

## From the Director



The 2023 Apr 20 Solar Eclipse Shadow of the Moon as seen on Earth, taken by iSpace's Hakuto-R lander from lunar orbit. Image credit: ISPACE. Taken from: https://www.bbc.co.uk/news/world-asia-65389730

It is well known that landing on Mars has always been fraught with danger, with only a $40 \%$ success rate at the time of the Mars 2020 rover landing. Something similar can be said for lunar lander attempts, with about 60 attempts so far and 21 landings, resulting in an even lower success rate of $35 \%$. The latest to suffer was the Japanese Hakuto-R Mission-1 lander. Details about the landing were hard to come by until closer to the day. However, it was established that the backup site of Lacus Somniorum, located between Posidonius and Lacus Mortis, was to be used instead of the primary target of Atlas crater. The lander was a technology demonstration mission, derived from the original Lunar X-Prize, that nobody had won by the deadline of 2018.

On board it carried a United Arab Emirates lunar rover, a NASA experiment, and two other robots from the Japanese JAXA space agency and the Tomy toy company. A live stream of the landing event was broadcast, but the landing sequence was a computer generated visualization synchronized to the actual timing of events of the landing. Unfortunately radio contact was lost above the lunar surface, and it is speculated that this may have been due to an altimeter issue and/or possibly running out of fuel. This occurred on Tue $25^{\text {th }}$ April 2023 at 16:40 UT. Although it ended in failure, an enormous amount was learnt from the mission, a tribute to its engineers and scientists, which will undoubtedly pave the way for the next attempt. We should not lose heart though as there are plenty of other missions coming up this year - though note that dates and landing sites may change:
*June 2023 launch - Mission One Peregrine lander and several onboard rovers
*June 2023 launch - Intuitive Machines - 1 Nova-C lander to Malapert-A

* 13 July 2023 launch - Russian Luna 25 lander to Boguslavsky crater
*July 2023 launch - India's Chandrayaan-3 to the lunar south pole
*August 2023 - Japan's SLIM lander and rovers - due to land near the Marius Hills lava tube skylight.
*December 2023 - Intuitive Machines - 2 Nova-C lander to the south pole area.
A couple of other points to mention - in the April BAA Journal there is a great article by Mark Kidger and Juan Jose Godoy Carrera on Backyard Lunar Mineral Prospecting. Secondly, on 2023 May 05 UT 15:14-19:32 there will be a penumbral eclipse of the Moon, visible from Asia, East Africa, Australia etc, with earlier and later stages visible from Europe, Japan, New Zealand etc. Penumbral eclipses are not very spectacular, but imaging them can give us information on scattering and refractive properties of our upper atmosphere, as well as nearzero phase angle photometry of the lunar surface.


## Tony Cook.

## Lunar Occultations May 2023 by Tim Haymes

## Time capsule: 50 year ago: in Vol 8 No. 5

*From the Director P Moore: Problems with the duplicator - this is a short issue.
*P. Ringsdore: I now have a post code number. TA8 2DU (TimH: interesting historical snipit?)
*K Gayner: How to observe and report lunar occultations (for new members). We now have 72 active observers listed in the Occultation sub-section (TimH: Remarkable!)
[ With thanks to Stuart Morris for the LSC archives ]

## April 24 and $25^{\text {th }}$ - reports

The evenings of the $24^{\text {th }}$ and $25^{\text {th }}$ April saw the Moon occult stars in Gemini at a favourable crescent illumination.

Ivan Walton (CADSAS in Kent) requested the predictions down to magnitude10. He observed with an 8" SCT after a power fault put the main instrument temporarily out of action. Two bright events at the dark limb were seen on the monitor screen. SER recordings were made with an Altair Hypercam 183C pro. Ivan reports:
" In the rush to locate an alternative location after the initial observatory failure, I'm afraid it wasn't the best planned session with unfamiliar equipment. We didn't pre-sync the PC clock "

The stars occulted were: SAO 78873 (mag 7.8) and ZC 1056 (mag 7.2) on May 25th. Well done CADSAS. I hope we may receive further reports from you from time to time.
Tim Haymes: The coordinator was clouded out on both evenings.

## Pete and Paul's Observing Challenges 2023.

Two of the challenges involve the lunar occultation of planets. Full details of the list, and their Winchester presentation pdf can be seen here: https://britastro.org/2023/pete-and-pauls-observing-challenges-for-2023 The first challenge is the daylight occultation of Jupiter on May $17^{\text {th }}$. The circumstance for 5 locations in Scotland are listed in Table-1

Daylight Occultation of Jupiter from Scotland, May 17 ${ }^{\text {th }}$
General Circumstances: Sun Alt, 45deg; Moon Alt, 30deg; Azimuth, 245; Lunar Phase, 5\% Waning.
Table-1 Limb contact times:

| City | D hhmmss | CA | R hhmmss | CA |
| :--- | :--- | :--- | :--- | :--- |
| Glasgow | $13: 44: 51$ | $-20 S$ | $14: 01: 27$ | $8 S$ |
| Edinburgh | $13: 45: 16$ | $-21 S$ | $14: 02: 43$ | $9 S$ |
| Dundee | $13: 42: 28$ | $-25 S$ | $14: 05: 09$ | 13 S |
| Aberdeen | $13: 54: 59$ | -27 S | $14: 09: 33$ | 17 S |
| Inverness | $13: 36: 04$ | -35 S | $14: 08: 23$ | 23 S |

Londonderry and Berwick-upon-Tweed are close to the graze zone.
SUN ALERT: Find a location that is shaded from the Sun, but has a view of the crescent Moon, in fact the planet may be easier to see than the Moon.

Eta Virginis on May 30 ${ }^{\text {th }}$ 01h
This could be followed in binoculars. I would be interested in reading reports of the event and the equipment used to observe the dark limb disappearance, even though it is at low altitude ( 8 deg ).

Occultation predictions for 2023 May (Times as other locations will +/- a few minutes)
Oxford: E. Longitude -001 18 47, Latitude 515540
To magnitude ca 8.5, Moon altitude $>7$ degrees.
day Time $P$ Star $S p$ Mag Mag \% Elon Sun Moon CA
Notes


See the December 2022 issue of LSC for an explanation of the table.
Detailed predictions at your location for 1 year are available upon request. Ask the Occultation Coordinator: tvh dot observatory at btinternet dot com, or the LS Director.

Interested in Grazes only? - Indicate your travel radius in Km and your home post code or nearest town. An aperture of 15 cm will be used unless advised. More predictions will be generated by this process.

## Communications.

## Study of Diophantus-Delisle area with earth-based telescopic photos. By K.C.Pau.

After reading the excellent article written by Barry Fitz-Gerald about the topographical study of DiophantusDelisle area in the LSC March 2023 issue, I have much interest to study this area especially the ray from a small crater Samir based on my own moon photos taken with a $250 \mathrm{~mm} \mathrm{f} / 6$ newtonian reflector. In the past years, I mainly focused on the changes of Mons Delisle under various angles of illumination and neglected the other features in this area. What's a pity! I flipped through volume 2 of my "Photographic Lunar Atlas for Moon Observers", which is freely downloaded since 2016, to a section about crater Delisle (section 58, page $320 \sim 325$ ). I am much grateful to Alberto Anunziato who frequently uses photos of the atlas in his visual observation reports published in "The Lunar Observer", which is a publication of the lunar section of ALPO. In page 322, I found a photo (Fig.1) with the lighting condition quite a match to Paul Abel's drawing and photos that taken by Bill Leatherbarrow but with Mons Delisle, Delisle and Diophantus much closer to the morning terminator. The line of craterlets and/or hummocks mentioned by Bill is clearly shown. What I perceive it is not a line of craterlets but a line of tiny hillocks, as some of them cast clear shadows.


Fig. 1 A photo showing a line of craterlets or hillocks north-east of crater Samir. It may be the ray like feature mentioned in Paul Abel's drawing. This photo is taken on 22 March 2013, 11h48m UT, colongitude: 35.1 ${ }^{\circ}$, seeing: 6~7/10, transparency: 5/10

No trace of crater ray along that line is detected as is prominently shown in Abel's drawing. Later, when I look through my moon photo archive, I found a photo of the Delisle area that was taken on the same date as Paul's drawing but about 6 hours earlier (Fig.2). However, there is still no trace of the ray detected in my photo. Is the ray really existing there? That is quite an interesting phenomenon. Maybe, the way of perception is different between the camera sensor and the human eye.


Fig. 2 Side by side comparison of drawing and photo taken on the same date but different hours. Ray in the drawing is very prominent but no other detail shown. Not a trace of ray is shown in the photo but only hummocky terrain around crater Delisle and Diophantus. The line of hillocks is shown clearly.

Searching and searching, eventually another photo pops up (Fig.3a). This photo has almost the same colongitude ( $37.4^{\circ}$ ) as Paul's drawing ( $37.8 \sim 38^{\circ}$ ) but on a different date and time. Traces of a ray now appears on the photo but all other detail is blurred due to poor seeing. I wonder if the seeing has played a role to intensify the appearance of the ray as the line of hillocks mentioned above may overlap or mix with one another under turbulent seeing. In another two photos (Fig's. 3b \& c) taken respectively on 7 December 2019 and 8 January 2017, a trace of a ray is barely detected near the north-eastern portion of the line of hillocks as the sun is higher up and the detail of the features begin to wash away. A small halo is seen around crater Samir.

