The Lunar Observer

A Publication of the Lunar Section of ALPO

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Back issues: http://www.alpo-astronomy.org/

July 2022

In This Issue

Be sure to check out the ALPO conference July 22-23, 2022.

Online readers, click on images for hyperlinks

Lunar Reflections

Many thanks to all who contributed to this issue of *The Lunar Observer*! It seems to be growing in size and contributors, which I think is a very good thing! In this issue, 30 contributors from 13 countries contributed 116 lunar reports, drawings, images and articles. In this issue, Rik Hill, Alberto Anunziato, Rafael Benavides and Robert H. Hays, Jr. take us on lunar adventures that we can join with just a small telescope. Darryl Wilson provides us another article on lunar imaging techniques and exploring for titanium with a small telescope. Gary T. Nowak provides an excellent analysis of just how small of a craterlet can be seen through a telescope. The results may surprise you. And top that off, Guillermo Scheidereiter shares some wonderful lunar poetry! Alberto Anunziato used many images to help write up his Focus-On article about Wonders of the Full Moon highlighting northern bright ray craters. Many thanks to all who contributed to the Recent Topographic Studies and submitting eclipse photos as well. As always, Tony Cook provides another interesting article on Lunar Geologic Change and starts his new Basins and Buried Project. Don't forget to send observations of lunar rays (southern disk) to Alberto Anunziato and myself by August 20th. Please be sure to note the ALPO Virtual Conference on page 5. I certainly hope that all can attend. This conference will be most special for us lunar observers!

Clear skies,

-**David Teske**

Lunar Topographic Studies

Coordinator – David Teske - david.teske@alpo-astronomy.org
Assistant Coordinator– Alberto Anunziato albertoanunziato@yahoo.com.ar
Assistant Coordinator-Wayne Bailey– wayne.bailey@alpo-astronomy.org
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Observations Received

Name	Location and Organization	Image/Article
Alberto Anunziato	Paraná, Argentina	Article and images *Wonders of the Full Moon: Northern Ray Craters, Jansen in the Terminator (and what the Slope Looks Like), Some Details on a Wrinkle Ridge in Mare Nectaris*, images of Anaxagoras (2) and Copernicus (2).
Sergio Babino	Montevideo, Uruguay	Images of Bessel, Kepler and Plato.
Rafael Benavides	Posadas Observatory MPC J53, Córdoba, Spain	Article and Image *Theophilus, Cyrillus and Catharina. A Different Trio*.
Juan Manuel Biagi	Oro Verde, Argentina	Image of Kepler.
Don Capone	Waxahachie, Texas, USA	Images of Stöfler, Albategnius, Julius Caesar, Hadley-Apenninus, Alpine Valley and Posidonius.
Francisco Alsina Cardinalli	Oro Verde, Argentina	Images of Anaxagoras (2), Aristillus, Proclus, Menelaus, Eratosthenes, Copernicus, Aristarchus (3), Plato, Mare Humboldtianum and Aristarchus.
Jairo Chavez	Popayán, Colombia	Images of the Waning Gibbous Moon (2), Waxing Gibbous Moon, Bessel and 61% Waxing Gibbous Moon.
Maurice Collins	Palmerston North, New Zealand	Images of the 4.8 day old Moon, southern highlands, Theophilus, Mare Serenitatis, Delambre, 6 day-old Moon, 10.9 day-old Moon, Gassendi (2), Clavius and Plato.
Leonardo Columbo	Córdoba, Argentina	Image of the Full Moon
Jef De Wit	Hove, Belgium	Drawings of the Full Moon, Kepler and Proclus.
Massimo Dionisi	Sassari (Sardinia) Italy	Images of Messier, Petavius, Yerkes, Vitruvius (2), Aristoteles, Arago, Fracastorius and Cauchy.
Walter Ricardo Elias	AEA, Oro Verde, Argentina	Image of the lunar eclipse,
István Zoltán Földvári	Budapest, Hungary	Drawings of Mare Australe, Mare Humboldtianum, Flamsteed T, Reiner, Belkovich, Helmert, Liapunov, Riemann, Plinius and Mare Insularum,.
Desiré Godoy	Oro Verde, Argentina	Images of Anaxagoras, Proclus (2),Bessel and Harpalus.

Lunar Topographic Studies

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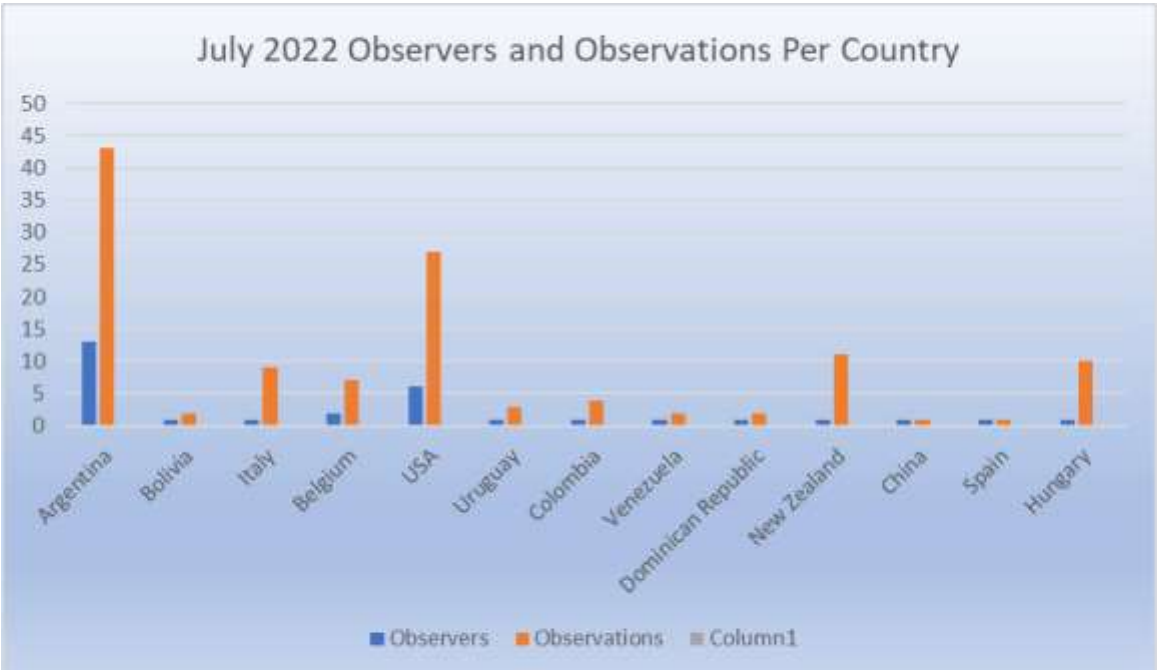
Observations Received

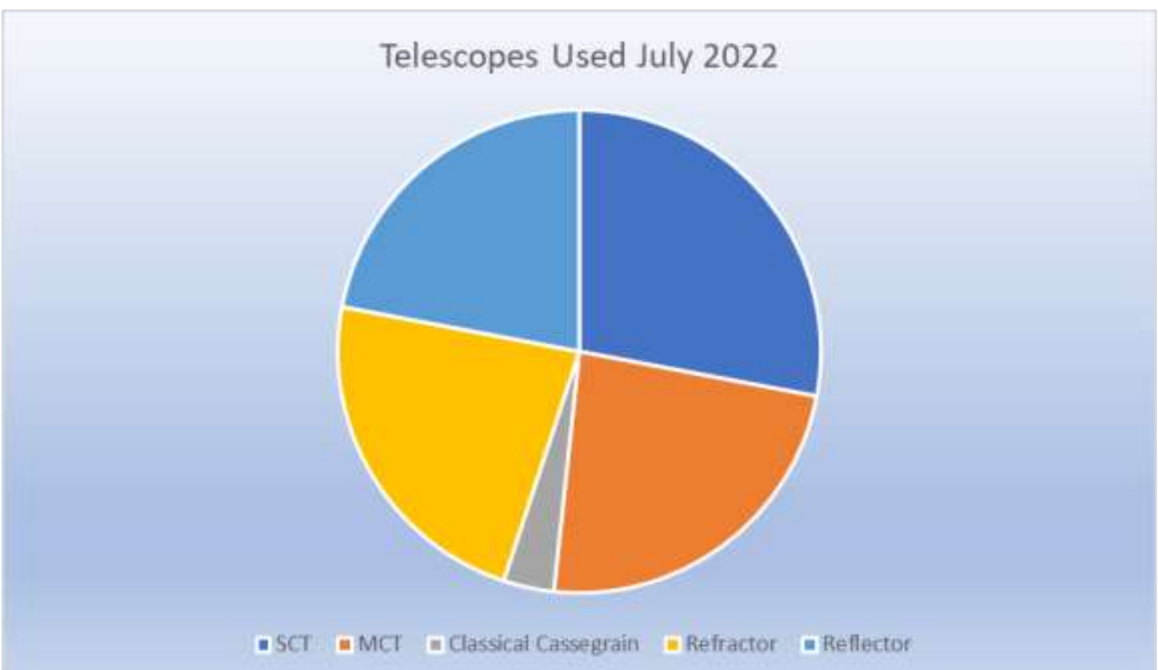
Name	Location and Organization	Image/Article
Marcelo Mojica Gundlach	Cochabamba, Bolivia	Images of Copernicus (2),.
Robert H. Hays, Jr.	Worth, Illinois, USA	Article and drawing *Thales Ray System*.
Rik Hill	Loudon Observatory, Tucson, Arizona, USA	Images and articles *Eratosthenes and Linné the Crater*
Eduardo Horacek-Esteban Andrada	Mar del Plata, Argentina	Image of Herodotus.
Dominique Hoste	Kortrijk, West Flanders, Belgium	Images of Aristillus, Copernicus, Belkovich and Thales
Felix León	Santo Domingo, República Dominicana	Images of Aristillus and Proclus.
Gary T. Nowak	Williston, Vermont, USA	Article *How Small of a Lunar Craterlet Can be Seen Through a Telescope?*
KC Pau	Hong Kong, China	Image of Fra Mauro.
Jesús Piñeiro	San Antonio de los Altos, Venezuela	Images of Archimedes and Copernicus.
Raúl Roberto Podestá	Formosa, Argentina	Images of the Waxing Gibbous Moon (2).
Pedro Romano	San Juan, Argentina	Images of Mare Serenitatis and Copernicus.
Guillermo Scheidereiter	Rural Area, Concordia, Entre Ríos, Argentina	The poem *La Luna* by Borges, images Moon by Day, Gassendi, Schiller and Moon at Sunset.
Fernando Surá	San Nicolás de los Arroyos, Argentina	Image of Thales.
Michael Sweetman	Sky Crest Observatory, Tucson, Arizona, USA	Images of Heraclitus, Copernicus, Eratosthenes to Copernicus, Timocharis
David Teske	Louisville, Mississippi, USA	Image of Mare Frigoris, Lacus Mortis, Plato, Mare Serenitatis (2), Apollo 16 and Copernicus (3).
Román García Verdier	Paraná, Argentina	Images of Thales, Bessel and Aristarchus.
Darryl Wilson	Marshall, Virginia, USA	Article and images *The Principal Component Transformation Extracts Hidden Information from Multiband Imager.*

Many thanks for all these observations, images, and drawings.

July 2022 *The Lunar Observer*
By the Numbers

This month there were 116 observations by 30 contributors in 13 countries.



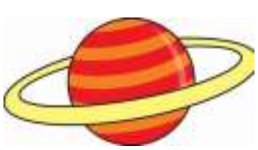


ALPO 2022 Conference
July 22-23, 2022

Due to the continuing nearly worldwide quarantining caused by the Covid-19 pandemic, the 2022 Conference of the ALPO will be held online on Friday and Saturday, July 22 and 23. The ALPO conference times will be: Friday from 1 p.m. to 5 p.m. Eastern Time (10 a.m. to 2 p.m. Pacific Time), Saturday from 1 p.m. to 6 p.m. Eastern Time (10 a.m. to 3 p.m. Pacific Time). The ALPO Conference is free and open to all via two different streaming methods: The free online conferencing software application, Zoom. On the ALPO YouTube channel at https://www.youtube.com/channel/ UCEmixiL-d5k2Fx27Ijfk41A. Those who plan to present astronomy papers or presentations must (1) already be members of the ALPO, (2) use Zoom, and (3) have it already installed on their computer prior to the conference dates. Zoom is free and available at https://zoom.us/.

Those who have not yet joined the ALPO may do so online, so as to qualify to present their work at this conference. Digital ALPO memberships start at only $18 a year. To join online, go to http:// www.astroleague.org/store/ index.php?main_page=product_info&cP ath=10&products_id=39, then scroll to the bottom of that page, select your membership type, click on “Add to Cart” and proceed from there. There will be different Zoom meeting hyperlinks to access the conference each of the two days of the conference. Both links will be posted on social media and e-mailed to those who wish to receive it that way on Thursday, July 22. The Zoom virtual (online) “meeting room” will open 15 minutes prior to the beginning of each day’s activities. Those individuals wishing to attend via Zoom should contact Tim Robertson at cometman@cometman.net as soon as possible. Conference Agenda The conference will consist of initial welcoming remarks and general announcements at the beginning each day, followed by papers and research findings on astronomy-related topics presented by ALPO members. Following a break after the last astronomy talk on Saturday will be presentations of the Walter Haas Observing Award and the Peggy Haas Service Award. A keynote speaker will then follow the awards presentations on Saturday. The selection of a keynote speaker is in progress and the final decision will be announced in the summer issue of this Journal (JALPO64-3). Presentation Guidelines: All presentations should be no more than 15 minutes in length; the preferred method is 12 minutes for the presentation itself plus 3 minutes for follow-up questions. The preferred format is Microsoft PowerPoint. Send all PowerPoint files of the presentations to Tim Robertson at cometman@cometman.net.

To all with interest in the Moon (that is everybody reading this!), Ken Poshedly has allowed me to announce that the keynote speaker is none other that **Charles A. Wood**, the author of The Modern Moon, A Personal View, the Lunar Picture of the Day and many more. This is an incredible opportunity to gain your lunar knowledge!



Theophilus, Cyrillus and Catharina. A Different Trio
Rafael Benavides Palencia

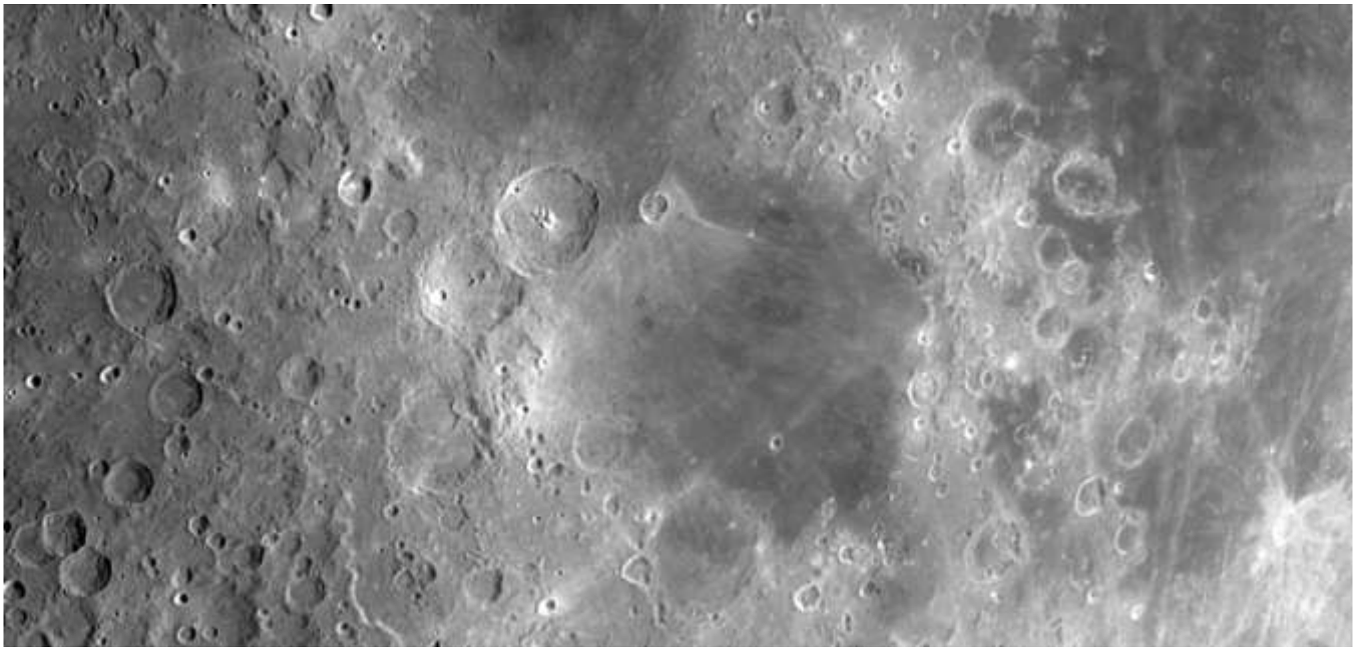


Figure 1: *Cropped image centered on the Mare Nectaris basin on a global image of the Moon obtained on June 13, 2016 with a QHY 5 P II Mono camera, IR Pass Baader Planetarium filter and a TS Photoline 130 mm f7 refractor.* https://www.flickr.com/photos/7473900@N02/52141207801/sizes/o/

The western edge of **Mare Nectaris** (Figure 1) is guarded by one of the most famous trios of craters on the Moon, and each more different. All three have almost the same diameter but have different histories, increasing in age from north to south.

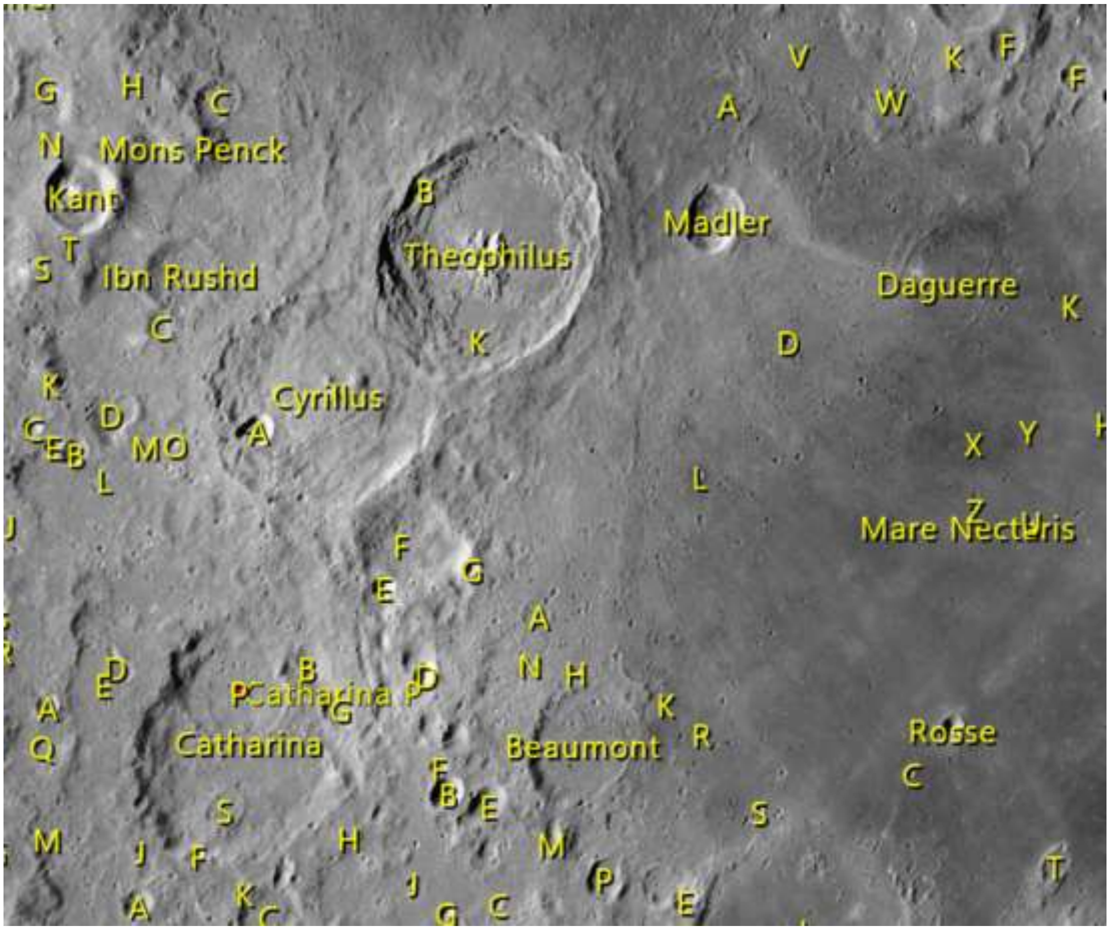


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Figure 2: *Cropped image obtained with the Virtual Moon Atlas v7.0 over the area object of the article.*

Figure 3: *Image obtained on January 22, 2022, 02 h 40 m UT. ZWO ASI 290 MM camera, IR Pass Baader Planetarium filter and Celestron 11.* https://www.flickr.com/photos/7473900@N02/51837105953/sizes/o/

The northernmost is **Theophilus** with 100 km in diameter. The perfect crater. At first glance, the impressive triple central peak that reaches 3000 meters in height catches our attention, look at the shadow that is projected and how sharp it is. The peaks have steeper and more vertical slopes in the east. The crater walls are terraced with signs of landslides, they rise up to 4400 meters above the crater floor, which is practically smooth, especially in its northern part, without later impacts of great importance. We are surprised by the ejecta, still clearly visible on the ground, with large fragments that even reach 600 meters in height.

Further south is the older **Cyrillus**. We can intuit it because it is more collapsed and also because Theophilus is superimposed on its northeast part due to a subsequent impact. It is 98 km in diameter. The central mountain with three peaks reaches only 1000 meters in height. Look at these peaks, much more eroded, without edges of special importance. The floor of the crater is more irregular and fractured with a rille that borders these peaks in its southern area.

And further south is **Catharina** with 100 km in diameter. Much older and weathered. Terraces are no longer visible on its wall, completely eroded. The ground presents moderate-sized impacts that were later flooded by lava, such as the **Catharina P** crater in its northern part, with a diameter of 45 km. In addition, the central peak has completely disappeared, which indicates its greater antiquity.

In this way, it is easy to order them from oldest to youngest: **Catharina – Cyrillus – Theophilus**.

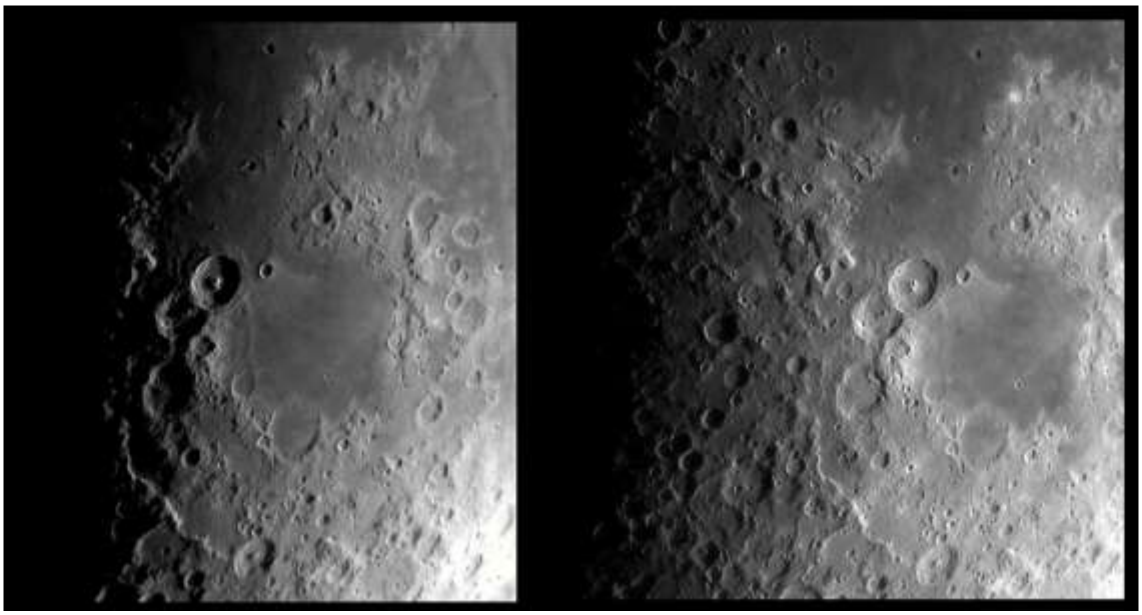

Figure 4: *Comparison in crescent moon phase during February 17, 2021, 20 h 44 m UT and February 18, 2021, 21 h 32 m UT. ZWO ASI 290 MM camera, IR Pass Baader Planetarium filter and a Celestron 11.* https://www.flickr.com/photos/7473900@N02/50971301066/sizes/o/

With the passing of the hours (figure 4), in a crescent phase, the shadows change and allow us to obtain an almost three-dimensional image. With the Sun at a lower altitude, we can see much better the profile of the walls and the shape of the Cyrillus peaks, which acquire much greater importance than when the Sun is higher and the shadows are smaller. Similarly, the union between Cyrillus and Catharina seems much deeper than it really is, presenting a deeply dark aspect. It is simply another point of view on the same lunar accidents. With the Sun higher, many of these spectacular sensations disappear.

Figure 5*: Image obtained on May 1, 2017, 20 h 44 m UT, with a Celestron 11, ZWO ASI 290 MM camera and IR Pass Baader Planetarium filter.* https://www.flickr.com/photos/7473900@N02/34051570190/sizes/o/

Figure 5 shows everything we have described above. In addition, we can easily appreciate the irregular profile of the east wall of Catharina, which despite the evident wear and erosion due to its age, still has some points and edges that are projected as sharp shadows.

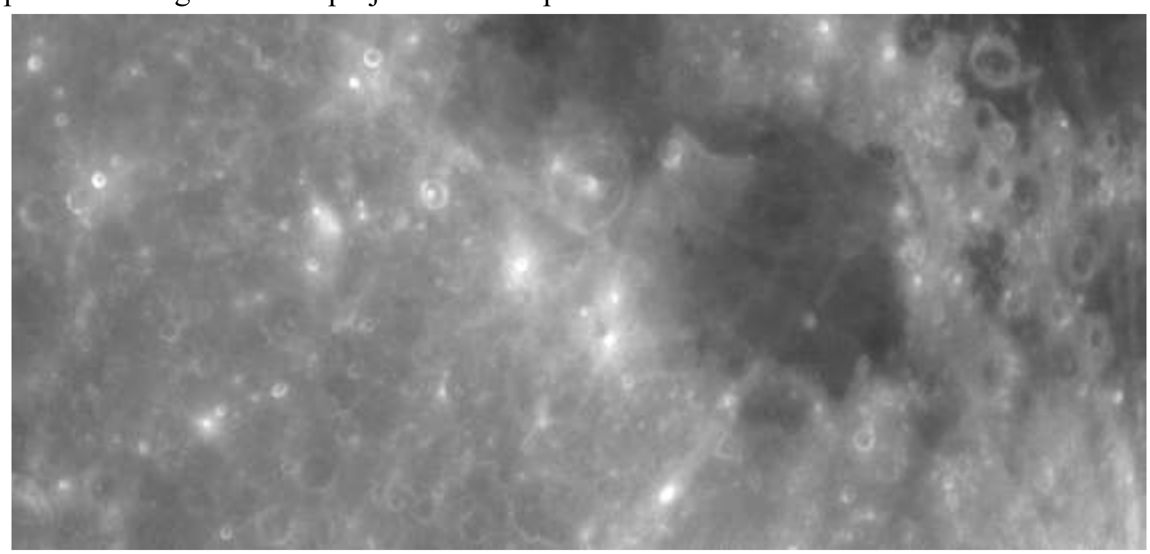

Figure 6: *Cropped image of the Mare Nectaris basin on a global image of the Moon obtained on May 19, 2016 with a TS Photoline 130 mm refractor, QHY 5P II camera and IR Pass Baader Planetarium filter.* https://www.flickr.com/photos/7473900@N02/27025654992/sizes/o/

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With the Sun much higher (figure 6), almost in the full moon phase, they are barely visible. Only **Theophilus** stands out for its better state of preservation. Curiously, **Cyrillus A**, a 17 km diameter crater, exactly in the center of the image, is one of the brightest points in the entire area. This means that he is very young. We are amazed to see the change it experiences in these lighting conditions. Much more modest is **Theophilus B**, a small crater 8 km in diameter, which is the brightest point on the west wall, which is also well visible under these conditions.

Under different lighting conditions, the same Lunar features tell us a story we must enjoy to and, sure, will never disappoint us.

The Principal Component Transformation Extracts Hidden Information from Multiband Imager

Darryl Wilson

This eighth article in the multiband image processing series finally describes an algorithm that works with two, three, four, or more bands of input imagery. If you have imaged the moon using more than three different color filters on a single occasion, you may have wondered how you might combine the information from all of the different colored images in a way that would allow you to display it simultaneously. The principal component transformation (PCT) can enable you to do this and more.

The principal component transformation performs a mathematical rotation on the image data from all of the input bands and produces a set of output images that are contrast enhanced based on the statistical distribution of the image data in N-dimensional space, where N is the number of input bands. If that description intrigues you, details of the inner workings of the algorithm can be found online, and in many remote sensing textbooks. This article will focus on the properties of the transform as applied to a five-band image set of the moon. We will avoid discussion of the mathematical inner workings and just examine the output results.

We will examine a set of principal component (PC) bands generated from the five input images that were taken using a 3" refractor and a Celestron 274C CCD imager. The five bands of input imagery correspond to five different regions of the electromagnetic spectrum - ultraviolet (UV), violet (V), blue (B), green (G), and red (R).

Figure 1 is an ultraviolet (UV) image of the moon. Figure 2 is a violet (V) image. Figures 3, 4, and 5 are blue (B), green (G), and red (R) images respectively. All images are labeled in the upper right corner. The UV band was generated by inserting an Astrodon UVenus UV filter and an Astronomik NIR Block into the light path. The V band was generated with an Orion #47 Violet (made in Japan ~1995) and an Astronomik NIR Block filter. The R, G, and B bands were produced by using the Celestron 274C imager with an Astronomik NIR Block filter.

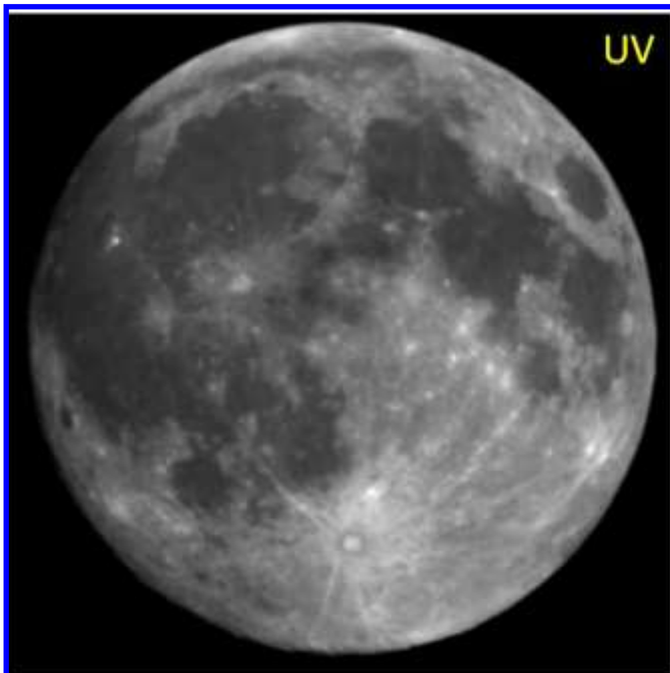

***Figure 1 (top), Full Moon**, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 00:58 UT. 3 inch refractor telescope, UV band filter, Skyris 274C, 2.55 arc seconds/pixel, exposure 1/15 second, gain 25.13 dB.*

***Figure 2 (bottom), Full Moon**, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:07 UT. 3 inch refractor telescope, Violet band filter, Skyris 274C, 2.55 arc seconds/pixel, exposure 1/177 second, gain 9.98 dB.*

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***Figure 3 (top), Full Moon**, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:54 UT. 3 inch refractor telescope, Blue band filter, Skyris 274C, 2.55 arc seconds/pixel, exposure 1/6061 second, gain 9.98 dB.*

***Figure 4 (bottom), Full Moon**, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:54 UT. 3 inch refractor telescope, Green band filter, Skyris 274C, 2.55 arc seconds/pixel, exposure 1/6061 second, gain 9.98 dB.*

Figure 5, Full Moon*, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:54 UT. 3 inch refractor telescope, Red band filter, Skyris 274C, 2.55 arc seconds/pixel, exposure 1/6061 second, gain 9.98 dB.*

Additional notes: The UV band is actually a spectral subset of the V band, but enough contrast difference existed between those two images to treat them as distinctly different bands. The 274C, a one-shot color imager, generated three different output bands when used with the UV filter. They corresponded to UV and B, UV and G, and UV and R. To maximize SNR, the UV and R band combination was used. Analogous reasoning resulted in the V and B band combination being used for the violet input band.

Although small contrast variations are apparent among the input bands, they all look pretty much the same to the eye - as experienced lunar photographers already know. An RGB composite could be formed using the V and/or the UV bands in place of any of the RGB bands. The resulting color image would appear slightly different from the standard RGB, but little additional information would be visible. If we applied HSV-based color enhancement after substituting bands, the results might be more interesting, but that is beyond the scope of this article.

Output bands are presented in Figures 6 through 10. A quick look at the PC bands reveals that they do not "all look pretty much the same". Major lunar features are easily recognizable in all of them, but the relative contrast varies greatly. Close examination reveals that smaller features also vary in contrast in (perhaps) surprising ways. Before diving in to study each of the PC images in turn, an overview of the PCT might be useful.

One way to characterize the PCT is by listing some of its properties. They include the following:

1) The PCT can be applied to two or more bands of input imagery.

2) Number of output bands equals the number of input bands.

3) Spectral contrast is enhanced.

4) Spectral information is lost.

5) The first PC band is a high SNR grayscale image of the scene.

6) The middle PC bands contain most of the interesting scene-related information.

7) The last PC bands often contain sensor noise, imaging artifacts, and materials with unusual colors.

8) The PCT can be inverted to recover the input bands from the PC band set.

9) Modifications to any PC band(s) will change recovered input band values after inversion.

In this article, we will examine the first seven properties listed above. Properties 8 and 9 will be discussed in a future article.

Let's have a look at PC band 1 in Figure 6. Most obviously, it seems to be a negative of one of the input bands. In this case, it is a negative of a weighted sum of all five input bands. In general, the first PC band is a positive weighted sum of all input bands, but the image statistics dictated otherwise in this case. For our purposes it really doesn't matter. You can invert the brightness levels and view (or save) it as a positive image if you prefer. More importantly, it has another property that can sometimes be used to advantage. The SNR of the first PC band is higher than the input bands. In this case, the pixel values of the input bands range from 0 to 255. The first PC band has a dynamic range of about 570 (256 * sqrt(5)).

As a point of trivia, if you have a coregistered set of noisy images, you can perform a PCT on the set and retrieve a single high SNR image in the first PC band. This is just a computationally expensive way to average a stack of images, but since it comes out of the PCT anyway you might as well be aware that you can take advantage of it if need be.

Since the first PC band is just a (weighted) sum of all of the input bands, it should be noted that spectral information achieved by imaging through different filters is lost. A close comparison between PC band 1 and the individual input bands shows that the PC band has less low contrast detail in the maria. That is because the low contrast features are mainly color-dependent. When you average all of the color images together, you destroy the wavelength-dependent reflectance information. All of digital image processing is an exercise in tradeoffs between one kind of information and another. Here, we have traded spectral information for SNR.

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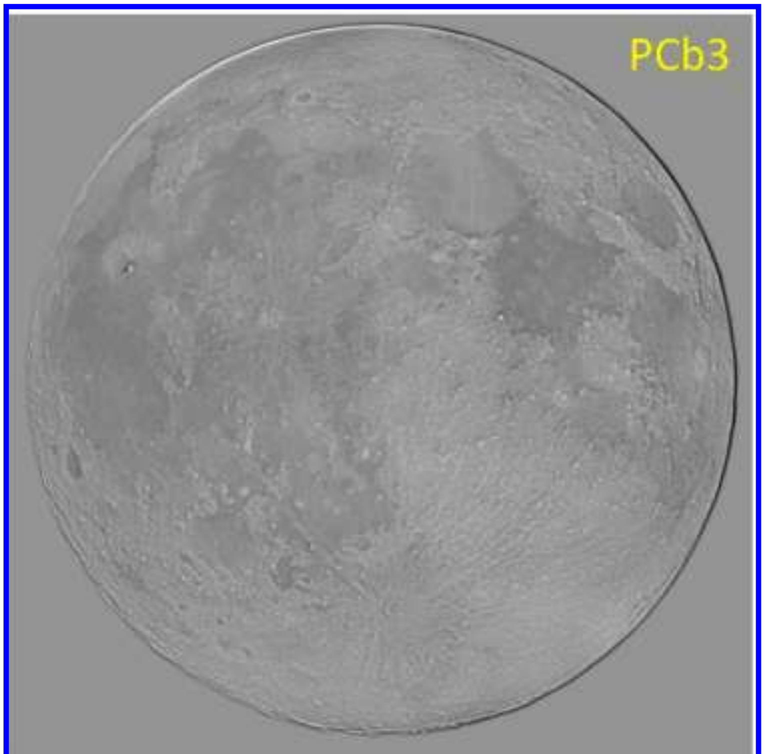
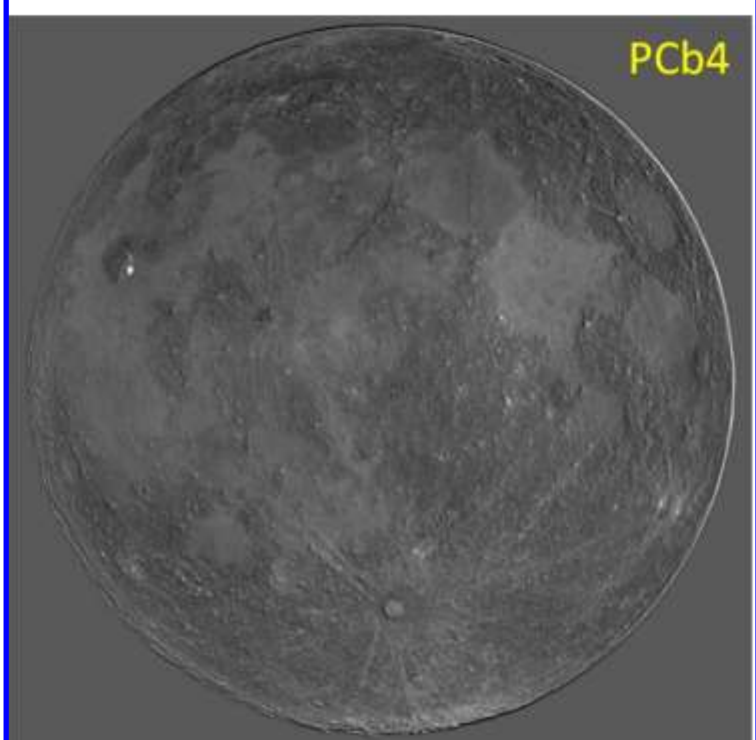
Figure 6 (top), Full Moon*, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 1, Input bands UV, V, B, G, R.*

Figure 7 (bottom), Full Moon*, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 2, Input bands UV, V, B, G, R.*

Figure 7 clearly shows some interesting contrast features in PC band 2 that are not easily seen in the input images. The left limb has a brightness irregularity that forms a thin crescent extending from northern Oceanus Procellarum down to its southern extent. The UV image shows some areas in extreme western Oceanus Procellarum that have unusually low albedo. Just beyond those dark areas the terrain changes and reflectivity rise until we reach the limb, which is only about 10 pixels away at that point. The effect in PC band 2 appears like an artifact of poor imaging or processing, but it is, in fact, a real lunar surface reflectance feature. With low solar illumination angle, some areas of extreme western Oceanus Procellarum reflect little UV light back towards the sun.





Earlier statements that "relative contrast varies greatly" and features "vary in contrast in (perhaps) surprising ways" are exemplified by noting that the darkest areas in the southern highlands of this image correspond to some of the brightest areas on the lunar surface, but northern Mare Imbrium shows the same brightness pattern as can be seen in the visible light images. Brightness in PC space is independent of visual albedo.

Several other surface features appear in PC band 2 including titanium (Ti) and iron (Fe) dependent contrasts, but these are better displayed in the next bands and will be discussed below.

PC band 3 is displayed in Figure 8. The familiar patterns of Ti and Fe deposition are extremely evident, and another feature is now plain to see. A dark, sinuous channel about 100 miles long and 10 to 20 miles wide extends from just NW of Montes Spitzbergen westward to a non-descript place in central Mare Imbrium (approximately 38N, 14W in selenographic coordinates). It seems to connect the two Ti-rich areas, and it is just visible on the Ti map we generated using the technique presented in the June 2022 issue of TLO. The enhanced visibility in this image suggests that something more than just a difference in Ti concentration exists. One can imagine a miles-wide channel of magma flowing from one side to the other billions of years ago.

***Figure 8 (top), Full Moon**, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 3, Input bands UV, V, B, G, R.*

***Figure 9 (bottom), Full Moon**, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 4, Input bands UV, V, B, G, R.*

As we from the first PC band to the last, the SNR declines with each step. PC band 4, shown in Figure 9, has a dynamic range of only about 26 digital counts. Even that seems to be a generous exaggeration when one realizes the standard deviation is less than 2.3. A moderate contrast stretch reveals noise-induced graininess in the image. Nevertheless, some interesting features can be seen easily. The contrast patterns in Mare Imbrium and Oceanus Procellarum are plainly evident, as is the 100 mile long "magma channel" mentioned above. Mare Tranquillitatis is notably brighter than the rest of the lunar surface except for some small bright spots. The later PC bands are where one should search for small, spectrally unusual features.

PC band 5 is displayed in Figure 10. The seventh property listed above is made evident in this example. Only the largest lunar features are identifiable - the maria and the ray system of Copernicus can be seen. Other patterns do not seem to correspond to known features.

Figure 10, Full Moon*, Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 5, Input bands UV, V, B, G, R.*

There are prominent bright swaths near the edges of the most of the maria. Are these indicators that the lunar surface changes as one traverses from the highlands to the basalt lava plains in such a manner that can only be discerned by specialized image processing techniques? Alas, no. Analysis of these patterns revealed that an anomaly had been introduced during the imaging process. Probably the result of an internal reflection, these "features" may have been caused by two filters stacked in the light path but not tightened securely, or by simple misalignment of one of the filter elements within its cell. They show the unmistakable sign of a relatively bright edge bleeding over onto a darker bordering area - in the same way everywhere in the image.

Have a look near the center of the image. Can you see numerous small black spots surrounded by bright circles? They are reminiscent of ringing around digitally sharpened stars (or lunar peaks in shadow). But these images have not been sharpened, so how could this be? As it turns out, in one sense they were. The modulation transfer function (MTF) of a digital image is a measure of its sharpness. High MTF equals sharp. An examination of the input images revealed that the UV image had noticeably lower MTF (was blurrier) than the others. Since the PCT combines input bands additively (and subtractively), an unsharp mask effect can occur if significant MTF differences exist among the bands. This can cause ringing, which would show up in the last (sensor noise) bands.

One astronomer's noise is another astronomer's signal. The last PC band(s) can often be used to diagnose problems in the image formation process, including sensor noise, vibrations, atmospheric blurring, misfocus, internal reflections, and others. We all like to spend our time making beautiful images. Sometimes we can learn how to do that better by analyzing the last PC band(s).

In summary, the PCT was introduced and characterized. The method of acquisition of five bands of input imagery was detailed. The input images were noted to all look similar to the eye. A look at the five PC bands revealed contrast features that were not visible in the input bands. With closer examination, some of the contrast features were seen to correspond to lunar surface mineralogy, while others correlated with solar illumination and reflectance geometry. Problems in the image formation process were plainly seen in the fifth PC band.

Author's Note:
I'd like to acknowledge the work done by Jim Hill (TLO June 2022, p. 36). Only in his mind's eye was he able to see brightly colored images of lunar landscapes caused by surface mineral deposits. In 1957, he did not have the technology necessary to make color-enhanced images but his 65-year-old photo is of excellent quality. Although the JPEG compression that was applied before it was published caused some loss of color fidelity, I was able to apply some HSV color enhancement to it and (with Jim's permission) the result is displayed in Figure 11. If Jim were inclined to scan more of his photos and write an article describing his 1957 work, I'm sure it would make interesting reading.

Figure 11, Vallis Schröteri, *Jim Hill, French Camp, Mississippi, USA. Color enhancement by Darryl Wilson.*

Jorge Luis Borges, *La Luna*

Shared by Guillermo Scheidereiter

I share with you a simple image of the Moon, but also if you will allow me, with absolute humility, something else. A few afternoons ago, our satellite, in a growing phase, rose imposing its figure at the time of change, when the Sun is lost, and motivated by the opportunity, I exhibited telescope and camera, with the childish illusion and the hope intact to capture its beauty. In the work (which in the end I always consider fruitless, because it is impossible to contain its beauty in an image), I remembered, not without mist, that magnificent poem by Borges, *La Luna*.

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Moon by Day, *Guillermo Scheidereiter, Rural Area, Concordia, Entre Ríos, Argentina. 2022 June 07 18:15 UT. 127 mm Maksutov-Cassegrain telescope, Nikon 5600 camera.*

We all, at some time in our lives, were captivated by its brightness, its form, its mystery, its secrets and even the magic of its changing phases, and our **great Argentine writer** was not without his charms. With her pen teacher she seems to embark on the profound mission of defining or describing her or perhaps understanding (or making us understand), which encloses the amazing word, Luna. However, aware of his limitations (well, he was human), in this fragment of his poem, he puts forward an apology for not capturing its essence:

The *essentials are* always *lost. It is a*
law of every word about numen.
She will not be able to avoid this summary
of my long trade with the moon.

