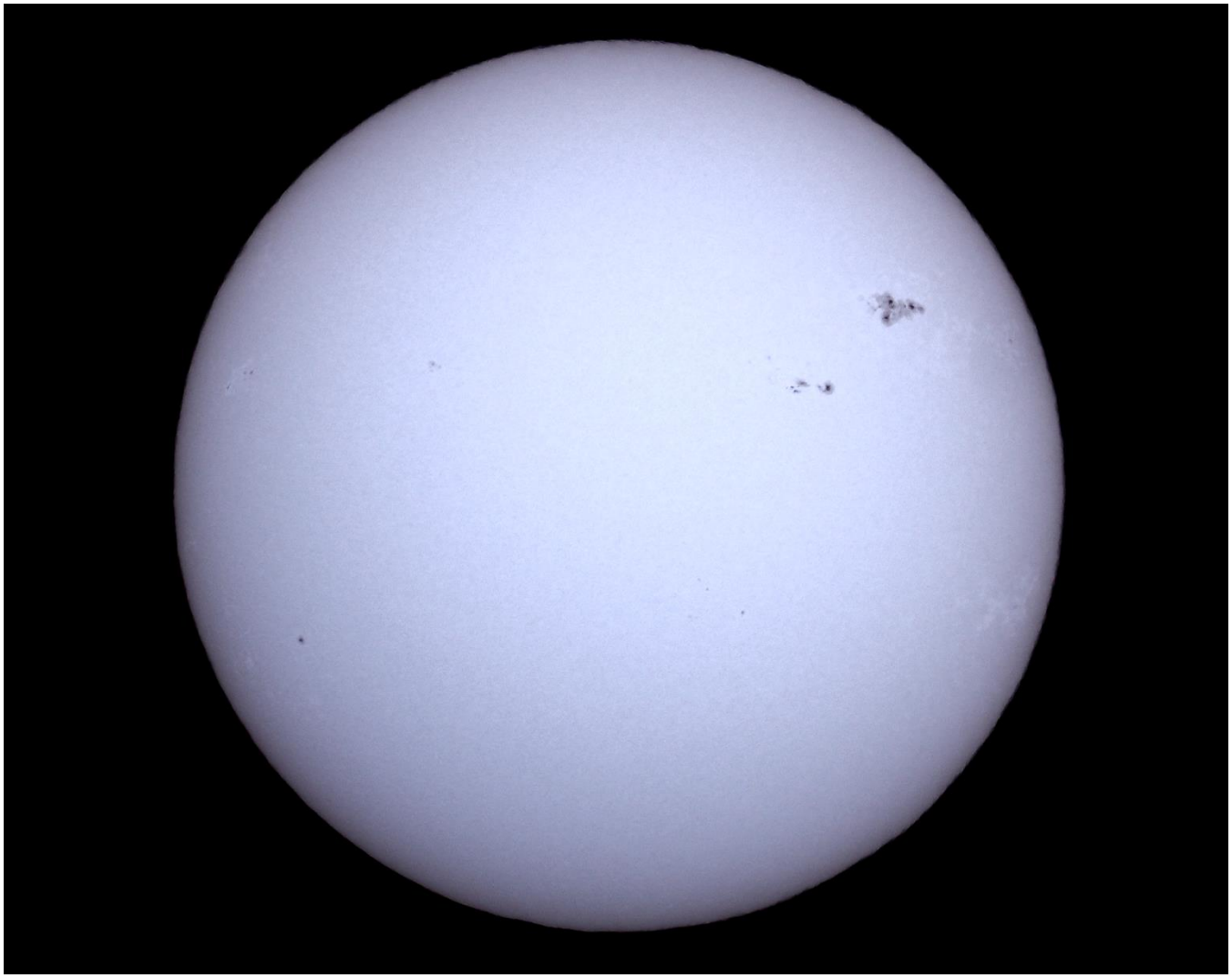
Our guide at Sant Maria was Constantino Sigismondi, an astronomer at the Sapienza University in Rome. He has been studying meridian lines for more than two decades and seemed to know everything there was to know about them. Among the phenomena that need to be taken into account when using the instrument are atmospheric refraction and even the varying effects of thin clouds and haze during the meridian transits. The accuracy of the meridian line, as recorded in a recent paper by Prof. Sigismondi, is one second of arc. There were times that his discussion was above our heads, literally, as we searched at one point with a small hand-held telescope for a daylight view of Sirius through the oculus, standing in just the right position. No go for us, but Prof. Sigismondi has seen it.

