SkyWAAtch

The Newsletter of Westchester Amateur Astronomers

May 2019

Leo Triplet by Arthur Rotfeld

Arthur imaged galaxies NGC 3628 (left), M65 (upper right) and M66 at Lake Taghkanic on a chilly evening in early February with an 80mm apochromat. The Leo triplet galaxies are 35 million light years distant. Although NGC 3628 is nominally the brightest of the group at magnitude 9.4, it was discovered by William Herschel in 1784, four years after Messier discovered the other two (M65 is 10.3, M66 is 9.7). The galaxies are gravitationally bound and interacted within the last billion years. The bright star just above them is HD98388, 7.12-magnitude, spectral type F8V, 143 light years distant.

WAA May Lecture

Friday, May 3rd, 7:30 pm

Lienhard Hall, 3rd floor
Pace University, Pleasantville, NY

Investigating asteroid impacts using three-dimensional petrography of ordinary chondrites.

John Friedrich, Fordham University

The imaging technique known as x-ray microtomography allows geologists and meteorite researchers to probe the internal structure of solid materials in three dimensions at extremely detailed resolution, up to 1 micron (1/1000th of a millimeter) per voxel (cubic pixel). Dr. Friedrich will discuss how this technique works and how it is used to investigate physical structure of meteorites and to reconstruct their impact history. This can provide information on the meteorite's parent body. In the case of ordinary chondrites, these parent bodies are the earliest relics of the newly formed solar system.

Jon Friedrich is a Professor of Chemistry at Fordham University. He studies the chemical and physical processes shaping the early solar system. He earned a Ph.D. from Purdue University and is a Research Associate of the American Museum of Natural History.

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

Also In This Issue

WAA Lectures will resume on September 13th with Members' Night

Starway to Heaven

Ward Pound Ridge Reservation, Cross River, NY

Saturday, April 27th Sunset is at 7:47 pm
Saturday, May 4th is make-up night.

Saturday, May 25th Sunset is at 8:15 pm
Saturday, June 1st is make-up night.

New Members

Steven Bellavia	Mattituck
Daniel Drury	White Plains
Mitchell Feller	Cortlandt Manor
Garth Landers	Stamford
Matthew McGowan	New York
Anthony Ortega	Scarsdale
Chris Porcelli	White Plains

Renewing Members

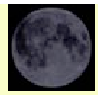
Lawrence C Bassett	Thornwood
John Benfatti	Bronx
Jim Cobb	Tarrytown
Everett Dickson	Dobbs Ferry
Ireneo Fante	White Plains
John & Maryann Fusco	Yonkers
Robbins Gottlock	Sleepy Hollow
Rena Hecht	Rye
Jeffrey Jacobs	Rye
Arumugam Manoharan	Yonkers
John Markowitz	Ossining
Arthur Rotfeld	White Plains
Neil Roth	Somers
Anthony Sarro	Scarsdale
Red Scully	Cortlandt Manor

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

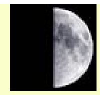
Editor: Larry Faltz
Assistant Editor: Scott Levine
Editor Emeritus: Tom Boustead

ALMANAC For May 2019

Bob Kelly, WAA VP for Field Events



New
May 4



1Q
May 11

Full
May 18

3Q
May 26

Bright planets are trickling into the first half of the night. Jupiter-rise advances from 11 pm to 9 pm by the end of May. Saturn appears by 11 pm by month-end. This leads to a summer of Jupiter and Saturn at our star parties. Mars leaves the scene before any of the bigger siblings show up.

Morning comes earlier and night comes later in May, leaving only five hours five minutes of true darkness each night by the end of the month. One advantage is satellite overflights are visible at any time of night, as the Sun is still shining on objects a few hundred miles above us, even at local midnight on the ground below.

The International Space Station sails over us many times a night from the 17th through the 20th. On the night of the 17th/18th six overflights may occur. In the first half of May, the ISS is visible several times each morning, and several times each evening in the last ten days of May.

Mercury slides through SOHO's fields around superior conjunction on the 21st. Mercury is on the far side of the Sun, small but fully lit and thus very bright, with magnitude of - 2.4. The innermost planet sneaks into the evening sky very late in May, but it's going to be hard to spot until the first days of June.

Venus struggles to hold some separation from the Sun. The brightest planet as seen from Earth is magnitude - 3.8, otherwise it would be very hard to find. It's only ten degrees above the horizon at sunrise and a small, gibbous disc in the telescope. A very thin Moon comes to visit on the 1st and 2nd. If you are already out with a telescope, magnitude + 5.9 Uranus is near Venus, closest on the 18th.

Mars reaches its highest declination, up with high-flying Taurus and Gemini, setting after 10:30 pm. Some very dedicated observers are getting photos showing some surface features, despite it being less than one-fifth the apparent size it will have at the upcoming 2020 opposition. Early in May, Mars stands between the ends of the horns of Taurus. On the 6th, our Moon stands on the bull's head, low in the west-northwest in twilight.

Have you seen the photos of Jupiter and Saturn taken by our earthly photographers? You could lose yourself for a good long while with all the detail on Jupiter. We lesser eyepiece-using mortals can check out the differently shaded bands on Jupiter. Could the typically lighter equatorial region be dark like the Northern and Southern Equatorial Belts? See for yourself! It's sad that Jupiter is about as low as it can get in our skies.

On the other side of Sagittarius from Jupiter, Saturn perches next to the Teapot asterism of stars. They are highest about 3 to 4 am daylight time, about 1/3 of the way up from the horizon to overhead. Saturn, magnitude + 0.4, tends not to stand out like - 2.5 Jupiter does. However, Saturn's rings seen in the telescope are never a disappointment to observers. Saturn's brightest moon, Titan, is not as bright as Jupiter's big four moons, but can be spotted in a small scope. You may need a larger scope for Iapetus, visible nearby to Saturn's west, dimming as it passes north of Saturn at mid-month. According to Sky & Telescope's *SaturnMoons* app for iPhones, a background star appears to track alongside Iapetus' path as Saturn moves westward this month.