This, one of the 23 quartets that compose it, succeeds a story of a man who intends to encrypt the universe in a book, but at the end of his project, in his last Stanza, he realizes that he forgets the Moon:

Thanks *he was going to surrender to*
fortune when he raised his eyes he saw a burnished
disc in the air and understood, stunned,
that he *had forgotten about the moon.*

And it is that Borges, in each of his works, with shades of legend, tells a story and much more. That led me to wonder if sometimes, captivated by the distant, we do not forget that in the near we can find the incredible, because the Moon reflects our passed in multiple dimensions and much more. I don't even remotely have the qualification to be Borges' exegete, but I am still amazed at the depth of his inspiration; he didn't write "in the air." She devoted herself to reading and analyzing what the greats of history, who preceded her, expressed about her. However, the moons of John, of Pythagoras, of Ariosto, of Apollodorus, of Quevedo do not seem to conform him:

Of distant ivory, of smoke, of cold
snow were the moons that illuminated
verses that certainly did *not achieve*
the arduous honor of typography.

Leaving behind the fear that in his poetry Lugones already used amber or sand to honor her, our great writer concludes, with acute intelligence, that the true essence that matters to unveil it is in the amazing relationship between man, the Moon and the word.

I know that the moon or the word moon
is a letter that was created for
the complex writing of that rare
thing that we are, numerous and one.

It is one of *the symbols*
that man gives the fairy or chance so that one day
of glorious *exaltation or agony he can write his true name.*

So, in my poor and blurred reflection (which I hope you know how to excuse), on the glorious handwriting of Borges, I stopped the shutter of my camera and I was contemplating that piece of the bowels of the Earth, that iconic symbol that makes us dream... I stared at the word and the man in the sky as the cold of rural dusk reminded me that, like Borges, I didn't know when I became aware of it.

I do not know where I saw it for the first time,
whether in the previous *sky of the doctrine*
of the Greek or in the afternoon that declines
on the courtyard of the well and the fig tree.

PS:
Borges includes this magnificent poem in The Maker, 1960. Those who wish to read it in full can do so in this link (among many others):
https://www.gaceta.unam.mx/la-luna-un-poema-de-borges/
Another reference: https://trianarts.com/jorge-luis-borges-la-luna/#sthash.FIaGNEeu.dpbs
I hope you like my modest image. The poem... the poem I know, it's Jorge Luis Borges.
Guillermo

Jansen in the Terminator (and what the Slope Looks Like)

Alberto Anunziato

Touring the terminator (where visual observation is most enjoyed) I was struck by how a crater seemed to be perched on a slope (IMAGE 1). It was not about the elevation of the rim but as if the terrain descended from the rim of the crater. The crater is Jansen, 23 kilometers in diameter, an Imbrian period crater with almost non-existent walls, almost a ghost crater. It was impossible to register the visual sensation in the drawing, but it really did look like a slope, due to the shade of the shadow (slightly dark) that started from the north edge. The east wall appeared brighter and even cast a small shadow in a short segment. On the sides were bright reliefs with light shadows and black lines. I wanted to check if the terrain really descended and that slope was represented by the shadow of an almost grayish hue. IMAGE 2 is the relief of the area extracted from the LROC Quickmap. Keep in mind that IMAGE 1 is the drawing taken directly from the observation notebook (that is why it is not well finished and shows the inversion of the Maksutov-Cassegrain from east to west). And if we look at the Lunar Orbiter Laser Altimeter (LOLA) data, we see (IMAGE 3) that the slope exists and is very steep, the highest point is the southern edge of Jansen. This data is interesting, it gives more confidence to know that details such as a slope can be perceived visually, even if they do not even appear in the images of probes such as the Lunar Reconnaissance Orbiter. The black lines to the north are two rilles, which are only perceived in depth, due to their internal shadows.

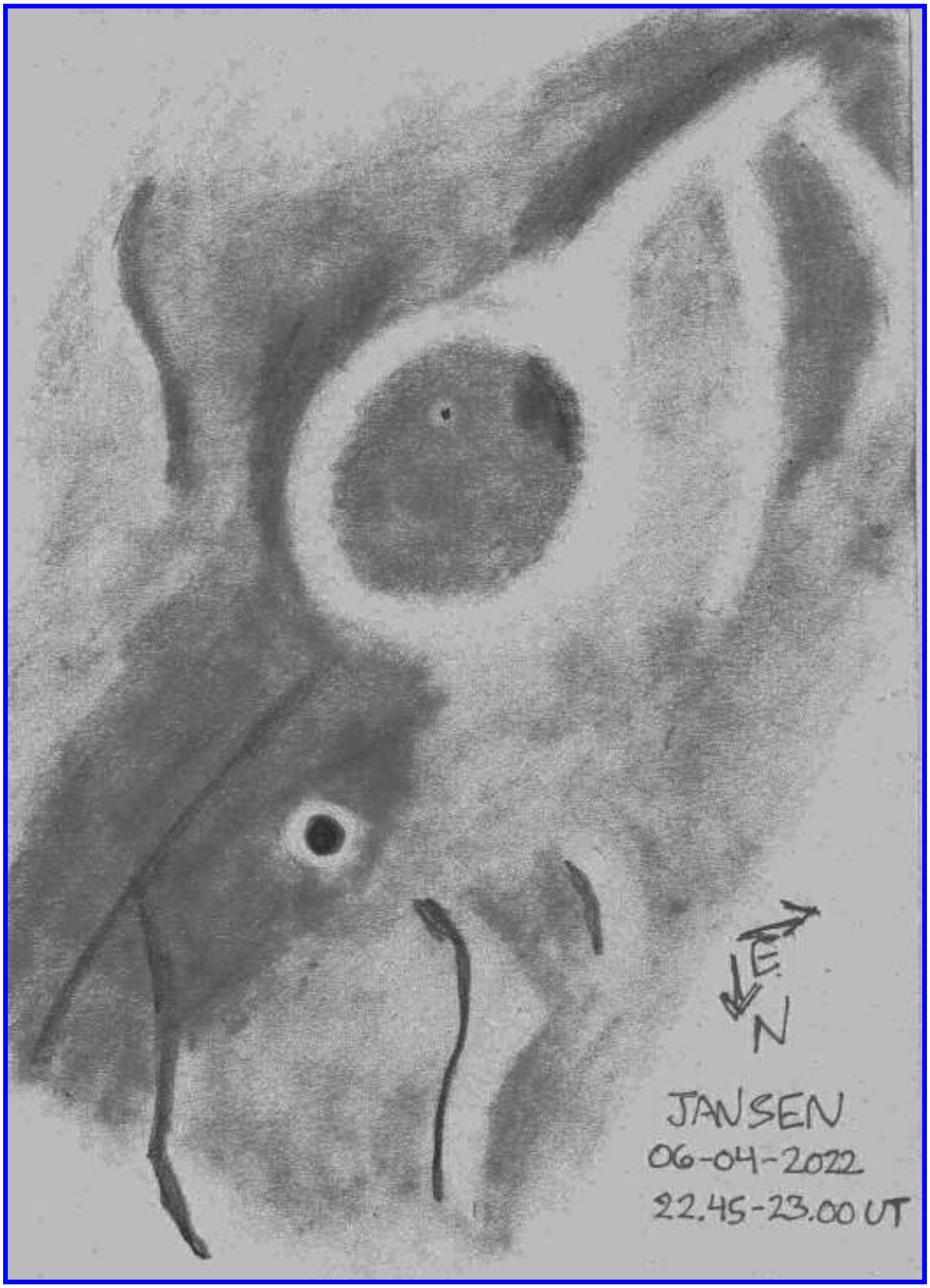

Image 1, Jansen, *Alberto Anunziato, Paraná, Argentina. 2022 June 04 22:45-23:00 UT. Meade EX105 mm Maksutov-Cassegrain telescope, 154 x.*

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Image 2, Jansen, *LROC QuickMap.*

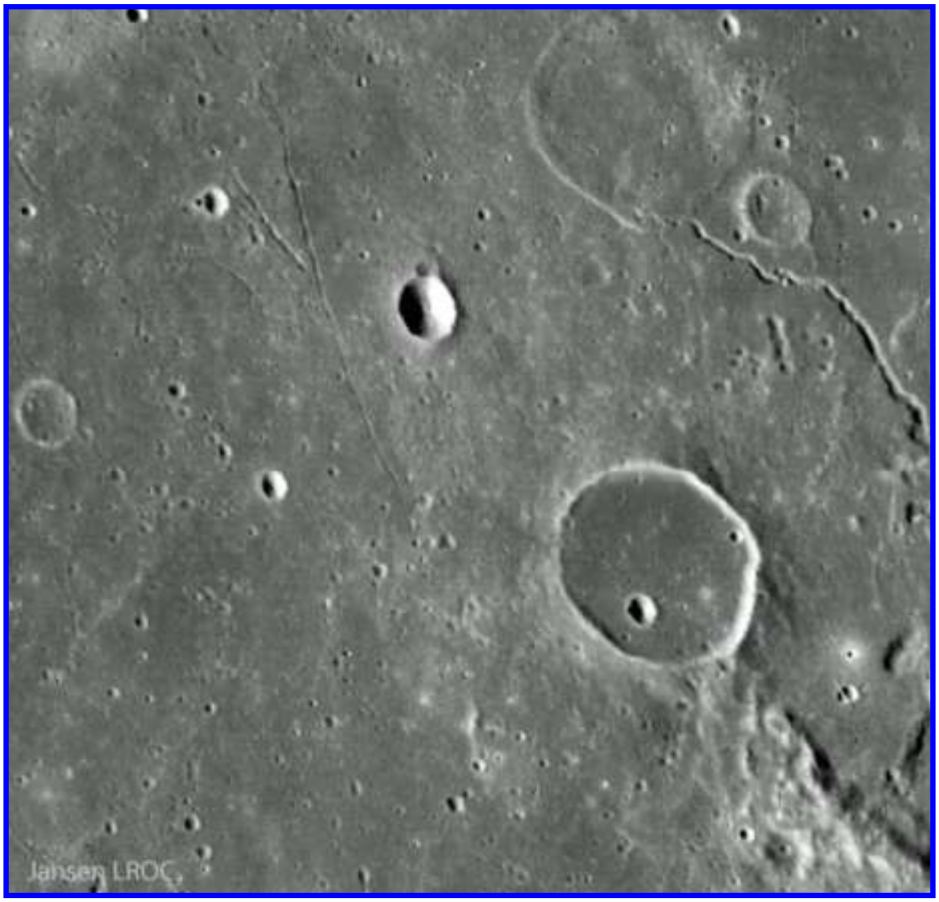
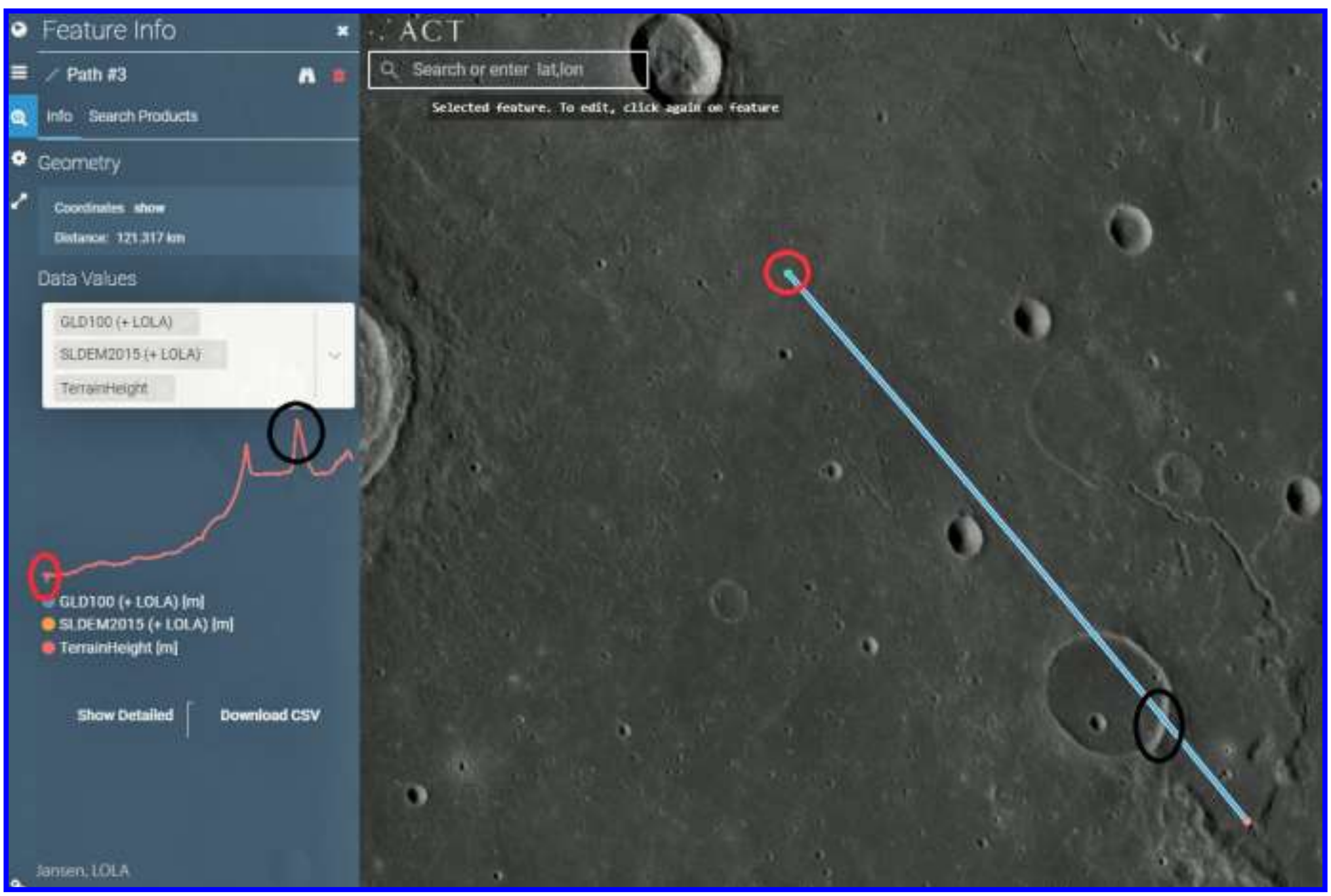


Image 3, Jansen, *LOLA.*



Eratosthenes

Rik Hill

Eratosthenes (60 km), is the large crater below center, at the very bottom of the magnificent range of the Montes Apenninus that run all the way up to Promontorium Fresnel nearly 1000 km away. It is usually overlooked because of the proximity to the great Copernicus crater just off the lower left edge of this image. The ejecta blanket is tight to the crater and best seen on the lower right side (lunar southeast) here. Just below the central peaks you can see one of the two domes reported on the floor of this crater. However, a look at a Lunar Orbiter image of this crater is less convincing. To the west or Eratosthenes, you can see a chain of craters with a gash on the north end. This is secondary cratering from Copernicus. These are fascinating to explore with high magnification on a real steady night.

On the other side of Eratosthenes, you can follow the Montes Apenninus northward to a bright peak halfway to the top of the image. This peak is Mons Wolff (alt. 3500 m) which must be an amazing sight from the floor of Mare Imbrium to the north. Note the ghost crater out in Imbrium north of Wolff. This is Wallace (27 km) over 3.2 billion years old and flooded by the Imbrium lavas. The crater on the left side of the image is Pytheas (20 km) a fairly young crater, less than a billion years, like Copernicus.

Eratosthenes, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2022 May 11 02:00 UT, colongitude 30.7^o. 8 inch TEC f/20 Maksutov-Cassegrain telescope, 665 nm filter, SKYRIS 132M camera. Seeing 8/10 with gusty wind.*

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Some Details on a Wrinkle Ridge in Mare Nectaris

Alberto Anunziato

At the time I began the observation (IMAGE 1) the terminator was passing very close to the western edge of Mare Nectaris, approximately where the draw ends, in the last quarter. Fifteen nights earlier, I observed almost exactly the same area in reverse illumination: Mare Nectaris' westernmost wrinkle ridge appeared anodyne, lacking any characteristic topographical detail, such as the crest on its top. My thought was that it was surely a wrinkle ridge caused by the relief submerged by the lava that formed Mare Nectaris, since the crest (which was missing) is a surface derivative of an underground thrust fault, more typical of the wrinkle ridges originated by the settlement of large volumes of lava. Fifteen days later the vision was unique and full of details that I tried to reproduce. The elongated shadows to the east belong to the 3 large western rim craters, from north to south Theophilus, Cyrillus F and Beaumont. The second relief, further to the east, looked like a second, lower wrinkle ridge.

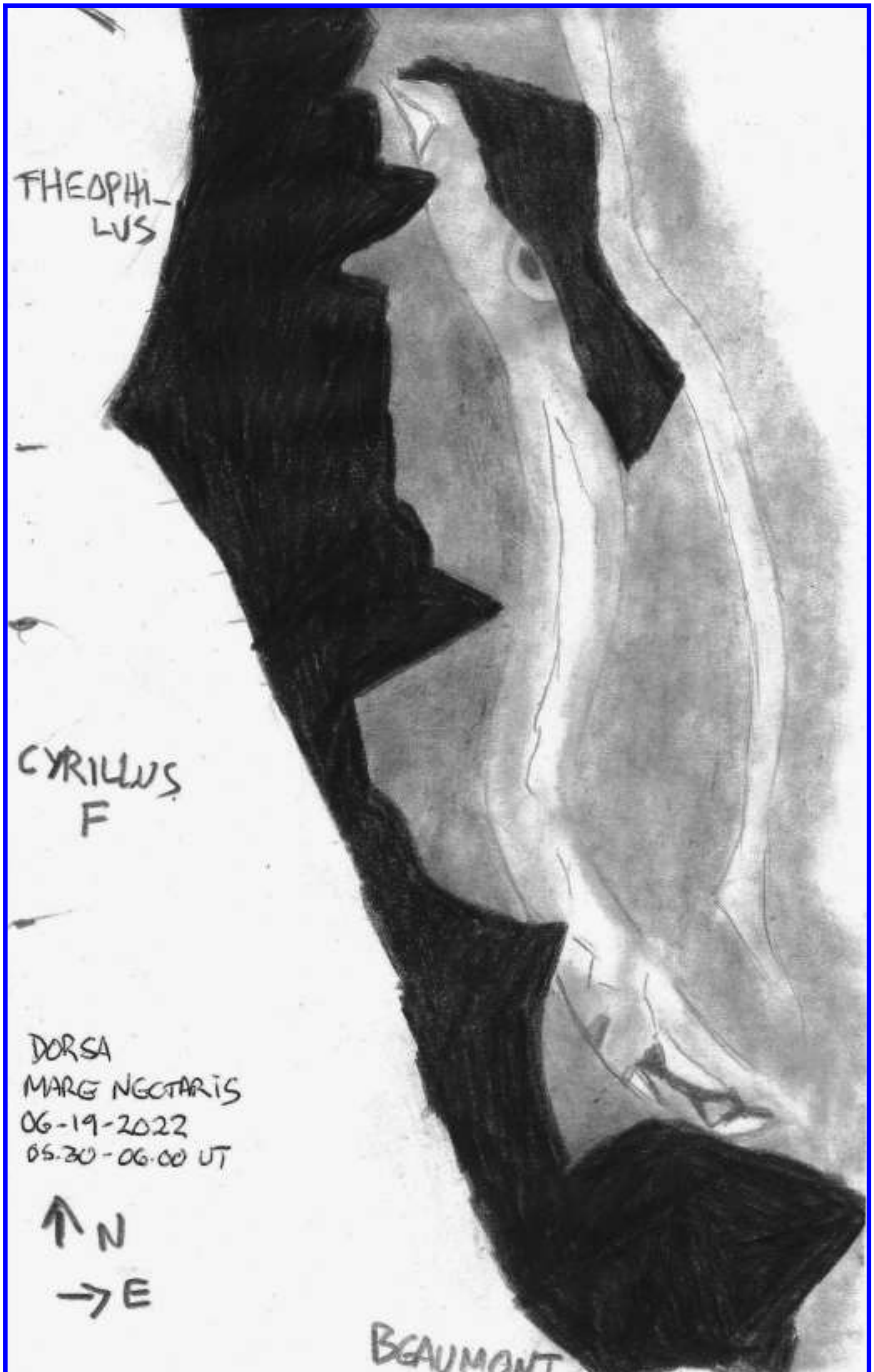


Image 1, Dorsa Mare Nectaris, *Alberto Anunziato, Paraná, Argentina. 2022 June 19 05:30-06:00 UT. Meade EX105 mm Maksutov-Cassegrain telescope, 186 x. Seeing 8/10.*

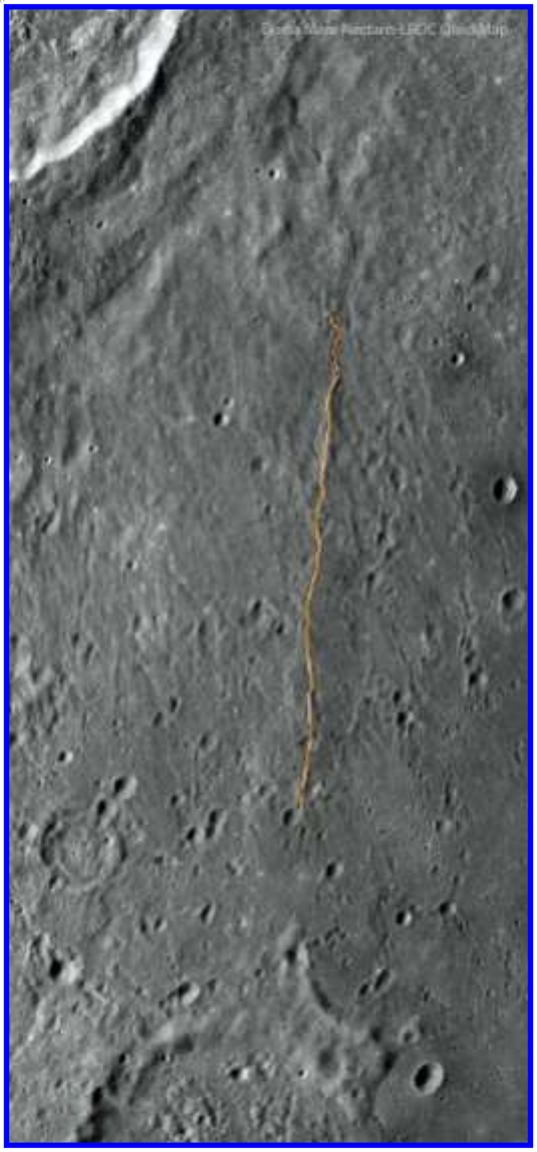


Image 2, ***Dorsa Mare Nectaris,*** *LROC QuickMap.*

Using the LROC Quickmap Map of Lunar Wrinkle Ridges, we know that the western relief is a wrinkle ridge and the eastern relief is not (IMAGE 2), but they are clearly two parallel heights, as seen in IMAGE 3, using another LROC Quickmap tool, Lunar Orbiter Laser Altimeter (LOLA) data: The terrain slopes to the east, but to the east of the wrinkle ridge "wavier" than they really are. With such oblique illumination, the wrinkle ridge was very detailed, I don't think I've ever seen one so close to the terminator. At the north end there was a very bright area, which I represented with a triangle (the approximate shape of what was observed). Further south a small crater was clearly visible on the eastern rim (or on the top, with the illumination it is hard to tell if you were looking at the full width of the wrinkle ridge or its western slope). From a little further south of the crater a slightly bright line could be seen that ran through most of the wrinkle ridge, it even seemed to have a slight shadow towards the west, it seemed like a detail of the relief, but I would hesitate to identify it as the crest, since fifteen days before, and also with oblique illumination, no signs of it were perceived. The southern end presented the most complicated relief: bright areas mixed with shadows, which I tried to represent with a certain (uncertain) geometry. In this type of observations, a fundamental problem arises (this is what happened while selenography was visual, we could say between 1609 and the 1960s): the selection of the most important thing that should be recorded among so many data, since you can draw everything as you can record everything (in principle) in a photograph. An interesting reflection, derived from the profitable reading of a very recent and exciting book: "A Treatise on Moon Maps", by Francis J. Manasek. referring to how long it took for obvious crater details such as terraces or central peaks to appear on lunar maps, Manasek says (page 338): "Perhaps this evolution suggests a required lengthy period of learning to perceive and interpret optical images, starting with the initial ambiguity following Galileo and not really coming to fruition until the 19th century, or that the codification of such detail required the more intensive observations resulting from chorographic presentation of lunar surface detail. We might argue that the central peak achieved recognition as selenology and geological science developed". From my humble experiences as a wrinkle ridges observer, I can say that the mechanism that Manasek cites is the correct one: as we know the possible structure of a lunar feature, its observation improves and then comes the problem of finding how to reproduce, simplified, in cartographic symbols, the complex image that is perceived when observing. Manasek and his splendid book made me reflect on the need to improve the cartographic semiotics of my observations, more precisely than the bright triangles I used in this image.

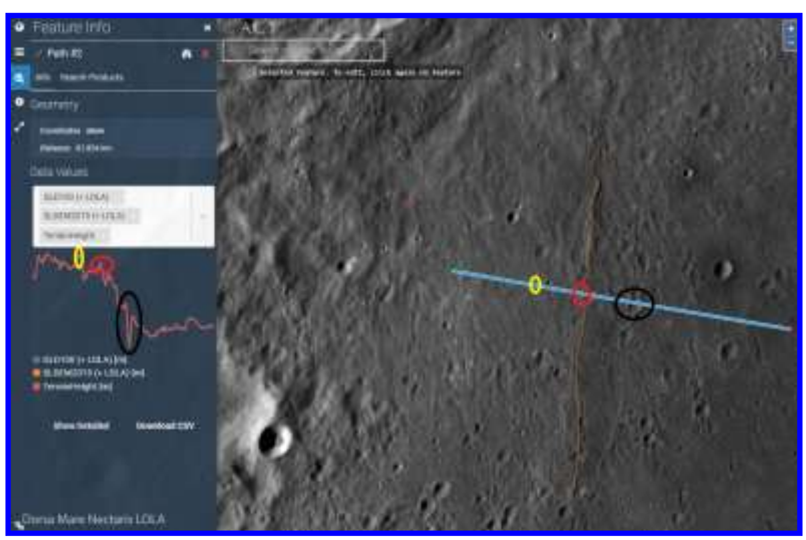


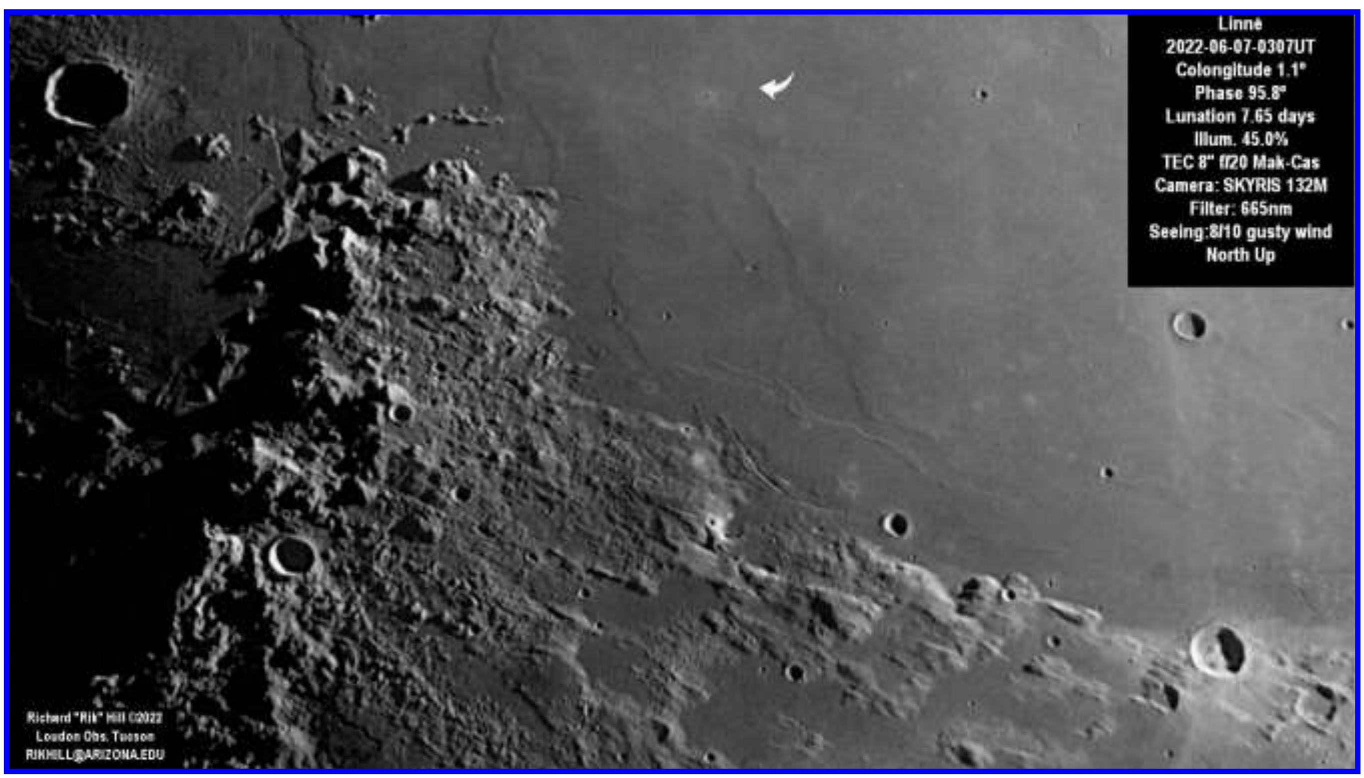
Image 3, Dorsa Mare Nectaris, *LOLA.*

Linné the Crater

Rik Hill

This is the same region done in an image I posted about a year ago, with some important differences. The extent of this image runs from Autolycus (41 km) in the upper left to Menelaus (27 km) in the lower right. Note to the right of Menelaus the small Rimae Menelaus with more of them just above almost orthogonal to these making up more of the rimae system. This crater sits on the southern coastline of Mare Serenitatis and the rimae, or most of them, are parallel to this coastline caused by subsidence of the lavas cooled. Just to the left of Menelaus is a smaller crater with a much larger name, Sulpicius Gallus (12 km) and above it another series of rilles, Rimae Sulpicius Gallus also parallel to the coastline. The grand mountain range on the left side of this image is the northern portion on Montes Apenninus with the brightly lighted peaks reaching 4,000-5,000 m in height.

But the highlight of this image is the little white blemish in Mare Serenitatis north of the Rimae Sulpicius Gallus just below the upper image edge (see arrow). In the center is a dark spot. This is the shadow filled tiny crater Linné (2.2 km), a relatively recently created crater of only a few tens of millions of years in age. Being in a barren expanse of the mare it had been drawn on maps made by lunar astronomers up though the first half of the 19th century and was well known with size estimates ranging from 8-10 km. Then in 1866, Johann Friedrich Schmidt, a well-known, respected and very competent lunar astronomer in his own right, reported that the crater was gone and only a white spot remained as seen in his 158 mm f/15 refractor at the Athens Observatory within eyesight of the Acropolis! There was a scramble to verify this transient event and reports ranged from confirmation to refutation. This crater was at the very limit of detection for his telescope. Larger apertures in better skies than downtown Athens cleared up the issue. It can be seen here as not just a white spot, but a small discernable shadow filled crater surrounded by a dull white ejecta blanket. LROC QuickMap shows it very nicely and the LROC webpage for this crater shows rocks inside the crater less than a meter across!!



Linné, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2022 June 07 03:07 UT, colongitude 1.1^o. 8 inch TEC f/20 Maksutov-Cassegrain telescope, 665 nm filter, SKYRIS 132M camera. Seeing 8/10 with gusty wind.*

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How Small of a Lunar Craterlet Can Be Seen Through a Telescope?

Gary T. Nowak

Introduction: The Moon is our closest celestial body. The Moon appears to us as a big, bright object in the night sky. A pair of binoculars will start to reveal some of the Moon's largest features. A good telescope will allow an observer to see the wonders of lunar surface details. Some amateur astronomers especially beginners are under the impression that some lunar surface details can be seen as small as an automobile… If only our amateur astronomer telescopes could do that. However, the true reality of lunar observations is often times not what we can image. So, this leads into the subject of this report. How small of a lunar craterlet can be seen or resolved visually in a telescope? This report will try to answer that question for our local (Vermont) observing conditions. The author will use his observational data and experience to come up with an answer to that question.

Factors Effecting Lunar Observations: There are a few factors to consider when one observes Lunar surface detail:

Telescope Optics
Telescope Mounts
Seeing Conditions

In order to see fine details on the Moon such as craterlets; one must have a telescope with high quality optics and a good steady mount. These two factors will not be discussed in this report. The author will concentrate on the 3rd factor; seeing conditions.

Dynamics of Seeing Conditions: Seeing is an astronomical term for the steadiness of the air or atmosphere. Our atmosphere is made up of air cells or seeing cells that vary in size and density. (Smith, p. 18). These seeing cells move about and the light from celestial objects is bent or refracted by these seeing cells. The rapid movement of these seeing cells causes the light from celestial objects to blur or move about. This movement causes the twinkling or scintillation of stars. The twinkling of the stars may be considered pretty by some but this is not what you want for great lunar observations. The causes of this scintillation are controlled by dynamic factors. These dynamic factors control the movement of seeing cells and this will determine the steadiness of the atmosphere and the steadiness of your view of the Moon in a telescope. (Grego, Moon Observe p. 243)

Dynamic Factors Controlling Seeing:

Jet Stream
Man Made Features
Geographic Features
Altitude of Celestial Object

One: Jet Stream: The jet stream is a band of high-speed winds that travels across the continental United States at high altitude. The jet stream movement causes the rapid movement and mixing of the seeing cells. This high-altitude mixing causes poor seeing conditions. Any time the jet stream is within 300 miles of your observing location, your local seeing conditions are often times degraded. The jet stream is a major contributing factor to poor seeing conditions. (Reeves, Digital p. 346). Weather fronts can often copy the effect of the jet stream. Any time a front is within 300 miles of your area, it will probably create poor seeing conditions. (Reeves, Digital p. 346)

Two: Man Made Features: Buildings, chimneys, roofs, and asphalt streets or parking lots play a role in creating turbulence. Heated by the Sun, these items give off heat which produce rising columns of warm air that mix with the seeing cells and create bad seeing conditions. (Dobbins, p. 19; Grego Moon Observe p. 243).

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Three: Geographic Features: Certain geographic features are often times superior to others features in effecting seeing. Plateaus are often producers of good seeing while mountains are not. Winds blowing over mountains often create turbulence which causes bad seeing. The effects of local topography play an important role in seeing conditions at your observing site. (Dobbins, p. 19).

Four: Altitude of Celestial Object: The atmosphere which we observe through is not uniform. The lower atmosphere near the horizon is a much thicker slice of air than the zenith region. The thicker air will have a better chance to distort the light from a celestial object. Celestial objects viewed in or around the zenith region have much less chance of being affected by bad seeing. (Grego, Moon Observe p. 243)

To determine one's local seeing conditions with accuracy and reliability; a special seeing scale is used. Now let's take a look at this special seeing scale.

The Seeing Scale of (0-10): A Scientific Seeing Scale

To determine seeing or steadiness of the atmosphere for lunar and planetary observations, a scientific seeing scale was made by William H. Pickering, a Harvard astronomer (1858-1938). This seeing scale was based on visible details and extent of the Airy disk and Airy rings of a star. The display of the Airy disk and rings was based on observations made with a 10" refractor. As the images of the Airy disk and rings deuterated, this would provide a lower rating on the scale. The original scale ratings were approximate since the Airy disk is complex and changing: Here's the seeing scale based on the Airy disk image. (Texereau, p. 310).

8-10 Excellent: Perfect images, no noticeable defects and rings are stables, $\theta = 0$

7-8 Very Good: Complete Airy Rings but some rings are not uniform, $\theta < 0.25\ \rho$

6-7 Good: Complete Airy Rings but some ring sections agitated, $\theta = 0.25\ \rho$

5 Moderate: Broken diffraction rings, Airy Disk has wavy edges, $\theta = 0.5\ \rho$

3-4 Poor: Distorted Airy Disk, some rings absent or faded, $\theta = 1.0\ \rho$

1-2 Very Poor: Airy Disk very agitated and strongly distorted, no rings, $\theta = 1.5\ \rho$

0 Terrible. Airy Disk appears bloated and broken into several sections, $\theta > 1.5\ \rho$

θ = Wave inclination angles (distortion); ρ = Angular radius of diffraction spot (Airy disk).

(Jean Texereau, p. 309 goes into a mathematical formula on how to determine the seeing rating based on observations of certain Airy disk parts.) (Also, Grego, Solar System p. 24).

However most lunar and planetary observers rarely go to the lengths of actually assessing the visual diffraction patterns of stars so the scale was adjusted for splitting double stars based on a 10" aperture. Use of splitting double stars visually was quicker and much easier way to determine seeing. So, here's the seeing scale based on the Dawes Limit (rounded off). Dawes Limit 10" aperture, 0.457" ≈ 0.5" (Grego, Solar System p. 24, Also North, p. 25).

Scale Rating	Double Star Separation
10	0.5"
8	0.7"
6	1.0"
4	1.5"
2	3.0"
0	5.0"

It should be noted that various individuals have adjusted the scale criteria to their specifications. This scale is good if you have a 10" telescope or something similar. However, this scale criteria can't be used with smaller apertures. So, here's the modified seeing scale for a 5" telescope by different authors. (Van Venrooij, p. 218). Dawes Limit 5" aperture, 0.914" ≈ 1.0".

5" Telescope	Seeing Scale	4" Telescope	Seeing Scale
Scale Rating	Double Star Separation	Scale Rating	Double Star Separation
10	1.0"	10	1.2"
8	1.4"	8	1.8"
6	2.0"	6	2.4"
4	3.0"	4	3.0"
2	4.0"	2	4.0"
0	5.0"	0	5.0"

The 5" seeing scale is very close to my 4.7" refractor size so I use this to determine my seeing. My average backyard seeing is based on splitting double stars with my 4.7" (120 mm) F/7.5 APO refractor. My average double star smallest separation is 2.2" which puts my average seeing about 5.0-5.5 on the scale. Authors such as Robert Reeves, Webcams p. 287F, Digital p. 345F and Richard Berry p. 19 cover factors that ruin your local seeing conditions including the major role that the jet stream plays in controlling seeing conditions. I now have 7 years of data on my seeing conditions from my back yard observing so I know what my average seeing (5.0 -5.5) will allow me to view.

Once you start doing observations of your local limit of double star separation to determine your seeing scale rating, you will find that it is very objective. Using this system takes the "subjectiveness" out of your seeing ratings... You need to make many observations over a period of time to build up a data base of your seeing conditions. You can then use the minimum double star separation to help you estimate how small a lunar craterlet or Mars surface feature you should be able to see.

Moon: 1" Resolution ≈ 1.9 km on the Moon with an apparent angular diameter of 31' (Grego, Moon Observe, p. 243).

Mars: 1" Resolution ≈ 280 km on Mars with an apparent angular diameter of 25" (Grego, Mars p. 214).

I know an extended object size is not exactly the same as the separation of two double stars but this conversion will give you an approximate resolution size for what you should able to see on the Moon or Mars based on your local seeing.

However, only a few amateurs know about this method. Some who do note atmospheric seeing do so using a 0-10 scale but one that uses subjective observations. This results in an unreliable record of local seeing conditions.

Lunar Observing Multipliers:

The Moon is probably the most observed astronomical object in the night sky. To help improve your ability to see fine lunar details; these lunar observing multipliers may help you get the best resolution of lunar details with your local seeing conditions.

Perigee Moon
Location of Moon on the Ecliptic
Moon Orbit Tilt
Terminator
Colored Filters

Perigee Moon: The Moon orbits around the Earth in an elliptical orbit. This orbit is not equal but off center. So, one part of the Moon elliptical orbit is closer to the Earth than the other part. At apogee, the Moon is further from the Earth and the Moon apparent apogee diameter is 29' 23". At perigee, the Moon is closest to the Earth and the Moon apparent perigee diameter is 33' 29". The perigee Moon is about 14% larger than the apogee Moon. The perigee Moon will help the lunar observer to see fine lunar detail. One should strive (if possible) to observe the Moon at its perigee position. (Grego, Moon Guide p.35).

Location of Moon on the Ecliptic: The Moon takes 29.5 days to go through a complete set of phases. These 29.5 days period is called the Synodic Month or Lunation. (Grego, Moon Guide p. 39). The Moon's orbital plane lies close to the ecliptic; its path is among the zodiac constellations. Each month the Moon orbit goes through the zodiac constellations and thus the Moon's height above the horizon varies. There are certain zodiac constellations which will give the Moon the most height or altitude above the horizon. This is due to certain zodiac constellations have the highest declination in the sky. The Moon's highest position is obtained when the Moon is on or near the 6th Hour of Right Accession (the Gemini – Taurus Constellations). The lowest lunar position is obtained when the Moon is on or near the 18th Hour of Right Accession (the Scorpius – Sagittarius Constellations). (Edgar, p. 159). For the 1st Quarter Moon this means the time in and around the Vernal Equinox, hence the months of February, March, and April. For the Last Quarter Moon this means the time in and around the Autumn Equinox, hence the months of August, September and October. Observing the Quarter Moons in their very favorable close positions, at a very high-altitude position; will help you to get better seeing conditions. (Grego, Moon Guide p. 39).

Moon's Orbital Tilt: The Moon's orbit is not parallel with the plane of the ecliptic. The Moon's orbit is tilted some 5° 09' to the ecliptic. The tilt of the Moon's orbit can add or subtract altitude to the Moon's position on the ecliptic. The combination of the Moon's orbital tilt plus the Moon's position in or near the 6th Hour of Right Accession while on the meridian line can give the Moon extra altitude above our horizon for our local observation sites. (Edgar, p. 159).

Terminator: The terminator is the line that divides the Moon sunlit side from its dark side. The Moon has no atmosphere, so it offers a well-defined dividing line between sunlight and darkness. Most lunar details can be best seen on or near the terminator because the Sun's low angle of illumination produces dark shadows and better contrast from lunar topographic features. The rims of craters are clearly defined due to the long dark shadows they cast. The First and Last Quarter Moons offer some of the best views of lunar surface details in and near the terminator. (Grego, Moon Guide p. 53).

Color Filters: The Moon reflects on average about 12% of sunlight it receives. Despite this low reflectivity, looking at the Moon in a telescope, it can appear to be exceeding bright and have lots of glare. Color filters are a good way to reduce lunar glare and irradiation. (Dobbins, p. 45). Yellow and green colored filters are often the most common-colored filters used. Here's a list of commonly used filters for viewing the Moon:

W56 Light Green, W58 Green also W57 Green

W11 Yellow Green

W15 Dark Yellow

W12 Yellow

W8 Light Yellow

Baader 500 nm Green ≈ W58

Baader 495 nm Yellow ≈ W12

The author has found for his lunar observations, the Baader 495 nm (Yellow) filter works best. The 495 nm filter sharpens the image a bit, seems to darken lunar shadows to a degree and cuts down glare. However, it should mention that using color filters is not a panacea. If seeing is bad, a color filter will not make the view in the eyepiece as steady as a photograph. Nor will a color filter help you see fine lunar details like the Lunar Orbiting Satellite produced.

Lunar Observational Data:

The goal of this report is to determine how small of a lunar craterlet can be resolved visually in telescopes of various sizes. The author learned from years of observations that the theoretical limits of a telescope can't be reached due to local seeing conditions. So, what is the smallest size lunar craterlet that can be seen in a given telescope with local seeing conditions? The results may be a surprise to some folks.

Lunar Sites Used for Observation: The lunar sites used in this report were chosen from the Lunar 100 card. The sites chosen wanted to be away from the heavily cratered southern portion of the Moon. These somewhat "isolated" sites would allow for easier identification of the different sizes craterlets next to the lunar feature.

Messier / Messier A: Oblique ricochet impact pair. #25 Feature on the Lunar 100 Card. This area is usually well seen around a 4-day old Crescent Moon.
Cauchy Region: Fault, rilles and domes. #48 Feature on the Lunar 100 Card. This area is usually well seen around a 4-day old Crescent Moon.
Apollo 11 Landing Site (Statio Tranquillitatis): #90 Feature on the Lunar 100 Card. This site is usually well seen around a 5-day old thick Crescent Moon.
Apollo 15 Landing Site (Mons Hadley and Rima Hadley Regio): #66 Feature on the Lunar 100 Card. This area is usually well seen around a 7-day old Moon (1st Quarter Moon).
Rupes Recta: Best example of a Straight Fault on the Moon. #15 Feature on the Lunar 100 Card. When I started out as an amateur astronomer way back in 1968, this was one of the first lunar features I identified and viewed. This area is usually well seen around an 8 -day old Moon.
Plato: Best example of a Lunar Flat Floored Walled Plain. #83 Feature on the Lunar 100 Card. This area is usually well seen around an 8-day old Moon.

Participants in the Lunar Observations:

All of the lunar observing data was gathered by the author in his back yard of his home in Williston, Vermont. The author used his 4.7" (120 mm) F/7.5 APO refractor to gather most of the lunar observing data. The author also used a 4" (100 mm) F/ 9 APO refractor on occasion as well. The lunar observation data was gathered from 20 June 2015 to 6 April 2022.

Supplement lunar observing data was supplied by the following observers.

Larry Garrett of Fairfax, Vermont: Larry used a 6" (150mm) F/8 Newtonian and a 12" (300 mm) F/6 Newtonian for his observations. Both Larry and the author are members of ALPO. (Association of Lunar and Planetary Observers).

Paul Walker of Middlebury, Vermont. Paul used a 10" (250 mm) F/5.6 Newtonian and a 12" (300 mm) F/4.8 Newtonian. Paul had also made observations using a binoviewer. Since the author and Larry did not have binoviewers; only observations used in this report were made using a monoviewer (single eyepiece). Perhaps in the future another report could be produced comparing the resolution gain of the binoviewer to the monoviewer on lunar features. All three observers are members of the VAS (Vermont Astronomical Society). The author extends his thanks and gratitude to both Larry and Paul for sharing their lunar observation data for this report.

Author's Lunar Observational Results:

4" (100 mm) F/9 APO Refractor 150X with Baader 495 nm (Yellow) filter.

Seeing Excellent ≥ 7.0 Min Double Star Separation 1.9" Smallest Crater 6 km (3.7 mile).

Seeing Average ≈ 5.0 Min Double Star Separation 2.7" Smallest Crater 8 km (4.9 mile).

This was my first set of observations and started me on my quest to find out what the local seeing conditions were doing to my resolution capacity of my 4" (100 mm) refractor. Craterlets used were Plato G 8 km, Plato M 8 km, Plato S 6 km and Plato U 6 km.