Prof. Sigismondi pointing out details of the meridian line. Photo by Natalia Mandelli

After three days in Rome, the tour moved on, via high-speed train, to Florence, to get a more personal experience with Galileo himself. To read about that you will have to wait for next month's Sky*WAA*tch. ■

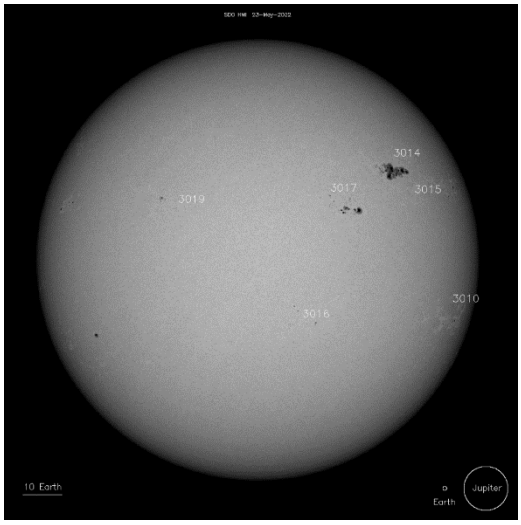
Images by Members

Sunspots in White Light by Larry Faltz



The Sun on May 23, 2022 at 11 a.m. A single image with a Canon T3i DSLR through a Stellarvue SVR-105 triplet refractor, Baader mylar filter, ISO 100, 1/2000 sec.

The active regions are identified on the image on the right, from the Solar Dynamics Observatory, made around the same time as Larry's image. AR 3014 is "βγδ" using the Hale classification. This scheme was proposed in a 1919 paper by George Ellery Hale and colleagues, [1] but much work has been done in the intervening century to refine it.[2] In this case, the region is very complex with 18 interacting subcomponents, making its magnetic structure chaotic.



[1] https://articles.adsabs.harvard.edu/pdf/1919ApJ....49..153H
[2] https://iopscience.iop.org/article/10.3847/1538-4357/aae31a

Four Galaxies by Steve Bellavia

Messier 82

Telescope: TSO 115-mm Triplet f/7 refractor with TSO 1.0X Field Flattener, 805-mm focal length
Camera: ZWO ASI 294MM Pro, cooled to -10C

Messier 106

Telescope: TSO 115-mm Triplet f/7 refractor with TSO 3-inch, 0.79X reducer-flattener, 645-mm focal length
Camera: ZWO ASI 294MM Pro, cooled to -10C

NGC 2976

Telescope: Astrophysics 155-mm f/7 triplet refractor
Camera: ZWO ASI 533MC cooled to -5C

NGC 4565

Telescope: TSO 115-mm Triplet f/7 refractor with TSO 3-inch, 0.79X reducer-flattener, 645-mm focal length
Camera: ZWO ASI 533MC Pro, cooled to -5C

The ever-prolific Steve Bellavia sent us these images over the past few months. They were all obtained on the North Fork of eastern Long Island. The rarely imaged NGC 2976 is a dwarf galaxy in the M81 group in Ursa Major. Steve has dubbed it the “Paramecium Galaxy.” The image was made with an AstroPhysics telescope located at the Custer Institute in Southold. It is mounted on a new Fornax 152 mount that Steve was testing for a joint Brookhaven National Labs/Custer Institute project. This high-precision German equatorial mount, made in Hungary, is for permanent installation: it weighs over 150 lbs. (without the pier) and costs well over $10,000. It will carry a payload of over 200 pounds.

The Horsehead Nebula by Steve Bellavia

Here's Steve 's image of the Horsehead Nebula, B33 in Orion, with the same equipment as his M82 image on the previous page. Steve collected data for over five hours. He noted that it was "very cold (-8°C) with wind from the Northwest from 8 to 10 mph, which subsided a little as the night progressed." That's what you have to be prepared for if you want to do imaging in January! To image the Horsehead in pleasant conditions, schlep yourself and your equipment to the Southern Hemisphere, where it's summer in January.

William Herschel compiled a catalog of 2,500 diffuse celestial objects in three lengthy papers published in 1786, 1789 and 1802. He did not include the Messier objects, always referring to them by their numbers in the *Connoissance du Temps*, the journal in which Messier published them, but not using Messier's name. In 1811, Herschel read a paper to the Royal Society, "Astronomical Observations relating to the Construction of the Heavens, arranged for the Purpose of a critical Examination, the Result of which appears to throw some new Light upon the Organization of the celestial Bodies."[1] This is a sequel to his 1785 paper "On the Construction of the Heavens," in which he first proposed a structure for the Milky Way.

