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Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 62, Number 1, Winter 2020

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Founded in 1947

Dr. Michael D. Reynolds
(See inside for details)

Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 62, No.1, Winter 2020
This issue published in December 2019 for distribution in both portable document format (pdf) and hardcopy format.

This publication is the official journal of the Association of Lunar & Planetary Observers (ALPO).

The purpose of this journal is to share observation reports, opinions, and other news from ALPO members with other members and the professional astronomical community.

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Visit the ALPO online at:
http://www.alpo-astronomy.org

Founded in 1947

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Association of Lunar & Planetary Observers (ALPO)

Founded by Walter H. Haas, 1947

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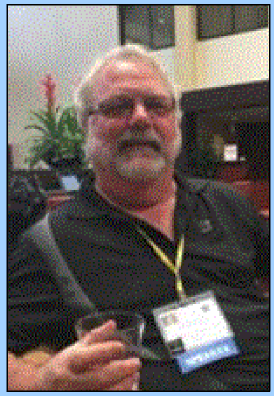
Point of View

In an Emergency, Priorities Change

By Tim Robertson, ALPO Training Section and Podcast coordinator



(Editor's Note: Tim, who resides in California, recently went through a horrific scare involving the brush fires. Here is his account.)

Living in Southern California, I am well aware of natural disasters in the area. I have lived here my whole life and have been in four earthquakes of 6.0 magnitude. Luckily, I survived all of those with only minor damage, except for my nerves. But for the past two years, another not-so-natural disasters have been happening in my area, brush fires. (I say "not-so-natural" because the cause of both fires in my area were the result of poorly maintained power lines). We have a weather condition that occurs in the early fall every year called the Santa Ana Winds. These winds are strong, dry, downslope winds in Southern California and northern Baja California. They're caused by clockwise circulation of air around areas of surface high pressure east of the Sierra Nevada Mountains in the Great Basin region. This year they reached speeds of 60-70 mph- no match for the power line infrastructure that hasn't been maintained in years. In addition, the humidity levels were in the single digits.

This takes me to the early morning of October 30, 2019. I woke up at 5:30 am to get ready to head to work, and for some reason, I felt the urge to look out the window, something I never do. I was shocked to see the entire mountain behind my home totally engulfed in flames.

At this time, my wife was safely 100 miles away enjoying her recent retirement in our brand-new travel trailer. So I quickly FaceTimed her, showing her the flames and told her that an evacuation order was sent out over our cell phones to get out now.

Now the thought hit me- what do I pack? I figured I had 15 minutes to get out. I grabbed a large suitcase, threw in some clothes and prescription bottles, ran to my wine cellar and got five bottles of my most expensive wines, and then I stopped and looked at my telescopes…… these all can be easily replaced. In a panic, I grabbed my eyepiece case, my Cass/Mak tube assembly -- then I realized that I should take the external drives for my home computer. After unplugging those, I put everything into my truck and headed out…. Where, I did not know.

(See "Dr. Michael D. Reynolds March 30, 1954 – October 15, 2019" on page 22.)

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News of General Interest

Our Cover: Dr. Michael Reynolds

This issue's front cover features beloved ALPO member Mike Reynolds (as we referred to him) just where he was most happy — at a telescope, in this case, the Chabot Observatory's 8-inch Alvan Clark and Sons refractor, donated to the city of Oakland by Anthony Chabot in 1883. Dr. Reynolds passed away on October 15 due to a heart ailment. See comments from others beginning on page XX of this Journal.

Staff Updates

Incoming

We are pleased to publish the following announcement by ALPO Executive Director Julius Benton: "Effective immediately (Thursday, December 12), I am appointing you Acting Coordinator of the ALPO Eclipse Section and the ALPO Mercury/Venus Transit Section. Congratulations and welcome aboard. I look forward to working with you."

Keith was previously acting assistant coordinator of both sections. This appointment fills the openings created with the passing of Dr. Mike Reynolds, who died in October. All new appointees to coordinator and assistant coordinator start as "acting" status until the board of directors votes to make the appointment permanent after a reasonable time.

Some background on Keith in his own words: "I am currently a student at Florida State College at Jacksonville (Florida) in the process of obtaining my bachelor's degree and in the future, a doctorate in Astrophysics. One day I hope to work for NASA in data analytics. I learned about the ALPO through my mentor and good friend, Dr. Mike Reynolds. I had the honor to work directly with Dr. Reynolds for a number of years in his classrooms, community outreach projects, and with the ALPO. It is my goal to run the Eclipse and Transit Sections in a way that would make him proud.

"In my spare time, I enjoy creating solar system computer simulations to better understand orbital dynamics, as well as practicing astrophotography on clear nights."

Keith Spring, acting coordinator of the ALPO Eclipse Section and the Mercury/Venus Transit Section.

Keith is currently at work on assembling a report about the November 11, 2019 Mercury transit for publication in this Journal. The Transit Section will then be dormant for quite a while since the next Mercury transit won't occur until November 13, 2032 and the next Venus transit won't occur until December 11, 2117.

The Eclipse Section, however, should remain active with solar and lunar eclipses occurring far more frequently.

All of us in the ALPO wish Keith much success with his new duties in our organization.

Outgoing

Due to increased demands at his regular job, ALPO Solar Section Assistant Coordinator Richard Gossett has resigned his position of managing the Yahoo Group for our Solar Section.

Theo Ramakers, also an assistant Solar Section coordinator will now oversee that responsibility.

We are sorry to lose Richard and hope that he remains a solar observer.

Additions to the ALPO Website

The following documents are now available for inspection and downloading from the ALPO website homepage:

- The ALPO Bylaws (ALPO_BYLAWS_120719.pdf)

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- The ALPO Standing Rules for Staff Management (ALPO_Standing_Rules_Staff_Management_120719)
- The ALPO Staff Guidelines (ALPO_Staff_Guidelines_3rd_Edition.pdf
- The ALPO Board Guidelines (ALPO_Board_Guidelines_052202)

Please address any questions about these documents to the ALPO Membership Secretary Matt Will, eemail to matt.will@alpo-astronomy.org

Call for JALPO Papers

The ALPO encourages its membership to submit written works (with images, if possible) for publication in this Journal.

As with other peer-reviewed publications, all papers will be forwarded to the appropriate observing section or interest section coordinator.

Thus, the best method is to send them directly to the coordinator of the ALPO section which handles your topic.

A complete list of ALPO section coordinators and their contact information can be found in the *ALPO Resources* section of this Journal.

ALPO Interest Section Reports

ALPO Online Section

Larry Owens, section coordinator
Larry.Owens@alpo-astronomy.org

Follow us on Twitter, "friend" us on FaceBook or join us on MySpace.

To all section coordinators: If you need an ID for your section's blog, contact Larry Owens at larry.owens@alpo-astronomy.org

For details on all of the above, visit the ALPO home page online at www.alpo-astronomy.org

Computing Section

Larry Owens, section coordinator
Larry.Owens@alpo-astronomy.org

On Wednesday, November 13, the ALPO board of directors voted by

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teleconference to officially retire the ALPO Computing Section and its associated Yahoo email discussion group. According to ALPO Secretary Matt Will, that section mainly focused on software development since its creation in July 1993 but it has been dormant (unused) for many years, even though it has been continuously listed in this Journal.

ALPO Online Section Coordinator Larry Owens has retrieve the files previously uploaded to the Computing Section Yahoo group and will make them available to all on the ALPO website.

The ALPO has tried in the past to reinvigorate other dormant programs, but with no success.

Articles about astronomically oriented software and hardware of interest to ALPO members should be sent to Larry Owens at *Larry.Owens@alpo-astronomy.org* for peer review so they can be published in the ALPO Journal.

Lunar & Planetary Training Program & 'Observers Notebook' Podcasts

Report by Tim Robertson, section coordinator
cometman@cometman.net

ALPO Lunar & Planetary Training Program

The ALPO Training Program currently has four active students at various stages of the program, an increase of one from my last quarterly report.

The ALPO Lunar & Planetary Training Program is a two-step program, and there is no time requirement for completing the steps. I have seen that those students who are motivated usually complete the steps in a short amount of time. The motivation comes from the desire to improve their observing skills and contribute to the pages of the Journal of the ALPO.

This program is open to all members of the ALPO, beginner as well as the expert observer. The goal is to help make members proficient observers. The ALPO revolves around the submission of astronomical observations of members for the purposes of scientific research. Therefore, it is the responsibility of our organization to guide prospective contributors toward a productive and meaningful scientific observation.

The course of instruction for the Training Program is two tiered:

- The first tier is the "Basic Level" and includes reading the *ALPO Novice Observers Handbook* and mastering the fundamentals of observing. These fundamentals include performing simple calculations and understanding observing techniques.
- When the student has successfully demonstrated these skills, he or she can advance to the "Novice Level" for further training where one can specialize in one or more areas of study. This includes obtaining and reading handbooks for specific lunar and planetary subjects. The novice then continues to learn and refine upon observing techniques specific to his or her area of study and is assigned to a tutor to monitor the novice's progress in the Novice Level of the program.

When the novice has mastered this final phase of the program, that person can then be certified to "Observer Status" for that particular field.

For more information on the ALPO Training Program, contact Tim Robertson at 195 Tierra Rejada Rd #148, Simi Valley CA, 93065; email to *cometman@cometman.net*

'Observers Notebook' Podcasts

The Observers Notebook podcast is going strong. I have recorded over 85 podcasts with various members of the ALPO, mostly section coordinators to highlight the programs within each section. The length of the podcast averages around 30 minutes in length. The longest podcast thus far is over 1 hour and 30 minutes — but there is no time limit and the hosting service has unlimited space available for podcasts

Here are a few interesting statistics you might be interested in:

- Number of downloads as of October 31, 2019: 33,000+
- Number of subscribers (all formats): 220+
- Average of number daily downloads (last 3 months): 75
- iTunes rating: 5 Stars!
- Locations of most downloads are the USA, the United Kingdom, Canada, Australia, Germany and France.
- The Top Three most downloaded podcasts so far are "All About Comets with Carl Hergenrother"!

The most recent podcasts that now online include a profile from ALPO Jupiter Coordinator Craig MacDougal,

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an interesting conversation with ALPO Solar Section coordinator Rik Hill and updates on the expected comets for 2020 with Comets Section Coordinator Carl Hergenrother.

It takes a great amount of time and money to make and produce these podcasts, thus far it has been done with the help of a service called Patreon. We currently have five supporters - two of whom are NOT even members of the ALPO!

You can support the podcast by giving as little as $1 a month; for $5 you receive early access to the podcast before it goes public; for a monthly donation $10 you receive a copy of the *Novice Observers Handbook*; and for $35 a month you receive producer credits on the podcast and a years membership to the ALPO. You can help us out by going to the link below:

https://www.patreon.com/ObserversNotebook

If you have a topic that you would like to hear on the podcast, please drop me a note. I would like to have a discussion on the use of color filters for planetary observing, and another on how you plan an evening observing session. If any of you would be interested in discussing those subjects please let me know.

I am also looking for member profile pieces where we get to know the members of the ALPO.

The podcast will also be used to “get the word out” on any breaking astronomy news or events happening in the night sky. So let me know if you have any breaking news that you want out there.

You can hear the podcast on iTunes, Stitcher, iHeart Radio, Amazon Echo, and Google Play just search for *Observers Notebook*. You can also listen to them at the link below:

https://soundcloud.com/observersnotebook

The *Observers Notebook* is also on Facebook – just search for “Observers Notebook” in the search field on top.

Podcasts are released on the 1st and 15th of every month, and if you subscribe to it via iTunes it will automatically be downloaded to your device.

Thanks for listening!For more information about the ALPO Lunar & Planetary Training Program or the *Observers Notebook*” podcasts, contact Tim Robertson at195 Tierra Rejada Rd #148, Simi Valley CA, 93065; email to cometman@cometman.net

ALPO Observing Section Reports

Eclipse Section

Keith Spring, section acting coordinator
star.man13@hotmail.com

January 2019 Total Lunar Eclipse

We are still accepting reports on the 20-21 January 2019 total lunar eclipse.

Please continue to send your reports via either email or regular mail to the contact information in the *ALPO Resources* section of this Journal.

Visit the ALPO Eclipse Section online at www.alpo-astronomy.org/eclipseblog

Upcoming Eclipses

Look forward to the following:

Mercury / Venus Transit Section

Keith Spring, section acting coordinator
star.man13@hotmail.com

Update: Transit of Mercury 11 November 2019

Please send your observing reports for the November 11 event to Keith Spring, 2173 John Hart Circle, Orange Park, FL 32073; star.man13@hotmail.com

Future Transits of Mercury 13 November 2032

While the next transits of Mercury are November 13, 2032 and November 7, 2039. the next Mercury transit that really favors even more observers in the western hemisphere won’t occur until May 7, 2049.

Also, if you are calendaring future transits, please include the next Venus transit on 10-11 December 2117.

Visit the ALPO Mercury/Venus Transit Section online at www.alpo-astronomy.org/transit

Meteors Section

Report by Robert Lunsford, section coordinator
lunro.imo.usa@cox.net

The year 2019 will not be remembered as one of the better years for meteor observing. There was bright moonlight interfering with nearly every major annual shower this year. We can all look forward to 2020, as the case is just the opposite with nearly every major annual shower free of moonlight. Now we just hope the weather cooperates!

Thanks to some helpful suggestions from Theo Ramakers, assistant coordinator of the ALPO Online Section, there have been improvements to the webpage of the ALPO Meteors Section. You will now find up-to-date articles and information on meteor activity as soon as you enter the site and not buried behind static presentations as before. Many thanks to Theo for the help!

Wishing observers all the best in 2020!

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Visit the ALPO Meteors Section online at www.alpo-astronomy.org/meteorblog/ Be sure to click on the link to viewing meteors, meteor shower calendar and references.

Meteorites Section

Report by Dolores H. Hill, section coordinator
dhill@lpl.arizona.edu

Section News

This report includes meteorite highlights and new meteorite approvals from the Meteoritical Society's Nomenclature Committee for the period August 16, 2019 to October 31, 2019.

The ALPO Meteorite Section received inquiries about suspected meteorites and rocks suspected to be meteorites from known fall areas. They are terrestrial and do not require further analysis.

As always, ALPO members who collect meteorites are encouraged to report unusual features in their meteorite samples that might be of interest to researchers for specialized analysis.

Impact Studies

Randy Tatum continues to investigate both known terrestrial impact craters and suspected ones. He recently visited eight impact craters including three in Canada and the Kentland, Indiana (USA) quarry. See photos of the Sudbury impact structure in Canada: Figure 1 is an excellent example of a pseudotachylite in a brecciated rock where rock was transformed into glassy veins by friction during the impact event and injected into the surrounding country rock. Figure 2 shows impact shattercones in situ. They are definitive markers for meteoroid impacts. The shock radiates from a point and spreads out into a cone-shaped feature. In addition to crater site examination, as part of his field studies, Randy obtains thin sections of rocks from suspected impact craters in search of shocked minerals which can be identified using a microscope.

Meteorite News

Noteworthy meteorites approved or updated during this period include the H5 meteorite Oued Sfayat (Algeria), a witnessed fall on May 16, 2019 and three historical falls with updated information: Barcelona (Spain) classification was corrected to L5 and updated locations for the Ohaba (H5) and Mezo-Madaras (L3.7) chondrites found in Romania in the mid-1800s. Oued Sfayat was witnessed by shepherds who felt a shock wave when it exploded. They recovered the first 80-gram stone the next day. Over the next few months,

(Above left) Located in the Sudbury impact structure in Canada, this is an excellent example of a pseudotachylite in a brecciated Earth rock. The rock was transformed into black glassy veins by friction during the impact event. It is interesting to note that pseudotachylites are seen in brecciated meteorites, too, providing insight into the history of collisions on their parent asteroids.
(Above right) Impact shattercones are definitive markers for meteoroid impacts. The shock radiates from a point and spreads downward creating a solid cone-shaped feature (not to be confused with "cone-in-cone" formations that look like small, stacked cornucopias). The shattercones in this rock were formed during the Sudbury impact. *Both images by Randy Tatum.*

a total of 6 kg were recovered by several individuals.

The *Meteoritical Bulletin* records officially recognized, classified meteorites of the world's inventory. As of October 15, 2019, it contains a total of 61,958 meteorites. There were 627 new meteorites approved, reclassified or discredited, most from desert regions. Some entries corrected or updated information on already known meteorites.

Newly approved meteorites include 457 ordinary chondrites (114 H, 144 L, 199 LL); 1 E4; 3 EH; 12 EL; 47 carbonaceous chondrites (12 CK, 16 CM, 10 CO, 9 CV); 5 R chondrites; 9 irons; 3 acapulcoites; 3 achondrites; 2 angrites; 2 brachinites, 1 lodranite, 8 mesosiderites; 3 pallasites, 12 ureilites; 43 HEDs; 9 Lunar; 6 Martian; 1 winonaite. More information and official details on particular meteorites can be found at: *https://www.lpi.usra.edu/meteor/metbull.php*

Visit the ALPO Meteorites Section online at *www.alpo-astronomy.org/meteorite/* for a very detailed explanation of all facets of meteorite studies.

Comets Section

Report by Carl Hergenrother, section coordinator
carl.hergenrother @ alpo-astronomy.org

The year 2020 is predicted to be a slow one for bright comets. While the total number of bright comets this year may be low, at least one will be easily visible during the first half of the year. Long-period comet C/2017 T2 (PANSTARRS) should be brighter than 10th magnitude and well-placed for northern observers through August. As 2020 begins, C/2017 T2 will be around magnitude 9.4 and slowly brighten to 8.6 by the end of March. It will be a northern circumpolar object as it moves through Perseus and Cassiopeia and is best observed during the evening sky. The comet may ultimately peak in brightness in May between magnitude 8.0 and 8.5. At that time, the comet will be at perihelion (May 4 at 1.62 au) and closest approach to Earth (May 27 at 1.66 au).

So far, the most exciting comet story of 2020 is the discovery of the first confirmed interstellar comet. 2I/2019 Q4 (Borisov) was discovered on August 30 by amateur Gennady Borisov with his home-built 0.65-m f/1.5 astrograph at MARGO observatory near Nauchnij, Crimea. It reaches perihelion on December 8 at 2.01 au on its very hyperbolic orbit (eccentricity = 3.35!). At discovery, the comet was 17th magnitude and should start 2020 near its peak brightness of 15th magnitude, though it will primarily be a southern object by this time. While a very difficult object for visual observers, CCD imagers are encouraged to monitor this unprecedented object.

Ephemerides for Comet C/2017 T2 (PANSTARRS) and Comet 2I/2019 Q4 (Borisov)

Date	R.A.	Decl.	r (au)	d (au)	Elong (deg)	m1	Const	Max El 40N	Max El 40S
C/2017 T2 (PANSTARRS)									
2020 Jan 01	03 25.4	+55 12	2.30	1.52	131	9.4	Per	75	0
2020 Jan 11	02 56.4	+56 28	2.21	1.54	120	9.3	Per	73	0
2020 Jan 21	02 33.4	+57 15	2.13	1.58	110	9.2	Per	73	0
2020 Jan 31	02 17.4	+57 54	2.05	1.62	100	9.1	Per	68	0
2020 Feb 10	02 08.4	+58 42	1.97	1.67	92	9.0	Per	62	0
2020 Feb 20	02 05.8	+59 49	1.90	1.71	85	8.9	Cas	55	0
2020 Mar 01	02 09.1	+61 20	1.83	1.74	79	8.9	Cas	49	0
2020 Mar 11	02 18.3	+63 18	1.78	1.76	74	8.8	Cas	45	0
2020 Mar 21	02 34.0	+65 42	1.73	1.77	70	8.7	Cas	41	0
2020 Mar 31	02 59.0	+68 29	1.68	1.77	68	8.6	Cas	39	0
2I/2019 Q4 (Borisov)									
2020 Jan 01	12 05.5	-36 01	2.08	1.94	83	15.3		14	56
2020 Jan 11	12 19.8	-42 54	2.14	1.97	86	15.4		7	65
2020 Jan 21	12 32.7	-49 06	2.23	2.01	89	15.6		1	71
2020 Jan 31	12 43.4	-54 30	2.34	2.07	92	15.8		0	73
2020 Feb 10	12 51.6	-59 04	2.45	2.15	95	16.1		0	71
2020 Feb 20	12 56.4	-62 48	2.59	2.24	99	16.3		0	67
2020 Mar 01	12 57.6	-65 43	2.73	2.33	102	16.6		0	64
2020 Mar 11	12 55.1	-67 50	2.88	2.43	106	16.9		0	62
2020 Mar 21	12 49.7	-69 12	3.04	2.54	110	17.2		0	61
2020 Mar 31	12 42.8	-69 53	3.20	2.66	114	17.5		0	60

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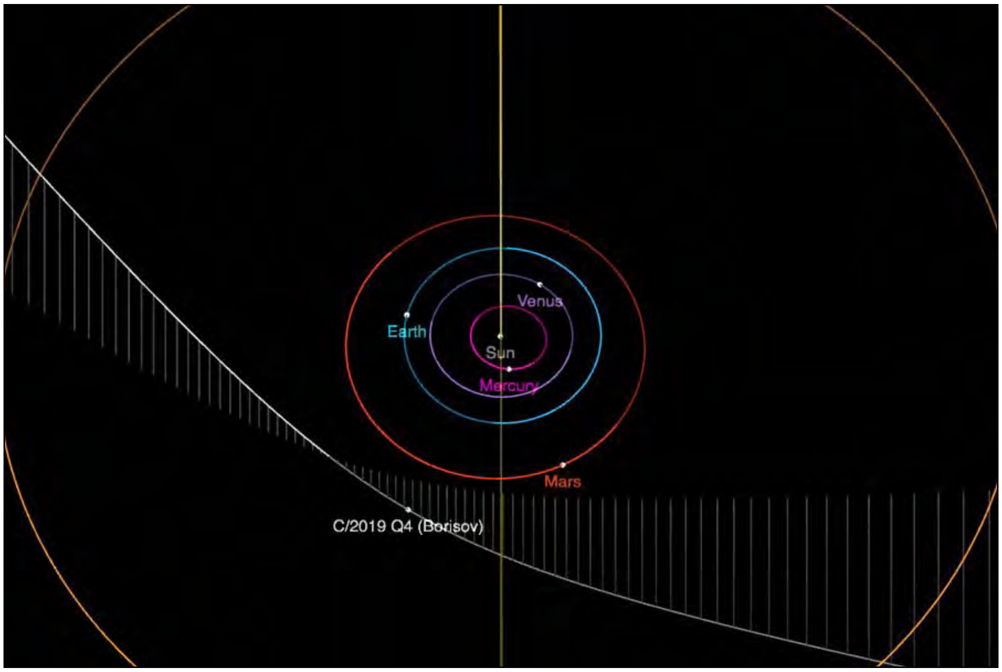

The path of interstellar comet 2I/Borisov is shown as it moves through the inner solar system. The location of Borisov and the planets are valid for 2019 December 8.6 UTC, the time of perihelion for Borisov. The diagram was created using the JPL Small-Body Database Browser.

There is no doubt that 2I/Borisov is a comet as it possesses a definite coma and tail, unlike 'Oumuamua, the first confirmed interstellar object. While some have surmised the presence of cometary activity from 'Oumuamua due to a measured acceleration from non-gravitational forces, no cometary activity was directly detected. Professional studies are in their early stages, but some results have already been published for 2I/Borisov on the publicly viewable arXiv e-Print archive (https://arxiv.org). These results include the definite detection of cyanide [CN] (https://arxiv.org/abs/1909.12144) and tentative detections of diatomic carbon [C2] (https://arxiv.org/abs/1910.03222) and daughter species produced by the photodissociation of water [O I & OH] (https://arxiv.org/abs/1910.12785 and https://arxiv.org/abs/1910.09078).

The relative ratios between these gas species are in line with those seen for long-period comets in our solar system. This is certainly just the beginning and more amazing observations of this intriguing object will be made in the coming months.

Image caption: The path of interstellar comet 2I/Borisov is shown as it moves through the inner solar system. The location of Borisov and the planets are valid for 2019 December 8.6 UTC, the time of perihelion for Borisov. The diagram was created using the JPL Small-Body Database Browser.

As always, the Comet Section is happy to receive all comet observations, whether images, drawings, magnitude estimates, and even spectra. Please send your observations via email to carl.hergenrother@alpo-astronomy.org

Drawings and images of current and past comets are being archived in the ALPO Comets Section image gallery at http://www.alpo-astronomy.org/gallery/main.php?g2_itemId=4491

Visit the ALPO Comets Section online at www.alpo-astronomy.org/comet

Solar Section

Report by Rik Hill, section coordinator & scientific advisor
rhill@lpl.arizona.edu

See also the papers "An Analysis of the Transition From Solar Cycle 24 to Solar Cycle 25" and "A Report on Carrington Rotations 2216 through 2220" later in this Journal.

Though solar activity has become extremely low with around 70% of the days spotless, still the activity of the ALPO Solar Section is good. This Solar Activity Report had plenty of observations to draw on! A couple members have fallen off, but this is to be expected at solar minimum as past solar minimums have taught us.

Assistant Coordinator Theo Ramakers has been diligent in pursuing potential Cycle 25 spots with great success. He reports the following:

The two graphs that accompany this report were made from my data regarding the reverse polarized areas which covers the time period from December 2016 till to date.

I measured the location on the Sun using *WinJupos* software for every observation identified, and made two graphs. Table 1 shows the latitude of every area by date, while the second table shows the location on the Sun by latitude and longitude. In terms of frequency, the distribution by degrees latitude is as shown in Table 1:

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Table 1

Latitude From	Latitude To	No. Active Regions
-90^{0}	-60^{0}	0
-60^{0}	-30^{0}	6
-30^{0}	0^{0}	35
0^{0}	$+30^{0}$	24
$+30^{0}$	$+60^{0}$	12
$+60^{0}$	$+90^{0}$	0

As for the distribution in degrees longitude, Table 2 shows the following results (top line: number of occurrences, second and third line show "between" degrees longitude.

