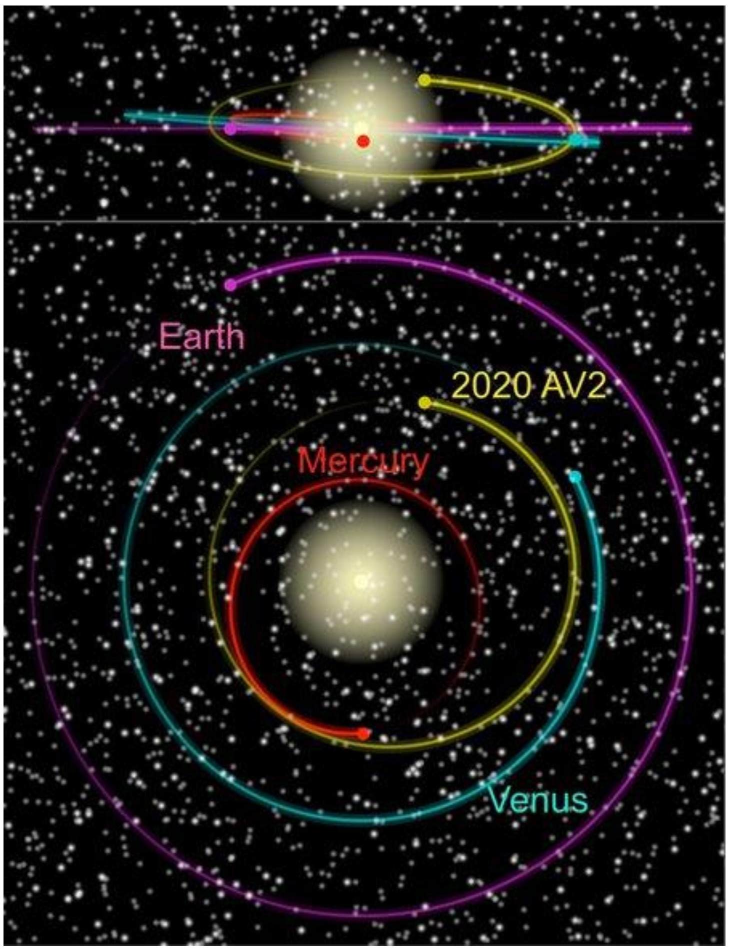
http://www.raclub.org/

The StarGazer

Newsletter of the Rappahannock Astronomy Club No. 3 Vol. 8 November 2019–January 2020

OK…What's a "V atira" When It's at Home?

By Linda Billard



2020 AV2 orbits entirely within the orbit of Venus. Credit: Bryce Bolin/Caltech

First, thanks to Scott Busby for this story idea.

In August 2019, astronomers were predicting the existence of V atiras (Vatiras)—asteroids whose orbits are totally within the orbit of Venus—but no one had actually seen one. In particular, in an abstract of their paper about recently discovered asteroid 2019 AQ3, Spanish astronomers C. de la Fuente Marcos and R. de la Fuente Marcos state:

> "Asteroid 2019 AQ3 may have experienced brief stints as a Vatira in the relatively recent past, and it may become a true Vatira in the future, outlining possible dynamical pathways that may transform Atiras into Vatiras and vice versa. Our results strongly suggest that 2019 AQ3 is only the tip of the iceberg: a likely numerous population of similar bodies may remain hidden in plain sight, permanently confined inside the Sun's glare."

Enter 2020 AV2—found January 4, 2020, by Caltech postdoctoral scholar Bryce Bolin using Caltech's Zwicky Transient Facility (ZWF) at Palomar Observatory. It's now the only known asteroid whose orbit is totally within the orbit of Venus. "Atira" is the appellation for asteroids whose orbits are completely inside the Earth's orbit, and "Vatira" refers to Atiras whose orbits also stay inside Venus's orbit.

An immediate alert posted by the Minor Planet Center (MPC) resulted in several other astronomers following up on the target, helping to define the body's orbit and estimate its size. One of those participating in the attempt to confirm was Italian astrophysicist Gianluca Masi, founder of the Virtual Telescope Project (VTP). VTP is a network of robotic telescopes each operated in a manner similar to our MSRO. Dr. Masi used the VTP robotic telescope in Ceccano, Italy, to photograph 2020 AV2 4 days after the MPC alert. (See https://www.virtualtelescope.eu/2020/01/09/2020-av2-the-first-intervenusian-asteroid-ever-discovered-an-mage-08-jan-2020/ for Masi's photograph.)

The asteroid is 1–3 km in diameter, and its orbital period is 151 days on an elongated path around the Sun that comes close to Mercury's orbit but does not cross it. According to a Caltech press release about the discovery, "The ZTF camera is particularly adept at finding asteroids because it scans the entire sky rapidly and thus can catch the asteroids during their short-lived appearances in the night sky. Because Vatiras orbit so close to our Sun, they are only visible at dusk or dawn." ***(Continued on page 3)***

How to Join RAClub

RAClub, located in the Fredericksburg, Virginia, area, is dedicated to the advancement of public interest in, and knowledge of, the science of astronomy. Members share a common interest in astronomy and related fields as well as a love of observing the night sky.

Membership is open to anyone interested in astronomy, regardless of his/her level of knowledge. Owning a telescope is not a requirement. All you need is a desire to expand your knowledge of astronomy. RAClub members are primarily from the Fredericksburg area, including, but not limited to, the City of Fredericksburg and the counties of Stafford, Spotsylvania, King George, and Orange. We also have several members who live outside Virginia and have joined to have the opportunity to use the Mark Slade Remote Observatory (MSRO)—one of the benefits of joining the club.

RAClub annual membership is $20 per family. Student membership is $7.50. Click here for a printable PDF application form.

The RAClub offers you a great opportunity to learn more about the stars, get advice on equipment purchases, and participate in community events. We meet once a month and hold regular **star parties** each month on the Saturday closest to the new Moon. Our website, www.raclub.org is the best source of information on our events.

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Website: www.raclub.org
Yahoo Group:
http://groups.yahoo.com/neo/groups/rac_group/info

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Upcoming Events		Recent Outreach Events Completed	
Star Party*	February 22	Presentations (3) Park Ridge Elem. Stafford	December 3
Star Party*†	March 21	Star Party, Caledon State Park	December 28
Star Party*	April 18		

*simultaneous star parties at Caledon State Park and Belmont Observatory—Caledon events are for the public; Belmont events are for RAC members only
†Messier Marathon

President's Corner

Dear Members,

RAC is currently without a Vice President. The same few members have been serving the club for many years. We have many new members with diverse talents. Please consider serving your club as Vice President and getting more involved by coming to the monthly meetings and star parties. The more we contribute our time and talent, the better RAC will be able to serve us and the community.

Yahoo!Groups is how RAC has been sending out eMails to its members. However, it has become more and more unreliable. RAC is looking into another eMail service provider. If you have any suggestions or can assist in this matter, please contact me or attend the next general meeting.

Wishing you transparent skies and excellent seeing.