In the 1811 paper, Herschel sought to classify his nebulas in an attempt to determine the nature of these diffuse objects: Are they merely congeries of faint stars, or made of something else? He arranged them in distinct morphologic groups ("Nebulae that are suddenly brighter in the middle," "Nebulae that have a Cometic appearance," "Nebulae that are remarkable for some peculiarity in Figure or Brightness," etc.). He also added 52 additional diffuse nebulas "that have not been published before." Of the new nebulas, object #25, described as a "diffuse milky nebulosity," is at the coordinates of the Horsehead and its associated nebula. There is no further

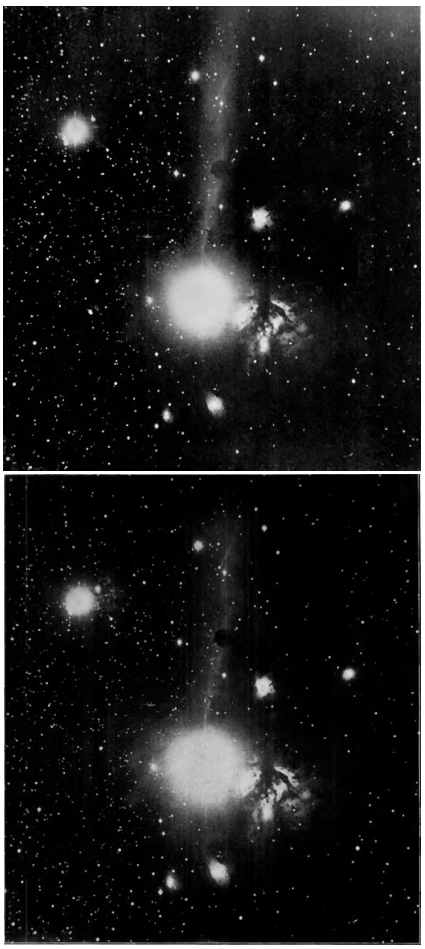
[1] https://royalsocietypublishing.org/doi/epdf/10.1098/rstl.1811.0018

description of the new #25, but in his survey of nebulas he did note that some seemed to have "opaque nebulous matter."

The glowing gas surrounding the Horsehead, and perhaps the Horsehead itself, was noticed by Williamina Fleming in 1888 or 1889 on one of the Harvard/Draper photographic plates, but she did not write a paper about it and did not name it. The gaseous nebula was included in the *Index Catalog* of 1895 (the supplement to the NGC) as IC 434, with "Pickering" (William or Edward?) listed as the observer. Reference is made to photographs in the *Annals of the Harvard College Observatory*, Vol. 18, but these images are not on-line. Perhaps it was the same plate that Fleming analyzed, or perhaps William, the likely imager, made a new plate.

The nebula was photographed by Isaac Roberts.[2] His image was published in the *Monthly Notices of the Royal Astronomical Society* in 1902 in a paper, "William Herschel's observed Nebulous Regions, 52 in number compared with Isaac Roberts' Photographs of the same Regions, taken simultaneously with the 20-inch reflector and the 5-inch Cooke lens." [3] Roberts' photos could only find nebulosity in four of the Herschel objects. While his descriptions of the plates in the other 51 nebulas (48 describing just stars and stating "no nebulosity") are just a few lines of text, Roberts provides a detailed description of #25, which clearly includes both the Horsehead and the Flame nebulas:

> Sky clear; stars very numerous on *p.* half of plate, but few on *f.* half, where there are large areas void of stars; large cloud of nebulosity *n. f. ζ Orionis* with broad division void of stars, but with some nebulosity in *s. f.* to *n. p.* direction; other divisions break up the cloud into separate masses. To the *s.* of *ζ* is a stream of nebulosity, 54 minutes of arc in length, with an embayment free from nebulosity dividing it in halves. Another faint nebulosity extends from *ζ* 27 minutes of arc toward the *s., s. p.* and *n. p.* The star B. D. - 1°1001 is in the midst of nebulosity, and it has a companion on the *s. p.* side. The star *B. D.* - 1 °1005 is involved in a large cloud of streaky nebulosity, and it has a companion on the A side. The star *B. D.* - 2°1345 is H *IV* 24, N. G. C. 2023; it is in the midst of a large, dense streaky cloud of nebulosity which has in it condensations and remarkable rifts free from nebulosity; near the *s.* end of one of these rifts is a twelfth magnitude star. The star *B. D.* - 2°1350 is in the midst of a cloud of nebulosity with some faint structure in it, and it has a companion on the *n. p.* side. The region here referred to, which covers four square degrees of the sky, has so many remarkable features that it is necessary, in order to make it intelligible to the reader, to present the photograph annexed along with the above description.[4]



Top: Roberts 1902, Bottom: Barnard 1903

In 1903, the *Astrophysical Journal* carried E.E. Barnard's article "Diffused Nebulosities in the Heavens." [5] It was a critique of Roberts's paper and to some extent a catty reminder that others, including Barnard himself, had already imaged the various nebulas. Barnard noted that "the curious nebulous ribbon extending southward from *ζ* Orionis seems to have been first photographed by Professor W. H. Pickering and others as far back as 1889." Barnard reported that he had captured it on film as early as 1894 when he was at Lick Observatory, prior to his move to the University of Chicago's Yerkes Observatory in 1895. Barnard asserted that Roberts's exposure times were too short to show nebulosity in most of the objects in spite of capturing 16th and 17th magnitude stars. We know now that the