4.7" (120mm) F/7.5 APO Refractor 180X with Baader 495 nm (Yellow) Filter.

Seeing Excellent 8.0 Min Double Star Separation 1.5" Smallest Crater 3.7 km (2.2 mile).

This observation was only made once. The craterlet observed was Messier J 3.7 km. This observation was greatly aided by a perigee Moon, high lunar altitude, and very favorable position near terminator. The only way I saw this craterlet is by its shadow. Most of the craterlet rim was ill defined. If it wasn't for the dark shadow, I wouldn't see the craterlet.

Seeing Excellent ≥ 7.0 Min Double Star Separation 1.7" Smallest Crater 4.0 km (2.4 mile).

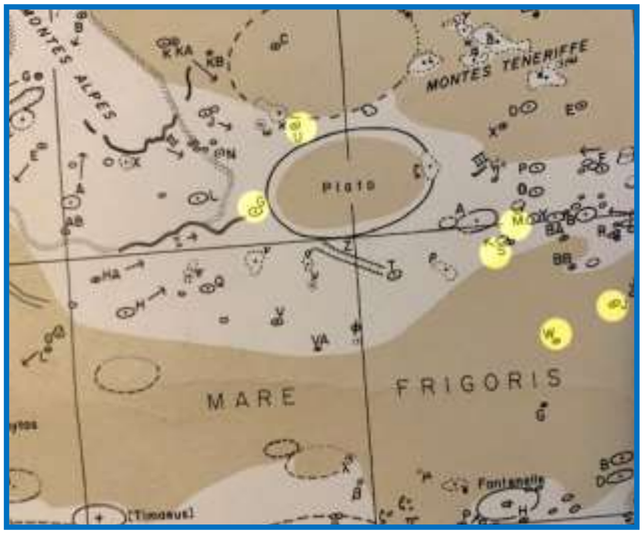
This size craterlet I was able to see 4 different times. These craterlets were Plato W 4.0 km and Cauchy E 4.0 km. These craters were seen as a fully defined circular rim with nice sharp dark shadow. I'm very positive about these observations since I was able to repeat these observation 4 different times. These observations make this resolution a good hard data point for seeing rating of 7.0.

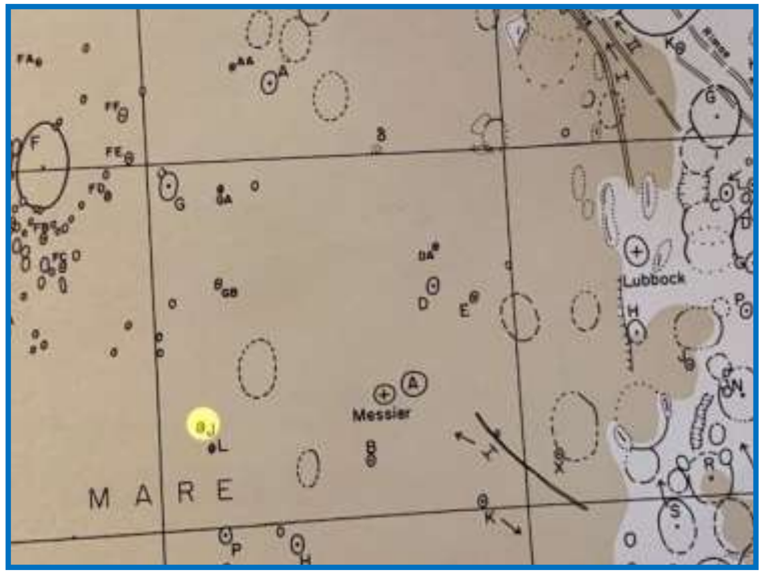
4.7" (120mm) F/7.5 APO Refractor 150X with Baader 495 nm (Yellow) Filter.

Seeing Average ≈ 5.0 Min Double Star Separation 2.2" Smallest Craters 8 km (4.9 mile), 7 km (4.3 mile), 6 km (3.7 mile).

These observations of the crater sizes were made many times with the 4.7" refractor. With the average seeing (5.0-5.5), 8 km craters were fairly easy. The 7 km craters were a bit tougher. The 6 km craters were sketchy and ill defined; their shadow helped a lot to see them. The number of many repeatable observations makes this another good hard data point for seeing rating of 5.0. The craterlets seen: Plato G, J, Q, 8 km; Rupes Recta (Birt A) 7 km; Plato U 6 km and Cauchy B 6 km.

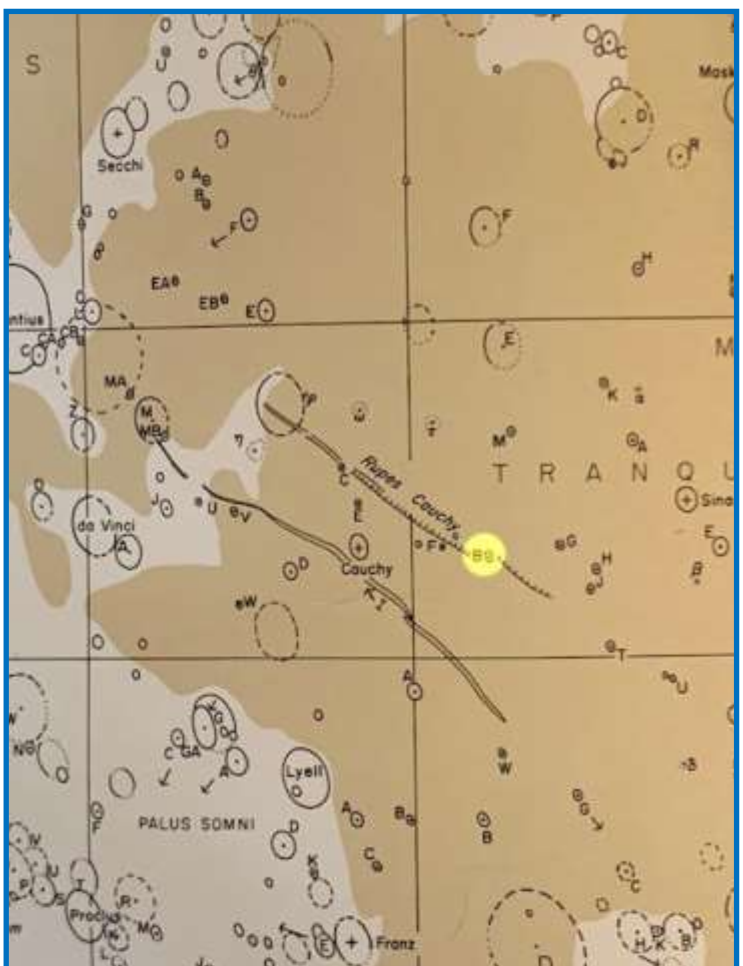
Despite my many attempts, I could not reach the theoretical resolution of my 4.7" (120 mm) telescope. The theoretical resolution of a 4.7" (120 mm) telescope is: resolution of smallest double star separation 0.97" and smallest crater 1.9 km. I will round off these values to make them easier to handle. Resolution 0.97" = 1.0"; 1.9 km = 2.0 km (1.2 mile). My smallest craterlet observation of 3.7 km (2.2 mile). I'm not going to place too much emphasis on it because I only saw it once and the craterlet was ill defined. Instead, I will use my 4 times observations of the 4.0 km (2.4 mile) craterlets… The 4 km crater observations corresponds to the "Working Limit Concept" of authors like Sam Brown, p. 18 and Terrence Dickerson, p. 50. The working limit concept effect is due to the local seeing conditions. The local seeing working limit is often 2X the theoretical limit. My excellent seeing conditions crater resolution of 4 km is 2X the theoretical limit (2.0 km). Unless my local seeing conditions can change dramatically, there is extremely statistically significant chance that I will never reach the theoretical limit of my telescope from my backyard observing site. There will be more about the chances of excellent seeing later in this report. So, let's compare my observational results to a Theoretical Telescope Resolution Chart.

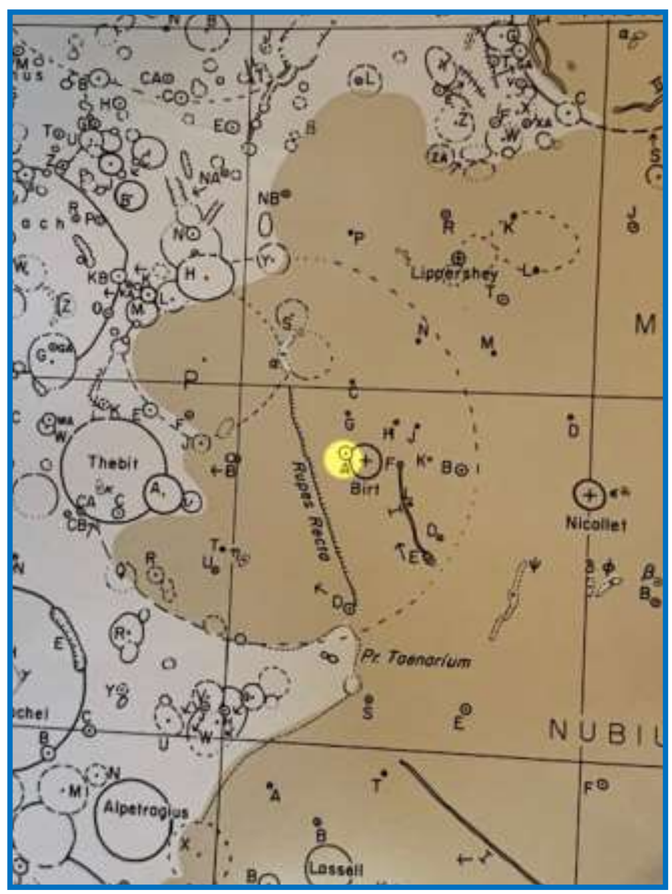




Now you find them! Highlighted are some of the craterlets that Gary Nowak used to test his telescope's resolution. As Gary describes, their visibility is highly dependent upon seeing conditions as well as lighting conditions. Give them a try when the lunar terminator is nearby.

All maps from the Lunar Quadrant Maps, Lunar and Planetary Laboratory, The University of Arizona, 1964. North down, west right.





Aperture	Resolution Smallest Double Star	Smallest Lunar Craterlet (Mean)
2.4” 60 mm	1.9”	3.6 km (2.2 mile)
3” 75 mm	1.5”	2.8 km (1.7 mile)
4” 100 mm	1.2”	2.3 km (1.4 mile)
4.7” 120 mm	1.0”	1.9 km (1.1 mile)
6” 150 mm	0.8”	1.5 km (0.9 mile)
8” 200 mm	0.6”	1.1 km (0.6 mile)
10” 250 mm	0.5”	1.0 km (0.5 mile)
12” 300 mm	0.4’	0.8 km (0.4 mile)

Note: Mean Moon = 31’ (Table from Grego, Moon Observe p. 243).

If I do a comparison to the chart and use my best result for resolution 1.5” then my 4.7” (120 mm) F/7.5 APO Refractor is acting like a 3” (75 mm) telescope. If I do a comparison to my best lunar craterlet resolution of 3.7 km (2.2 mile) to the chart then my telescope is acting like a 2.4” (60 mm) refractor. This result is considerably worse that I had expected. Seeing plays a very important role in controlling the limit of telescopic resolution. This supports the working limit concept in observing and needs to be taken into account to adjust one’s expectations.

Other’s Lunar Observational Results:

Paul Walker of Middlebury, Vermont observes in his backyard with a 10” (250 mm) F/5.6 Newtonian at 174X and a 12” (300 mm) F/4.8 Newtonian at 188X. Paul also uses a binoviewer and takes images of the Moon. Only his observations with a monoviewer (single eyepiece) will be considered. Paul also used English Units in his size data so I did the conversion equivalent to Metric. So, here’s a summary of Paul’s results:

Excellent Seeing	Resolution 0.83”	Smallest Crater 2 Miles (3.2 km)
Mostly Good Seeing	?	Smallest Crater 2.5 Miles (4.0 km), 2.8 Miles (4.5 km)
Average Seeing	?	Smallest Crater 4.0 Miles (6.4 km)

Both of Pauls’ Telescopes 10” (250 mm) F/5.6 and 12” (300 mm) F/4.8 did not reach theoretical limit at all. Paul’s smallest crater resolution of 2.0 miles (3.2 km) was not too far off from my best and only one observation of the 2.2 Miles (3.7 km) craterlet. My other 4 observations of the 2.4 miles (4.0 km) are similar to Paul’s mostly good seeing craters of 2.5 miles (4.0 km) and 2.8 miles (4.5 km) results. Clearly the local seeing conditions are playing the major role in limiting the resolution of Paul’s two telescope. Paul’s best resolution of 0.83” is right on the limit of resolution for a 6” (150 mm) Telescope (0.8”). Another way of looking at this is; seeing is causing or limiting Paul’s two telescopes to act with the resolution of a 6” (150 mm) telescope.

Larry Garrett of Fairfax, Vermont observes in his backyard with a 6” (150 mm) F/8 Newtonian at 171 X, 230 X and a 12” (300 mm) F/6 at 217X and 261X. Larry uses the Baader 495 nm (Yellow) filter as well. Larry came up with similar results as well. Using his 6” (150 mm) F/8 Newtonian at 171X with the Baader 495 nm filter; he observed Cauchy E and Cauchy C both at 4.0 km (2.4 m). Most of the time Larry notes that the 12” (300 mm) will only show what the 6” (150 mm) can resolve. Its only when there’s really excellent seeing that the 12” (300 mm) will out preform the 6” (150 mm).

From the 3 observing sites data we can see that seeing is the major controlling factor that prevents the telescopes from reaching their theoretical limits either in double star minimum separation or smallest lunar crater resolution. It seems that Vermont atmospherics conditions are not prone to give out excellent seeing nights. This then raises the question of what are the chances of having excellent seeing at your local observing site? The author has observation conditions data for his backyard observing site in Williston, Vermont. The data spans the dates of 20 June 2015 through 6 April 2022. Data is from 166 observing sessions in my back yard. This data does not contain observations made at other sites during this time frame. Note some data values are rounded off.

Seeing	#	% of Observation Sessions
Excellent ≥ 7.0	18	10 %
Average ≈ 5.0	118	71 %
Poor ≤ 3.0	30	18 %
Total	166	99%

Transparency Data was included for completeness; however, this data will have no influence on the resolution results.

Transparency	#	% of Observing Sessions
Excellent ≥ 5.7	7	04 %
Average ≈ 5.3	123	74 %
Poor ≤ 4.5	36	21 %
Total	166	99 %

Summary:

Each local observation site will have its own local observing conditions. These local conditions may be better or worst that the author's backyard… For the author's site, there's only a 10% chance that on a given night, the backyard site will have excellent seeing conditions. On the other end of the data there's an 18% chance of experiencing poor seeing on a given night. The majority of nights have a 71% chance of having average seeing. So, an observer should set their expectations accordingly. Vermont skies are not known to produce a lot of excellent seeing conditions. This is something a lunar observer should take consideration in; especially if said observer is thinking of a larger size telescope to give them smaller lunar resolution. From the data, roughly around the 4 km (2.4 mile) size resolution of lunar craterlets seems to be "the normal". This data indicates that for most observing conditions a 6" (150 mm) telescope seems to be the largest aperture to deliver lunar details in most of the common occurring seeing conditions in certain areas of Vermont. Both Sky & Telescope authors, Gary Seronik and Dennis di Cicco support this statement. Lunar observers in Vermont may just have to live with the working limit concept and its confines. Perhaps author Peter Grego sums up the restriction of seeing conditions best as… " For most of us, viewing rarely allows us to resolve lunar detail finer than 1 arcsecond, regardless of the size of the telescope used, and more often than not a 150 mm (6") telescope will show as much detail as a 300 mm (12") telescope, which has a light-gathering area 4 times as great. It is only on the nights of really good visibility that the benefits of the resolving powers of larger telescopes can be experienced." (Grego, Moon Observe p. 243-244).

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.Wonders of the Full Moon: Northern Bright Ray Craters

Alberto Anunziato

Image 1, Waning Gibbous Moon, *Jairo Chavez, Popayán, Colombia. 2022 April 08 03:17 UT. Konus 114 mm reflector telescope, Moto E5 Play camera. North is down, west is right.*

Image 2, Waxing Gibbous Moon, *Jairo Chavez, Popayán, Colombia. 2019 July 16 02:11 UT. 10 inch truss Dobsonian reflector telescope. North is down, west is right.*

Image 3, Full Moon, *Leonard Columbo, Córdoba, Argentina. 2021 August 22 07:59 UT. 70 mm refractor telescope, QHY5L-IIM camera. North is down, west is right.*

Image 4, Full Moon*, Jef De Wit, Hove, Belgium. 2022 January 17 19:00-20:30 UT. 30 cm Dobsonian reflector telescope, 50 x, ND 96-0.9 moon filter. Illumination 100%, lunation 15.0 days*

Focus-On: Wonders of the Full Moon

“The bright rays are nothing more than a thin layer of ejecta that extend hundreds of kilometers from the crater of origin, which is relatively young in geological terms (almost always from the Copernican period) and therefore very bright. That layer of ejecta is only visible in vertical illumination conditions, therefore, they begin to shine as the near side begins to approach the full moon phase, which is when they reach their full splendor, completely changing the landscape, as many of the selenographic features disappear under its brightness. This is an amateur observer definition, now a more accurate definition, from a classic study on our subject: “Crater rays are formed during a cratering event as target material is ballistically ejected to distances of many crater radii forming narrow, generally high albedo, approximately linear features extending out-ward from the crater (…) Crater rays are filamentous, generally high-albedo features that emanate nearly radially from young impact structures. Rays are narrow in relation to the crater radius, extend distally for many crater radii, and constitute a distinctive albedo feature around some of the largest and freshest lunar craters visible from earth” (Pieters et al.).

In this tour of the bright ray craters of the north of the near side, we will take as a guide the wonderful dossier on the subject that is chapter 23 (“Observing Lunar Bright and Light Rays, Bright Spots and Banded Craters”) of the monumental “Luna Cognita” by Robert A. Garfinkle, as well as we will try to relate the images that we present with the objectives of the Bright Lunar Ray Project of the ALPO Lunar Section.

Until relatively recently, the bright lunar rays were considered one of the great enigmas of selenography. Theories that explained them were numerous (Garfinkle describes them extensively in the cited work): lava outcrops in cracks (Nasmyth), marks of subterranean vapors heated by the Sun (Beer and Mädler), volcanic ash (Schmidt), ice crystals (Fauth), frozen water and carbonic acid vapor (Pickering), salt deposits (Tomkins), and snowfields (Firsoff). It was with the first images of the lunar surface in the foreground, by the Ranger missions, that Eugene Shoemaker determined that the rays had a composition similar to dust and that they did not cast a shadow or affect the surface they crossed, therefore they were not a relief, as had been speculated for centuries. The current state of knowledge of the bright rays has changed even recently, with studies such as "The nature of Crater Rays: The Copernicus Example" of 1985, which added to the factor "immaturity of the soil excavated by secondary and tertiary impacts" of the crater of origin that of "component of Highland primary ejecta", that is: we have two types of bright rays. The "compositional rays" have a brightness that is due to the composition of the material that composes them, coming from the bright highlands. These bright rays are degraded by solar radiation much more slowly than the second class, the immature rays whose brightness is due to the presence of fresh high-albedo materials from the impacts (primary, secondary and tertiary).

Do we have samples on Earth of the material that makes up these bright rays? It seems so, from Copernicus. Not only because somewhere on our planet there is most likely material excavated by the colossal impact that generated this giant crater 800 million years ago, but also because the members of the Apollo 12 mission brought back samples of one of Copernicus' rays. In words of David M. Harland (“Exploring the Moon. The Apollo Expeditions”): “As Bean followed Conrad around Head’s rim, he noticed that his commander’s boots were breaking though the surficial regolith to expose a lighter material. This provoked howls of delight from the scientists in Mission Control’s Backroom. One of the reasons for selecting Surveyor 3 as the target was that one of the bright rays radiating out from Copernicus crossed the site. Could this subsurface be the ray? Conrad was surprised, because they had not exposed such material in deploying the ALSEP nearby. “Let’s trench this” he decided. After taking a Surface sample, they scraped out a 15-cm -deep hole and sampled the floor (…) Subsequent analysis of the isotopic radios in the material showed it to be 819 million years old, and although the link is tenuous, this is generally accepted as dating Copernicus. In providing an absolute date for this stratigraphic feature Apollo 12 achieved one of its objectives”.

Anaxagoras:

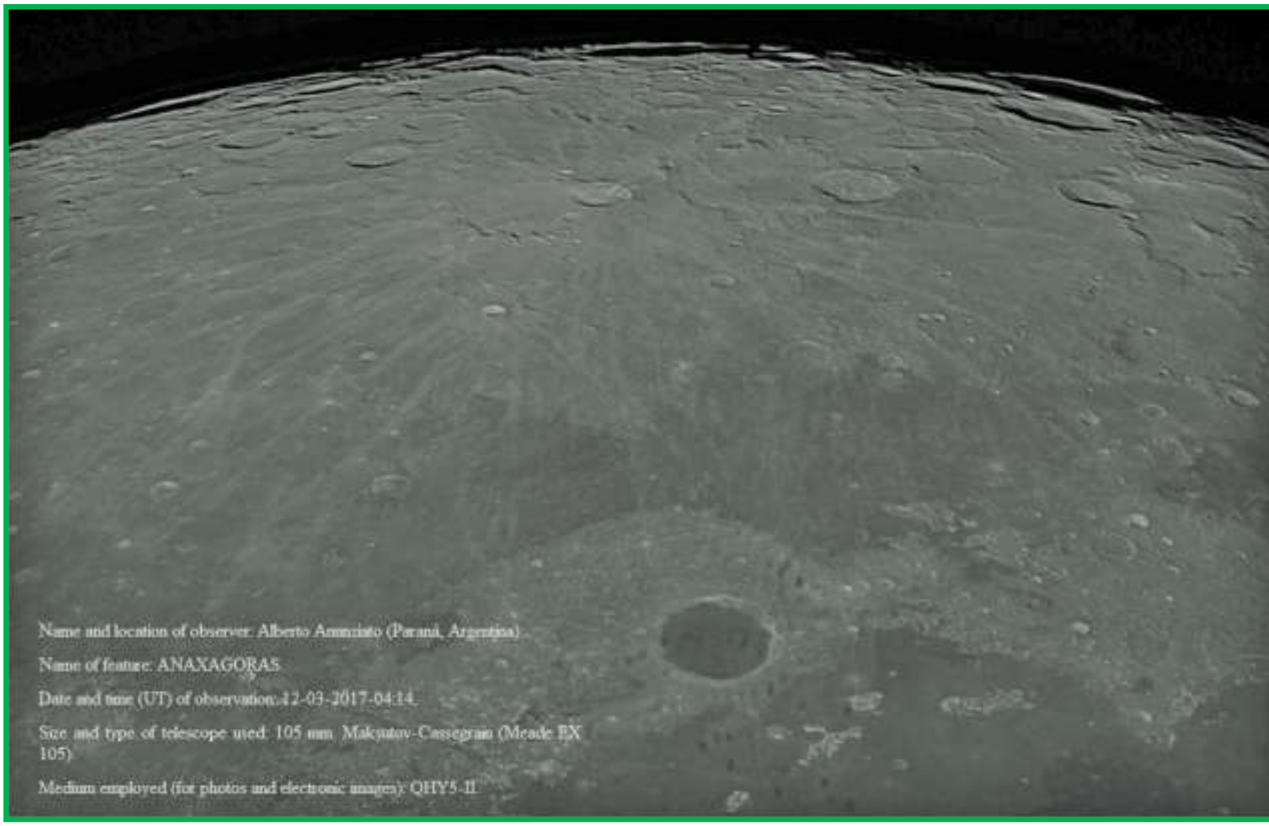

Image 5, Anaxagoras, *Alberto Anunziato, Paraná, Argentina. 2017 December 03 04:14 UT. Meade EX105 mm Maksutov-Cassegrain telescope, QHY5-II camera.*

We start from the north, obviously, and with the most boreal bright ray crater: Anaxagoras (51 km diameter), a spectacular crater affected by its location in the far north, very close to the limb and therefore very difficult to observe. Anaxagoras appears to be one of the ray craters whose rays are distributed more evenly around their parent crater. The comparison with the ray systems of the 3 giants Copernicus-Aristarchus-Kepler is very didactic, the rays of Anaxagoras are narrower, and seem to go further, and their ejection field around their edge is also smaller. Do the rays of different systems overlap? Yes, the Anaxagoras rays mix with the rays of a rayed crater that would not be in the list of known bright ray craters: Epigenes A (IMAGE 5 DETAIL), and the bright ray systems of both allow the question: Is it possible to determine which system is younger? What do you think? It appears that Epigenes A is older because some of Anaxagoras's rays, especially those passing east, appear to overlap with those of the much shorter Epigenes A.

Anaxagoras is famous for the two bright lines emerging from the crater center and extending out of the crater, likely bright material (anorthosite) ejected during crater formation. It is not fresh bright material but a bright material per se, being the oldest type of lunar rock, the material that formed the lunar crust and is preserved on the surface of the highlands. These two strange rays, much brighter than the radial rays, are bright for two reasons: 1) in parts it is intrinsically bright material, anorthosite ejected from the crust by the Copernican impact, and therefore recent, 2) in part it is material that it has not yet been darkened by space weather, like all bright rays. This is why both inner rays appear brighter than the central peak, which we also know to be pure anorthosite. NASA had selected the central peak of Anaxagoras as a Region of Interest for the canceled Constellation Program, since obtaining samples from that area was an opportunity to access the original lunar crust.

Image 5 Detail-Anaxagoras and Epigenes A, *Alberto Anunziato, Paraná, Argentina. 2017 December 03 04:14 UT. Meade EX105 mm Maksutov-Cassegrain telescope, QHY5-II camera.*

Image 6, Anaxagoras, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2019 February 17 03:30 UT. 200 mm refractor telescope, QHY5-II camera. North is down, west is right.*

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Image 7, Anaxagoras, *Alberto Anunziato, Paraná, Argentina. 2019 September 15 04:28 UT. 180 mm Newtonian reflector telescope, QHY5-II.7 camera.*

Image 8, Anaxagoras, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 April 21 22:29 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, QHY5-II camera. North left, west down.*

Focus-On: Wonders of the Full Moon

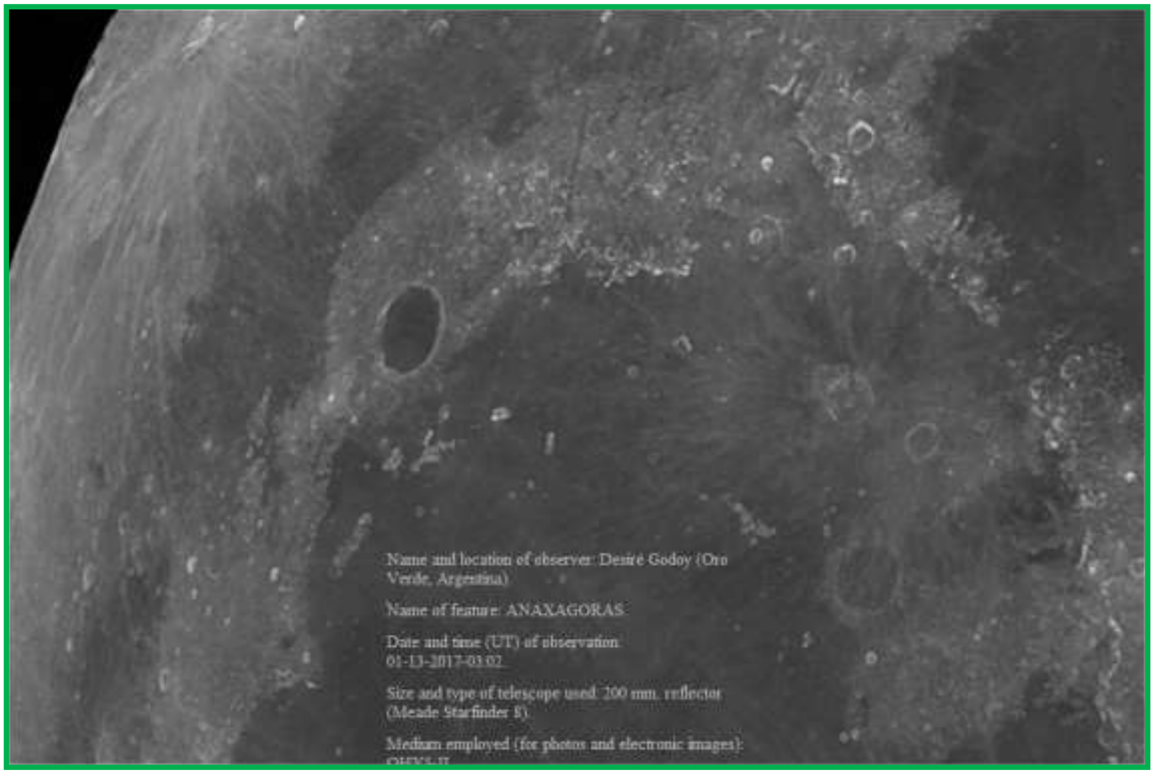

Figure 9, Anaxagoras, *Desiré Godoy, Oro Verde, Argentina. 2017 January 13 03:02 UT. 200 mm Meade Starfinder reflector telescope, QHY5-II camera. North is left, west is down.*

Figure 10, Mare Frigoris*, David Teske, Louisville, Mississippi, USA. 2022 March 20 07:31 UT, colongitude 117.0^{o}. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.*

Focus-On: Wonders of the Full Moon

Thales

Thales (31 km diameter) is about the same line as Anaxagoras, to the east, so we presume that, like this crater, much of its rays are projected towards the far side, but the rays we do observe are not distributed uniformly around the crater of origin, which is clearly seen in IMAGE 11 and 12. Garfinkle says that "There is a lack of rays in the rugged hilly plateau region to the northwest of the crater", indicated by the red arrow (IMAGE 11). To the question, if rays emanate from a crater do they start from its center, edge, or some way from the rim? We can't answer for sure; the rays seem to start some distance from the rim, but the ones heading southeast (towards Atlas and Hercules) seem to start closer to the rim. Although Anaxagoras and Thales are both Copernican craters, it is clear that Thales is older and that its ray system has suffered much more from space weather. IMAGE 13 shows Thales in more perspective, being wider field, and illustrates what may be a long bright ray from Thales, extending through the center of Mare Serenitatis (and passing through Bessel off-screen) or rather a kind of optical illusion that aligns a series of rays coming from different craters. It is the ray that dominates Giovanni Cassini's famous map of 1679, in which said "big ray" is drawn with relief and shadow. IMAGE 14 IMAGE 15 and IMAGE 16 clearly show the bright rays from Thales and even a ray from Belkovich crater, which crosses the northwest part of Mare Humboldtianum.

Thales' bright ray system is discussed in detail in "Thales Ray System," the text by Robert H. Hays, Jr. that forms part of this section.

Figure 11, Thales, *Román García Verdier, Paraná, Argentina. 2020 November 01 04:48 UT 180 mm Newtonian reflector telescope, QHY5-II camera. North to the lower right, west to the upper right.*

***Figure 12, Lacus Mortis**, David Teske, Louisville, Mississippi, USA. 2022 February 10 03:13 UT, colongitude 12.2º. 3.5 inch Questar Maksutov-Cassegrain telescope, 2x barlow, IR block filter, ZWO ASI120mm/s camera.*

***Image 13, Thales,** Fernando Surá, San Nicolás de los Arroyos, Argentina. 2022 January 12 10:50 UT. 127 mm Maksutov-Cassegrain telescope, CPL Sbony filter, Canon Revel T7i Reflex camera.*

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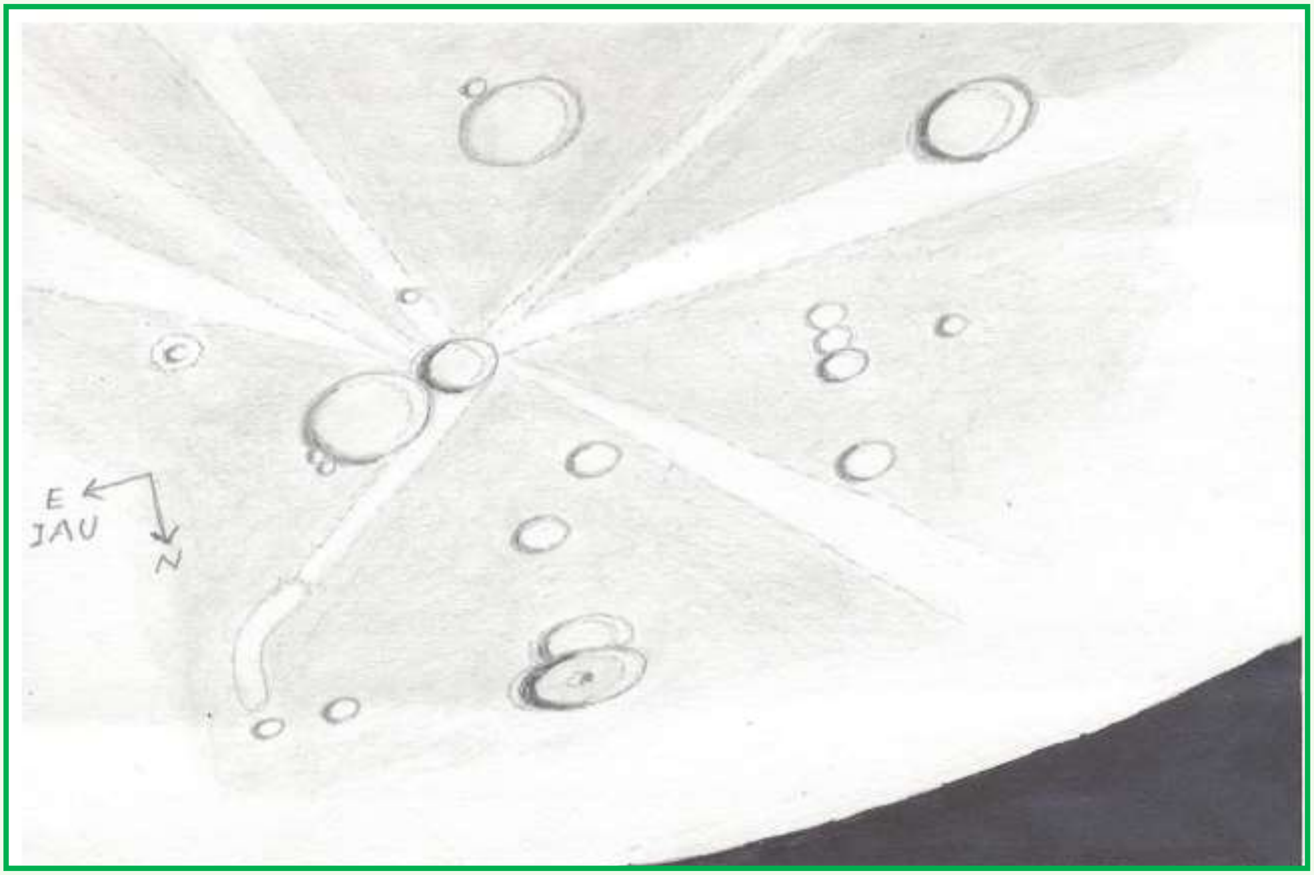
Image 14 Left and 15 below, Belkovich Ray, *Dominique Hoste, Kortrijk, West Flanders, Belgium. 2014 March 08 22:05 UT. Meade LX10 8 inch Schmidt-Cassegrain telescope, Meade LPI camera.*

Image 16, Thales, *Dominique Hoste, Kortrijk, West Flanders, Belgium. 2014 March 08 22:05 UT. Meade LX10 8 inch Schmidt-Cassegrain telescope, Meade LPI camera.*

Focus-On: Wonders of the Full Moon

.Thales Ray System

Robert H. Hays, Jr.



Thales Ray System, *Robert H. Hays, Jr., Worth, Illinois, USA. 2010 May 23 03:34 – 03:58 UT. 15 cm reflector telescope, 116 x. Seeing 7/10, transparency 6/6.*

I observed this area on the evening of May 22/23, 2010 after the Moon hid 6th magnitude ZC 1713. This area is near the limb north of Lacus Mortis, but librations were very favorable for it that evening. It was also rather far from the terminator, so the sketch is somewhat generalized. Thales is a fairly large, bright, crisp crater that is the center of a conspicuous ray system. Strabo is the larger crater just northeast of Thales. It is duskier and less crisp than Thales, and it has two craterlets on its northeast limb. The small, very bright crater southeast of Strabo is de la Rue J, and the large, dark, rather vague crater to the south is probably Thales F. Democritus is the well-defined crater to the west, and Schwabe is the most complete of three rings northeast of Democritus. A large, crisp crater with a central peak is well north of Thales. It must be fairly deep since it still had dark interior shadow. This crater partially obliterated a shallow ring to its south. I'm not sure of its identity, but it might be Hayn E; if so, the partial ring on its south side might be Hayn J. A numbered guide (next page) is given with a copy of the sketch.

The brightest ray from Thales extends westward toward the north end of Democritus, passing south of Schwabe and its companions. A vaguer ray extends to the northwest toward Schwabe F. The area between these rays appears quite gray. A narrow, straight ray reaches to the southwest between Democritus and Thales F. A wide group of rays extends southward between Thales F and de la Rue J. The ray on the east side of this group (nearest de la Rue J) is the brightest of this bunch. A weak ray reaches to the northeast past the west end of Strabo toward an angular bright patch. I'm not sure what this patch is, but it doesn't look like a ray.

This first appeared in The Lunar Observer in May 2011.

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NUMBER GUIDE TO THALES AREA CRATERS

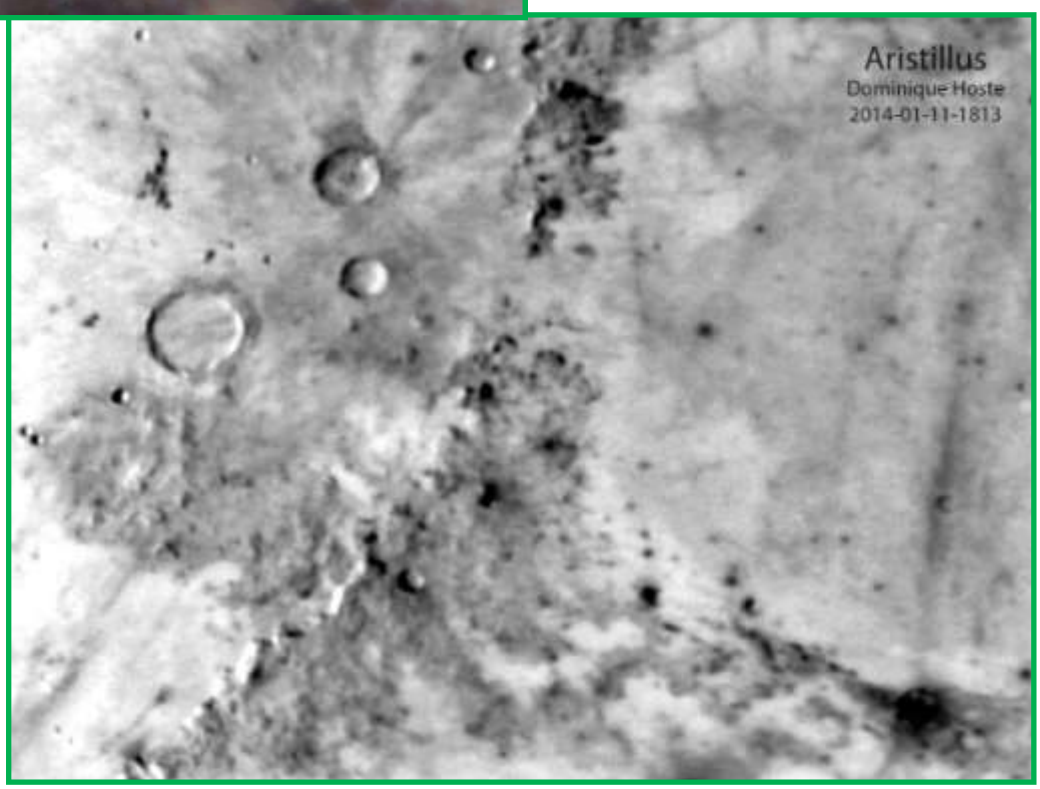
1. Thales
2. Strabo
3. de la Rue J
4. Thales F (probably)
5. Democritus
6. Schwabe
7. Schwabe G
8. Schwabe F
9. Strabo L (probably)
10. Strabo N (probably)
11. Hayn E (?)

Focus-On: Wonders of the Full Moon

Aristillus and Autolycus

These two craters have ray systems that are not so bright, but extremely peculiar: "These craters are a fine contrasting pair, because Aristillus has a more pronounced ray system, and Autolycus has a larger and more homogenous ejecta blanket" (Garfinkle). Clearly the rays of Aristillus are much more important than those of Autolycus, it is clearly seen in IMAGE 17, but especially in IMAGE 18 with inverted colors.

Image 17 left and Image 18 below, Aristillus, *Dominique Hoste, Kortrijk, West Flanders, Belgium. 2014 January 11 18:13 UT. Meade LX10 8 inch Schmidt-Cassegrain telescope, Meade LPI camera.*



Focus-On: Wonders of the Full Moon

Do rays from different systems overlap? Yes, the rays from Aristillus overlap with those of Autolycus, although the rays of the first cross the ejecta field and even the floor of Archimedes (in the detail of IMAGE 8 they are perceived as 3 bright bands). In both IMAGE 19 and IMAGE 20 we see that the most magnificent rays, those of Aristillus, are not continuous like those of Anaxagoras (they are less bright as well). This last image shows that this kind of bright lobe to the north of Aristillus, which points towards Cassini, and which in IMAGE 19 appears to be a kind of irregularity of the ejecta mantle, would actually be a raised area on the edge (red arrow in IMAGE 20). IMAGE 19 shows both bright ray systems in all their glory, crossing the floor of the older Archimedes, and the strangest feature of Aristillus: its dark band. In Peter Grego's "The Moon and How to Observe It" we read: "The northeastern inner wall is marked by a prominent dark band that extends from the crater's floor to its rim. This feature, one of the most noteworthy dark albedo bands to be found in any lunar crater, does not appear to be associated with any topographic formation". We also see the dark band in IMAGE 21, where we also see the Aristillus ray system in all its glory: isn't it almost identical to a little Copernicus?