Table 2

Longitude From	Longitude To	No. Active Regions
0^{0}	60^{0}	19
60^{0}	120^{0}	13
120^{0}	180^{0}	14
180^{0}	240^{0}	10
240^{0}	300^{0}	13
300^{0}	360^{0}	8

If we can read anything in these numbers, it is that the southern hemisphere shows a larger number of "micro" reverse polarized areas than the northern hemisphere. (41 versus 36)

We also see a larger number of these areas on one side of the Sun, namely the area between the 0° longitude and 180° degrees longitude. (46 vs. 31)

We need to keep in mind that we only have seen two reverse polarized areas, which have evolved into named Active Regions during this period.

The report on the ALPO Solar Section website is up to date through 10/23/2019. *http://www.alpo-astronomy.org/solarblog/wp-content/uploads/2019/04/2019-04-xx-RevPolarized.pdf* .

I wish to thank our observers and the NASA's Solar Dynamics Observatory website, whose images have been used in addition to the submissions to the ALPO-Archive for this ongoing analysis.

To join the Yahoo Solar ALPO e-mail list, please go to *https://groups.yahoo.com/neo/groups/Solar-Alpo/info*

For information on solar observing – including the various observing forms and information on completing them – go to *www.alpo-astronomy.org/solar*

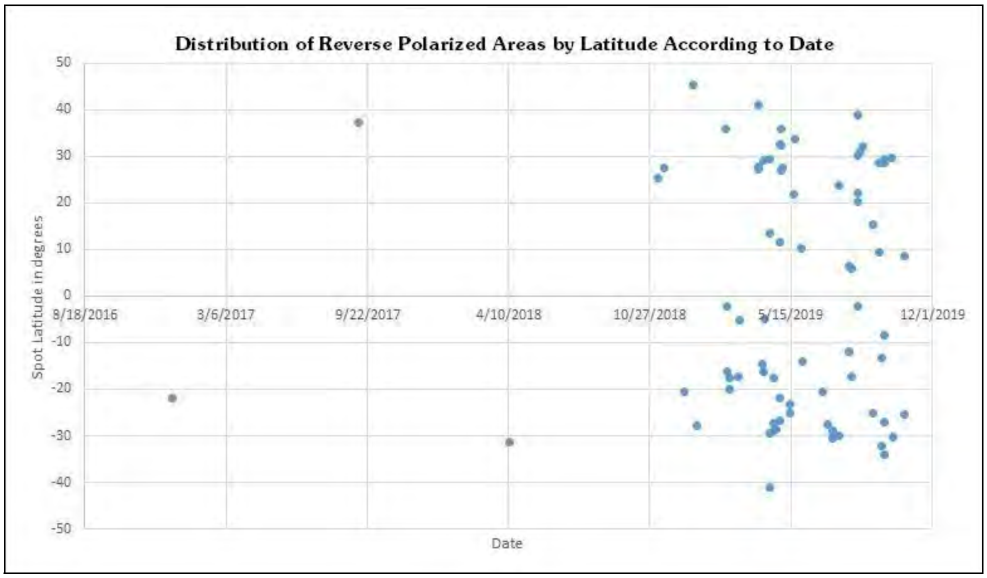

Figure 1

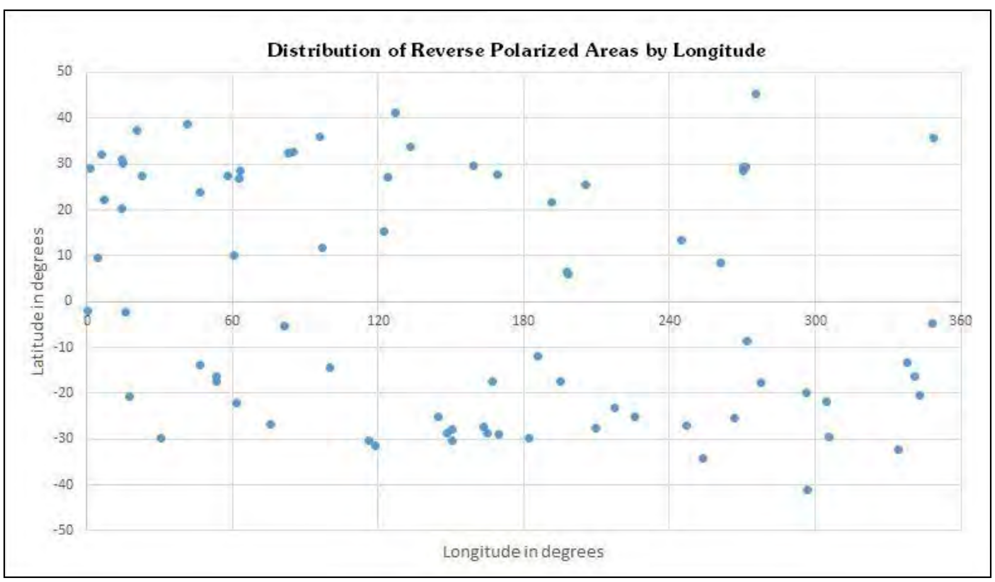

Figure 2

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Mercury Section

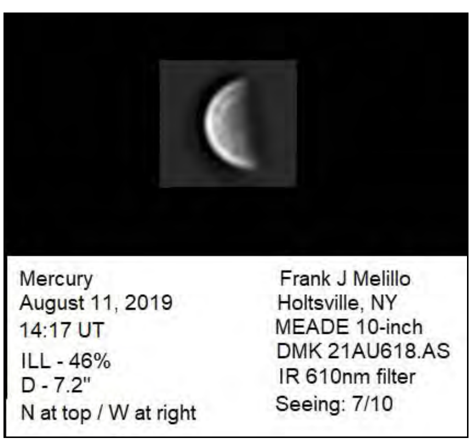
Report by Frank J. Melillo, section coordinator
frankj12@aol.com

By the time you read this, Mercury will be displaying the finest morning apparition of the year. I am hoping some of you will take advantage of this tiny planet that is easily visible in the morning twilight.

I also hope that many of you saw the transit of Mercury on November 11. We are very lucky that there were two transits just 3 ½ years apart that were visible from the same region. Some other times, the transits are many, many years apart. There will be reports of this transit in the near feature.

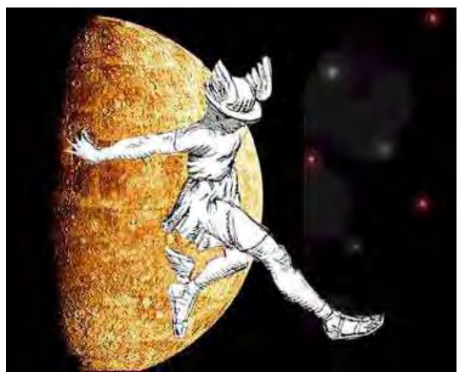
Also, Mercury had its second-best morning apparition last August. I took some fine images in broad daylight when Mercury was nearly 70 degrees above the southern horizon! On August 11, Mercury displayed a fat crescent with a bright-rayed crater near the terminator (Figure 1). Our new member, Michel Deconinck of France, also sent in some of his Mercury sketches.

Looking ahead into early 2020, Mercury will lose its visibility in the morning twilight during the start of the new year, but will once more become an evening object by the end of January. Venus will shine brightly above Mercury throughout the whole evening apparition. On January 27, the thin crescent Moon will lie between Mercury and Venus. It should be a fine sight with the naked eye after sunset.



Mercury as imaged by Frank Melillo. Note bright crater near center. See image for details.

Mercury Needs You!!



More correctly, the ALPO Mercury Observing Section needs you.

Your reports — no matter how sparse they may be — are indeed valuable for scientific research.

Our professional-amateur collaboration activities are getting stronger and we need you to keep the movement going!

During the first three weeks of February, Mercury will shine its full glory about an hour after sunset. On February 10, it will reach the greatest western elongation at 18 degrees west of the Sun. By month's end, Mercury will slowly fade out of view. We always appreciate receiving your observations, so please, send them in!

Please be sure to send your observation reports to the Mercury Section so we can have nice coverage of these apparitions and especially the November 11 transit.

Visit the ALPO Mercury Section online at www.alpo-astronomy.org/mercury

Venus Section

Report by Julius Benton, section coordinator
jlbaina@msn.com

Venus became visible in the western sky just before sunset during the months leading into the fall season of 2019, and is now becoming more favorably placed for viewing this winter, reaching Greatest Elongation East of 46.1° on March 24, 2020.

Venus will be passing through its waning phases (a progression from a nearly fully illuminated disk to various crescent phases). Thus, observers are now witnessing the leading hemisphere of the planet as it increases its apparent diameter at the time of sunset on Earth. Venus is predicted to reach theoretical dichotomy (half phase) on March 27th and then subsequently attain its greatest illuminated extent by April 28, 2020 at visual magnitude -4.6.

Venus will reach Inferior Conjunction with the Sun on June 3, 2020, thereby ending the Eastern (Evening) Apparition.

The accompanying table of Geocentric Phenomena in Universal Time (UT) are

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presented for the convenience of observers for the 2019-20 Eastern (Evening) Apparition.

As of the date of this report, observers are already underway starting to make visual drawings in integrated (unfiltered) light and with color filters, as well as performing digital imaging of the planet UV and near IR wavelengths.

Readers of this Journal should be familiar with our continuing collaboration with professional astronomers as exemplified by our sharing of visual observations and digital images at various wavelengths during ESA's *Venus Express* (VEX) mission that ran for about nine years from 2006 until the mission ended in 2015. It remains as one of the most successful Pro-Am efforts to date involving ALPO Venus observers around the globe. Such observations will remain important for further study and will continue to be analyzed for several years to come as a result of this endeavor. For reference, the VEX website is

For reference, the VEX website is *http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=38833&fbodylongid=1856.*

A follow-on collaborative Pro-Am effort remains underway this apparition in support of Japan's (JAXA) *Akatsuki* mission that began full-scale observations starting back three years ago during April of 2016. The website for the *Akatsuki* mission is currently active so interested and adequately equipped ALPO observers can still register and start submitting images if they have not already done so. More information will be provided on the progress of the mission in forthcoming reports in this Journal.

It is extremely important that all observers participating in the programs of the ALPO Venus Section always first contribute their observations to the ALPO Venus Section at the same time submittals are sent to the Akatsuki mission.

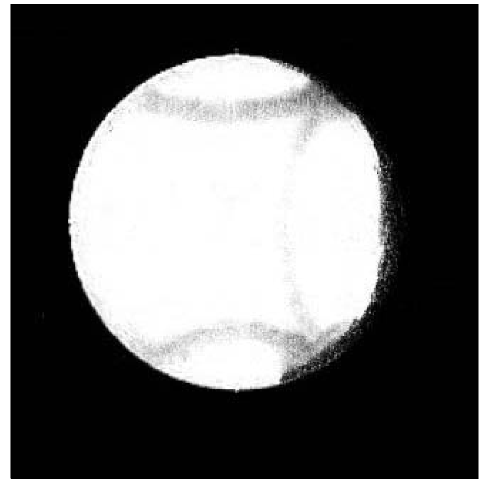
This will enable full coordination and teamwork between the ALPO Venus Section and the *Akatsuki* team in collection and analysis of all observations whether they are submitted to the *Akatsuki* team or not. If there are any questions, please do not hesitate to contact the ALPO Venus Section for guidance and assistance.

Those still wishing to register to participate in the coordinated observing effort between the ALPO and Japan's (JAXA) *Akatsuki* mission should utilize the following link:

https://akatsuki.matsue-ct.jp/

The observation programs of the ALPO Venus Section are listed on the Venus page of the ALPO website at *http://www.alpo-astronomy.org/venus* as well as in considerable detail in the author's *ALPO Venus Handbook* available from the ALPO Venus Section as a pdf file.

Observers are urged to attempt to make simultaneous observations by performing digital imaging of Venus at the same time and date that others are imaging or making drawings of the planet at visual wavelengths. Regular imaging of Venus in both UV, near-IR and other wavelengths is important, as are visual numerical relative intensity estimates and reports of features seen or suspected in the atmosphere of the planet (e.g., dusky atmospheric markings, visibility of cusp caps and cusp bands, measurement of cusp extensions, monitoring the Schröter phase effect near the date of predicted dichotomy, and looking for terminator irregularities).



Detlev Niechoy of Göttingen, Germany submitted this full disk drawing of Venus in integrated light (no filter) at 08:38UT on June 18, 2019 using his 20.8 cm (8.0 in.) SCT under fair seeing conditions at 163X. The drawing depicts no obvious dusky atmospheric markings other than a curious narrow dusky streak extending from N to S on the disk. Both cusp caps and cusp bands are sketched on the drawing. The apparent diameter of Venus is 10.2", phase k=0.963 (96.3% illuminated), and visual magnitude -3.7. South is at the top of drawing.

Routine use of the standard ALPO Venus observing form will help observers know what should be reported in addition to supporting information such as telescope aperture and type, UT date and time,

Geocentric Phenomena of the 2019-20 Eastern (Evening) Apparition of Venus in Universal Time (UT)

Superior Conjunction	2019 Aug 14^d 00^h UT (angular diameter = 9.7″)
Greatest Elongation East	2020 Mar 24^d 00^h UT (46.1°)
Theoretical Dichotomy	2020 Mar 27.04^d UT (Venus is predicted to be exactly half phase)
Greatest Illuminated Extent	2020 Apr 28^d 00^h UT ($-4.6m_v$)
Inferior Conjunction	2020 Jun 03^d 00^h UT(angular diameter = 58.3″)

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magnifications and filters used, seeing and transparency conditions, etc. The ALPO Venus observing form is located online at:

http://alpo-astronomy.org/gallery3/var/albums/Publications-Section/Observing-Section-Publications/Venus/VenusReportForm.pdf?m=1521162039

Under favorable circumstances during future apparitions, Venus observers should monitor the dark side of Venus visually for the Ashen Light and use digital imagers to capture any illumination that may be present on the planet as a cooperative simultaneous observing endeavor with visual observers. Also, observers should undertake imaging of the planet at near-IR wavelengths (e.g., 1,000nm) the time of inferior conjunction, whereby the hot surface of the planet becomes apparent and occasionally mottling shows up in such images attributable to cooler dark higher-elevation terrain and warmer bright lower surface areas in the near-IR.

Individuals interested in participating in the programs of the ALPO Venus Section are encouraged to visit the ALPO Venus Section online *http://www.alpo-astronomy.org/venusblog/*

Lunar Section

Lunar Topographical Studies / Selected Areas Program

Report by David Teske, acting program coordinator
drteske@yahoo.com

See also "Rheita E and Rio Cuarto: Oblique Craters in Two Worlds" later in this Journal.

The ALPO Lunar Topographic Studies Section (ALPO LTSS) received a total of 183 observations from 21 observers in five countries during the July-September quarter.

Twenty-three articles were published in addition to numerous commentaries on images selected in the monthly newsletter *The Lunar Observer*. A total of 139 lunar images and drawings were submitted.

The *Focus-On* series continued under Jerry Hubbell, with an article on the Apollo 11 landing site region in the July 2019 issue of *The Lunar Observer.* This finished a series of *Focus-On* topics that included an examination of all six Apollo landing sites. The September 2019 issue of *The Lunar Observer* brought a new *Focus-On* series, with craters from the ALPO Selected Areas Program. This series of *Focus-On* articles will appear bi-monthly for six months. The September 2019 article featured the remarkable craters Alphonsus and Aristarchus.

The next *Focus-On* subject will include the craters Tycho and Herodotus. The deadline for observations, reports, drawings, and images of these craters is February 20, 2020.

The lunar image gallery/archive is also now active. At the time of this writing (October 2019), all images received after December 2017 are in the gallery. Images will continue to be added, working back through the years. Also, all issues of *The Lunar Observer*, including those from its beginning in 1997 as an American Lunar Society publication to

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June 2004 when it became the newsletter of this ALPO program, are now available on the website at *moon.scopesandscapes.com*.

Electronic submissions can now be submitted through the ALPO website, (*lunar@alpo-astronomy.org*). The former method of submitting them directly to the coordinators will still work, but please DO NOT submit through both the website and directly. See the most recent issue of *The Lunar Observer* (*http://moon.scopesandscapes.com/tlo.pdf*) for instructions on its use. Hard copy submissions should continue to be mailed to me at the address listed in the ALPO resources section of the Journal.

Also presented later in this Journal are two images and a short paper about oblique craters that have formed on the Moon and on the Earth. We all know of the remarkable meteor crater in Arizona, but in this article by Francisco Alsina Cardinali and Alberto Anunziato of Oro Verde, Argentina, states that a recently discovered oblique crater in Argentina is related to similar craters on the Moon.

Visit the following online web site for more info, including current and archived issues of *The Lunar Observer*: *moon.scopesandscapes.com*.

Lunar Meteoritic Impacts

Report by Brian Cudnik, program coordinator
cudnik@sbcglobal.net

From 1 August to 16 October, this writer received reports of three lunar Perseid candidates by IOTA (International Occultation Timing Association) member Lawrence Garrett. He recorded each of these candidates on 5 August 2019, with an Eagle Run video camera attached to a Celestron 8-inch Cassegrain telescope and f/6.3 focal reducer under clear skies with good seeing. His observing location was latitude 44° 39.6619' North, longitude 72° 59.3715' West (near Fairfax, Vermont USA), elevation 126.5 m.

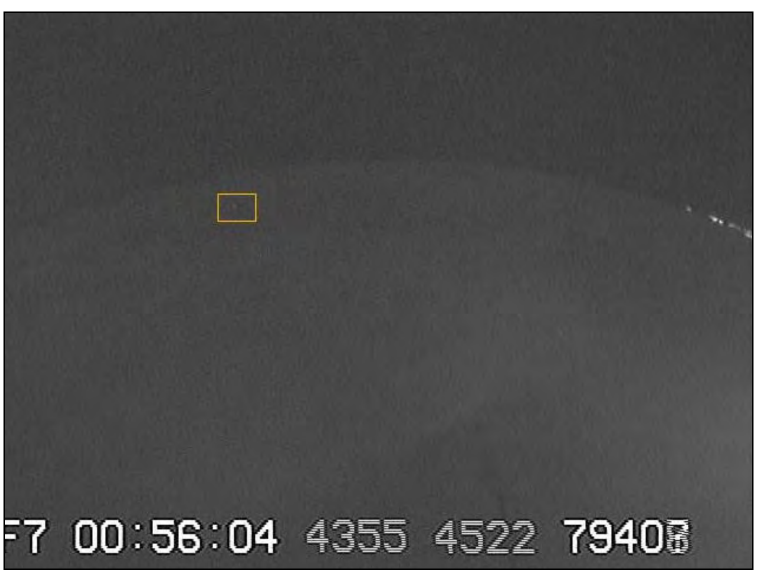
No confirming observations of these three impact event candidates have been received, so they remain unconfirmed candidates for the moment. The multi-frame duration lends credibility to their lunar nature, but the ones in Figure 2 may be noise or a multiple impact event. To date, no simultaneous impacts of two or more meteoroids have been recorded on the lunar disk. Aside from these events, no other reports have been received.

Please visit the ALPO Lunar Meteoritic Impact Search site online at *http://alpo-astronomy.org/lunarupload/lunimpacts.htm*

Lunar Transient Phenomena

Report by Dr. Anthony Cook, program coordinator
tony.cook@alpo-astronomy.org

Three candidate LTP reports have been received since the last quarterly report in this Journal:



(Above left) Boxed: 5 August 2019, 00:56:04.4021 UT meteoroid impact event candidate in crater South, W 46.6° N 55.5°, appears on 3 frames.
(Above right) Left, boxed: 5 August 2019, 01:18:11:1010 UT impact candidate event, occurred near Mons La Hire W24.0° N26.0°, possible double impact, visible in 5 frames. Right, boxed: 5 August 2019, 01:18:11:0676 UT impact candidate event, occurred near Archimedes W1.5 N30, possible double impact, visible in 4 frames.

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- 2019 Sep 02 UT 22:45:36 Marcello Zurita (Joao Pessoa, Paraiba, Brazil - Astronomy Association of Paraiba/ Brazilian Meteor Observation Network/Brazil Astronomical Society) videoed earthshine and captured a flash in the Mare Nubium region. Although this might have been an impact flash, it is an unconfirmed sighting, since it appears in only one frame and so could easily be a cosmic ray event.
- 2019 Sep 06 UT 21:44-22:20 Trevor Smith (Near Great Yarmouth, UK) noticed a very bright spot on the SW rim of Adams D - by far the brightest feature on the NW quadrant. It appeared almost, but not quite, as bright as Proclus - though did not change in brightness and no color was seen either. We shall assign an ALPO/BAA LTP weight of 1 and check this out at the next repeat illumination opportunity.
- 2019 Sep 13 UT 23:26 Kevin Kilburn (Manchester, UK - BAA) was taking a sequence of images of the NW limb region and recorded on one image only a blue-green spot on Galvani B crater. It might be a cosmic ray or a Bayer color filter mask effect enhancing the bright narrow crater rim here in blue/green light. For now, this report has been assigned an ALPO/BAA LTP weight of 2.

The ALPO/BAA LTP weight scale ranges from 1 (slight chance of being an LTP) to 5 (unquestionably a LTP). Lunar observers are encouraged to image, or visually observe, the Moon at specific narrow selenographic colongitude and sub-solar latitude observing windows that match those of many past LTP observations.This has proved very successful in eliminating some past LTP reports as normal appearances of the lunar surface.

The *Lunar Observing Schedule* can be found online at:

http://users.aber.ac.uk/atc/lunar_schedule.htm

We welcome new participants in our program, whether they are experienced visual observers, or high-resolution lunar imagers. This helps us to solve some past historical lunar observational puzzles.

LTP observational alerts are given on this Twitter page: *https://twitter.com/lunarnaut*

Please visit the ALPO Lunar Transient Phenomena site online at *http://users.aber.ac.uk/atc/alpo/ltp.htm*

Lunar Domes Studies

Report by Raffaello Lena, program coordinator
raffaello.lena@alpo-astronomy.org

See also "Lunar Domes in the Milichius - Tobias Mayer Region: Dome M23" later in this Journal.

We have received 90 images including some by Raffaele Barzacchi, Howard Eskildsen, Guy Heinen, Richard Hill, Raffaello Lena, K.C. Pau, Jim Phillips, Frank Schenck, Maximillian Teodorescu and Ivica Zajac.

Pau has imaged the Valentine domes. Hill has submitted images of the dome near Kies, Herodotus Omega dome, Doppelmayer domes, and the highland domes Gruithuisen and Mairan. Zajac has imaged the domes field in Milichius - T. Mayer - Hortensius and Marius Hills.

Heinen has imaged many domes, including Archytas 1 and 2 domes, Piccolomini dome, domes of the Vitruvius-Cauchy region, the Milichius - T. Mayer - Hortensius domes, highland domes in Gruithuisen, domes in Gambart D, the Birt bisected domes, Valentine domes, and the Herodotus Omega dome.

Heinen also imaged the "kipuka" (a high standing remnant of an earlier terrain surrounded by lava flows) near Rimae Opelt. Lena first documented this classic example of a lunar kipuka, which was also posted as a Lunar Photo of the Day by Wood (*https://www2.lpod.org/wiki/April_11,_2012*). The feature has a slight rise (about 500 m over a radius of roughly 25 km) cut by the Opelt Rille at the boundary of Maria Cognitum and Nubium.

With lower resolution images not much difference is visible between the rise and the surrounding terrain, so it resembles a large dome. But it is clear in high resolution telescope images and in Lunar Reconnaissance Orbiter (LROC) Wide Area Camera (WAC) imagery that Opelt is more fractured and more pitted with small craters. It is not the same material and this terrain is older than the mare.

Barzacchi, Eskildsen, Heinen, Hill, Pau, Phillips and Schenck have imaged a dome near the crater Mason under different solar illumination angles and colongitudes. A full study of this dome, which we termed Mason 1 (Mas1), located at coordinates 40.90° N and 29.71° E, is in progress and a future report will be prepared for the JALPO. The dome has a base diameter of 8.0 km ± 0.3 km. Its height is 190 m ± 15 m and the average slope angle is 2.6° ± 0.2°. Spectral data indicate a basaltic composition.

Eskildsen has submitted many images under different solar illumination angles of the domes near Aristillus and Autolycus, the Herodotus Omega dome, Hansteen domes, the Menelaus bisected domes, Rümker, Marius Hills, the Gruithuisen highland domes, the Meton 1 dome, the Vitruvius-Cauchy domes, Piccolomini dome, the Arago domes and Grimaldi dome.

He has also submitted a report including measurements of the Herodotus Omega

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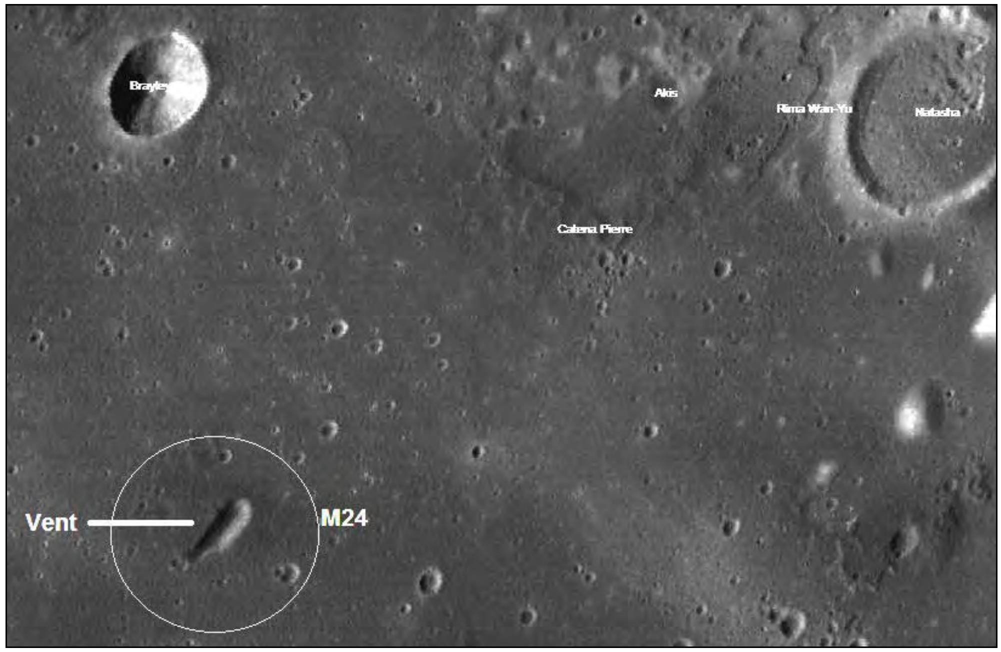

Figure 1. Lunar Reconnaissance Orbiter WAC imagery showing the location and appearance of M24 and its vent.