Glenn Faini
President

Did You Know? by Scott Busby

From his entrance into the observatory in 1886 until the present time (1927), William H. Pickering has given much time to observations of the lunar surface. He earlier announced his rejection of the general belief that the moon is an entirely dead and waterless world, void of any atmosphere. His own observations, supported by those of other observers, indicated, in his opinion, considerable changes on the lunar surface, especially in the craters Plato and Linné. He even concluded that his observations pointed strongly to the existence of some form of lunar vegetation at the present time. He asserted the existence of a lunar atmosphere and was convinced that his observations of Linné made during the total eclipse of October 16, 1902, showed definite changes.

Source: *History and Work of the Harvard Observatory 1839–1927*, Solon I. Bailey, McGraw-Hill Book Co., 1931

Editor's Note: If you are interested lunar changes, the Lunar Section of the Association of Lunar & Planetary Observers (ALPO) has a program dedicated to reporting on such changes. You can find these reports in the Lunar Section's bimonthly newsletter *The Lunar Observer.* This regular feature is called Lunar Geologic Change Detection Program. Visit the latest newsletter here and look for "Lunar Geologic Change Detection Program."

OK…What's a "V atira" When It's at Home? *(continued from page 1)*

No wonder they're so hard to find. It is believed that others exist, but so far, they have remained hidden in the Sun's glare. Tom Prince (Professor of Physics at Caltech and a senior research scientist at JPL) theorizes that an encounter with a planet (which one is unknown) threw 2020 AV2 into its current orbit. This behavior is the opposite of what happens when a space mission swings by a planet for a gravity boost. Instead of gaining energy from a planet, it loses it.

A number of sources fund ZTF's search for near-Earth objects, including NASA through the Near-Earth Object Observations program.

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Your Barlow Magnification Might Not Be What You Think It Is

By Glenn Faini

Celestron 2x Barlow Ultima Sv Series

Back in 1999, I purchased a Celestron Micro-Guide eyepiece to make astronomical measurements. Before measuring angular distances with any specific telescope, one must calibrate the Micro-Guide's linear scale in arc seconds. Because published focal lengths are only averages, accurate calibration requires calculating the actual focal length of the telescope. I calculated the focal length of my Celestron C80 to be 893 mm rather than the advertised 910 mm. I also calculated the magnification of my Celestron Ultima 2x Barlow lens to be 2.36x. If you are interested in the technical details of how I did these calculations, please read my article *Using the Celestron Micro-Guide Eyepiece to Make Astronomical Measurements*, published in StarGazer No. 3, Vol. 2 November 2013–January 2014.

Twenty years later, I learned that it's not quite that simple. I discovered that the Barlow magnification factor that I was getting with my DSLR camera was far greater than 2.36x. Even a child will notice that the magnification produced by his magnifying glass varies depending on how close he holds it to his eye. The same physics applies to Barlow lenses.

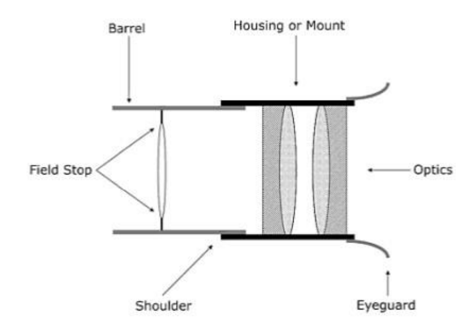

Fig. 1.3 Major components of an eyepiece (Illustration by the author)

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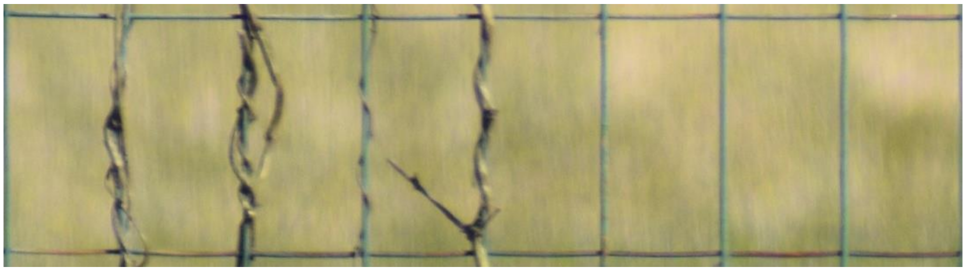
The illustration at right, from William Paolini's book *Choosing and Using Astronomical Eyepieces*, depicts the major components of an eyepiece. The **Field Stop** is a circular opening at the lens's focal plane that produces the sharp edges of the field of view. Ideally, the field stop is located at the **Shoulder**, where the **Housing** and **Barrel** meet and where the eyepiece rests in the focuser or Barlow lens. The advertised magnification factor (2x for my Celestron Ultima Barlow) assumes the focal plane of the eyepiece is located precisely at the shoulder. If the field stop is above the shoulder and therefore farther from the Barlow lens, the magnification will increase. If the field stop is lower and therefore closer to the Barlow lens, the magnification will decrease. Consequently, it is the location of the focal plane in the Micro-Guide eyepiece that results in a Barlow magnification factor of 2.36x. The focal plane of my DSLR camera is much farther back, resulting in a much higher magnification factor.

Because the Barlow magnification determines the effective focal length of the telescope and therefore the *f*-ratio, it is important to know the precise magnification factor to calculate exposures. I used two different methods to calculate the magnification factor of the Barlow lens in conjunction with my Nikon DSLR.

First, I photographed a section of my back fence with and without the Barlow lens. I then cropped the images to the same eight wire sections wide. The ratio of the width of the image in pixels should be the magnification.



$$Magnification = \frac{4915\ pixels}{1498\ pixels} = 3.28x$$

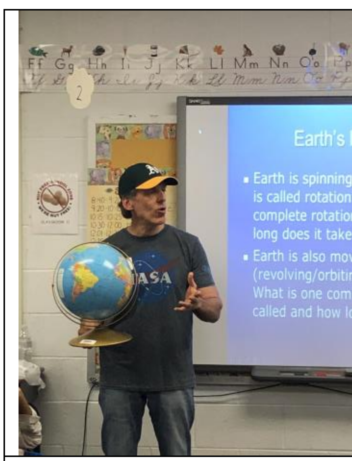
I then used the meter stick method, which is explained on pages 91–92 of *Choosing and Using Astronomical Eyepieces*, and on the webpage Determine Actual Barlow Magnification. It is basically the same concept. Photograph a meter stick with and without the Barlow lens and then take a ratio of the length, in mm, visible in each image. Using this method, I got a magnification factor of 3.27x.

Placing a star diagonal between the Barlow lens and eyepiece provides an additional magnification factor of 1.5 by moving the eyepiece's focal plane even farther from the Barlow. I was not able to perform measurements with the Barlow at the so-called 3x position because my focuser isn't long enough to bring the image into focus. However, by comparing the sizes of Jupiter and Saturn in pixels when photographed with a Barlow at the 2x and 3x positions, I calculated an increased magnification factor of 1.4x rather than the advertised 1.5x. Therefore, the Barlow lens provides magnification factors of 3.3x and 4.6x in conjunction with my DSLR camera.

Now I know to multiply the focal length and *f*-ratio of my telescopes by 3.3 or 4.6 when using my Celestron Ultima Barlow lens in conjunction with my Nikon D3300 DSLR.

Recent Club Events and Star Parties

By Glenn Faini, David Abbou, and Linda Billard



David Abbou Presenting at Park Ridge Elementary

The weather in November and January did not cooperate to allow our scheduled star parties but December was excellent. Read on.