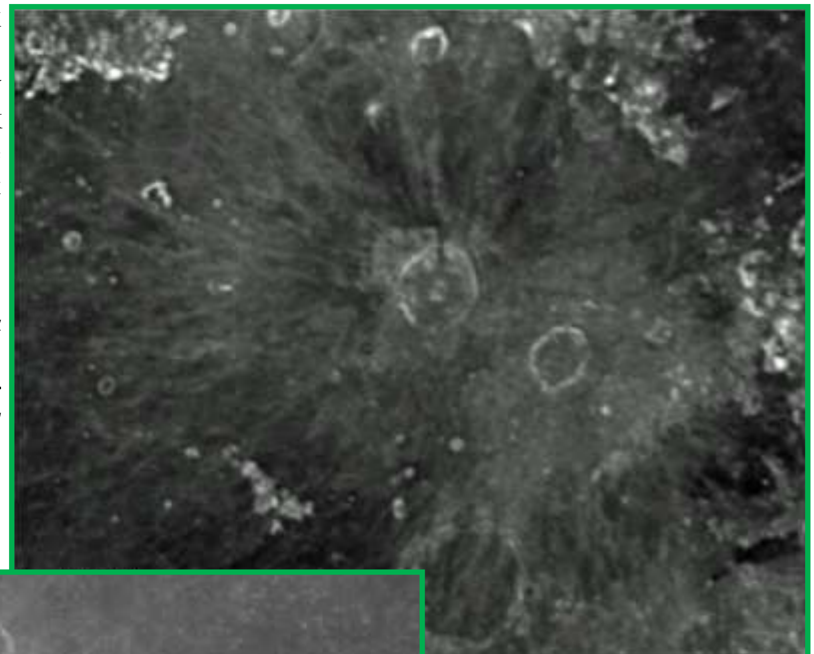


Image 8, Detail of Aristillus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 April 21 22:29 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, QHY5-II camera. North is upper left, west is lower left.*

Image 19, Aristillus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 June 19 05:15 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, QHY5-II camera. North left, west down.*

Focus-On: Wonders of the Full Moon

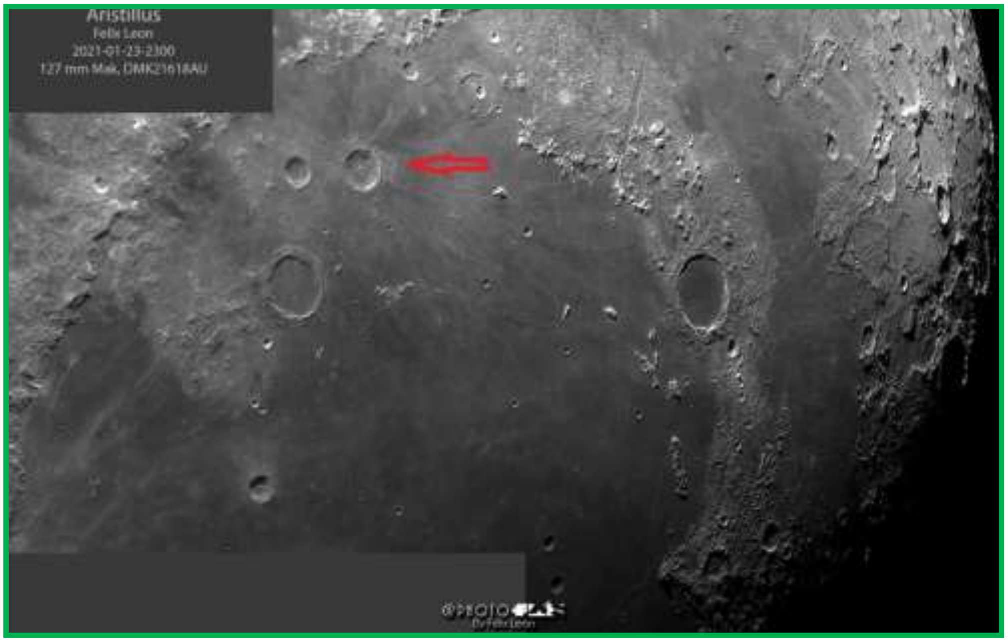


Image 20, Aristillus, *Felix León, Santo Domingo, República Dominicana. 2021 January 23 23:00 UT. 127 mm Maksutov-Cassegrain telescope, DMK21618AU camera. North is right, west is down.*

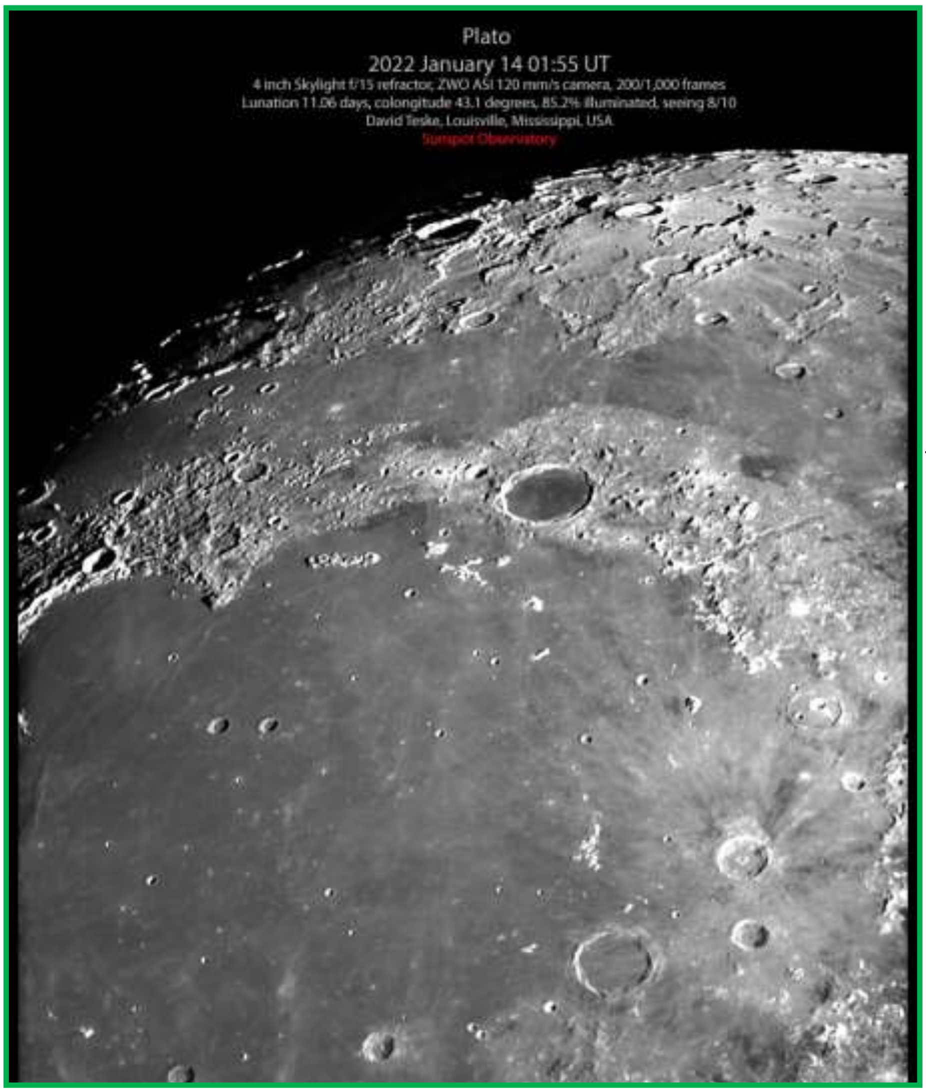


Image 21, Plato*, David Teske, Louisville, Mississippi, USA. 2022 January 14 01:55 UT, colongitude 43.1°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.*

Focus-On: Wonders of the Full Moon

Proclus and Taruntius

Proclus is only 28 km in diameter, but it is one of the most conspicuous points on the surface of the near side of the Moon, due to its intense brightness and its strange asymmetrical system of bright rays. As we see in IMAGE 22 and 22A, its rays are very bright, but they are much less bright than Proclus himself (whose north wall is much brighter). Are the rays distributed evenly around their parent crater? Proclus is the paradigmatic case of an asymmetric system of bright rays, although there is some symmetry: the rays extend to the north and south, some extend to the east, although they are less bright (or appear to be). But there are no rays to the west, the direction that the impacting object came from the west or else the rays heading west were blocked by the mountains to the west of Proclus. The lack of bright rays west of Proclus, the region called Palus Somni, has generated various theories such as that of Harold Urey, who "theorized that Palus Somni floats on lava and remains darkened due to its continual heating by subsurface hydrogen sulfide" (Garfinkle), today we know that the asymmetry derives from the oblique impact.

In the same IMAGE 22 we see another Copernican crater, but with a much older bright ray system, Taruntius, also completely asymmetrical, with longer southbound rays than the others.

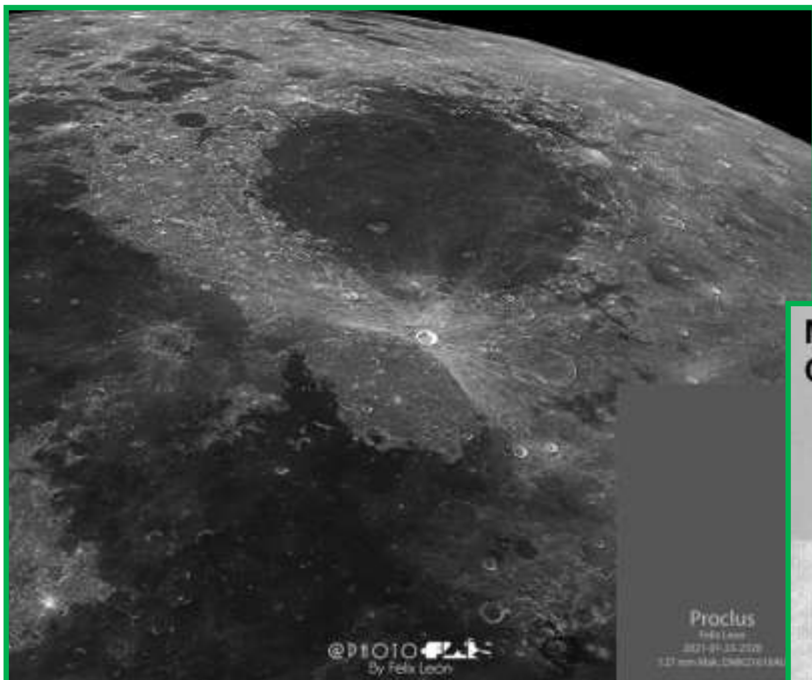


Image 22, Proclus, *Felix León, Santo Domingo, República Dominicana. 2021 January 23 23:20 UT. 127 mm Maksutov-Cassegrain telescope, DMK21618AU camera. North is left, west is down.*

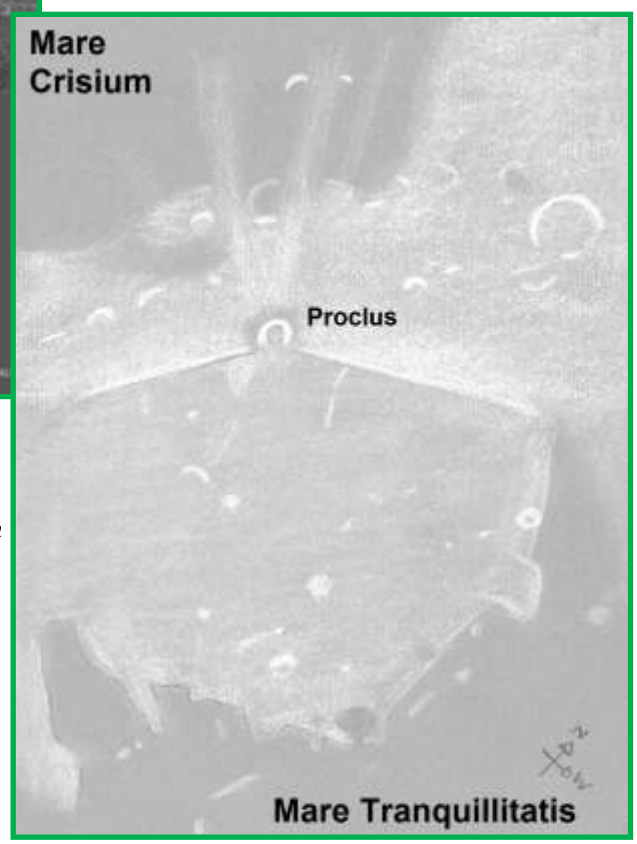


Image 22A, Proclus*, Jef De Wit, Hove, Belgium. 2011 March 19 22:00-23:00 UT. 8 cm refractor telescope,158 x.*

***Image 23, Proclus,** Desiré Godoy, Oro Verde, Argentina. 2019 November 08 01:22 UT. 200 mm Meade Starfinder reflector telescope, QHY5-LIIM camera. North is left, west is down.*

***Image 24, Proclus,** Desiré Godoy, Oro Verde, Argentina. 2019 November 08 01:32 UT. 200 mm Meade Starfinder reflector telescope, QHY5-LIIM camera. North is left, west is down.*

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Image 25, Proclus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 May 14 02:16 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, Astronomik ProPlanet 742 nm IR pass filter, QHY5-II camera. North left, west down.*

Menelaus and Manilius

On the southwestern shore of Mare Serenitatis, we find Menelaus (27 km diameter) in the Montes Haemus (IMAGE 26 and IMAGE 27). In the details we see that its rays are not evenly distributed around the crater and that some of them start from its bright center. Its continuous ejecta deposit is also seen in both details and, curiously, it does not extend to the surface of the Mare Serenitatis (oblique impact or is it anterior to the mare?). The bright ray that seems to come from Menelaus is actually that famous "super-ray" that also seems to come from Thales, as we see in IMAGE 28. Looking at IMAGES 29 to 34, it does not seem so clear that the ray that passes through Bessel comes from Menelaus, rather it looks like a brighter strip of the floor of Serenitatis, although Bessel is a Copernican crater and therefore entitled to bright rays, but there seems to be no indication of another than this segment of that "super-ray" coming from Thales but which is actually a composition of our brain that joins various bright lines, or a ray from Tycho. Around Menelaus we see other craters with bright rays. In the detail of IMAGE 27 we see Plinius, with a barely perceptible ray system, typical of the Eratosthenian craters and the small Tacquet, which looks like a bright little star that interrupts the darker lava strip on the edge of Mare Serenitatis, at the left of Menelaus. In IMAGE 35 we see the irregular system of bright ejecta of Plinius, which starts at its center.

Southwest of Menelaus is Manilius (IMAGE 36 MANILIUS) “with a thick ejecta blanket covering a large portion of the northeastern flats of Mare Vaporum. The ejecta blanket is sprinkled with numerous bright secondary craters” (Garfinkle). In IMAGE 36 we can see a panoramic view of Menelaus, Manilius, Dionysius and a little-known bright ray crater that appears clearly in the image: Alfraganus (IMAGE 36 ALFRAGANUS).

***Image 26, Menelaus,** Francisco Alsina Cardinalli, Oro Verde, Argentina. 2019 August 06 23:34 UT. 200 mm refractor telescope, Astronomik ProPlanet 742 nm IR pass filter, QHY5-I camera. North is down, west is left.*

***Image 26, Menelaus Detail,** Francisco Alsina Cardinalli, Oro Verde, Argentina. 2019 August 106 23:34 UT. 200 mm refractor telescope, Astronomik ProPlanet 742 nm IR pass filter, QHY5-I camera.*

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Image 27, Bessel, *Román García Verdier, Paraná, Argentina. 2020 September 26 23:57 UT 180 mm Newtonian reflector telescope, QHY5-II camera. North is down, west is left.*

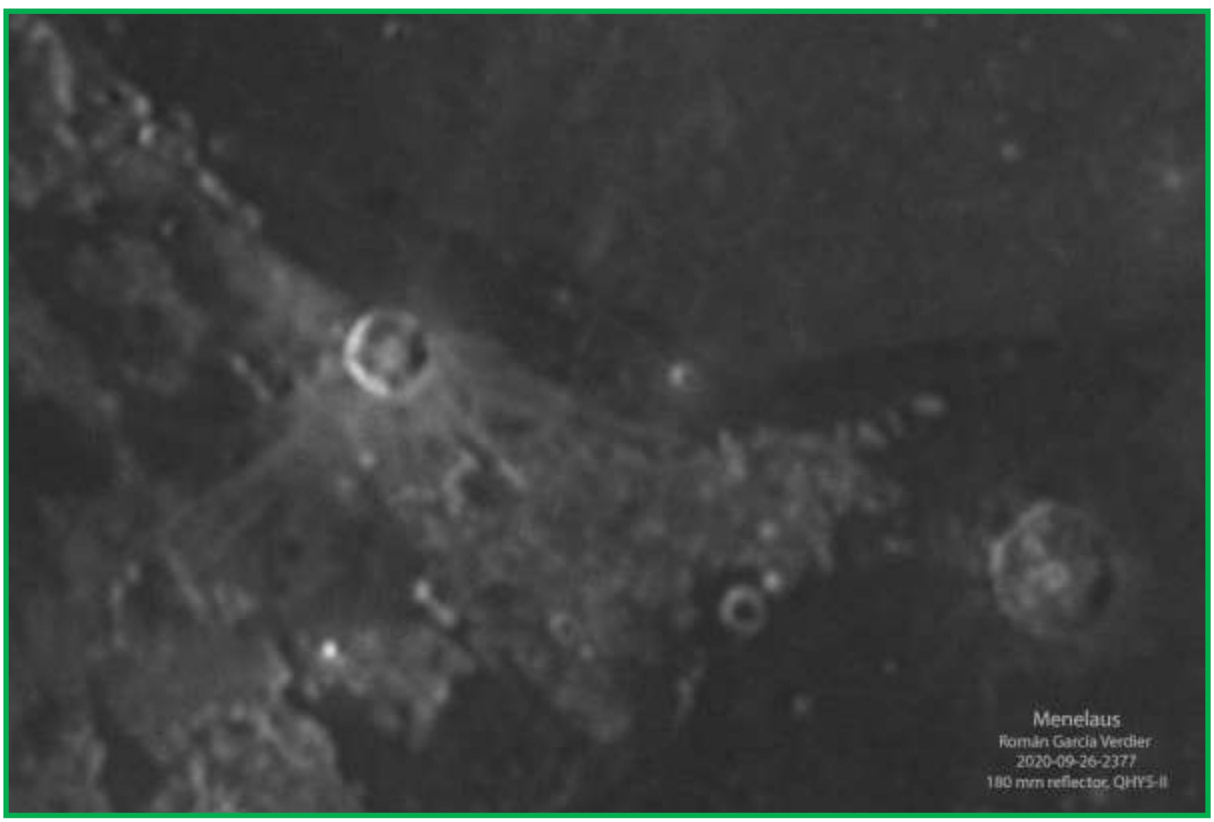

Image ***27, Menelaus,*** *Román García Verdier, Paraná, Argentina. 2020 September 26 23:57 UT 180 mm Newtonian reflector telescope, QHY5-II camera.*

Focus-On: Wonders of the Full Moon

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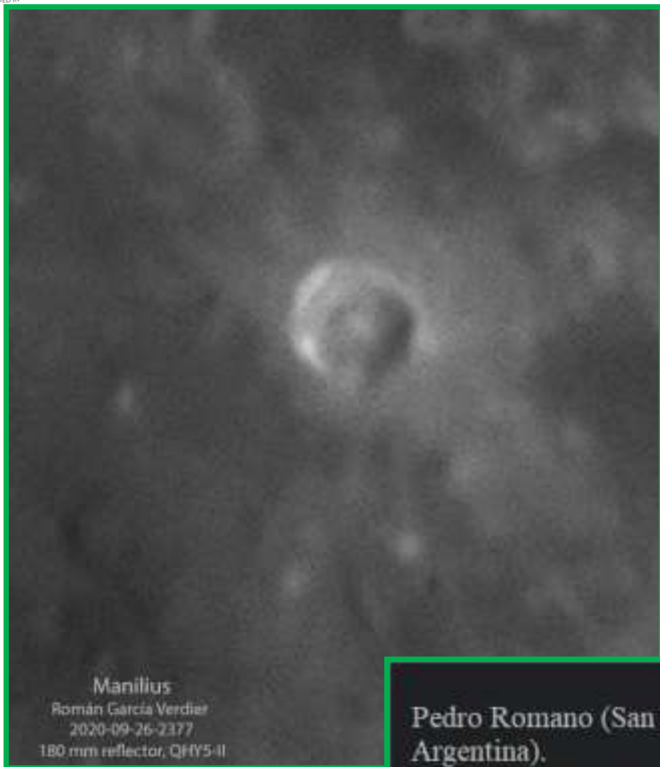

Image 27, Manilius, *Román García Verdier, Paraná, Argentina. 2020 September 26 23:57 UT 180 mm Newtonian reflector telescope, QHY5-II camera.*

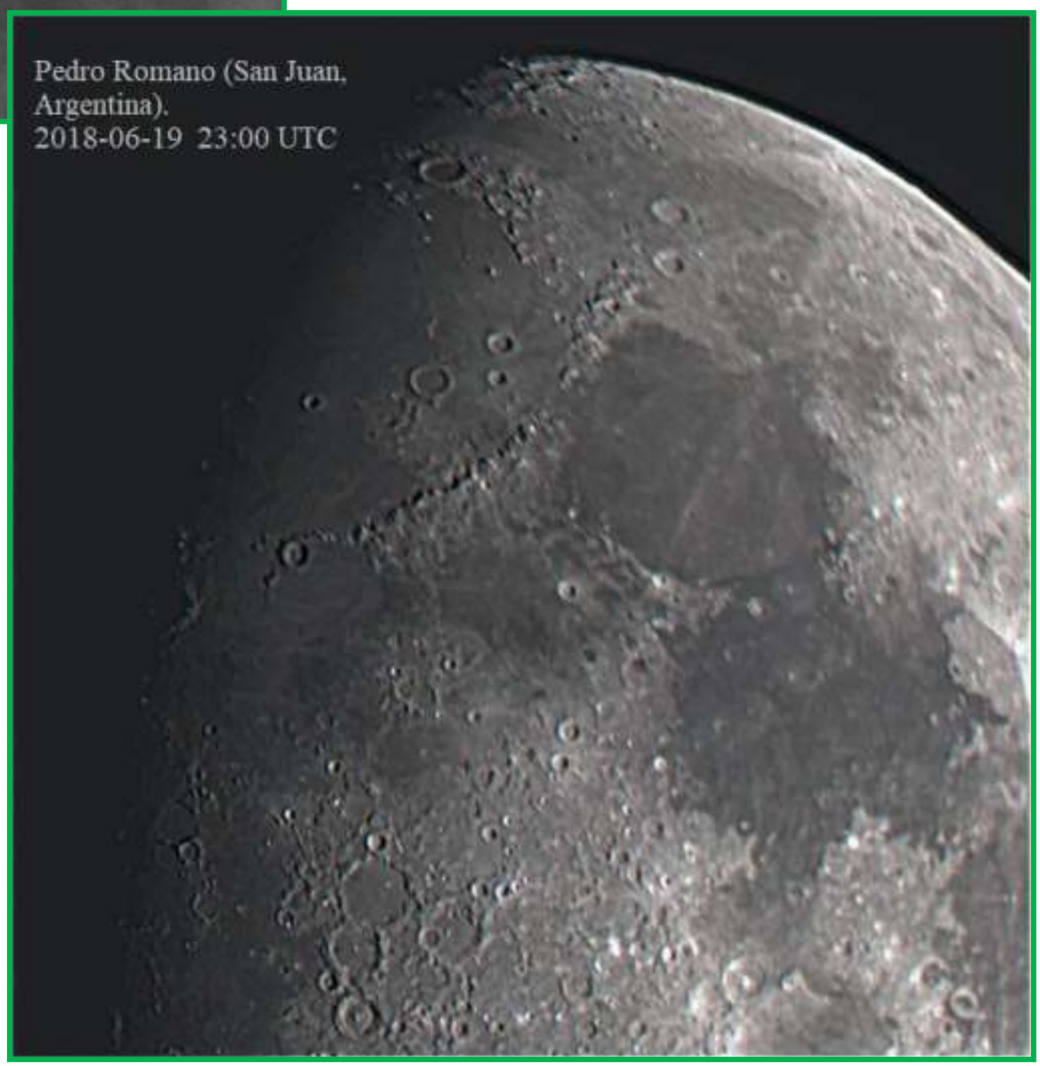

Image 28, Mare Serenitatis, *Pedro Romano, San Juan, Argentina. 2018 June 19 23:00 UT. 500 mm reflector telescope, ZWO ASI120 camera.*

Focus-On: Wonders of the Full Moon

Image 29, Bessel, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2017 July 01 23:34 UT. 200 mm refractor telescope, QHY5-II camera. North is lower left, west is lower right*

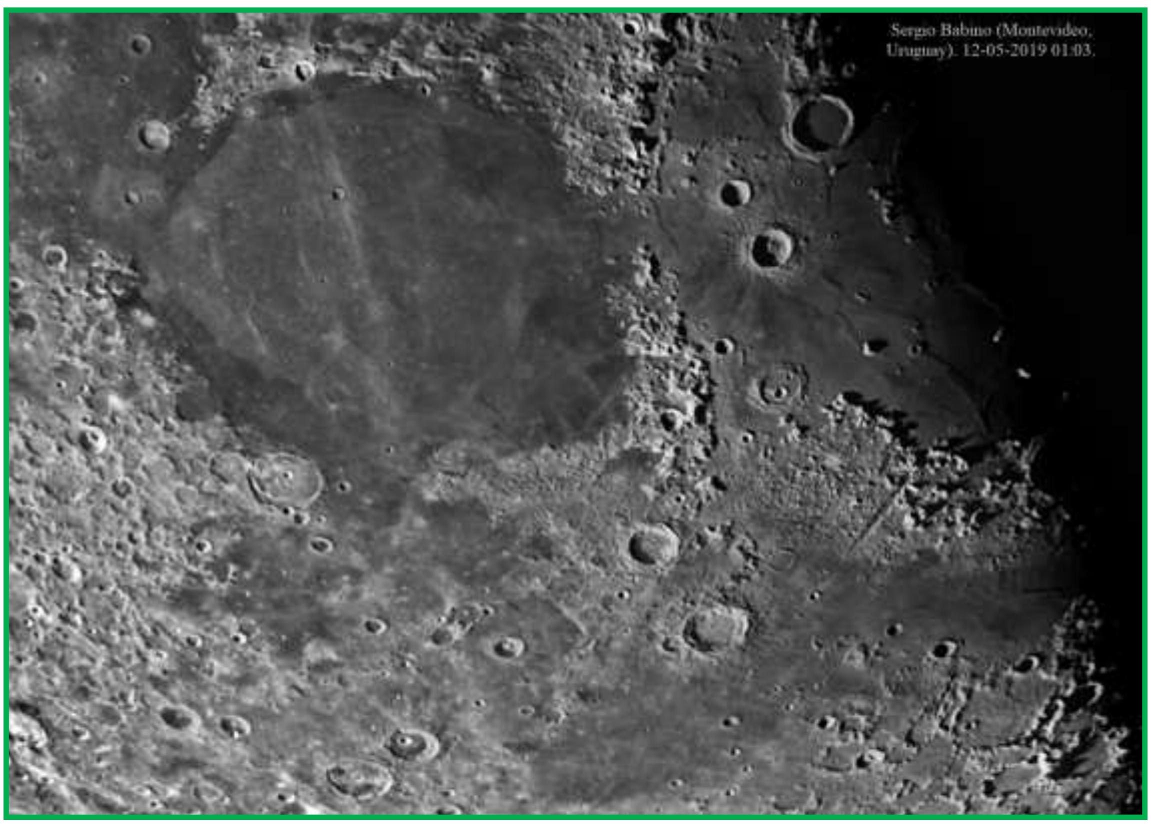

Image 30, Bessel, *Sergio Babino, Montevideo, Uruguay. 2019 December 05 01:03 UT. 250 mm catadrioptic telescope, ZWO ASI174MM camera. North is to the lower left, west is to the upper right.*

Focus-On: Wonders of the Full Moon

Image 31, Waxing Gibbous Moon, *Jairo Chavez, Popayán, Colombia. 2019 July 11 03:03 UT. 10 inch truss Dobsonian reflector telescope,* Sony *DSC-WX 50 camera. North is lower left, west is lower right.*

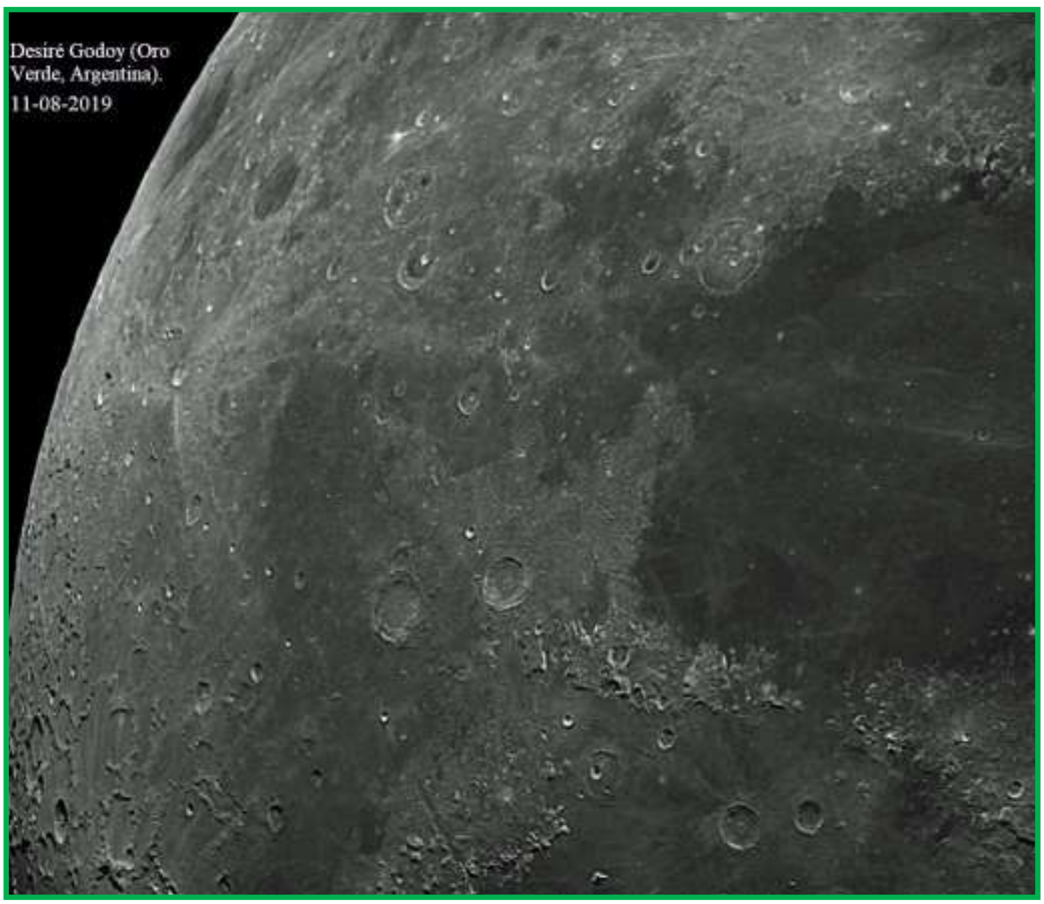

Image 32, Bessel, *Desiré Godoy, Oro Verde, Argentina. 2019 November 08 01:20 UT. 200 mm Meade Starfinder reflector telescope, QHY5-LIIM camera. North is left, west is down.*

Focus-On: Wonders of the Full Moon

***Image 33, Mare Serenitatis**, David Teske, Louisville, Mississippi, USA. 2022 January 12 00:44 UT, colongitude 18.1^{o}. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.*

***Image 34, Mare Serenitatis**, David Teske, Louisville, Mississippi, USA. 2022 February 09 02:04 UT, colongitude 359.4^{o}. 3.5 inch Questar Maksutov-Cassegrain telescope, IR block filter, ZWO ASI120mm/s camera.*

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Image 35, Plinius, István Zoltán Földvári, Budapest, Hungary. 2018 September 21, 21:20 UT, colongitude 45.89 degrees. 70 mm refractor telescope, 500 mm focal length, 100 x.

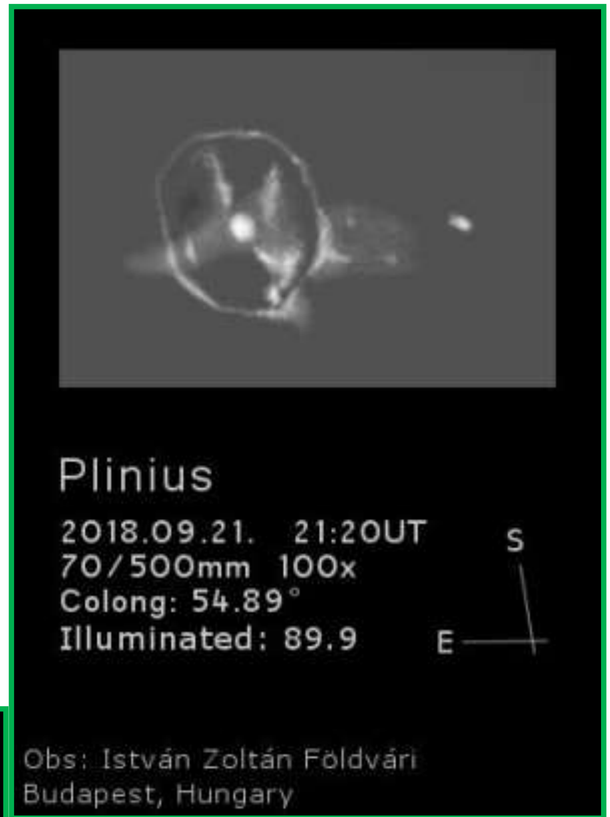

Image 36, Apollo 16, David Teske, Louisville, Mississippi, USA. 2022 March 20 07:14 UT, colongitude 116.9°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.

Focus-On: Wonders

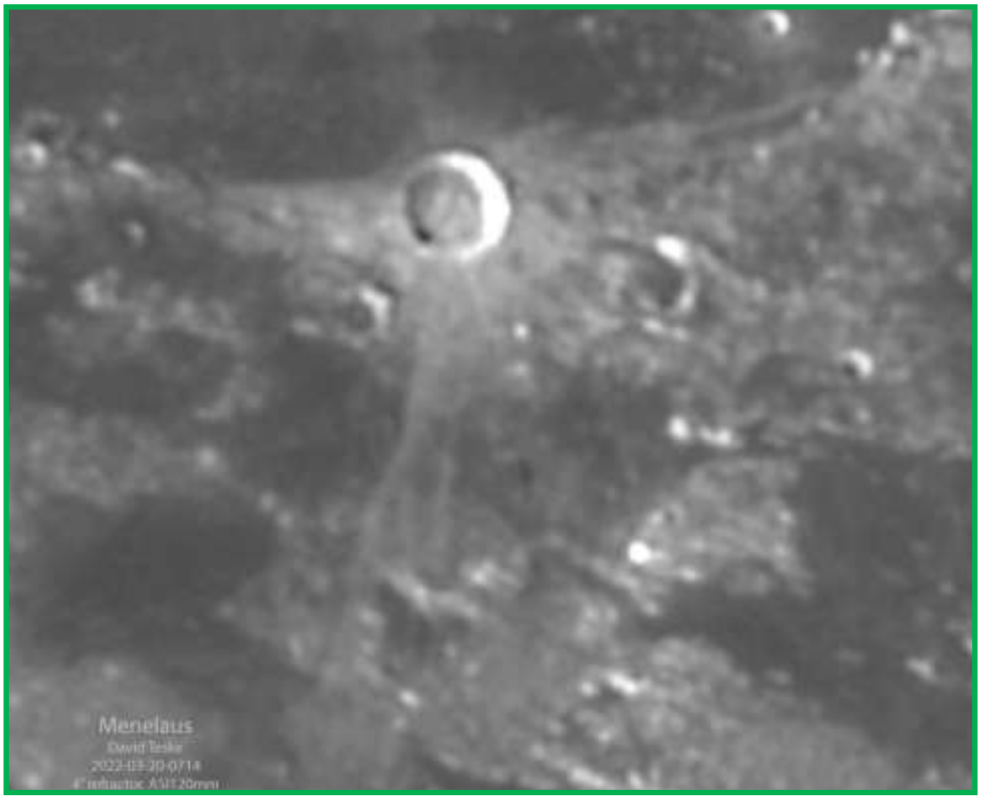

Image 36, Menelaus, *David Teske, Louisville, Mississippi, USA. 2022 March 20 07:14 UT, colongitude 116.9°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.*

Image 36, Alfraganus, *David Teske, Louisville, Mississippi, USA. 2022 March 20 07:14 UT, colongitude 116.9°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.*

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The magnificent trio: Copernicus, Kepler and Aristarchus

While Tycho takes the prize for the popularity of bright ray craters (usually the first one people ask to see through the telescope), the 3 most interesting bright ray craters, to my knowledge, are the ones that make up the magnificent trio in Oceanus Procellarum: Copernicus, Kepler and Aristarchus. Garfinkle clearly points out the difference between Tycho in the highlands and the craters of the Oceanus Procellarum: "The ejecta blankets around mare craters tend to be broader near the crater than for highland craters and their rays tend to be shorter with fuzzy feathery edges. A few of the larger mare rayed craters have long twisted tapering rays that extend for hundreds of kilometers beyond the ejecta blanket. The bright rays of highland craters tend to be longer, narrower, and straighter than mare crater rays. This difference in the two main types of bright rays is probably due to the difference of the mechanical properties of the mare basaltic rocks compared to the more compacted rocky highland materials". This difference is clearly seen in IMAGE 37.

Image 37, Waxing Gibbous Moon, *Jairo Chavez, Popayán, Colombia. 2018 August 31 05:31 UT. 10 inch truss Dobsonian reflector telescope,* Sony *DSC-WX 50 camera.*

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In IMAGE 38 we can compare the three bright ray systems: Copernicus and Kepler have a uniform structure, Aristarchus has an asymmetric structure, with the bright rays pointing northwest interrupted by the Aristarchus Plateau; and as for the question whether craters are always brighter than their rays, there seems to be a scale: Aristarchus is much brighter, Copernicus a little brighter, and Kepler seems to be at least as bright as their rays. And regarding the starting point of the rays, the differences can be seen better in IMAGE 39: Kepler has an ejecta mantle that blends in with its rim, Copernicus's is marked with dark spots and Aristarchus is completely asymmetric: towards to the east the rays start far from the rim, separated from the east by a dark semicircle, while to the west the interaction with Herodotus and the Vallis Schröteri makes it more difficult to discern their range (although Aristarchus is younger than these two features, as indicated by the bright rays crossing them).

Image 38, Aristarchus, *Román García Verdier, Paraná, Argentina. 2019 September 15 03:28 UT 180 mm Newtonian reflector telescope, QHY5-II camera.*

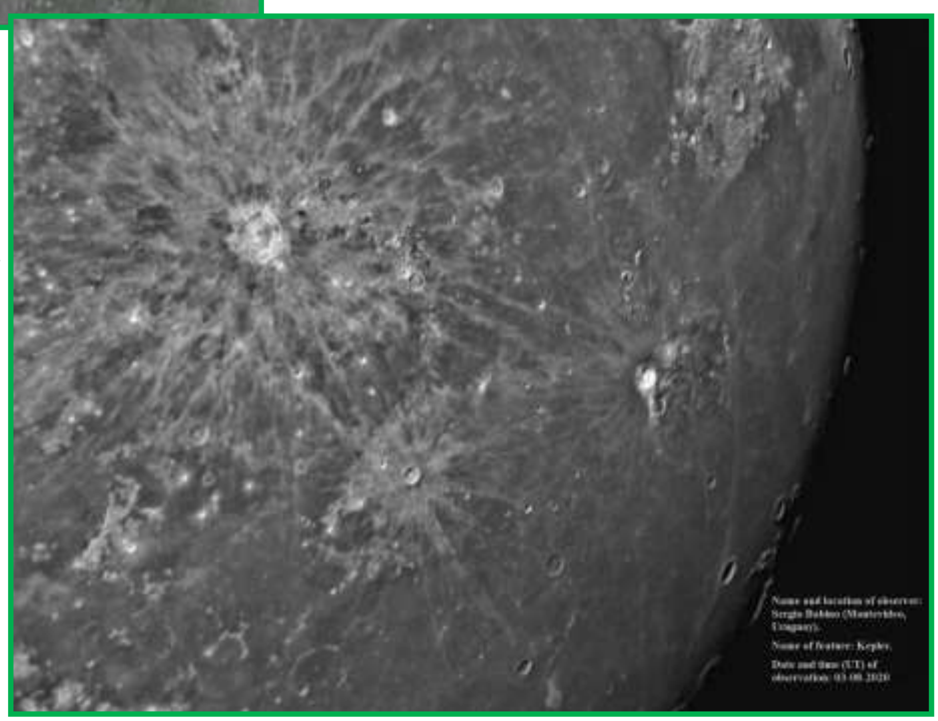

Image 39, Kepler, *Sergio Babino, Montevideo, Uruguay. 2020 March 08 01:29 UT. 203 mm catadrioptic telescope, ZWO ASI174MM camera. North is down, west is right.*

Focus-On: Wonders of the Full Moon

The most extensive of the bright ray systems corresponds to the largest of the 3 craters: "The greatest glory of Copernicus is its far-flung system of bright rays that extend almost 700 km across the surrounding maria" (Wood, The Modern Moon), "As far as I am concerned, the gray, paint-like splatter of the crater Copernicus ejecta blanket and its ray system are the most interesting and complex lunar ray system to observe" (Garfinkle). The extensive ejecta blanket is punctuated by circular blotches, marking post-Copernicus impacts that have exposed dark Oceanus Procellarum material beneath bright material ejected earlier by the Copernicus impact and secondary impacts (IMAGE 40 TO 44).

Image 40, Copernicus, *Alberto Anunziato, Oro Verde, Argentina. 2016 August 21 05:32 UT. 10 inch Meade LX200 Schmidt-Cassegrain telescope, Astronomik ProPlanet 742 nm IR pass filter, QHY5-II camera.*

Image 41, Kepler to Copernicus*, David Teske, Louisville, Mississippi, USA. 2022 January 14 01:49 UT, colongitude 43.1°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.*

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***Image 42, Copernicus**, David Teske, Louisville, Mississippi, USA. 2022 May 11 01:44 UT, colongitude 28.4°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.*

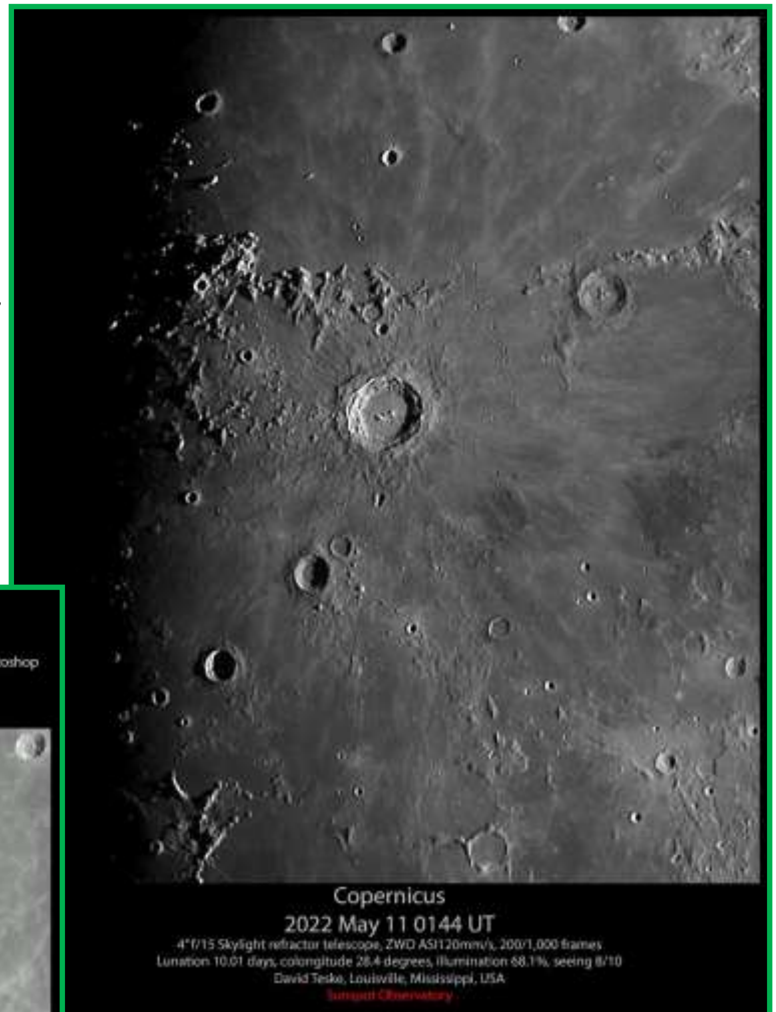

***Image 43, Copernicus**, David Teske, Louisville, Mississippi, USA. 2022 February 12 02:04 UT, colongitude 36.0°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera.*

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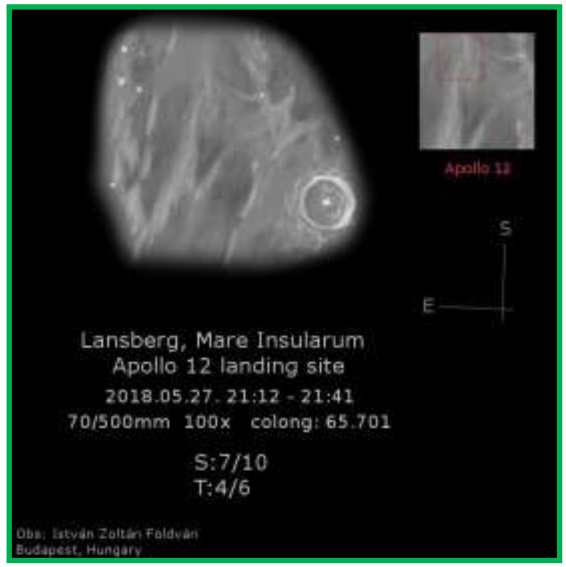

Image 44, Lansberg and Mare Insularum, *István Zoltán Földvári, Budapest, Hungary. 2018 May 27, 21:12-21:41 UT, colongitude 65.701 degrees. 70 mm refractor telescope, 500 mm focal length, 100 x. Seing 7/10, transparency 4/6.*

In IMAGE 45 we can discern how "material excavated and ejected from the initial impact event changes in thickness and character with increasing distance from the originating crater. The nearest ejecta is thick, contributing to the height of the crater rim itself. It then rapidly decreases farther from the rim reaching the level of the original terrain at about one crater radius away. This inner annulus is called the continuous ejecta deposit. Beyond that is an area of abundant secondary craters in clusters and chains-the zone of continuous secondaries. Then, stretching hundreds of kilometers from larger craters rather than clusters of secondary impacts is a zone of discontinuous secondaries often isolated craters rather than clusters of secondary impacts. These are formed by high-velocity blocks of ejecta shot out from near the center of the primary crater" (Wood, Craters Rays-Mysterious No More).

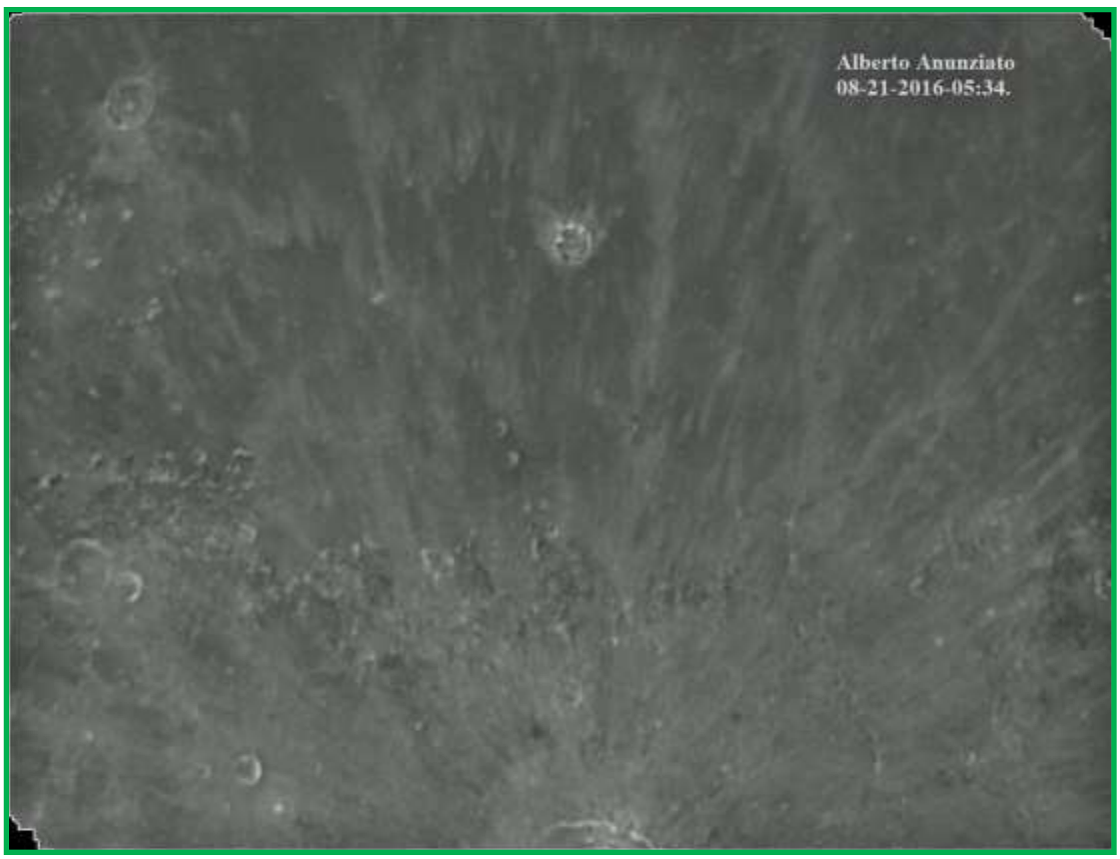

Image 45, Copernicus, *Alberto Anunziato, Oro Verde, Argentina. 2016 August 21 05:34 UT. 10 inch Meade LX200 Schmidt-Cassegrain telescope, Astronomik Pro-Planet 742 nm IR pass filter, QHY5-II camera.*

Focus-On: Wonders of the Full Moon

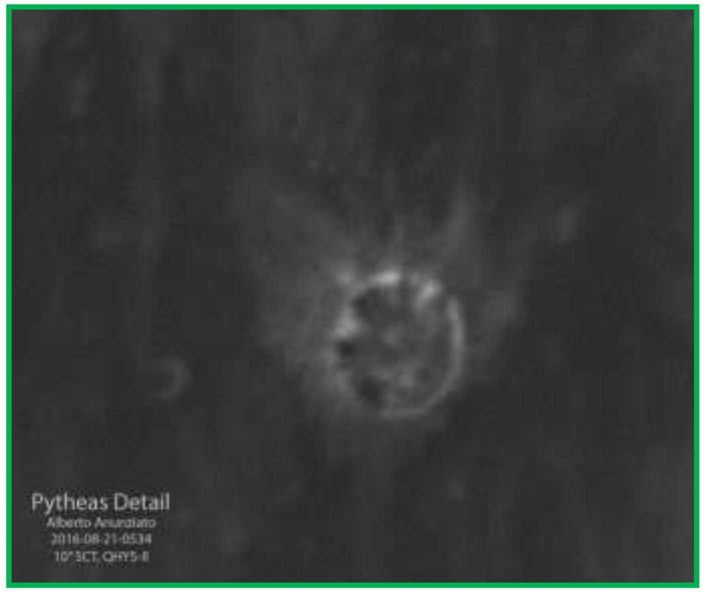

Image 45, Detail of Pytheas, *Alberto Anunziato, Oro Verde, Argentina. 2016 August 21 05:34 UT. 10 inch Meade LX200 Schmidt-Cassegrain telescope, Astronomik ProPlanet 742 nm IR pass filter, QHY5-II camera.*

In IMAGE 45 we also see a bright ray crater (Pytheas) inserted in the field of discontinuous ejecta of another bright ray crater, Copernicus. Pytheas is also a Copernican crater. It has a diameter of approximately 20 kilometers and is located north of Copernicus, in a straight line and surrounded by the material ejected by the impact that generated the neighboring giant, although that material from the impact that generated Copernicus does not overlap with Pytheas or its particular ray system. Pytheas rays are doubly asymmetric. They are practically non-existent to the south and to the north they divide into two lobes, the eastern lobe being brighter than the broader and more diffuse western lobe. This IMAGE 45 illustrates one of the most fascinating aspects of the Copernicus rays: "One of the easiest places to see secondary within rays is in the Copernican rays that pass both to the east and west of the crater Pytheas" (Wood, The Modern Moon). Do you remember that we said that the brightness of some rays is due to the impact of rocks belonging to highlands, with a high albedo? Copernicus is the most famous example: "the present brightness of Copernicus is due largely to the component of highland primary ejecta intimately mixed with local substrate (mare basalt soil) and not to brightness associated solely with immature soils excavated by secondary and tertiary impacts" (Pieters et al.).