When the sun is getting higher and higher, the rays from Samir appear prominently as a narrow fan of bright rays not just a single ray as shown in Paul's drawing and Bill Leatherbarrow's photos (Fig. 4).

The photo (Fig.5) is the side by side comparison of an enhanced image taken on 18 October 2021 with that of Barry's OMAT mosaic image. Coincidentally, two images look very similar.

In his article, Barry stated that the middle ray (b) is what Paul and Bill recorded in their drawing and photo. When I compare all the photos that show the ray, I may not agree with Barry's view. I believe the ray labelled C should be the pick.


Fig. 3a This photo has the almost the same colongitude (37.4) as Paul's drawing taken under 4/10 seeing on $13^{\text {th }}$ Oct 2005 13h33m UT. A trace of the ray is detected but all other details are blurred with poor seeing. Fig. 3 b shows photo taken on $7^{\text {th }}$ December 2019, 12h43m UT, Colongitude: 37.8 ${ }^{\text {o }}$, seeing: 6~7/10, transparency: 8/10 and Fig.3c shows photo taken on $8^{\text {th }}$ January 2017,13h35m UT, Colongitude: 38.8 ${ }^{\circ}$, seeing:7/10, transparency: 6/10


Fig. 4 Ray from Samir at different angle of illumination. In the middle image, the rays look like a search-light. The white arrows shown in the two left-sided photos correspond to ray indicated by yellow arrow from Leatherbarrow's photo.


Fig. 5 Side by side comparison of a photo taken on 18 October 2021 with Barry's OMAT mosaic image.

## Observations around Plinius by Trevor Smith.

I was observing the area around Plinius and it's system of rilles on 27/03/23 when I noticed on the rille, just due north of Plinius, that there was two noticeable 'notches' or perhaps they might be small craterlets or pieces of ejecta from the impact of Plinius, the seeing would not allow them to be properly resolved but they were nevertheless easily seen at times.


I took a quick photo (see above together with sketch made at the eyepiece ) with my phone which does not show as good a view as was obtained visually with the telescope at x247.The photo just about shows the two notches but they were more distinct in the eyepiece. The 'notches' are found on the most southerly rille directly north of Plinius and are some 15 to 20 km apart.

Rukl (Map 24) shows something in about the right place and there is a hint of something on Map19b of the Cambridge Photographic Moon Atlas. The 'notches' are not clearly seen in the $21^{\text {st }}$ Century Atlas Of The Moon and Hatfields lunar atlas lacks the clarity and does not show them!

I wonder if anyone was imaging at around 20.00 UT on the $27 / 03 / 23$ or perhaps have images from a previous
lunation with similar lighting conditions. I wonder if these 'notches' may be very dependent on the angle of the sunlight striking them?.

I will endeavour to check this area again visually and with filters.
Editor Comments: This appears to be Rima Plinius I, and where it passes to the north of Plinius it is heavily draped in ejecta from that crater. It is possible that radial ridges in the ejecta from Plinius has divided up the rille in to short sections, and certainly in the position shown by Trevor of the westernmost notch there is a distinctly wider crater like section which may be the result of such a process.

The Arago-Lamont region - A Geologist's Playground? by Bill Leatherbarrow.


The image above was captured on the evening of 27 March 2023 at 19.04 UT, using my OMC300 Mak-Cass and an ASI290MM camera. The low sunrise illumination threw into stark relief the profusion of interesting geological features in this area. The two well-known large clumpy domes Arago Alpha and Beta are clearly seen to the north and west of crater Arago itself, but there are many other smaller and smoother domes visible on the image. There is much other evidence of localised past volcanic and tectonic activity in the region, most obviously a profusion of sinuous and linear rilles and the striking patterns of wrinkle ridges around the strange 'ghost' formation Lamont. There is also an abrupt albedo transition visible in the lavas to the east and north of

Lamont, perhaps indicating different ages or composition. This transition seems unaffected by the wrinkle ridges that cross them. There are small mysteries too: what is that strange, hen's foot-like ridge emerging from the south wall of Arago and stretching southwest towards the nearby crater Manners? Is it just part of the circular ridges that appear to surround Lamont? Or is it something altogether different?

But the biggest questions are posed by Lamont itself. Spacecraft data from the 1960s onwards have suggested that Lamont sits astride the sort of mass concentration usually associated with impact basins. In this case we must promote Lamont from the category of simple ghost crater and acknowledge the possibility that it is an ancient buried basin. This reminds me that back in the 1960s, when life still flickered in the theory that the majority of lunar craters were formed through volcanic, rather than impact mechanisms, Gilbert Fielder - a past Director of our Lunar Section - described the possibility that 'ghost' craters like Lamont might not be the ancient remains of once proud craters buried under subsequent lava flows. Instead, Fielder suggested that they might on the contrary be relatively young features - 'elementary rings' created by the volcanic extrusion of magma through ring-faults. Later in the formation process the area enclosed by those outer rings would subside to form the crater and its inner terraces.

Such ideas seem fanciful now that the great volcanic-versus-impact debate has long been settled, but the AragoLamont region still poses questions and we still have much to learn!

## BAA Handbook Lunar Occultations by Julian Aucken.

Today is silly question time. In the column headed 'Ill phase of Moon $\%$ ', how can it be negative? And for all the apparently positive numbers, why is there a + sign at all, and why does it follow rather than precede? Finally, how can it exceed 100? (bottom of page 38) I suppose the signs do not have their usual meaning? Please will you explain?

Before writing to you I consulted Howard Miles excellent Explanatory Supplement, but it couldn't help. In this respect it was quite out of date. Not surprising perhaps, in view of its publication date, 1988. Perhaps there is a case for a 2 nd edition and there may well be other places where an update is desirable.

Tony Cook replied: No question is too silly, simply because if you do not know then others also probably do not know - so its a fair question!

Answer - the "+" corresponds to phases from New Moon to First Quarter to Full Moon. The "-" refers to phases from Full Moon to Third Quarter, and back to New Moon.

## Lunar mountains by Harry Warren.

Thanks for sending me the latest Lunar Section circular. I was flattered to see that you'd published my query about the lunar mountains. I've actually been going through old books and articles about the moon and spaceflight generally, trying to track the evolution of astronomers' ideas about their nature. I've looked through 53 of them so far, and I'm still going.

I'm particularly interested in the pivot point, where it was discovered that everyone had got it wrong, and that lunar mountains weren't even as dramatic in appearance as our own, let alone even more dramatic. It had been thought that they might be because they hadn't suffered the taming effects of wind and water erosion as our mountains had.

I've arrived at the point where it appears that this realisation began to dawn in the late 1950 s , when it began to seem possible that an expedition to the moon might actually take place in the foreseeable future, and finding out what the moon's surface is really like, before anyone set foot on it suddenly became a matter of life and death. A more intensive study of it began, together with a more intensive attempt to map it accurately.

The most emphatic declaration I've found so far that the traditional idea of what lunar mountains are like was wrong, appears in the Time-Life book 'Man and Space', which was published in the USA towards the end of 1964. The text had been written in the course of that year by Arthur C.Clarke, who was at the same time discussing ideas for what became the film '2001: A Space Odyssey' with Stanley Kubrick. Clarke included two small pen and ink sketches in the book to demonstrate the difference between the old and the new ideas about lunar mountains. One showed, in simplified form, a group of roughly conical mountains with steep slopes and jagged peaks, while the other - the new idea - depicted something that resembled a neolithic long barrow, stripped of its grass. The contrast between the two couldn't have been more striking.

Illustrations in children's books demonstrate the change of thought very clearly. One of them, by the American writer Franklyn Branley, went through several editions which trace the evolution of our ideas about lunar mountains in simple form. While the first edition showed them as steep and jagged, subsequent editions were updated periodically to reflect the change in thought, and these showed the contours of the lunar surface as being soft and rolling. Eventually, the illustrator took this 'soft and rolling' idea so far that the moon's surface began to resemble marshmallow or melting ice cream.

## Lamont by Ken Kennedy.

Thanks once again - and this time for your epic Circular! Fantastic information. I sent it out to two of the most lunar interested members of Dundee Astronomical Society and both are more than impressed with one saying 'Thank you - that is my bedtime reading sorted for a night or two!!' This particular member set herself the task of taking a photograph of each day of the lunar 'month' so the phases are recorded throughout. Naturally, it can't be done in one lunation but she is almost there after many months - and getting up very early for some of the last quarter phases.

Recently I came across a book which told the story of John Lamont who was sent to Germany for his education, stayed there and became Astronomer Royal of Bavaria. He was of particular interest to me as he was born in 1805 at Corriemulzie, a house a few miles from Braemar on the dead-end road to Linn of Dee. Braemar is about 50 miles from where I live, but I have walked the road many times on trips to the southern Cairngorms and passed his birth place at Muckle Inverey, where there is a memorial to him. I was unaware of this but intend going back this summer to find his birth place and the memorial which is just a mile away. I mention this because, on 27th March I imaging the Moon and decided to take the Arago and domes area. Having done this I realised that I had some time ago identified the feature Lamont formed by convoluted wrinkle ridges.