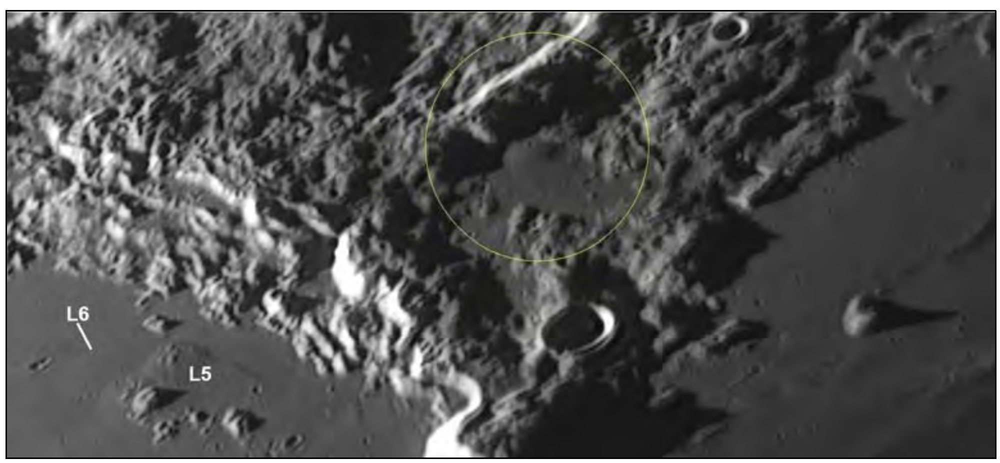

Figure 2. Image by Teodorescu taken on September 23, 2019 at 02:30 UT using a 355mm (14 in.) Newtonian reflector and an ASI 174MM Monochrome CMOS camera. The examined lunar dome (L1) is circled.

dome based on an image taken on August 28, 2019. The Lunar Terminator Visualization Tool (LTVT) was used to estimate dome diameter and coordinates, and the LROC QuickMap was used for comparison and also to measure dome diameter, elevation, slope, and the depth of the central vent. The data reported by Eskildsen are in agreement, within the error interval, with our previous measurements. Herodotus Omega, with its slope of 2.4° ± 0.2°, diameter of 14.4km ± 0.5km, height of 220m ± 20m and large edifice volume belongs to class B1 of the effusive lunar domes (See Lena et. al., 2013 for more on lunar dome classification). He also reported measurements carried out on a possible volcanic intrusion with associated uplift between Dionysius and Ritter, which could be consistent with a putative intrusive dome.

Guy Heinen from Linger, Luxembourg, has reported a possible dome with a summit vent located south of the crater Brayley D at 19.17° N and 32.55° W. He submitted two images of this feature. We provisionally designate this volcanic construct as M24, to be consistent with previous dome nomenclature for the Milichius - T. Mayer region.

The detailed study of lunar domes requires images of the lunar surface obtained under oblique illumination conditions for their measurements and for maximum detail. Thus we await further telescopic CCD images of this feature in order to better characterize it. Preliminary data indicates a diameter of about 18km and height of about 90m. A United States Geological Survey lunar geologic map of the region displays the feature as a dome (*https://www.lpi.usra.edu/resources/mapcatalog/usgs/I465/150dpi.jpg*). Many lunar domes have a summit crater pit likely representing the vent of the volcano which was enlarged by magma withdrawal and/or later erosion. M24 does not display a circular summit pit but its summit is crossed by an elongated fissure of 4.5km length (see Fig. 1).

Volcanoes can have such elongated vents especially when they were formed along a fissure or by a dike intrusion. Hence, this depression represents the original vent, the place at which lava poured out over the lunar surface, successively building up a shield-type volcano around it. Note that the vent of M24 is breached in the SW direction and material of lower albedo is present near the rim and nearby soil, which could be pyroclastic material. A full spectral analysis is in

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progress in order to identify any glass or olivine components of the material. In the revised catalogue of lunar domes by Kapral and Garfinkle a dome- described as "unverified" is reported at same coordinates but without any data of height, slope and volume. Another image of M24 was submitted by Eskildsen, Teodorescu, Pau and Hill. Apollo 17 images display the examined feature. They are:

- https://www.lpi.usra.edu/resources/apollo/images/print/AS17/160/23992.jpg
- https://www.lpi.usra.edu/resources/apollo/images/print/AS17/160/23983.jpg

A request for observations was sent to the ALPO in a preliminary note describing the feature (http://www.alpo-astronomy.org/lunarblog/wp-content/uploads/2019/09/Dome_brayley.pdf). We encourage more high-resolution imagery of this area so we can identify the shape of this dome and fully characterize its morphometric and spectral properties. Please also check your past imagery and send them to us for this ongoing study.

Recently, a lunar dome in Promontorium Laplace designated L1 has been imaged by Teodorescu in Romania. An excellent CCD terrestrial images taken by Teodorescu under oblique solar illumination displays the dome very well and demonstrates the utility of high resolution CCD imagery for the recognition of elusive non-cataloged domes (Fig. 2).

Teodorescu has submitted three images of L1 taken under different solar illumination angles and Phillips has submitted another image of the region. A preliminary note of L1, including a spectral analysis, is published on the ALPO website at: http://www.alpo-astronomy.org/lunarblog/wp-content/uploads/2019/10/dome-sinus-iridum-alpo.pdf . A full analysis is ongoing.

Interested observers can publish their newly acquired images using the email lunar-domes@alpo-astronomy.org . Received images are also shared in our Facebook group Lunar Dome Atlas Project: https://www.facebook.com/groups/814815478531774/ .

Reference: Lena, R., Wöhler, C., Phillips, J., Chiocchetta, M.T., "Lunar Domes Classification Scheme" in: "Lunar Domes: Properties and Formation Processes", "Springer Praxis Books", pp. 59-65, 2013

Interested observers can also participate in the lunar domes program by contacting and emailing their observations to both Raffaello Lena, Lunar Dome Program coordinator (raffaello.lena@alpo-astronomy.org) and Jim Phillips, Assistant coordinator (thefamily90@gmail.com).

Mars Section

Report by Roger Venable, section coordinator
rjvmd@hughes.net

See also "A Preview of the 2019 - 2021 Perihelic Apparition of Mars" later in this Journal for guidance about what will be visible and when to look.

The 2019 - 2021 apparition of Mars has just begun. Besides the paper stated in the box above, the best guide for more information about observing Mars is Jeff Beish's new book, *Mars: An Observing Guide*, published by the Astronomical League. It is available at https://store.astroleague.org -- look for 'Observing Manuals' in the list on the left of that web page. It is essentially a print version of Jeff's series of articles in *The Mars Observers Cafe*, which is available via links on the ALPO website, www.alpo-astronomy.org .

On the ALPO home page, click on the "Mars Section" link in the left sidebar, then click on "Mars Observers Cafe" link in the right sidebar to get to the "The Mars Observer's Handbook". There is no more direct link to it.

Any observer of Mars who wishes to hone his skills and knowledge may wish to achieve the Mars Observing Award of the Astronomical League during this apparition. The instructions about the observing program include guidance on instruments and filters, as well as important features of Mars that should be monitored. Persistent observing is required to achieve the award, so it is best to plan observations and begin them fairly early in the apparition. Details are given at https://www.astroleague.org/content/mars-observing-program .

All those interested in Mars are invited to join the marsobservers email group, which is now a Groups.IO group at https://groups.io/g/marsobservers . We successfully transferred the Yahoo marsobservers group to Groups.IO, as the functions available to us in the Yahoo group are soon to be unavailable, due to changes at Yahoo. If you were a participant in the Yahoo marsobservers group, you are already a member of the groups.io marsobservers group. All you need to do is go to the group's page and sign in by using the same email address that you used for the Yahoo group, and set up a groups.io password. Although the Yahoo group still exists, please post all new messages, observation reports, images, and drawings to ONLY the new group. We hope to see you there.

Be sure to check the ALPO Mars image gallery on the ALPO website:

First, go to http://www.alpo-astronomy.org, then click on the "ALPO Section Galleries" link at the upper right corner of the screen. Next click on the "Mars images and observations" icon, then click

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on the Mars image folder for the desired year.

Please consider contributing your images, drawings and descriptions to this archive – not only for the coming apparition, but also for the just-finished 2018 apparition. Send your observations directly to mars@alpo-astronomy.org.

Minor Planets Section

Report by Frederick Pilcher, section coordinator
pilcher35@gmail.com

Some of the highlights published in *The Minor Planet Bulletin*, Volume 46, No. 4, 2019 October-December, are hereby presented. These represent the recent achievements of the ALPO Minor Planets Section.

Brian Skiff, Kyle McLelland, Jason Sanborn, and Bruce Koehn published lightcurves of 143 asteroids from the Lowell Observatory Near-Earth Asteroid Photometric Survey. Most of these objects are Mars crossers or near-Earth asteroids.

The Minor Planet Bulletin announces a position opening for Associate Producer that will probably promote in two years into Producer. Required skills are Proficiency with Microsoft Word 2013/ 2010, pdf computer documents, and email. Production status is tracked using excel. The applicant should also have sufficient expertise with asteroid astronomy to do some error checking, recommend editorial corrections, and strong skill with written English. Any ALPO member who would like to apply please send an application to Richard Binzel, publisher of the Minor Planet Bulletin, email address rpb@mit.edu.

Lorenzo Franco published a spin-shape model for 131 Vala. He found a sidereal rotation period 5.18081 hours with the usual two ambiguous rotational pole positions at celestial longitude and latitude 54 degrees and +29 degrees; 243 degrees and +30 degrees, respectively, both +/- 15 degrees.

A satellite of an asteroid may be detected photometically if a brief dip is observed in the rotational lightcurve as the secondary either transits or is occulted by the primary. Their combined light is reduced during these satellite events. Dual period software can separate the two lightcurves with separate periods from the observed combined lightcurve. Asteroids with this reported behavior are in the table below.

Asteroids with this reported behavior are listed in the first portion of table in this report.

If the satellite's orbital plane is not close to the line of sight, satellite events are not observed. It may be possible to detect the presence of the satellite if primary and secondary have different rotation periods and amplitudes, and their combined lightcurve can be separated with dual period software. Five asteroids reported to have different primary and secondary rotation periods, but no observed transit/ occultation events, are listed in the second portion of table in this report.

Six very small Earth approachers, diameters 40 to 300 meters, were found to have very short rotation periods, faster than the centrifugal limit and therefore indicative of being solid rocks (monoliths) rather than the usual rubble piles. They are listed in the third portion of table in this report.

In addition to asteroids specifically identified above, lightcurves with derived rotation periods are published for 234 other asteroids as listed below:

50, 57, 59, 194, 234, 261, 338, 349, 444, 714, 722, 767, 856, 985, 997, 1036, 1090, 1166, 1178, 1199, 1229, 1293, 1387, 1397, 1468, 1475, 1483, 1516, 1517, 1551, 1558, 1677, 1711, 1744, 1774, 1865, 1902, 1914, 1943, 2025, 2281, 2357, 2363, 2378, 2396, 2433, 2460, 2510, 2525, 2564, 2638, 2727, 2744, 2778, 2784, 2937, 2956,

Table of Minor Planets Detailed in This Report

Minor Planet	Type	Author(s)	Primary Rotation Period (h)	Orbital Revolution Period (h	Status
Asteroids with Occulting Satellites					
2602 Moore	Main Belt	B. Warner, R. Stephens	3.4673	27.455	secure
3880 Kaiserman	Hungaria		5.269	16.09	tentative
66391 1999 KW4	Near-Earth	L. Franco et al.	2.7644	17.47	
Asteroids with Non-Occulting Satellites					
27568 2000 PT6	Hungaria	R. Stephens, B. Warner	3.5006	16.10	tentative
68216 2001 CV26	Near-Earth		2.4292	15.83	
142040 2002 QE15			47.1	3.891	
185851 2000 DP107		B. Skiff et al.	2.774	long	
2019 KZ3		B. Warner, R. Stephens	0.39368	17.2	
Probably Solid Rock Asteroid (Very Fast Rotation Periods)					
2004 XK3	Near-Earth	B. Skiff et al.	0.484		—
2008 SA			0.1297		
2011 AL37			0.10926		
2019 HC		B. Warner, R. Stephens	1.2612		
2019 KZ3			0.39368		
2019 MB4			0.13441		

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3040, 3073, 3086, 3103, 3147, 3315, 3446, 3451, 3552, 3554, 3570, 3577, 3653, 3671, 3672, 3838, 3843, 3875, 4160, 4748, 4807, 4892, 4894, 5011, 5253, 5262, 5332, 5351, 5604, 5620, 5627, 5693, 5869, 5945, 5999, 6012, 6239, 6310, 6329, 6372, 6455, 6582, 6859, 7267, 7305, 7673, 7965, 8444, 9564, 9951, 10422, 10480, 10524, 10997, 12538, 14195, 14402, 15700, 15925, 17492, 19402, 20691, 20936, 21104, 22262, 23183, 24029, 24643, 26355, 26471, 32772, 33324, 33729, 36274, 38074, 39266, 42811, 42930, 47369, 52768, 53440, 55854, 62836, 65679, 68134, 68350, 68950, 74779, 74823, 85236, 85839, 85989, 87684, 99913, 100926, 102873, 112221, 136568, 138883, 141432, 141498, 141525, 143381, 143651, 144898, 152558, 152952, 153814, 154244, 154278, 161989, 162181, 162385, 162820, 163000, 163696, 164716, 174599, 175706, 184990, 185854, 188542, 194386, 207945, 208023, 219071, 220124, 244670, 248818, 257744, 260141, 277039, 302111, 305090, 326777, 341843, 345705, 355256, 410650, 410777, 446791, 453778, 455736, 488515, 494999, 504025, 518638, 524522, 528159, 529668, 2002 JW15, 2006 KE, 2008 HS3, 2008 JT35, 2008 QS11, 2008 SE, 2008 WL60, 2008 WX32, 2009 DL1, 2009 DO111, 2009 JM2, 2009 UU1, 2010 LF86, 2010 RC130, 2010 SC41, 2010 TU5, 2010 TC55, 2010 TX168, 2010 UX6, 2011 HP, 2014 LJ21, 2014 SZ303, 2018 EB, 2018 XG5, 2019 JB1, 2019 JX7.

Secure periods have been found for some of these asteroids, and for others only tentative or ambiguous periods. Some are of asteroids with no previous lightcurve photometry, others are of asteroids with previously published periods that may or may not be consistent with the newly determined values.

Newly found periods that are consistent with periods previously reported are of more value than the uninitiated may realize. Observations of asteroids at multiple oppositions widely spaced around the sky are necessary to find axes of rotation and highly accurate sidereal periods.

The Minor Planet Bulletin is a refereed publication and that it is available online at:

http://www.MinorPlanet.info/MPB/mpb.php

Annual voluntary contributions of $5 or more in support of the publication are welcome.

Please visit the ALPO Minor Planets Section online at *http://www.alpo-astronomy.org/minor*

Jupiter Section

Report by section staff members Richard Schmude, Craig MacDougal and John McAnally

See also a summary of Galilean satellite eclipse timing observations covering 2013-2014 later in this Journal. This Journal will publish the remaining Eclipse Timing Program reports completed by the late John Westfall.

Jupiter will be near conjunction with the Sun in early January, but by February it should be visible in the early morning sky before sunrise. Since Jupiter is at a southern declination, it will be best seen from latitudes south of 30? N.

Craig MacDougal reports 512 members are in the Yahoo Jupiter group as of October 7, 2019. He also reports that about 550 images were shared by group members. The first image of the 2018-2019 apparition was taken by Paul Maxson on December 25, 2018.

This coordinator continued to collect near infrared brightness measurements of Jupiter mostly during the first half of 2019.

A draft of the 2015-2016 Jupiter apparition report was submitted to John McAnally, assistant coordinator, in early October for his review before sending it on for publication in the ALPO Journal. This coordinator plans to submit that report for publication in November and plans to produce the next three apparition reports by the summer of 2020.

As stated in the last Journal, a search is now in progress for a new coordinator for this section. While this position had been held by Richard Schmude for many years, he stepped down several years ago to assistant coordinator, but continued to prepare the Jupiter apparition reports. Former assistant coordinator Ed Grafton then stepped up to full coordinator, but he later left that position due to health reasons a few years later, leaving Richard Schmude to once more become full coordinator.

Therefore, we really need a new full coordinator to prepare these short, quarterly section reports and perform only a few other duties. Richard Schmude will continue to prepare the Jupiter apparition reports.

This is to reminds all that the updated Jupiter manual, "Observing Jupiter in the 21st Century" is now available from the Astronomical League. Because there are several important updates in this revised version, all who observe or image Jupiter are strongly urged to obtain a copy.

It is available at *https://store.astroleague.org* -- scroll down to “New Products For November” to find it.

Another reminder, all contributors are advised to send all images ONLY to *Jupiter@alpo-astronomy.org* where they will be scanned for viruses before being forwarded on to me. Those received

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images will also be posted in the ALPO Jupiter Images and Observations gallery.

Visit the ALPO Jupiter Section online at *http://www.alpo-astronomy.org/jupiter*

Saturn Section

Report by Julius Benton, section coordinator
jlbaina@msn.com

Saturn's westward elongation increased steadily during the fall months with the planet remaining reasonably well-placed to view, draw and image for quite a few hours after sunset. Saturn will reach conjunction n with the Sun on January 13, 2020, thereby ending the 2019-20 apparition.

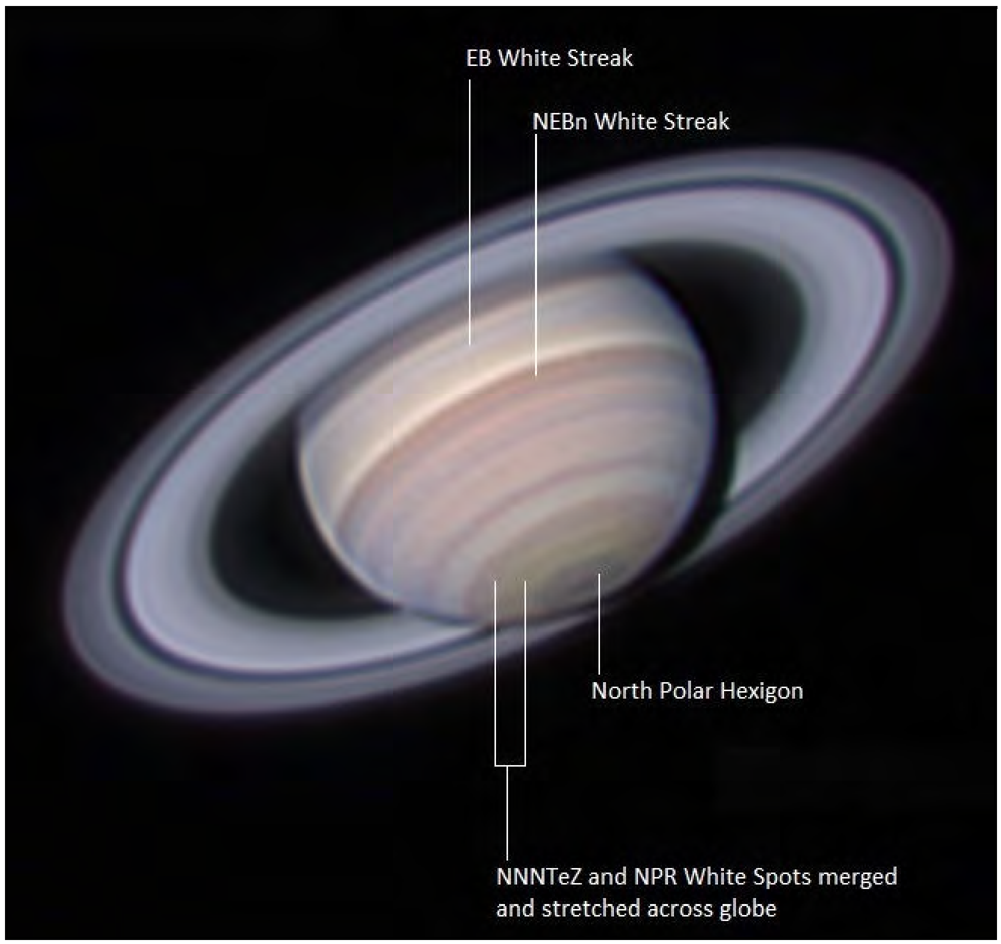
The accompanying Table of Geocentric Phenomena for the forthcoming 2020-21 Apparition in Universal Time (UT) is included here for the convenience of observers.

During the 2019-20 apparition, the ALPO Saturn Section received several hundred excellent digital images of the planet at visual and infrared wavelengths, as well as disk drawings. Observers consistently reported discrete atmospheric phenomena in Saturn's northern hemisphere, including interesting recurring small white spots in the EZn (northern half of the Equatorial Zone) interacting with the adjacent EB (equatorial band), plus a possible small white spot in the EZs (southern half of the Equatorial Zone, as well as a recurring group of white spots in the NNNTeZ (North North North Temperate Zone) that seemingly merged with one another and spread out across the globe at approximate saturnigraphic latitude 65.0° with what appeared to be closely associated white spots near the southern edge of the NPR (North Polar Region).

There were also several possible white spots that have been noted within the NEBZ (North Equatorial Belt Zone) that lies midway between the NEBn (North Equatorial Belt, northern component) and NEBs (North Equatorial Belt, southern component).

These observations seem to suggest that the aforementioned white spot activity at these saturnigraphic latitudes probably have persisted since the earlier 2018-19 apparition. Somewhat elongated white streaks imaged within the EB (Equatorial Belt). The aforementioned white spots activity showed up well in most images submitted using RGB, red, IR, and CH4 (methane) filters.

It will be extremely worthwhile during the 2020-21 observing season for observers to continue to monitor Saturn and



Detailed RGB image of Saturn taken by Trevor Barry of Broken Hill, Australia, on September 14, 2019 at 09:31 UT. His image was captured in good seeing using a 40.6cm (16.0 in.) Newtonian reflector. His image reveals elongated white streaks within the EB (Equatorial Belt) and the NEBn, (northern component of the North Equatorial Belt). A string of several NNNTeZ (North North North Temperate Zone) white spots appear to have merged together and are just barely noticeable distributed across the globe within same saturnigraphic latitude of +65.0° with what appears to be closely associated merging white spots near the southern edge of the NPR (North Polar Region). The North Polar Hexagon is visible also. The apparent diameter of Saturn's globe was 18.0" with a ring tilt of +25.2°. CMI = 339.4°, CMII = 151.3°, CMIII = 246.510.2°. The apparent visual magnitude = +0.4. S is at the top of the image.

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capture images with the same multi-wavelength filters to determine if the same or similar features last well into the 2020-21 apparition. Observers should be watchful for any new atmospheric phenomena that might suddenly appear.

With the rings tilted by about +21° toward our line of sight from Earth in 2020-21, observers still have reasonably decent opportunities to view, draw, or image the northern hemisphere of the globe and north face of the rings during this apparition despite Saturn's southerly declination of -21° for Northern Hemisphere observers.

Pro-Am cooperation with the *Cassini* mission continued back during the past 2016-17 apparition as NASA's remarkable close-range surveillance of the planet for nearly 13 years that started back on April 1, 2004, concluding it's amazing odyssey back on September 15, 2017 when it plunged into Saturn's atmosphere.

For quite a few years to come, planetary scientists will be carefully studying the vast database of images and data gleaned from the *Cassini* mission, including images provided during the mission by ALPO observers.

It should be emphasized, that ALPO Pro-Am efforts did not cease when the Cassini mission ended during September of 2017. Indeed, as in the immediately preceding 2018-19 and 2019-20 apparitions, our team of observers are regularly monitoring Saturn for atmospheric phenomena and we are actively sharing our results and images with the professional community. Therefore, anyone worldwide who wants to join us in our observational endeavors is highly encouraged to submit systematic observations and digital images of the planet at various wavelengths throughout the current 2020-21 apparition.

Observers are also reminded that visual numerical relative intensity estimates (also known as visual photometry) remain an extremely important part of our visual observing program and are badly needed to ascertain recurring brightness variations in the belts and zones on Saturn as well as the major ring components.

ALPO Saturn observing programs are listed on the Saturn page of the ALPO website at http://www.alpo-astronomy.org/saturn as well as in more detail in the author's book, *Saturn and How to Observe It*, available from Springer, Amazon.com, etc., or by writing to the ALPO Saturn Section for further information.

Observers are urged to pursue digital imaging of Saturn at the same time that others are imaging or visually monitoring the planet (i.e., simultaneous observations).

The ALPO Saturn Section thanks all observers for their dedication and perseverance in regularly submitting so many excellent reports and images in recent years. Cassini mission scientists, as well as other professional specialists, continue to request drawings, digital images, and supporting data from amateur observers around the globe in an active Pro-Am cooperative effort.

Information on ALPO Saturn programs, including observing forms and instructions, can be found on the Saturn pages on the official ALPO Website at www.alpo-astronomy.org/saturn

All are invited to also subscribe to the Saturn e-mail discussion group at Saturn-ALPO@yahoogroups.com

Table of Geocentric Phenomena for the 2020-21 Apparition of Saturn in Universal Time (UT)

Conjunction	2020 Jan 13^{d} 15^{h} UT
Opposition	2020 Jul 20^{d} 22^{h} UT
Conjunction	2021 Jan 24^{d} 00^{h} UT
Opposition Data for July 20, 2020	
Equatorial Diameter Globe	18.4″
Polar Diameter Globe	16.2″
Major Axis of Rings	41.7″
Minor Axis of Rings	15.4″
Visual Magnitude (m_V)	+0.1
B = Declination Constellation	+21.6° -20.6° Capricornus

Remote Planets Section

Report by Richard W. Schmude, Jr., section coordinator
schmude@gordonstate.edu

See also “ALPO Observations of the Remote Planets in 2018-2019” later in this Journal.