1 Ceres, the first asteroid to be discovered, and the only one of the bodies between Mars and Jupiter to be named a "dwarf planet" by the IAU, is brightest in May and June, peaking at magnitude + 7.0. It holds magnitude 7 brightness into June as it passes from Ophiuchus into Scorpius and rises higher in the sky earlier in the evening. Then it passes north of the top of the vertical line of three stars leading the scorpion.

The Eta Aquariid meteor shower peaks at dawn on Saturday May 4th. The radiant rises just before 3 am daylight time, so there is a small window of opportunity to see many of these pieces of Comet Halley. Meteor rates for this shower are still high for a few days before and after the peak. If Saturday morning is not for you or it's cloudy, try another day or two before or after. Eta Aquariids tend to have larger pieces than most showers, so the meteors are often bright. With the radiant low in the east, meteors that skim the top of the atmosphere can leave long, exciting trains.

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

Member Profile: Roman Tytla

Home town: North Salem, NY

Family: Wife Angela and sons Alexander and Maximus

How did you get interested in astronomy? As a city kid from Brooklyn, I spent the summer months since I was an infant in the high peaks region of the Catskill Mountains. The minimal light pollution made it easy for me to discover and contemplate the night sky. As an adult, what really got me hooked was a coffee table book featuring Hubble's first (corrected) images. The image of the "Pillars of Creation" was on the front cover and I remember thinking to myself, "OMG, what the heck is that?" So, it was the Hubble that got me hooked.

Do you recall the first time you looked through a telescope? It was at the Stamford Observatory in Stamford, CT. Fellow WAA member Rick Bria was operating the 22" scope. The first object I saw was a galaxy, not sure which one. I was surprised to see only a white mist. I was expecting to see something similar to the Hubble images but Rick explained that there are not enough photons to see the all details in real-time. That's where a camera and exposure times make all the difference.

What's your favorite object(s) to view? It's a toss up between Saturn and Jupiter. Saturn has its wonderful rings but the moons orbiting Jupiter are just as amazing.

What kind of equipment do you have? Meade 4500 Equatorial Refractor.

What kind of equipment would you like to get that you don't have? A C8 that Rick Bria promised me two years ago. Rick, are you reading this?

Have you taken any trips or vacations dedicated to astronomy? My wife Angela and I traveled to Casper, WY in 2017 for the total solar eclipse. Initially, Angela was lukewarm at best at the thought of traveling across the country for an eclipse, but after the event was over I received heartfelt thanks from her. She simply had no idea of the impact it would have.

Are there areas of current astronomical research that particularly interest you? Exoplanet discovery. The science is just getting started.

Do you have any favorite personal astronomical experiences you'd like to relate? My favorite astro activity is to simply lie on a chaise lounge on a summer evening in the Catskills and stare into the heart of our Milky Way galaxy. No telescope necessary. Just a special beverage in one hand and the Sky Safari app in the other.

What do you do in "real life"? I'm a graphic artist, musician/recording artist and entrepreneur. I run my own marketing/advertising agency from home. I also run an e-commerce business that specializes in authentic prints of the cosmos, Big Bang Prints (https://bigbangprints.com/).

Have you read any books about astronomy that you'd like to recommend? *Breakthrough* by Robert Gendler.

How did you get involved in WAA? I thought it would be a great way to meet like-minded people that share my awe and wonder of the cosmos.

What WAA activities do you participate in? I've participated in several lectures and have attended the annual BBQ.

Provide any other information you think would be interesting to your fellow club members, and don't be bashful! There is an abandoned small airport on a mountaintop in North Lexington, NY (Catskills high peaks region) that I've taken my telescope to several times. The night sky is beautifully exposed and the light pollution is minimal. There are a few slightly taller mountains circling the airport so it's not a perfect horizon-to-horizon dome but it is still an exceptional observation spot. I have received permission from the property owner to use the airport for observation. As it is only a 2 hour drive from Westchester county, I would highly recommend taking a trip up. You can stay at my family's 4 apartment ski chalet, which is only 2 miles down the mountain from the airport. And of course, any WAA members get the family discount rates! ■

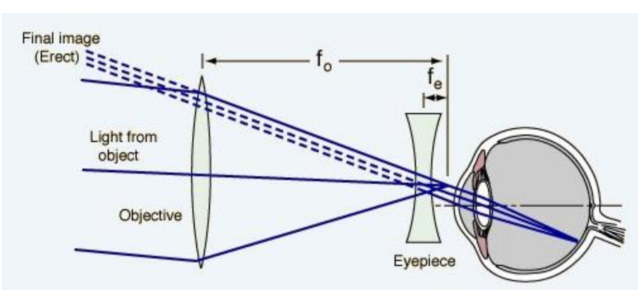
Moon Lost, Moon Found

Larry Faltz

The report in the February 21st issue of *Nature* of the discovery of another moon orbiting Neptune got me thinking about the rather vast number of moons in the solar system, with which the addition of the tiny (8-10 km radius) Hippocamp comes to 194. Until four hundred and nine years ago, there weren't any moons, although before Copernicus every solar system body might have been considered a moon since they all were presumed to orbit the Earth. But that's hindsight.

In January 1610, Galileo discovered four satellites revolving around Jupiter. If Jupiter had moons, why not the other planets as well? By the mid-seventeenth century the hunt was on. The new science of astronomy and its companion discipline optics grew hand-in-hand. A decade before the discovery of Saturn's moon Titan by Christiaan Huygens in 1655, using a refractor of his own design and manufacture, an astronomer with a new instrument claimed to have seen a moon of Venus.

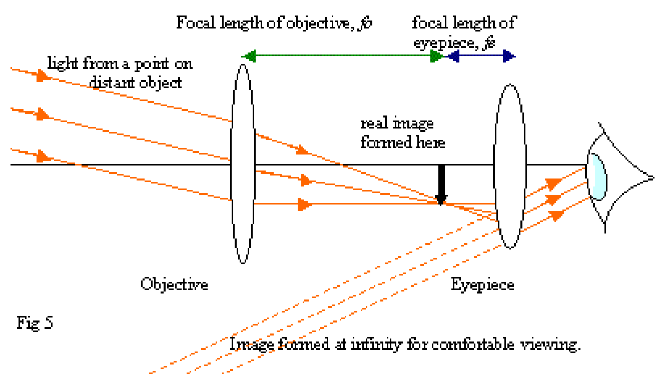
Galileo's telescope consisted of a convex objective and a concave eyepiece, both with spherical figures. The eyepiece receives the image from the objective before it comes to focus. It gave an upright, correct image but with significant spherical and chromatic aberration, a narrow field of view and rather small eye relief. The only Galilean telescopes in use today are those foldable opera glasses that give 2-3X, probably sufficient if you are in the back row at *Hamilton* or *Gotterdammerung*.