On the 27th, Lamont was in an ideal position to show its shape, ringed by the low ridges (see above image). Lamont is certainly an interesting object with speculation that an impact crater lies beneath the formation. I don't believe we can be certain of this and it's interesting to note that the formation is associated with a mason. I wonder if the mascon is the remnant of an ancient sub-surface magma chamber? The other interesting feature is the well defined lighter area around Lamont. At first I wondered if it was just my image but it is shown on other images and also in Rukl. Anyway, I thought I would send my image and would welcome any comments about the feature. Image taken with Celestron C8 at f10, Camera, Altair GP-CAM,

## Imaging Workflow advice by John Axtell.

The reason for writing is to ask advice as to whether the Lunar Section, or BAA more generally, has a recommended workflow, or preferred YouTube or other video tutorial, leading one through the capture and processing of lunar images? I have at long last taken the plunge and have started using my planetary camera ZWO ASI120 MC, but just on my Celestron C6 mounted on an iOptron Mini Tower II mount (Alt-az of course) and am pleased with my initial results of Jupiter and Mars. The software used for capture was SharpCap, followed by PIPP, then AutoStakkert for stacking, wavelets for detail in Registax, final contrast/brightness adjustment in GIMP. I've now tried the ZWO on the Moon for the first time a couple of night's ago, again with the C6. I tried several different YouTube tutorials, but I got my best result with SharpCap, Registax and Gimp. I found some of the tutorials I watched suggested differing routes, settings, options etc - so I thought that there might be one that Lunar Section colleagues thought best, or maybe an earlier edition of our Newsletter might have covered this.

Ed. Comments: A regular contributor to the section, Mark Radice has a YouTube Channel entitled 'Refreshing Views of the Night Sky'. There are a number of tutorials that go into the finer points of imaging and image processing, the following relate to the Moon and Solar System specifically and may be a good place to start. He also uses a ZWOASI 120MC Camera:
https://www.youtube.com/watch?v=1VPhED1IkTU\&t=3s
https://www.youtube.com/watch?v=Meax0tNuzGo
From the Archive.


MAUROLYCUS
1951 JANUARY 15th.7.0-17.30GT.
$6 \frac{1}{2} \frac{1 n}{} \times 300$
Showing pourt of floor at higher level than the rest and two shaded patches on wimer woll.
$\qquad$

The above drawings are very interesting renditions of the area around Heraclitus and the crater Maurolycus, taken from 'The Moon, Vol. 2 No.2, January 1954. Both drawings were made by Roland Clarkson with a $61 / 2$ inch telescope, which judging from a photograph of Clarkson in a JBAA article by Richard McKim, appears to have been a rather nice long focus newtonian*. The drawings are extremely pleasing to look at and very clear and uncluttered.

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## Images and Drawings from Members.

## Mineral Moon Copernicus.



05/02/2023, 22u55 UT - C8 F10 SCT, UVIIR blocking filter, ASI462MC
Image by Alexander Vandenbohede with details of time/date and equipment in caption.
Alexander Comments: I used an ASI462MC colour camera and the result was used to increase the colour saturation. Basalts wit different FeO and $\mathrm{TiO} 2 \mathrm{w} \%$, the impact melt of Copernicus, and the immature soils of the ray systems can be seen.

Ed. comments: For more on lunar mineral prospecting using colour cameras please see the article 'Backyard lunar mineral prospection (Part.1)' by Mark Kidger and Juan José Carrera in the BAA Journal Vol.133, No.2.

The Southern Highlands in daylight.


Image taken by Bob Stuart on Wednesday, 22 March 2023 taken in daylight at 12:51 using a 850nm near IR filter. Only processing was stacking and Registax. Note the blackness of the sky!

## Rhaeticus, Godin and Lade.



Rhaeticus, Godin, Lade 2022.09.16 06:01 UT, S Col. $156.6^{\circ}$, seeing 5/10, transparency fair Libration: latitude $-01^{\circ} 52^{\prime}$, longitude $-04^{\circ} 33^{\prime}$
305 mm Meade LX200 ACF, f 25, ZWO ASI 120MMS camera, Baader IR pass filter: 685 nm . 640 frames processed in Registax 6 and Paintshop Pro 8.
Dave Finnigan, Halesowen

## Image by Dave Finnigan with details of time/date and equipment in image.

Geological Notes: This area is well and truly gouged by the 'Imbrium Sculpture' which is thought to have resulted from the scouring of the surface by low angle ejecta from the Imbrium Basin, which is off towards the top left of the frame. This ejecta has filled in the older pre-Imbrium craters such as Rhaeticus and Lade which are reasonably circular in outline, albeit a bit battered. Godin however has a distinctly triangular look to it, something you might also discern in Agrippa (the southern rim of which is just peeking through the top right of the frame) and Ukert (to the NW and the other side of Sinus Medii). These craters obviously post-date the Imbrium Basin, and this may account for their less than circular outline, as the intense faulting and fracturing of the crust associated with the basin formation may well have influenced the shape of craters that formed subsequently. Meteor Crater in Arizona is an example of this where the squarish outline is due to a complex of faults in the country rock that pre-date the crater. Horrocks is just clipped by the lower edge of the frame, and to its NE is the 15 km diameter Pickering, which is quite circular in outline. This might suggest that the outline of smaller craters in this size range ( $<15 \mathrm{kms}$ ) are not as heavily influenced by pre-existing faults as larger complex craters such as Godin which is 34 kms in diameter.

## 6.5 day old Moon.



Image by Ken Kennedy on $\mathbf{2 6}^{\text {th }}$ February 2023 using a Celestron 8 at prime focus (f10, 2000mm) and with a x2 Barlow.

Ken Comments: As I had hoped, the high elevation Moon last night was in relatively still air. It makes imaging so much easier as the image isn't jumping about all over the place! The Moon was at a phase of 6.5 days and I used my Celestron 8 at prime focus (f10, 2000mm) and with a x2 Barlow, so f20, 4000mm f.l. I tend to use the gain turned quite far down to prevent too much contrast and so the imaging is slower but I tried to get about 4,000 images for each image of SER file with my Altair camera.

## Albategnius.



## Image by Bill Leatherbarow taken on the morning of 17 September 2022 under reasonable seeing with a OMC300 and ASI290 camera.

Geological Comments: Albategnius takes centre stage in this image with Alphonsus just off the left of the frame and Ptolemaeus occupying the top left corner. Elements of the Imbrium Sculpture are conspicuous, orientated from top to bottom of the frame, particularly the deep trough that clips the western rim of Halley and passes down the eastern rim of Albategnius. Another feature that sticks out to the south-east of Albategnius is 24 km diameter Burnham, though the term 'diameter' is a bit ambiguous when referring to such an irregularly shaped crater. As you can see, the crater floor is occupied by numerous small hills and there are breaches in the crater rim to the north-west and south - almost suggestive of a breached a volcanic cone, but of course these could well be components of the Imbrium Sculpture and nothing to do with a more exotic volcanic origin. The crater floor is barely lower than the surface of the smooth plains surrounding the crater, serving to increase the un-crater like nature of Burnham.

So is this a distorted impact crater, or is it something else? One possibility is that it represents an ancient volcanic edifice of some sort, with any evidence of this in the for of volcanic, deposits now shrouded in later layers of impact debris and basin deposits. The hills on the crater floor however have a strong plagioclase signal in the mineral data, which would argue against a volcanic origin - so maybe not a volcanic structure after all and just a battered crater. Whatever its true nature it appears quite atypical compared to the other craters in this area of the southern highlands.

## Aristoteles and Eudoxus.



Image by Leo Aerts taken on May 8th 2022 under good seeing conditions and using a Celestron 14" with an Ir filter and webcam ASI 290MM.

## Geological Comments:



Compare Leo's image to the above drawing by B.T. Doherty from The Moon Vol. 13 No. 4 which shows a number of suspected domes he charted in the area around Egede. Leo's image and spacecraft data do not indicate any volcanic features, but the mare surface to the NW of the crater is scarred by secondaries and ejecta from Aristoteles as well as the odd highland peak which projects above the lavas of Mare Frigoris. These may have had a distinct 'dome' like appearance under low angle illumination, but I suspect they are not volcanic in origin.

Klaproth and Casatus.


2023 January 02, Start: 1845 Finish: 1900. Seeing: All, Transparency: Average- some haze present.
305mm Newtonian Reflector, x300. Filter(s): None- integrated light only.
Moon's age: 10.4 d , Illumination= $85 \%$, Colong: $38.1^{\circ}$ to: $38.3^{\circ}$
Paul G. Abel, Leicester UK
Drawing by Paul Abel with details of time/date and equipment shown.
Geological Comments: These two ancient craters lie to the south of Clavius and immediately west of the much younger Moretus. The older of the pair, Klaproth which is in the foreground, pre-dates Casatus, which partially overlaps it, and both probably date to the pre-Nectarian. Both craters are extremely shallow, and their floors are covered in smooth plains which is thought to be ejecta from basins such as Imbrium or Orientale. This would account for the widespread distribution of these light plains* though many questions remain unanswered with regard to these deposits and their origin. So whilst the conventional model suggest these plains are primarily impact debris, there is uncertainty as to whether they are exclusively fragmentary in nature or if an impact melt component may contribute to the overall volume. At one time volcanism was thought to be responsible for these plains, but post-Apollo work suggests that volcanism does not play a part in their formation, with the exception maybe of the Appenine Bench Formation which are believed to be KREEP basalts. Despite its smooth appearance the floor of Klaproth is quite uneven on a small scale as revealed in Lunar Orbiter images** indicating the presence of an irregular buried surface, whilst Casatus has a number of partially buried secondary craters on its floor. One thing absent from the floors of both is any ejecta from Moretus, which considering its size and proximity ( 114 kms diameter and about 100 kms distant) is peculiar and may indicate that Klaproth and Casatus are in a Zone of Avoidance type gap in the Moretus ejecta.