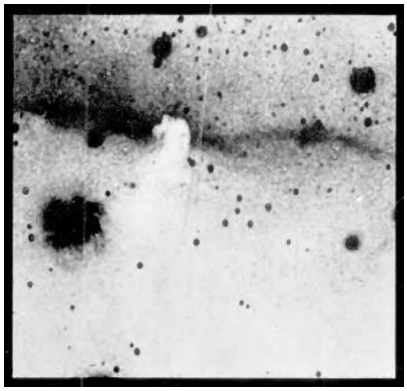
[2] See the April 2022 SkyWAAtch, p. 20-22, for more on astrophotography pioneer Roberts.
[3] https://articles.adsabs.harvard.edu/pdf/1902MNRAS..63...26R
[4] Astronomers used a lot of abbreviations in the old days!
[5] https://articles.adsabs.harvard.edu/pdf/1903ApJ....17...77B

plates in use at the time were very insensitive in the red end of the spectrum, where almost all of the nebular light is emitted (the hydrogen alpha line at 656.28 nm). In addition, he appealed to prior authority:

> it is a little unreasonable to suppose that Herschel, who made so few blunders compared with the wonderful and varied work that he accomplished, should be so palpably mistaken in forty-eight out of fifty-two observations of this kind.[6]

In any case, Barnard went on to describe his own 1903 photograph (page 22) of #25, an exposure of two hours with a "small, cheap lantern lens belonging to Professor Hale." This lens was 1.6" in diameter with a focal length of 6.3 inches (*f*/4). Although he doesn't describe the Horsehead, it's clear from this photograph that it's there. His photograph is almost identical to Roberts's, but by citing the tiny size of his optic, he was perhaps tweaking Roberts' nose. In fact, in looking at the publications cited in the NASA ADS database for the 1890s and early 1900s, there are a number of papers by Barnard that gently critique Roberts' photographic efforts as inferior to his own. And they probably were.

A decade later, Barnard recalled Roberts's 1903 paper. He seemed to chafe, all of a sudden, at Roberts's description of the Horsehead as "an embayment." In a 1913 paper "Dark Regions in the Sky Suggesting an Obscuration of Light" [7] he wrote,



Barnard's 1913 image of the Horsehead. as he presented it in the paper, as a negative.

> With respect to the question of obscuration of light in space, there is one other object which strikingly shows this effect. In the east side of the well-known nebulous stream that runs southward from ζ Orionis is a very conspicuous black notch which is very sharply defined….
>
> This object has not received the attention it deserves. It seems to be looked upon as a rift or hole in the nebulosity, as implied in the quotation from Dr. Roberts' paper. I have made numerous photographs of it, and in the past winter gave a long exposure with the expressed purpose of showing more definitely the true form of the object. This last photograph on February 7, 1913, with an exposure of 4 h 33 m, shows the nebulosity better than I have seen it before. Instead of an indentation, the almost complete outline of a dark object is shown projected against the bright nebulosity. The west side of it is very definite and sharp, while the eastern limit is scarcely discernible, and is entirely lost in the enlargement. The best description I can give of it is to present the photograph of the object itself for inspection. A glance at the original would show that this is not a perforation in the nebula. It is clearly a dark body projected against, and breaking the continuity of, the brighter nebulosity. Possibly this is a portion of the nebula itself nearer to us, but dark and opaque, that cuts out the light from the rest of the nebula against which it is projected.

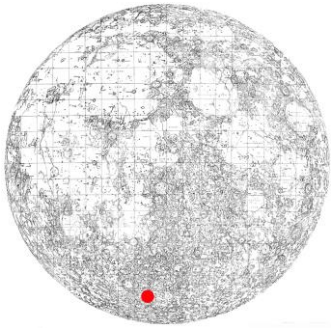
On November 4, 1913, on a night of good seeing, Barnard observed the nebula visually with the 40-inch Yerkes refractor at 460X and confirmed "the supposition of an obscuring medium."

When did B33 become the "Horsehead"? Barnard's 1919 catalog of dark nebulas only provides the description "dark mass, diam. 4', on nebulous strip extending south from *ζ Orionis*." Besides "embayment," "black notch" and "dark body" quoted above, it was called a "dark bay…like an ink-blot" by Lick's Heber Curtis in 1918,[8] and again a "dark bay" by John Duncan in a 1921 photographic study[9] with the 100-inch Hooker telescope at Mt. Wilson. Given its morphology the name "Horsehead" was inevitable. Its first appearance in the NASA/ADS astronomy literature database (as "horse's head," in quotes) is in the minutes of the May 13, 1921 meeting of the Royal Astronomical Society, at which lantern slides of Roberts's and Duncan's images were projected.[10] It's possible that the appellation was already in the astronomy vernacular despite not appearing in formal publications, but I think it's very likely this was the first time the sobriquet was applied. LF■

[6] Appealing to authorities in astronomy can be dangerous: just ask all those guys who cited Ptolemy for 1500 years.
[7] https://articles.adsabs.harvard.edu/pdf/1913ApJ....38..496B
[8] https://articles.adsabs.harvard.edu/pdf/1918PLicO..13....9C
[9] https://articles.adsabs.harvard.edu/pdf/1921CMWCI.209....1D
[10] https://articles.adsabs.harvard.edu/pdf/1921Obs....44..169. (see page 174)