Galilean telescope

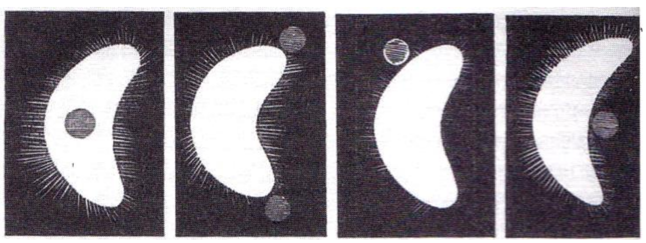
The telescope worked, but as Isaac Asimov points out in *Eyes on the Universe*, Galileo didn't know *why* it worked. Johannes Kepler was the first to study telescope optics rigorously. He was able to see that a spherical lens didn't focus all the light rays at a single point. He considered the lens of the human eye and realized it didn't have a spherical curvature, and he speculated that a way might be found to grind a lens into a more complex shape. That didn't happen until long after Kepler was gone. Aberration was controlled by other means, primarily through long focal lengths and masking the edges of the lens so that only the central zone, less angled to the light rays, is used.

Kepler's study of the Galilean telescope led him to propose that the image from the convex objective be allowed to come to focus within the telescope tube and permitted to diverge again, with a convex eyepiece on the other side of the focus. The image would be sharper and the field wider at the expense of being upside-down, a tolerable flaw in the setting of astronomical observation. In addition, cross-hairs would be in focus if placed at the point that the objective formed an image, allowing the telescope to be precisely pointed. Positions of stars and planets could then be accurately measured. The tube would be longer, but imaginative mountings could cope with that.



Keplerian refractor telescope

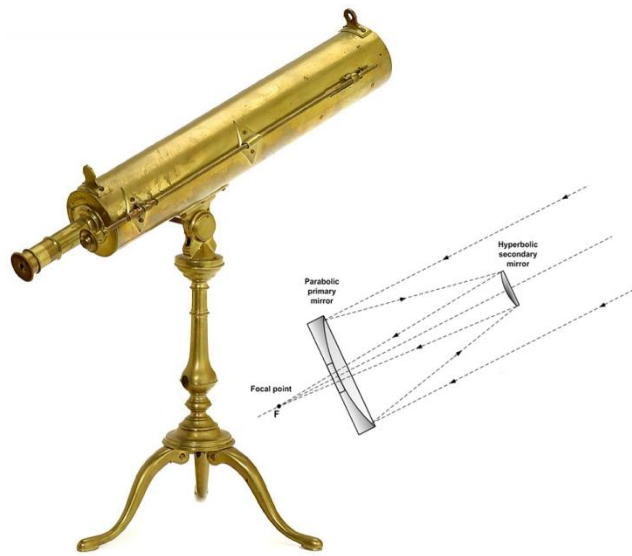
The first person to use a Keplerian telescope may have been Christoph Scheiner, a competitor and apparent enemy of Galileo who studied sunspots and thought they were opaque objects circling the sun rather than things on the solar surface, as Galileo correctly surmised. Beginning in 1640, the Italian lawyer and astronomer Francesco Fontana made Keplerian telescopes, observed Jupiter's belts and claimed to see markings on Mars. On November 11, 1645, Fontana trained his telescope on the planet Venus and saw two small circular objects that seemed to follow the planet. He saw one at the top of Venus's convex side on Christmas Day and on January 22, 1646 he saw it facing the concave edge. He published his observations in a scholarly work *Novae coelestium terrestriumque rerum observationes, et fortasse hactenus non vulgatae* (New Observations of Heavenly and Earthly Objects Perhaps Heretofore Not Known). The discovery was met with a bit of disdain. Apparently, whatever his skills as a telescope maker, Fontana's stature as an observer was not particularly high. Other observers failed to find the satellites. Evangelista Torricelli, inventor of the barometer and an acquaintance of Galileo, called the moons "stupidities observed, or rather dreamed up" and French philosopher and polymath Pierre Gassendi was unable to repeat the observation with his Galilean telescope. Jesuit astronomer Giambattista Riccioli, who discovered the first double star, said the moon was "very ungraceful" and proposed it might be due to meteors or clouds. Fontana had his defenders, however. Andreas Tacquet, a prominent Flemish mathematician, suggested that the failure of others to observe the moons was due to their inferior telescopes.



Fontana's original woodcuts from 1646 showing the putative Venusian satellites. The thin lines emanating from Venus represent its flickering in the atmosphere.

There were no other sightings until 1672, when Jean-Dominique (Giovanni Domenico) Cassini, the first director of the brand new Paris Observatory, thought he observed the satellite. Cassini had discovered Saturn's moons Iapetus, Rhea, Tethys, and Dione and these were quickly confirmed by other observers. Cassini wasn't sure about the Venus observation, so he didn't publish that observation right away. He thought he saw it again in 1686. He still didn't publish. In 1683, Cassini studied the zodiacal light, which he thought was a phenomenon of the solar atmosphere (we now know it is due to cosmic dust particles in the plane of the ecliptic reflecting the Sun's light). Cassini died in 1712, but when his paper on the zodiacal light was reprinted in 1730 the two Venusian moon observations were included. In the text, he admitted that he wasn't really sure what he had seen.

There were no further observations of a Venusian moon until November 3, 1740, when Scotsman James Short made an observation with his Gregorian reflecting telescope. James Gregory had designed the telescope in 1663. It required a parabolic primary mirror and a hyperbolic secondary mirror, figures which were beyond the craftsmen of the day. A few years later Isaac Newton invented his version of the reflector, accepting the limitations of a spherical mirror, which was much easier to figure. Elected to the Royal Society in 1737, Short was the first person to overcome the difficulties of crafting the more complex parabolic and hyperbolic figures in speculum metal. His telescopes were said to give superior images and even though he priced them several times above the competition, he produced and sold over 1,000 of them, becoming wealthy in the process. He kept his production processes secret and even had his tools destroyed upon his death.