Having said that volcanism is not believed to contribute (much) to light plains formation, the 44 km diameter crater Balancus C which is no more than 25 kms away from the northern rim of Klaproth, and outside the area shown in the drawing (towards bottom right) is a very rare example of a highland Floor Fracture Crater (FFC) which are the result of volcanism. As can be seen in the LRO WAC image below, this crater has a number of fractures crossing its floor, which is domed upwards with the central part 200 m higher than its edges. The hint of a central peak can be seen in the middle of the floor in the form of a 50 m high nubbin, with the rest presumably buried by the deposits that cover the floor. Many FFC's, whist obviously the result of volcanic uplift, have floors bereft of obvious volcanic deposits, and this is the case here. But this might only mean that any basaltic lavas or other volcanic deposits that do exist are now buried by these light plains, a conclusion
based on the presence in some of these ancient craters of 'cryptomaria' buried ancient lavas the presence of which are only indicated by dark halo craters where impacts have punched through the light plains to expose the darker iron rich rocks below. None of these are however visible in either Balancus C, Klaproth or Casatus.


LRO WAC image of Balancus C


Image of Klaproth and Casatus by Bill Leatherbarrow with Balancus $C$ towards the lower edge of the frame
So, volcanism may well have been more widespread in the highlands than is commonly assumed, with the FFC nature of Balancus $C$ suggesting that this area could have experienced volcanic activity in the ancient past.

[^1]Kepler.


Image by Les Fry with details time/date and equipment shown in image.
Geological Comments: We are all familiar with crater rays, but I saw a question on an Astro forum the other day which asked a rather obvious question - why do crater rays differ from one crater to another? So in this image compare the straight edged rays from Kepler with the rather feathery ray from Copernicus entering the frame from the lower right. One obvious factor is impact angle and velocity, another is local geology and possibly even impactor size and composition. But what about pre-existing topography? Though not the first to suggest this possibility, a 2018 paper*suggests that the local topography surrounding an impact can produce rays as a result of ejecta being locally focused from the side walls of valleys or possibly even pre existing craters on the surrounding surface. Their conclusions were supported by lab experiments and simulations where the impacted surface varied from being smooth, which resulted in no rays to quite knobbly which resulted in quite spectacular rays developing. The authors suggest that this data could be used to determine impactor size and estimate pre-impact topography. They attempt this using Kepler as an example but in their analysis they mistakenly identify the ray from Copernicus noted above, as belonging to Kepler, but that may too be too big a flaw in their argument.

[^2] Physical Review Letters. 120. 10.1103/PhysRevLett.120.264501.

Rima Hyginus.


Image by Luigi Morone with details of time/date and equipment in caption.
Geological Notes: Another comparison, this time of Luigi's image of the Rima Hyginus with a (upside-down) chart produced by E.A Whitaker from a photograph taken at Pic du Midi March $21^{\text {st }} 1945$ and published in The Moon Vol. 4 No. 4 1956. Whitaker thought the drawing was "equivalent to visual observations under perfect seeing conditions with about $14^{\prime \prime}$ aperture" which is the size of instrument used by Luigi.


Whitaker comments that a number of observers believed that the rima or as he called it the 'cleft' could be traced across the floor of Hyginus itself, but as you can see in Luigi's image this does not appear to be the case, and spacecraft imagery also do not show any continuation across the floor of Hyginus. Of course it is likely that in 1956 Hyginus was viewed as an ordinary impact crater and not as a volcanic collapse pit as is now widely believed.

Sea of Crises.


Image taken by Mark Radice with details of time/date and equipment as shown in the caption.
Mark Comments: The near full moon is not a popular sight but for those in the know there is always something fascinating to see. This evening, the terminator was on the eastern shores of the Sea of Crises. I have been fascinated by this region as the mountainous ramparts have been flooded by lava leaving isolated mountain peaks, in particular Alhazen alpha and beta, protruding from the flat and lifeless surface. Capturing 4 images I mosaiced them together to produce the image below.

## Geological Comments:



As a 15 yr old, much of the contents of the 1970's BAA Journals was beyond me, but I clearly recall the article entitled 'The banded face of Alhazen alpha' by L.E.Fitton in Vol.82, and the above drawing is from that article and made using a 215 mm reflector x200. You can clearly see the bands on the face of Alhazen alpha in Mark's image, and which appear too be made up of lower albedo material which has accumulated in gullies running down the western face of the 4000 m high mountain.


Image by Maurice Collins with details of time/date and equipment shown in image.

## Archimedes, Montes Spitzbergen and Mons Piton.



Image taken by K.C.Pau on 28 February 2023, 12h51m UT with a 250 mm f/6 Newtonian, 2.5X barlow and QHYCCD290M camera.

## Plato.



## Plato 2022.08.19-06.14 UT

300mm Meade LX90, ASI 224MC Camera with Pro Planet 742nm I-R Pass Filter.
750/3,000 Frames. Seeing: 7/10. 750/3,000 Frames. Seeing: 7/10. Rod Lyon

## Image by Rod Lyon with details of date/time and equipment in image.

Geological Comments: Rod's image nicely resolves the craterlets A,B,C and D on the floor of Plato - often difficult targets under varying seeing. The image also shows the straight ridge separating the small craters Plato K ( 6.5 kms ) from its partner KA ( 5.4 kms ) on the mare surface to the SE of Plato. This pair formed simultaneously and the ridge is where the ejecta from each crater collided and was deposited on the surface. The ridge is actually slightly chevron shaped with the vertex pointing towards K which is the larger crater and from which a more powerful ejecta curtain swept the forming ridge towards the smaller crater. The craters do not overlap but are slightly separated with the ridge in between, which is actually a good 200 m higher that the rims of either K or KA.

## Apollo 16 region.



Image by Richard Hill with details of time/date and equipment in image.

Rik Comments: This image is full of goodies! There is the magnificent Theophilus crater (104km dia) on the right (lunar east) side of this image with its splendidly detailed central peaks. Below is the older and slightly smaller Cyrillus (100km). To the east of Theophilus is Madler with a fascinating ejecta splash surrounding. On the left side of this image (lunar west) is the huge shadow filled Albategnius (139km). Between these two extremes of this image are several very interesting features. Almost dead center in the image you will see a small ' $o$ '. This marks the location of the Apollo 16 in the Descartes highlands. The little white spot just below the 'o' is Stone Mountain that was explored by the astronauts and above are the Smoky Mountains. Below this region is the ruined crater Descartes (49km) which has an interior ring and Descartes A (14km) on the west side. Just below center is a large flat floored crater, Abulfeda ( 65 km ). Tangential to the southeast wall of this crater and trailing off this image to the southwest is a chain of craters called Catena Abulfeda. The length is listed as 216 km running almost to Polybius with many of the larger craterlets being named as satellite craters of larger nearby craters but generally they are not named below the 5 km diameter.

There is much more to see in this region, too much to detail here.
This image was made from pieces of 3, 1800 frame AVIs stacked with AVIStack2 (IDL) and finish processed with GIMP and IrfanView

## Basin and Buried Crater Project by Tony Cook.

## The Schiller-Zucchius Basin

Following on from the March "BBC" project about the Schiller-Zucchius basin, I was pleased to receive a sketch from Dr Paul Abel (Fig 1), and then an image (Fig 2) from Prof Bill Leatherbarrow.


Figure 1. Outline sketch by Dr Paul Abel (BAA) of ghost craters, designated A and B, seen on the floor of the Schiller-Zucchius multi-ring impact basin.

Paul writes: "Bill suggested if I see I could see any ghost craters in the mare region between Schiller and Segner crater. I had a look on 2nd April (in rather poor seeing) and I've attached a line drawing showing what seemed to me to be the approximate position of two definite ghost like craters. I wonder how they change depending on different angles of illumination?".

In reply to Paul and myself, Bill writes: "I also observed these areas at around the same time under reasonable seeing, and I attach my images for comparison (copied to Tony). The 'ghost craters'you mention near Schiller are probably part of a buried 3rd inner ring of the Schiller-Zucchius multi-ring basin. The two outer rings are much more obvious. This basin was the subject of a paper by John Rogers in the BAA Journal some years ago, I seem to recall."

The paper that Bill refers to is: "The Largest Crater on the face of the Moon", 1976, JBAA, Vol 86, p471-474, and if you read that you can see that John Rogers refers to two previous publications : Lowman, P.D., Lunar Panorama, Zurich, 1969. \& Stuart-Alexander, D.E., and Howard, K.A., Icarus, 12, 440 (1970). The paper by John Rogers has an early hand drawn chart, based upon Lunar Orbiter images of the basin, reproduced here in Fig 3 - he gives ring diameters of 340 km and 180 km .


Figure 2. The Schiller-Zucchius multi-ring basin as imaged by Prof Bill Leatherbarrow on the night of 2023 April 02, close to the time of the sketch in Fig 1. Note orientation is with north to the right.


Figure 3. The Schiller-Zucchius basin as depicted as the then named "Schiller Annular Plain" (SAP) from a 1975 JBAA paper by John Rogers.

I was grateful to receive another image of this basin via David Teske, the ALPO Lunar Section director, taken by Larry Todd (ALPO) from New Zealand (Fig 4).