Clavius by Larry Faltz

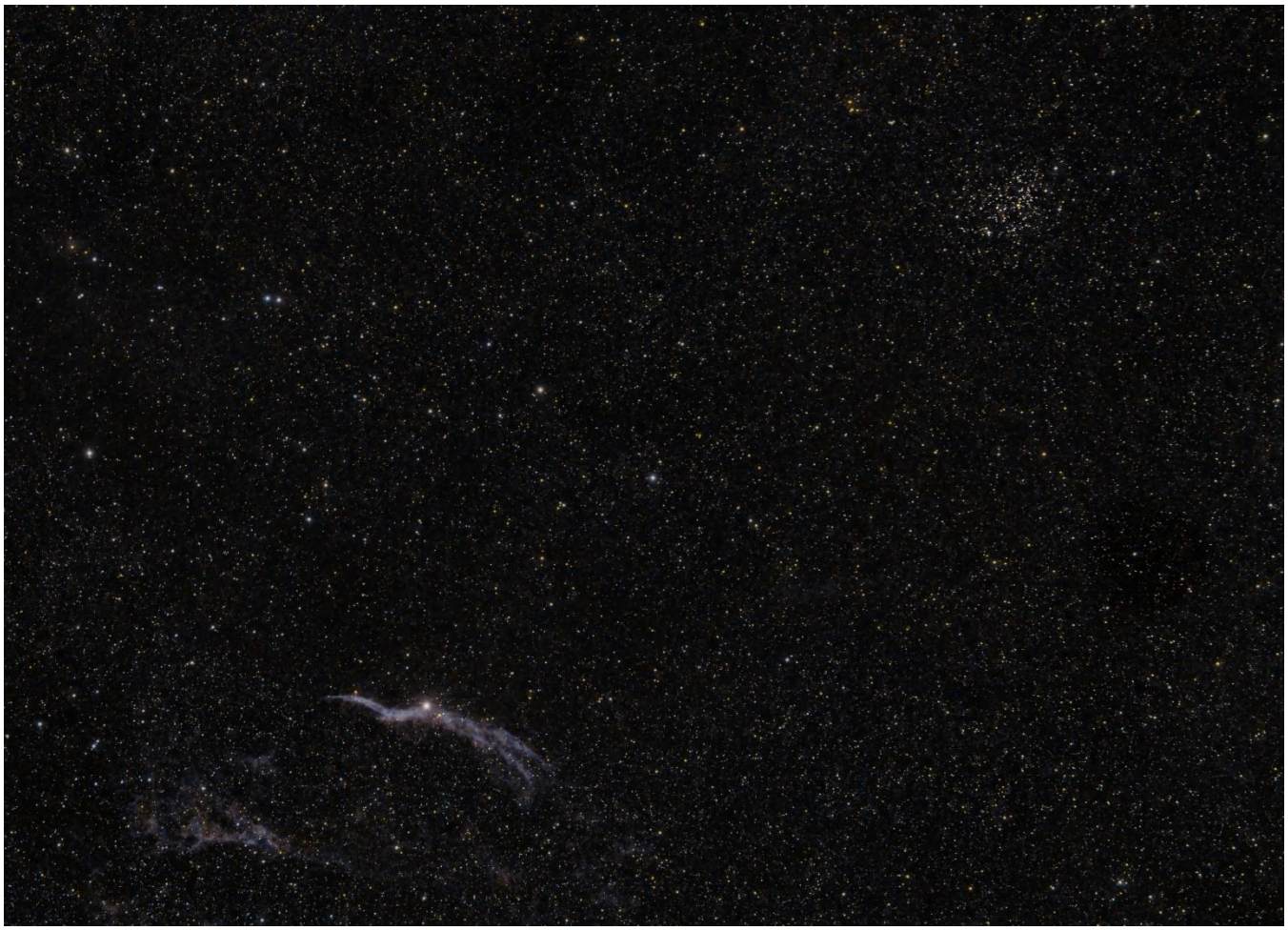
Clavius is 136 miles in diameter. It was formed in the lunar Nectarian era, some 3.9 billion years ago. The smaller craters within it are much younger, except possibly Porter, the less distinct crater on Clavius' northern (upper) edge. I usually use the free *Virtual Moon Atlas* program to identify lunar features. VMA dates Porter to an even earlier lunar era. This didn't seem correct, though, since the shape of Clavius strongly suggests an impact origin. "Walled plain" is just an old appellation for a large, old crater. A wall-interrupting impact crater has to be younger, doesn't it? Gerald North, in *Observing the Moon*, says Porter is a later impact.