On December 3, David Abbou gave three separate astronomy presentations to a total of 125 third grade students at Park Ridge Elementary School in Stafford. The main topics were the motions of Earth and the Moon and the resulting cycles of day/night, seasons, phases, and tides. His presentations reinforced what the students were learning for their Standards of Learning (SOLs). He received the following comments from one of the teachers: “Mr. Abbou, We can't thank you enough for coming into our classrooms and sharing your knowledge with our students. They loved it, and you did such a great job reinforcing everything that we have taught them over the past 2 weeks! Looking forward to working with you in the future!”

Glenn Faini reported that the December 18 RAC Star Party at Caledon was a GO even though forecasts were for partly to mostly cloudy skies. The weather was unseasonably warm, and the sky was mostly clear. He counted 3 club members, 5 telescopes (2 of which were Christmas gifts), 1 park ranger, and 18 guests. The group concentrated on the conjunction of Venus and the 2-day-old Moon, and Orion and Betelgeuse. The highlight for many was a lone, bright Ursid meteor streaking through Auriga. Some clouds moved through, but the evening turned out to be mostly clear. Glenn commented, “I should NOT have trusted the weather forecasts and set up a telescope.”

Inspection/Testing of RAClub's 94mm f/7 Brandon by VernonScope

By Myron E. Wasiuta

Note from the Editor: Myron keeps detailed notes when he tests out scopes donated to the club. The following article details his checkout of a beautiful old VernonScope we received back in 2013. It provides some insights on what and how to investigate the capabilities and limitations of a new (to you) scope.

I met Glenn Holiday at the LDS Church on Fall Hill Ave to pick up the scope. Delivered was the following:

- 94-mm f/7 light blue OTA with dust cap and 32-mm 2-inch OD plossl eyepiece (21X) in a rack-and-pinion focuser. Focuser is baffled and painted flat black on the interior indicating this telescope was among the later models produced (probably around 1990). There are a few scratches on the focuser and outside the lens cell. The objective lens and coating look to be in excellent condition. Lens has the following printed on edge in green ink: VernonScope and Co. Candor NY 13743. Lens has number "604" written in black felt marker in two places on edge. Is this the serial number of objective? Tube is baby blue enamel, with a small paint chip defect near the place where the tube cradle rings make contact with tube.
- Wooden field tripod with folding legs (the footing covers at bottom of tripod legs appear to be missing) and high-quality counterweighted alt-azimuth mount (Unitron) with slow motion in both azimuth and altitude. Cradle with hinged rings attached to mount. Plastic wing nut at bottom of one leg is cracked and missing one wing.
- 2-inch image-erecting prism diagonal with plastic lens cap.
- 8-mm "Brandon" 1.25-inch OD eyepiece (82X) with plastic field lens cap
- 4-mm "Super Plossl" 1.25-inch OD eyepiece (164X) in plastic lens barrel case
- Red plastic lens cover for 1.25-inch eyepiece
- Small chain for tripod legs
- 2-inch to 1.25-inch adapter

Initial Test Under Stars-Just Getting Acquainted:

After arriving home, with gibbous Moon in sky, I had opportunity to use this nice telescope. Below are a few of my first impressions.

The telescope on its mount and tripod is very portable and light. No problem carrying it. Tripod is tricky to set up because legs swing out from inside and have tendency to collapse until fully set up and tension screws tightened. Recommend setting up tripod without OTA attached.

It is unable to point closer than about 20 degrees to zenith because the OTA makes contact with alt/az slow-motion knobs.

Focuser is rack and pinion and coarse in its operation with some image shift. Not up to quality of today's units on apochromatic refractors-but adequate for visual use.

Using the 32-mm 2-inch plossl eyepiece, I observed the Moon. No noticeable color aberration—very clear and pleasing view. Contrast was excellent with faint visibility of Earthshine. Turning the telescope to the stars, I observed M42 (sword of Orion). Stars were tack sharp with excellent contrast in the center of field, but near the edge of the field, stars showed distortion owing to the eyepiece, making them look like little seagulls. Using this eyepiece, FOV was equal to spacing of the Belt stars of Orion. I replaced the eyepiece with my high quality 55-

mm Televue Plossl. Stunning view with crisp stars to edge of field! FOV even wider, with Orion's Belt framed just within view. Clusters such as Pleiades, Double Cluster, and M35 were also observed and were very beautiful.

Next, I placed the 8-mm eyepiece in the telescope and observed Jupiter. Nice crisp image, but poor eye relief. Jupiter showed no false color in focus, with only a hint of yellow fringe when placed just outside focus and a trace of magenta fringe when just inside focus. This telescope performs very well with the expected level of color correction with this type of triplet objective. Using the 4-mm super plossl-view was somewhat soft owing to the seeing, but still pleasing. However, eye relief is so short that this eyepiece is not very useful. I switched to my high quality 6mm Radian, and the view was much more pleasing. Jupiter showed subtle detail, with no false color, and the Galilean Moons could be seen as disks! Next, with this eyepiece, I observed the Moon. The view was very sharp and again with no evidence of false color in focus except for a faint yellowish fringe at the lunar limb. However, this was very subtle and had to be consciously looked for to see. Again, an excellent result demonstrating very good color correction.

Preliminary Star Test (performed on Rigel with 6-mm Radian eyepiece)

12/12/2013

When I checked the objective using a penlight, it appeared to be squared on.

1/2 turn inside focus: Diffraction pattern shows a round luminous disk with prominent interference rings. Slight magenta color to edges. There is a noticeable area in center of disk that is slightly less bright—mild zonal error?

¼ turn inside focus: Luminous disk still round, slight magenta color more noticeable. There is a bright point-like concentration of light on the top edge of disk at edge. Tube current possible but unlikely as scope has been outdoors for over an hour.

At Focus: Brilliant white star with diffraction disk visible at times—seeing only fair so diffraction rings are only fleetingly glimpsed. Companion easily seen. Telescope passes "snap test."

¼ Turn outside focus: Disc round, bright point concentration not noticed, interference rings softer with edge of disc somewhat fuzzy with hint of yellowish green color to edge.

½ turn outside focus: Disc round, definitely softer interference rings with an overall slightly fuzzy appearance. Outer rings appear a little stronger. Edge of disk slightly yellowish green.

My impression is this telescope has good color correction with perhaps some mild spherical aberration or zonal error. However, in focus, both lunar and planetary views are very pleasing with good contrast. Will need to retest on a night with better seeing.

12/13/2013

Placed OTA on my CG-5 GEM and observed gibbous Moon with 6-mm Radian (110x). Seeing is better than last night although still only about a 6–7 on scale of 0–10 with 10 perfect.

Observing Gassendi—view is very nice! Fractures on floor easily visible—lots of fine detail seen in Mare Humorum, including system of rilles cutting through Hippalus. Limb of Moon sharp with no noticeable color in focus. Intensely white mountain peak seen detached from southern limb. No false color! Detail very sharp. Very clear focus position—-again passes "snap test."

Obtained lunar video using Dynex webcam at f/7, f/21 (3x Barlow) and f/35 (5x power mate).