Gregorian telescope by James Short c. 1753. The telescope is focused by moving the secondary.

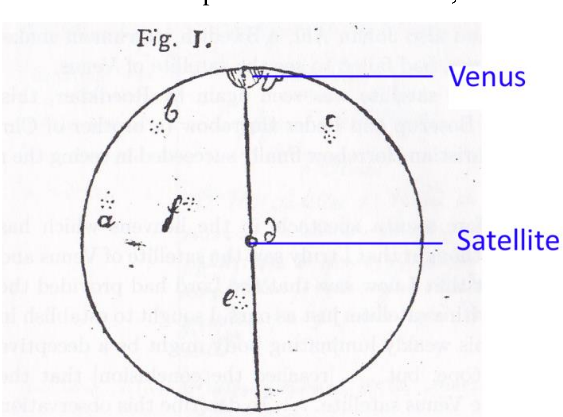
Short looked for the satellite on subsequent occasions but was unable to find it. Later in life he came to the conclusion that whatever he had seen, it wasn't a satellite of Venus.

On May 20, 1759, German astronomer Andreas Mayer observed "a little globe of far inferior brightness, about 1½ diameter of Venus from herself." Mayer delayed publication of this observation until 1762, when he included it in a report on the June 6, 1761 transit of Venus.

Johannes Kepler's *Rudolphine Tables*, published in 1630, predicated that Mercury would cross the face of the Sun on November 7, 1631 and Venus would cross on December 7, 1631. No one saw those transits, but the predicted transit of Venus on December 4, 1639, was corroborated by Jeremiah Horrocks and William Crabtree, who viewed the event from Much Hoole, England. Famously, Edmund Halley showed in 1716 that precise measurements of the times of ingress and egress of the planet, when taken from different places on the Earth's surface, could be used to determine the astronomical unit, the distance between the Earth and the Sun. As a result, the next pair of transits, on June 6, 1761 and June 3, 1769, stimulated many international scientific expeditions, as told in Andrea Wulf's excellent 2012 book, *Chasing Venus*. Just about every astronomer of note planned to observe the event, some making daunting voyages (often without success due to weather or travel problems). While most of the observers were interesting in achieving precise timings, many also looked for the Venusian moon, which presumably would transit either before or after the host planet. There isn't much else to do between 2nd and 3rd contact as the planet crossed the solar disk, which took 5 hours 58 minutes in 1761 and 5 hours 42 minutes in 1769, so one might as well look for it.

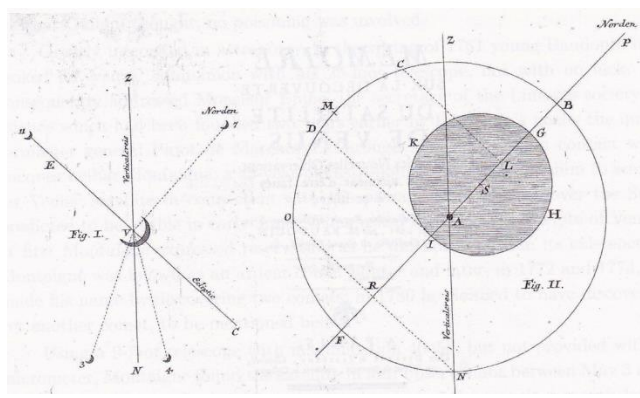
The heightened interest in the possibility of a moon sighting motivated many astronomers to observe Venus in anticipation of the transit, and there were 16 reports of a Venusian moon in 1761. There were just three during the transit, none by a professional astronomer. A Danish amateur, Friedrich Artzt, observed with a 3-foot (focal length) reflector from Zeeland and claimed to have seen a small body that moved differently than the five sunspots that he recorded. Artzt only published this observation in 1813.

In Crefeld, Germany, a Jewish amateur, Abraham Scheuten, waited until 1775 to report in a letter to the astronomer Johann Lambert that he had tracked the satellite across the Sun during the eclipse, and had even seen it after Venus had left the disk. An anonymous Englishman sent a vague report to the *London Chronicle* that was published on June 16, 1761.



Artzt's drawing of his 1761 transit observation, labeled by LF

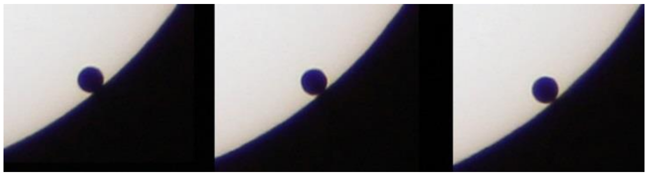
Of the observations that preceded the 1761 transit, there were several by Louis Lagrange, a French-Italian Jesuit (not related to the more famous mathematician Joseph Lagrange) at the Marseilles Observatory. He used a "6 foot" telescope made by Short. He claimed to see a "star" that followed a path perpendicular to the ecliptic. He was sanguine about the accuracy of this observation and didn't report it immediately. Shortly thereafter, Jacques Montaigne observed the moon from Limoges with a "9 foot" telescope. Montaigne sent his observations to Armand Henri Baudouin de Guémadeuc, a civil servant with an interest in astronomy. He read a paper at the Royal Academy in Paris in May 1761 summarizing Montaigne's observations. Although Baudouin had not seen the moon himself, he believed in Montaigne's observations. He even used them to calculate the proposed satellite's orbital period, about 12 days, as well as the ratio of Venus's mass to the Earth's, coming up with 0.98 (the correct value is about 0.8). Baudouin was later imprisoned for fraud and then exiled from France.



Baudouin's diagram of the Venus-moon system (1761). The grey disc is the Sun.

Sandwiched between the two 18th century transits were a few more observations. Christian Horrebow at the Round Tower in Copenhagen claimed two sightings in 1764 and one in 1768. Peder Roedkiæker, also in Copenhagen, claimed two in the same year, to add to the eight he had seen in 1761 (not during the transit), and a Monsieur Montbarron, an amateur using a Gregorian telescope in Auxerre, France whose first name is unknown, claimed three sightings in 1764. He delayed reporting them until 1768.