Copernicus rays also show interesting examples of interaction with older selenographic features. In IMAGES 46 to 49 how they enter Mare Imbrium and seem to "climb" the concentric wrinkle ridges and in IMAGE 50 as Eratosthenes almost disappears, with frontal illumination, under the bright ejections of the younger Copernicus.

Image 46, Copernicus, *Marcelo Mojica Gundlach, Cochabamba, Bolivia. 2018 August 22 23:36 UT. 150 mm refractor telescope, Orion V-block filter, SWO CMOS camera. North is right, west is down.*

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Image 47, Copernicus, *Marcelo Mojica Gundlach, Cochabamba, Bolivia. 2018 August 22 23:36 UT. 150 mm refractor telescope, Orion V-block filter, SWO CMOS camera. North is right, west is down.*

Image 48 Copernicus, *Jesús Piñeiro,* *San Antonio de los Altos, Venezuela. 2020 November 24 22:48 UT. Meade ETX90 Maksutov-Cassegrain telescope, Astronomik 807 filter, ZWO ASI462MC camera. North is lower right, west is upper right.*

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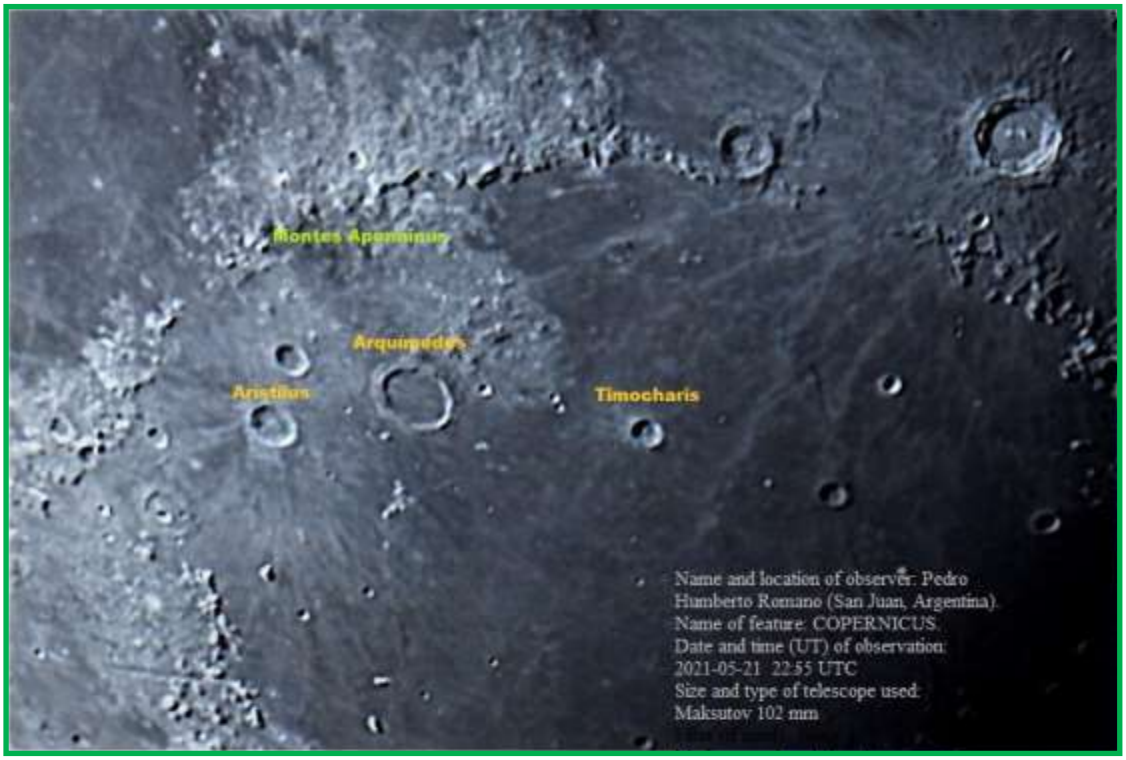

Image 49, Copernicus, *Pedro Romano, San Juan, Argentina. 2021 May 21 22:55 UT. 102 mm Maksutov-Cassegrain telescope, Canon 450 D camera. North is down, west is right.*

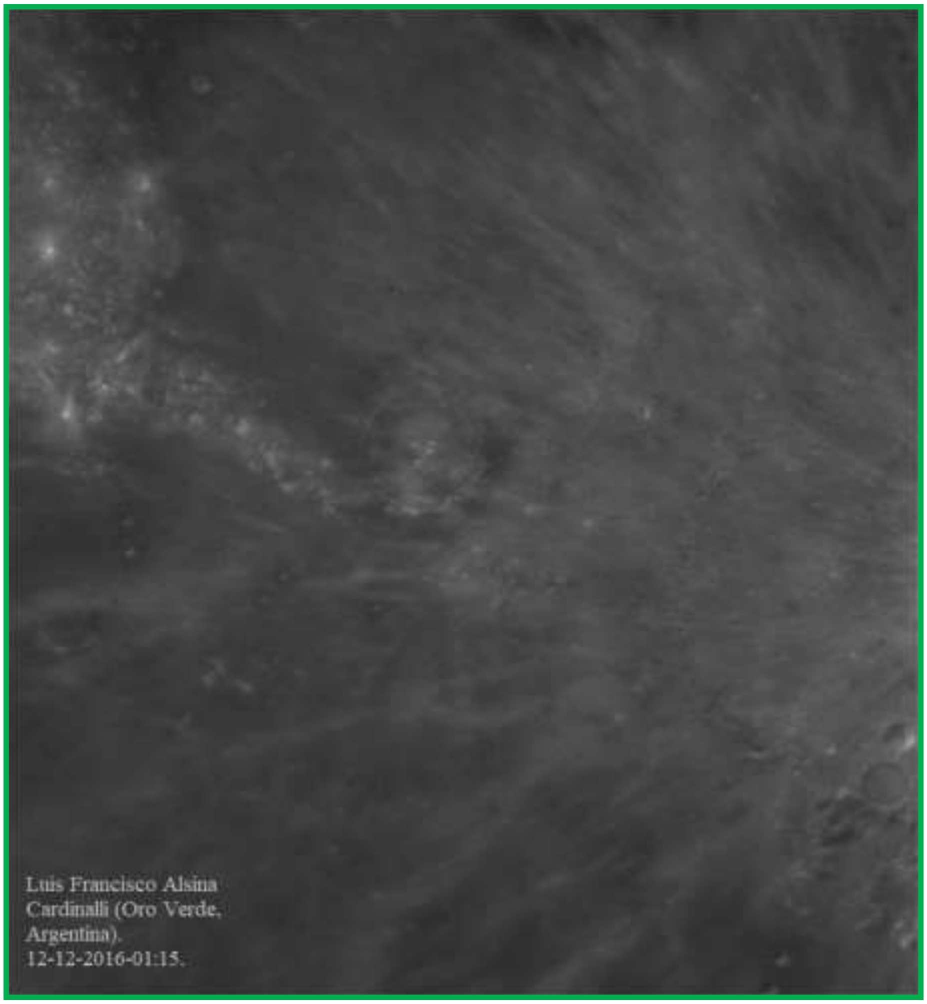

Image 50, Eratosthenes, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 December 12 01:15 UT. Meade Starfinder 8 200 mm reflector telescope, Astronomik ProPlanet 742 IR pass filter. North is up, west is right.*

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In IMAGE 51 we see how the gigantic Copernicus ray system interacts with the rays of two small craters such as Pytheas (left) and Gambart A (right) and the larger Lalande (right edge).

The bright rays of Aristarchus are less conspicuous than those of Copernicus and Kepler, overshadowed by the intense brightness of the crater and its inner bands, but, as Garfinkle says, once again: "The relatively young crater Aristarchus is a very bright-rayed crater with a large ejecta blanket and thin sinuous rays. The rays splatter over the ghost crater Prinz to the northeast and intermix with those of Copernicus, Kepler, and Diophantus" (IMAGES 52 to 54).

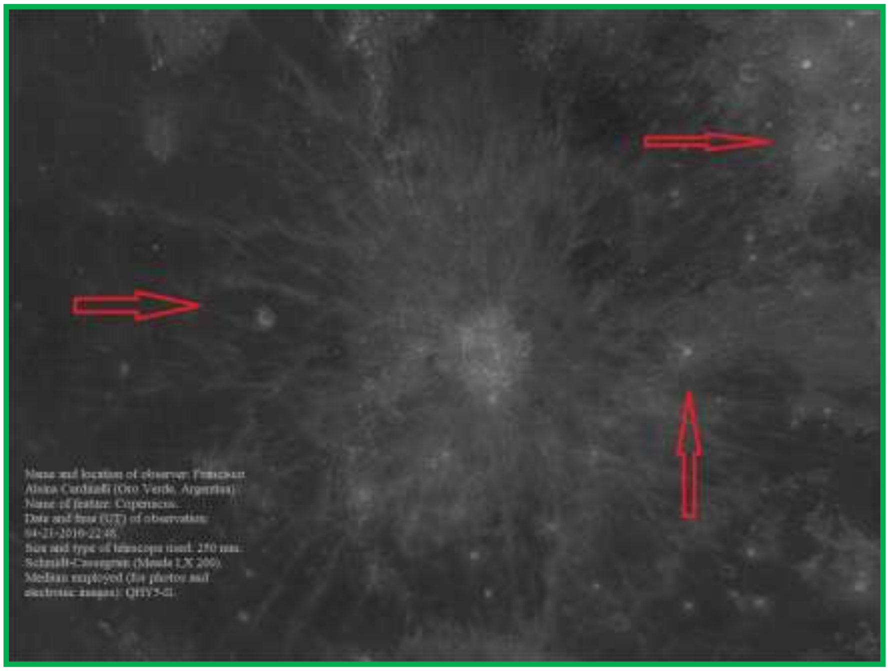

Image 51, Copernicus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 April 21 22:48 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, QHY5-II camera. North is left, west is down.*

Image 52, Aristarchus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2015 December 20 00:39 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, Canon EOS Digital Rebel XS camera.*

Focus-On: Wonders of the Full Moon

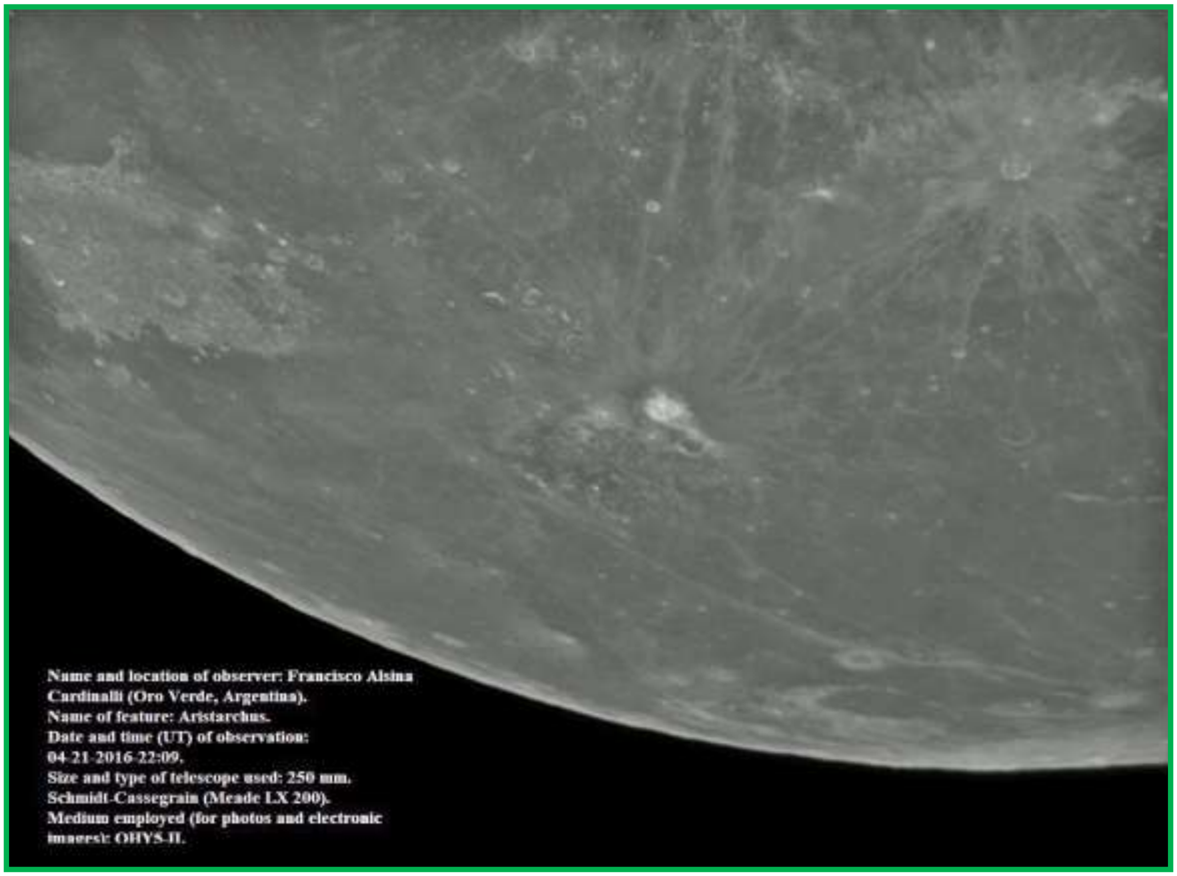

Image 53, Aristarchus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 April 21 22:09 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, QHY5-II camera. North is left, west is down.*

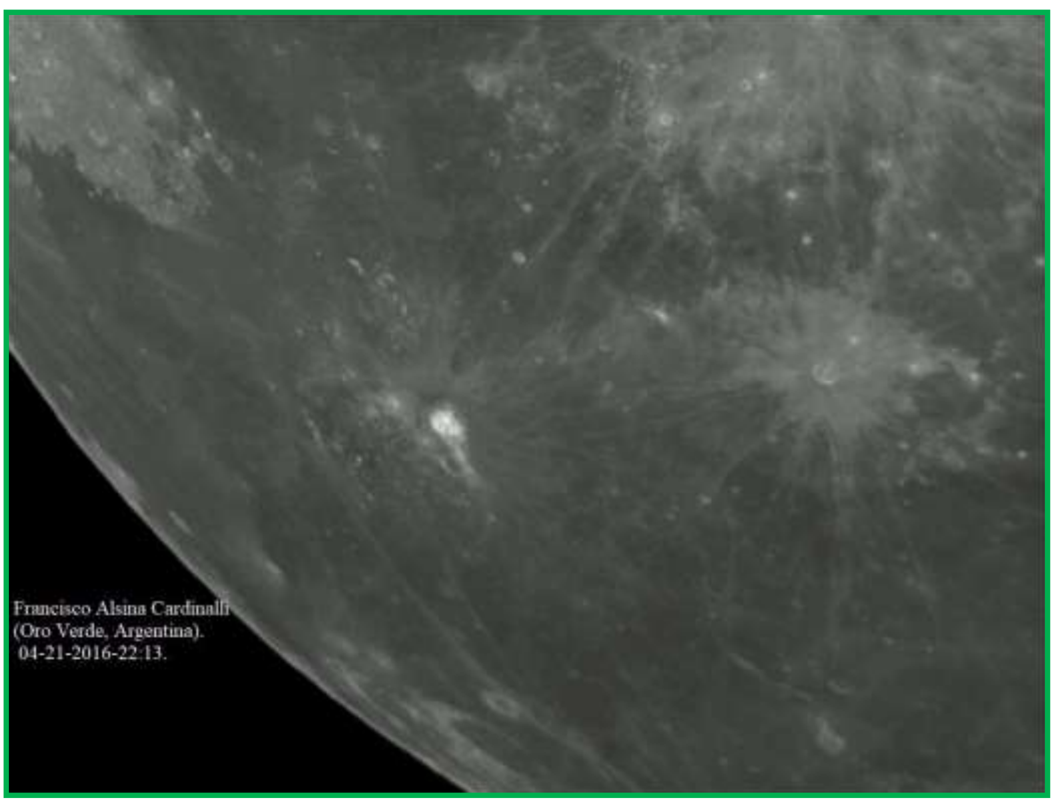

Image 54, Aristarchus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 April 21 22:13 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, QHY5-II camera. North is left, west is down.*

Kepler (IMAGE 55 to 58) also shows a large splattered-ejecta blanket and sinuous ray system. The ejecta blanket covers a larger area on the eastern side and the rays of the west side are longer and more sinuous, perhaps because towards the Mare Insularum its rays were covered by those of Copernicus. In IMAGE 59 we can see how Kepler's rays interact with the concentric dorsa to the west of Oceanus Procellarum, especially in the area indicated by the red arrow. I remember visually seeing how the lightning appears to "go up and down" on the wrinkle ridge.

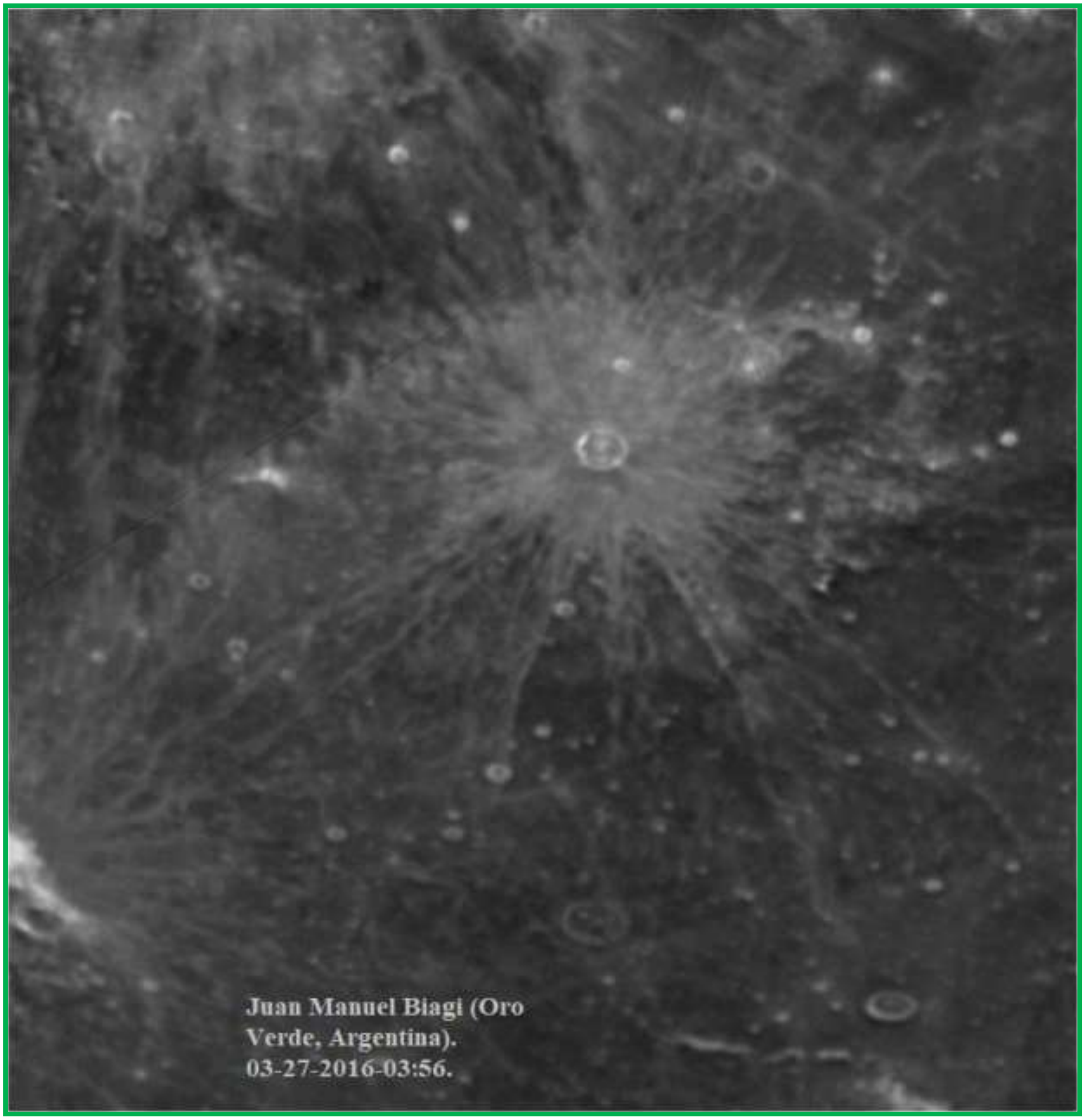

Image 55, Kepler, *Juan Manuel Biagi, Oro Verde, Argentina. 2016 March 27 03:56 UT. Celestron 11 inch Edge HD Schmidt-Cassegrain telescope, Canon EOS Digital Rebel XS camera.   North is left, west is down.*

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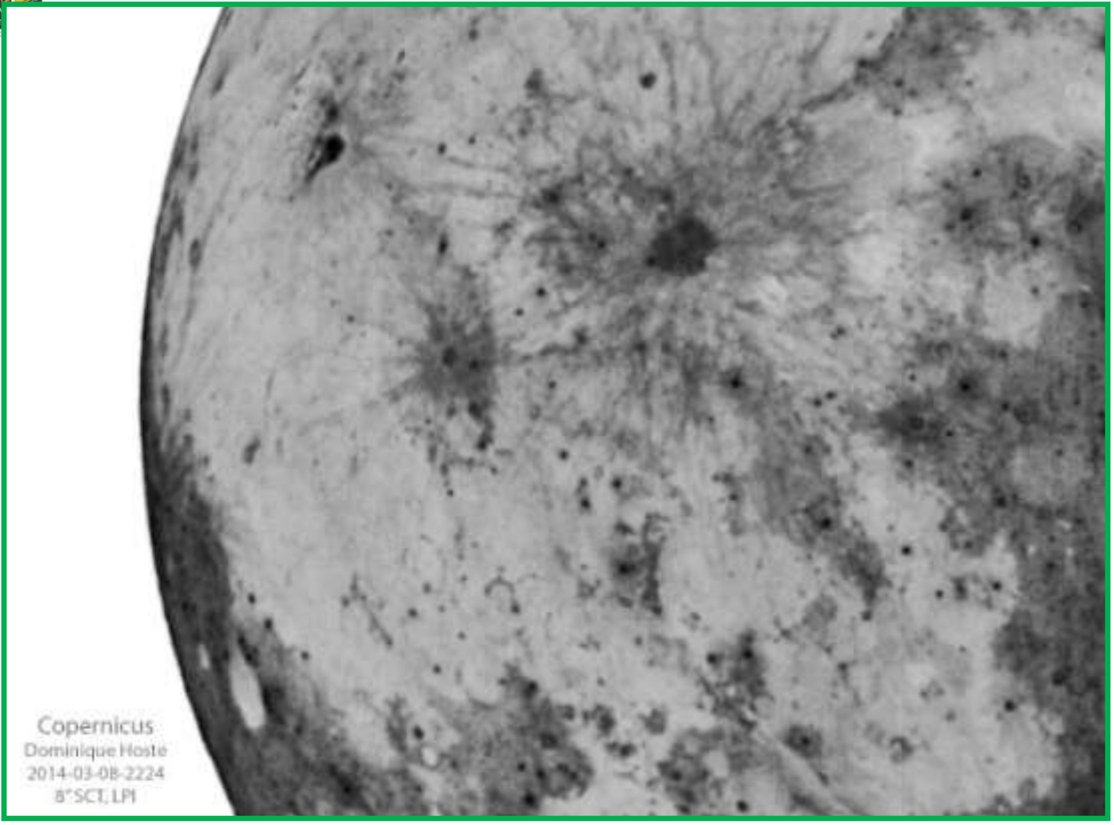
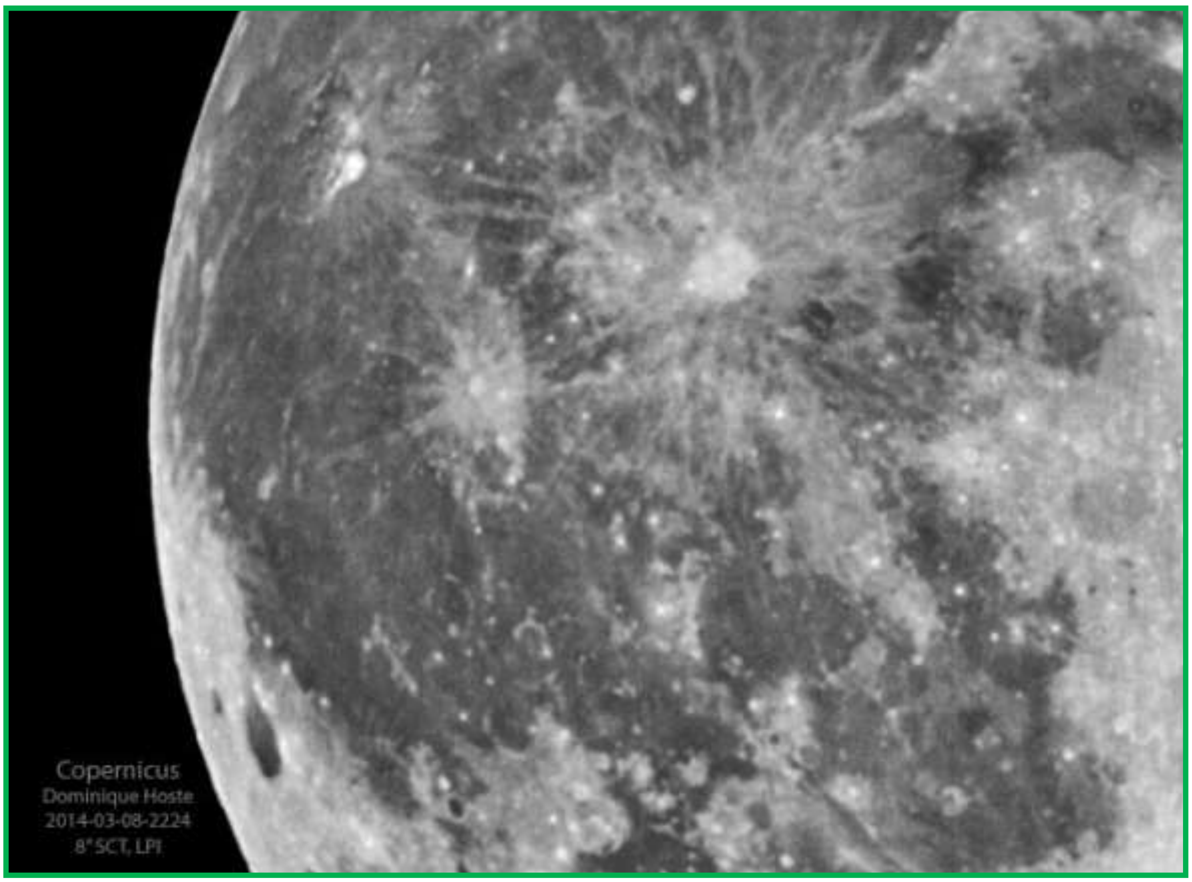


Images 56 and 57, Copernicus, *Dominique Hoste, Kortrijk, West Flanders, Belgium. 2014 March 08 22:24 UT. Meade LX10 8 inch Schmidt-Cassegrain telescope, Meade LPI camera.*



Focus-On: Wonders of the Full Moon

Image 58, Kepler, *Jef De Wit, Hove, Belgium. 2011 August 08 20:30-21:30 UT. 8 cm refractor telescope,111 x. Illumination 91%, lunation 11.1 days, altitude 21°.*

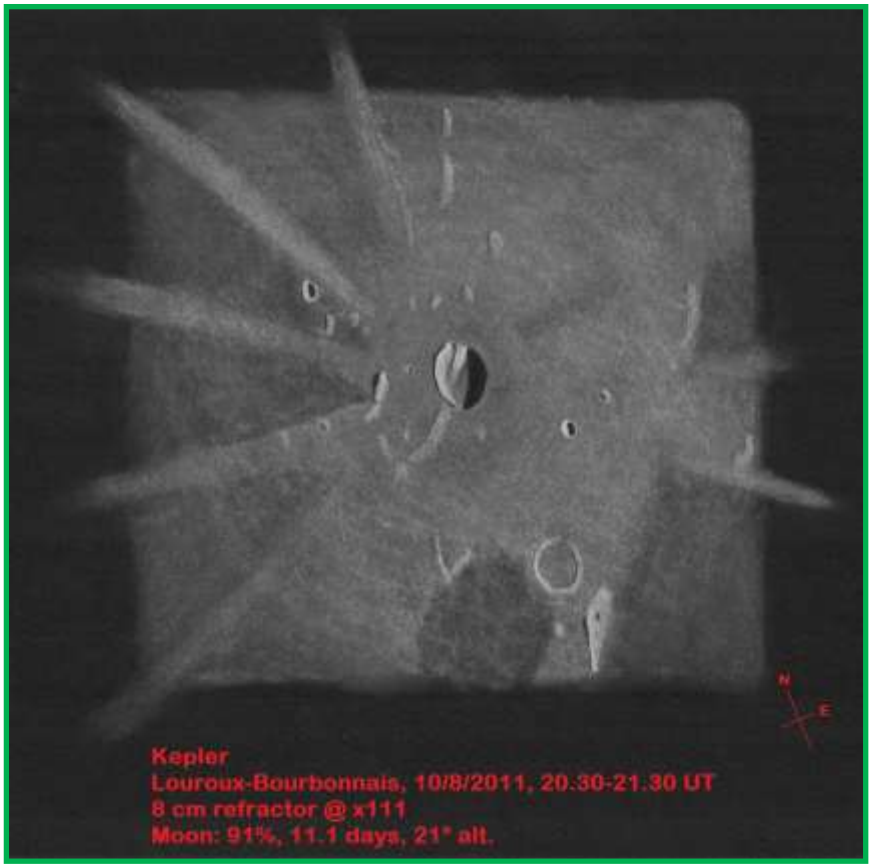


Image 59, Herodotus, *Eduardo Horacek-Esteban Andrada, Mar del Plata, Argentina. 2021 August 20 00:22 UT. 150 mm Maksutov-Cassegrain telescope, EOS Rebel T5i. North is left, west is down*

Focus-On: Wonders of the Full Moon

At Sea Frigoris

Bright Ray Craters in Mare Frigoris are very little known, we were able to learn about them by studying this peculiar mare for the previous Focus On. We chose 3 that we consider the most representative, although none is particularly spectacular. Egede A has a rare and asymmetrical bright ray system (IMAGE 60), in the detail we see that the north and south directed rays are much more prominent, those directed to the west are a little denser than those directed to the east (the direction the impact would have come from?). We can deduce that Harpalus (IMAGE 61) is an old crater because its ray system appears spectacular in its extent but dim, similar to Langrenus or Taruntius, for example. La Condamine S (IMAGE 62) is a craterlet with bright rays, barely 4 km in diameter, which without this characteristic would go unnoticed.

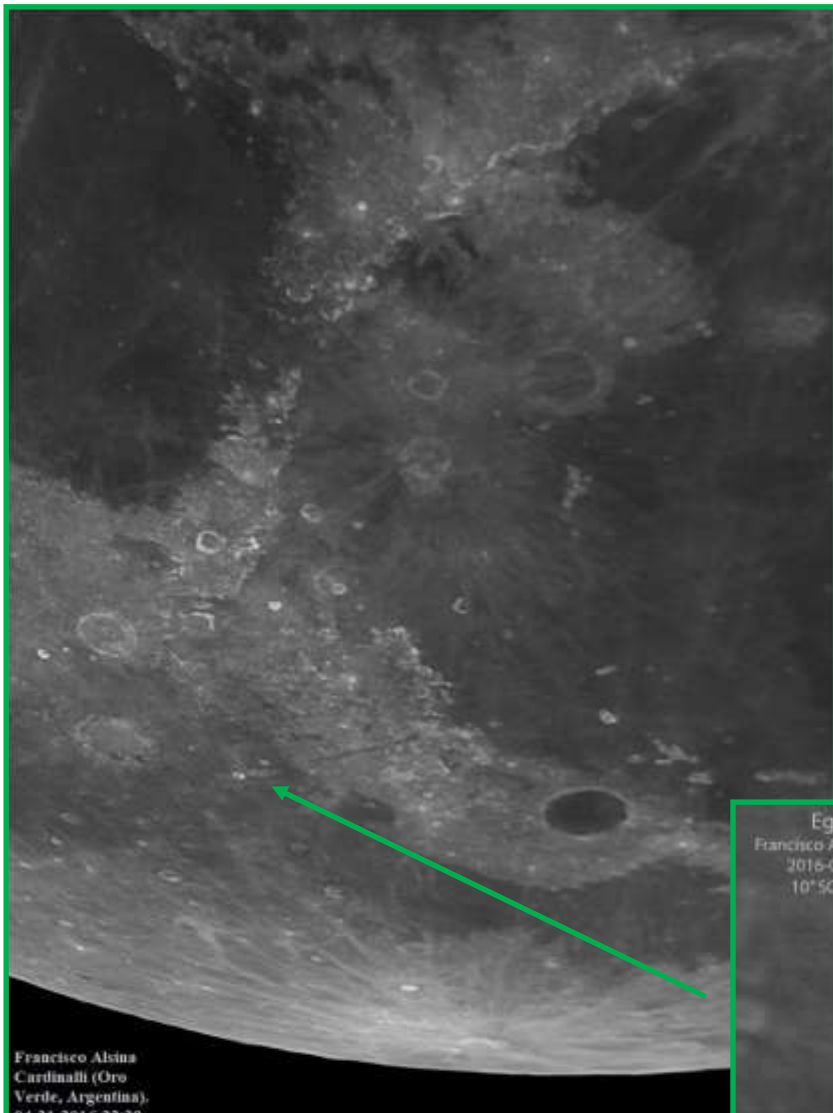
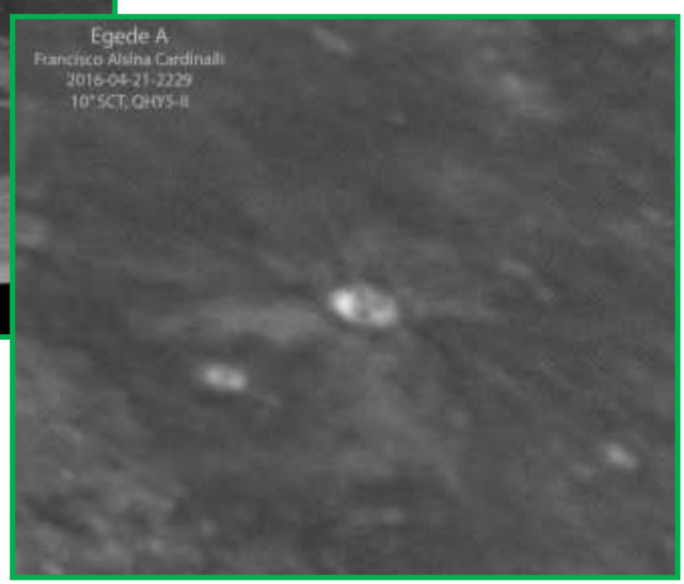
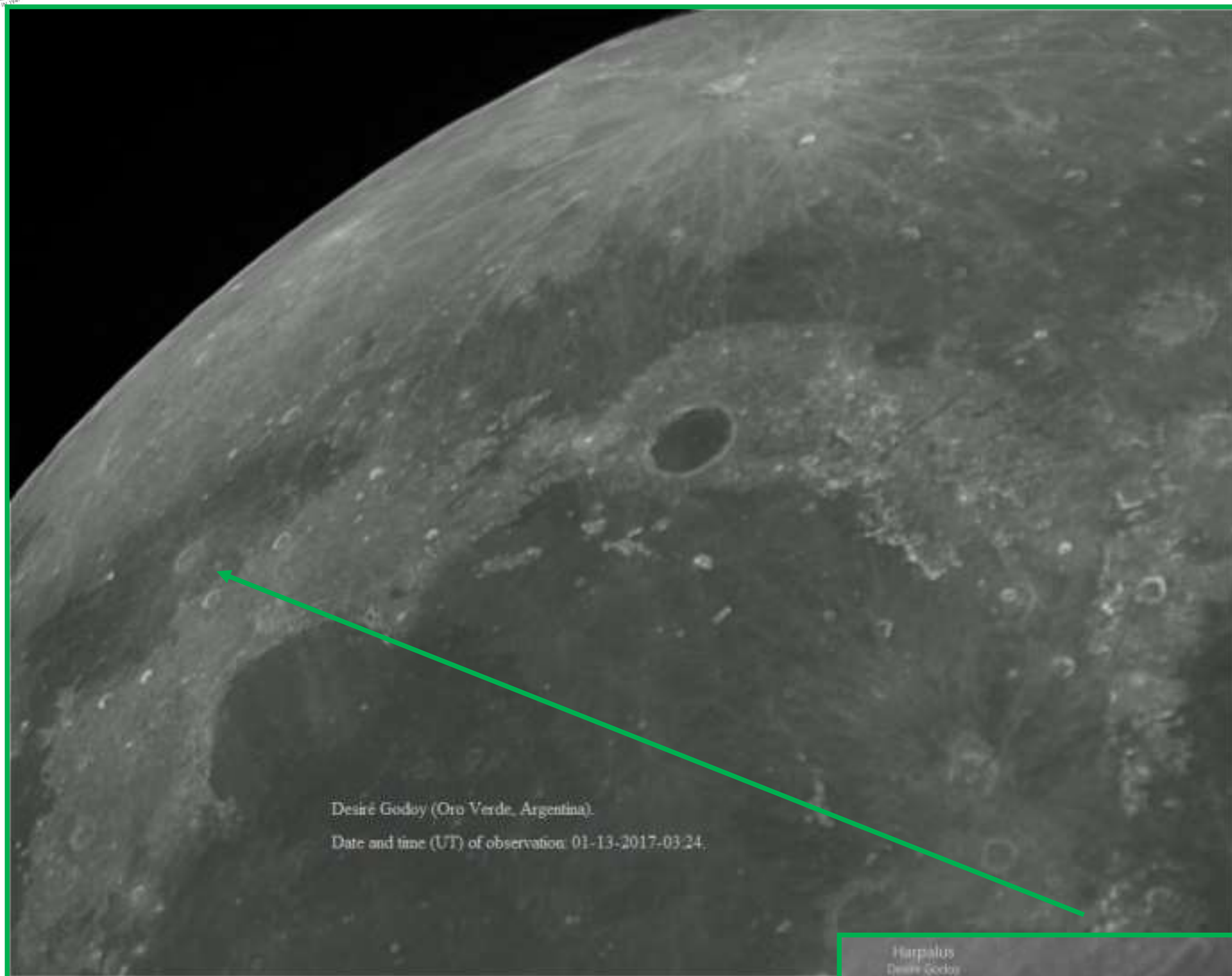


__Image 60, Plato,__ Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 April 21 22:29 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, QHY5-II camera. North is down, west is right. Below is a close-up of the rayed crater Egede A.





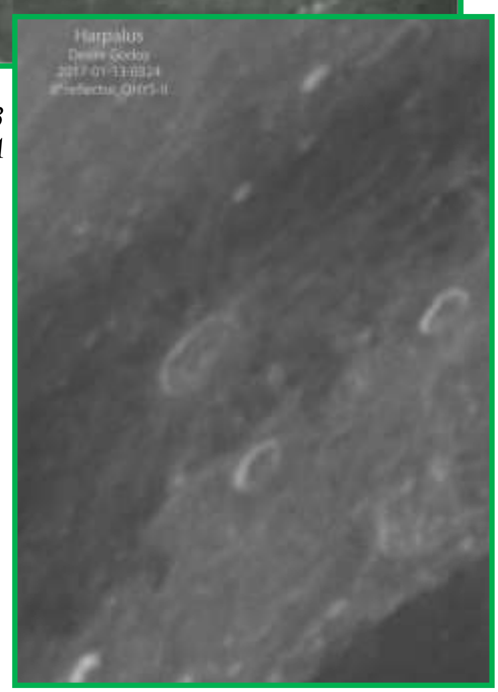


Image 61, Harpalus, *Desiré Godoy, Oro Verde, Argentina. 2017 January 13 03:24 UT. 200 mm Meade Starfinder reflector telescope, QHY5-II camera. A close-up of the rayed crater Harpalus is to the right.*

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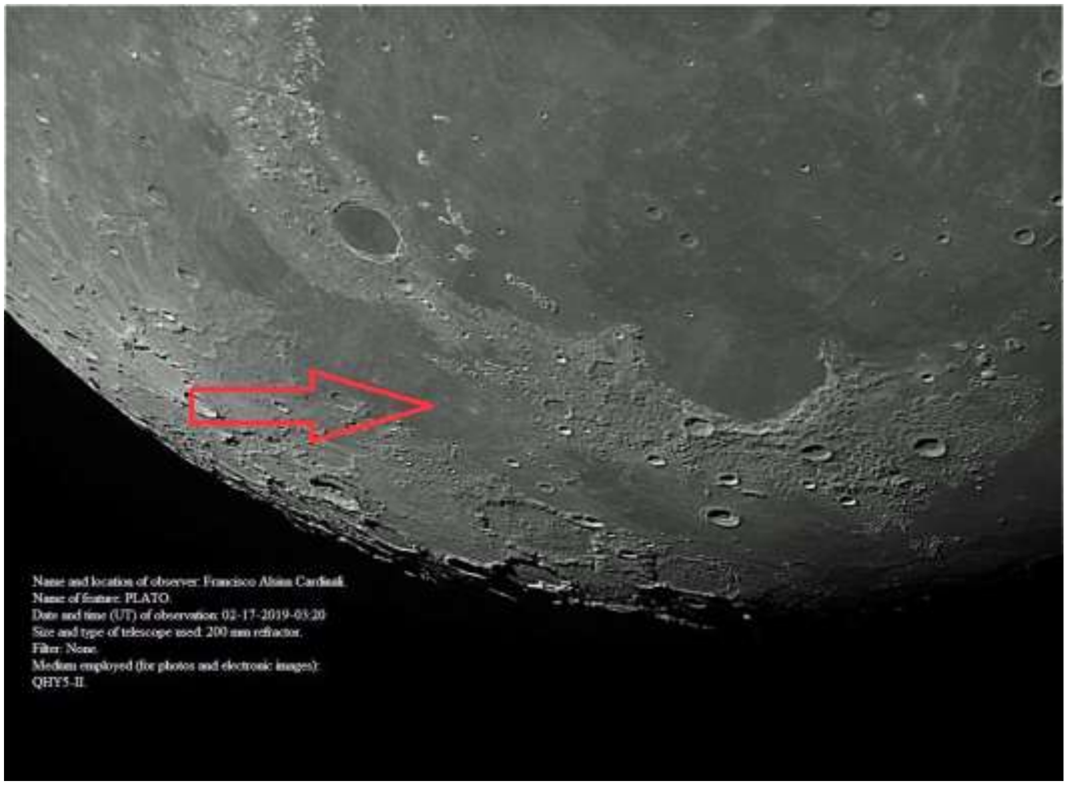
Image 62, Plato, Francisco Alsina Cardinalli, Oro Verde, Argentina. 2017 February 17 03:20 UT. 200 mm refractor telescope, QHY5-II camera. North is down, west is left. La Condamine S is the bright spot just past the tip of the red arrow.