In addition to his position at the Roman College and his involvement with Galileo (see page 13), the Jesuit mathematician Christopher Clavius was the head of the Papal commission to re-form the calendar, which was approved by Pope Gregory XIII in 1582 and is the calendar we use today. The pope is interred in a monument made by Camillo Rusconi in 1723. It's in the nave of St. Peter's Basilica in the Vatican. A bas-relief on the front of the sarcopha-gus shows Clavius presenting the calendar to the Pope.

April 13, 2022, Orion Apex 127, ASI290MM, best 10% of 4000 frames, Autostakkaert!3, Registax. Resolution in the image is about 1.5 miles.

Veil and Cluster by Gary Miller



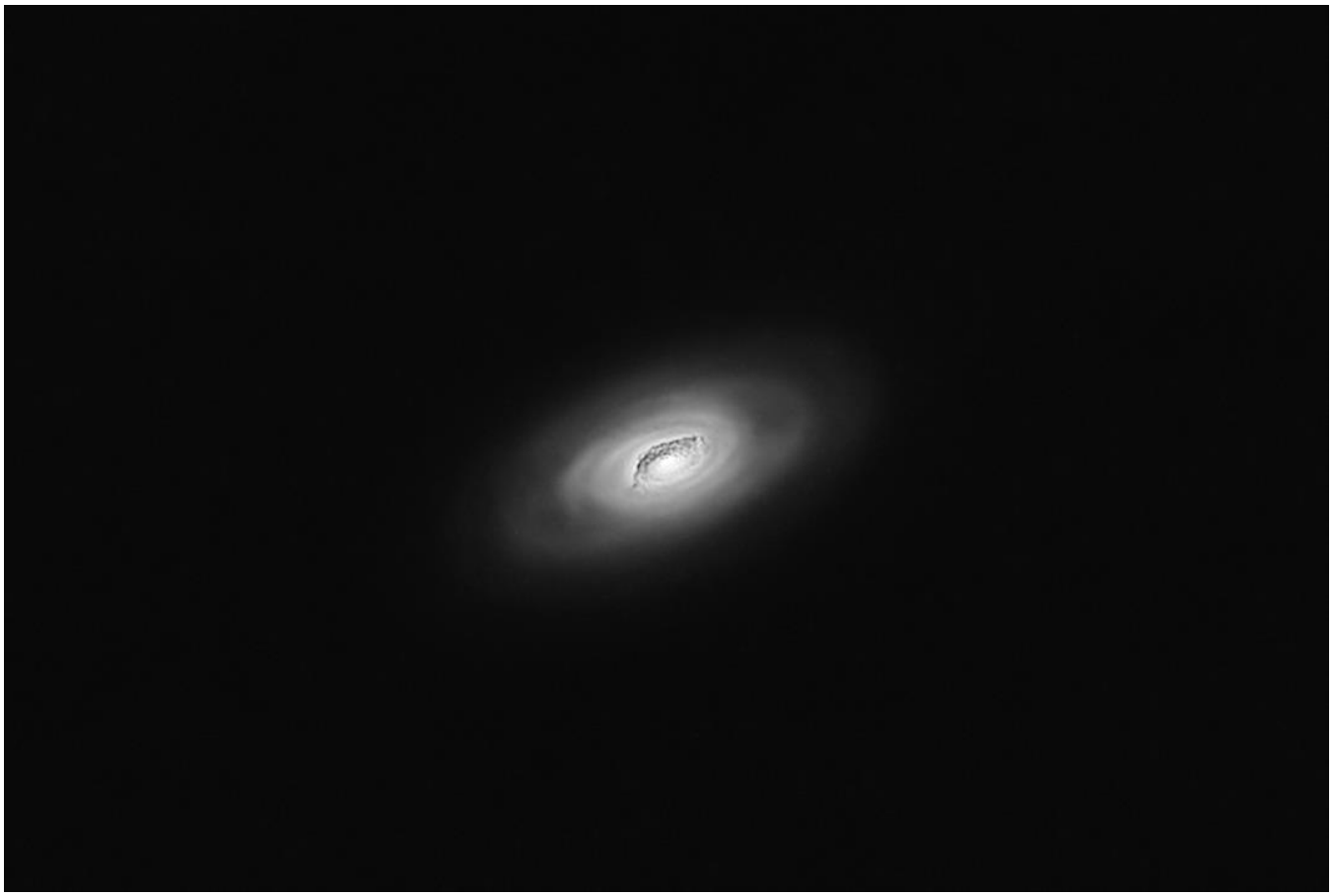
The open cluster NGC 6940 in Vulpecula sits 3¼ degrees to the southwest of the Western Veil nebula, NGC 6960. This is an image from 2019 taken with a DSLR. To capture the full Veil plus the cluster would require a field of approximately 6 x 5 degrees. It's probably a job for a telephoto lens rather than a telescope, unless one has a camera with a full-size chip.

NGC 6940 lies at a distance of 2,500 light years, just a little further away than the Veil (2,400 LY). With an apparent magnitude of +6.3 it is a fine binocular object in a dark sky. It is estimated to be 1.1 billion years old and contains many red giant stars.