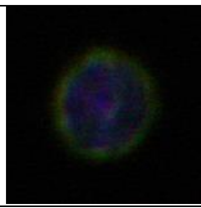
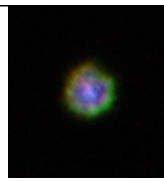
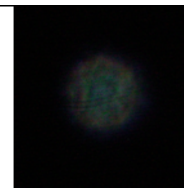
12/15/2013

Star Testing on Vega: Seeing 5–6 on scale 1-10. Used Vega as target in NW sky. 5x power mate with 32 mm plossl

Inside focus 1/3 turn: Slightly fuzzy disc edges with yellowish disc coloration. Interference rings fuzzy but seen. Slightly darker center indicating slight zonal error. Disc round with no evidence of misalignment or pinched optics.

At focus: Brilliant star, well-formed diffraction disc. Faint diffraction ring visible. No false color seen.

Outside focus 1/3 turn: sharp disc with sharp, easily seen concentric interference rings. Outer edge of disc is yellowish green; inside of this is a slightly magenta-colored pattern of interference rings. No sign of focal spot noted two nights ago—must have been a tube current effect. Disc round with no evidence of misalignment or pinched optics. Below are images of star test taken afocally using a 6mm Radian Eyepiece and handheld digital camera.

			
1/3 turn outside focus	Just outside focus	At Focus	About 1/3 turn inside focus

Also obtained a video of star test using Dynex webcam-although camera sensitivity not enough to show test well.

Conclusion

This telescope has excellent optics and color correction. It does have some mild overcorrected spherical aberration, but for all but the most demanding applications, this telescope will more than satisfy the expectations of a discriminating observer! It is a joy to use and can go from providing sparkling pinpoint wide-field star images to very nice high-power lunar and planetary views. It will need footing covers for the tripod legs, and a good storage case for the OTA. Otherwise, the scope is ready to use as is. No adjustment or cleaning of the optics is necessary. The mount is in perfect working order. The only improvement could be the addition of a slightly heavier counterweight. The one included leaves the telescope slightly imbalanced. However, this can be overcome by tension on the slow-motion controls, which are very smooth.

Focus On: Plato and Theophilus

Jerry Hubbell

(Note from the author: A version of this article was published in the January 2020 ALPO The Lunar Observer *as the Focus On bi-monthly article. Part of my role as the Assistant Coordinator (Lunar Topographical Studies) is to write articles periodically on research done by ALPO contributors. To see full-size versions of the photos in this article, go to http://moon.scopesandscapes.com/tlo_back.html To see the latest issue of* The Lunar Observer, go to *http://moon.scopesandscapes.com/tlo.pdf)*

This article is part of a series on the craters in the Lunar Topographical Studies Selected Areas Program (SAP). This is a visual observing program that most beginners can easily start using a small refractor or Newtonian reflector. The program is designed to focus attention on areas of the Moon that have shown unusual albedo changes during the lunation period. The SAP is a great way to get familiar with some of the main features of the Moon and enjoy visually roaming over the landscape to see every tiny detail. You will find all the information needed to start this observing program in the SAP Handbook.

As in the previous articles, we continue to use the Lunar Terminator Visualization Tool (LTVT) to do various measurements of these craters. The goal is to start using this tool to help monitor and detect the "regular and cyclical long-term variations" that may occur in these areas. To learn more about LTVT, please visit the LTVT Wiki. The LTVT allows you to not only measure the size of features, but also systematically measure the size of the various peaks and hills on the Moon using shadow measurements. Some of the changes in these areas involve the shifting shadows, and by measuring specific locations over the long term, the apparent shift in the measured heights over time provides information about the precision of our measurements and allows detection of other shadow anomalies that may occur. Using the [SAP crater drawing templates] and the Lunar Aeronautical Charts (LACs) for each crater, I will be identifying specific shadows to measure. I welcome any suggestions you may have in this regard.

In this article, I cover the craters Plato—63 miles (101 km) and Theophilus—63 miles (101 km). By mere coincidence, these two craters are about the same size.

Plato

Figure 1 shows the crater drawing outlines used in the SAP for Plato, and Figure 2 shows its LAC view. Note that the SAP drawings are depicted rotated 180° (north up, east right) compared with the [crater drawing outline chart] (SAP form) available on the website. This makes comparison easier.

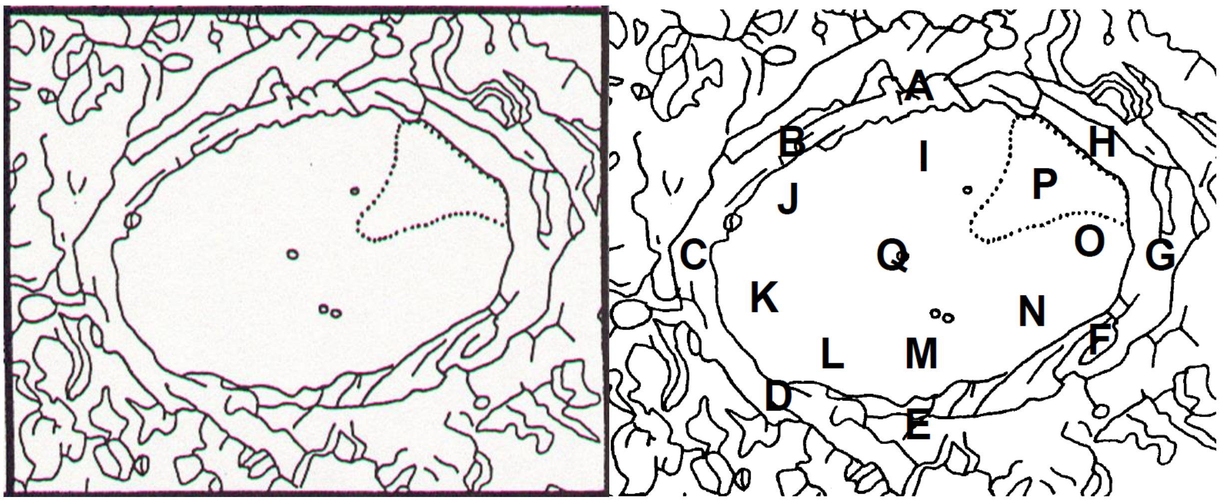


Figure 1. Outline drawing of Plato (left) and Albedo Points for Plato (right) (north-down, east-left)

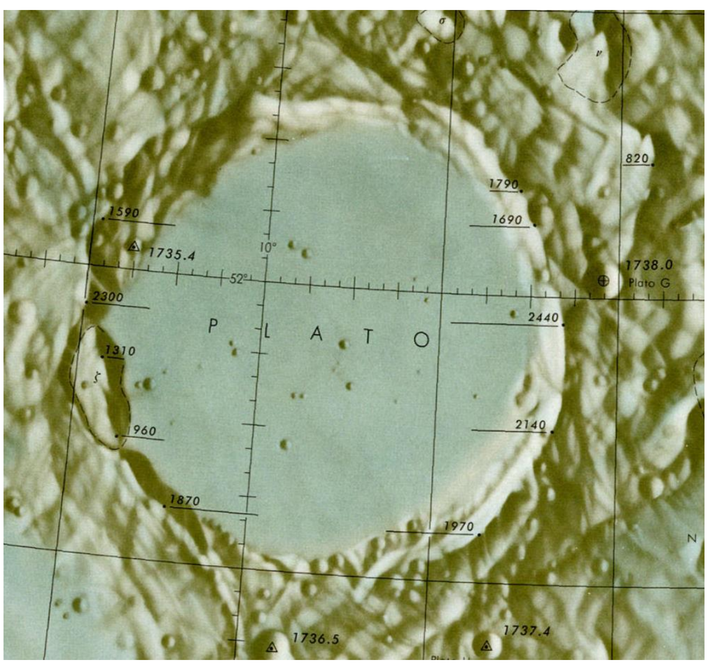


Figure 2. LAC12 chart of Plato. (north-up, east-right)

Plato, 63 miles (101 km) in diameter, was named for ancient Greek Athenian philosopher Plato, a philosopher who lived during the Classical period in Ancient Greece and was founder of the Platonist school of thought. He also founded the Academy, the first institution of higher learning in the Western world. The crater is located on the northeastern shore of Mare Imbrium, at the western edge of Montes Alpes. To the south are several hills collectively named Montes Tenerife. To the north lies the wide stretch of the Mare Frigoris. East of the crater, among the Montes Alpes, are several rilles collectively named the Rimae Plato.