A bright “V”

I had never heard of this series of craterlets with bright rays, which we rather perceive as bright points, which form a V in the vicinity of Carlini (IMAGE 63), (see next page) in the center of Mare Imbrium, it was the reading of Garfinkle's Chapter 23 that led me to the discovery: “To the southwest of Carlini is a nice V-shaped group of seven bright spots that includes the satellite craters Carlini E, Carlini G, Carlini H, and four undesignated craterlets. Carlini E is about 1 km (0.5 mile) in diameter, but has a very bright, small ejecta blanket. At 4 km (2.5 miles) in diameter the cone crater Carlini G is the largest crater in this formation. Its star-like ray pattern extends across the V-shaped formation. Carlini H is about 3 km (1.8 miles) in diameter with a small ejecta blanket and stubby rays. The undesignated bright craterlets are about the size of the crater Carlini E”.

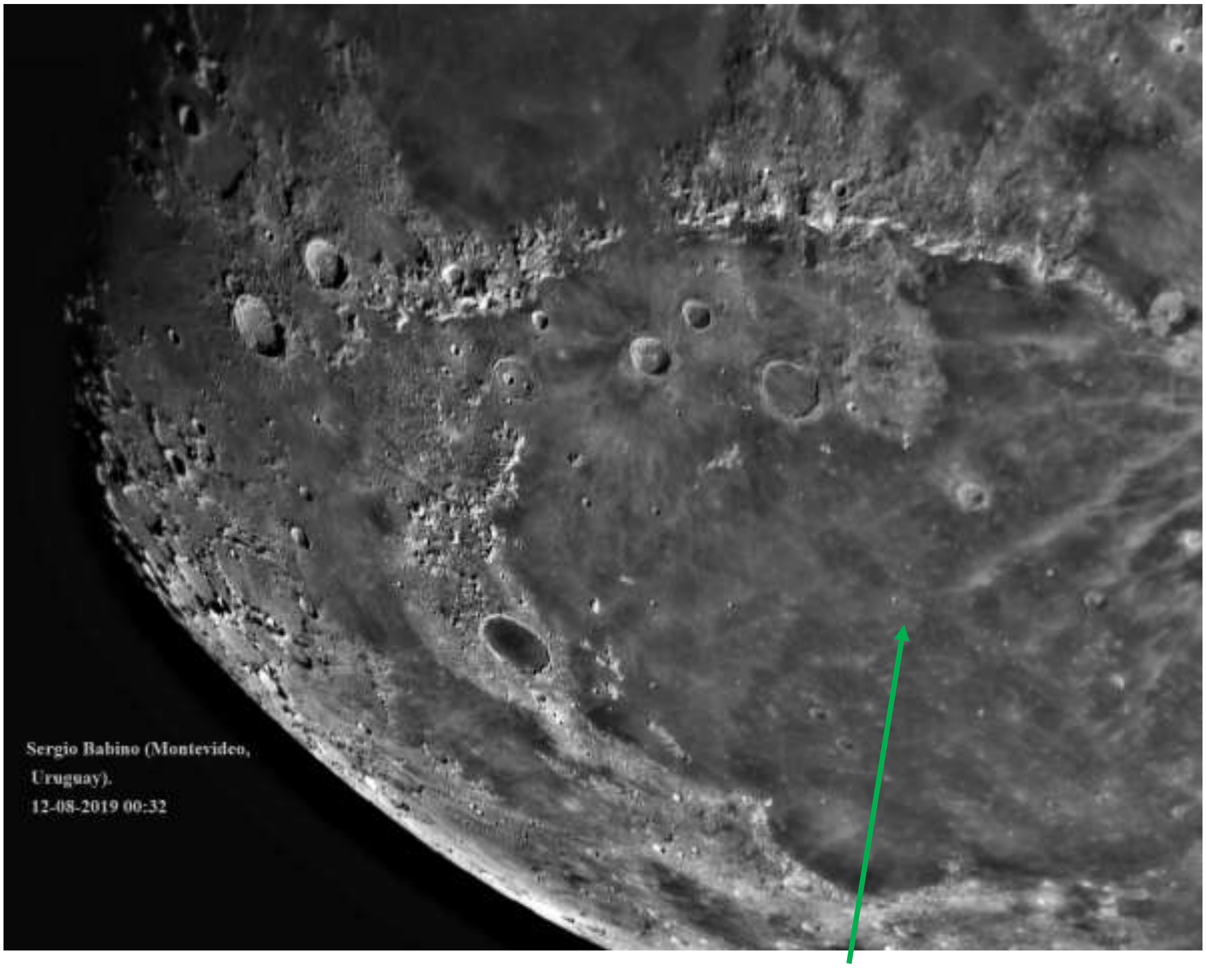
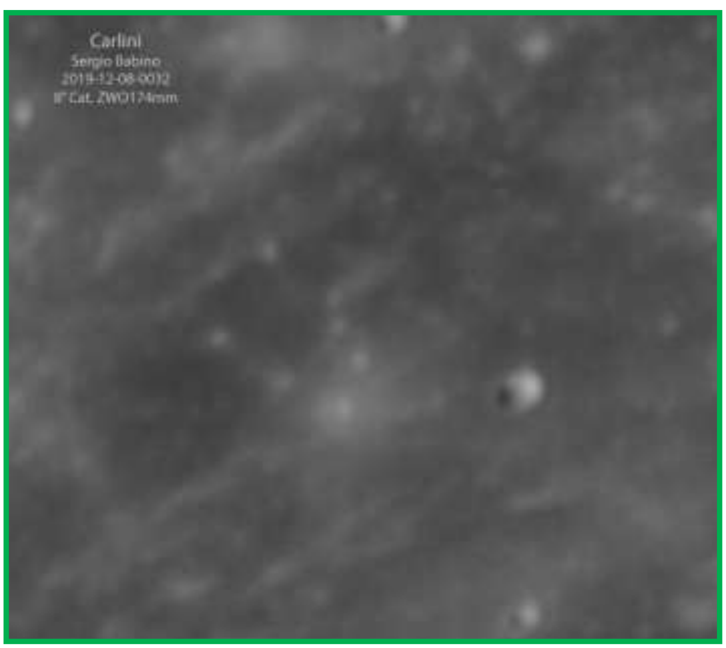


Image 63, Plato, *Sergio Babino, Montevideo, Uruguay. 2019 December 08 00:32 UT. 203 mm catadrioptic telescope, ZWO ASI174MM camera. North is left, west is down. Below is a close-up of Carlini.*



Focus-On: Wonders of the Full Moon

The bright spot east of Atlas

One of the most beautiful (in my opinion) bright ray craters has no name and is not even unanimously considered a crater. In the Bright Ray Craters List of the Bright Lunar Ray Program, it appears as "Atlas Companion". It has a crater-like appearance, its rim is brighter than its rays (like the average rayed crater) and its ejecta mantle seems to match that of small-diameter rayed crater; but the horseshoe-shaped rim is strange (IMAGE 64). For Garfinkle, it is indeed a crater: “To the northeast of the crater Atlas and due north of its satellite crater Atlas A are the dense bright rays of an unnamed cone crater (…) Most of the rays are to the north of the crater, but one bright streak almost touches Atlas A”.

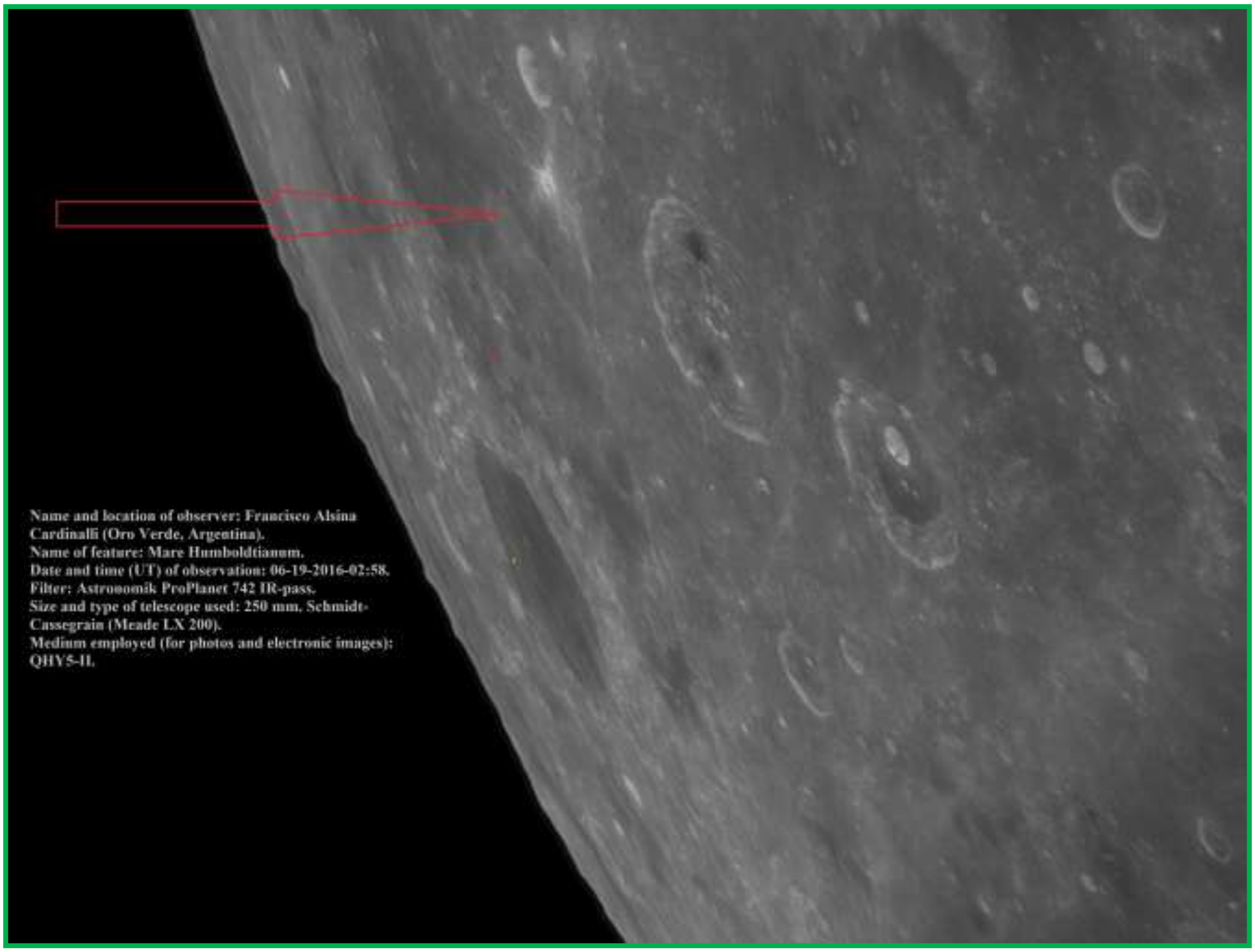


Image 64, Mare Humboldtianum, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 June 19 02:58 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, Astronomik ProPlanet 742 IR Pass filter, QHY5-II camera. North is left, west is down.*

Focus-On: Wonders of the Full Moon

Lichtenberg

We closed with a small crater, 20 kms in diameter, with a ray system characteristic of craters with bright rays located in the maria: broad ejecta blanket and short rays with fuzzy feathery edges: Lichtenberg (IMAGE 65). The asymmetric distribution of its rays is not a rarity. What is a rarity is that we cannot infer from the asymmetric rays the origin of the impactor? The reason is given by Charles Wood in “The Modern Moon”: “the lavas near Lichtenberg were apparently the youngest on the Moon. A crater the size of Lichtenberg should have lost its rays by its billionth birthday-the crater must be younger than that and so must the mare lava (…) the dark lavas that cover the rays southeast of the crater and in fact go right up to its rim. Clearly the lavas are younger than the bright-rayed crater.” That is, the question “Do rays appear to be deflected, interrupted, or obscured by surface features?” should be posed as “Are there surface features that have buried the bright rays? And the answer, I think, is only Lichtenberg (perhaps Menelaus), the proof that the volcanism on the Moon seems to be younger than we are used to thinking, since in this case we observe lavas from the Copernican period.

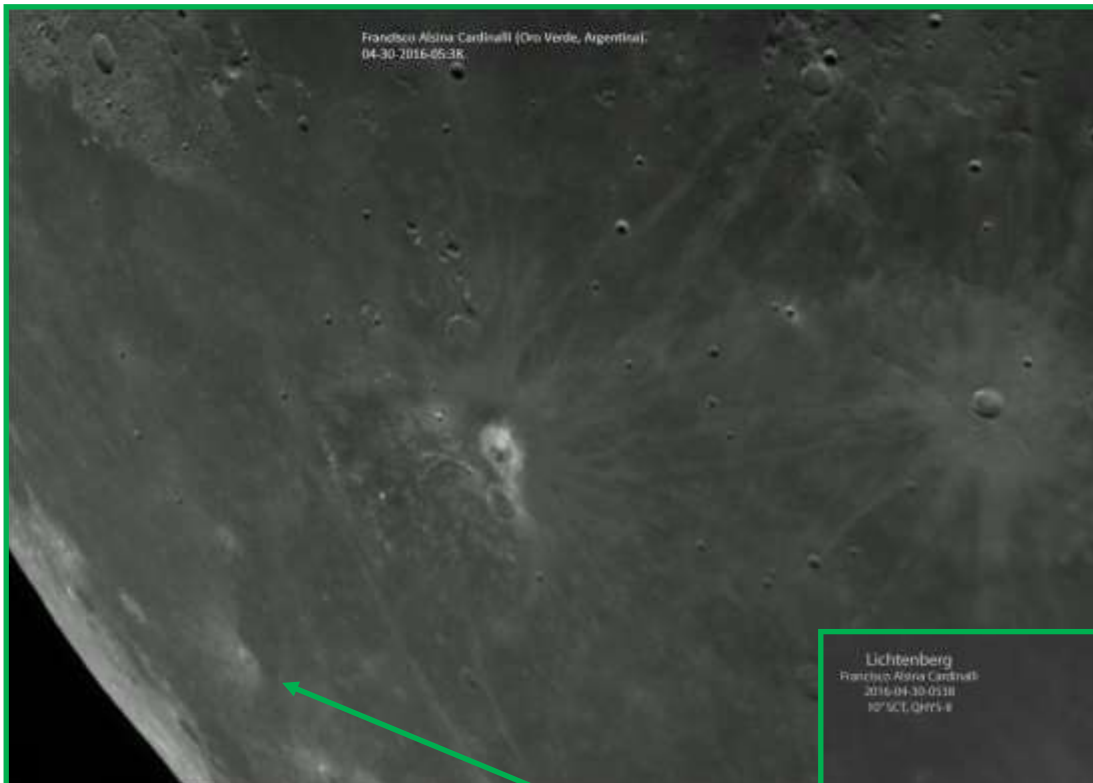


Image 65, Aristarchus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 April 30 05:38 UT. Meade LX200 10 inch Schmidt-Cassegrain telescope, QHY5-II camera. North is left, west is down. Below is a close-up of Lichtenberg.*

Focus-On: Wonders of the Full Moon

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Wood, Charles A. (2022), Crater Rays-Mysterious No More. Sky and Telescope, April 2022.

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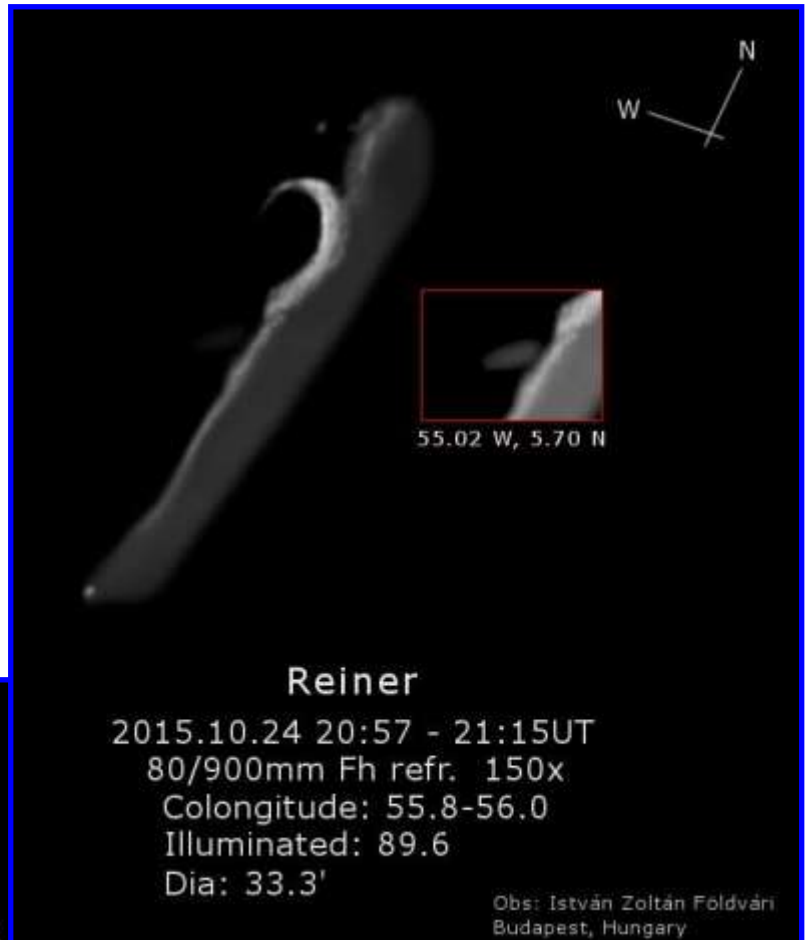
Reiner, *István Zoltán Földvári, Budapest, Hungary. 2015 October 24, 20:57-21:15 UT, colongitude 55.8-56.0 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 6/10, transparency 5/6.*



Waxing Gibbous Moon, *Raúl Roberto Podestá, Formosa, Argentina. 2022 June 21 01:37 UT. 130 mm reflector telescope, ZWO ASI178MC camera.*

Bullialdus, Campanus, Mercator and Capuanus, *Guillermo Scheidereiter, Rural Area, Concordia, Entre Ríos, Argentina. 2022 June 10 21:36 UT. 127 mm Maksutov-Cassegrain telescope, IR850 filter, Player One Ceres C camera. North is left, west is down.*

Archimedes, Aristillus, Autolycus and Montes Apenninus, Jesús Piñeiro, *San Antonio de los Altos, Venezuela. 2022 January 10 23:27 UT. Meade 10 inch Schmidt-Cassegrain telescope, f/16.6, Astronomik L2 UV/IR 2 inch filter, ZWO ASI462MC camera. North is left, west is down.*

Hayn and Belkovich, *István Zoltán Földvári, Budapest, Hungary. 2015 October 27, 19:18-19:52 UT, colongitude 91.4-91.7 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 6/10, transparency 6/6.*

Messier, *Massimo Dionisi, Sassari (Sardinia) Italy. 2022 February 18 23:56 UT. 250 mm f/5 Newtonian reflector telescope, 3x barlow, W25 filter, ZWO ASI120MC camera.*

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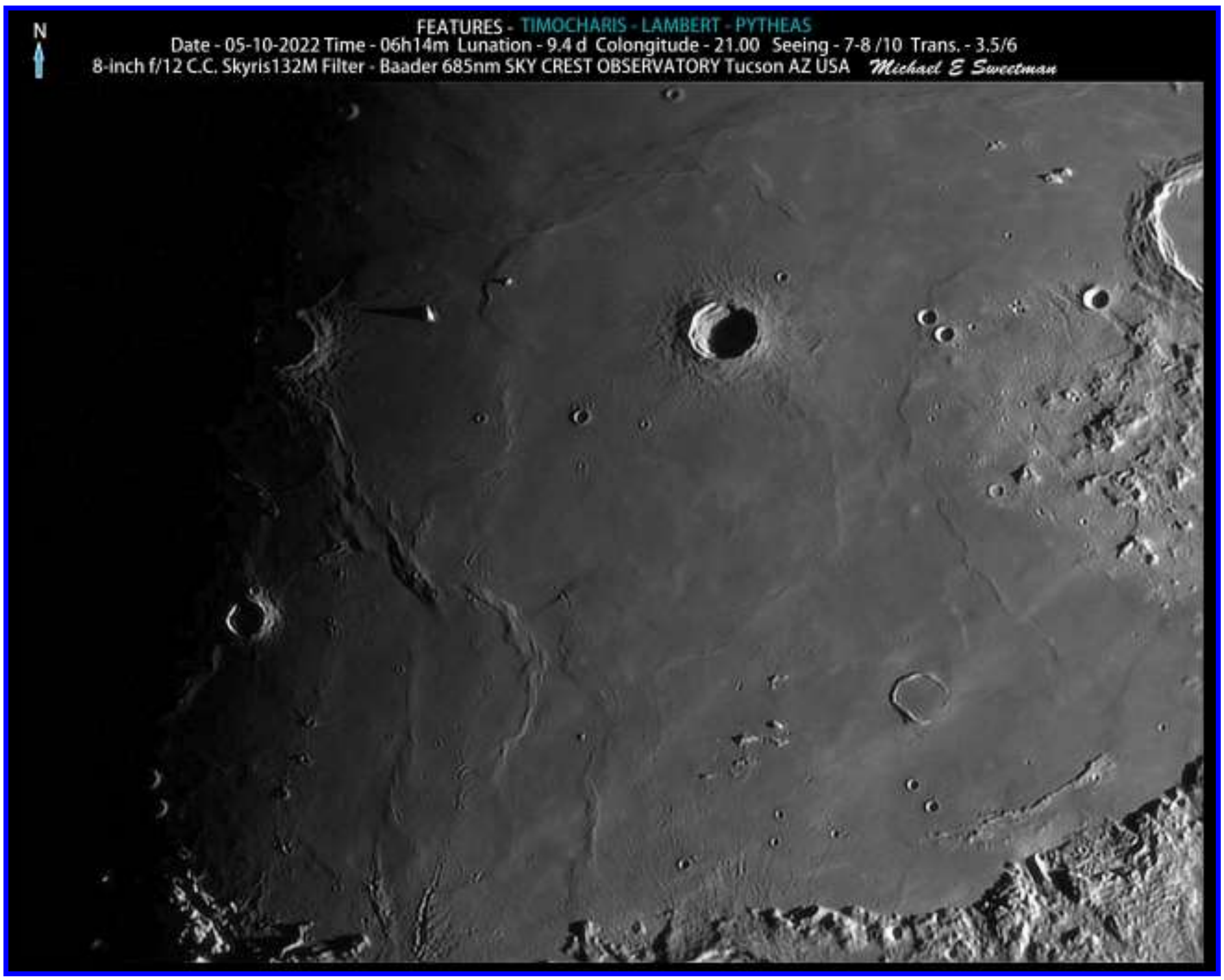
Riemann, Beals, *István Zoltán Földvári, Budapest, Hungary. 2015 October 27, 21:05-21:25 UT, colongitude 92.3 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 7/10, transparency 6/6.*

Timocharis, Lambert Pytheas, *Michael E. Sweetman, Sky Crest Observatory, Tucson, Arizona, USA. 2022 May 10 06:14 UT, colongitude 21.00 degrees. 8 inch f/12 Guan Sheng classical Cassegrain telescope, Baader IR 685 nm filter, Skyris 132 M camera. Seeing 7-8/10, transparency 3.5/6.*



6.8 day-old Moon, *Maurice Collins, Palmerston North, New Zealand, 2022 June 06 05:51-05:53 UT. Meade EXT-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*

Maurice adds: Here is the Moon from night before last taken with the ETX-90 without any tracking working. I found upon opening the base that the batteries had gone flat since I last used it and leaked badly, corroding the terminal clips all the way through. I have managed to get it running again yesterday luckily though.

On a very sad note, I would like to dedicate these images to my long time Moon friend Brendan Shaw of Devon, UK, who has just passed away. I still use the software he developed each time I look up the age of the Moon for my images, and others he developed. I hope he is up there somewhere getting a closer look at the Moon and Universe! Ad Astra and R.I.P. my friend you will be missed.

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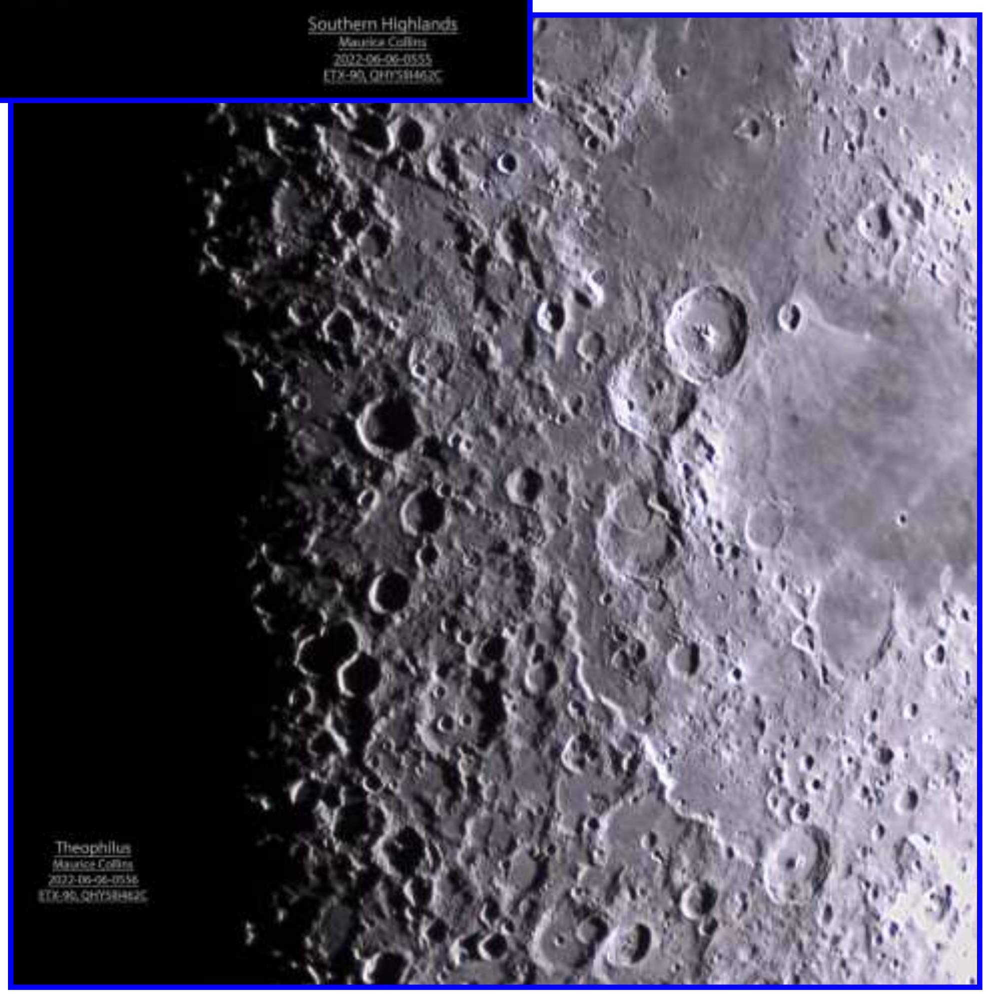
Southern Highlands, *Maurice Collins, Palmerston North, New Zealand, 2022 June 06 05:55 UT. Meade EXT-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*



Theophilus, *Maurice Collins, Palmerston North, New Zealand, 2022 June 06 05:56 UT. Meade EXT-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*

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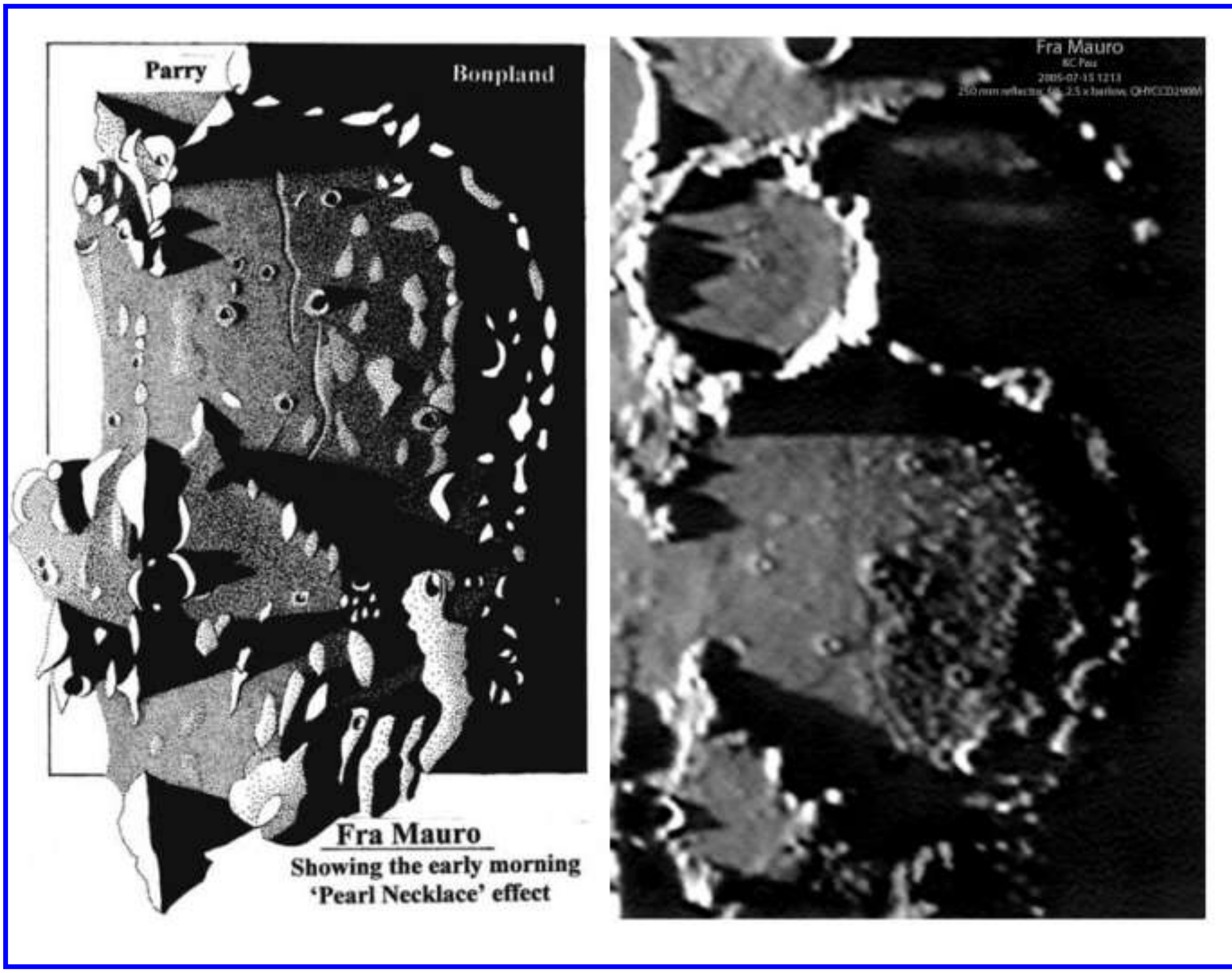
Mare Serenitatis, *Maurice Collins, Palmerston North, New Zealand, 2022 June 06 05:55 UT. Meade EXT-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*

Delamdre, *Maurice Collins, Palmerston North, New Zealand, 2022 June 06 05:56 UT. Meade EXT-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*



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Fra Mauro "String of Pearls" (right), *KC Pau, Hong Kong, China. 2005 July 15 12:13 UT. 10 inch f/6 reflector, 2.5 x barlow, QHYCCD290M camera.*

KC adds: Enclosed is a photo of Fra Mauro Pearl Necklace that was mentioned by Phil Morgan in 2007 November issue of LSC. My photo was taken with 250mm f/6 Newtonian with 2.5X barlow and QHYCCD290M camera on 15 July 2005 at 12h13m UT. The colongitude is 18.2 degree, which is a bit later than that of Morgan's drawing. I put Morgan's drawing and my photo side by side for comparison. I admit that the photo could not express the spectacular view of the necklace as the drawing did. It seem that the visual impression of the necklace is quite different from that of photographic means. In my photo, the southern neighboring crater Bonpland also shows the small-scale pearl necklace effect.

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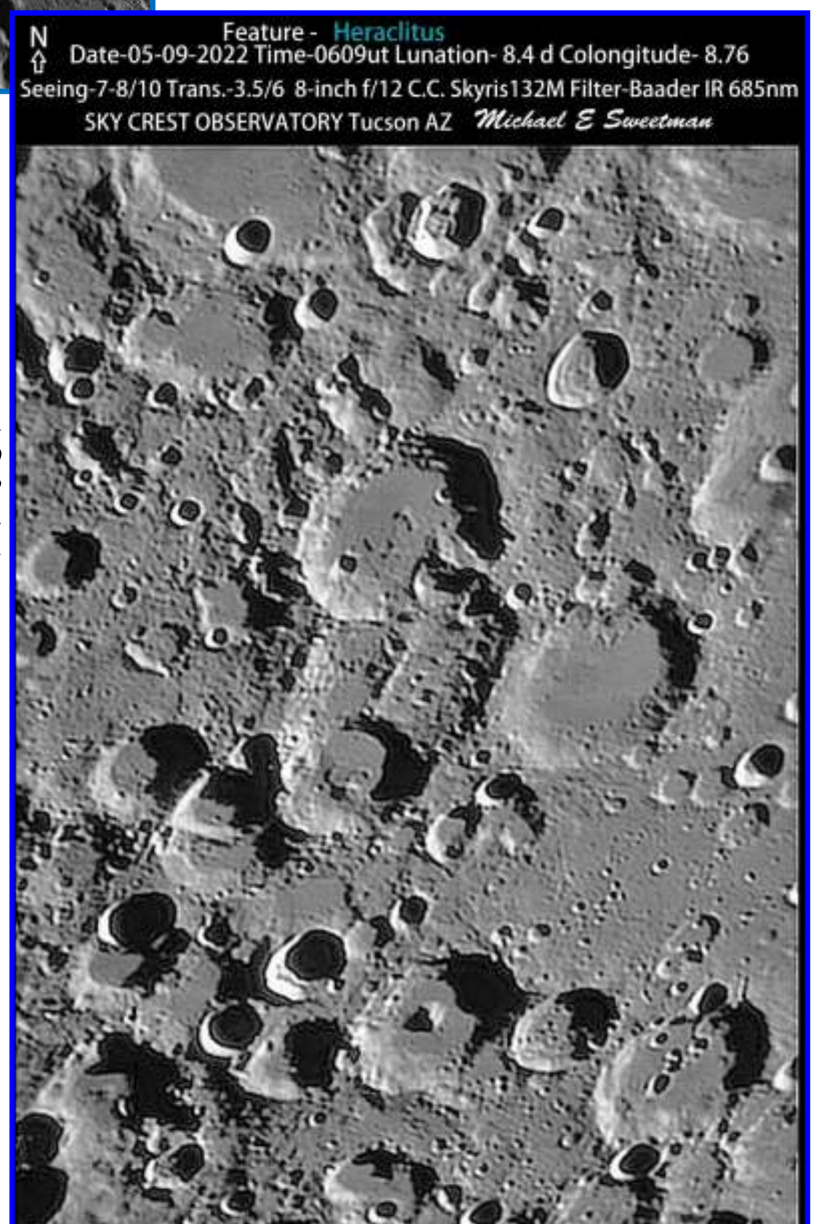
Stöfler, *Don Capone, Waxahachie, Texas, USA. 2022 June 07 02:10 UT. Meade 2120 10 inch Schmidt-Cassegrain telescope, ASI485MC camera.*

Gassendi, *Maurice Collins, Palmerston North, New Zealand, 2022 June 10 09:06 UT. Meade ETX90Maksutov-Cassegrain telescope, QHY5III462C camera.*

Albategnius, *Don Capone, Waxahachie, Texas, USA. 2022 June 07 02:15 UT. Meade 2120 10 inch Schmidt-Cassegrain telescope, ASI485MC camera.*



Heraclitus, *Michael E. Sweetman, Sky Crest Observatory, Tucson, Arizona, USA. 2022 May 09 06:09 UT, colongitude 8.76 degrees. 8 inch f/12 Guan Sheng classical Cassegrain telescope, Baader IR 685 nm filter, Skyris 132 M camera. Seeing 7-8/10, transparency 3.5/6.*

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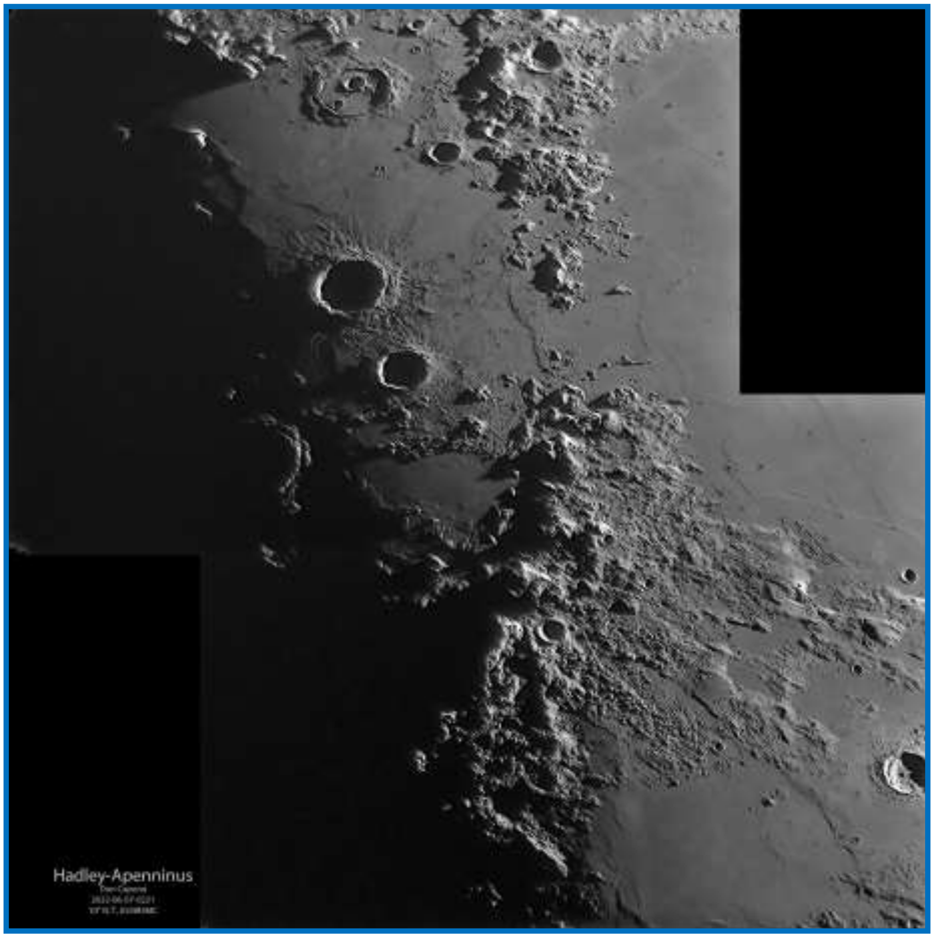
Julius Caesar to Rima Hyginus, *Don Capone, Waxahachie, Texas, USA. 2022 June 07 02:18 UT. Meade 2120 10 inch Schmidt-Cassegrain telescope, ASI485 MC camera.*

Copernicus, *Michael E. Sweetman, Sky Crest Observatory, Tucson, Arizona, USA. 2022 May 09 06:09 UT, colongitude 8.76 degrees. 8 inch f/12 Guan Sheng classical Cassegrain telescope, Baader IR 685 nm filter, Skyris 132 M camera. Seeing 5-7/10, transparency 3.5/6.*



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Hadley and Apenninus, *Don Capone, Waxahachie, Texas, USA. 2022 June 07 02:21 UT. Meade 2120 10 inch Schmidt-Cassegrain telescope, ASI485 MC camera.*

Plato, *Maurice Collins, Palmerston North, New Zealand, 2022 June 10 09:04 UT. Meade ETX90Maksutov-Cassegrain telescope, QHY5III462C camera.*

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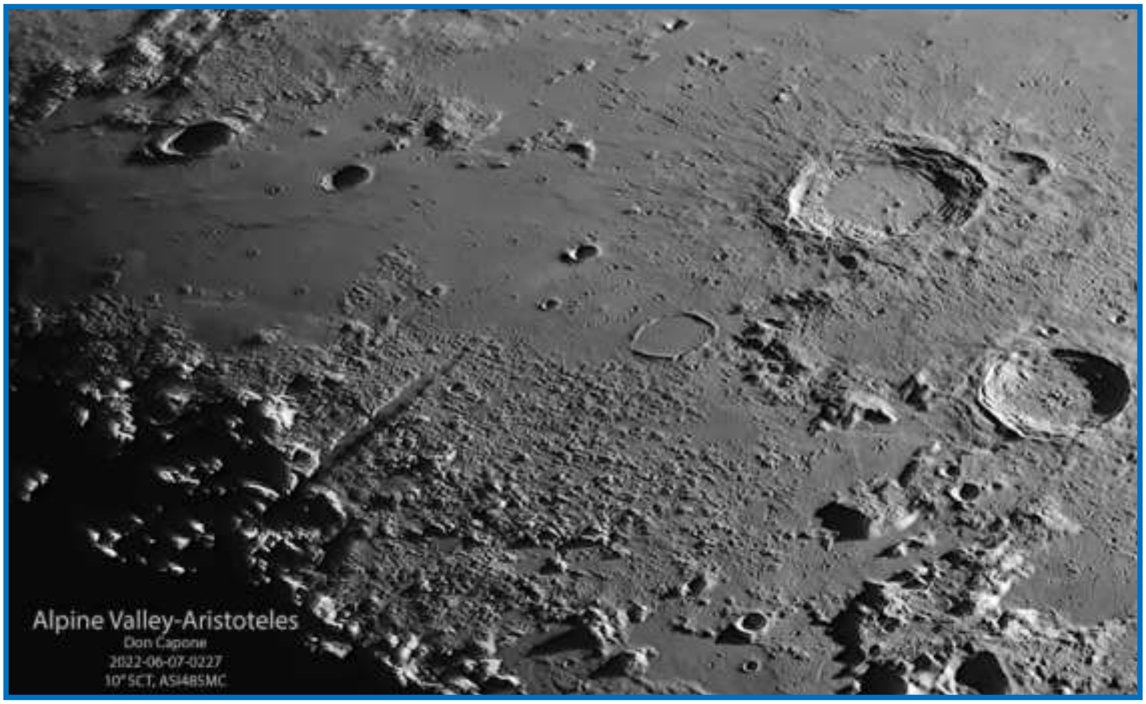
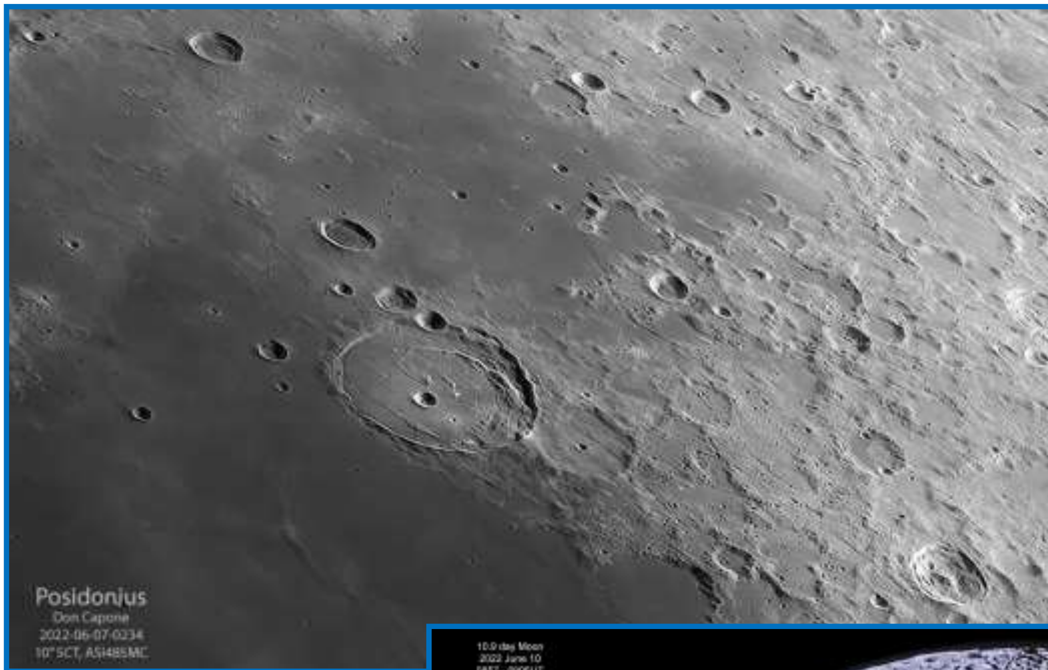
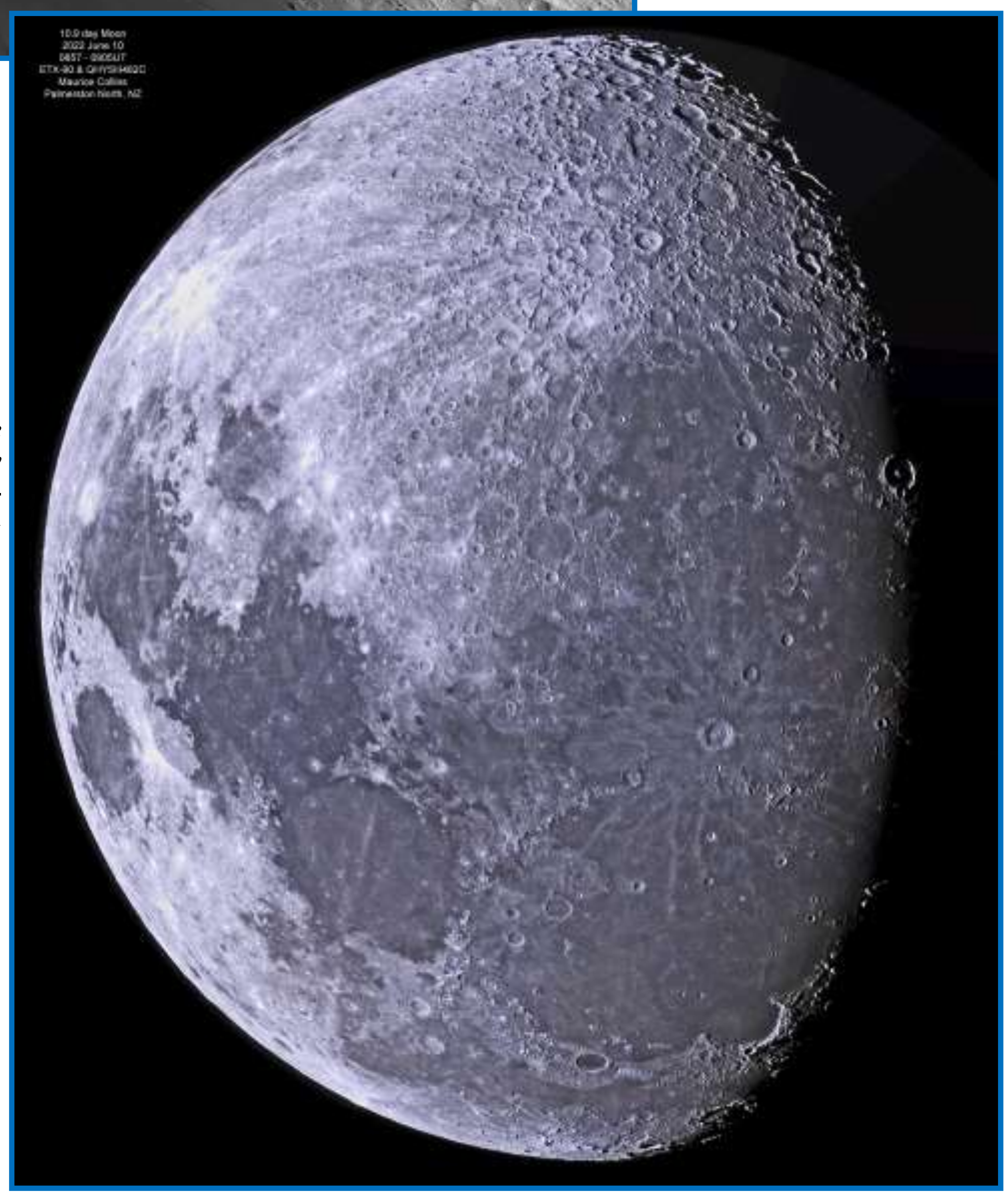
Alpine Valley to Aristoteles, *Don Capone, Waxahachie, Texas, USA. 2022 June 07 02:21 UT. Meade 2120 10 inch Schmidt-Cassegrain telescope, ASI485 MC camera.*