Found in *Popular Astronomy*, April 1921:

Distance traveled by an Octogenarian.—Mr. Albert J. Canney, of Seattle, Wash., who is just eighty years old, has made the observation that it would require five thousand years for a rifle ball with a velocity of one-half mile per second to go as far as a man who is 80 years old and has lived at the 42° of latitude, has been carried simultaneously by the earth's diurnal rotation, its annular revolution around the sun and the movement of the solar system through space, since his birth.

Messier 64 by Rick Bria



Rick writes:

The Black Eye Galaxy, M64, is a small galaxy less than half the size of our Milky Way. Although it appears gaseous, M64 contains almost 100 billion stars. It is 16 million light years away and nearly 50,000 light years in diameter. Its name comes from the dark ribbon of material seen in silhouette against the galaxy's bright center.

The Black Eye Galaxy is unusual because the outer sections of the Galaxy are rotating in the opposite direction of the core sections. The likely explanation for this is a collision with another galaxy in the distant past.

Rick obtained this image on the night of April 30, 2022, using the 14-inch Dall-Kirkheim telescope at the Mary Aloysia Hardey Observatory at Sacred Heart School in Greenwich. The camera was an STX-16803. Forty 240-second luminance frames were stacked to make this monochrome image.

M64 (NGC 2846 in Canes Venatici, magnitude +9.6) is a type 2 Seyfert galaxy with an HII/LINER nucleus. LINER (low-ionization nuclear emission-line region) galaxies are characterized by emissions from non- or incompletely ionized atoms, such as O, O+, and S^{+}, with weak emissions from more strongly ionized atoms such as O^{++}, S^{++}, and Ne^{++}. The exact source and mechanism of the ionization are unclear. The ionization may arise near the active nucleus, with its supermassive black hole, or from star-forming regions. The mechanism is either due to shock waves in the interstellar gas, or from ultraviolet radiation. LINER galaxies are common, with up to one-third of nearby galaxies meeting the description.

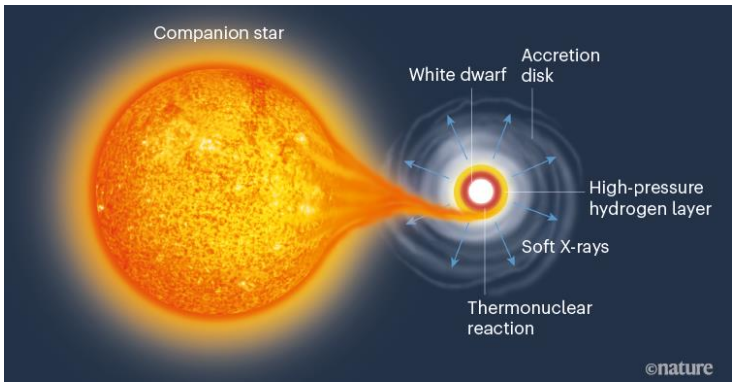
Research Highlight of the Month

König, O, Wilms, J, Arcodia, R, et. al., X-ray detection of a nova in the fireball phase, *Nature* 2022; 605:248-250 (published May 12, 2022)

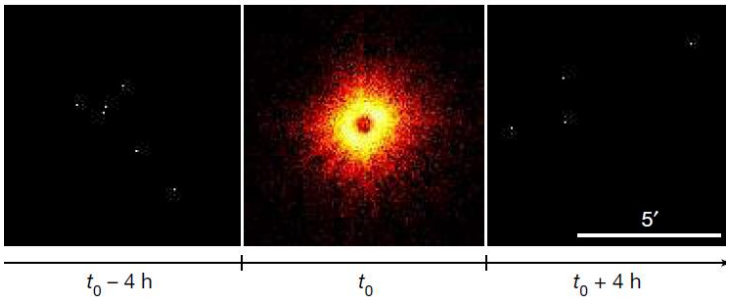
Because of its immense gravity, the surface of white dwarf in a binary system can accrete enough material from the companion star to set off a thermonuclear explosion. The material is concentrated by gravity at the white dwarf's surface, achieving a state in which its pressure is a function of the quantum nature of electrons. Although its temperature increases, it does not expand. When the temperature is high enough, explosive fusion occurs. In 1990, it was predicted that a bright X-ray flash would occur when the blast reached the photosphere, which would achieve a temperature of several million degrees. As it expands, it cools, shifting the radiation spectrum to visible wavelengths, making the nova visible. Later on, as the material is even more diluted, soft X-rays can pass through it, due to steady (non-explosive) nuclear burning continuing on the dwarf's surface.