Plato is about 3.8 billion years old and is younger than the Mare Imbrium to the south. The irregular rim has 2-km-tall jagged peaks that project prominent shadows across the crater floor when the Sun is at a low angle. Sections of the inner wall display signs of past slumping, most notably a large triangular slide along the western side. Plato, being far north shows a fair amount of foreshortening and looks like an oval flat plate. Figure 3 is an aerial view of Plato from David Teske's May 14, 2019 image that shows it is really a circle.

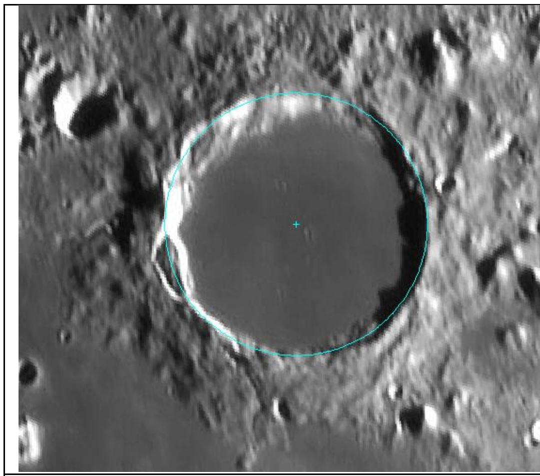


Figure 3. Crater Plato, David Teske, Louisville, Mississippi, USA. 14 May 2019 0321 UT, Colongitude 27.2°. 180 mm Takahashi Mewlon telescope, ZWO ASI 120 mms camera, 500 frames, Firecapture, Registax, Photoshop. Seeing 7/10. North/Up, East/Right. Note: Processed in LTVT and cropped by Jerry Hubbell.

The floor of Plato has a relatively low albedo, making it appear darker than the surrounding terrain. The floor is free of medium-size impact craters and lacks a central peak because the crater was filled with lava during its formation. A few small craterlets are scattered across the floor that are challenging to observe and image. There are reports of transient lunar phenomena (TLP) occurring in Plato, including flashes of light, unusual color patterns, and areas of haze. These anomalies are likely a result of seeing conditions, combined with the effects of different illumination angles of the Sun.

Alberto Anunziato sent in a very nice image of Plato obtained by Francisco Alsina Cardinalli. This image (Figure 4) shows good detail and provides some good shadows on the eastern rim that can be used to measure the height of the rim above the very flat floor of the crater. Alberto and Francisco provide the following description:

"*Probably Plato is the most peculiar crater on the Moon. We are amazed by its almost completely flat and dark floor. Sunk two kilometers beneath the level of the Alps where it is located, interrupted only by a few small craters (very difficult to discern), a dark and huge mass of basaltic lava fills an oval of more than 100 kilometers in diameter. A romantic landscape that is dramatically accentuated when the shadows of the eastern rim cast sharp shadows that look like claws that extend to the western rim, revealing irregularities in the western rim that cannot be observed directly. Another unknown is how so much lava came into Plato's interior if no openings are observed at the rim, lava that flooded a hypothetical central peak that would have to rise 1.5 kilometers above the surface according to the models that explain the impact craters. Among these fascinating features of Plato, we choose the two bright sides triangles that we can observe on the western rim. They are two huge blocks disconnected from the steep rim and that have had to slide down in gigantic landslides of which we don't know their causes… the terminator moves away from Plato and only parts of its west rim are illuminated: the most prominent triangle, a thin line to the south and to the north a very bright spot and some high areas. Image 2 (Figure 4) was obtained with the same instruments just over an hour later and the edges of the famous Plato triangle are clearly determined and inside it we can see a shaded area to the west and a lighter one to the east. The second triangle to the north appears sharper than in image 1…*"

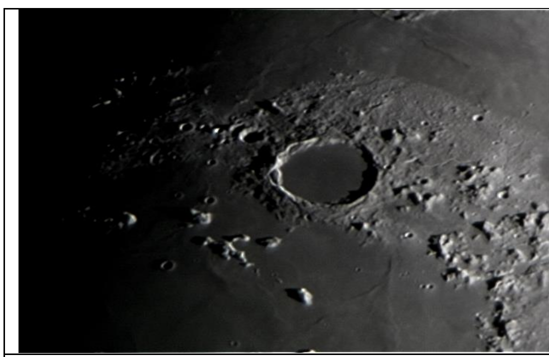


Figure 4. Crater Plato (image 2), Francisco Alsina Cardinalli, Oro Verde, Argentina. 20 December 2015 0206 UT, Colongitude 20.4°. 10-inch Meade LX200 SCT, Canon EOS Digital Rebel XS camera, 500 frames, Firecapture, Registax, Photoshop, Seeing 7/10, north/up, east/right.

The portion of Plato's western rim that slipped down in a triangular shape is very noticeable in Figure 5. This region of the crater rim is a good candidate to determine how much that section of the rim slipped down compared with the section north of the slippage. Figure 6 shows the LTVT analysis of the crater rim in this area, and from the various measurements, we can estimate how much the section slipped. Table 1 shows the measurements.

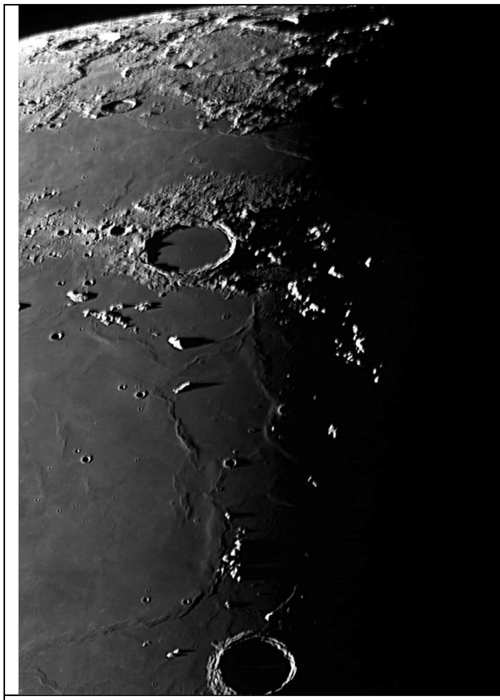


Figure 5. Craters Plato (top) and Archimedes (bottom), David Teske, Louisville, Mississippi, USA. 17 December 19, 2019 1156 UT, Colongitude 183.5°. 180 mm Takahashi Mewlon telescope, ZWO ASI 120 mms camera, 500 frames, Firecapture, Registax, Photoshop. Seeing 9/10.