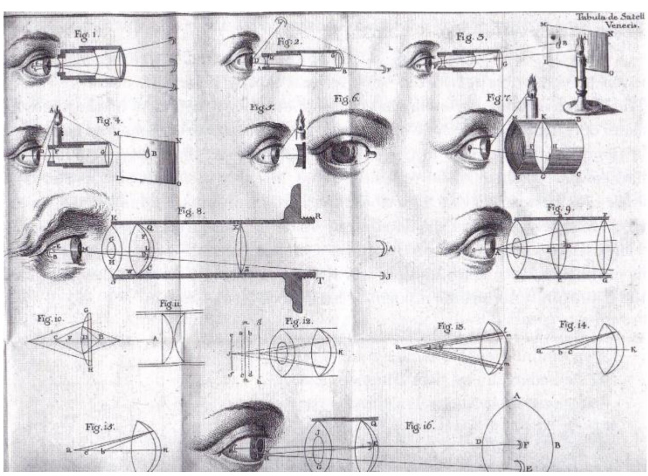
It was during the 1761 transit that that Mikhail Lomonosov, observing at St. Petersburg, discovered that Venus had an atmosphere. The "black drop" effect, which was thought for a long time to be due to the Venusian atmosphere but is not, prevents accurate timing of the transit and limits the accuracy of the calculated Sun-Earth distance. All things considered the results weren't terrible: the 1769 data gave distances of between 148.108 and 154.726 million km. The current value is 149.598 million km.



The black drop effect as seen at second contact, June 5, 2012, Mauna Kea, photos by the author, 80 mm refractor.

There were no reported Venus moon sightings during the 1769 eclipse, which was very widely observed, and none thereafter. Most astronomers concluded that the moon did not exist. Some of the individuals who made sightings were obviously unsure of what they had seen, either delaying publication, often for years or subsequently retracting the observations.

To explain the minimal number of sightings if an actual satellite did exist, an enveloping solar atmosphere was invoked, perhaps the zodiacal light that Cassini had studied. This was proposed by an esteemed French physicist, Jean Jacques d'Ortous de Mairan. He argued that the aurora borealis was also a manifestation of the solar atmosphere (which in a sense it actually is, although in a manner rather quite different than Mairan's idea) because the atmosphere presumably extended as far as Earth. Being denser around Venus, it could obscure a faint moon



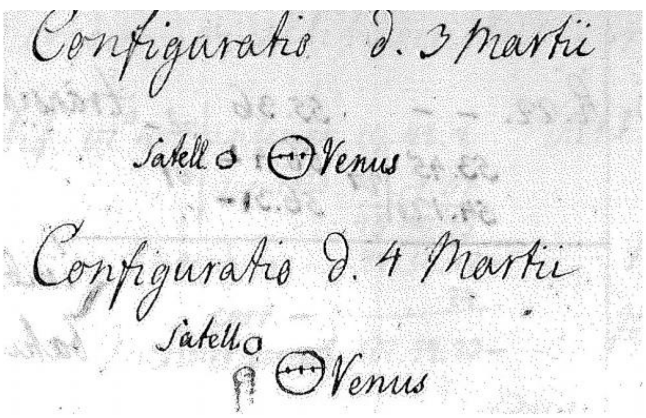
From Maximilian Hell, *De satellite Veneris*, 1765

The most accepted explanation for mistaken sightings was what you might have expected: aberrations in the astronomers' optical systems, whether Galilean, Gregorian or Newtonian. In 1765, Maximilian Hell, the first director of the Vienna Observatory, published an extensive treatise, *De satellite Veneris*. He did experimental research on optical systems and found that for certain eye positions the image of the planet was reflected in the telescope's lenses and then off the observer's cornea, creating a false image.

Five moons of Saturn were discovered in the 18th century, Titan by Cassini and Iapetus, Rhea, Tethys and Dione by Cassini. Why would Jupiter have four and Saturn five? (Jupiter's fainter moons only began being discovered in 1892). Mairan had articulated a theory that was apparently common among astronomers in the two centuries after Galileo: satellites had a specific function in the scheme of the Solar System. It was a common belief that the other planets, and even perhaps the Sun, were inhabited. Since the denizens of the more distant worlds receive less sunlight, the moons were put there to increase the amount of illumination, either by reflection or perhaps by generating it themselves, for the inhabitants' benefit. The farther a planet was from the Sun, the more moons it needed to assist the population. There was still a substantial religious presence in the sciences and an expectation that "the heavens reflected the glory of God," so the theory made a kind of utilitarian sense. It was assumed that Mars had satellites although they were not seen until the two tiny satellites Deimos and Phobos were found by Asaph Hall in 1877 with the 26-inch refractor in Washington, DC. Nevertheless, Mars with two satellites appears in two famous 18th century works of fiction, Jonathan Swift's *Gulliver's Travels* (1726) and Voltaire's *Micromégas* (1752). Even though Venus was closer to the Sun than Earth, it could still have a small satellite to assist its inhabitants, but undoubtedly it would be smaller than the Earth's moon. Maintaining proportionality was important in this theory.

In spite of the general rejection of the Venusian satellite by the scientific astronomical community, references to the moon of Venus made its way into popular astronomical treatises of the late 18th and 19th centuries. Some authors revisited the prior observations and suggested that more observations should be carried out, while others just logged it as a bit of astronomical trivia. It's a bit like discussions of the Big Bang that say that the steady state theory of the universe could still be correct even though Penzias and Wilson had discovered the cosmic microwave background in 1965, for which the steady state had no explanation. The Venusian moon was discussed in Camille Flammarion's widely read *Astronomy Populaire* of 1880. Flammarion doubted the existence of the satellite and wrote "Probably, Venus is found in these epochs to move in front of one of the many small planets found between Mars and Jupiter." The first asteroid, Ceres, wasn't seen until 1801 and so these bodies could not have been considered by earlier observers. The possibility of a Venusian satellite even made into a Jules Verne novel, *Hector Servadae*, in 1877. The protagonists study the planet, review observations by (non-fictional) astronomers who claimed to see a moon, search themselves, but fail to find a satellite.