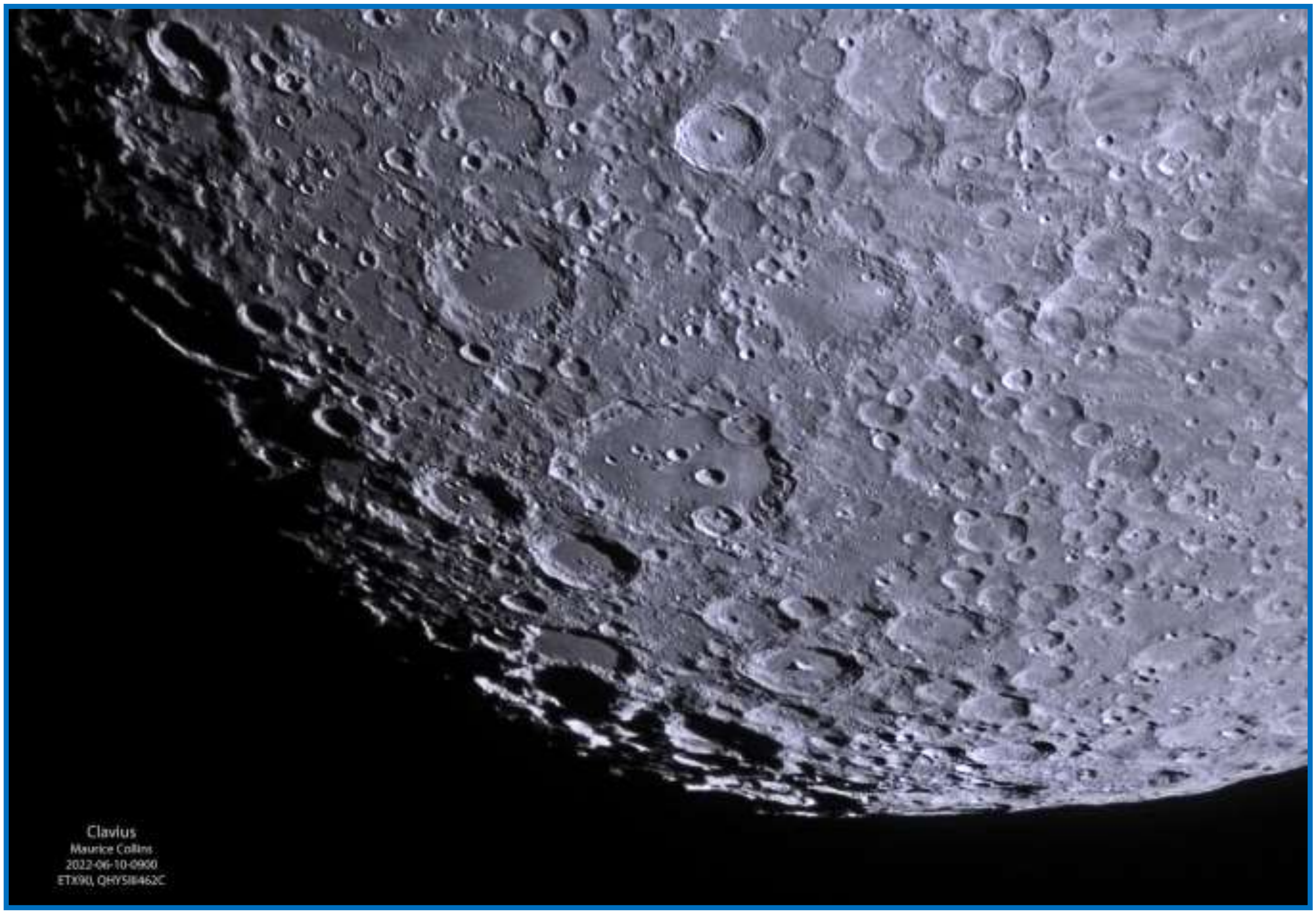
Copernicus Domes, *Michael E. Sweetman, Sky Crest Observatory, Tucson, Arizona, USA. 2022 May 09 06:09 UT, colongitude 8.76 degrees. 8 inch f/12 Guan Sheng classical Cassegrain telescope, Baader IR 685 nm filter, Skyris 132 M camera. Seeing 5-7/10, transparency 3.5/6.*

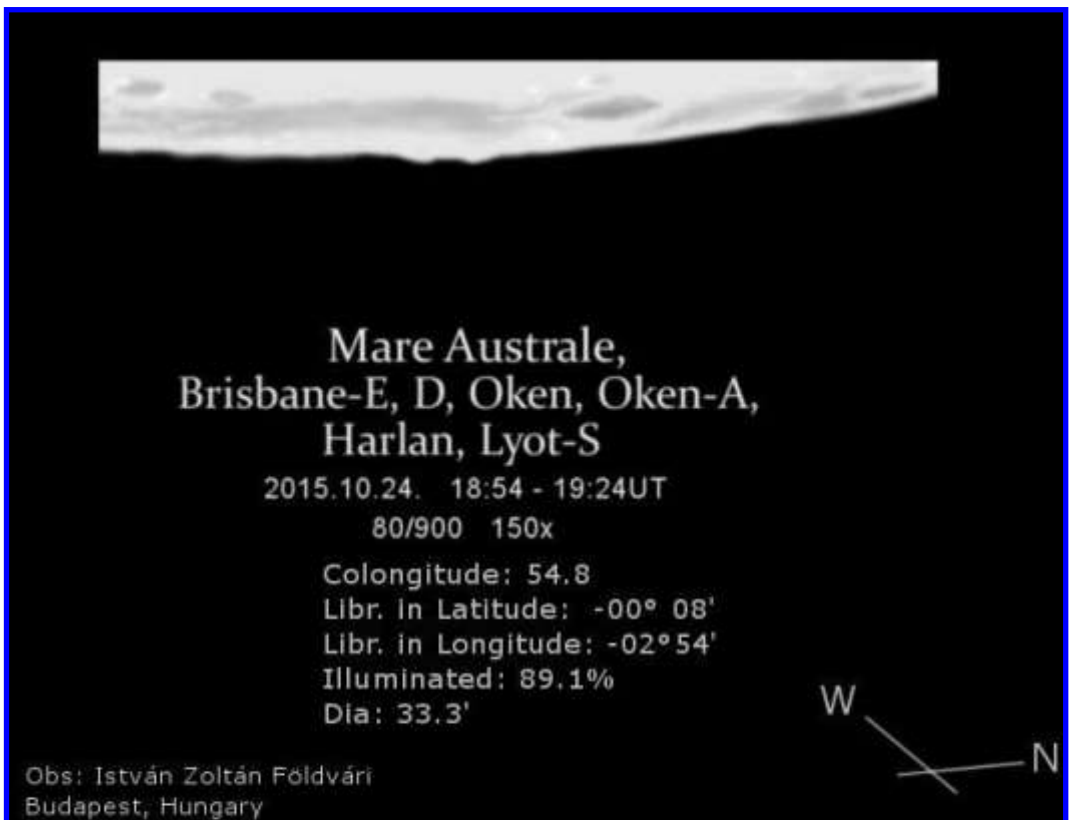


Posidonius, *Don Capone, Waxahachie, Texas, USA. 2022 June 07 02:34 UT. Meade 2120 10 inch Schmidt-Cassegrain telescope, ASI485 MC camera.*



10.9 day old Moon, *Maurice Collins, Palmerston North, New Zealand, 2022 June 10 08:57-09:05 UT. Meade ETX90Maksutov-Cassegrain telescope, QHY5III462C camera.*



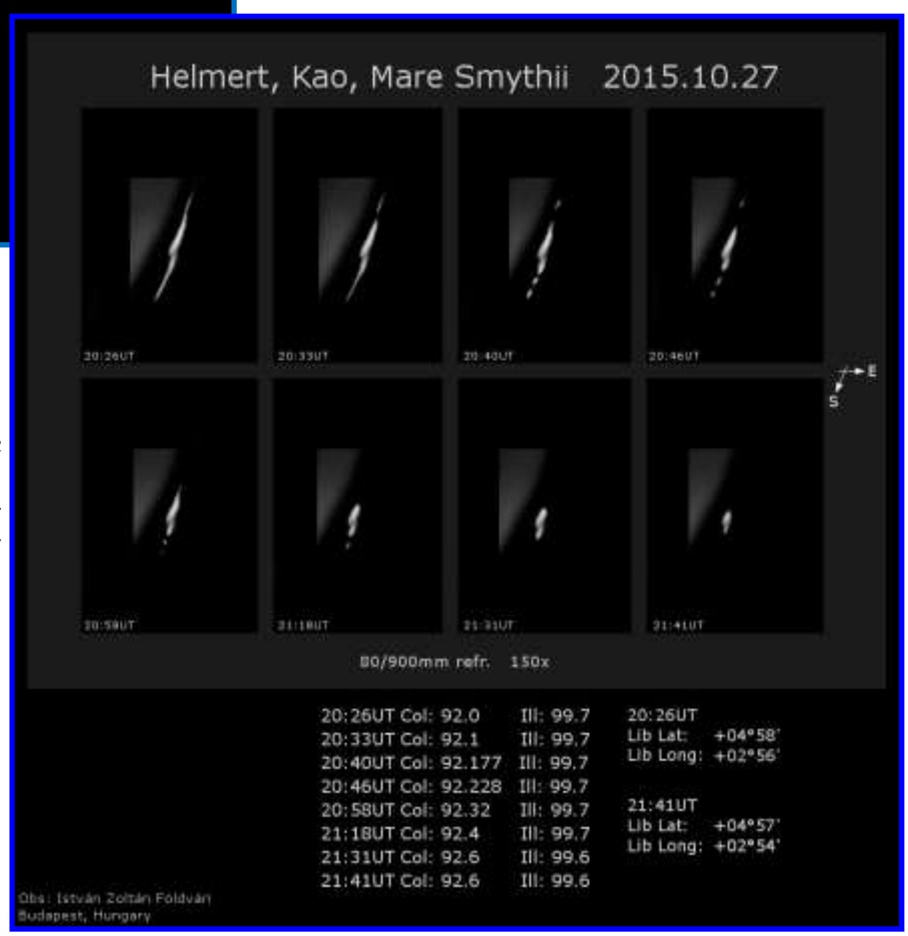


Clavius, *Maurice Collins, Palmerston North, New Zealand, 2022 June 10 09:00 UT. Meade ETX90Maksutov-Cassegrain telescope, QHY5III462C camera.*

Mare Australe, *István Zoltán Földvári, Budapest, Hungary. 2015 October 24, 18:54-19:24 UT, colongitude 54.8 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 6/10, transparency 4/6.*

4.8 day old Moon, *Maurice Collins, Palmerston North, New Zealand, 2022 June 04 05:27-05:31 UT. Celestron 8 inch Schmidt-Cassegrain telescope, QHY5III462C camera. Maurice adds:*

Here is The Moon from Saturday night. I also had a look at Omega Centauri globular cluster and the Jewel Box cluster in the Southern Cross, all with the 8-inch Schmitt-Cassegrain reflector, and all before 6pm. Seeing was not the best (A-IV) for the Moon with the C8 though. I visually observed with a 12.5mm eyepiece at 160X and looked especially at Messier and Endymion craters. All looked normal on the Moon.



Helmert, Kao, Mare Smythii, *István Zoltán Földvári, Budapest, Hungary. 2015 October 27, 20:26-21:41 UT, colongitude 92.0-92.6 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 7/10, transparency 6/6.*

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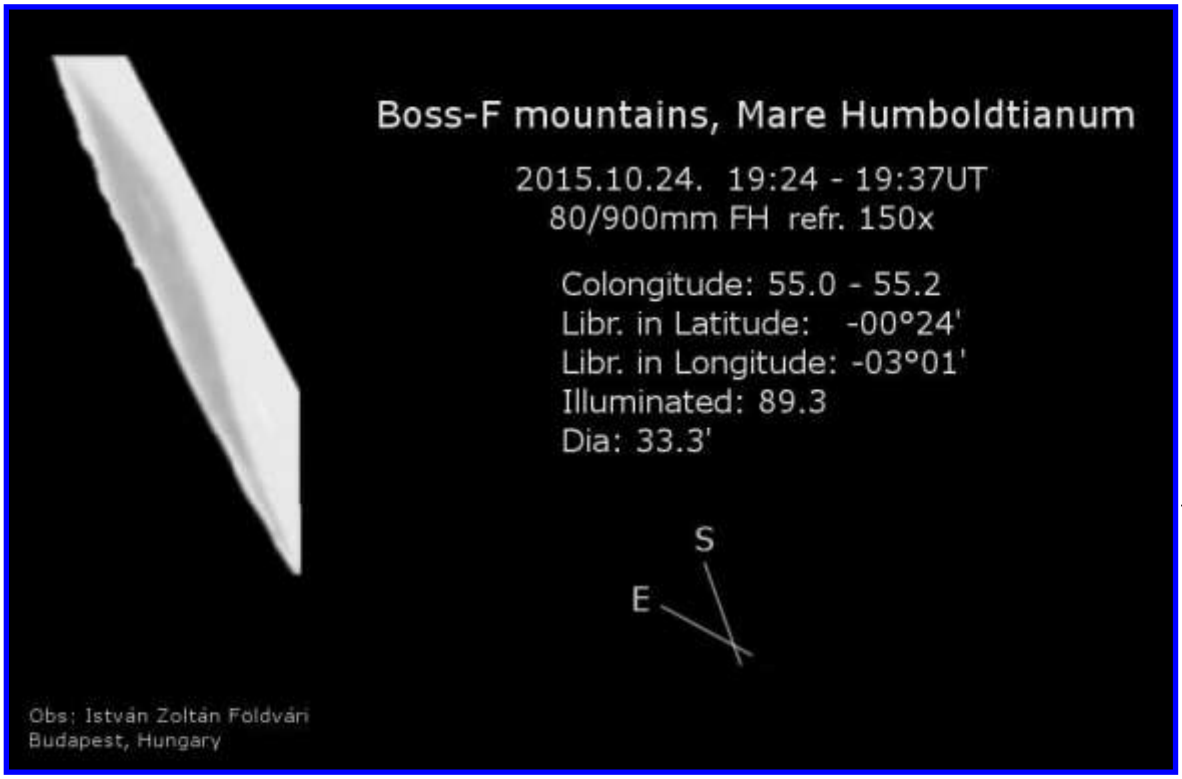
Gassendi, *Maurice Collins, Palmerston North, New Zealand, 2022 June 10 08:55 UT. Meade ETX90Maksutov-Cassegrain telescope, QHY5III462C camera.*

Gassendi and Mare Humorum *Guillermo Scheidereiter, Rural Area, Concordia, Entre Ríos, Argentina. 2022 June 10 21:30 UT. 127 mm Maksutov-Cassegrain telescope, IR850 filter, Player One Ceres C camera. North is left west is down.*



Mare Humboltianum, *István Zoltán Földvári, Budapest, Hungary. 2015 October 24, 19:24-19:37 UT, colongitude 55.0-55.2 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 7/10, transparency 4/6.*

Schiller and Hainzel, *Guillermo Scheidereiter, Rural Area, Concordia, Entre Ríos, Argentina. 2022 June 10 21:42 UT. 127 mm Maksutov-Cassegrain telescope, IR850 filter, Player One Ceres C camera. North is left west is down.*

Eratosthenes to Copernicus, *Michael E. Sweetman, Sky Crest Observatory, Tucson, Arizona, USA. 2022 May 10 06:16 UT, colongitude 21.02 degrees. 8 inch f/12 Guan Sheng classical Cassegrain telescope, Baader IR 685 nm filter, Skyris 132 M camera. Seeing 7-8/10, transparency 3.5/6.*

Petavius, *Massimo Dionisi, Sassari (Sardinia) Italy. 2022 February 19 00:27 UT. 250 mm f/5 Newtonian reflector telescope, 3x barlow, ZWO ASI120MC camera.*

Waxing Gibbous Moon, *Raúl Roberto Podestá, Formosa, Argentina. 2022 June 21 01:37 UT. 130 mm reflector telescope, ZWO ASI178MC camera.*

Yerkes, *Massimo Dionisi, Sassari (Sardinia) Italy. 2022 February 18 23:34 UT. 250 mm f/5 Newtonian reflector telescope, 3x barlow, ZWO ASI120MC camera.*

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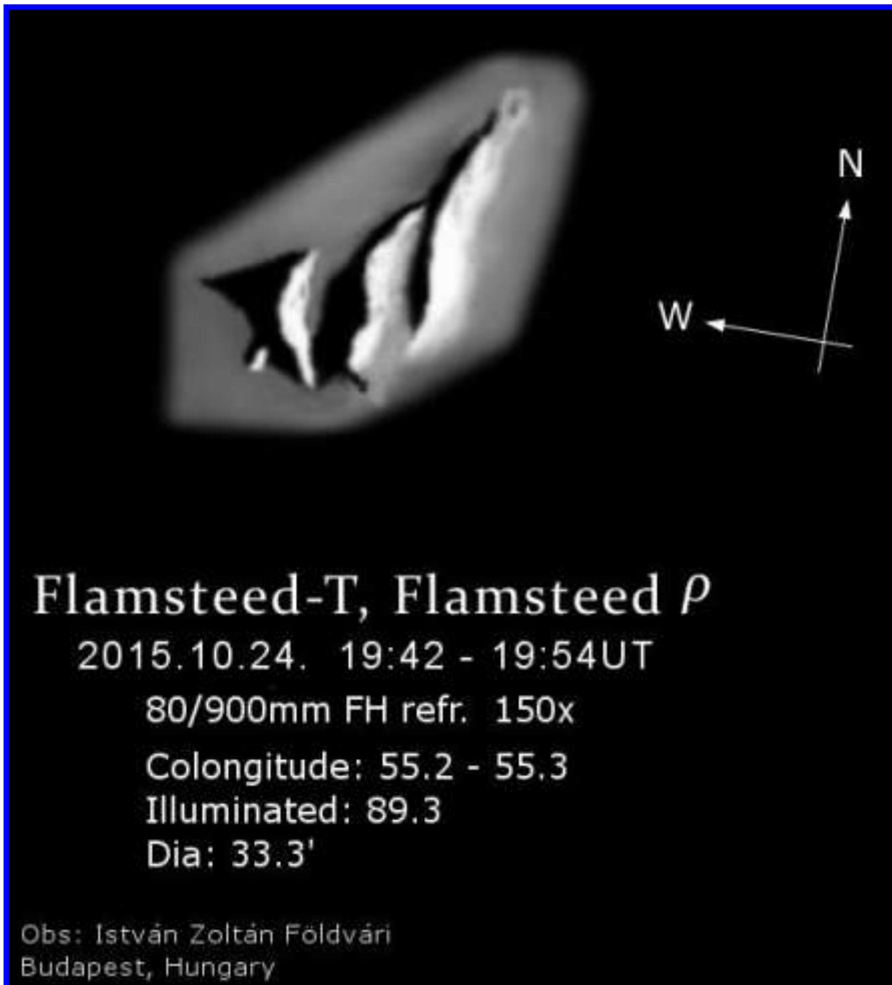
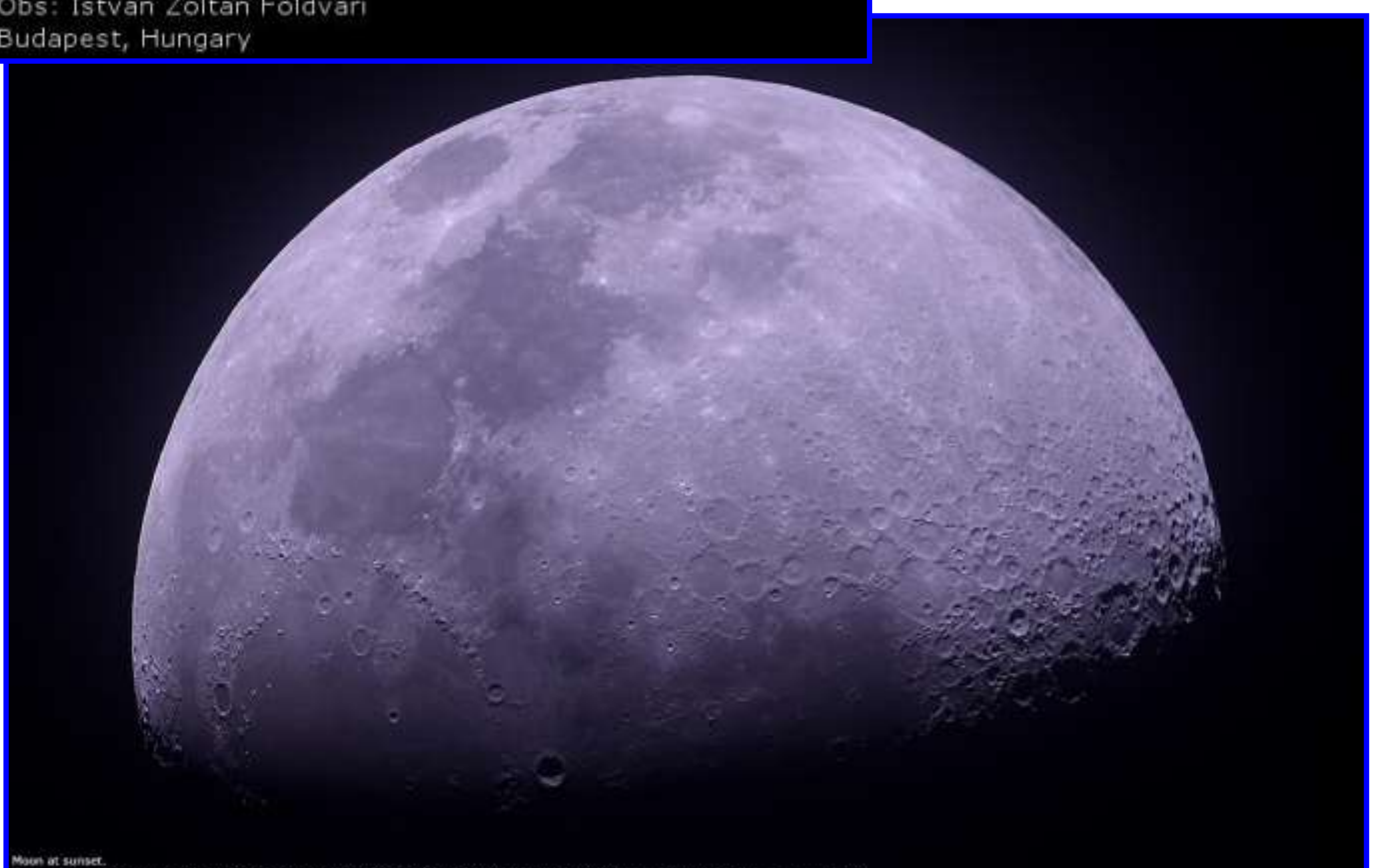


Flamsteed-T, Flamsteed ρ, *István Zoltán Földvári, Budapest, Hungary. 2015 October 24, 19:42-19:54 UT, colongitude 55.2 -55.3 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 7/10, transparency 4/6.*

Moon by Sunset, *Guillermo Scheidereiter, Rural Area, Concordia, Entre Ríos, Argentina. 2022 June 08 21:08 UT. 127 mm Maksutov-Cassegrain telescope, Nikon 5600 camera.*



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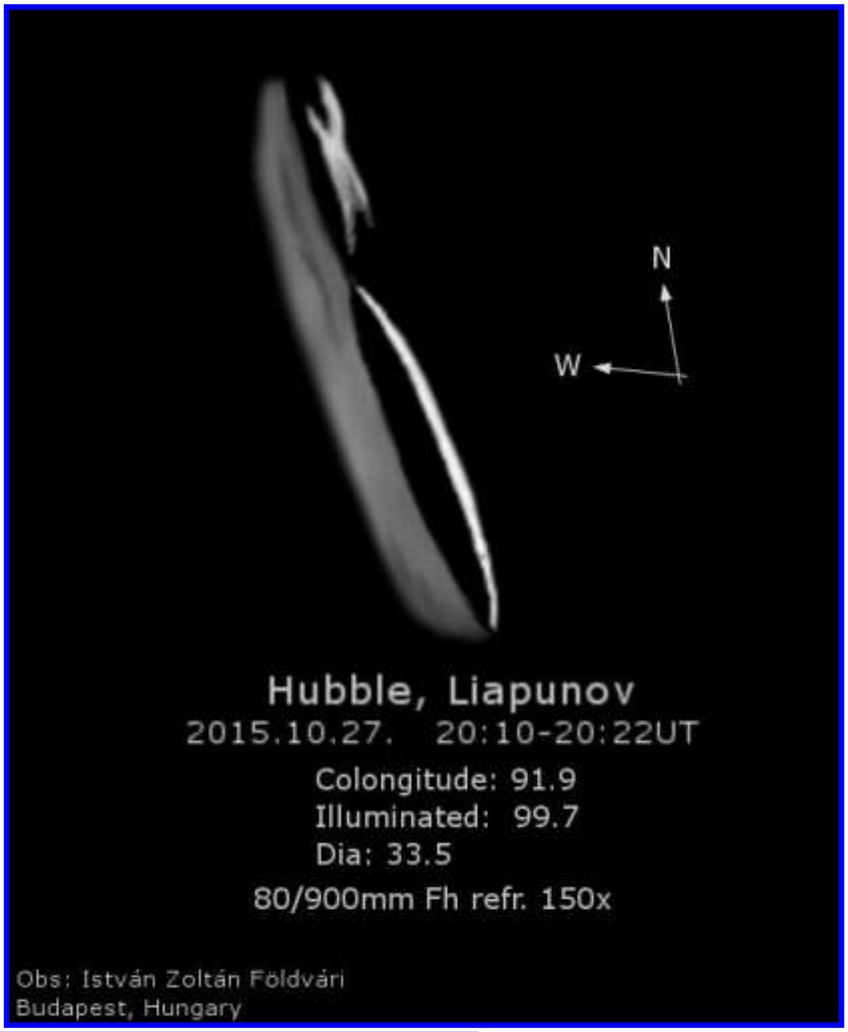
Hubble, Liapunov, *István Zoltán Földvári, Budapest, Hungary. 2015 October 27, 20:10 -20:22 UT, colongitude 91.9 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 4-6/10, transparency 6/6.*



Vitruvius, *Massimo Dionisi, Sassari (Sardinia) Italy. 2022 February 19 01:24 UT. 250 mm f/5 Newtonian reflector telescope, eyepiece projection 7 mm, W8 filter, ZWO ASI120MC camera.*

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Aristoteles, *Massimo Dionisi, Sassari (Sardinia) Italy. 2022 February 19 01:31 UT. 250 mm f/5 Newtonian reflector telescope, eyepiece projection 7 mm, W8 filter, ZWO ASI120MC camera.*

Arago, *Massimo Dionisi, Sassari (Sardinia) Italy. 2022 February 19 02:02 UT. 250 mm f/5 Newtonian reflector telescope, eyepiece projection 7 mm, W8 filter, ZWO ASI120MC camera.*

Vitruvius Domes Region, *Massimo Dionisi, Sassari (Sardinia) Italy. 2020 August 08 00:02 UT. 200 mm Meade Schmidt-Cassegrain telescope, eyepiece projection 9 mm, ZWO ASI120MC camera.*

Fracastorius Region, *Massimo Dionisi, Sassari (Sardinia) Italy. 2020 August 08 00:16 UT. 200 mm Meade Schmidt-Cassegrain telescope, eyepiece projection 9 mm, ZWO ASI120MC camera.*

Lunar Eclipse, *Walter Ricardo Elias, AEA, Oro Verde, Argentina. 2022 May 15 22:11 UT. Celestron CPC1100 Schmidt-Cassegrain telescope, Canon T7i camera.*

Cauchy Domes Region, *Massimo Dionisi, Sassari (Sardinia) Italy. 2020 August 08 00:05 UT. 200 mm Meade Schmidt-Cassegrain telescope, eyepiece projection 9 mm, ZWO ASI120MC camera.*

Lunar Geologic Change Detection Program

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2022 July

News: Peter Andersen (Australia – BAA) has forwarded a PowerPoint presentation (fig 1) as a poignant reminder for observers to be careful when interpreting color on the lunar surface*: "What this PowerPoint demonstrates is the variation in the appearance and in the relative luminosity of brightly illuminated lunar peaks, 'frame by frame', under poor atmospheric conditions. I am struck by LTP reports in some LSC's where it appears that inexperience coupled with such atmospheric effects may combine to cause a spurious LTP report. Perhaps the images in this PowerPoint may prove of some use to demonstrate the effect, which is of course well known to experienced observers…* He also comments that visually *"On this occasion the Moon was low and the central peak of Alphonsus was becoming fully illuminated and twinkling like a bright low altitude star, complete with chromatic effects.* So, all observers are reminded that if they suspect a LTP, that they to check adjacent features on a similar longitude, to see if the effect is present there too – if so then it is not lunar in origin but related to the Earth's atmosphere – especially the case if the Moon is low in altitude. A good set of guides on what to check out, if you suspect a LTP is available in the appendix B of "The Hatfield Lunar Atlas: A Digitally Remastered Edition" and the SCT version.

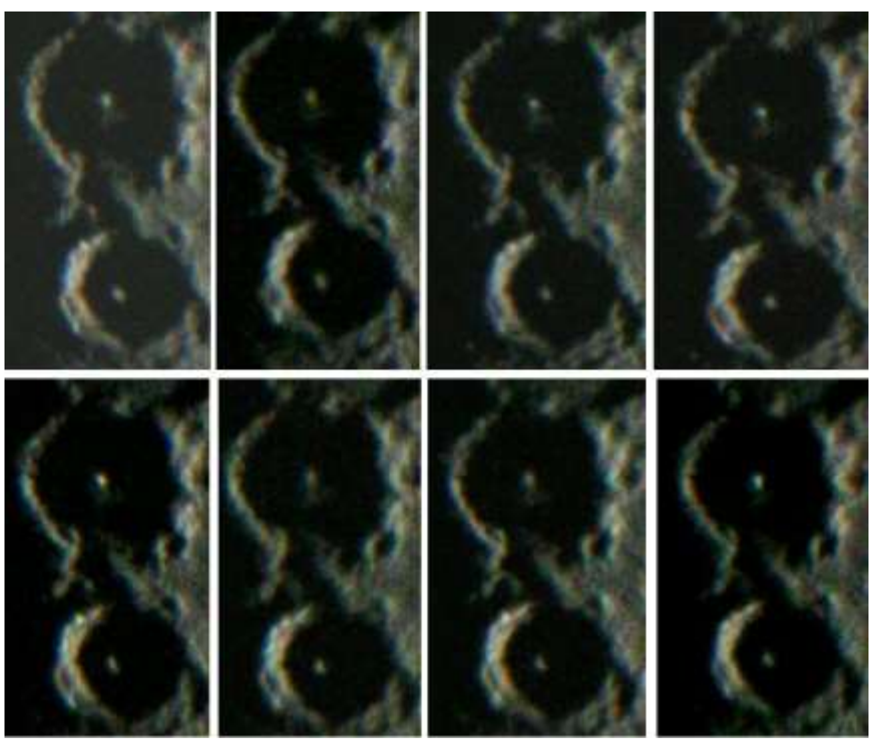

Figure 1. *The effects of atmospheric spectral dispersion on the lunar surface as imaged by Peter Anderson (BAA) on 2013 Apr 18. Note how the central peak of Alphonsus changes in brightness and color and the red fringes on the east on light/dark borders and the blue on the west of dark/light edges.*

Brendan Shaw (1956-2022)

I received an email from Brendan's partner, Mary, that Brendan had quietly passed away in his sleep on the 6th June. Brendan was one of our expert lunar digital photographers (See Fig 2), and very active in the BAA Lunar Section from as early as 2002 until 2015. He contributed many images to the repeat illumination program, and on 2003 May 9 obtained an image of the shadowed floor of Tycho which appeared to show a faint patch where the central peak should have been. Calculations showed that this should not have been illuminated at the time as the Sun was just 1.2° above the horizon, i.e., too low for light to directly reach the floor of the crater or even the top of the peak. Scattered light from the sunlit rim was a possibility, but repeat illumination observations have posed a challenge to replicate this effect.

I am indebted to Mary for providing the following information: *Brendan was born in 1956 and grew up in Anlaby near Hull, UK. His interest in astronomy was sparked when he was very young and read all about comets in his Ladybird book (British children book series akin to the "How & Why Wonder Books" in the US). His dad took him out into the garden to have a look at the night sky and he never looked back. His degrees were in geology and he and Mary spent many happy hours on beaches looking for rocks and fossils. He was especially interested in astrogeology and managed to acquire a tiny bit of moon rock which was the pride of his collection. He worked in IT all his life but retired about ten years ago and really enjoyed living in Devon, England, where he threw himself into village activities. He was one of the most generous people Mary ever knew and was always happy to share his knowledge. He was diagnosed with mesothelioma at the end of last year, and it was had hoped that he would have more time, but he was able to slip away very peacefully in his own home in the end. He will be very much missed. Mary likes to think of him watching the moon and the stars now but, from closer up.*

A note from Maurice Collins: *"I still use the software he developed each time I look up the age of the Moon for my images, and others he developed. I hope he is up there somewhere getting a closer look at the Moon and Universe! Ad Astra and R.I.P. my friend you will be missed."*

LTP reports: No reports were received for June.

Routine Reports received for May included: Jay Albert (Lake Worth, FL, USA – ALPO) observed: Alphonsus, Kies, Lambert Gamma, and Sasserides H. Alberto Anunziato (Argentina – SLA) observed: Aristarchus, Atlas, the Lunar Eclipse, the Lunar Poles, Manilius, Menelaus, Mare Serenitatis, Mons Piton, Oceanus Procellarum, Riccioli, and Tycho. Massimo Alessandro Bianchi (Italy – UAI) imaged: Campanus and Plato. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Archimedes, Aristarchus, Clavius, Copernicus, Letronne, Mare Humorum, Marius, Schickard, Schiller, Sinus Iridum, Tycho, and several features. Alexandra Cook (Spain) imaged the lunar eclipse. Anthony Cook (Newtown – ALPO/BAA) videoed earthshine in visible light and SWIR (1.1-1.7 microns), and also imaged several features in the visible, SWIR and in the thermal IR. Walter Elias (Argentina – AEA) imaged: Gassendi and Plato. Valerio Fontani (Italy – UAI) imaged: Campanus, Herschel and Plato. Di Giovanni Giovanni (Italy – BAA) imaged the lunar eclipse. Massimo Giuntoli (Italy – BAA) observed: Cavendish E. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Eratosthenes, Hortensius, the Lunar Eclipse, and Plato. Mark Radice (near Salisbury, UK – BAA) imaged: Flammarion and Ptolemaeus. Aldo Tonon (Italy – UAI) imaged: Campanus, Herodotus, Heschel, and Lichtenberg. Trevor Smith (Codnor, UK – BAA) observed: Aristarchus, Bullialdus, Cassini, earthshine, Eudoxus, Mare Humorum, the north pole region, Plato, Proclus, Ptolemaeus, Tycho and the west limb. Aldo Tonon (Italy – UAI) imaged: Campanus, Herodotus, Herschel, and Lichtenberg. Fabio Verza (Italy – UAI) imaged: Campanus, Eudoxus, Herodotus and Herschel.

Analysis of Reports Received:

Proclus: On 2022 May 5 UT 20:41-21:05 & 21:57-22:12 Trevor Smith (BAA) observed this crater under similar illumination to the following report:

On 1989 Feb 10 at UT 19:00? Edmonds (England) observed a "bright red coppery" color in the northwestern part of Proclus crater. He checked and found that there was no color elsewhere, though he still suspects that the effect was spurious color. Cameron comments that usually blue is seen in the north and red in the south if due to spurious color. The Cameron 2006 catalog ID=350 and the weight=3. The ALPO/BAA weight=2.

Trevor was using a 16-inch Newtonian (x247) under Antoniadi III-IV seeing conditions. Immediately upon looking he noticed a slight coppery red color to the N/W part of the rim. The reddish color was more concentrated where the bright N/W wall met the dark interior floor shadow. In between clouds he was able to view the crater through orange Wratten 21, blue Wratten 38A, and light blue Wratten 80A filters, but they did not seem to affect the appearance. Cloud then hindered observing at 21:05, but he was able to undertake a second observing session later. There was still a reddish color on the NW wall, but checks on some other craters also revealed the same effect, though not as strong as in Proclus. The redness seemed to appear and disappear, but this may have been related to the poor seeing conditions. We shall lower the weight from 2 to 1.

Sasserides H: On 2022 May 11 UT 02:55-03:15 Jay Albert (ALPO) examined this area under the same illumination conditions to the following LTP report:

On 1974 Jan 03 at UT 18:30 a Norwegian amateur astronomer, Hoydalsvik(Hakonsgate, in West Norway, 60mm refractor) photographed the Moon using High Speed Ektachrome (400ASA) film with good focus. The LTP was located on the southern slope of Sasserides H and was pink in color with some bluish in it. The colored area was circular with a diameter of 0.5 minutes of arc. Only one exposure was taken. The photograph was checked by the Institute of Theoretical Astrophysics, University of Oslo. This report was received by the BAA Lunar Section. ALPO/BAA weight=2.

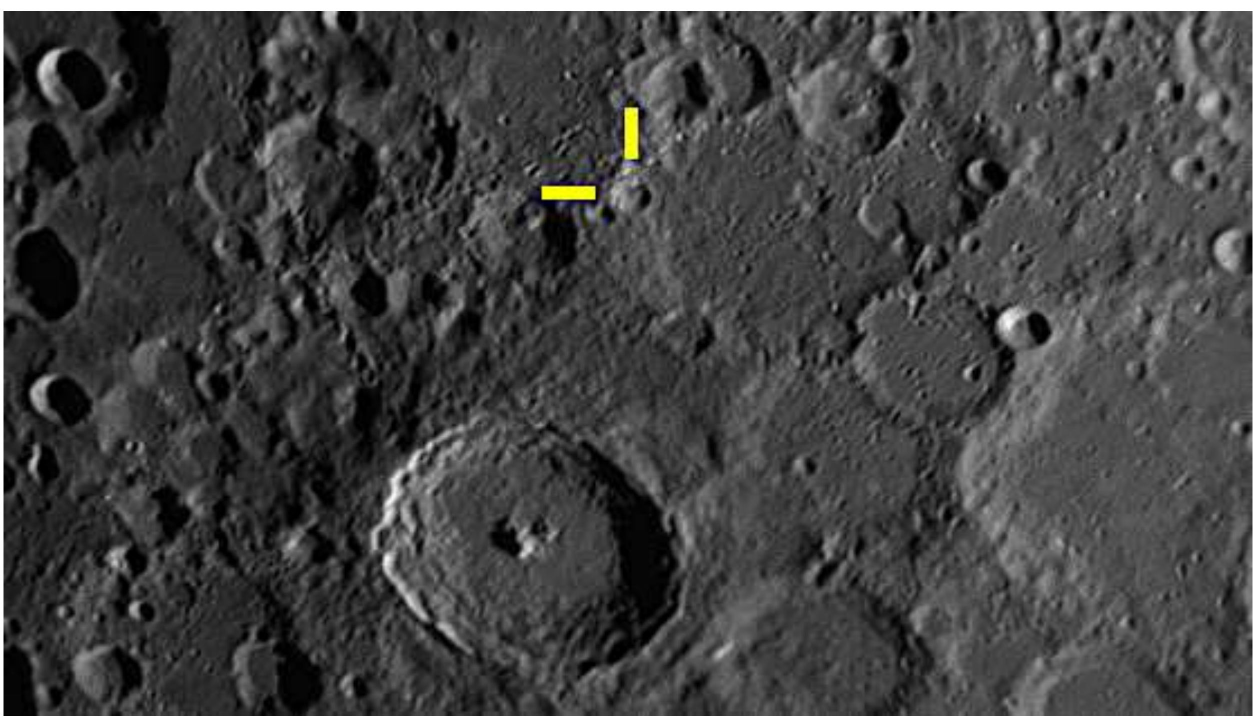

Figure 2. Sasserides H, as captured by Brendan Shaw on 2011 Jan 14 UT 17:43 and orientated with north towards the top. The yellow tick marks indicate the location of the crater.

Jay was using a Celestron NexStar Evolution 8" SCT under 3rd magnitude transparency with 5/10 seeing. He comments that: *"Sasserides H was shadow-filled with a bright W rim. The seeing at this time was deteriorating, so I dd not attempt a photo. I saw no pink, blue or other color on H's S slope or elsewhere in or around the Sasserides area. I had to reduce the magnification to 226x due to the seeing"*. He has previously observed this crater on 2010 Jun 22 and 2014 Apr 10, and on both occasions the crater looked normal. Alas the BAA lunar section does not appear to have the 1974 photograph in its archives, but does at least have the original letter from the Theoretical Physics department, to Patrick Moore, and also a rebuttal letter by Lawrence Fitton who thinks it was an effect of static electricity on the film or a processing artifact. It is not clear from the correspondence, back in 1974, whether the color film was eventually sent off to Kodak's for checking. This is a pity as although incredibly rare, there is a very slight chance that it was an impact flash. Either way, I thought it would be interesting to show a repeat illumination image (Fig 2) of what the area would look like under normal conditions – as you can imagine a photo through a 2" refractor would have been of much lower resolution, but at least the claimed LTP would have been easily seen at 2/3rd of the diameter of Tycho crater. We shall lower the weight the ALPO/BAA LTP weight to 1 as it is not clear whether a photographic processing lab checked the photo or whether a "Theoretical Astrophysics Institute" had sufficient photographic knowledge to correctly interpret the image.

Herschel: On 2022 May 12 UAI observers: Valerio Fontani and Fabio Verza, imaged this crater under different resolutions, for the following Lunar Schedule request:

BAA Request: Can you see, or image, a very black rectangular feature along the western side of Herschel and slightly to the north? You can use a telescope aperture as small as 3.5-inches(90mm) to make this observational study. All observations should be emailed to: a t c @ a b e r. a c. u k

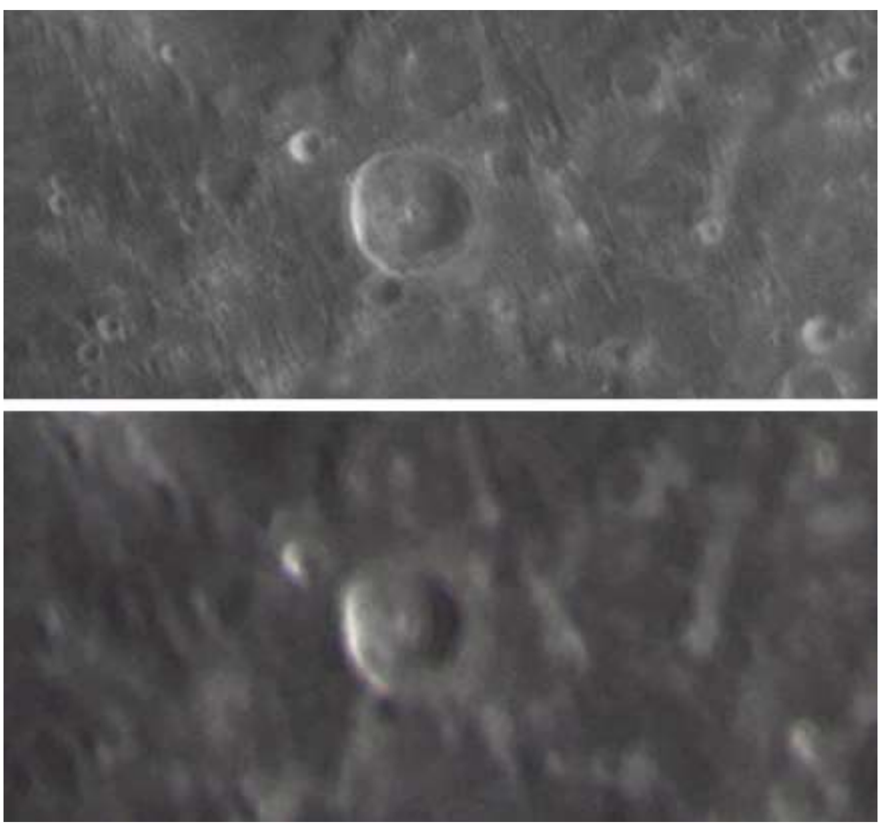

Figure 3. *Herschel oriented with north towards the top, taken on 2022 May 12.* ***(Top)*** *an image by Fabrio Verza (UAI) taken at 21:26 UT.* ***(Bottom)*** *An image by Valerio Fontani (UAI) at 22:21 UT.*

The two different resolution images in Fig 3 do not show anything obviously rectangular, or very dark, along the western edge of Herschel. The original LTP report was: *"On 2015 Sep 25 UT 03:28-03:40 D. Davis (Albany, OR, USA, Questar telescope used, x80 and x120, seeing 6, transparency), saw a very black rectangular feature along the western side of Herschel and slightly to the north. the effect was first noticed at 03:28-03:32 and it was checked again at 03:37-03:40. The length was ~4x the width and it was roughly 80-100 km long by 15-20km wide. Probably not a LTP, but it's worth checking again under similar illumination. ALPO/BAA weight=1"*. Fig 3 (bottom) is a closer match to the resolution obtained through a Questar telescope back in 2015. Could it be that they mistook "J. Herschel" for "Herschel"? I used NASA's [Dial a Moon] website to feed in 2022 May 12 UT 22:00 and came up with this startling finding that neatly explains the Daryl Davies report – see Fig 4. It turns out that J. Herschel does indeed have a nice dark rectangular shadowed area, but some distance west of its western rim. I wonder if this is what Darryl Davis saw back in 2015? Unfortunately, his email address from 2015 no longer works, so if anybody knows him, please let me have his contact details so I can ask him what he thinks about this this theory.