The planets Uranus and Neptune will be visible in the early evening sky after sunset in early January. Neptune will reach conjunction in early March while Uranus will reach conjunction in late April. Pluto will be at conjunction with the Sun in early 2020 and therefore will not be visible.

During the fall of 2019, Anthony Wesley imaged bright features on both Uranus and Neptune. The most obvious feature

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on Uranus was the bright polar area. He imaged this feature on October 26 using red and near-infrared light. Wesley used red and near-infrared light to image a bright Neptune cloud near 30? S on September 27.

Both Jim Fox and Richard Schmude, Jr. have also carried out brightness measurements of Uranus and Neptune. Richard also presented a review of ultraviolet measurements at the Georgia Regional Astronomers Meeting (GRAM) held at Dalton State College (Georgia) on October 26.

To find any of the remote planets for telescopic observations, it is suggested that you first use a star chart which shows the position of the target, then use binoculars to find the target. [Note that *skyandtelescope.com* is a great source to find specific locations of sky objects.]

Next, locate the target in the finder scope of your telescope. Finally, use a low-power eyepiece and center it in the field-of-view. Note that you may need a dark site to locate Neptune in binoculars and in the finder scope.

Both planets have albedo features, which can be imaged with a near infrared filter. Uranus has a bright North Polar Region while Neptune may have irregular bright spots.

Finally, a reminder that the book *Uranus, Neptune and Pluto and How to Observe Them* is available from Springer at www.springer.com/astronomy/popular+astronomy/book/978-0-387-76601-0 or elsewhere (such as www.amazon.ca/Uranus-Neptune-Pluto-Observe-Them/dp/0387766014).

Visit the ALPO Remote Planets Section online at www.alpoastronomy.org/remote

In an Emergency, Priorities Change (Continued from page 2)

Well, friends called and took me in for the day; our power went out for over 48 hours, and the fire quickly was blown away from my neighborhood, where minor local structure damage occurred. The fire department would not let us back into our neighborhood for a few days as well, so I finally headed out to stay with my wife in the travel trailer.

When we finally were let back into our neighborhood, we were very relieved that there was no damage except for the smell of smoke.

Like I said earlier, I've already dealt with earthquakes and e do have earthquake preparedness kits in our vehicles and home. But these recent fires have burned so quickly and done so much damage that I had no idea what to do or pack. We must prepare for everything.

I cannot say enough about the heroism, dedication, selfless firefighters in California who all came together to save so many homes (including my own) property, livestock and lives. They run head on into fires, while the rest of us run away. God bless all of you.

Notable Deaths

Dr. Michael D. Reynolds March 30, 1954 – October 15, 2019

The following tribute was authored by Scott Roberts, president of High Point Scientific, and originally published on the *Sky & Telescope* web site on November 20, 2019. The text and photos are reprinted here with permission from both High Point Scientific and *Sky & Telescope* magazine. Other tributes follow afterwards.

Remembering Dr. Michael D. Reynolds, 1954 – 2019

By: Scott Roberts | November 20, 2019

Mike Reynolds, passionate astronomy educator and former executive director of the Association of Lunar & Planetary Observers (ALPO), passed away suddenly on October 15th.

Mike Reynolds, passionate astronomy educator and former executive director of the Association of Lunar & Planetary Observers (ALPO), passed away suddenly on October 15th. Mike built an enduring legacy of making the world more scientifically literate through the greater understanding of space exploration and astronomy. He worked tirelessly on programs in formal education, public educational outreach, and recognition awards.

Born on March 30, 1954, to Ruth and Raymond Reynolds in Jacksonville, Florida, Mike was the oldest of three children. While in elementary school on May 5, 1961, seven-year-old Mike watched the live broadcast as Alan Shepard flew on Freedom 7 — NASA's first human spaceflight. He later pointed to this as one of the seminal moments of inspiration that led to his lifelong interest in astronomy and space exploration. It was also around 1961 that he got his first telescope, a 3-inch Gilbert Newtonian. He kept the telescope for the rest of his life.

Mike lived his childhood in Jacksonville, graduating from Duncan U. Fletcher High School, where he met the love of

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Portrait of Michael David Reynolds of Duncan U. Fletcher High School, ca 1986. Taken after Reynolds was awarded Florida Teacher of the Year.

his life, Debbie Thompson. They married soon after graduation, and Debbie recounts one of her favorite memories of Mike from just after their wedding:

"On our honeymoon, we traveled to Winnipeg in the dead of winter to witness a grazing occultation. It was freezing cold, but Mike had become fascinated by watching a star blink in and out as it crossed the edge of the Moon's mountains and valleys. You know, many would not have found this to be [a] particularly memorable or enjoyable way to spend a honeymoon . . . but even though I wasn't an astronomer, I loved it."

As they settled in to build their lives in Jacksonville, Mike worked three day jobs (teaching, UPS, and yardwork) while studying at night to earn his bachelor's degree in natural sciences at Thomas Edison State College. He then got a master's degree in science from University of North Florida in Jacksonville. In 1981 he began his career as an educator at the same high school he graduated from, and in 1986 he was awarded Florida Teacher of the Year.

In 1984, President Ronald Reagan announced the Teachers in Space Program to fly educators aboard NASA's Space Shuttles. Mike Reynolds applied along with 40,000 other applicants. By the next year, Reynolds was selected as a leading candidate and began astronaut training at NASA facilities. His fellow educator and friend, Christa McAuliffe, was chosen to fly; he was watching from the launch site when she and six other crew members lost their lives in the Space Shuttle Challenger disaster in 1986. It was a turning point for him: With a new sense of how precious each day is, he left his teaching position at the high school and took an outreach position created in McAuliffe's honor by the Florida Department of Education and NASA. Later, Mike became Planetarium Director at the Museum of Science and History in Jacksonville.

Mike finished his doctorate in science education and astronomy in 1990, and he, Debbie, and their two children, Aimee and Jeremy, moved to California in 1991. There, he became CEO and executive director of the Chabot Space and Science Center and modernized and resurrected the facilities, helping to obtain millions of dollars to relocate the original historic telescopes and build an

A young Michael Reynolds in Jacksonville, Florida.

"At the awards ceromony at the Winter Star Party: Dr. Mike Reynolds (left), Tippy D'Auria, Alan Traino (on behalf of the Rockland Astronomy Club), and Scott W. Roberts (for David and Wendee Levy)
Astronomy Outreach Network"

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Michael Reynolds won the Peltier Award in 2016 in recognition of his work in astronomy education.
The Astronomical League

88,000-square-foot state-of-the-art museum in Oakland that has served untold numbers of visitors.

I met Mike and Debbie when I visited the science center in 2001. I was working in sales for Meade Instruments at the time, and Mike was interested in selling telescopes in the gift shop. We hit it off immediately, and I visited Chabot as often as my schedule allowed.

It was during one of these visits that I suggested to Mike that the annual Astronomical League Conference (of which Mike and I had already attended many) would be more dynamic if several organizations came together at once. Ever willing to take on a project, Mike agreed and in 2004 he pulled together the American Association of Variable Star Observers, the Association of Lunar and Planetary Observers, the Astronomical Society of the Pacific, and the Astronomical League. This mega conference was hosted by three astronomical societies, and the speaker's list read like a who's who of astronomy and space exploration. People who were there still talk about it as a mind-blowing experience.

Mike was a meteorite expert and even discovered a rare meteorite buried in the ice in Antarctica. He also prepared museum-quality meteorite specimens, some of which were displayed at Chabot. Together we developed a meteorite kit that we sold through Meade Instruments and later through Explore Scientific. Mike provided the meteorites and the technical details about them, and I researched and wrote the stories behind the meteorites.

Chabot was running smoothly, with Mike heading up arguably the crown jewel of science centers in California. One would think that his life was set. But both Mike and Debbie's mothers were experiencing health issues back in Jacksonville, and ultimately they decided to return home. I still remember when he called to tell me. Family comes first, he said. Six months after moving back, Mike was hired as an astronomy professor at Florida State College.

Mike's accolades would fill paragraphs. He was president of the Antique Telescope Society, a member of the American Astronomical Society, and a Fellow of the Royal Astronomical Society. He served on the boards of several national nonprofits, coordinating the Astronomical League's Outreach Award Program until 2015. He wrote many articles as a corresponding editor of Astronomy magazine as well as popular books on eclipses, binocular astronomy, and meteoritics, and he led eclipse and meteorite expeditions around the world. He also received many recognitions and awards, including the G. Bruce Blair Medal, a Fellowship with the Royal Astronomical Society, and the Leslie Peltier Award. Mike was also honored with asteroid 298877 Michaelreynolds, which was discovered at Jarnac Observatory by David Levy, Wendy Levy, and Tom Glinos on September 24, 2004.

My friendship with Mike started with a shared passion for educational outreach and astronomy, but as I got to know the man, I developed great respect and admiration for him. Looking over all of his accomplishments, dedication, loyalty, sacrifices, and hard work, it's hard to imagine that someone could do so much in such a short time, and it's humbling when you realize the sum of his legacy. I can think of no better way to honor Mike's life than to continue to share the experience of looking at the stars, and to inspire others to see life from a

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perspective that helps them realize that anything in the universe is possible.

Remembrances from Others

From Matt Will, ALPO Membership Secretary & Treasurer and Member of the Board

ALPO Board Directors member and former Executive Director Dr. Michael D. Reynolds, one of the ALPO's and amateur astronomy's great ambassadors, passed away on October 15, 2019. Mike championed astronomy for many other institutions he represented and was a man wearing many hats throughout his life. But more than an institutionalist, Mike was most known for the connection that he made with amateur astronomers on a one-to-one basis, not just on stage when giving a presentation, but in conversation as well.

Mike was born on March 30, 1954. Mike's interest in astronomy came at an early age through watching the launch of America's first astronaut in space, Alan Shepard, in 1961. This one event propelled Mike's fascination with space and astronomy. Mike's interest in amateur astronomy would grow as it did for many of his peers at the time, a journey of self-discovery and discovery of astronomy through observing celestial events and solar system bodies with a telescope that he had built for himself 1. After graduating high school, Mike attended Thomas Edison State College in Trenton, New Jersey, where he obtained a Bachelor of Arts degree in Natural Sciences in 1980. Mike furthered his education and received a Masters degree in Science Education from the University of North Florida in 1982, and a Ph.D. from the University of Florida in Science Education and Astronomy in 1990.

After college, Dr. Reynolds pursued a career in the "informal" education of astronomy with the Chabot Space & Science Center in Oakland, California. He served as the Science Center's Executive Director and CEO from 1991 to 2002, where he led the effort to design, fundraise and overview construction of a new 88,000-square-foot astronomy and space-oriented science center which opened in 2000 to replace the 1915-era facility.

During Mike's academic career, he taught physics and astronomy both at the high school and university levels. As a high school teacher, Mike was a finalist for the NASA Teacher-in-Space Program in 1984 and was winner of the 1986 Florida State Teacher of the Year award from the State of Florida Department of Education. Mike went on later to serve as Dean of Mathematics & Natural Sciences and Professor of Astronomy at Florida State College in Jacksonville, Florida until his retirement in 2019.

Dr. Reynolds' astronomical research has been primarily focused on Solar System objects, as well as meteoritics. He has led expeditions around the world for numerous total solar eclipses, meteorite crater research, and meteorite recoveries. He worked with Meade Instruments in 2005 to develop and create Meade's Meteorite Kit, a special set of meteorites, tektites and impactites. Mike also sold meteorites as a sideline through his business, "Out of this World Astro." He also wrote *Falling Stars: A Guide to Meteors and Meteorites*.

As an amateur, Mike was passionate about solar and lunar eclipses and served as the ALPO's coordinator for its Eclipse Section from April 1999 until his death. Mike witnessed 19 solar eclipses in his life without ever being clouded out! Mike co-authored *Observe Eclipses*, an Astronomical League Publication, that has become a well-regarded reference for amateurs that want to image, video record, or simply observe visually these magnificent events in astronomy.

Other engagements that Dr. Reynolds has had in the past have included serving as president of the Antique Telescope Society and as a chair the Astronomical League's individual Outreach Awards, which he initiated for the League. Dr. Reynolds has also served as a chair or co-chair for several conferences, including the highly successful AstroCon 2004 (no ALCON in 2004) held in Berkeley, California. Mike's associations included a membership in the American Astronomical Society and a fellowship of the Royal Astronomical Society. Mike also reached many persons in communicating science and astronomy as a corresponding editor for *Astronomy* magazine and as a "science analyst" for WJXT-TV Channel 2 in Jacksonville, Florida. He also served on three other national non-profit boards that included the StarGarden Foundation, the National Sharing the Skies Foundation, and the W Foundation (for space exploration education). He was also on the Meade 4M Community Board of Advisors.

In addition to Mike's leadership as ALPO Eclipse Coordinator, Mike joined the ALPO Board of Directors in August 2003. Mike also served as ALPO Executive Director for two terms, from July 2007 through August 2009 and from July 2015 through October 2017. Mike also briefly served as coordinator of the now-retired Instruments Section from July 2007 to August 2008. Recently, Mike was appointed acting coordinator of the Mercury and Venus Transits Section to succeed the late John Westfall.

Throughout his life, Dr. Reynolds received many accolades as an educator, professor, and amateur astronomer. Some have already been mentioned above. Below are more of the many that he received.

Recipient of the following awards:

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- Florida State Chemistry Teacher of the Year; American Chemistry Society; 1984 [could not confirm, only one source, http://www.astronomyoutreach.net]
- Distinguished Alumni, Florida Community College at Jacksonville; 1985 [could not confirm, only one source, http://www.astronomyoutreach.net]
- Outstanding Young Floridian, Florida Jaycees; 1985 [could not confirm, only one source, http://www.astronomyoutreach.net]
- Distinguished Alumni, University of North Florida; 1990 [could not confirm, only one source, http://www.astronomyoutreach.net]
- Outstanding Alumni, Edison State College; 1995 [could not confirm, only one source, http://www.astronomyoutreach.net]
- Professional Astronomer Award, Astronomical Association of Northern California; 2001
- Western Amateur Astronomers' G. Bruce Blair Medal, 2002
- Astronomical League's Peltier Award, 2016
- Inductee, Astronomy Outreach Hall of Fame 2009

A more extensive listing of career milestones and achievements for Mike Reynolds can be viewed at *http://www.astronomyoutreach.net/index.php?title=Dr._Mike_Reynolds*

Mike was also extensively published in the Journal of the ALPO and was a frequent guest on the ALPO podcasts in recent years. ALPO Editor Shawn Dilles provides a listing of his articles and appearances below:

Eclipse Section . . . . Vol. 43, No. 04, pp. 5-6

Eclipse Section Report for 2003 . . . . .Vol. 45, No. 03, p. 4

Eclipse Section: Upcoming in 2004 . . . . Vol. 46, No. 01, pp. 3-4

Classifications of Meteorites . . . . . . Vol. 46, No. 01, pp. 13-17

Eclipse Section . .Vol. 46, No. 03, p. 5

Eclipse Section . .Vol. 46, No. 04, p. 4

Eclipse Section . .Vol. 47, No. 01, p. 5

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Eclipse Section . .Vol. 49, No. 03, p. 6

The 2008 Total Solar Eclipse - A Look Ahead . . . . . . Vol. 49, No. 03, pp. 17-18

Point of View: Introducing Our New Executive Director. . . . . . . .Vol. 49, No. 04, pp. 3, 18

New Webmaster, New Home, New Name for the ALPO Website . . . . .Vol. 49, No. 04, p. 4

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Instruments Section . . . . .Vol. 49, No. 04, p. 6

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Instruments Section . . . . .Vol. 50, No. 01, p. 9

A Report on the August 28, 2007 Total Lunar Eclipse . . . . . . Vol. 50, No. 01, pp. 26-29

Eclipse Section . . Vol. 50, No. 02, p. 7

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Inside the ALPO
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ALPO Podcast: The Observer's Notebook Interviews with Mike Reynolds:

Finally, Dr. Reynolds was honored by the International Astronomical Union with the naming of asteroid “2004 SY26 MICHAELREYNOLDS”, nominated by David Levy and Tippy DiAuria. The citation from MPC 80329, reads as follows:

“(298877) Michaelreynolds = 2004 SY26 Michael D. Reynolds (b. 1954) has spent many years inspiring students in astronomy in his role as Dean of mathematics and sciences and professor of astronomy at Florida State College in Jacksonville, Florida.”

Mike Reynolds was a friend to a great many amateur astronomers both inside and outside the ALPO. His enthusiasm for astronomy and science was contagious even for non science types as he was an effective communicator in many types of media and platforms. In an ever increasingly complicated world of information and communications, Mike brought clarity to the scientific subjects he spoke of and related it in an everyday manner that could be easily digested. We will miss Mike for his knowledge and wisdom, and his friendly manner in delivering that content.

1 "Our universe is our classroom - Dr. Mike Reynolds - TEDxFSCJ". YouTube. TEDxFSCJ. November 24, 2014. Retrieved October 8, 2019.

2 Influential Jacksonville Science Professor Mike Reynolds Dies at 65. By Rebecca Barry, Meteorologist, WJXT-TV, posted October 16, 2019. https://www.news4jax.com/weather/dr-mike-reynolds-dies-at-age-65

From Julius Benton, ALPO Executive Director, 2019-2020

I first met Mike Reynolds back in 1970 a year after I had joined the ALPO while I was in Jacksonville, FL promoting interest among aspiring young enthusiasts at a local astronomy club who showed interests in lunar and planetary observing. That was the year of seeing my first total solar eclipse as the path of totality crossed the Southeastern states. Mike was very interested as a young amateur astronomer in my observational endeavors because he was obviously as excited as I was to view the eclipse with me. His excitement during that memorable experience inspired me to reach out to others to join the ALPO.

During the years to come, Mike and I maintained regular correspondence as I became Recorder of the ALPO Saturn and Venus Sections (Recorders are now referred to as Coordinators). He was one of my first observers sending me visual drawings of Saturn. Mike and I saw each other frequently at joint Astronomical League and ALPO conferences, and we worked side by side as colleagues and ALPO Board members helping make sure we focused on promoting our organization to the astronomical community and helping maintain its success.

I always enjoyed Mike’s intriguing colorful reports on his many worldwide solar eclipse expeditions at such gatherings. His sense of humor made everything he said enjoyable, and his enthusiasm was contagious and was responsible for many people getting started and sticking with observing in general. He was a gifted leader and dear friend who I will truly miss. Rest in peace, Mike.

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Mary Alba, daughter of ALPO founder Walter H. Haas
My heart is broken hearing this news. I am in shock. He was a wonderful man and will be greatly missed. As you stated, he had extraordinary knowledge to say the least.

The ALPO has lost another devoted member: Don Parker, Walter H. Haas, John Westfall and now Mike Reynolds

My deepest condolence to his wife and family.

From Pamela Shivak, Assistant Coordinator, ALPO Solar Section
One of my fond memories of Dr. Mike was when I was a speaker at the ALPO Conference held in Athens Georgia, in the fall of 2017. I was very nervous but in his calm, kind manner he assured me that I'd "do just fine".

He was also kind enough to arrange one of my Worldwide Outreach Events, International SUNday at the Museum in Jacksonville, Florida, with fellow members of the local astronomy club NEFAS. He made me feel special as his guest of honor.

I've heard others recount memories of his kindness and selflessness. It was my honor to have known him and experience it first hand.

Jim Phillips, ALPO Assistant Coordinator , ALPO Lunar Domes Survey Program
Thank you for letting me know. Sad news. What a guy!!

John Mcanally, Assistant Coordinator, ALPO Jupiter Section
I was very sad to hear about Mike's passing. He will certainly be missed.

Kim Hay, former Cordinator, ALPO Solar Section
I am very sorry to hear this.Mike was a great person, and had many great conversations. My condolences to his family and friends.

David Levy, ALPO Lifetime Member
So sorry to hear this. I loved Mike.

You be well, my friend.

Pam Shivak with Mike Reynolds in June 2018 at the Jacksonville Museum of Science & History during the Northeast Florida Astronomical Society's International SUNday Event, founded by Pam.

From Jeff Beish, former ALPO Assistant Coordinator, Mars Section
Mike and I were friends for 39 years. Words are not enough.

Gene Cross, ALPO Lifetime Member
I had the pleasure of meeting Mike Reynolds when he was director of Chabot Space Science Center.

In my mind, Mike Reynolds was the best and most altruistic director Chabot has ever had.

Eric Rachut, ALPO member
Thank you. I am very sorry to learn this.

Phil Plante, ALPO member
Another sad day for the ALPO. A loss to the ALPO leadership indeed. I send my deepest condolences to his wife Debbie and to his family. Mike was a good friend; we shared a few times under a solar eclipse in various parts of the world. He was a familiar face at most past ALPO meetings/dinners. I will miss his humor and lively talks. The meteorites he sold to me have even more significance to me now. RIP Mike.

Michael Rosolina, ALPO member
I am very sorry to hear that Mike Reynolds passed away and sorry for your loss of a friend. I never met Dr. Reynolds but did correspond with him via email when I submitted my sketch of the 2017 total eclipse. I was astonished to hear that he had seen 19 total eclipses!

Again, sorry for your loss.

Jim Fox, ALPO member, Past President, The Astronomical League
Thank you (I think) for the sad news about Mike. He will certainly be missed; he has contributed in so many ways. I have passed your information on to a few of his friends in the Astronomical League for whom I have email addresses (mainly past Presidents).

Jackie Beucher, ALPO member, Vice President, Astronomical Society of Kansas City
I've been on quite a few eclipse trips with Mike and Debbie, and I really feel the loss. So very sad…….

Larry Trutter, ALPO Sustaining Member
Thanks for letting us know about this good video report. I learned a few more things about him in that video - an amazing guy.

From Ken Poshedly, ALPO Publications Coordinator and Member of the Board
I have very little to add to what you see previous to my little message. But I must second how genuinely interested (and interesting!) Mike was. We shared some good background stories during our phone chats and at ALPO events, and I recall him ending our phone chats with him saying how glad he was for us to be friends. One just doesn't hear that too often (or at all) anymore. Rest in peace, Mike.

Inside the ALPO
Member, section and activity news

Membership Report: Sponsors, Sustaining Members and Newest Members (as of November 13, 2019)

by Matthew L. Will, ALPO Membership Secretary/Treasurer

The ALPO wishes to thank the following members listed below for voluntarily paying higher dues. The extra income helps in maintaining the quality of the ALPO Journal while also strengthening our endowment. Thank you!

PATRONS, BENEFACTORS, PROVIDERS, FUNDERS and UNIVERSAL Members - Giving $250 or more per membership

Member	City	State
John Centala	Marion	IA
Carl Hergenrother	Tucson	AZ
Mike Hood	Kathleen	GA
Gregory Macievic	Camden	OH
Stephen Sands	Alton	IL
Thomas R Williams	Houston	TX

SPONSORS - Members giving $150 or more per membership

<table>
<tr><th>Member</th><th>City</th><th>State</th><th>Country</th></tr>
<tr><td>John Bedsole</td><td>Mobile</td><td>AL</td><td rowspan="9">USA</td></tr>
<tr><td>Brian Combs</td><td>Macon</td><td>GA</td></tr>
<tr><td>Howard Eskildsen</td><td>Ocala</td><td>FL</td></tr>
<tr><td>Robert A Garfinkle</td><td>Union City</td><td>CA</td></tr>
<tr><td>Ed Grafton</td><td>Houston</td><td>TX</td></tr>
<tr><td>Carl Hergenrother</td><td>Tucson</td><td>AZ</td></tr>
<tr><td>Robert Maxey</td><td>Summit</td><td>MS</td></tr>
<tr><td>John W Mc Anally</td><td>Waco</td><td>TX</td></tr>
<tr><td>John R Nagle</td><td>Baton Rouge</td><td>LA</td></tr>
<tr><td>Detlev Niechoy</td><td>Goettingen</td><td></td><td>GERMANY</td></tr>
<tr><td>Roy Parish</td><td>Shreveport</td><td>LA</td><td rowspan="6">USA</td></tr>
<tr><td>Steve Siedentop</td><td>Snellville</td><td>GA</td></tr>
<tr><td>Berton & Janet Stevens</td><td>Las Cruces</td><td>NM</td></tr>
<tr><td>Roger Venable</td><td>Chester</td><td>GA</td></tr>
<tr><td>Gary K Walker, MD</td><td>Macon</td><td>GA</td></tr>
<tr><td>Christopher Will</td><td>Springfield</td><td>IL</td></tr>
</table>

Inside the ALPO

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SUSTAINING MEMBERS - Members giving $75 per membership

Member	City	State	Country
Jay Albert	Lake Worth	FL	USA
Stephen Bennett	Flossmoor	IL	
Raffaello Braga	Milano		ITALY
Orville H Brettman	Huntley	IL	USA
Bruce Cordell	Tucson	AZ	
Dan Davis	Stoney Brook	NY	
William Dembowski	Windber	PA	
Leland A Dolan	Houston	TX	
Thomas Wesley Erickson	Warner Springs	CA	
William Flanagan	Houston	TX	
Gordon Garcia	Bartlett	IL	
Joe Gianninoto	Tucson	AZ	
Michel Granger	Chalon-sur-saãne	BURGUNDY	FRANCE
Robin Gray	Winnemucca	NV	USA
Dr John M Hill	Tucson	AZ	
David Houlihan	Wichita	KS	
William Howes	Holliston	MA	
Gerald Hubbell	Locust Grove	VA	
David Jackson	Reynoldsburg	OH	
Roy A Kaelin	Flossmoor	IL	
Vince Laman	San Clemente	CA	
Jim Lamm	Stallings	NC	
Michael Lawson	Chester	VA	
Radon B Loveland	Mesilla	NM	
Dr Michael T Mc Ewen	Oaklahoma	OK	
Jean-christophe Meriaux	San Bruno	CA	
John O'neal	Statesville	NC	
Marla Pinaire	Goshen	KY	
Theo Ramakers	Oxford	GA	
Guido E Santacana	San Juan	PR	
Mark L Schmidt	Racine	WI	
Bob Soltis	Lakewood	OH	
Lawrence Trutter	Springfield	IL	
Richard S Wright, Jr	Lake Mary	FL	

Special thank you notices are given to ALPO members that have made special donations, in the past year. These include contributions from Wayne Bailey for $250, Robert G. Warren $124, Elizabeth Westfall for $100, Tim Robertson $100, Robert H. Hays, Jr. $100, David Jackson $25, Michel Legrand $25 and Robert Garfinkle for an additional $50 contribution.