There seemed to have been a small revival of interest in a Venusian moon around the time of the transits of 1874 and 1882, perhaps aided by interest in the planet Vulcan. After the discovery of Neptune in 1846, Urbain Le Verrier, whose solutions to Newton's equations successfully predicted the position of the planet, considered the problem of the anomalous orbit of Mercury and suggested that the equations predicted another planet closer to the Sun than Mercury. This set off a search, about which I will write in an upcoming article. Several 19th century astronomers suggested that what was seen earlier as a satellite of Venus was really Vulcan. After the 1878 total solar eclipse, observed in the western United States by many eminent and well-equipped astronomers, Vulcan's existence was firmly doubted, and it was put completely to rest by General Relativity in 1916.



Peder Roedkiæker's notes from 1764

Some scholarly discussions were published in the 1870's and 1880's recalling the history of prior observations. Most were skeptical, but not all. A German physician and amateur astronomer, F. Schorr, wrote *Der Venusmond*, a scholarly treatise, in 1875, which claimed that early observations were "not illusions." He recommended a new observing program. The work was reviewed in *Nature* by Thomas William Webb. Discussing the prior observations (recall that the last one was claimed in 1768), Webb noted that if Herschel, Secchi and other astronomers equipped with modern instruments couldn't see a moon, it was hardly like that earlier observers with inferior instruments saw one either. A few astronomers did take a look during the 19th century transits, but detected nothing. In 1887, Paul Stroobant, a young Belgian astronomer, published *Etudes sur le satellite énigmatique de Vénus*," a lengthy paper in the journal of France's Royal Academy of Sciences. He thoroughly analyzed the prior observations, and found that many of the 18th century observations were actually just stars.

One interesting suggestion was made in 1802 by another German physician and amateur astronomer, Julius August Koch, that Roedkiæker's March 4, 1764 sighting of a Venusian satellite was actually the identification of the as-yet undiscovered planet Uranus, which had been discovered by Herschel in 1783. On that date in Copenhagen, Uranus was just 10 arcminutes from Venus at 1 pm and just 16 arcminutes at sunset (I confirmed this with Cartes du Ciel). Stroobant provided arguments that this pre-discovery was unlikely. He concluded that "the satellite of Venus does not exist." By 1900 there was no longer any professional interest in the satellite, but a tiny spark of curiosity remained. The scrupulously objective Patrick Moore wrote in his 1956 book *The Planet Venus* that "it is not impossible that Venus may have a tiny companion" but the reference was left out in the 1982 edition, most likely because Russian and American space missions had finally sealed the moon's fate.

Although Venus doesn't have a satellite, there's some evidence it may have had one in the past. Its slow clockwise (seen from above) rotation is unique in the Solar System. It has been suggested that shortly after its formation, Venus had a moon but it was in an unstable orbit and crashed into the planet, altering its rotation. The relatively young (300-500 million years) Venusian surface would have covered up any topological evidence of an impact, and we're not about to go down to the 872 degree Fahrenheit, 96 atmosphere surface to look for geological evidence.

Venus does have something called a "quasi-satellite," a body in 1:1 resonance with a planet, taking the same time to orbit the Sun but with a different orbital eccentricity. The orbits are unstable. 2002 VE68 is an asteroid that is temporarily travelling with Venus. It was discovered at the Lowell Observatory with a 0.6-meter f/1.8 Schmidt camera as part of the LONEOS (Lowell Observatory Near-Earth-Object Search) project that ran from 1993 to 2008. 2002 VE68 is magnitude 20.50 and appears to be an elongated structure perhaps 200 meters across. Its eccentric orbit (0.410), inclined

9 degrees to the ecliptic, means that it intersects the orbits of both Mercury and the Earth. It seems to have attached itself (barely) to Venus 7,000 years ago and will be ejected from our part of the Solar System in about 500 years. It doesn't get closer to Venus than about 0.2 AU, and by virtue of its faintness it could not have been observed visually. The Earth has five known quasi-satellites and Neptune has one.

It's intriguing to think about what the experience of observing was like for 17^{th} and 18^{th} century astronomers. The sky was unknown, an almost empty canvas. Although there were star maps, these didn't go beyond 6^{th} magnitude, and the narrow field of view in early telescopes, with their substantial spherical and chromatic aberrations, made identifying objects very difficult. Observers had to have a vast amount of patience and take scrupulous notes, figuring out how to describe in words what they saw, or imagined they saw, in the telescope. It's no wonder that the earliest observations were of the brightest objects in the sky. Like any other view of the unknown, imagination plays a part, and desire for discovery can provoke spurious conclusions. It's only natural that some astronomers saw what they hoped to see. We should recall Ernst Wilhelm Tempel's credo: "It is not great telescopes that make great astronomers." [For more information on Tempel, see my article in the January 2017 Sky*WAA*tch.]

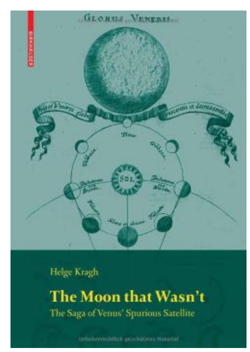
Natural Satellites in the Solar System		
Body	Up to 1910	As of March 4,2019
Mercury	0	0
Venus	0	0
Earth	1	1
Mars	2	2
Jupiter	8	79
Saturn	9	62
Uranus	4	27
Neptune	1	14
Pluto	Body unknown	5
Haumea	Body unknown	2
Makemake	Body unknown	1
Eris	Body unknown	1

As telescope quality improved and then sensitivity was increased by the introduction of astrophotography, imaging sensors, space telescopes and planetary probes, the number of moons in the Solar System increased dramatically. Four hundred and ten years ago, there was one moon. In 1610, Galileo made it five, and in 1655 Huygens made it 6. By 1910, there were 25, and now, with addition of the diminutive Hippocamp (named after a mythical seahorse) to the Neptunian system, there are 194.