Figure 4. The Schiller-Zucchius multi-ring basin as imaged by Larry Todd (ALPO) on 2023 Apr 02 UT 10:12 and orientated with north towards the right.

I think it's debatable whether there is a degraded inner rim (or peak ring) near the centre (making the basin a 3 ring basin), or if its collection of two or more buried craters, as Paul has spotted (two). We certainly have some great imagery to continue out studies with.

## Buried Crater(?) South East of Grove Crater



Figure 5. Grove crater as sketched by Alberto Anunziato for the date and UTs given.
Alberto Anunziato (SLA) has emailed in a sketch (Fig 5) and some LROC Quick Map hill shaded LOLA terrain views (Fig 6). His sketch shows an oval darker albedo area, adjoining to the south east of Grove crater, which prompted him to look for evidence in the LOLA hill shaded DEM.


Figure 6. Alberto's attempt to measure a possible buried crater SE of Grove.
Using a more contrasty (lower sun angle illumination) virtual view (Fig 7), one can see a possible arc of hillocks. However taking diameter measurements (Fig 8) gives a longest diameter of 28 km and a shortest diameter of 20 km , so if there really is a buried crater here ( $33.8 \mathrm{E}, 39.6 \mathrm{~N}$ ) then it is elliptical, inferring a shallow angle impactor. It is certainly smaller than the dark patch that Alberto noticed. If I had a systematic way of assigning weights (I have not figured the most sensible way to do this yet) to buried craters then this one would get a low weight of 1 out of 10 . Obviously we have to be careful not to jump to conclusions for every single thing that looks like a circular or arc of a circle/ellipse, as the hillocks could be volcanic in origin, but anyway it probably won't do harm to put this one into the database, pending further investigation.


Figure 7. Tony's attempt to define the position of the candidate buried crater SW of Grove. ACT Layers $($ Experimental $) /$ TerrainHillShade (Zenith Angle $=86.4^{\circ}$ and Azimuth $=181.0^{\circ}$ ).

If you think that you have discovered a new impact basin, or unknown buried crater, please check whether it has been found previously on the following web site, and if not email me its location and diameter so that I can update the list.

## https://users.aber.ac.uk/atc/basin and buried_crater_project.htm.

Alternatively, if you want an observational challenge, try to see if you can image one of more of the basins or buried craters at sunrise/set and establish what colongitude range they are best depicted at. Or you can even do this "virtually" with LTVT software. As you can see from the tables on the web sites there are lot of blank cells to fill in on the sunrise and sunset colongitude columns - so a good opportunity for you to get busy!


## Lunar Domes (part LXV): Lunar domes in the easternmost regions of the Moon By Raffaello Lena

Lunar mare domes formed during the later stages of volcanic episode on the Moon, characterized by a decreasing rate of lava extrusion and comparably low eruption temperatures, resulted in the formation of effusive domes ${ }^{[1-3]}$.
Such studies may help to gain more insight into regional geological processes and mare basin dome evolution.


Andrea Vanoni, from Italy, has imaged possible domes located near the crater Dubyago V, in Mare Undarum (Fig. Figure 1: Telescopic image made on October 12, 2022 at 00:31 UT by Vanoni. The identified domes are marked with white lines. Mare Undarum, for its location close to the limb, is strongly foreshortened. The dome named Dubyago V 2 is emerging from the terminator and is not clearly detectable (bottom right). Newton 400 mm of diameter.

The examined domes described in the current preliminary note are reported in Table 1. In the LRO WAC imagery they are not as prominent as in the telescopic terrestrial image taken under lower solar illumination angle and with telescope of large diameter. Based on ACT react quick map and the Tool Terrain Hill shade the examined domes are detectable as shown in Figs. 2-3. Some domes have already been measured in previous studies ${ }^{[3-4]}$ and are reported in brackets.

|  | Long $\left[{ }^{\circ}\right]$ | Lat $\left[{ }^{\circ}\right]$ | $\mathrm{D}[\mathrm{Km}]$ | $\mathrm{h}[\mathrm{m}]$ | Slope $\left[{ }^{\circ}\right]$ | Volume $\left[\mathrm{Km}^{3}\right]$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| Dubyago V 1 | 68.03 | 5.82 | 17 | 170 | 1.13 | 19.0 |
| Dubyago V 2 | 69.21 | 5.52 | 11.2 | 90 | 0.89 | 4.0 |
| Dubyago V 3 | 68.80 | 6.03 | 12 | 170 | 1.6 | 11.0 |
| Dubyago V 4 | 68.70 | 6.80 | 18 | 130 | 0.8 | 14.5 |

Table 1. Morphometric properties and coordinates of the domes under analysis.

The 3D reconstruction of the domes, named as Dub V 1-4, obtained using WAC mosaic draped on top of the global WAC-derived elevation model GLD100, is shown in Figs. 4-7.


Figure 2: ACT react quick map. Mare Undarum around the craters Dubyago W and Dubyago V. Some domes have already been measured in previous studies by the author and are reported in brackets. The current study describes four domes named as Dubyago V 1-4.


Figure 3: ACT react quick map Terrain Hill shade of the examined domes. Enlarged image.

Wöhler and Lena ${ }^{[5]}$ studied some intrusive domes on lunar surface based on telescope observations and proposed that intrusive domes have low flank slopes (less than $1^{\circ}$ ), large diameters (usually $10-20 \mathrm{~km}$ and can be larger than 30 km ), regular but noncircular outline, and lack summit pits. Besides, tensional features such as faults and linear rilles could be found near the intrusive domes of class In1 ${ }^{[5]}$.


Figure 4: 3D reconstruction of Dub V 1. The vertical axis is 10 times exaggerated.


Figure 5: 3D reconstruction of Dub V 2. The vertical axis is 7 times exaggerated.

The domes Dub V 1, 3 and 4 are not consistent with most of these criteria and may not be intrusive domes, although this possibility cannot be ruled out. It is more likely that these domes are effusive volcanic constructs formed by lava eruptions.

Only Dub V 2 displays an elongated shape with a circularity ( $\mathrm{c}=$ minor axis/major axis) of about 0.7 . A reliable discriminative criterion in the dome classification is the circularity of the dome outline: the putative intrusive domes are elongated and with low slopes $\left(<0.9^{\circ}\right)$. Class In1 comprises large domes with diameters above 25 km and flank slopes of $0.2^{\circ}-0.6^{\circ}$ and have linear or curvilinear rilles traversing the summit. Class In2 is made up by smaller and slightly steeper domes with diameters of $10-15 \mathrm{~km}$ and flank slopes between $0.4^{\circ}$ and $0.9^{\circ}$. Class In3 comprises low domes with diameters of 13-20 km and flank slopes below $0.3^{\circ}{ }^{[3,5]}$.

Hence the dome Dub V 2 would match the properties derived for putative intrusive dome belonging to class In2 and could imply on origin due to a subsurface intrusion of a magmatic body. A similar construct in Mare Undarum (see Fig. 3) named Dubyago 3, has similar morphometric properties as described in ${ }^{[3,4]}$.


Figure 6: 3D reconstruction of Dub V 3. The vertical axis is 7 times exaggerated.


Figure 7: 3D reconstruction of Dub V 4. The vertical axis is 10 times exaggerated.
The derived abundance maps in $\mathrm{wt} \%$ of plagioclase, olivine, clinopyroxene and orthopyroxene created from to-pographically-corrected Mineral Mapper reflectance data acquired by the JAXA Selene/Kaguya are reported in Table 2 and Fig. 8. The $\mathrm{TiO}_{2}$ content of the examined lunar domes is $1-2.2 \mathrm{wt} \%$, while the FeO content varies from $15.9 \mathrm{wt} \%$ to $18.9 \mathrm{wt} \%$. The derived abundance maps in $\mathrm{wt} \%$ of olivine and plagioclase are shown in Fig. 9.

| Feature | $\mathrm{TiO}_{2}$ \% <br> wt | FeO \% <br> wt | CPX \% <br> wt | OPX \% <br> wt | Oliv \% <br> wt | Plag \% <br> wt |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Dub V 1 | 1.1 | 18.9 | 30.5 | 24.4 | 6.8 | 39.1 |
| Dub V 2 | 1 | 16.4 | 27.2 | 16.1 | 10.4 | 46.0 |
| Dub V 3 | 1.1 | 15.9 | 18.6 | 23.8 | 10.1 | 47.2 |
| Dub V 4 | 2.2 | 16.3 | 16.2 | 27.0 | 10.0 | 46.0 |

Table 2. Derived abundance in $w t \%$ of the examined domes derived from topographically-corrected Mineral Mapper reflectance data.

I encourage more high-resolution imagery of these domes, which has been not characterized in the morphometric and spectral properties yet. Further analyses are in progress. Please check also your past imagery and send them to me for the ongoing study (raffaello.lena59@gmail.com).


Figure 8: Mineral Mapper reflectance data acquired by the JAXA Selene/Kaguya. Top abundance in wt\% of clinopyroxene ( $C P X$ ), orthopyroxene ( $O P X$ ), $\mathrm{TiO}_{2}, \mathrm{FeO}$.


Figure 9: Abundance in wt\% of olivine and plagioclase (PLAG).

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## LUNAR GEOLOGICAL CHANGE DETECTION PROGRAM <br> By Tony Cook.