The ALPO is deeply grateful for a donation of $117,540.42 from the charitable trust of the late John E. Westfall. We also extend our heart-felt thanks to Mary Alba, the daughter of our founder Walter H. Haas, for a donation of $4,000.00 from her father's estate.

If you wish to make a contribution to the ALPO, please send your check or money order to the ALPO, PO Box 13456, Springfield, IL 62791-3456 or you can pay by credit card on the Astronomical League online store at this URL: https://www.astroleague.org/store/index.php?main_page=product_info&cPath=10&products_id=50&zenid=g29852ugiccivalvfgkjc5i185

Thank you!

Inside the ALPO
Member, section and activity news

NEWEST MEMBERS...

The ALPO would like to wish a warm welcome to those who recently became members. Below are persons that have become new members from November 10, 2018 through November 13, 2019: their locations and their interest in lunar and planetary astronomy. The legend for the interest codes are located at the bottom of the page. Welcome aboard!

Member	City	State	Country	Interests
Damian Allis	Fairport	NY	USA	
Alberto Anunziato	Paran	ENTRE RIOS	ARGENTINA	
Jillian Benham	Grand Rapids	MN	USA	
Richard P Binzel	Cambridge	MA		
Gordon Clarke	Cranley	QLD	AUSTRALIA	023HIX
Roger Corbett	Portland	OR	USA	
Francis Crowder	Simpsonville	SC		
Dan Davis	Stoney Brook	NY		
William Davis	Metairie	LA		
Michel Deconinck	Provence		FRANCE	
Steven Diesso	New Berlin	WI	USA	056ACDE
Kenneth Dodd	Gibsonton	FL		
James Eyster	Centerburg	OH		
James R Fisher	Little Rock	AR		3456CEHMPX
Jorge Garcia	Madrid		SPAIN	
Addison Garro	Newton Falls	OH	USA	
William Garro	Newton Falls	OH		
John Glover	Naperville	IL		03M
Jesse Goldbaum	Woodland Hills	CA		
Juan Gonzalez-rivera	San Juan	PR		
Doug Goodin	Manhattan	KS		
David Grant	Broomfield	CO		
John Harrington	Newton	MA		
Cameron Izard	Winsor	ON	CANADA	
Luc Jaspers	Grimbergen		BELGIUM	
Russ Klvacek	West Jordan	UT	USA	
Andre Kovacs	Ap2113	SP	BRAZIL	
Don Knabb	West Chester	PA	USA	
Leonard S Matula	Temple City	CA		
Vincent Manjoney	Stratford	CT		
Michael Mc Shan	Oklahoma City	OK		
Terry Mealy	Bethel Park	PA		
Barry Murphy	Two Rocks	WA	AUSTRALIA	
Mike Novo	Greenfield	CA	USA	
R O'donnell	Clackamas	OR		
Floyd O'quinn	Santa Anna	TX		345CK

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Member	City	State	Country	Interests
Ronald Pearson	Evergreen	CO	USA	
Peter Perry	Harwood	MD		
Marla Pinaire	Goshen	KY		
Bertman Plummer	Elizabethton	TN		
Eric Rachut	Moody	TX		35HIX
William Romanishin	Norman	OK		
Andrew Salthouse	Millington	NJ		
Geert Vandenbulcke	Oostduninkerke		BELGIUM	
Fred Veretto	Oceanside	CA	USA	
Heather Wendelboe	Cheyenne	WY		
Gido Weselowski	Docholt		GERMANY	
Charles White	Upper Musquodobit	NS	CANADA	
Kacper Wierzchos	Oro Valley	AZ	USA	
Darryl Wilson	Marshall	VA		O23456DEV

Table of Interest Codes

0 = Sun	6 = Saturn	D = CCD Imaging	P = Photography
1 = Mercury	7 = Uranus	E = Eclipses	R = Radio Astronomy
2 = Venus	8 = Neptune	H = History	S = Astronomical Software
3 = Moon	9 = Pluto	I = Instruments	T = Tutoring
4 = Mars	A = Asteroids	M = Meteors	V = Videography
5 = Jupiter	C = Comets	O = Meteorites	X = Visual Drawing

Papers & Presentations

ALPO Board Teleconference Meeting Minutes, November 13, 2019

Meeting minutes provided by
Matt Will, ALPO Secretary / Treasurer
matt.will@alpo-astronomy.org

Introductory Note

The ALPO Board convened a teleconference call on the evening of Wednesday, November 13, 2019. The primary purpose of the teleconference call was to conclude some unfinished business from the July 12, 2019 ALPO Board of Directors meeting. This concerned future changes in the management of the ALPO Endowment as expressed in Issue 5 of the minutes of that meeting (see page 26, Vol. 61, No. 4, Autumn, 2019). Specifically, the teleconference aims were to seek input on these revisions from the Board and obtain approval of them to better administrate the ALPO Endowment. To better understand the context of the discussion below, please consult Issue 5 of the Board meeting minutes.

Minutes

The conference call began at 7:45 p.m. EST with Julius Benton, Carl Hergenrother, Sanjay Limaye, Ken Poshedly and Matt Will online. Richard Schmude joined the call a few minutes later after experiencing some technical difficulties.

Matt Will summarized the rationale for revisions to the ALPO Bylaws and its Standing Rules for Staff Management as they pertained to the ALPO Endowment. There was a wide-ranging question and answer session concerning the status and prospects for the Endowment at first. After the Q & A session, Matt proceeded to discuss the actual changes to the Bylaws and Standing Rules that included some updating of obsolete language in some sections of the Bylaws and Standing Rules that did not related to the Endowment.

Ken Poshedly pointed out a potential problem with the language in proposed Section 3. ACTIONS in ARTICLE 13 of the Bylaws. Ken suggested that language for the Board of Trustees being accountable to the ALPO Board of Directors through reporting of financial transactions be included in the language in that section. Matt Will agreed as did the other Board members that this language should be included. Matt will "wordsmith" some language to that effect to reflect Ken's proposal and will get back to the ALPO Board within the next week.

A motion was made by Ken to conditionally approve the revised ALPO Guidelines and the Standing Rules provided that proposed Section 3. ACTIONS in ARTICLE 13 be reworded to reflect reporting of financial transactions. Sanjay Limaye seconded the motion and the Board voted unanimously for the motion. This vote satisfied the requirement of a two-thirds majority vote in favor of changes in the ALPO Bylaws and a simple majority for the Standing Rules for staff management.

On another matter, Ken also made a motion to dissolve the Computing Section due to inactivity for a very long time. The CS Yahoo Group did contain various programs and other documentation that will be going away due to the new downsizing policy of Yahoo Groups. Online Section Coordinator Larry Owens has downloaded these items for safe-keeping and continued access on our website. Sanjay seconded Ken's motion and the vote to dissolve this section was unanimous. Ken said that this action in no way should discourage ALPO members from contributing articles about computing in future issues of the Journal.

Before the meeting closed, Ken and Sanjay recommended that Glenn Orton be contacted about heading the ALPO Jupiter Section. Mr. Orton is a professional astronomer specializing in planetary studies and would be a welcome addition to the ALPO staff. Julius agreed with the proposal and stated that he would follow up with Mr. Orton.

With no other business to conduct the meeting concluded at 8:59PM EST.

Closing Note

The revisions for the ALPO Bylaws and The Standing Rules for Staff Management have since been voted on and approved by the ALPO Board of Directors. They are now available on the ALPO website homepage.

Papers & Presentations:
An Analysis of the Transition From Solar Cycle 24 to Solar Cycle 25

By Theo Ramakers,
Assistant Coordinator,
ALPO Solar Section
theo@ceastronomy.org

Abstract

This paper discusses some of the statistics of the transition from solar cycle 24 to solar cycle 25 and analyzes the data based on the size of the active region areas between the years 1874 and 2019, as well as the transition period of large areas between cycles. The analysis shows a modulation of the regular solar cycle activity with, what seems to be, another cycle lasting over 100 years, but does not come to a definite conclusion as to when the current transition will end.

Terminology

The paper refers to active region areas which typically contain one or more sunspots and are measured in the number of millionths of the solar hemisphere. For a more expanded definition, see "SWPC's Users Guide to The Preliminary Report and Forecast of Solar Geophysical Data".

The "Total Daily Active Region Area" identifies the sum of all the individual daily active region areas which are visible on the Sun for a given day.

The total rotation active region areas refers to the sum of all total daily active region areas for a Carrington Rotation.

Presentation

Many of us dream of a Sun full of sunspots, faculae, filaments, plages, and huge prominences around the surface and perimeter of the Sun. Instead, however, we face a Sun with different characteristics. The Sun is currently in the end-phase of solar cycle 24 and the question keeps being raised as to when solar cycle 25 will start. Having had several peaks during solar maximum and the possibility that similar peaks could happen during the solar minimum as well makes this determination even harder.

So the excuse is, "We are approaching solar minimum". That's true, but how does this stack up to a "normal" Sun and other solar cycles? There are many ways to analyze the behavior of our Sun. Scientists use high technology-based instruments to make all kind of measurements and predictions. As amateurs, we decided to use more common and simple ways and considered two methods:

- The Wolf (or Sunspot) number.

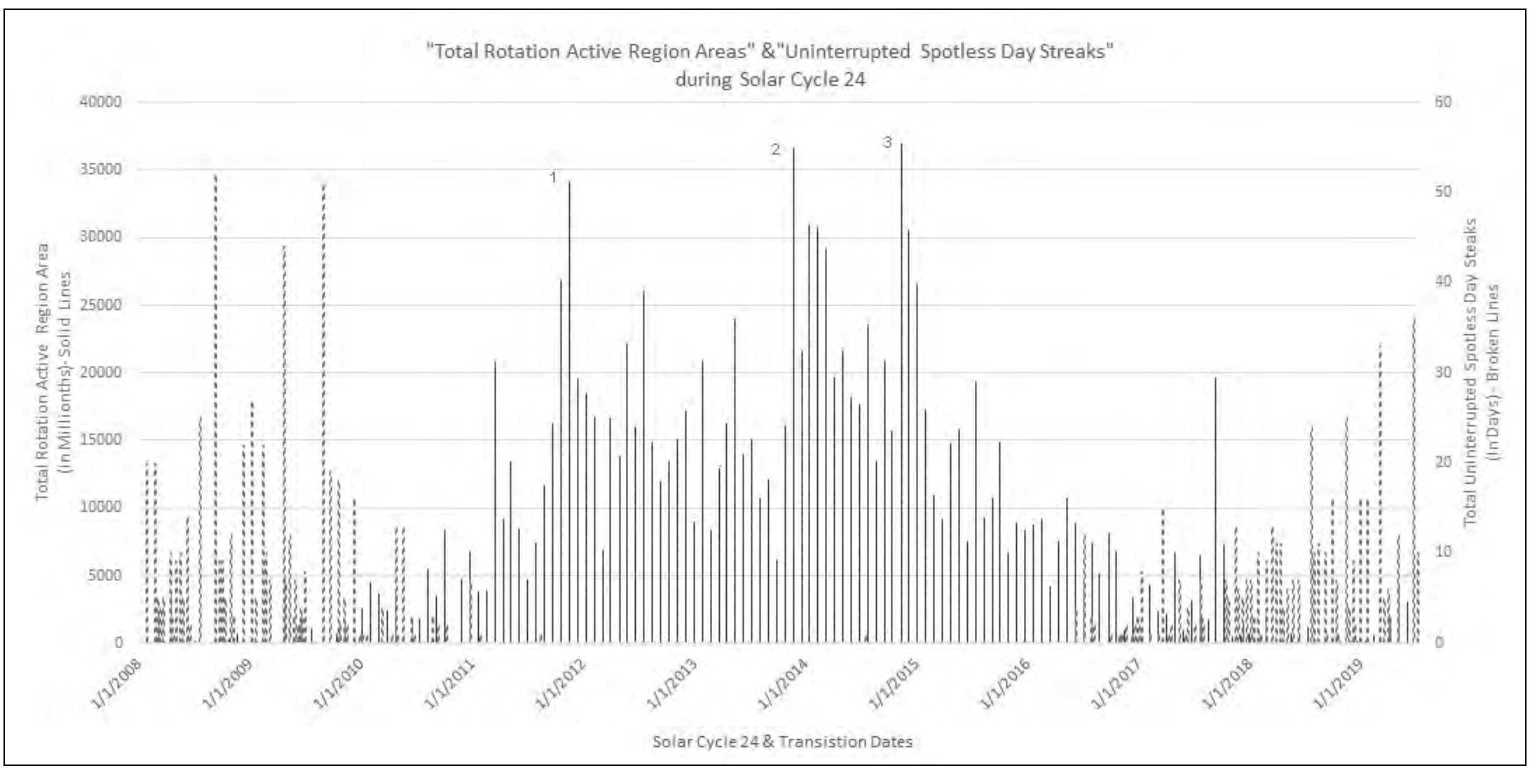

Figure 1

- The size of active region areas or the areas that contain the sunspots.

In the end, we decided to analyze the size of active region areas rather than the sunspot number.

This choice was for several reasons. To start with, the sunspot number (Ri) is generally used in a normalized way, that is, averaged over a period of time. Additionally, in our view, previous research has shown that area sizes show more accurate spontaneous reactions on the Sun and better reflect localized daily activity than sunspot numbers.

In order to shed light onto where we are in the solar cycle, let's first look at the current cycle 24 and its transition to cycle 25. We've been logging data provided by NOAA (National Oceanic and Atmospheric Administration) in its daily GEOA reports (a coded message containing a summary of solar-geophysical activity) into a database and here is what we found.

At first glance, Figure 1 gives a good view of overall solar activity during the period. That is, it shows the total of the daily active region areas for each Carrington Rotation (solid lines in the center of the graph), as well as the streaks of uninterrupted spotless days (broken lines at the outside of the graph). The transition from cycle 23 to 24 showed two long and spotless streaks of respectively 51 and 52 spotless days, as well as a shorter streak representing 44 days.

On the other side, the current transition so far has produced only four "long" streaks of 24, 25, 33 and 36 days, or in other words, only two streaks that lasted longer than a rotation.

Reviewing the size of the active region areas during the cycle shows three peaks, each with gradually decreasing activity. Other than that, the general size of the active region areas during the cycle looks a little higher in the second half of the cycle.

But looking at the rest of the data does not give us great insight into what is happening with the new cycle, and we need to look beyond the current cycle and into the transition between the cycles to find some clues.

In 2008, William Livingston and Matthew Penn predicted that with cycle 24, we were going to enter a new Maunder Minimum, which has not yet happened. However, we see the slow-down of solar activity in the second half of the cycle. So, in order to get a better understanding of this, we used data provided by the SWPC (Space Weather Prediction Center) on the largest sunspot areas, all the way back to the beginning of solar cycle 12 in 1874 up to and including cycle 22.

These active regions covered an area of at least 1,000 millionths of the solar hemisphere. To put the size of these spots into perspective, it is generally assumed that spots over 1,000 millionths can be seen with the naked eye and do not require a telescope, so they are significant in size. We did expand the SWPC information with the same data from cycles 23 and 24, which allowed us to create the graph up to today, as shown in Figure 2. This graph suggests that in addition to the regular 11-year solar cycle, something else may be at work, at least for large sunspots. This resulted in a much higher activity around

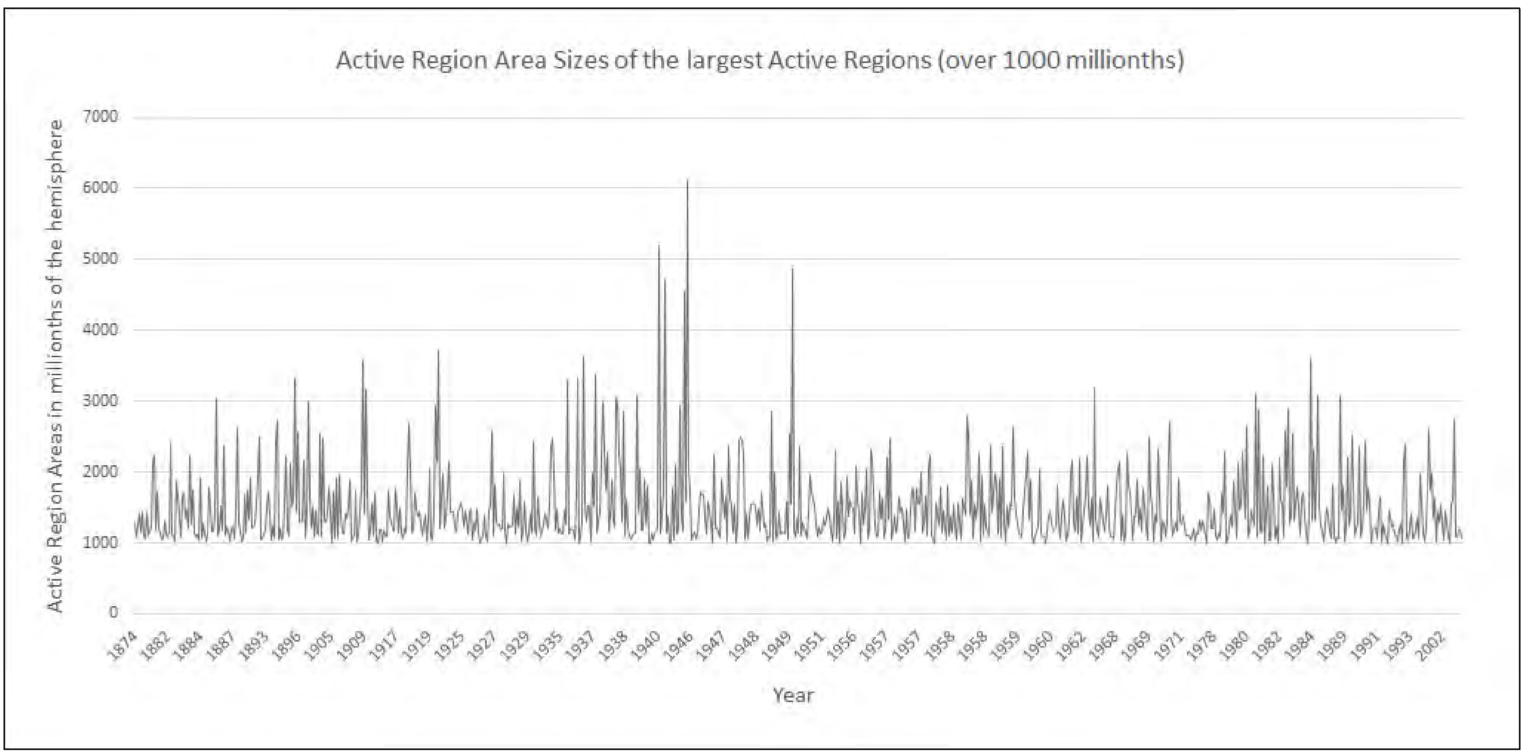

Figure 2

the middle of the last century. But it still does not give us much insight for the current transition.

So we removed the "noise" and looked at the distribution of the number of regions of the solar cycles. The effect of this is shown in Figure 3, where we see a definite increase in the numbers of the regions during those cycles towards the middle of the century. The following decreasing cycles in the second half of the century suggest that the regular solar cycles may be modulated by an additional cycle lasting over 100 years.

Next we analyzed how the larger of the regions were distributed, so we selected only the regions of 2,000 millionths and higher. The regions were classified into groups of 1,000 millionths with the exception of those groups that reached above 5,000 millionths, of which there were two.

One was even larger than 6,100 millionths. We now clearly not only see the effects of a slow moving solar cycle modulating the regular cycles by an increasing number of occurrences, but also an increase of their sizes over time (Figure 4), which showed a peak in solar cycles 17, 18 and 19, followed by a substantial decrease in the subsequent solar cycles.

This also resulted in cycle 24 showing a very small number of these areas so far. Based on the time-frame of this slow moving cycle, it does not look like it is only the 80-year Gleissberg cycle, but another slower moving cycle causing the downward time-frame to extend beyond the 80 years. In fact, for the cycle 24 time period between 2008 and 2019, there was only one area that exceeded the size of 2,000 millionths. It was the well-known active region AR2192 in October 2014.

In addition, the over 2,000 millionths area graph (Figure 4) shows the lowest activity during cycle 24 in almost a century and a half of active regions. However, even as we are at Very Low solar activity levels at the end of cycle 24, this cycle is not yet complete, so we are not able to draw any definite conclusions.

Therefore, to look at this from another perspective, we mapped the transition periods between cycles, specifically the time between the occurrences of large (over 1,000 millionths) active regions (Figure 5). Here we see that the time period between the last of these active region areas during a cycle and the first of these areas in the next cycle substantially increased from one and a half years in the 1930s to about six years for the cycle 23 to cycle 24 transition.

Since cycle 24 is not yet complete, we do not know what this time will be for the current transition. The only thing we know of the current transition is that the last region reaching the threshold of 1,000 millionths happened on September 9, 2017. This was two days after the region in question (AR2673) produced two X-class flares, one of which was an X9.3, the largest flare of the cycle.

Since we do not have data that would show if the long-term cycle causing the up-and-down trend from cycle 12 to cycle 24 has come to its end, we are unable at this time to draw any conclusions on how the current transition will end.

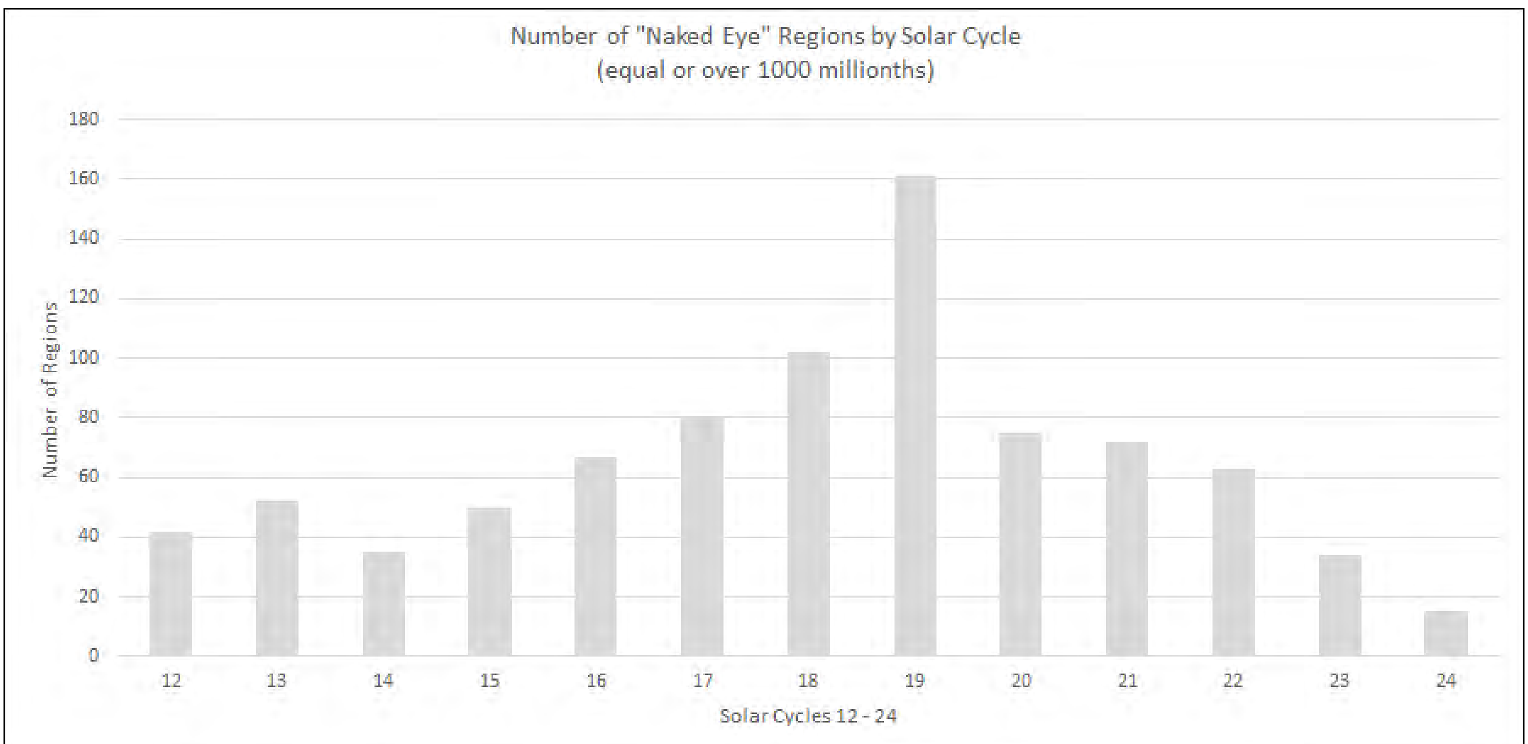

Figure 3

But we can look at how the duration of Cycle 24 stacks up against the duration of the other cycles. Figure 6 shows the length of all Solar cycles since 1874 until today from Solar minimum to the next Solar minimum in years. The one exception is Cycle 24 [which is only shown up to the date of this writing (July 2019)]. For Cycle 24 to equal the time for Cycle 23, we still have a while to go.

Conclusion

We know that the current transition time between over 1,000 millionths regions has already exceeded this transition time identified between cycle 16 to cycle 17 and cycle 18. If the increased cycle 24 - cycle 25 transition time continues as suggested by the upward trend in Figure 5 and Figure 6, it seems we may be in for a prolonged solar low. Or it might be possible that cycle 25 will not have any areas that exceed 2,000 millionth at all.

This is underscored by the fact that the last transition period for the large regions was six years (see Figure 5), and we have not seen a downward peak yet in the current transition. In addition, we have not seen any uninterrupted spotless streaks that lasted substantially longer than a Carrington rotation like at the end of cycle 23.

And lastly, as identified in a previous paper "Are we there yet?", cycle 25 polarized areas, identified by their reverse polarized activity, have been long and far between so far, and very small in size.

Does this mean that this lower activity trend which could not go lower than "spotless" would translate to extending the time period of the solar minimum? It might be that these items suggest that cycle 25 will still be in the making for some time to come.