The Voyager, Galileo and Cassini spacecraft were prolific moon discovers, but they don't hold the record. Scott Sheppard of the Carnegie Institution of Washington lays claim to 59 of Jupiter's moons, 25 of Saturn's, 2 of Uranus's and 1 Neptunian moon, all discovered since 2000 with telescopes on the top of Mauna Kea in Hawaii. Mark Showalter, who is with the SETI Institute, developed special image-processing techniques for the Hubble Space Telescope and has discovered two moons of Uranus, two of Pluto and now Hippocamp, which may be a fragment of the larger Neptunian moon Proteus, itself a Voyager 2 discovery in 1989. [See the *Research Finding of the Month* in this issue.] Showalter also discovered the Saturnian moon Pan in 1991 by scouring old Voyager 2 images of the planet's rings.

Alex Teachey and David Kepping of Columbia University detected a satellite of the exoplanet Kepler 1625, and we're likely to find more exoplanet moons in the future. We're probably not finished finding moons in the Solar System either. But not one around Venus.

For a thorough examination of the history of the satellite of Venus, read Helge Kragh's scholarly *The Moon that Wasn't* (2008). Kragh is a professor of the history of science and technology at Aarhus University in Denmark. For this book, he appears to have read all the original sources and seemingly tracked down every secondary reference to the satellite of Venus in the history of astronomical literature! It's a remarkable look at astronomy in the 17^{th}, 18^{th} and 19^{th} centuries. Kragh and Kurt Møller Pedersen, Kragh's colleague at Aarhus, wrote a briefer article[1] that's available on the internet and I highly recommend it for a bit more detail than I have provided, although not as much as is in Kragh's first-rate book. ■



[1] Pedersen, KM, Kragh H, The Phantom Moon of Venus, 1645-1768, *Journal of Astronomical History and Heritage* 2008; 11:227-234. http://www.narit.or.th/en/files/2008JAHHvol11/2008JAHH...11..227M.pdf

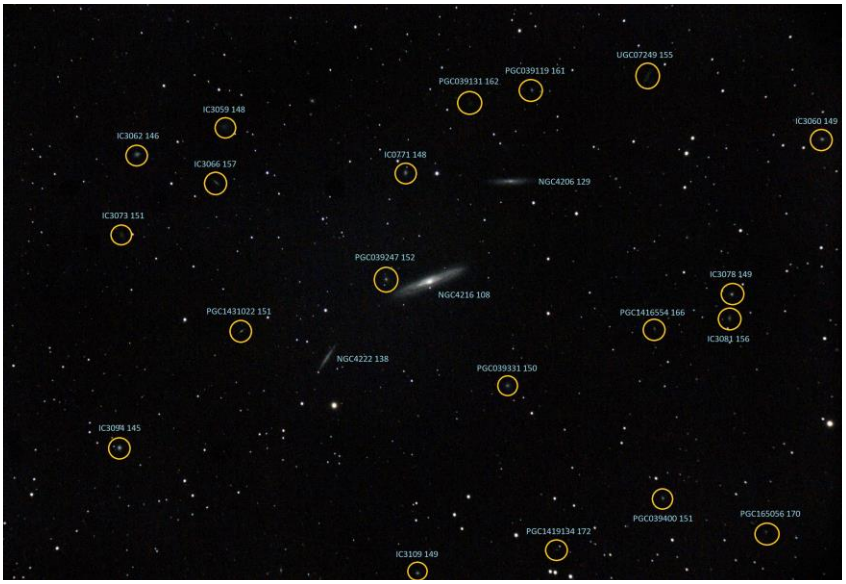
Images

Peter Rothstein and his wife Kate were in Finland on an aurora trip earlier this year. With temperatures of -5 to -10, most of the tour members didn't want to fiddle with camera equipment, so guide Angus King set up a camera with the correct exposure and ISO settings, and supplied these pictures to the group.
Here's Peter, ready for a night of aurora viewing.

The first star party of the year on March 8th had clear skies for just an hour and a half or so early in the evening. There were 5 scopes set up for viewing and even a few hardy members of the public also showed up. Larry Faltz set up a Mallin-cam Color Hyper Plus video camera on his 8" SCT with a focal reducer operating at about f/4.2. Shortly before the clouds rolled in he made this single frame screen capture of the galaxy Messier 82 in Ursa Major, the "Cigar Galaxy," a 14-second exposure.

NGC 4216 and environs by Gary Miller

NGC 4216 is one of the largest and brightest spiral galaxies in the Virgo Cluster. It is 16.87 megaparsecs distant (55 million light years). Gary obtained this image at Ward Pound on April 6th.



Gary's image shows a large number of background IC, UGC and PGC catalog galaxies as faint as 17th magnitude. Enlarge the page to see them. Magnitudes are given without the decimal point. The Virgo cluster has perhaps 2,000 members, and is a component of the Virgo Supercluster that includes the Local Group, of which the Milky Way is a member. Enlarge the page in your Acrobat Reader to see the details.

The bright dot just below the core of NGC 4216 is UCAC4 516-054692, a 14.62 magnitude star. UCAC4 is the Fourth US Naval Observatory CCD Astrograph Catalog of about 113 million stars down to magnitude 16. It is available as a free add-on catalog for many PC astronomy programs.