News: There will be a $4^{\text {th }}$ Europlanet Workshop on Fireballs/Lunar Impact Flashes on $12-13^{\text {th }}$ May that is free to attend and completely on-line. If you want to get into lunar impact flash observing then this will be especially useful. You can register and then join from the following web site: https://www.europlanet-society.org/4th-europlanet-workshop-on-fireballs-lunar-impact-flashes/

Brian Cudnik (ALPO Lunar Impact Flash coordinator) has emailed (bmcudnik @ gmail.com) in: "I read in the March issue of Sky \& Telescope magazine an article by Thomas Dobbins about looking for Venus fireballs this summer. The optimal time in the Northern Hemisphere is from June 16 to July 7, when a combination of favorable elongation, large apparent size and fraction of unilluminated/ nightside hemisphere is presented toward Earth. The techniques and technology used for these are similar to those in existing lunar meteor monitoring setup. Please spread the word in the BAA to those who may be interested in videotaping, or visually observing, the night side of Venus during this interval. Also e-mail me at the above address with questions or if you'd like more details. ". Although this is not lunar related, the technology, software and observing is very similar for lunar impact flash work, so it might be worth a go.


Figure 1. The Lunik 5 upper stage rocket possible impact cloud of unspent fuel(?) from a paper by Geake and Mills: Possible Physical Processes Causing Transient Lunar Phenomena Events, Physics of the Earth and Planetary Interiors, 14 (1977) p299-320. Note that the central image is not from this paper but is a subtraction of the $\mathrm{t}=270$ and $\mathrm{t}=30 \mathrm{sec}$ images.

I was contacted by veteran planetary cartographer: Dr Phil Stooke, assistant Professor in Geography at the Center for Planetary and Science Exploration, Western University Ontario, Canada, regarding the Luna 5 Crash site(s) (Fig. 1) mentioned in a previous newsletter: "This concerns the note by Tony Cook regarding a paper by Ksanfomality (2018). The two locations mentioned were said at the time to be different objects. The Lansberg object was the Luna 5 lander. The Mare Nubium object was said (in New Scientist) to be the upper stage of the launch vehicle. The latter is the one with a very large apparent dust cloud. If this is a real observation it suggests to me that a substantial amount of residual propellant was released as the tanks ruptured on impact, creating a vapor cloud which could lift and spread dust, not just a ballistic ejection of dust. We don't really know all the facts, but I think the two objects explain the two locations." I would like to thank Phil for correcting us on this and the TLP description(s) will be updated accordingly.

TLP Reports: After the publication of the April BAA LSC, Walter Elias sent me an email concerning images he took showing Faraday and Apianus craters in March (See Fig. 2 inserts). It caught his attention that despite being dark, reflections can be seen at the base of the craters. He notes that it is as if the wall reflected on the surface of the base. He wondered if this was normal? Just as a check I found a similar illumination image by Maurice Collins (Fig. 2 background).


Figure 2. Apianus and Faraday craters, with contrast enhanced to bring out details in shadowed areas orientated with north towards the top. (Background) Image captured by Maurice Collins (ALPO/BAA/RASNZ) on 2016 Apr 14 UT 07:42. (Top Insert) Apianus crater as imaged by Walter Elias (AEA) on 2023 Mar 28 UT 23:01. (Top Insert) Faraday crater, to the south east of Stöfler, as imaged by Walter Elias (AEA) on 2023 Mar 28 UT 23:03.

Although Maurice's imagery, from a camera era of seven years ago, it confirms the shadows are in the same location, the resolution and contrast are not quite up to what Walter was achieving with his system. In the contrast stretched inserts in Fig. 2 we can see some lighter areas inside the shadows contouring the illuminated rims for Apianus and more so for Faraday. However, it is not just confined to these craters, take a look at Maurolycus, to the east of Faraday, as you can see some detail in the shadow on the inner eastern slopes too. There is a possibility that this lighter shading inside shadows, adjacent to illuminate areas could be an artefact of the image processing being done on the images, as there is evidence for "ringing effects" on bright/dark boundaries. I think that we shall put this onto the "Lunar Schedule" web site and see if we can obtain repeat colongitude images that show the same effect? If so then we will know for sure that its due to scattered light off illuminated rims.

No TLP reports were received for April, though Brazilian amateur Passos Pereira, from João Pessoa, Brazil, videoed a candidate impact flash close to Mare Vaporum at 21:52:19UT on 2023 Apr 22. According to a preliminary analysis by Marcelo Zurita, the location was close to Marco Polo F crater. If anybody was imaging/videoing earthshine at the time, please get in touch.

Additional reports received for February included: Alberto Anunziato (Argentina - SLA) observed: Apianus D, Censorinus, and Ross D. Francisco Alsina Cardinalli (Argentina - SLA) imaged: Aristarchus and its surrounds.

Routine reports received for March included: Alberto Anunziato (Argentina - SLA) observed: Grove. Anthony Cook (Newtown, UK - ALPO/BAA) imaged: several features in the Short-Wave IR, Long Wave IR, and in visible light. Walter Elias (Argentina - AEA) imaged: Apianus, Aristarchus, Faraday. Les Fry (West Wales, UK - NAS) imaged earthshine. Massimo Giuntoli (Italy - BAA) observed: Cavendish E. Michael

Hather (Sheffield, UK - BAA) observed several features. Rik Hill (Tucson, AZ, USA - ALPO/BAA) imaged the surroundings of the Apollo 16 landing site. Jean Marc Lechopier (Teneriffe, Spain - UAI) observed: Aristarchus. Eugenio Polito (Italy - UAI) imaged: Plato and several features. Mark Radice (Swindon, UK BAA) imaged: Clavius, Sinus Iridum, and Tycho. Trevor Smith (Codnor, UK - BAA) observed: Aristarchus, Proclus and Torricelli B. Bob Stuart (Rhayader, UK - BAA) imaged: Alphonsus, Archimedes, Clavius, Longomontanus, Plato, Tycho, Vallis Alpes, and several features. Franco Taccogna (Italy - UAI) imaged: earthshine, the Moon, and several features. Aldo Tonon (Italy - UAI) imaged: the Moon. Luigi Zanatta (Italy UAI) videoed earthshine.

## Analysis of Reports Received:

Correction: Aristarchus: On 2023 Feb 04 UT 02:25 Luis Francisco Alsina Cardinalli (SLA) imaged the crater under similar illumination to the following report:

Aristarchus 1989 Oct 13 UT 21:00 Observed by Cook (Frimley, Surrey, UK, 20cm reflector (visual and video) "Aristarchus had what appeared to be outline of a ghost crater on its eastern side - quite large and bright". Cameron 2006 extended catalog TLP ID No=378 and weight=5.ALPO/BAA weight=3.
N.B. this is a correction to what was reported in the last Lunar Section Circular:


Figure 3. Aristarchus orientated with north towards the bottom. (Left) An image by Luis Francisco Alsina Cardinalli (SLA) taken on 2023 Feb 04 UT 02:25. (Right) A sketch made off the TV screen from video feed from the telescope during a TLP seen by Tony Cook on 1989 Oct 13, after the original visual detection.

The TLP I saw in 1989 was a very interesting one. It was detected visually by myself, and I would like to quote from my report: "On examining Aristarchus my attention was drawn by a very bright blob on the east. This was much brighter than I had ever seen before and was comparable in brightness to the central peak of Aristarchus. Also, a lot of fine detail was seen in and around this blob, including a bright arc to the south east of the crater, (attached to the blob and continued north of this). This was so prominent that it gave the impression that there was a second crater attached to the South East of Aristarchus. I began to set up the CCD video equipment for monitoring of Aristarchus and began operating this at 21:02UT. Unfortunately, the video recorder was in "Play" rather than "Record" mode and this fault was not discovered until sometime later. Successful recordings were obtained at the following times: 22:04-22:08 UT, 22:13:10-22:22:26UT, 22:25:0222:32:12UT. Observations ceased after 22:32UT due to cloud. A drawing of Aristarchus based on the video recordings appears on the next sheet. The bright blob was certainly not as bright on the video than it was at 21:00UT'. The sketch I made by tracing over the TV screen can be seen in Fig. 3 (right). The general appearance is very similar to Luis' image in Fig. 3 (left) in terms of interior detail, though the blob on the east
exterior, in his image, is significantly not as bright as it was in the 1989 visual TLP nor the CCD sketch i.e. much fainter than the central peak in Luis' image. The ghost crater effect that I saw initially visually, had faded by the time the successful video recording was captured and is not at all visible in Luis' image. We shall leave the weight at 3 for now, but it is good that we have a more modern context image.

Correction: Aristarchus: On 2023 Feb 06 UT 02:11 Walter Elias (AEA) imaged the crater under similar illumination and similar topocentric libration (both to within $\pm 1^{\circ}$ ) to the following report:

Aristarchus-Herodotus 1969 Jan 04 UT 03:00-03:45 Observed by Taboada (Mexico) \& Corralitos Observatory (Organ Pass, NM, USA, 24" reflector + Moon Blink) "Brightness increased slightly around Herod. \& cleft (S.V?) became darker than previous day. The dark gray \& pink formed yellowish at $0345 h$ in whole region of Aris. Bluing around crater in Corralitos MB (photos?) (confirm. of activity at Aris.?)" NASA catalog weight=5. NASA catalog ID \#1115. ALPO/BAA weight=3.
N.B. this is a correction to what was reported in the last Lunar Section Circular:


Figure. 4 Aristarchus orientated with north towards the top - a monochrome image taken by Walter Elias (AEA) taken on 2023 Feb 06 UT 02:11

Although Fig. 4 is in monochrome, it nevertheless is a useful context image in that the bright spots, bands, and general shape of Aristarchus and Herodotus are what the craters should have looked like to Taboada in 1969. We shall leave the weight at 3 for now.