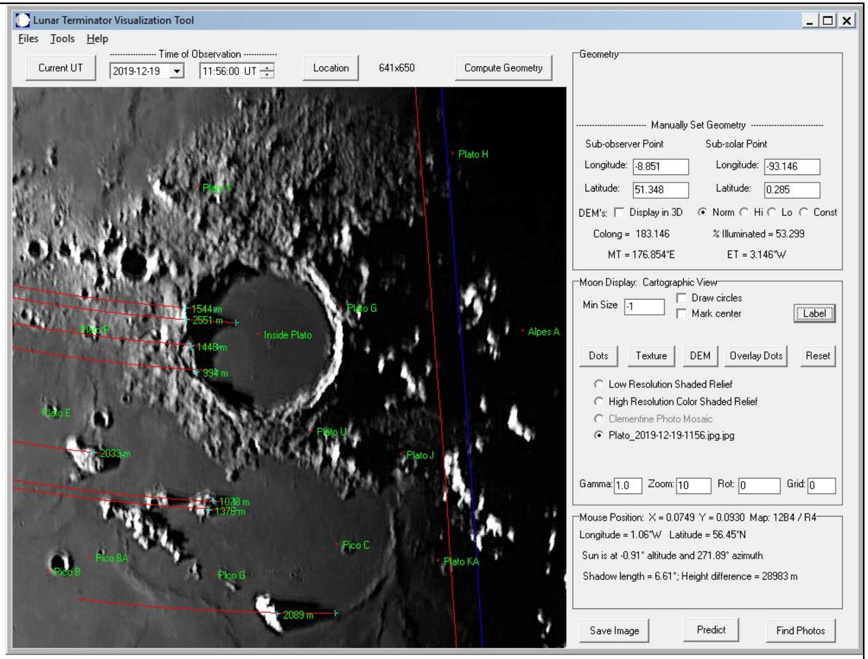


Figure 6. LTVT Measurement of Crater Plato, David Teske, Louisville, Mississippi, USA. 17 December 19, 2019 1156 UT, Colongitude 183.5°. 180 mm Takahashi Mewlon telescope, ZWO ASI 120 mms camera, 500 frames, Firecapture, Registax, Photoshop. Seeing 9/10. Processed in LTVT by Jerry Hubbell

Parameter*	Measured Value	LAC12 Value
Crater Rim Shadow Point 1	1544 m (5,066 ft)	
Crater Rim Shadow Point 2	2551 m (8,369 ft)	
Crater Rim Shadow Point 3 (Slipped Region)	1448 m (4,751 ft)	1310 m (4,298 ft)
Crater Rim Shadow Point 4 (Slipped Region)	994 m (3,261 ft)	960 m (3,150 ft)
Isolated Peak Shadow Point 1 (west Mons Teneriffe)	1078 m (3,537 ft)	
Isolated Peak Shadow Point 2 (west Mons Teneriffe)	1378 m (4,521 ft)	
Isolated Peak Shadow Point 3 (Mons Pico)	2089 m (6,854 ft)	2420 m (7,940 ft)

*As shown from north to south on Figure 6. These measurements are at a colongitude of 183.5°.

Table 1. Plato LTVT Measurements.

The amount of slippage based on the difference between shadow point 2 and adjacent shadow point 3 is ≈1100 m or ≈3,600 ft.

Theophilus

Figures 7 and 8 show the crater drawing and LAC for Theophilus. As with Plato, Note the SAP drawings are depicted rotated 180° (north up, east right) compared with the crater drawing outline chart (SAP form) available on the website to make comparison easier.

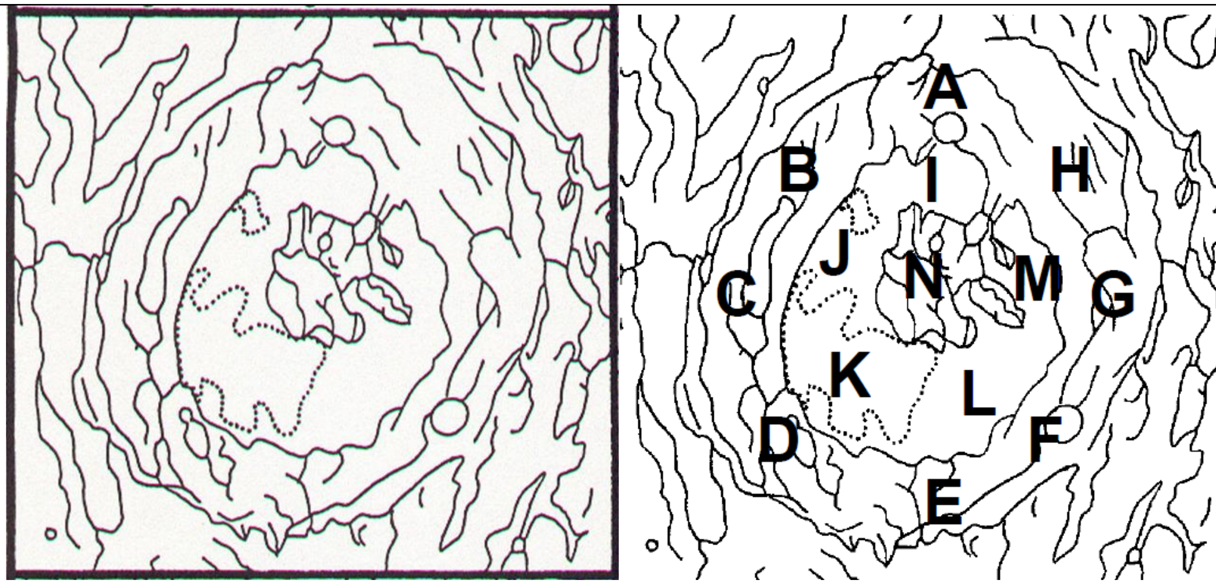


Figure 7. Outline drawing of Theophilus (left) and Albedo points for Theophilus (north-down, east-left).

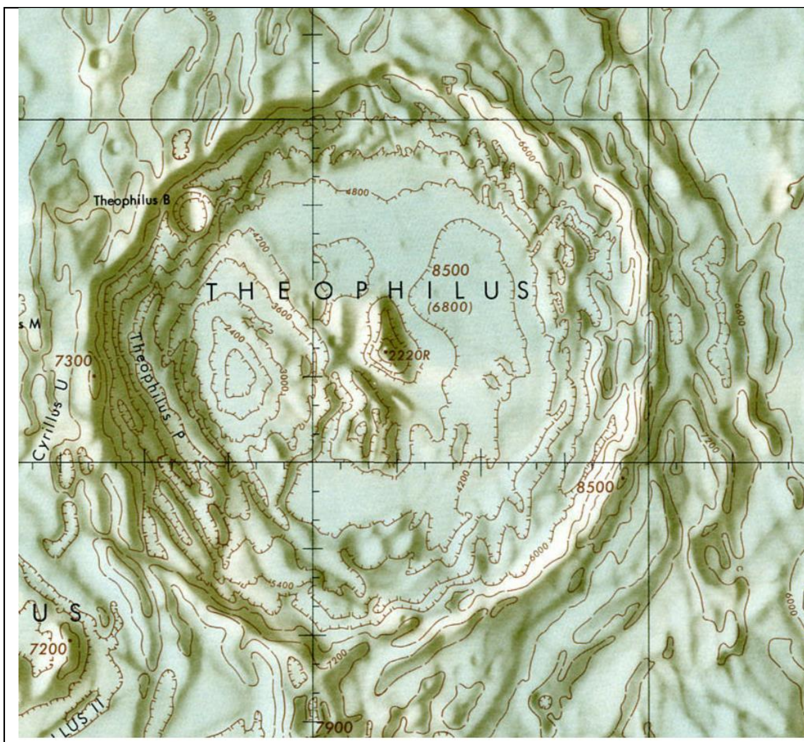


Figure 8. LAC78 chart excerpt of crater Theophilus.