If, on the other hand, we start seeing the long, spotless streaks and more and larger reversed polarized areas, this may be an indication that the century-long cycle has reversed and an upswing may be in sight.

At this time, we keep monitoring and can only say: Time will tell.

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Frederick Colbourn. 2015. The Gleissberg Cycle of Solar Activity. https://geoscienceenvironment.wordpress.com/2015/10/23/the-gleissberg-cycle-of-solar-activity/

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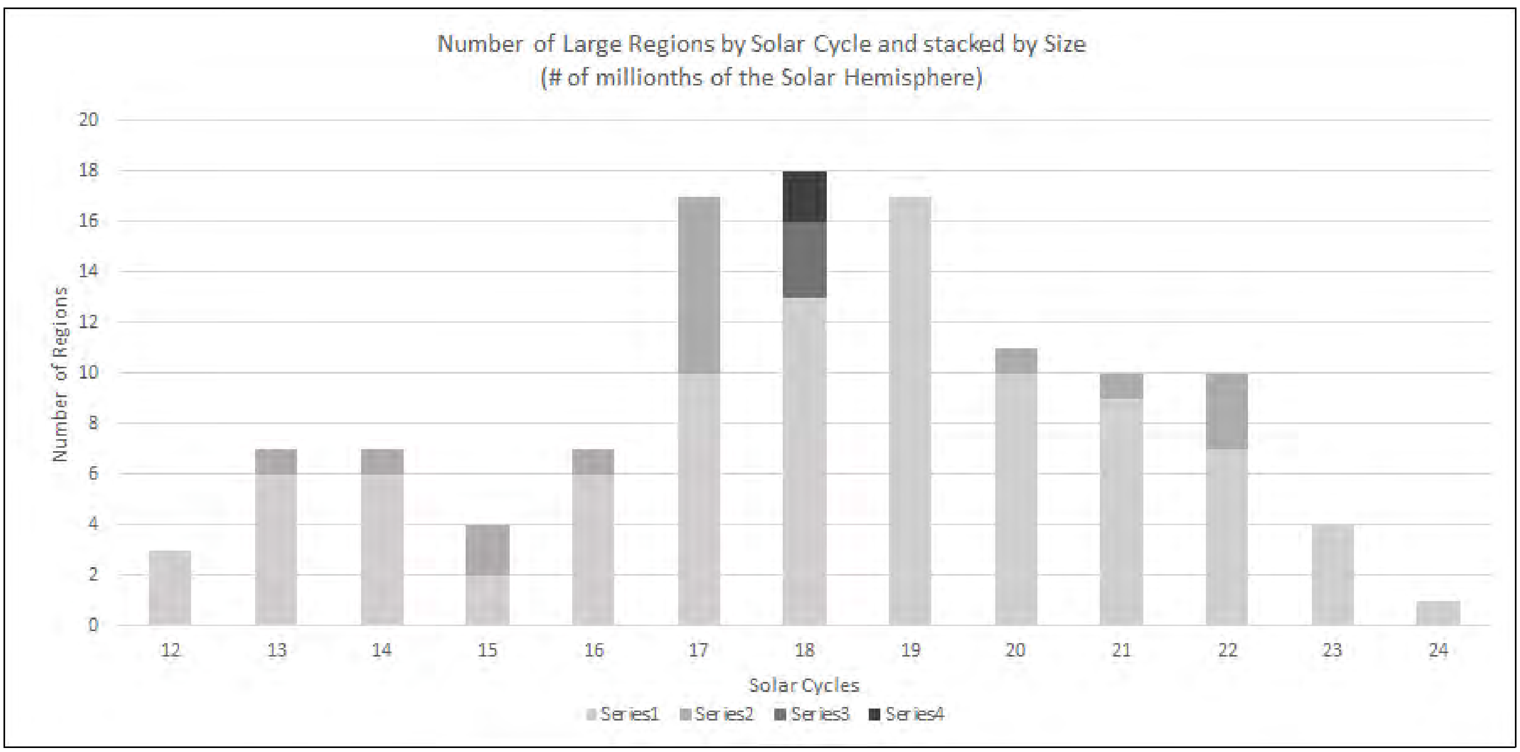

Figure 4

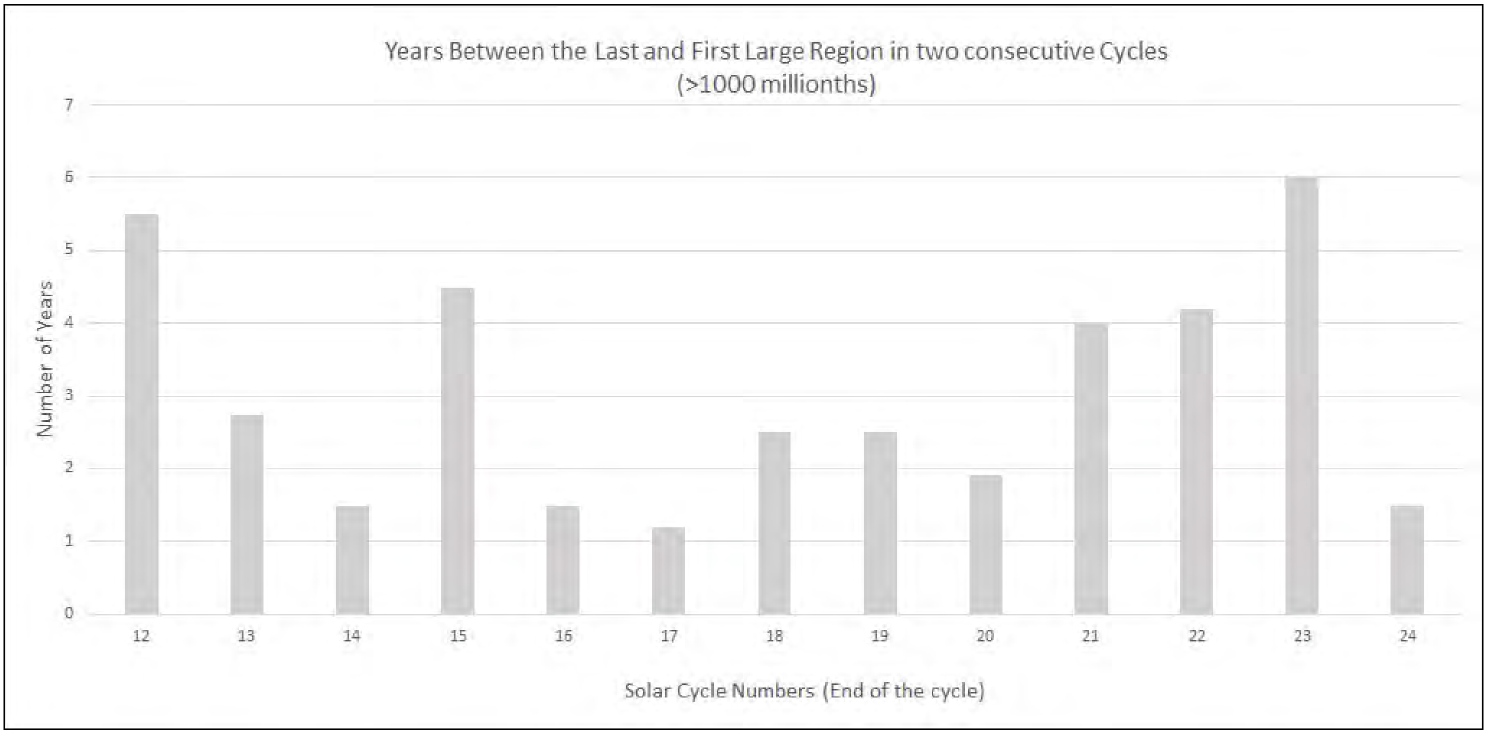

Figure 5

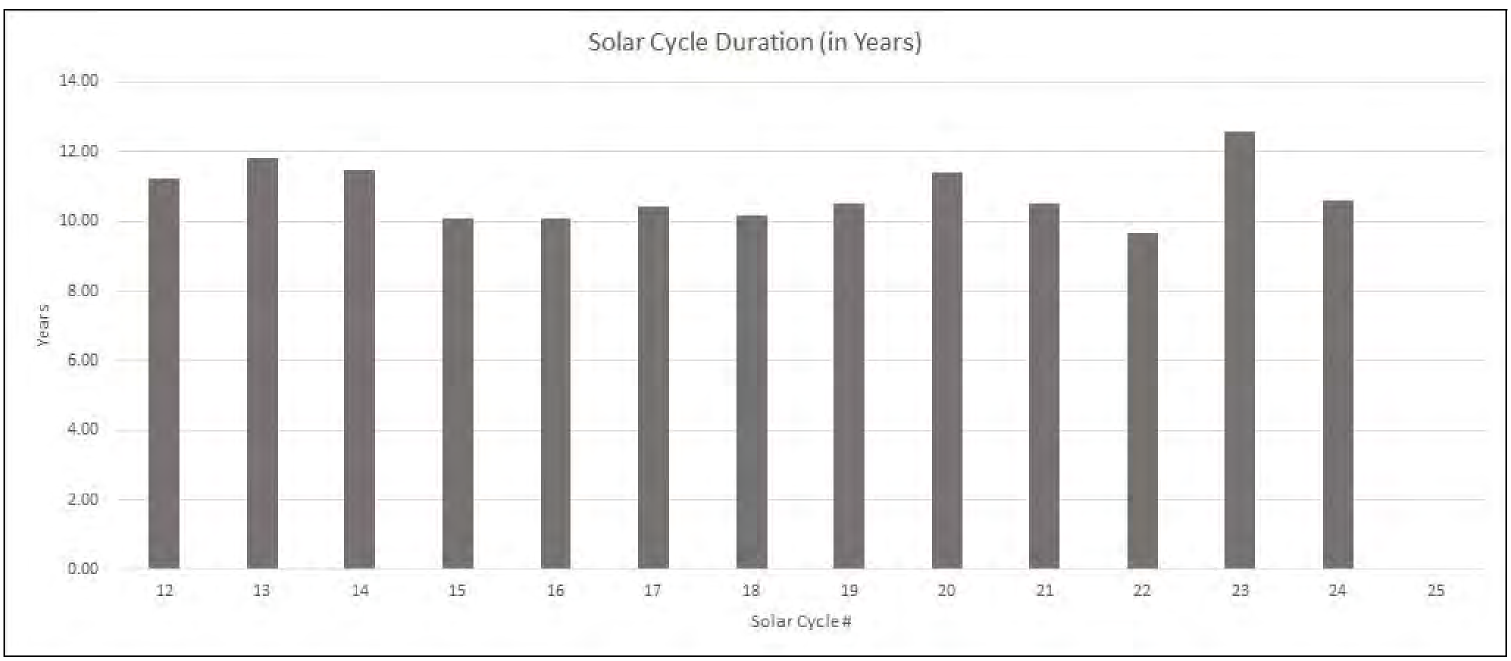

Figure 6

Papers & Presentations:
A Report on Carrington Rotations 2216 through 2220 (2019 04 08.7993 to 2019 08 22.9000)

By Richard (Rik) Hill,
Coordinator &
Scientific Advisor,
ALPO Solar Section
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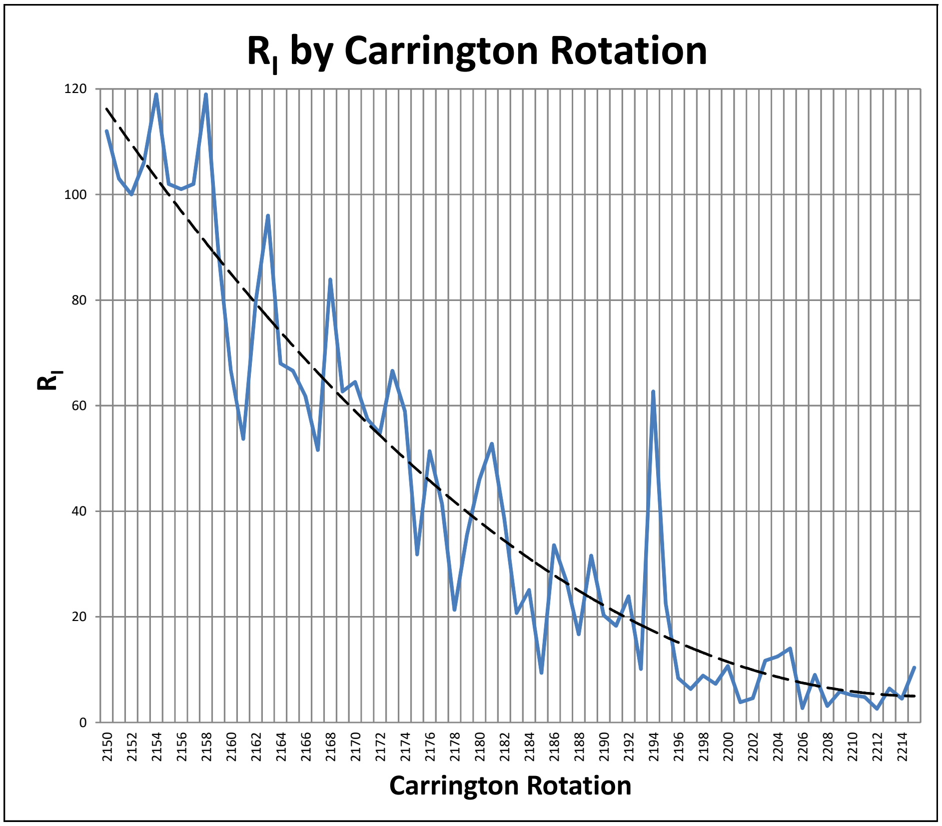
To our hard-copy readers: This paper can be viewed in full-color in the online (pdf) version of this Journal.

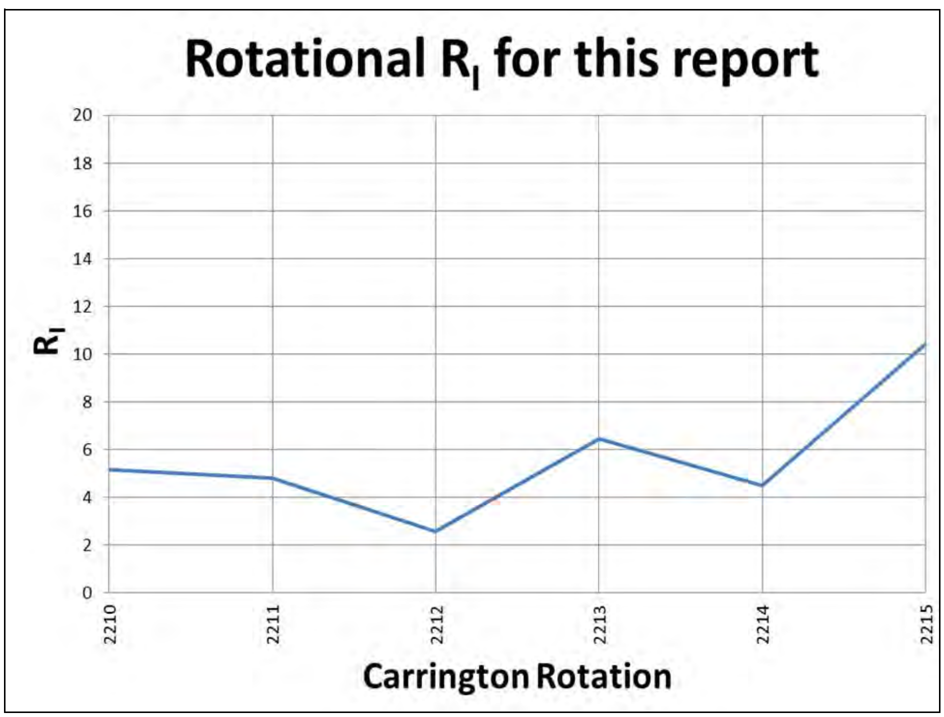
Overview

Activity in this reporting period ranged from very low to extremely low (see "R_I by Carrington Rotation"). The average R_I (international sunspot number) for the period was 3.75, well below the 5.65 of the previous reporting period (CR 2210-2215) as we plunge towards solar minimum.

Of the 137 days of this report, 97 (or about 70%) were spotless. Most of the activity took place in the first two rotations, but then in CR 2218, the bottom fell out of the sunspot numbers with a low for the report occurring in CR 2220 with an R_I average of only 0.85 (see "Rotational R_I for this Report").

Peak daily activity occurred on 5/11 at 27 with ARs 2740 & 2741 on the solar disk. Only one region evolved beyond C-class during the period and that was for only one day: AR 2740, which attained Dho with an area of 280 millionths on 5/6.





Terms and Abbreviations Used In This Report

Readers are encouraged to review this section to reacquaint themselves with the terms and abbreviations that will be used. In this paper, the ALPO Solar Section is referred to as "the Section", and Carrington Rotations are called "CRs". Active Regions are "ARs" and are

Table of Contributors to This Report

Observer	Location	Telescope (aperture, type)	Camera	Mode	Format
Michael Borman	Evansville, IN	102mm, RFR	Point Grey GS3	W-L	digital images
		90mm, RFR		H-a	digital images
		102mm, RFR		CaK	digital images
Richard Bosman	Enschede, Netherlands	110mm, RFR	Basler Ace 1280	H-a	digital images
		355mm, SCT		W-L	digital images
Raffaello Braga	Milano, Italy	112mm,RFR	PGR Chameleon USB 2.0 mono	H-a	digital images
Tony Broxton	Launceston, Cornwall, UK	127mm, SCT	—	W-L	Visual sunspot reports
Jeffery Carels	Bruges, Belgium	100mm, RFR	ZWO-ASI120MM	W-L	digital images
Gabriel Corban	Bucharest, Romania	120mm, RFL-N	Point Grey GS3-U3	H-a	digital images
				W-L	digital images
Brennerad Damacenco	Sao Palo, Brazil	90mm, MCT	ASI224MC	W-L	digital images
Franky Dubois	West-Vlaanderen, Belgium	125mm, RFR	—	W-L	Visual sunspot reports
Howard Eskildsen	Ocala, FL	80mm, RFR	DMK41AF02	W-L wedge	digital images
				CaK	digital images
Joe Gianninoto	Tucson, AZ	85mm, RFR	—	W-L	drawings
		60mm, RFR		H-a	drawings
Guilherme Grassmann	Curitiba, Brazil	60mm, RFR	Lumenera Skynyx 2.0	H-a	digital images
Richard Hill	Tucson, AZ	90mm, MCT	Skyris 445M	W-L	digital images
		120mm, SCT			
David Jackson	Reynoldsburg, OH	124mm, SCT	—	W-L	drawings
Jamey Jenkins	Homer, IL	102mm, RFR	DMK41AF02	W-L	digital images
		125mm, RFR		CaK	digital images
Pete Lawrence	Selsey, West Sussex, UK	102.5mm, RFR	ZWO ASI174MM	H-a	digital images
Monty Leventhal	Sydney, New South Wales, Australia	250mm, SCT	—	W-L/H-a	drawings
			Canon-Rebel	H-a	digital images
Tom Mangelsdorf	Wasilla, AK	120mm, RFR	—	W-L	drawings
Frank Mellilo	Holtsville, NY	200mm, SCT	DMK21AU03AS	H-a	digital images
Efrain Morales	Aguadilla, Puerto Rico	50mm, RFR	Point Grey Flea3	H-a	digital images
German Morales	Cochabamba, Bolivia	200mm, SCT	—	W-L	Visual sunspot reports
John O'Neal	Statesville, NC	6 in., RFR	ZWO AS174MM	Na-D	digital images
Theo Ramakers	Oxford, GA	80mm, RFR	ZWO ASI174MM	H-a	digital images
		11 in., SCT	DMK41AU02AS	W-L	digital images
		40mm, H-a PST	DMK21AU03AS	H-a	digital images
		40mm, CaK PST	DMK21AU03AS	CaK	digital images

Table of Contributors to This Report (Continued)

Observer	Location	Telescope (aperture, type)	Camera	Mode	Format
Ryc Rienks	Baker City, OR	203mm, SCT	—	W-L	drawings
		40mm, PST	—	H-a	drawings
Laura Schreiber	Wuertzburg, Germany	280mm, SCT	Basler IMX174	W-L	digital images
Chris Schur	Payson, AZ	152mm, RFR	DMK51	CaK	digital images
				W-L (CaK-off-band continuum)	digital images
		100mm, RFR	DMK51	H-a	digital images
Randy Shivak	Prescott, AZ	152mm, RFR	ZWO-ASI174	H-a	digital images
Avani Soares	Canoas, Brazil	120mm, RFR	ZWO-ASI 224	W-L	digital images
Randy Tatum	Bon Air, VA	180mm, RFR	DFK31AU	W-L-pentaprism	digital images
David Teske	Louisville, MS	60mm, RFR	—	W-L/H-a	drawings
		100mm, RFR	ZWO-ASI120MM	H-a	digital images
Vince Tramazzo	Tucson, AZ	94mm, RFR	—	W-L	drawings
		50mm, RFR	—	H-a	drawings
James Kevin Ty	Manila, Philippines	TV101-RFR	ZWO-ASI120MM	H-a	digital images
David Tyler	Buckinghamshire, UK	178mm, RFR	ZWO	W-L	digital images
		90mm, RFR	ZWO	H-a	digital images
Christian Viladrich	Nattages, France	300mm, RFN	Basler acA1920-155	W-L	digital images
Talha Zia	Karachi, Pakistan	90mm, RFR	Canon 1200D	W-L	digital images
Telescope Types: Refractor (RFR), Newtonian Reflector (RFN), Schmidt Cassegrain (SCT), Maksutov-Cassegrain (MCT), Cassegrain (Cass)					

designated by the National Oceanic and Atmospheric Administration (NOAA) referring to all activity in all wavelengths for that area on the Sun. Only the last four digits of the full NOAA number are used here. The term "groups" refers to the visible light or "white light" sunspots associated with an active region.

Statistics compiled by the author have their origin in the finalized daily International Sunspot Number data published by the World Data Center - Solar Index and Long Term Solar Observations (WDC-SILSO) at the Royal Observatory of Belgium. All times used here are Coordinated Universal Time and dates are reckoned from that and are expressed numerically, with month/day such as "9/6" or "10/23". Carrington Rotation commencement dates are obtained from the table listed on the ALPO Solar Section web page at: *http://alpo-astronomy.org/solarblog/wp-content/uploads/ephems/CNSun_2159_2306_A.pdf*

The terms "leader" and "follower" are usually used instead of "east" or "west". This follows the "right-hand rule" where, using your right hand, your thumb pointing up is the North Pole and the rotation follows the curl of your fingers. Orientation of images shown here will be north up and celestial west to the right (northern hemisphere chauvinism). The cardinal directions (north, south, east, west) may be abbreviated as N, S, E and W. Central Meridian of the visible disk is shortened to CM.

The abbreviation to indicate white-light observations is "w-l", while hydrogen-alpha is "H-a", calcium K-line is "CaK" and "Na-D" refers to a sodium-D filter. "Naked-eye sunspots" refers to the ability to see these spots on the Sun without amplification but through proper and safe solar filtration.

As a reminder, you should never look at the Sun, however briefly, without such filtration - even at sunrise/set.

Areas of regions and groups are expressed in the standard units of millionths of the solar disk, abbreviated "millionths". Most naked-eye spots are generally about 900-1,000 millionths for the average observer, though one of that size has not been seen for several years now!

The McIntosh Sunspot Classification used here was defined by the late Patrick McIntosh formerly of NOAA (McIntosh 1981, 1989) and is detailed in an article in the JALPO Volume 33 (Hill 1989). This description is also on the ALPO

Solar Section website at *http://www.alpo-astronomy.org/solarblog/?page_id=1233* in an article on white-light flare observation. This will be referred to as the McIntosh Class or simply "class". The magnetic class of regions is assigned by NOAA and will be entered parenthetically after the McIntosh class unless specifically referred to as "mag. class".

Lastly, and due to the constraints of publishing, most of the images in this report have been cropped, reduced or otherwise edited. The reader is advised that all images in this report, and a hundred times more, can be viewed at full resolution in the ALPO Solar Observations Archive.

To access this archive, left-click on the "ALPO Section Galleries" link at the top of the right sidebar of the ALPO home page, at *www.alpo-astronomy.org* then left-click on the Solar Observations folder.

You can also access the Solar Observations Archive via this link:

http://alpo-astronomy.org/gallery3/index.php/Solar-Observations-Archive

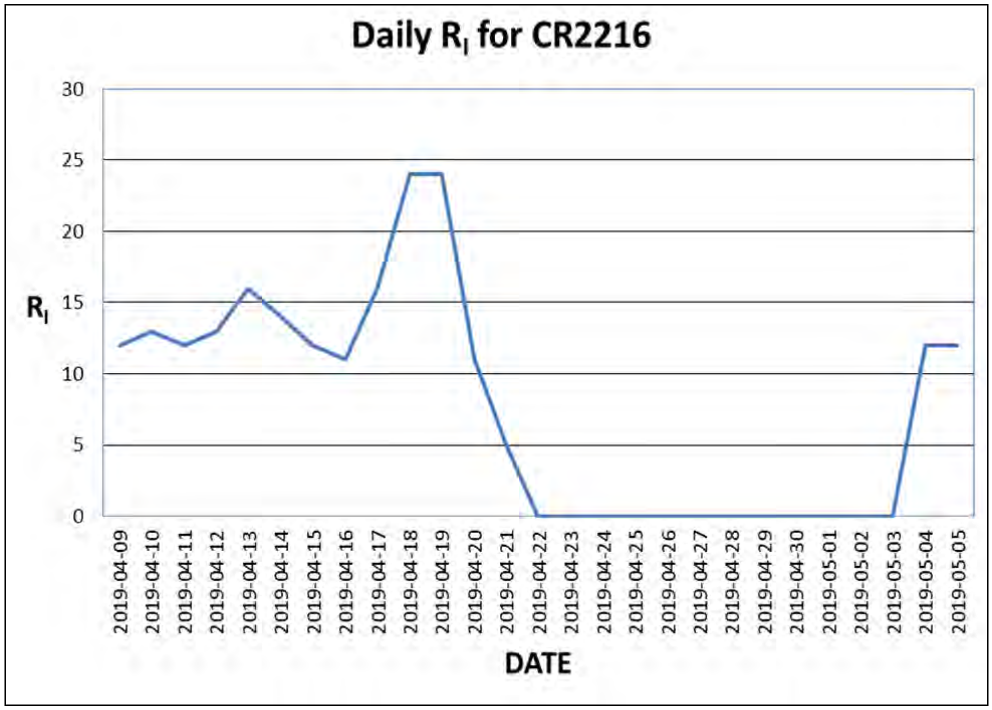
Section observers, their equipment and modes of observing are summarized in the *Table of Contributors* which accompanies this report. While not all individuals necessarily contributed to this specific report, they have contributed to recent reports and are considered ALPO Solar Section members. This should be used as a reference throughout this report.