Apianus D: On 2023 Feb 27 UT 00:10-00:15 Alberto Anuziato (SLA) observed visually this crater under similar illumination to the following report:

Apianus D On 2011 Oct 03 UT 21:00-21:20 F. Power (Meath, Ireland, 11" SCT) observed changing colours (blue, white, and red) on the inner western rim of this crater. He changed eyepieces and moved the scope around to look at different parts of the Moon, but nowhere else exhibited anything similar. As another test he asked his wife to have a look without telling her what he was seeing. She confirmed the same effect. 5 digital camera images had been taken. Most of these were out of focus and the first one was saturated, however one of them showed an approximately 35 km long, by 11 km wide (at the north) lopsided carrot shaped orange colour to the western rim of Apianus D. No similar strong colour could be seen anywhere else on the image, nor on the other 4 images. This TLP is being given an $A L P O / B A A$ weight of 1 as the Moon was low, but an image taken looks interesting.


Figure 5. A sequence of images (enhanced) of the Apianus D and its surrounds captured by Fran Power (Meath, Ireland) on 2011 Oct 03 sometime during UT 21:00-21:20 UT. North is towards the top.

Alberto, using a Meade EX 105 at x154, reported that no colours were seen and Apianus D looked normal. This is in contrast to the appearance of the crater in Fig 5 ( $4^{\text {th }}$ image from left), but more like the appearance of the craters in the other images in Fig 5. However we still cannot rule out the most likely explanation that it was due to the Moon being low on the horizon - on the other hand, no similar colour was exhibited elsewhere? We shall keep this at a weight of 1 for now.

Plato: On 2023 Mar 02 UT 16:57 Bob Stuart (BAA) imaged the crater under similar illumination and similar topocentric libration to within $\pm 1.0^{\circ}$ to the following report:

Plato 1981 Jun 12: P. Moore at $21: 10$ found the southern wall (and onto the southern floor) of the crater to be indistinct. Elsewhere in the crater everything was sharp. The effect was still seen at 21:42UT, but less strong. A check was made for colour with a Moonblink device, but none was seen. There was still a trace of this effect at 21:44UT, although detail was now becoming visible. By 21:48UT vertical streaks were seen crossing the floor from the obscuration area and these were more visible in the red filter and not in the blue. Cameron comments that undefined patches on the floor of Plato are not normal. By $21: 55 U T$ some craterlets on the floor started to become visible and the TLP for Moore ended by UT22:23. P.Foley was alerted by Moore and saw a "massive dense obscuration on the south wall, south floor and south outer glacis to the Mare". Foley noted that by $21: 50 U T$ the effect was fading and finished by 22:03UT. Foley reported an orange translucent haze covering half of the floor, but floor craterlets could be seen on and off - however his atmospheric seeing conditions were IV. At 22:00 UT Foley reported the floor close to the north wall to be "milky or misty". No detail was visible at 21:15UT and variability in the floor continued until 23:10UT. Hedley-Robinson was alerted at $21: 35 U T$ and found no difference between red and blue views of the area, however he did find that the south rim was indistinct although this effect had lessened by 22:00 UT and was normal by 22:17UT. M. Mobberley saw a white spot on the floor at $21: 20$ UT, whereas he normally would have expected to see craterlets. Mobberley was alerted at $21: 40$ UT and took some colour photos. He also made sketches that showed variability in the floor and dark lines and patches in the north west corner. However the altitude of the Moon was low. Cameron mentions that two of the photos show loss of detail at the south wall and beyond and also a change in the floor markings. The north wall at $21: 50 U T$ was strangely reddish (didn't think this was spurious colour). The rest of the wall was sharp at $22: 20 U T$ through a yellow filter. Large bright patch in the centre and rest of the floor was apparently of the same shading as Mare Imbrium. The above notes are based upon the Cameron 2006 catalog extension TLP ID 145 and weight=4. ALPO/BAA weight=3.


Figure 6. (Left) Shows the view of Plato that Bob Stuart (BAA) took on 2023 Mar 02 at 16:57 UT, orientated with north towards the top. (Right) A simulated atmospheric blurred (1.5 pixels) version.

Bob's image (Fig 6) is one of those, very rare moments in time when both illumination and viewing angles match closely to the original TLP report. One does not have to wait 18.6 years, or the Saros cycle, for this to
happen, due to libration varying depending upon where we view on the Earth's surface, but nevertheless the wait can be several months or even years. Why is this important? Well if there was some form of specular reflection from crystals e.g. exposed semi-parallel mica crystals (unlikely due to space weathering), or refraction from volcanic glass beads, then matching the optical geometry to what it was in 1981 should reproduce the results reported by Patrick Moore and others. As you can see in Fig 6 (Right) the southern rim is indeed indistinct, but so too part of the north eastern rim. The Foley description of obscuration outside the rim on the crater exterior has a ring of truth in it for Fig. 6 (Right), but we cannot say that the southern floor, inside the rim, had an obscured appearance too as all of the floor of Plato looks obscured under poorer seeing.

Other aspects of the 1981 report to consider are the craterlets and shadings on the floor that Moore and others reported. So Fig. 7 (Top Left) in a highly contrast stretched version of Bob's image, in order to bring out such floor detail. I have inverted it with north towards the top so you can compare with three sketches made back in 1981 by Foley, Robinson, Mobberley.

Although the slightly lighter triangular sector on the SW floor of Plato is consistent in all the sketches, there is a fair amount of variability in other features depicted, in particular Peter Foley's location of the floor craterlets (Fig. 7 - Bottom Left) has some geometry issues. The inconsistency in the visual sketches lowers confidence in the reports. I checked the Moon's altitude for the Moore observation and it varies from 32 to 17 degrees above the horizon - the high value at the start should not explain the obscure nature of the southern rim, unless the seeing was bad. In view of the sketch inconsistencies I will lower the weight of this report from 3 to 2 .


Figure 7. Plato orientated with north towards the bottom. (Top Left) A contrast stretched version of an image taken by Bob Stuart (BAA) on 2023 Mar 02 at 16:57 UT. (Top Right) A sketch by Martin Mobberley made on 1981 Jun 12 UT 21:30. (Bottom Left) A sketch by Peter Foley (BAA) made on 1981 Jun 12 sometime between UT 21:15-21:51. (Bottom Right) A sketch by Hedley Robinson (BAA) made on 1981 Jun 12 sometime between UT 21:41-21:53.

Aristarchus: On 2023 Mar 03 UT Jean Marc Lechopier (UAI) observed this crater under similar illumination to the following lunar schedule request:

BAA Request: Is there a bright spot on the west interior wall of this crater? Compare it to other features and note if it varies in brightness over time. Please send all reports or images.

This actually refers to a TLP report from 2006 Feb 09 UT17:45-23:59:

[^3]

Figure 8. Aristarchus as imaged by Brendan Shaw (BAA) on 2009 Feb 09 UT 23:13 and orientated with north towards the top.

Jean Marc commented: "The inner western wall of Aristarchus looks like a sickle of fairly uniform light. Looking more closely, a dark and subtly jagged line divides the sickle into two equal parts from horn to horn of the sickle. That dark line appears as a fault line or as a succession of aligned terraces receiving less sunlight. The black of that line is less dense than Aristarchus' background. In the southwest part (according to the equatorial directions of the telescope) of the inner wall of Aristarchus, in the luminous sickle, a very white spot appears, of a more intense whiteness than the sickle of light. It is resolved as a small crater set in the walls, or rather, as a cavity or indentation in the terraces. It has an elongated shape, parallel to the circular edge of Aristarchus, about twice its width. Its northern part seems wider than its southern part. It is almost in contact with the dark fracture line at a slightly higher altitude. The seeing of the evening did not allow to reach the resolving power of the instrument (0.8"/arc) but the observed detail was perfectly resolved at 300x magnification. At 375x it gained in apparent size without being able to take advantage of it. I estimate its size in three/four arcseconds long and 1.5"/2" wide. Seeing it, I didn't doubt for a moment that it was the object of the $T L P$ as its whiteness stands out with the surrounding areas. A handful of "/arc further south two other particularly white spots were visible, not resolved, very close to each other, at slightly different altitudes from each other but very close to that dark fracture line. One was a little bigger than the other. The southern horn of the sickle of light allowed to see less luminous reliefs, well contrasted and detailed, at the same level as the dark line, with dimensions of a few "/arc. All the observed and transcribed details are undoubtedly accessible to a good l20mm refractor and good seeing. To evaluate the seeing I carefully observed the Gruithuisen Gamma dome, whose surface was rough but $I$ did not see the summit crater."

Fortunately we have images from the night of John Armitage's TLP report, despite the fact that he did not record the UT. One of the images, by Brendan Shaw, is shown in Fig 8. The rim of the crater is a bit overexposed, but it may help to interpret Jean Marc's written description above. In view of the fact that Jean Marc saw a white spot on western wall, I think we shall lower the weight of the 2009 TLP report from 2 to 1 .