The crater Theophilus is 63 miles (101 km) in diameter. It was named for Pope Theophilus of Alexandria (d. 412 A.D.) according to Wikipedia; however, he is listed as “Greek astronomer (unkn-A.D. 412)” in the IAU Gazetteer of Planetary Names Origins field and does not mention that it is Pope Theophilus. However, the date A.D. 412 in the Origins field seems to confirm it as Pope Theophilus. The crater Theophilus on the lunar surface is near two other large craters nearly identical in size—Cyrillus 59 miles (95 km), and Catharina 61 miles (98 km), which form a trio of craters that are all worth extended study.

The crater has a terraced inner surface and is ≈4300 m deep from the southwestern portion of its rim to the floor and encroaches into the crater Cyrillus. It was formed during the Eratosthene period (1.1 to 3.2 Gy). The central mountain peak is a very interesting formation of four summits, the tallest of which rises ≈2200 m above the floor.

Theophilus is a good candidate for analysis with LTVT because of its numerous peaks and rim features that are easy to see and measure on photographs taken at low Sun angles. Figure 9 is an excellent candidate for analysis with LTVT providing many shadow peaks and crater rim profiles. (Figure 10.)

The measured values for the crater rim at the two points that bracket the estimated rim height of ≈4300 m (14,107 ft) are 4026 m and 4550 m. The average of these is very close to this estimate and is 4288 m (14,068 ft). I estimate the precision to be about ≈ ±130 m (≈ ±430 ft). I think this demonstrates the power of using LTVT to do these measurements.

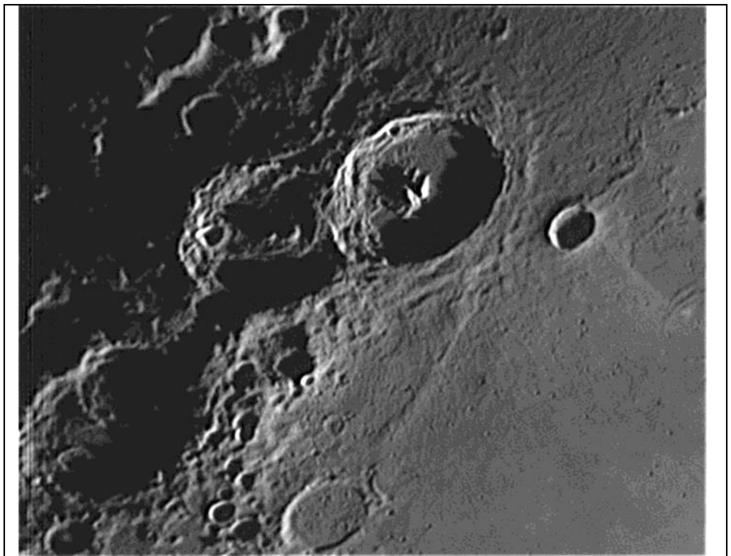


Figure 9. Craters Theophilus, Cyrillus, and Catharina, Jerry Hubbell, MSRO Wilderness, VA. USA. January 11, 2019 2244 UT, Colongitude 339.3°. 12-inch Meade LX200 SCT, 2x Barlow, Red Filter, FLIR Systems Flea3 GigE CCD Camera, north/up, east/right, Seeing 8/10, Transparency 5/6.

Note the triangular slip formation on the southwestern rim of Theophilus (Figure 10, red oval) that is very similar to the larger slip formation in Plato. I had not noticed this before, and it apparently is something that happens on these larger craters. Finally, I measured the diameter of Theophilus and came up with a value of 60 miles (96 km) versus 63 miles (101 km). I would be interested in what your measurements are.

When repeating the shadow measurements at different colongitude values, it is important to make sure you are measuring from the same point on the rim of the crater. This will allow you to trend the measured value for that specific point on the rim over time. Several measurements made at the same colongitude can be averaged, and the scatter of the data can be used to estimate the precision of the measurement. You can use the program Virtual Moon Atlas (VMA) to calculate the time and date at your location for a given colongitude value so that you can image at those times every month to gather your data. Over time, a record of the measurements will show you how your imaging technique has improved the resolution of your images.