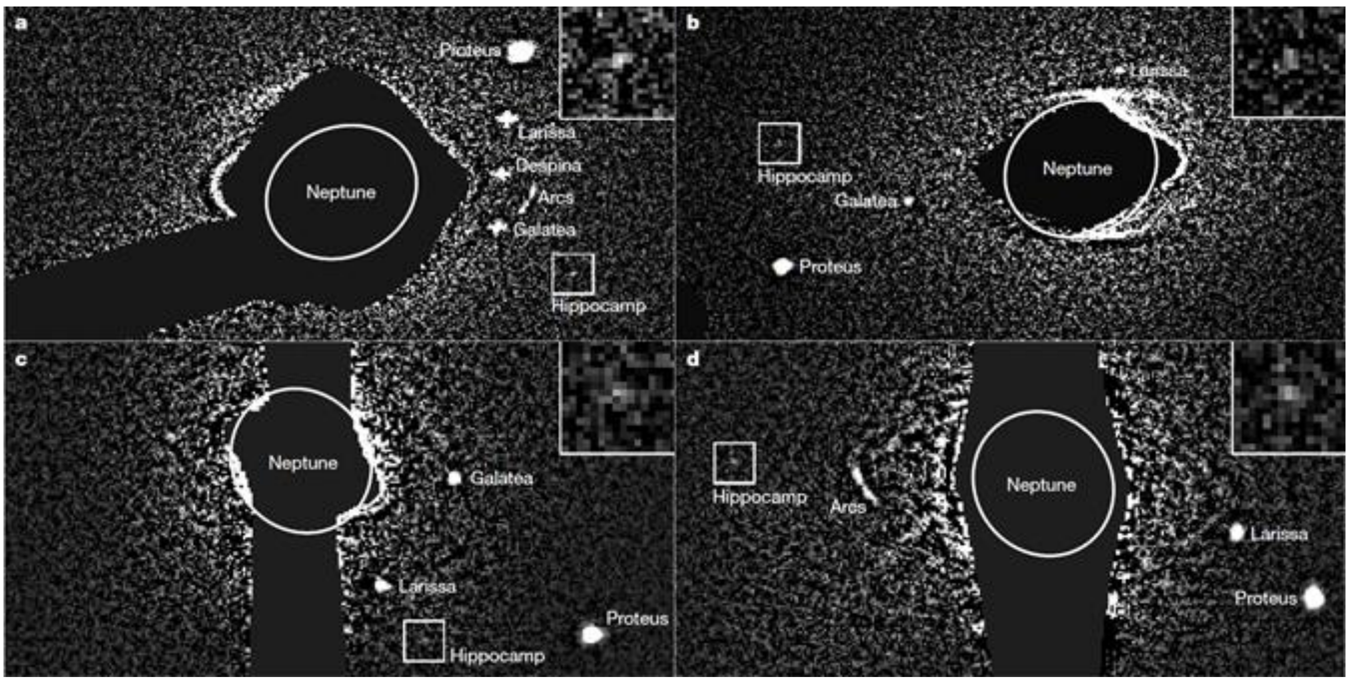
Research Highlight of the Month

Discovery images of Neptune's moon Hippocamp from the Hubble Space Telescope.

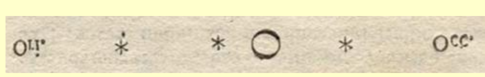
Showalter, MR, de Pater, I, French, RS, The seventh inner moon of Neptune, *Nature* 2019; 566: 350-353

Abstract:

During its 1989 flyby, the Voyager 2 spacecraft imaged six small moons of Neptune, all with orbits well interior to that of the large, retrograde moon Triton. Along with a set of nearby rings, these moons are probably younger than Neptune itself; they formed shortly after the capture of Triton and most of them have probably been fragmented multiple times by cometary impacts. Here we report Hubble Space Telescope observations of a seventh inner moon, Hippocamp. It is smaller than the other six, with a mean radius of about 17 kilometres. We also observe Naiad, Neptune's innermost moon, which was last seen in 1989, and provide astrometry, orbit determinations and size estimates for all the inner moons, using an analysis technique that involves distorting consecutive images to compensate for each moon's orbital motion and that is potentially applicable to searches for other moons and exoplanets. Hippocamp orbits close to Proteus, the outermost and largest of these moons, and the orbital semimajor axes of the two moons differ by only ten per cent. Proteus has migrated outwards because of tidal interactions with Neptune. Our results suggest that Hippocamp is probably an ancient fragment of Proteus, providing further support for the hypothesis that the inner Neptune system has been shaped by numerous impacts.



Accordingly, on the seventh day of January of the present year 1610, at the first hour of the night, when I inspected the celestial constellations through a spyglass, Jupiter presented himself. And since I had prepared for myself a superlative instrument, I saw (which earlier had not happened because of the weakness of the other instruments) that three little stars were positioned near him—small but yet very bright. Although I believed them to be among the number of fixed stars, they nevertheless intrigued me because they appeared to be arranged exactly along a straight line and parallel to the ecliptic, and to be brighter than others of equal size. And their disposition among themselves and with respect to Jupiter was as follows:



Galileo Galilei, *Siderus Nuncius*, March 1610

Member & Club Equipment for Sale

Item	Description	Asking price	Name/Email
Celestron 8" SCT on Advanced VX mount	Purchased in 2016. Equatorial mount, portable power supply, polar scope, AC adaptor, manual, new condition.	$1200	Santian Vataj spvataj@hotmail.com
Celestron CPC800 8" SCT (alt-az mount)	Like new condition, perfect optics. Starizona Hyperstar-ready secondary (allows interchangeable conversion to 8" f/2 astrograph if you get a Hyperstar and wedge). Additional accessories: see August 2018 newsletter for details. Donated to WAA.	$1000	WAA ads@westchesterastronomers.org
Celestron StarSense auto-align	New condition. Accurate auto-alignment. Works with all recent Celestron telescopes (fork mount or GEM). See info on Celestron web site. Complete with hand control, cable, 2 mounts, original packaging, documentation. List $359. Donated to WAA.	$225	WAA ads@westchesterastronomers.org
Meade 395 90 mm achromatic refractor	Long-tube refractor, f/11 (focal length 1000 mm). Straight-through finder. Rings but no dovetail. 1.25" rack-and-pinion focuser. No eyepiece. Excellent condition. A "planet killer." Donated to WAA.	$100	WAA ads@westchesterastronomers.org
Explore Scientific Twilight I Mount	Manual Alt/Az, capacity 18 lb. Steel tripod. Excellent condition. Used fewer than 10 times. Great for grab-and-go viewing. Owner upgrading to an EQ mount.	$130	Eugene Lewis genelew1@gmail.com
Televue Plossl 55mm 2-inch	Very lightly used. Excellent condition. Original box.	$150	Eugene Lewis genelew1@gmail.com
Astro-Tech AT102ED Doublet, f/6.95	ED glass, dual speed FeatherTouch focuser, retractable dew shield, one tiny scratch on the tube, optics perfect. Original travel case. Tube rings, Orion/Vixen dovetail. AstroTech 2" dielectric diagonal and Astro-Tech red-dot finder included. Rarely used, purchased 2009.	$625	Susan Lewis sawl6633@gmail.com
Universal Astronomics Unistar Heavy Deluxe Alt-Az mount	2" Jaw, UA Medium Aluminum Tripod w/ Fixed Spreader, Adjustable Guide Handle, Heavy Tripod Mounting Post 5/8-11. Very good condition. .	$275	Susan Lewis sawl6633@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 submit 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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