Cavendish E: On 2023 Mar 04 UT 21:10 Massimo Giuntoli (BAA) continued his studies of this crater which occasionally can be very bright. On this occasion, using a 10 cm refractor, x312 under Antoniadi III seeing conditions, the crater was perhaps a little brighter than usual, but nothing that Massimo considered as abnormal. Selenographic Colongitude $=62^{\circ}$ and sub-solar longitude $-1.2^{\circ}$. Topographic libration (sub-observer viewing point): $-0.67^{\circ}$ colongitude and $-6.13^{\circ}$ latitude.

Aristarchus: On 2023 Mar 06 UT 20:21-20:32 collectively Franco Taccogna and Aldo Tonon imaged the Moon for the following lunar schedule request:

ALPO Request: Try taking hand held digital SLR telephoto shots of the Moon at an image scale capable of detecting Aristarchus. Do not use the digital zoom feature. What we are attempting to do here is to mimic a report from 2011 where the images showed variations in the brightness of Aristarchus - possibly due to vibrations when pressing the camera shutter? We would like a new set of images, at the same illumination, to check out this theory. All images should be sent to me on the email address below: a tc@aber.ac.uk

I had a look to see what the 2011 report refers to, and it turns out that 2011 was a typographical error and it should read 2009 Sep 03 observation by Barry Gibbs. This I have now corrected for future lunar schedule predictions. So the report referred to was:

On 2009 Sep 03 at UT23:15-23:17 B.Gibbs took some hand held digital SLR images of the Moon (Sky conditions clear). Four images were taken at: 23:14:53, 23:15:59, 23:16:05 and 23:17:23 (uncertainty $+/-15$ sec offset from actual UT). These showed some apparent variation in the brightness of Aristarchus. However there are ways to explain this through image motion blur when the images were taken. However we cannot be absolutely sure. The ALPO/BAA weight=1.

This does not affect the repeat illumination observations sent in, and we can now compare them to the correct 2009 observations. You can see Barry Gibbs image sequence in Fig 9.


Figure 9. The original images taken by Barry Gibbs on 2009 Sep 03 with annotation added by the observer. UTs running from left to right are: 17:17, 17:19, 17:20, 17:21.

For comparison you can see Franco and Aldo's more modern day images in Fig. 10.


Figure 10. The Moon on 2023 Mar 06 UT 20:21 by UAI observers. (Left) Taken by Franco Taccogna using a Nikon D7100 with 300 mm telephoto. (Right) Taken by Aldo Tonon using a Canon EOS 2000D with 400 mm telephoto.

There are lots of ways we can analyse the images, in great depth, or just a glance to get a feel for the image brightness statistics. We will chose the latter. Figure 11 is a plot to compare two sets of images to look for variations which could be due to image resolution, image noise, or positional errors on where we are sampling the digital image brightness (varies from 0 to 255 ). Ideally we would fit a line through these points and any
points that deviate from the line the most are worth looking at in more detail - but I think you can plainly see for the 2009 observation that Aristarchus is an outlier here and for the 2023 observations Proclus has not departed from the diagonal, but has swapped positions, with Tycho and Hell, compared to the 2009 observations.


Figure 11 (Left) A plot of measurements of brightness values of 8 lunar craters from 2009 Sep 03. The Y axis values are from 17:21UT and the X axis values are from 17:17UT. (Right) A plot comparing the brightness of the same 8 lunar craters, taken at the same time of $20: 21 \mathrm{UT}$ on 2023 Mar 06 , with the Y axis measurements from Aldo Tonon's image and the X axis from Franco Taccogna's image.

The real problem of low resolution photometry attempts, with DSLR cameras are issues like camera shake and image resolution on point-like objects. Take a look at Fig. 9 (Right) and Fig. 9 (Far Right). The former has some camera shake and as a result point-like features like Aristarchus appear significantly blurred and lose their peak brightness, where as more extended features like Kepler do suffer extra blurring. Likewise the difference in resolution between a 300 mm and a 400 mm telephoto lens in Fig. 10 (Left and Right) can have a similar effect on point-like features.

I think its appropriate to remove the 2009 report from the ALPO/BAA TLP database - it has been said by Moore, Middlehurst and Cameron that TLP reports using small aperture equipment are a bit more dubious.

Aristarchus: On 2023 Mar 07 UT 20:39 Eugenio Polito (UAI) imaged the Moon under similar illumination and similar topocentric libration to within $\pm 1.0^{\circ}$ to the following report:

On 1978 May 22/23 UT 22:00-00:15 Aristarchus was not normal, but all the following features were: Mare Crisium, Proclus, Sinus Iridium, Grimaldi, and Tycho. Observed by Mellor and Fitton, UK. Observer notes that Aristarchus is brighter than Tycho when normal. Estimated variation was 25\%. However the Moon was low and the Moon was yellow. Despite this the observer decided that the effect was real. Cameron 2006 extension catalog $I D=32$ and weight=2. ALPO/BAA weight=1.

It turns out that the observation was published in p. 55 of the July 1978 BAA Lunar Section circular, and the observer was Lawrence Fitton (not Mellor), using a photoelectric photometer with approximately 7 x 7 km effective coverage footprint on the lunar surface. He recorded Aristarchus as being initially brighter than Tycho, when normally it is less bright at this phase, however later Aristarchus became less bright than Tycho with the variation as discussed above. Figure 12 (Left) shows the appearance before the repeat illumination, and (Right) during the repeat illumination/libration. To the eye Aristarchus looks brighter than Tycho in both images, and maybe brighter in the earlier one - however what we are seeing here are contrast effects with respect to the background. So instead I took some digital number value readings, then normalized them.


Figure 12. The Full Moon on 2023 Mar 07. (Left) As imaged by Franco Taccogna (UAI) at 19:14UT. (Right) As imaged by Eugenio Polito (UAI) at 20:39UT.

In the 19:14 UT image (Fig 12 - Left), Aristarchus has a brightness of 201 and Tycho a brightness of 171. In the 20:39 image, Aristarchus has a brightness of 161 and Tycho a brightness of 149. The background sky in both image has a brightness of 1 . Normalizing the 20:39 image (Fig 12 - Right) to the 19:14 one, using Tycho as a reference would give the 19:14 image an Aristarchus brightness of 184 and a Tycho brightness of 149. Now 184 is about $14 \%$ brighter than what it was at 20:39UT. However this all depends upon where on Aristarchus we do the photometry. Aristarchus, being such a small feature, compared to Tycho presents problems for measuring, and I would quite imagine that back in 1978 it would have been quite tricky to place Aristarchus centrally over the photodiode (or photo transistor) that Lawrence Fitton was using. I think we shall leave the weight at 1 for now as it is not clear that this was an instrumental effect or not, but I suspect the latter. It would have been helpful to have had results from some other observing runs to compare against.

Proclus: On 2023 Mar 27 UT 18:48-19:00 Trevor Smith (BAA) observed visually this crater under similar illumination to the following report:

Proclus: 1985 Apr 25 UT 21:50 M. Cook (Frimley, UK). Almost certainly the following was spurious colour and not a TLP. Proclus was found to be brighter than Censorinus. Red was seen on the northern inner floor and blue on the edge of the external north rim NNE-NW. The rim to the SW could not be seen. ALPO/BAA weight=1.

Trevor, using a 16 inch telescope under Antoniadi III-IV conditions, found that Proclus was much brighter than Censorinus, and the latter seemed to be fainter than what he regarded as usual. No real detail seen inside Proclus due to light sky conditions. No colour seen.


Figure 1.3 Proclus orientated with north towards the bottom. (Left) A sketch by Marie Cook (BAA) made on 1985 Apr 25 UT 21:50. (Right) An image by Walter Elias (AEA) from 2020 Jan 30 UT 23:04.

Fig. 13 (Left) shows the original report. In view of the fact that: Trevor saw Proclus brighter than Censorinus and that matches the original report, the original report was rather specific that it was spurious colour
(atmospheric spectral dispersion (the Moon was at an altitude of $25^{\circ}$ at the time though) and/or chromatic aberration), and a colour image by Walter Elias (AEA) in Fig. 13 (Right) also shows spurious colour roughly in the same place, I think we can safely lower the weight from 1 to 0 and remove it from the ALPO/BAA database of TLP.

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. If in the unlikely event you do ever see a TLP, firstly read the TLP 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 5055681 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 TLP alerts can be accessed on https://twitter.com/lunarnaut.

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Items for the June circular should reach the Director or Editor by the 20th May 2023 at the addresses show below - Thanks!

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[^0]:    * McKim, R (2020) Roland L T Clarckson a Suffolk Astronomer, JBAA, 130 [2] 83-94.

[^1]:    *Meyer, Heather \& Denevi, B.W. \& Robinson, M.S. \& Boyd, A.. (2020). The Global Distribution of Lunar Light Plains From the Lunar Reconnaissance Orbiter Camera. Journal of Geophysical Research: Planets. 125. 10.1029/2019JE006073.
    **https://www.lpi.usra.edu/resources/lunarorbiter/images/preview/4154_h2.jpg

[^2]:    * Sabuwala, Tapan \& Butcher, Christian \& Gioia, Gustavo \& Chakraborty, Pinaki. (2018). Ray Systems in Granular Cratering.

[^3]:    J. Armitage noted a bright spot on the interior west wall that seemed brighter than what they would have expected. unfortunately the precise time of this observation was not recorded so the moon-rise and midnight UT values are used to place a limit on the time of observation. Images by Shaw taken at UT 1754, 18:45 and 23:13 do not exhibit the effect. ALPO/BAA weight=2.