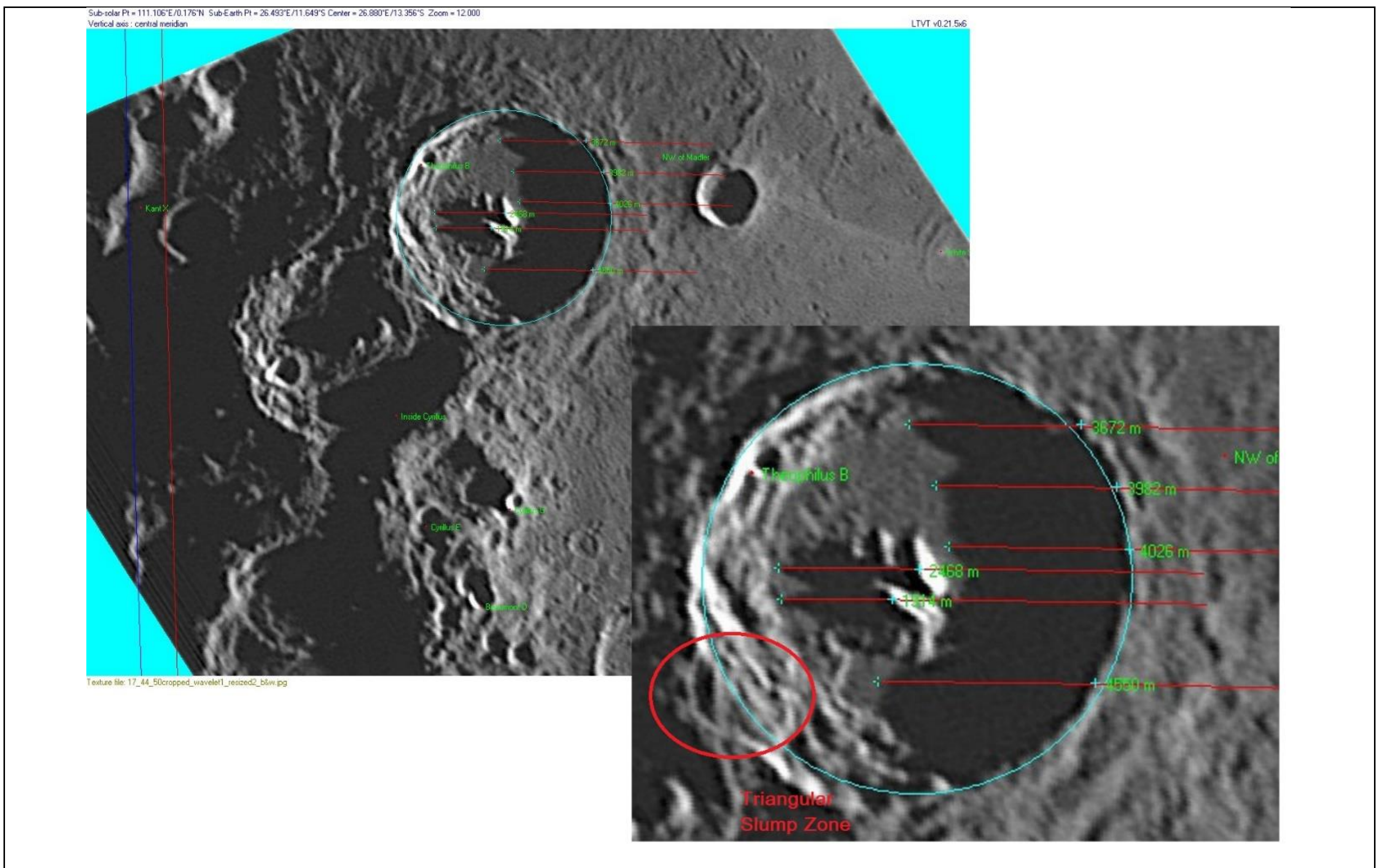


Figure 10, Crater Theophilus Peak Measurements, Jerry Hubbell, MSRO Wilderness, VA. USA. January 11, 2019 2244 UT, Colongitude 339.3°. 12-inch Meade LX200 SCT, 2x Barlow, Red Filter, FLIR Systems Flea3 GigE CCD Camera, north/up, east/right, Seeing 8/10, Transparency 5/6. Processed in LTVT by Jerry Hubbell.

Parameter*	Measured Value	LAC Value
Crater Rim Shadow Point 1	3672 m (12,047 ft)	
Crater Rim Shadow Point	3982 m (13,064 ft)	
Crater Rim Shadow Point	4026 m (13,209 ft)	≈4300 m (14,107 ft)
Central Peak Shadow Point 1	2468 m (8,097 ft)	
Central Peak Shadow Point 2	1914 m (6,280 ft)	
Central Peak Shadow Point 4	4550 m (14,928 ft)	≈4300 m (14,107 ft)

*As shown from North to South on Figure 10 inset. These measurements are at a Colongitude of 339.3°.

Table 2. Theophilus LTVT Measurements

In the next few months, I will be establishing the optimum colongitude for each of the craters in the SAP and the selenographic longitudes and latitudes of the crater rim locations for shadow measurements. That way we all can make repeatable measurements every month and start to understand if we have any odd occurrences in these craters with this additional data.

COMPUTER PROGRAMS

Virtual Moon Atlas https://sourceforge.net/projects/virtualmoon/

Lunar Terminator Visualization Tool (LTVT) http://www.alpoastronomy.org/lunarupload/LTVT/ltvt_20180429-HTML.zip

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Highlights of Recent RAClub Presentations

Abstracted from Bart Billard's Meeting Minutes
NOTE: There was no presentation at the November meeting, which was the annual election of officers.

December 2019—Adventures in Skycam Imaging

Myron Wasiuta began his presentation by saying that the MSRO skycam had been imaging the sky on clear nights starting in May. The first version was mounted on the observatory structure and was put together using a monochrome guiding camera in a plastic electric junction box with Plexiglas on the imaging end and a feed through for USB on the back end. The current version is on the MSRO StationTwo shelter structure with the guiding camera replaced by a low-light security camera. Myron noted the cost was about $300 for the camera and $16 for the enclosure, compared with about $1,000 for a commercial version. He said club members could get the TeamViewer login from him to watch images from home.

Myron also mentioned a StationThree telescope was recently added and was available for training. Beginners interested in learning to operate remote telescopes from home would find StationThree much easier, and he thought the cost should be lower. It uses the monochrome QHY5L-II camera that was on the StationOne structure as the first skycam. The StationThree telescope mount is being used for testing for Explore Scientific as a possible mount upgrade product.

The skycam runs on every clear night, and raw data are kept for a couple of months. It takes one image every 30 seconds. Myron said the last clear night prior to the meeting was December 15. He said he reviews what was recorded each night and saves interesting images to folders with labels like "biological transients," "meteors," "artificial satellites," "unidentified," and "cosmic ray hits."

Myron showed a recent bolide from early November. He confirmed he could judge the start and end of the trail from the image and said he reported it to the American Meteor Society (event 5564-2019), which could help them predict where it might have reached the ground. He also showed a cosmic ray hit and how varied color pixels were excited. He thought another optical transient image he showed us was probably a satellite flare.

Myron next showed images from the "biological transients" folder. These were firefly trails, and he pointed out interesting variations that showed up during the season. The early images showed "segmented trails" with two to nine flashes. They started brighter and ended dimmer and shorter, suggesting "running out of charge." Some were straight and some were curved. Myron said the fireflies did not fly in rain but came out quickly after rain ended. A little later in the season, the trails became continuous, after a mix of segmented and continuous trails near the end of May. He said he learned the continuous trails were made by a different species. Myron showed images from early June with fewer segmented and more continuous trails. He pointed out flashes that could be seen in the trees, and that the trails in the air pointed toward the trees. There were still more continuous trails after mid-June, and a little later, we saw dog legs, or "looping J" trails. As another example of a "biological," Myron showed an image with a spider on the enclosure window.

At the end, Myron showed some very cool lightning images taken at very low gain once every 3 seconds. One pair of images apparently caught the same lightning overlapping the two exposures. The first image could be the leader, and the second could be the full stroke. He also showed a time-lapse video of the January 21, 2019, lunar eclipse, "The night of the Cuba Moon Eclipse," which is posted on YouTube.

January 2020—New Gear

The group spent some time talking about new gear as the January program topic. Bart Billard brought his QHY5L-II camera and explained he had purchased it to try out with his interferometer project. The goal is to get spectra with higher resolution than available with gratings like those used at MSRO. The new camera could get up to twice the resolution possible with the Imaging Source camera Bart was currently using, and more than four times the resolution of the MSRO gratings. Troy Major said he got a new dual-speed focuser for one of his telescopes. Glenn Faini talked about a device he got to provide a Wi-Fi connection between his telescope mount and a laptop or other device to control the telescope. However, he found the connection was not very reliable at home and would even more of a problem at star parties with other WiFi signals within range. When the connection dropped, he would have to start over with aligning the mount to the sky. Glenn F. said he decided to return the Wi-Fi adapter. He also got a second Bahtinov focus mask for his refractpr telescopes. Scott Busby said his Bahtinov focus mask was the only thing he could use to successfully focus his large telescope. It has a helical focuser that rotates the camera as focus is adjusted.

Image of the Quarter

Andromeda Galaxy by Troy Major

Taken December 20, 2019, at the RAClub star party held at Caledon State Park.

Equipment: Williams Optics 98-mm triplet OTA. Celestron AVX Mount. Canon EOS m50 mirrorless camera.

Exposure: 64 30-second exposures iso3500 stacked using DeepSkyStacker.

Postprocessed using Photoshop Express