Carrington Rotation 2216

Dates: 2019 04 08.7993 to 2019 05 06.0542

Avg. R_I = 7.67
High R_I = 24 (4/18 and 4/19)
Low R_I = 0 (12 days)

There were four active regions on the disk for this rotation (AR 2737 thru 2740). The largest region, AR 2738, was officially designated on 4/8 but first captured in the previous rotation by Carels on 4/7 at 10:17 in w-l and then



by Melillo in w-l on 4/7 at 15:25 (figures 1 and 2 respectively).

The next day we get a good look at the state of this region in three colors by Eskildsen (Figure 3). It was at this time listed as Hsx (alpha) with an area of 300 millionths with only 8 small flares noted in the first two days. Not much changed in this region over the next few days and Tyler got a good look in both H-a and w-l on 4/10 at 09:48 and 08:59 respectively (Figure 4). In the H-a view, we can see the flare-producing plage following the single, large leader spot, though it was only producing one small flare every 3-4 hours. In w-l, we can see the smaller following spots that changed the class from Hsx to Cho of 300 millionths area (beta). On 4/14 we see that the region is only slightly different with the official class and area unchanged.

This class was confirmed in a w-l image by Zia at 07:02 showing a few small pores following a fairly circular main spot with a hole near the center of the umbra. Zia shows a size comparison with 4 Earths laid side-by-side (Figure 5).

On the same day, we get a spectacular CaK by Viladrich at 10:53 that shows how the hold in the main umbra is likely a small region trapped by merging umbral spots (Figure 6). The next day, 4/15, the region became Hhx of 250 millionths and stayed that way, with slight variations in area, until it left the disk on 4/19.

Carrington Rotation 2217

Dates: 2019 05 06.0542 to 2019 06 02.2701

Avg. R_I = 10.5
High R_I = 27 (5/11)
Low R_I = 0 (13 days)

There were only two active regions for this rotation (AR 2740 and AR 2741), which are the returns of AR 2738 and AR 2739 respectively from the previous rotation. We get a first good look at the first region, AR 2740, in two Ramakers images from 5/6 at 13:10 (w-l) and 13:16 (CaK). Note how the faculae mimic the layout of the plage (Figure 7). The class was Dho of 280 millionths area (beta-delta) and in 48 hours, it produced several dozen small flares up to C9.9 in that plage area. This would be maximum development for this region. In these images, AR 2741 can be seen on the extreme limb.

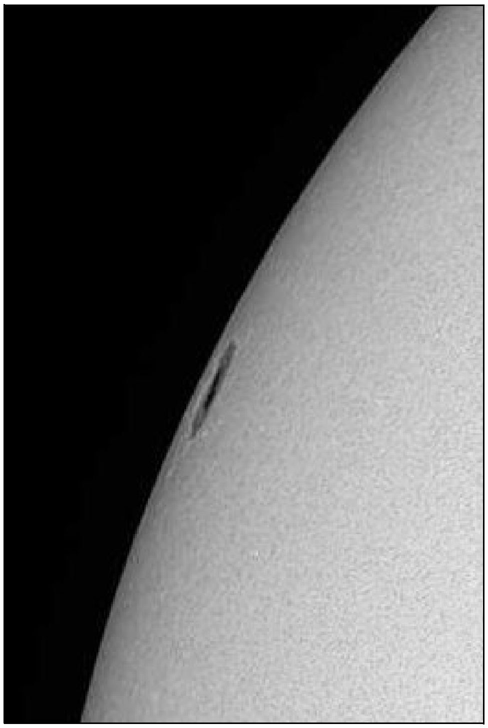


Figure 1. AR 2738 as observed in white light by Carels at 10:17 UT on 4/7.

Figure 2. A Melillo H-a image of AR 2738 on 4/7 at 15:25 UT.

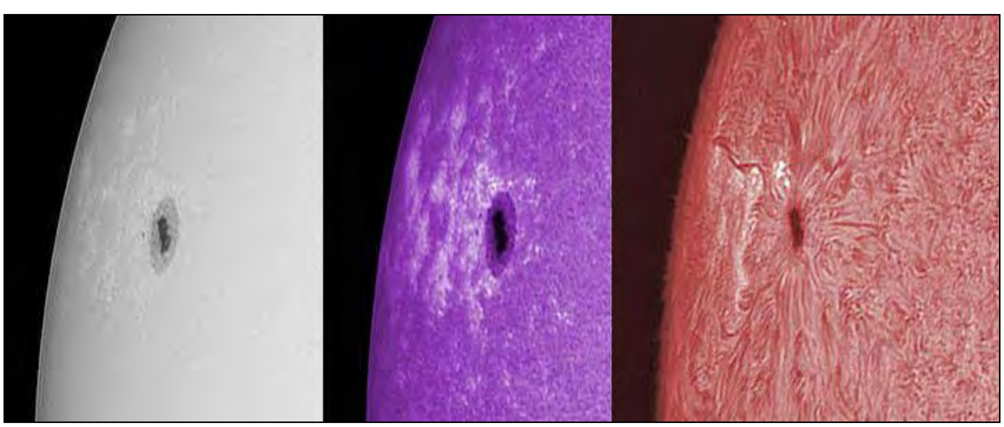


Figure 3. A three-pane w-l, CaK and H-a image of AR 2738 by Eskildsen on 4/8 at 14:10, 14:28 and 14:14 UT respectively.

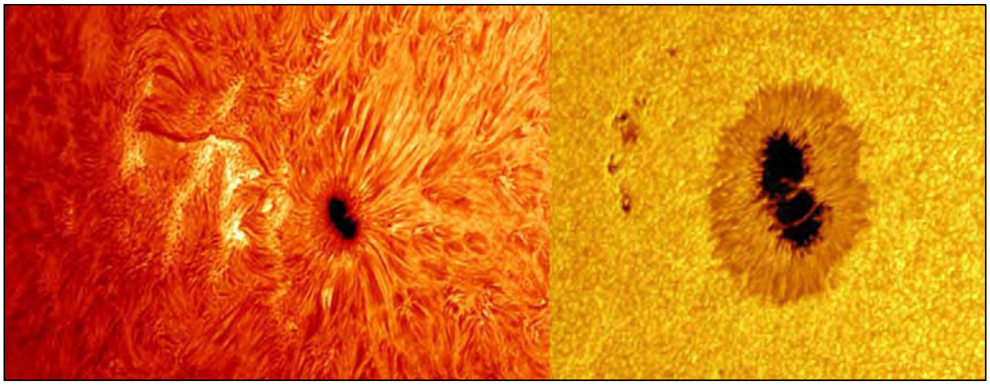


Figure 4. Two Tyler images of AR 2738 on 4/10 in H-a and w-l at 9:48 and 9:59 UT respectively.

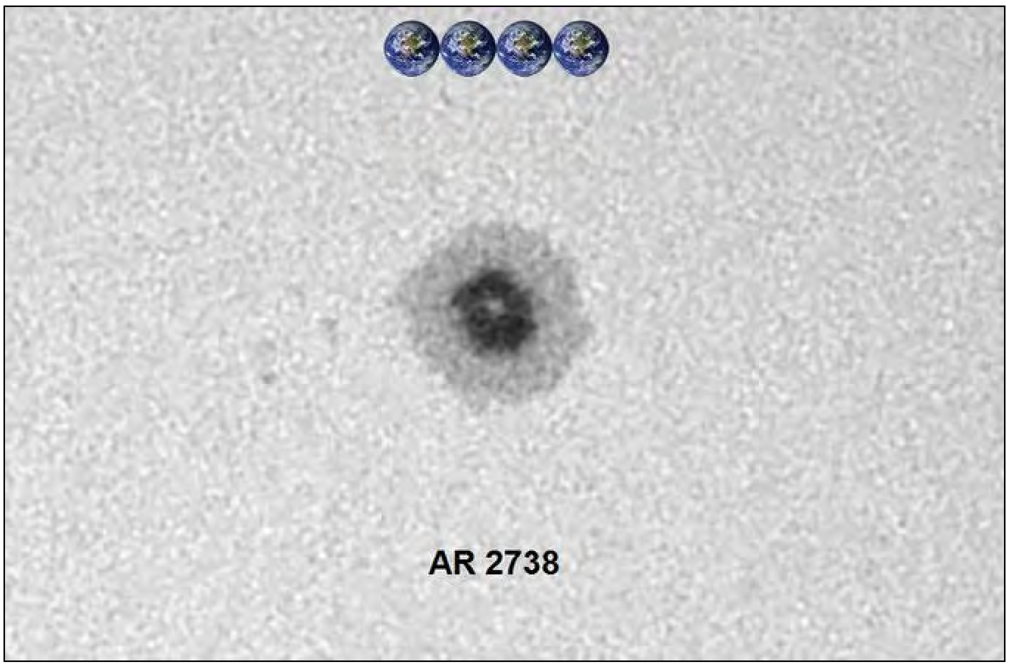


Figure 5. AR 2738 in a w-l image by Zia on 4/14 at 07:02 UT with earth images for comparison.

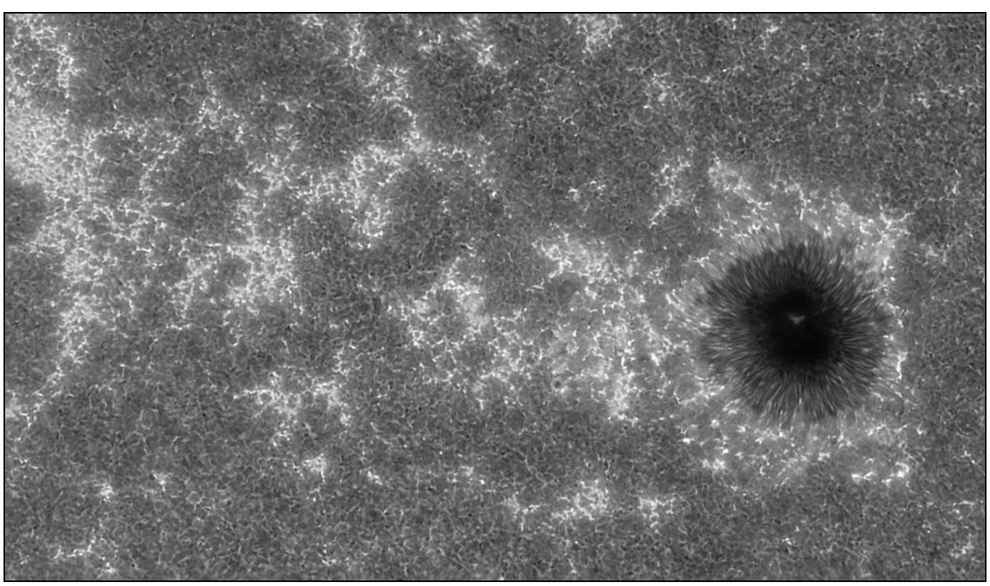
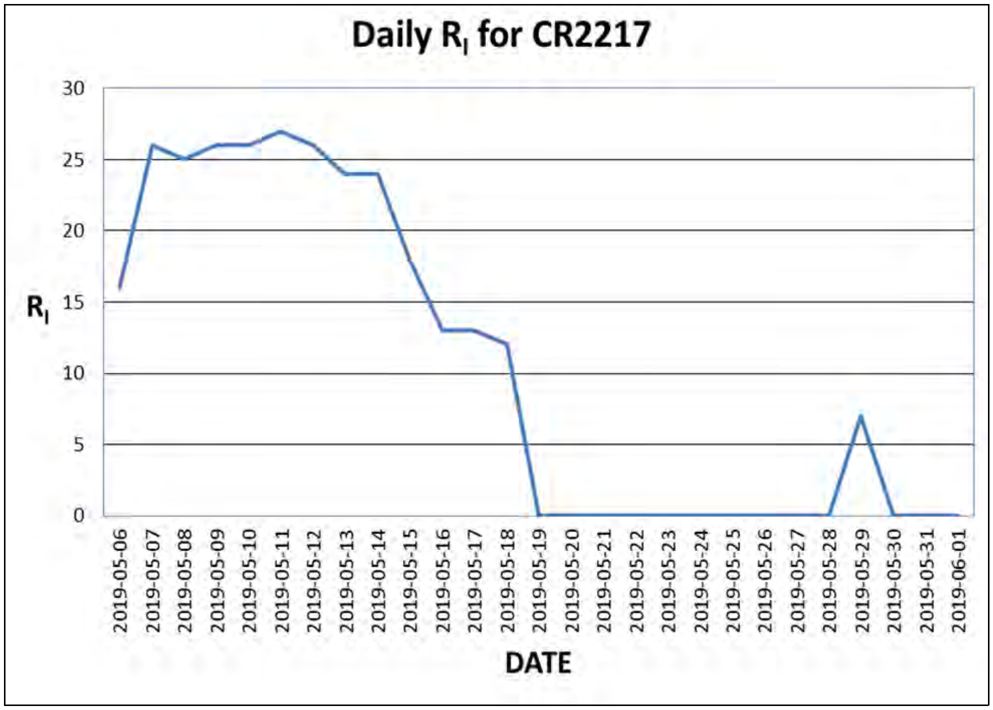


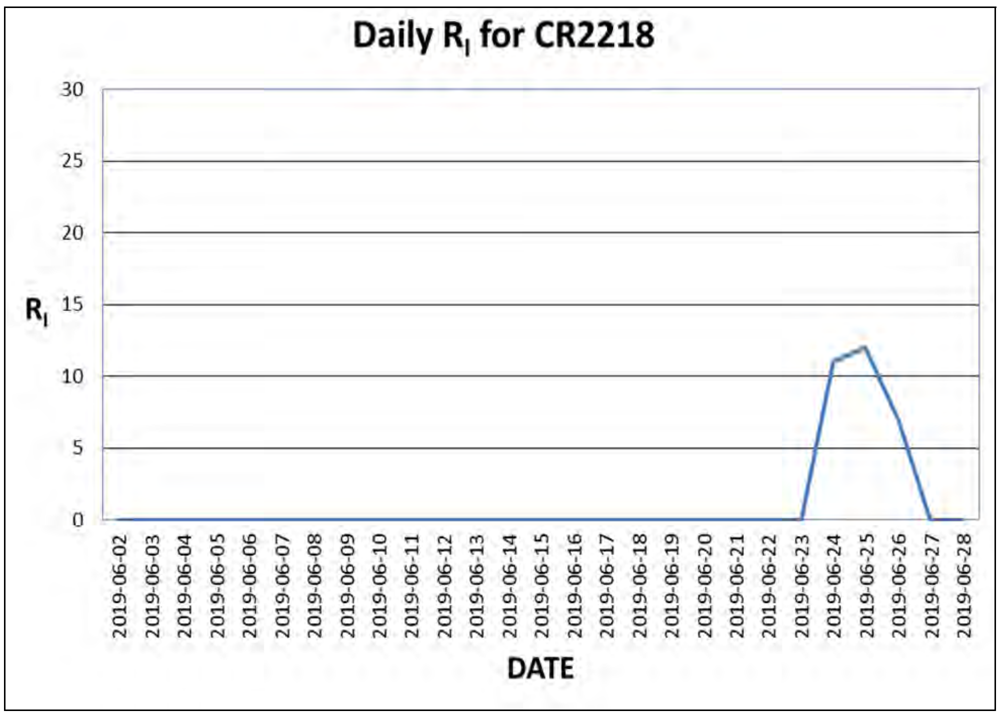
Figure 6. A high-resolution CaK image of AR 2738 by Viladrich at 10:53 UT on 4/14.

On 5/7, Viadrich got another spectacular H-a image of AR 2740 (no time given) showing large projecting filaments (Figure 8). Then on 5/8, Shivak got a breathtaking sub-arc-second image in H-a of AR 2741 (Figure 9). It dramatically shows the sunspot rising over the following plage. Meridian passage for AR2 2740 was on 5/9.

On that date both regions were officially listed as 160 millionths of the disk, with AR 2740 being classed as Cao (beta) and 2741 as Hsx (alpha). They are together seen here on a Grassmann H-a image and it's a little hard to see the equivalence in area (Figure 10). Leventhal classed them as Cki and Hhs late on the same date. Note the dark, short filament above and to the left of AR 2740. Corban got a very interesting look at this on 5/11 in H-a and another on the opposite side of the region (Figure 11). AR 2740 devolved to Hrx as it approached the limb and was only 10 millionths by 5/14. But AR 2741 continued to provide a nice target for a few more days.

On 5/16 we have a good w-l image by Tyler at 10:54 (Figure 12) and a rarity, an AR drawing by Carels at 20:19 (Figure 13). The drawing's features are nicely confirmed in the Tyler image. At this time AR 2741 was listed as Hax region of 150 millionths (alpha). We get a final view of this region on the limb in three filtrations by Ramakers on 5/18 (Figure 14). The class and area are unchanged and the region had become completely quiescent with no reported flares in over 48 hours.





Carrington Rotation 2218

Dates: 2019 06 02.2701 to 2019 06 29.4674

Avg. R_I = 1.11
High R_I = 12 (6/25)
Low R_I = 0 (24 days)

There were only two active regions for this rotation (AR 2742 & 2743), neither of which exceeded 10 millionths in area or lasted more than a couple days. The official designation was made on 6/24 and Grassmann got a good CaK image of both regions on 6/25 at 12:51 (Figure 15).

Corban got an interesting negative H-a image of AR 2743 on 6/26 at 12:45 where he expands the contrast on a positive inset blow-up of the region (Figure 16).

Carrington Rotation 2219

Dates: 2019 06 29.4674 to 2019 07 26.6715

Avg. R_I = 1.19
High R_I = 9 (7/7)
Low R_I = 0 (23 days)

There were only two active regions for this rotation (AR 2744 & 2745). Only

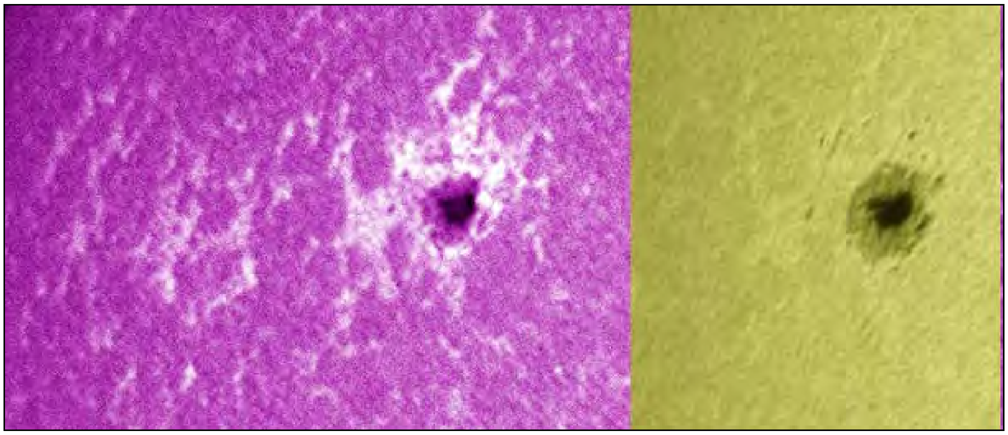


Figure 7. Two images of AR 2740 by Ramakers on 5/6 CaK on the left at 13:16 UT and w-l on the right at 13:10 UT. Notice AR 2741 on the limb.

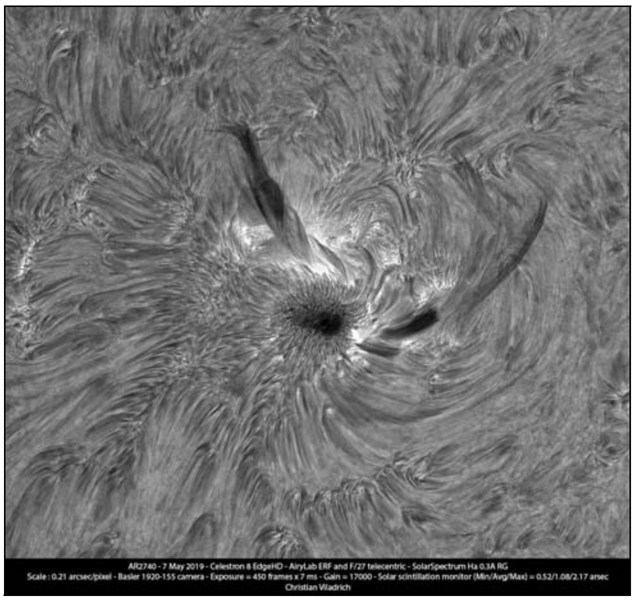


Figure 8. Amazing Viladrich H-a view of AR 2740 on 5/7 (time unspecified).

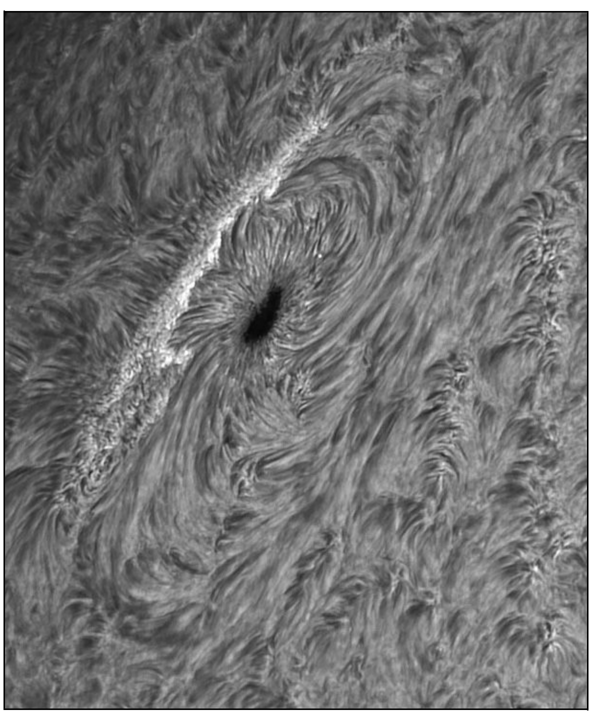


Figure 9. A beautiful sub-arc-second H-a image of AR 2741 on 5/8 at 13:39 UT by Shivak.

Figure 10. A Grassmann H-a image showing AR 2740 and 2741 together on the disk at 12:23 UT on 5/9.

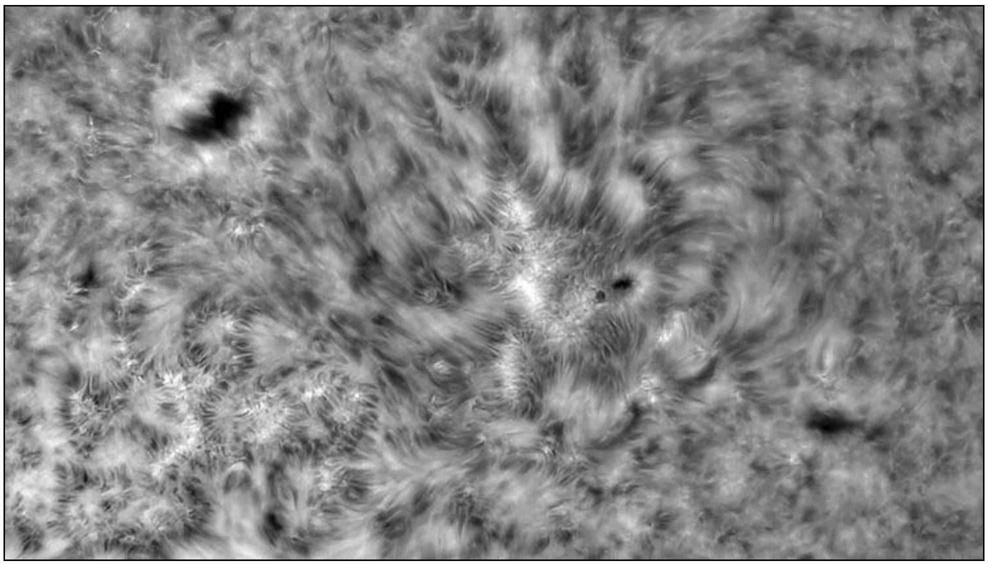


Figure 11. H-a image on 5/11 at 15:16 UT of AR 2740 by Corban showing the dark filament piece northeast of the spot (near center).

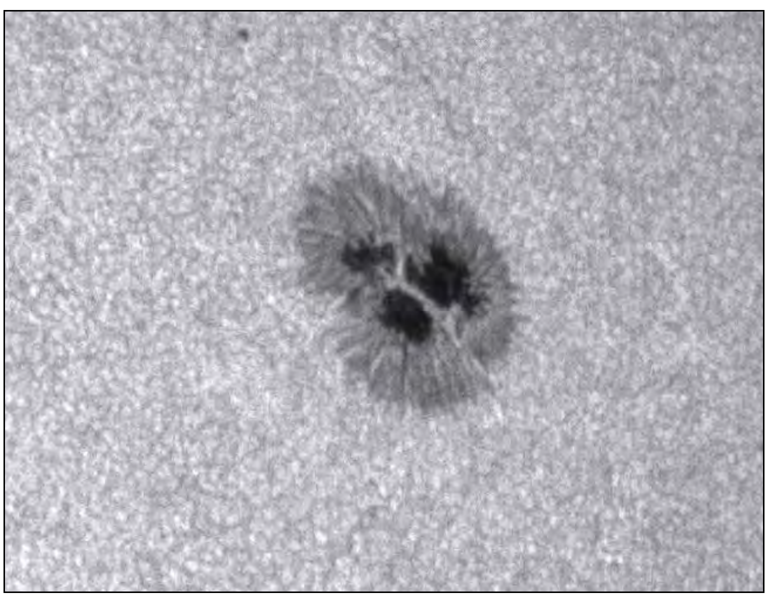


Figure 12. A Tyler w-l image of AR 2741 on 5/16 at 10:54 UT showing good internal umbral detail.