Figure 4. *J. Herschel as visualized by Dial a Moon for 2022 May 12 UT 22:00 and orientated with north towards the top.*

Aristarchus: On 2022 May 13 UT 05:47 Maurice Collins (ALPO/BAA/RASNZ) imaged this crater under similar illumination to the following two reports:

On 2004 May 01 at UT 22:20 R. Lena (GLR, Italy) received an image from one of his observers showing possible blue color in Aristarchus crater and part of the ray towards Herodotus. The ALPO/BAA weight=1.

Aristarchus, Schroter's Valley 1963 Dec 28 UTC 01:15-02:00 Observed by Olivarez, Edinburgh? TX?, USA, 17" reflector) "In poorer moments of seeing, red on Aris. rim & Sch. Valley. Spurious seeing effects?". NASA catalog weight=1. NASA catalog ID #788. ALPO/BAA weight=1.

Figure 5. *Aristarchus as imaged my Maurice Collins on 2022 May 13 UT 05:47, orientated with north towards the top and color saturation increased to 30%.*

Maurice's image does indeed show some red on the rim of Aristarchus and Vallis Schroteri. You can also see some tinge of blue on the illuminated rim of Aristarchus (natural color). The fact that the 1963 observation refers to red being seen during poorer moments of seeing, is not exactly encouraging over the reliability of the report. For the 2004 report, the fact that blue was seen on the crater is not unexpected, as we can see it in Fig 5. We can therefore remove these two LTP reports from the ALPO/BAA database by assigning weights of 0.

Cavendish E: On 2022 May 13 UT 20:15 Massimo Giuntoli (BAA) observed this crater using a 20cm Newtonian (x200 & x250, seeing IV. He found the northern floor of the crater has its usual appearance - bright but not brilliant. (colong. 65.9° / sub sol. lat. 0.0 / libr. lat. -2°38', libr. long. -6°11').

Plato: On 2022 May 14 UT 21:00 Massimo Alessandro Bianchi imaged the Moon under similar illumination to the following report below and to a lunar schedule request for the second report:

Mannheim Observers 1788 Dec 11 - Bright point seen on the dark part. Cameron 1978 catalog ID is 38 and the weight assigned is 5. ALPO/BAA weight=1.

Two observers have reported color on the rim around this colongitude, once in 1938, and again in 2013. Please take a look and report what you see, and where on the rim. Please send any high resolution images, detailed sketches, or visual descriptions to: a t c @ a b e r. a c. u k.

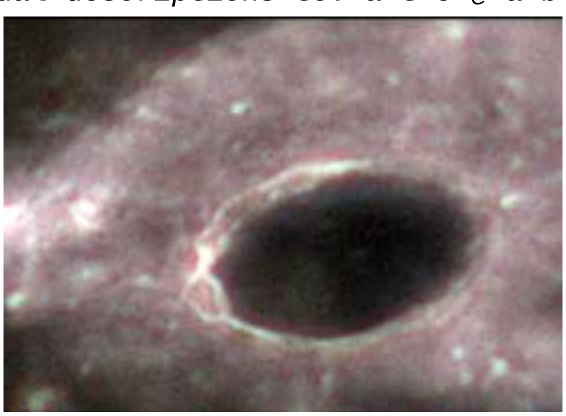

Figure 6. *Plato as imaged by Massimo Alessandro Bianchi on 2022 May 14 UT 21:00 and orientated with north towards the top. The image has been color normalised and had its color saturation increased to 30%.*

I am wondering if, for the 1788 LTP report, they are simply referring to the central craterlet on the dark floor of Plato. If so then visibility is dependent upon seeing and image contrast. It is just about visible in Massimo's image (Fig 6). The lunar schedule request actually refers to two LTP reports: 1938 and 2013, both at similar colongitudes. The 1938 report was for a prominent gold-brown spot on the east wall with a yellow glow but no definite boundary, spreading out over onto the floor of Plato. The 2013 report was for a golden yellow color being seen on the eastern rim. Although color normalized and color saturation enhanced, Massimo's image shows no yellow color on the eastern rim of Plato. We have covered repeat illumination observations for the 1938 and 2013 LTP, before in the 2015 Feb and 2018 Jan newsletters, and the yellow color never reappeared in those reports. So what ever happened in 1938 and 2013 was clearly most unusual and so we shall leave the weights of those two LTP unadjusted.

Gassendi: On 2021 May 14 UT 21:13 Walter Elias (AEA) imaged the crater under similar illumination to the following report:

Gassendi 1973 Dec 08 UT 20:20-20:22 observed by J-H Robinson (Devon, UK, seeing fair to poor). Suspected blink detected on crater floor - might have been due to atmospheric conditions? ALPO/BAA weight=1.

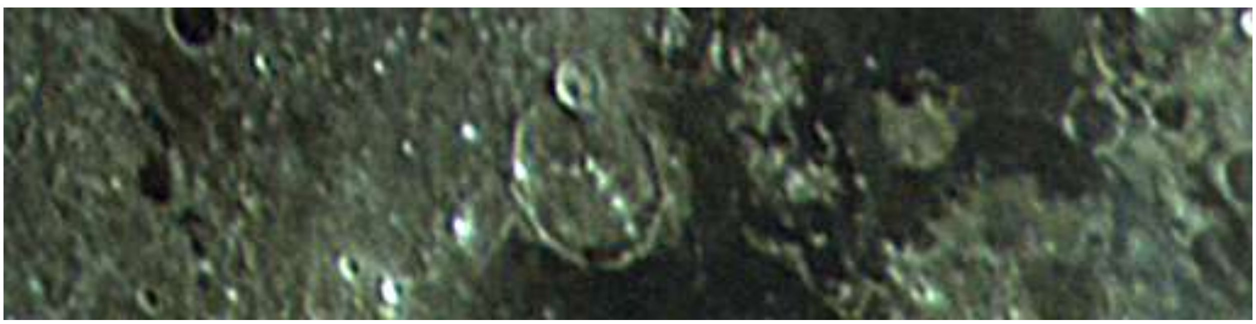

Figure 7. Gassendi as imaged by Walter Elias (AEA) on 2021 May 14 UT 21:13 and orientated with north towards the top. The image has been color normalised and then had its color saturation increased to 70%.

Walter's image (Fig 7) shows that there is no natural color here that could explain the effect seen in 1973. As the original report was already a weight of 1, we cannot go much lower on the weight. Despite the poor seeing mentioned by Hedley Robinson, it is interesting in the original report that the effect lasts about 2 minutes and is then not seen again that night. Also, a visual Moon Blink was used, which would rule out atmospheric spectral dispersion or chromatic aberration. For now, we shall keep the ALPO/BAA weight at 1.

Lichtenberg: On 2022 May 15 UT 19:58 Aldo Tonon (UAI) imaged the crater in color for the following repeat illumination request:

BAA Request: An important historical LTP sketch of this crater, and its surrounds, made by Richard Baum back in 1951 seems to have the wrong UT? It is very important that we establish what the UT and date of this observation actually was. In this prediction we are seeing if his date was off by 1 day. Please email any sketches, monochrome, and especially color images to: a t c @ a b e r . a c. u k

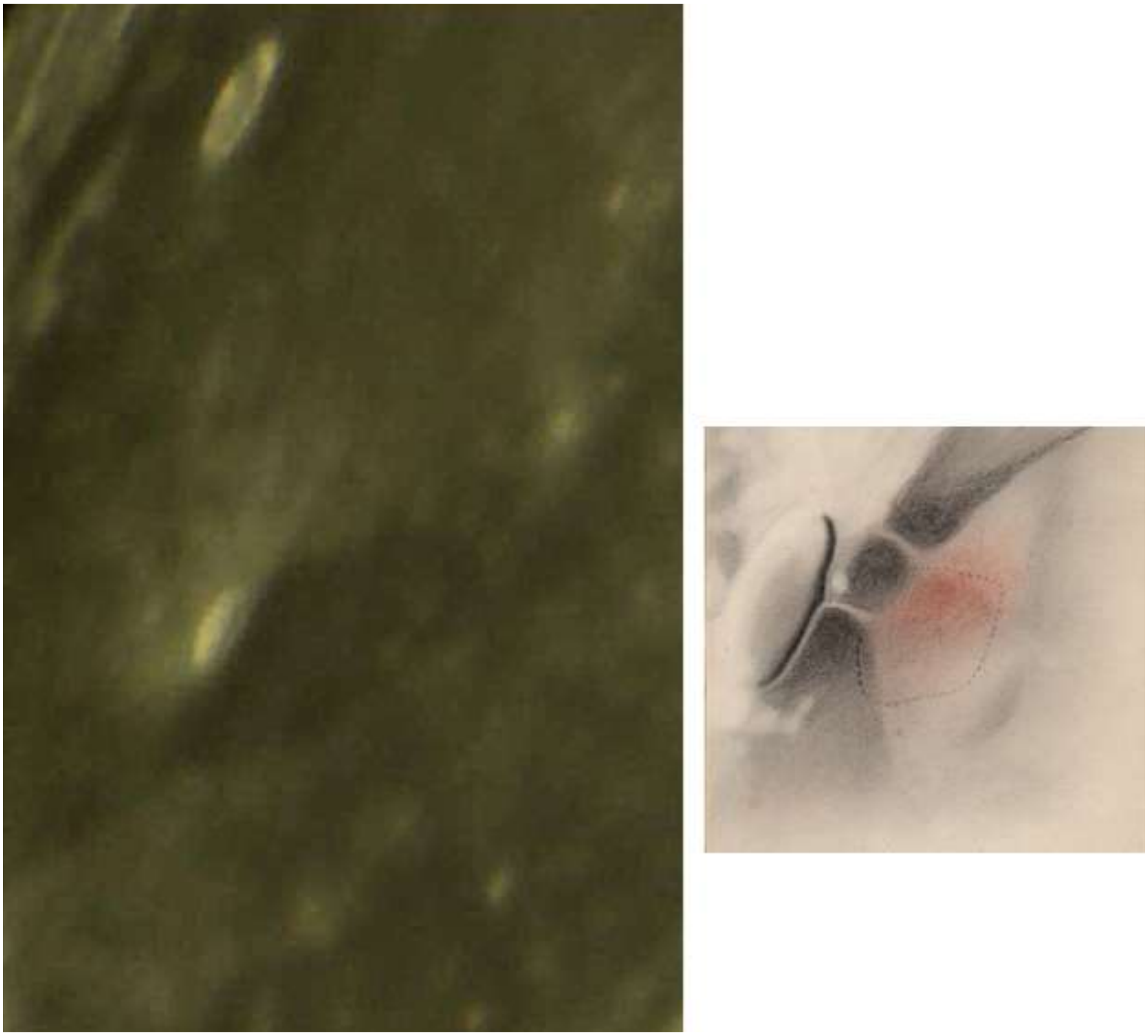

Figure 8. *Lichtenberg, oriented with north towards the top.* ***(Left)*** *A color image by Aldo Tonon (UAI) taken on 2022 May 15 UT 19:58.* ***(Right)*** *A sketch by Richard Baum – where the date and UT were given as 1951 Jan 21 UT 18:19-18:39.*

Aldo's image in Fig 8 shows the dark "bow-tie" appearance SE of Lichtenberg and also has the appropriate amount of shadow inside the crater. This suggests strongly that the date that Richard Baum used for his Lichtenberg sketch was probably off by one day. We have covered this before in the 2020 Jun, 2021 Apr and 2021 Jul newsletter and I think we have enough proof now to adjust the date in the LTP catalog from 1955 Jan 21 to Jan 22 UT 19:19-18:39. What was causing the rose tinge SE of the crater, back in 1951 remains a mystery.

Grimaldi: On 2022 May 16 UT 01:56-02:05 Alberto Anunziato (SLA) observed this crater under similar illumination to the following report:

On 1964 Jun 25 at UT ~01:07 Rubens de Azevedo (Brazil) observed a white streak from Grimaldi on the limb, during an eclipse. The Cameron 1978 catalog ID=822 and weight=4. The ALPO/BAA weight=2.

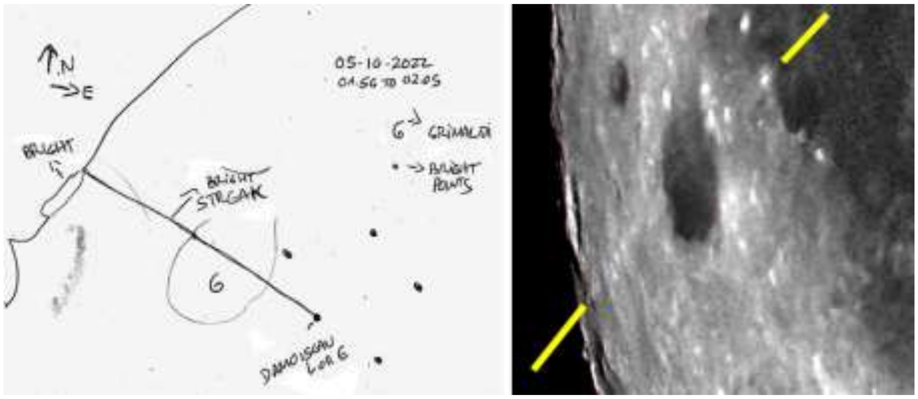

Figure 9. Grimaldi and the west limb of the Moon. **(Left)** A sketch of this region during the penumbral stage of the lunar eclipse by Alberto Anunziato (SLA), made on 2022 May 16 UT 01:56-02:05. Image has been mirror reversed, orientated with north towards the top and text has been re-orientated from the original drawing. **(Right)** A section of the same area from an archive image of the Full Moon, by Valerio Fontani (UAI), taken on 2022 Dec 18 UT 21:32 – the yellow tick marks indicate a possible ray.

Alberto could see a white streak from Damoiseau L (or Damoiseau E) passing through Grimaldi and ending on the West Limb (See Fig 9 - Left). Note that this was seen during the penumbral stage of the eclipse, but the Brazilian report was made between first contact of the umbra and totality. As the Full Moon is a good analog to the phase angle, we see the surface at during a lunar eclipse, an examination of a near-Full Moon image (Fig 9-Right) is a useful reference and shows the alleged ray quite well. Searching through the archives I managed also to find a series of sketches (Fig 10) that seem to match the Grimaldi ray in Fig 8, but appear to be a lot more prominent – they were actually made during the 1968 lunar eclipses, but as you can see the original claimed discovery of the "valley of Grimaldi" was from 1964. On p94 of the same Lunar Section Circular it states: *"On receiving a letter from SAVAL (Sociedad Astronomica de Valparaiso, Chile) I was informed by the team of such society, organized to observe the recent and total eclipse of the Moon, that they again observed the "valley" of Grimaldi, which was registered by my friend and colleague, Prof. Rubens de Azevdeo and his team, observed for the first time during the eclipse of June, 1964. This strange formation appears to start from the western (IAU) wall of Grimaldi running to the nearby limb. According to all who have observed it, it is conspicuous and "very bright". One could observe it even without any experience of Moon observing. Another colleague, of ASOA (Salto, Uruguay) saw this strange ray "as a subsequent chain of bright spots" and exactly on the same place. It is to be noted that Prof. Rubens and a group of 20 observers, noticed it again during the recent eclipse. Their instruments were powerful enough to avoid mistakes: 12-inch, F/d:7, Reflector and some less powerful. From my own observation, it was not seen, but this could be attributed to phenomena particularly observed during eclipses only"*. – J. Niccolini (Brazil).

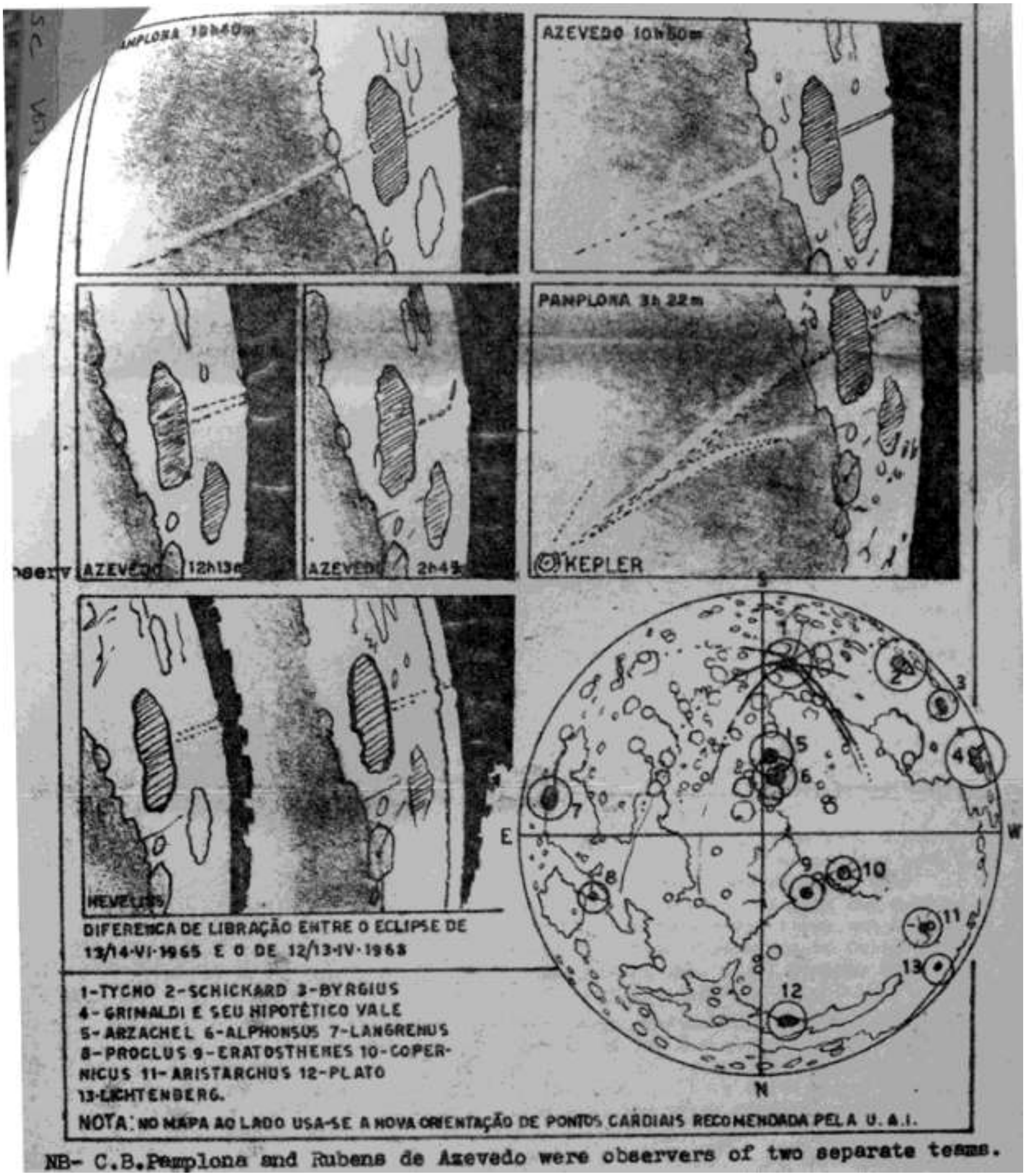

Figure 10. *Sketches of rays in the Grimaldi area of the Moon, made by Pamplona and Azevedo, during the two eclipses of the Moon in 1968. From the BAA Lunar Section Circular p103, No. 10, Vol 3, from 1968. Not these are orientated with north towards the bottom.*

So, to summarize this 1964 LTP report concerns a ray system that is strongest on the western side of Grimaldi, towards the limb, and the observers attributed the bright spots, in the vicinity of Damoiseau, as a continuation of the ray, possibly as far as Kepler. Examination of the Full Moon image and Alberto's sketch (Fig 9), and also an image from a Wikipedia page, about the 2022 May 16 eclipse, looks similar to the sketches in Fig 10. I think the visibility of this supposed alignment, is related to observing conditions. We shall therefore lower the weight from 2 to 0 and effectively remove this report from the ALPO/BAA LTP database.

General Information: For repeat illumination (and a few repeat libration) observations for the coming month - these can be found on the following web site: http://users.aber.ac.uk/atc/lunar_schedule.htm . By re-observing and submitting your observations, only this way can we fully resolve past observational puzzles. To keep yourself busy on cloudy nights, why not try "Spot the Difference" between spacecraft imagery taken on different dates? This can be found on: http://users.aber.ac.uk/atc/tlp/spot_the_difference.htm . If in the unlikely event you do ever see a LTP, firstly read the LTP checklist on http://users.aber.ac.uk/atc/alpo/ltp.htm , and if this does not explain what you are seeing, please give me a call on my cell phone: +44 (0)798 505 5681 and I will alert other observers. Note when telephoning from outside the UK you must not use the (0). When phoning from within the UK please do not use the +44! Twitter LTP alerts can be accessed on https://twitter.com/lunarnaut .

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Basin and Buried Crater Project

Coordinator Dr. Anthony Cook- atc@aber.ac.uk

News: Daryl Dobbs has emailed me the following:

Very interesting project the lunar basins and buried craters, this may not be of much use but this paper from 2016 uses the GRAIL data to come up with two lists of buried features: "Identification of buried lunar impact craters from GRAIL data and implications for the nearside maria" by Evans

There are a couple of interesting tables in the supporting information section, S1 gives the latitude and longitude plus diameter of 103 quasi-circular mass anomalies, table S2 lists 50 partially filled craters with their lunar co-ordinates and diameters. Alas it doesn't give any names only where they are which might suggest they are largely unnamed, perhaps the data in the tables might be a good starting point for further investigation to confirm if they are visible. Since they set an upper limit of 300km, it's no use for the lunar basin list but might be useful for the buried craters.

Regarding a buried crater proposed in 2015 using the GRAIL data the authors proposed the name Earhart, at a 2015 LPSC conference in abstract #1883. The crater in question is centred 41.2N 21.8E and 120km in diameter in the Lacus Sominorum, I'm not entirely convinced they were the first to find it, looking at Section III:III in The Map of the Moon by H P Wilkins published by the RGO seems to indicate something there but it does require a bit of imagination. Also some of the plates (2b and 2d) in section 2 in the Hatfield Photographic Lunar Atlas seems to indicate a feature there too."

I have taken note of this information and updated the tables.

Vaporum Impact Basin(?)

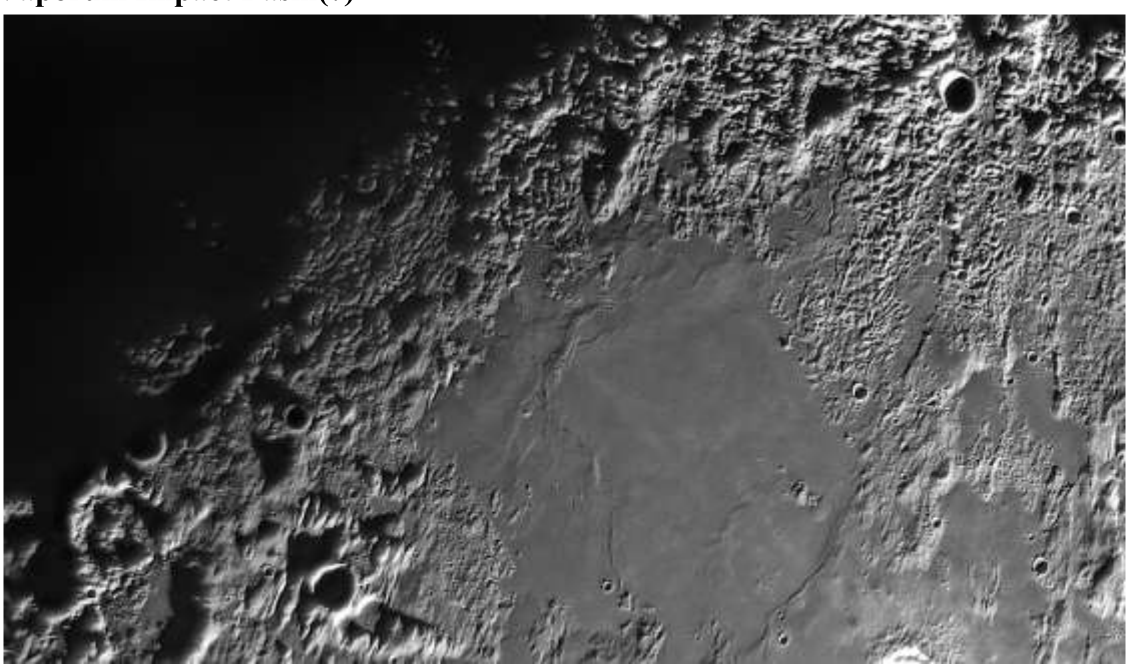


Figure 1. *Mare Vaporum as imaged by Leo Aerts on 2022 May 08, taken with a 25 cm f/15 Opticon Schmidt Cassegrain, red filter and webcam ASI 290MM. North is towards the top right.*

This month we will look at the possible basin in which Mare Vaporum resides. Mare Vaporium is on the near side, close to the centre of the lunar disk, located at 3N 14E, and according to [Neumann *et al.* (2015)](#) has two basin rings – one being 220 km in diameter (an inner peak ring?) and a possible outer one at 410 km in diameter. The floor has several wrinkle ridges, and at least one volcanic dome. There are some well-rounded elongated and parallel hillocks near Ukert crater. You can see some evidence for this being a basin in the geophysical datasets (Fig 2) from the NASA/ACT Quickmap website. Firstly we can see there is clearly a topographic depression here, secondly there is a weak mascon (concentration of denser material) at the centre, thirdly the crustal thickness is less at the centre, and fourthly the gravity gradient and topographic slope azimuth plots both show a nice ring that matches the visible ring. The ring diameter I measure is about 220 km across (agreeing with Neumann *et al.*), but basins traditionally start at 300 km in diameter, and even if the visible ring it is just an inner peak ring, I can see little evidence for the proposed 440 km diameter ring. I also cannot see any radial ejecta scour marks, as can be found on some other basins, although if the region has been heavily eroded by subsequent large impacts and the surrounds buried by ejecta deposits from elsewhere, then these may no longer be visible. As for the age of the proposed basin, the NASA/ACT Quickmap website gives a Hiesinger crater count age of the Mare Vaporum deposits of 3.45 Ga, or late Imbrium era, so we can therefore say that the depression in which the mare material reside must be older than this.

So is this an ancient impact basin or just a flooded depression/large crater? I do not know, but at least, according to Leo's image we know that for lunar sunrise conditions, it is best seen at a Selenographical Colongitude of between 3° to 6°.

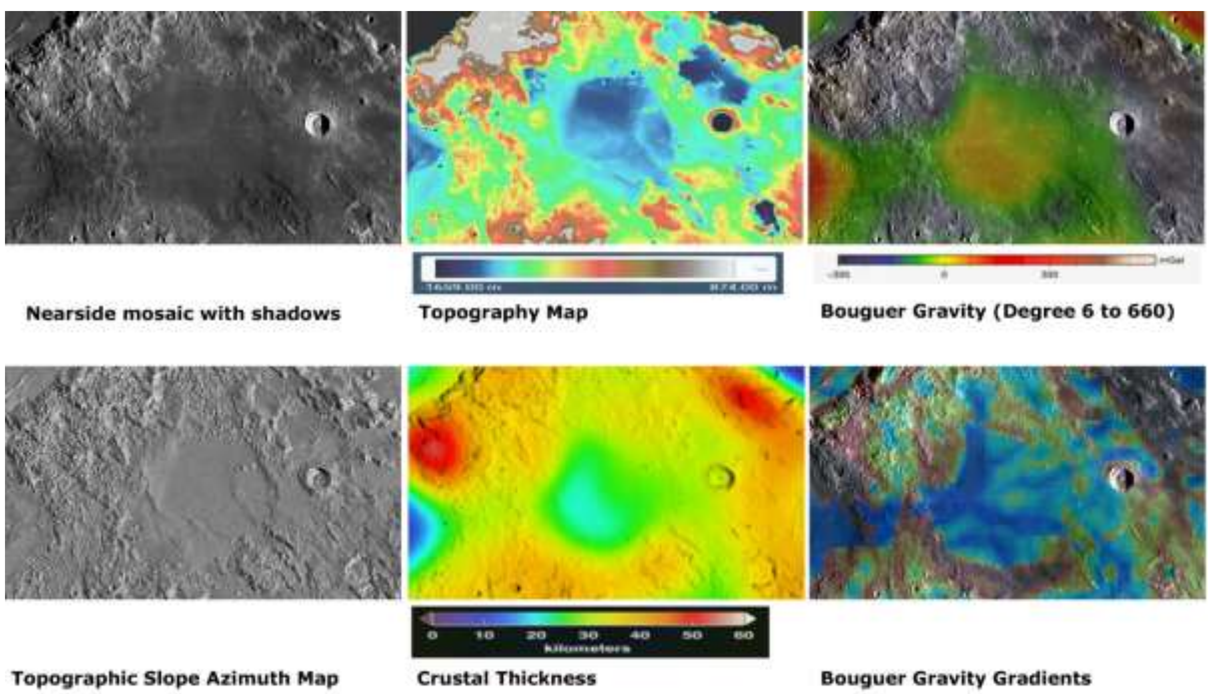


Figure 2. *Geophysical datasets for the Vaporum impact basin.*

Please take a look at our website for other lunar impact basins and buried craters that you may want to image: https://users.aber.ac.uk/atc/basin_and_buried_crater_project.htm . I am really keen to gather imagery of the less certain basins, and also for all basins and buried craters in order to find the best selenographic colongitudes to see them at sunrise and sunset.

Tony Cook

Lunar Calendar July 2022

Date	UT	Event
3		South limb most exposed -6.7°
7	0214	First Quarter Moon
7		West limb most exposed -7.4°
13	0900	Moon at perigee 357,264 km, large tides
13		Greatest southern declination -26.9°
13	1838	Full Moon largest of 2022
15	2000	Saturn 4° north of moon
16		North limb most exposed +6.6°
18	0100	Neptune 3° north of Moon
19	0100	Jupiter 2° north of Moon
19		East limb most exposed +7.9°
20	1419	Last Quarter Moon
21	1700	Mars 1.1° south of Moon, occultation Japan to Greenland
22	0600	Uranus 0.2° south of Moon, occultation South America, Europe, Africa, India
26		Greatest northern declination +26.9°
26	1000	Moon at apogee 406,274 km
26	1400	Venus 4° south of Moon
28	1755	New Moon, lunation 1232
30		South limb most exposed -6.6°

The Lunar Observer welcomes all lunar related images, drawings, articles, reviews of equipment and reviews of books. You do not have to be a member of ALPO to submit material, though membership is highly encouraged. Please see below for membership and near the end of *The Lunar Observer* for submission guidelines.

AN INVITATION TO JOIN THE A.L.P.O.

The Lunar Observer is a publication of the Association of Lunar and Planetary Observers that is available for access and participation by non- members free of charge, but there is more to the A.L.P.O. than a monthly lunar newsletter. If you are a non-member you are invited to join our organization for its many other advantages.

We have sections devoted to the observation of all types of bodies found in our solar system. Section coordinators collect and study members' observations, correspond with observers, encourage beginners, and contribute reports to our Journal at appropriate intervals.

Our quarterly journal, *The Journal of the Association of Lunar and Planetary Observers-The Strolling Astronomer*, contains the results of the many observing programs which we sponsor including the drawings and images produced by individual amateurs. Additional information about the A.L.P.O. and its Journal is on-line at: **http://www.alpo-astronomy.org.** I invite you to spend a few minutes browsing the Section Pages to learn more about the fine work being done by your fellow amateur astronomers.

To learn more about membership in the A.L.P.O. go to: **http://www.alpo- astronomy.org/main/member.html** which now also provides links so that you can enroll and pay your membership dues online.

SUBMISSION THROUGH THE ALPO IMAGE ARCHIVE

ALPO's archives go back many years and preserve the many observations and reports made by amateur astronomers. ALPO's galleries allow you to see on-line the thumbnail images of the submitted pictures/observations, as well as full size versions. It now is as simple as sending an email to include your images in the archives. Simply attach the image to an email addressed to

lunar@alpo-astronomy.org (lunar images).

It is helpful if the filenames follow the naming convention :

FEATURE-NAME_YYYY-MM-DD-HHMM.ext

YYYY {0..9} Year

MM {0..9} Month

DD {0..9} Day

HH {0..9} Hour (UT)

MM {0..9} Minute (UT)

.ext (file type extension)

(NO spaces or special characters other than "_" or "-". Spaces within a feature name should be replaced by "-".)
As an example the following file name would be a valid filename:

Sinus-Iridum_2018-04-25-0916.jpg
(Feature Sinus Iridum, Year 2018, Month April, Day 25, UT Time 09 hr16 min)

Additional information requested for lunar images (next page) should, if possible, be included on the image. Alternatively, include the information in the submittal e-mail, and/or in the file name (in which case, the coordinator will superimpose it on the image before archiving). As always, additional commentary is always welcome and should be included in the submittal email, or attached as a separate file.

If the filename does not conform to the standard, the staff member who uploads the image into the data base will make the changes prior to uploading the image(s). However, use of the recommended format, reduces the effort to post the images significantly. Observers who submit digital versions of drawings should scan their images at a resolution of 72 dpi and save the file as a 8 1/2"“x 11” or A4 sized picture.

Finally a word to the type and size of the submitted images. It is recommended that the image type of the file submitted be jpg. Other file types (such as png, bmp or tif) may be submitted, but may be converted to jpg at the discretion of the coordinator. Use the minimum file size that retains image detail (use jpg quality settings. Most single frame images are adequately represented at 200-300 kB). However, images intended for photometric analysis should be submitted as tif or bmp files to avoid lossy compression.

Images may still be submitted directly to the coordinators (as described on the next page). However, since all images submitted through the on-line gallery will be automatically forwarded to the coordinators, it has the advantage of not changing if coordinators change.

When submitting observations to the A.L.P.O. Lunar Section

In addition to information specifically related to the observing program being addressed, the following data should be included:

Name and location of observer
Name of feature
Date and time (UT) of observation (use month name or specify mm-dd-yyyy-hhmm or yyyy-mm-dd-hhmm)
Filter (if used)
Size and type of telescope used Magnification (for sketches)
Medium employed (for photos and electronic images)
Orientation of image: (North/South - East/West)
Seeing: 0 to 10 (0-Worst 10-Best)
Transparency: 1 to 6

Resolution appropriate to the image detail is preferred-it is not necessary to reduce the size of images. *Additional commentary accompanying images is always welcome.* **Items in bold are required. Submissions lacking this basic information will be discarded.**

Digitally submitted images should be sent to:
David Teske – david.teske@alpo-astronomy.org
Alberto Anunziato–albertoanunziato@yahoo.com.ar
Wayne Bailey—wayne.bailey@alpo-astronomy.org

Hard copy submissions should be mailed to David Teske at the address on page one.

CALL FOR OBSERVATIONS:
FOCUS ON: Wonders of the Full Moon

Focus on is a bi-monthly series of articles, which includes observations received for a specific feature or class of features. The subject for the September 2022 Focus-On will be the craters rayed craters of the Moon's southern hemisphere. In November 2022, Eratosthenes eill be the subject of the Focus-On article. Observations at all phases and of all kinds (electronic or film based images, drawings, etc.) are welcomed and invited. Keep in mind that observations do not have to be recent ones, so search your files and/or add these features to your observing list and send your favorites to (both):

Alberto Anunziato – albertoanziato@yahoo.com-ar
David Teske – david.teske@alpo-astronomy.org

FUTURE FOCUS ON ARTICLES:

In order to provide more lead time for contributors the following future targets have been selected:

Subject	TLO Issue	Deadline
Bright Rays South	**September 2022**	**August 20, 2022**
Ever Changing Eratosthenes	**November 2022**	**October 20, 2022**

Focus-On Announcement

WONDERS OF THE FULL MOON

The full moon is loved by almost everyone, except for the majority of astronomers. But when the near side is illuminated almost completely by frontal light, it is the opportunity to enjoy a unique spectacle: the bright ray craters. It is a field of study favorable to amateur observation with scientific value: how far does each bright ray reach? Are some rays brighter than others coming from the same crater? Are they altered by the relief over which they pass? And many other questions that ALPO's Bright Lunar Rays Project has as its objectives.

Bright Lunar Rays Project Objectives:
https://moon.scopesandscapes.com/ALPO%20Rays%20Project.htm

List of rayed craters and other non-crater features:
https://moon.scopesandscapes.com/alpo-rays-table.pdf

JULY 2022 ISSUE-Due **June 20th, 2022**: **NORTHERN BRIGHT RAY CRATERS**
SEPTEMBER 2022 ISSUE-Due **August 20th, 2022: SOUTHERN BRIGHT RAY CRATERS**

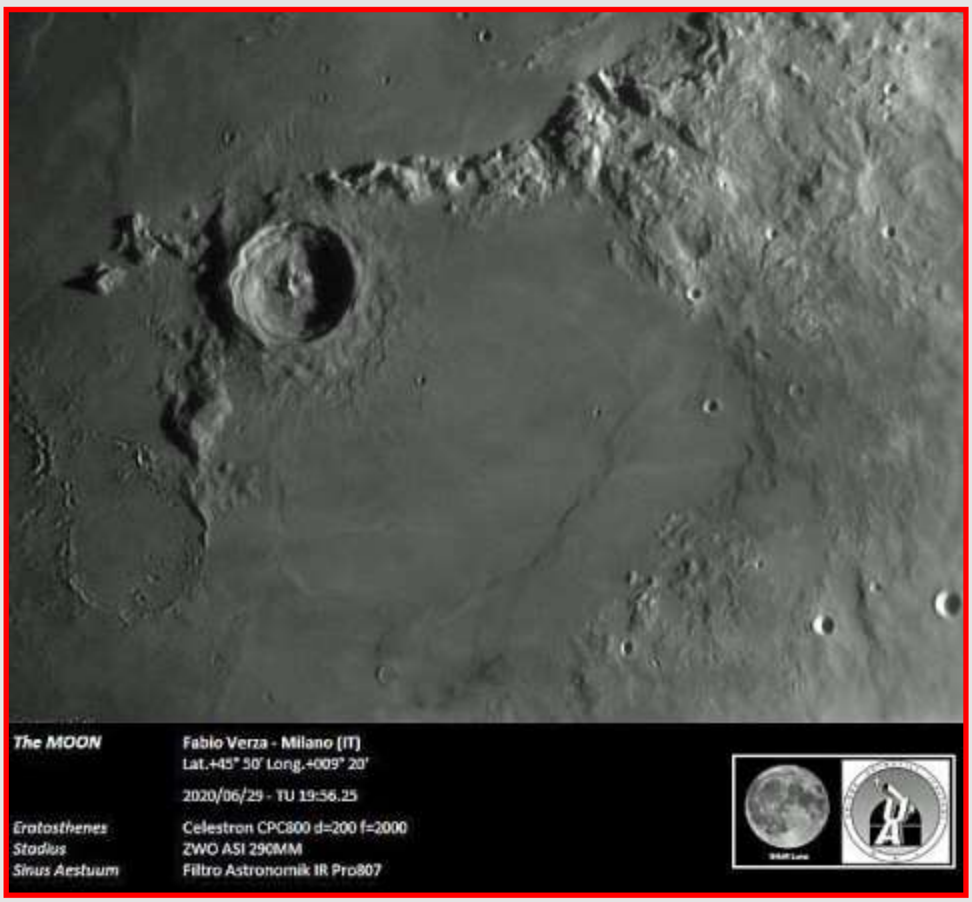
Leandro Sid

Focus-On Announcement

EVER CHANGING ERATOSTHENES

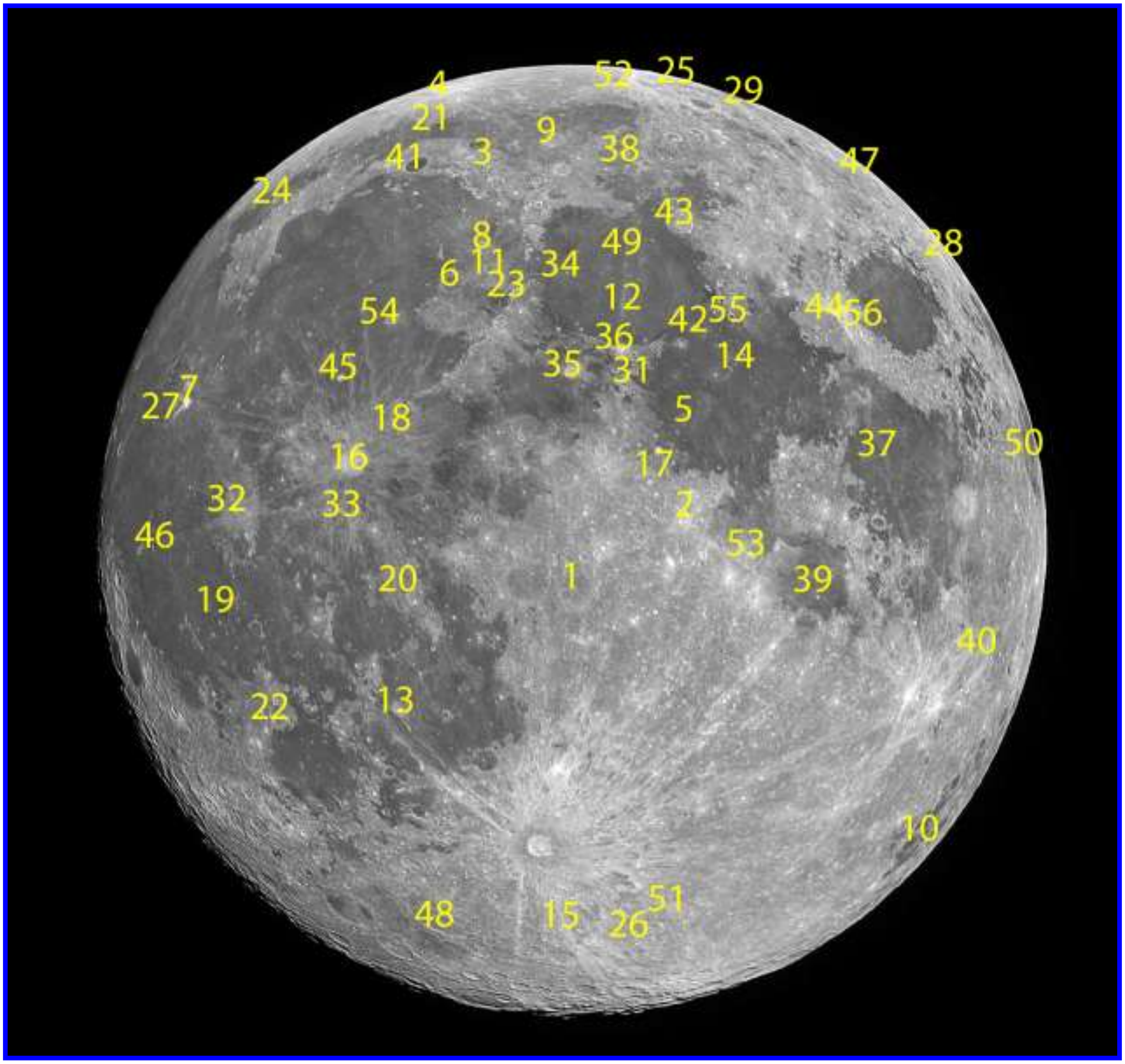
Eratosthenes is a model impact crater, albeit "unfairly" overshadowed by the younger Copernican craters. It is interesting to observe its rim, well defined and with linear segments, its spectacular terraced walls, the central peaks, its irregular and fractured floor full of mounds, and its majestic ramp-shaped ejecta field, formerly known as “glacis”. Eratosthenes is very changeable, it is seen as a deep well of darkness near the terminator, passing through its phase of maximum splendor in the first or last quarter and to practically disappear in full moon, buried by the ejecta of its younger relative, Copernicus. And in addition to Copernicus, Eratosthenes has other very interesting sights: the complex topography of Sinus Aestuum and the grandeur of the Montes Apenninus.

NOVEMBER 2022 ISSUE-**Due October 20th, 2022: ERATOSTHENES**



Fabio Verza

Key to Images In This Issue



1. Albategnius
2. Alfraganus
3. Alpes, Vallis
4. Anaxagoras
5. Arago
6. Archimedes
7. Aristarchus
8. Aristillus
9. Aristoteles
10. Australe, Mare
11. Autolycus
12. Bessel
13. Bullialdus
14. Cauchy
15. Clavius
16. Copernicus
17. Delamdre
18. Eratosthenes
19. Flamsteed
20. Fra Mauro
21. Frigoris, Mare
22. Gassendi
23. Hadley
24. Harpalus
25. Hayn
26. Heraclitus
27. Herodotus
28. Hubble
29. Humboldtianum, Mare
30. Jansen
31. Julius Caesar
32. Kepler
33. Lansberg
34. Linné
35. Manilius
36. Menelaus
37. Messier
38. Mortis, Lacus
39. Nectaris, Mare
40. Petavius
41. Plato
42. Plinius
43. Posidonius
44. Proclus
45. Pytheas
46. Reiner
47. Riemann
48. Schiller
49. Serenitatis, Mare
50. Smythii, Mare
51. Stöfler
52. Thales
53. Theophilus
54. Timocharis
55. Vitruvius
56. Yerkes