In July 2020, the eROSITA X-ray telescope, which is located at the L2 Lagrangian point (it's a neighbor of Webb) was pointed at an area in the southern constellation Reticulum. Its first 22 scans, each separated by 4 hours, detected nothing, but the 23rd scan detected a bright source, which was not present in any further scans. It lasted 35.8 seconds. Some 2.2 hours later, the All-Sky Automated Survey for Supernovae, which had previously noted a magnitude 15.8 object at that location, detected a magnitude 5.5 object that brightened to mag 3.7 some 4.1 days after the X-ray detection. This was labeled Nova YZ Reticuli, the second brightest nova of the decade.

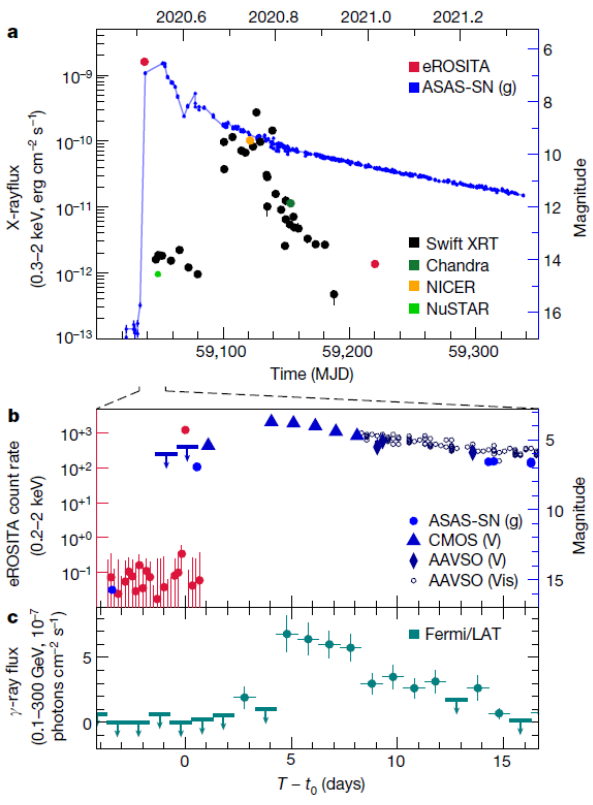
The X-ray flash was the fireball generated by the thermonuclear explosion, the first time this has been detected. Subsequent measurements with other telescopes including Swift, Chandra, NICER and NuSTAR, as well as reports from members of the AAVSO, confirmed the model for the evolution of the nova.



Cartoon of the structure of a nova



Three adjacent images from the eROSITA telescope on 07 July 2020, centered on RA 3h 58m 30s, Dec -54° 46' 41".



Multiwavelength light curves of the event

For more on white dwarfs and how they were discovered, see the May 2020 SkyWAAtch.

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
Astronomy Books	From classic books on astronomy and astrophotography to bios and science classics. Selling all as one unit. See the titles at https://is.gd/cefbooks	$50	Mike Cefola meteormik@aol.com
Meade 90-mm refractor	Meade 90-mm f/1000 DS series refractor. Computer controlled. Diagonal, tripod, manuals and batteries included, no eyepieces. Fits perfectly in included Orion case. Great condition. Picture at https://is.gd/Meade90.	$125	Marc Favreau mfavreau@optonline.net
Meade 8" SCT LX-80	Go-to mount, tripod. Tube wrapped in Reflectix for faster cooling. See https://is.gd/16F0Tv.	$600	Greg Borrelly gregborrelly@gmail.com
Celestron Astromaster 130	5" f/6 Newtonian on GEM with motorized RA axis (uses 9V battery). Zero-power illuminated finder. Excellent condition. Donated to WAA. Current model lists for $379.	$200	WAA ads@westchesterastronomers.org
Celestron SE mount	No optical tube. Go-to alt-az mount and tripod. Can carry 12 lb payload or tube up to 17". Upgradeable hand control.	$300	Greg Borrelly gregborrelly@gmail.com
Celestron Binoviewer	Use both eyes with your telescope. Original case, with two 18-mm eye pieces.	$180	Greg Borrelly gregborrelly@gmail.com
Celestron Eyepiece Set	Like new condition. 4, 6, 9, 10, 15, 32-mm eyepieces, 2X Barlow, 6 colored planetary filters, Moon filter, in padded case. Donated to WAA	$125	WAA ads@westchesterastronomers.org
APM 100-90° ED APO binocular telescope.	Big astronomy binos! Two APM 18-mm UFF eyepieces (30x). Vixen dovetail. Weighs 16 lbs. Magnesium body, nitrogen filled. Soft case with hard foam insert. Four years old. Lightly used, excellent condition. See it here.	$1695	Eugene Lewis genelew1@gmail.com
Celestron Cometron telescope	Small, lightweight 114 mm f/4 reflector. Red dot finder, 25 mm eyepiece. Dovetail. A starter scope for a smart child. No tripod (use a camera tripod). Excellent condition.	$50	WAA ads@westchesterastronomers.org
ADM R100 Tube Rings	Pair of 100 mm adjustable rings with large Delrin-tipped thumb screws. Fits tubes 70-90 mm. You supply the dovetail bar. 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

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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