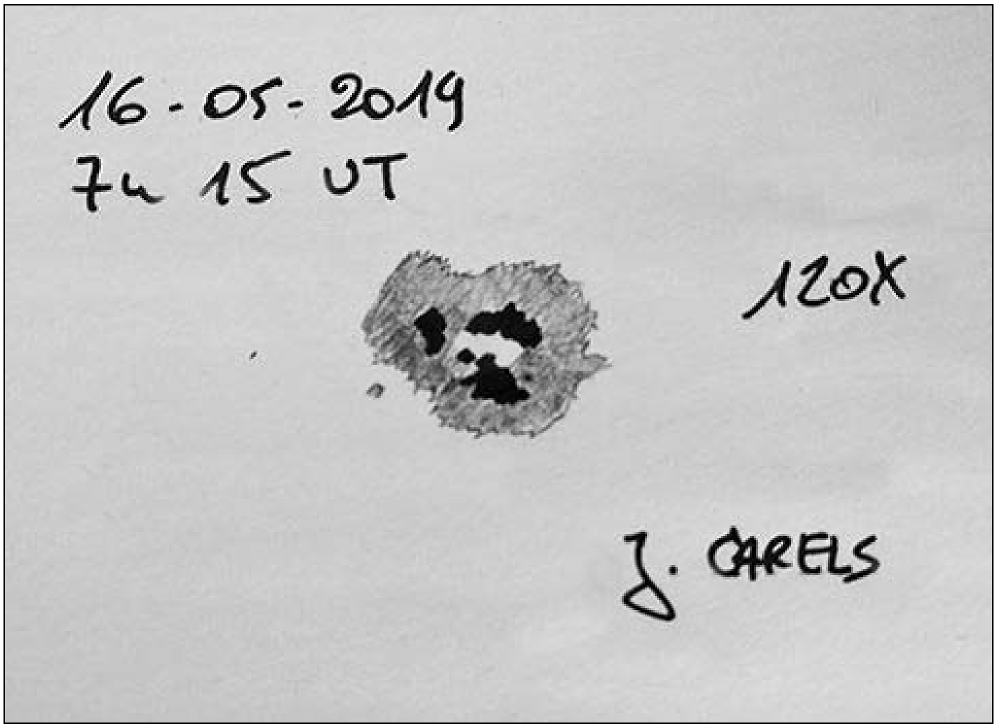
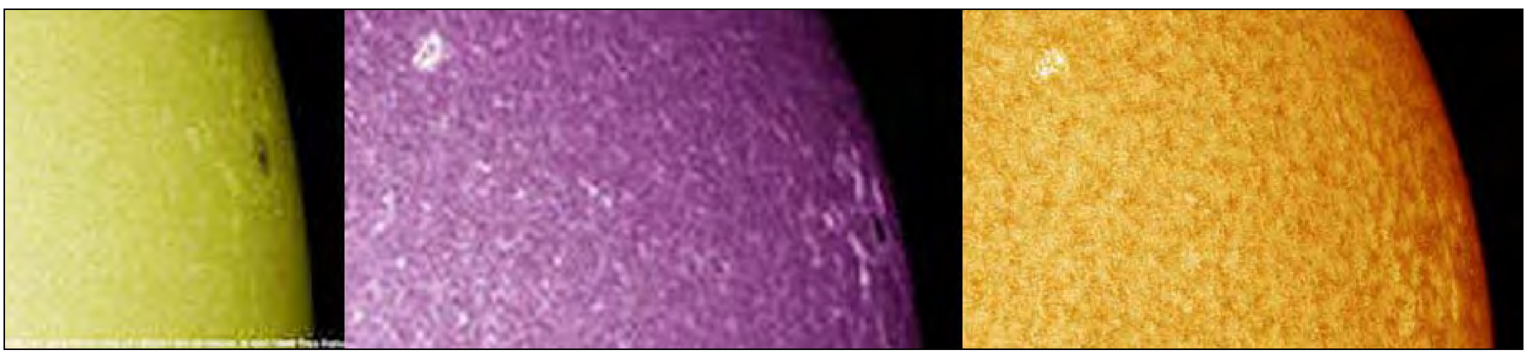


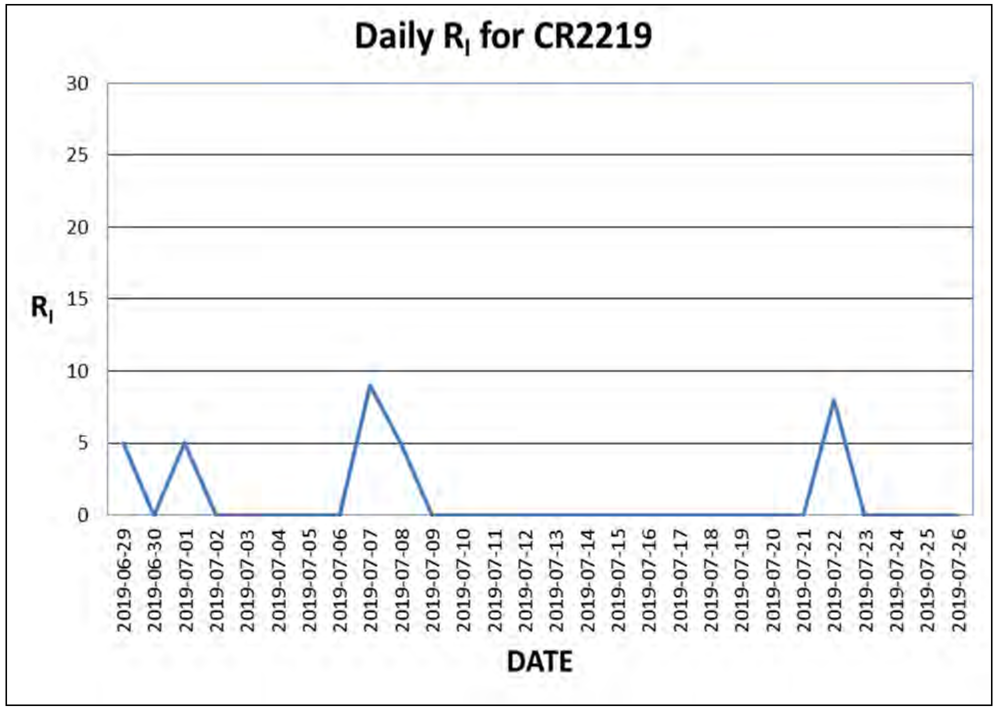
Figure 13. A Carels w-l regional drawing of AR 2741 on 5/16 at 07:15 UT. Compare to figure 12.

Figure 14. Three images of AR 2741 by Ramakers on 5/18. Left to right: w-l (12:50 UT), Cak (12:55 UT) and H-a (13:01 UT).



AR 2744 got to Bxo 20 millionths for one day. Nevertheless, there were some interesting features that deserve mention.

Corban caught some beautiful feathery limb prominences on 6/30 at 13:18 and Ramakers caught dark filaments on several days with the one on 7/7 at 12:59 being the best (figures 17 and 18 respectively).



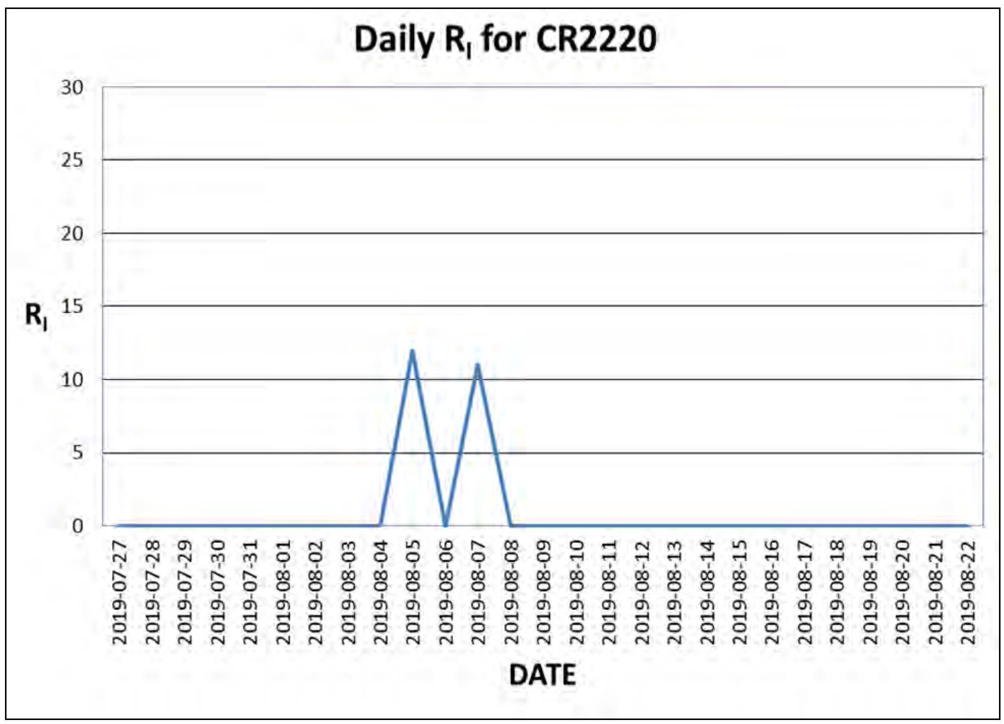
Carrington Rotation 2220

Dates: 2019 07 26.6715 to 2019 08 22.9000

Avg. R_I = 0.85
High R_I = 12 (8/5)
Low R_I = 0 (25 days!)

This was the nadir of activity for this report and since the last solar minimum! While there were three active regions (AR 2745 thru 2747) all occurring between 8/4 and 8/9, none were over 10 millionths area.

A couple of images serve to show the larger of these regions, AR 2745 by Viladrich in H-a on 8/6 and Corban (also in H-a) on 8/9 (figures 19 and 20 respectively).



Conclusion

Activity continues to decline and will continue that trend for at least another year. Still, we need people to be watching for the unusual - like the things highlighted here - and to detect whatever may signal an increase into Cycle 25. Polar faculae and filaments are a good thing to watch for.

While we have a number of observers on our Observers Table, a few have allowed their ALPO membership to lapse. Let me point out that the minimum membership dues in our fine organization is only $18 (U.S.) and that gets you the digital Journal of the ALPO with full-color images of all our observations, something not available in the hard-copy Journal. Please consider renewing/joining as it supports the ALPO as well as being a very good deal and gives you and your observations more exposure in the amateur astronomical community.

For more information go to: *http://www.alpo-astronomy.org/member/ALPO_Standard_Memberships.html*

Sunny skies to you all!

References

Hill, R.E., (1989) "A Three-Dimensional Sunspot Classification System" *Journal of the Assn of Lunar & Planetary Observers*, Vol. 33, p. 10. *http://articles.adsabs.harvard.edu/cgi-bin/nph-iarticle_query?1989JALPO..33...10H&data_type=PDF_HIGH&whole_paper=YES&type=PRINTER&filetype=.pdf*

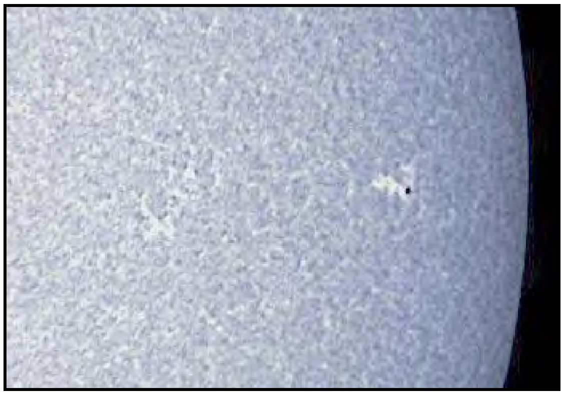


Figure 15. A Grassmann CaK image of both AR 2742 and 2743 at 12:51 UT on 6/25.

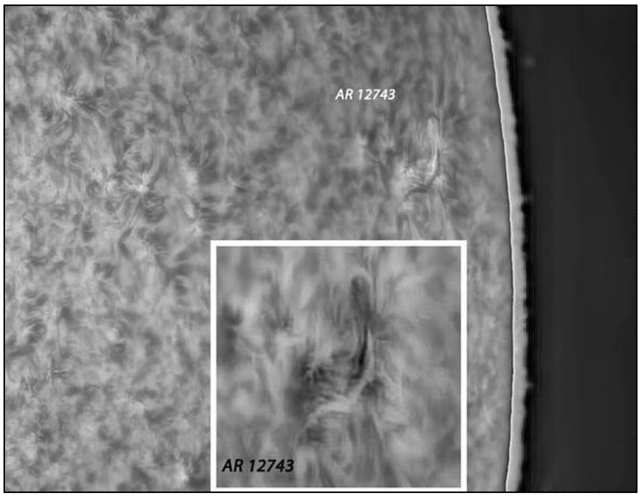


Figure 16. A Corban close-up negative and positive view of AR 2743 on 6/26 at 12:45 UT.

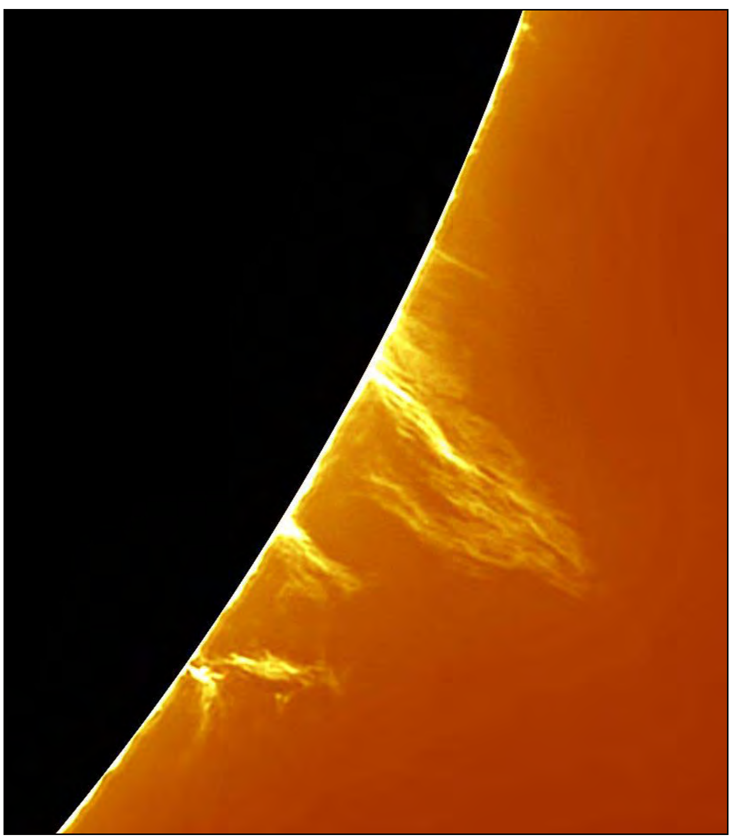


Figure 17. Beautiful limb prominences by Corban on 6/30 at 13:18 UT.

Livingston, W., Penn, M.; (2008) "Sunspots may vanish by 2015." *https://wattsupwiththat.files.wordpress.com/2008/06/livingston-penn_sunspots2.pdf*

McIntosh, Patrick S., (1981) "The Physics Of Sunspots". Sacramento Peak National Observatory, Sunspot, NM; L.E. Cram and J.H.Thomas (eds.), p.7. *https://sourcelibraries.com/browse/the-physics-of-sunspots/*

McIntosh, Patrick S., (1989) "The Classification of Sunspot Groups" *Solar Physics*, Vol. 125, Feb. 1990, pp. 251-267. *http://adsabs.harvard.edu/abs/1990SoPh..125..251M*

Additional references used in the preparation of this report:

Solar Map of Active Regions
https://www.raben.com/maps/date

SILSO World Data Center
http://sidc.be/silso/home

SILSO Sunspot Number
http://www.sidc.be/silso/datafiles

The Mass Time-of-Flight spectrometer (MTOF) and the solar wind Proton Monitor (PM) Data by Carrington Rotation
http://umtof.umd.edu/pm/crn/

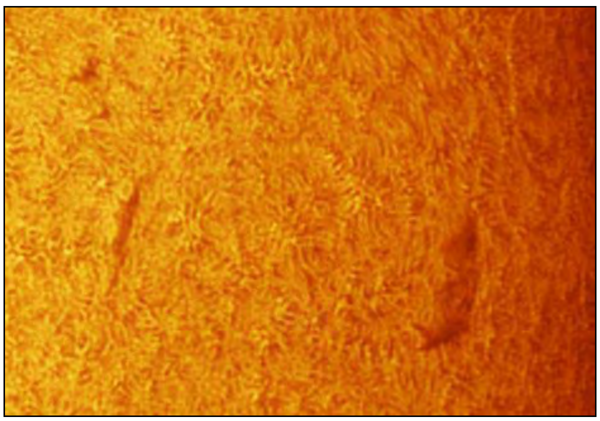


Figure 18. Two short, dark filaments imaged in H-a by Ramakers on 7/7 at 12:59 UT.

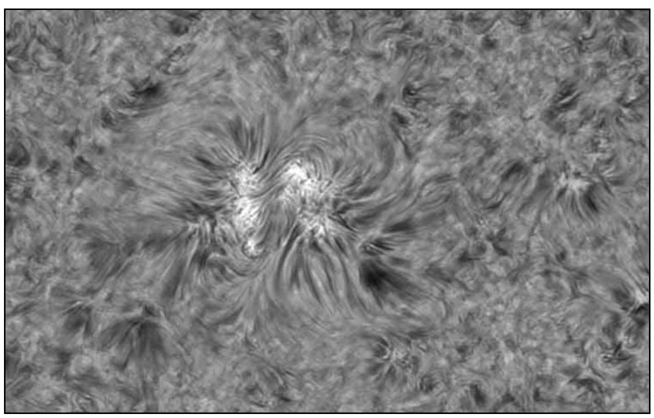


Figure 19. A very detailed H-a image of AR 2745 by VIladrich on 8/6 at 08:27 UT.

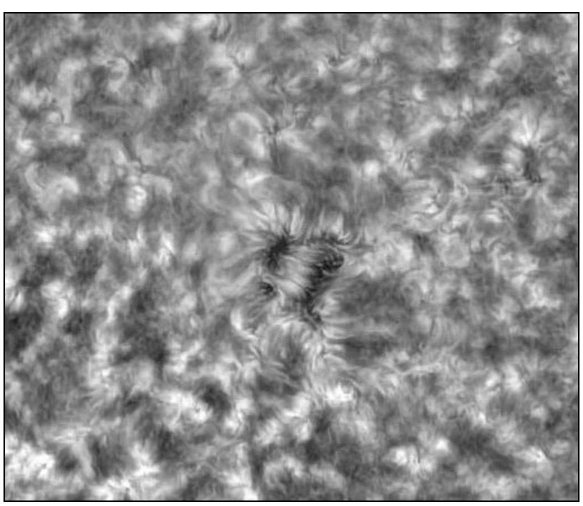


Figure 20. A sub-arc-second look AR 2745 in H-a by Corban on 8/9 at 13:51 UT.

ALPO Solar Section

OBSERVER____

ADDRESS____

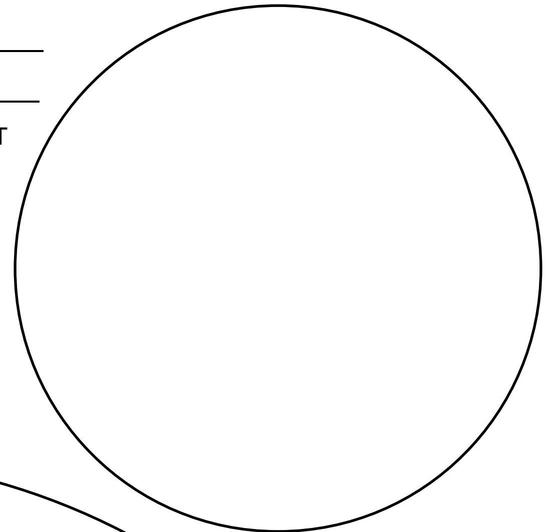
DATE/TIME____UT

SEEING____________ CLOUDS____________ WIND____________

APERTURE__________mm FOCAL LENGTH__________mm TYPE________

EYEPIECE________mm FILTRATION__________________________

OBSERVATION: *DIRECT* OR *PROJECTED*? (CIRCLE ONE)



ROTATION________________

P_____ B_____ L_____

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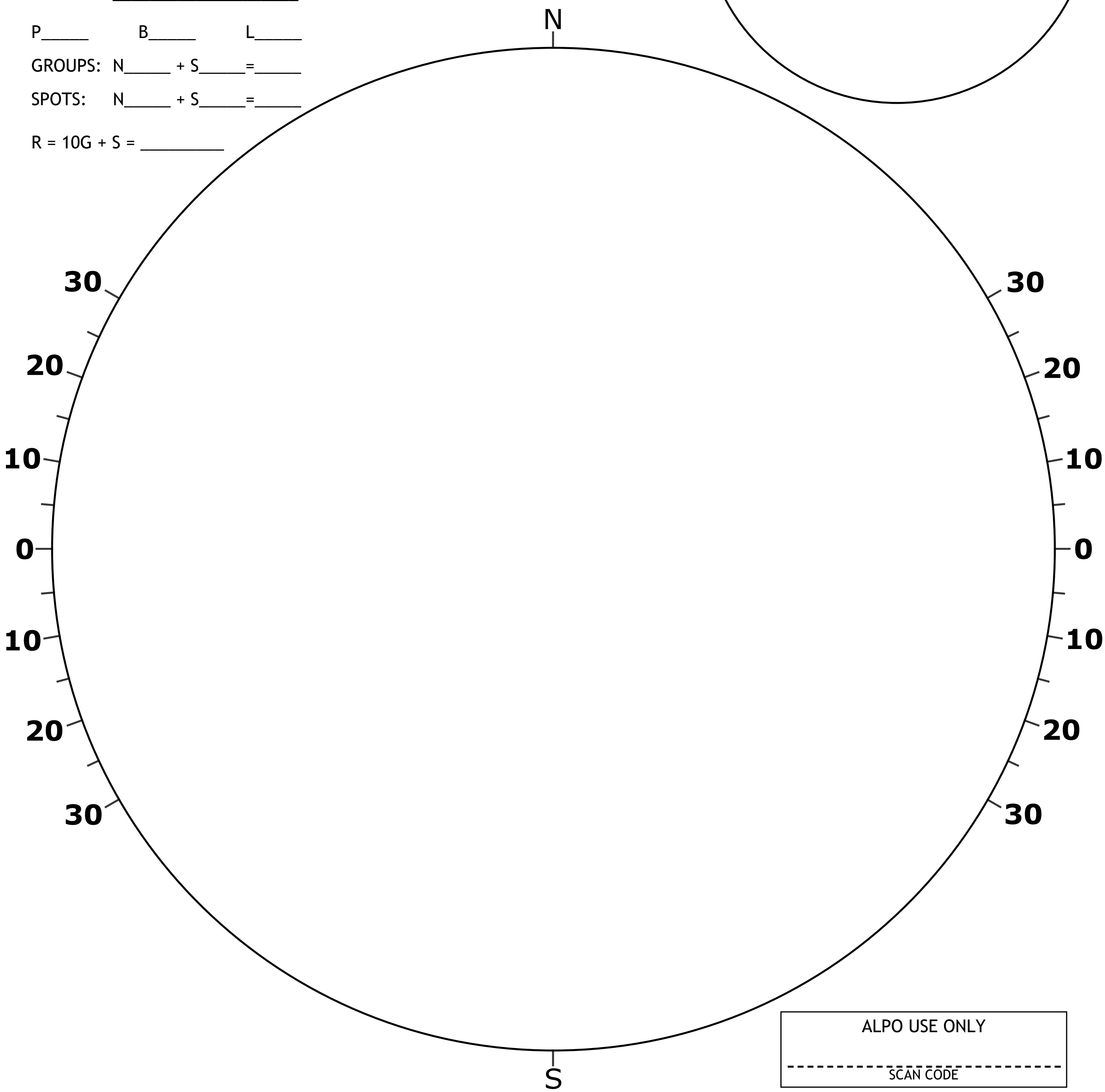

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SCAN CODE

ALPO SOLAR SECTION

ACTIVE REGION DRAWING REPORT FORM

SKY/SITE

Date/Time(UT) ____

Rotat.No. _______ A.R. __________ Cen.Meridian _________ Altitude _________

Sky cond. _____________ Seeing __________ Clouds _____________ Wind ________

Observatory type (circle one): roll off roof, roll off bldg., dome, none

TELESCOPE:

Inst. type ________________________ Mounting type ___________________________

Clock drive? ______ Type of drive ____

Full aperture ___________________________ Focal length ____________ f/________

Aperture stop/type ___________________________ Final f/_______________________

Address: Phone No. ( )area code_______________________

Papers & Presentations

Lunar Domes in the Milichius - Tobias Mayer Region: Dome M23

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Abstract

In this study we examine a lunar dome identified using CCD terrestrial images, Clementine multispectral data, Chandrayaan-1 Moon Mineralogy Mapper (M^3) data, LROC WAC images and the LROC WAC-based GLD100 DTM. The dome, named M23, lies to the west of the crater T. Mayer and has a base diameter of 5.5 km, height of 230 m and average slope angle of 4.70°. Spectral data indicate a basaltic composition. Based on the morphometric properties, we infer the physical conditions under which the M23 dome was formed (lava viscosity, effusion rate, magma rise speed) as well as the geometries of the feeder dikes. Finally, using newly acquired data we have updated our maps, which illustrate the distribution of lunar domes in the wide Milichius - T. Mayer - Hortensius shield.

Introduction

The apparent indigenous origin of lunar domes was a major factor in endogenic interpretations of the maria, and their low profiles suggest a volcanism characteristic of fluid mafic magmas (Wilhelms, 1987). The extrusive origin of lunar domes and their similarity to terrestrial features like small shield volcanoes have been described in the literature (Head & Gifford, 1980; Basaltic Volcanism Study Project, 1981).

Since 2004 our survey has identified and characterized a total of 22 domes (M1-M22) in the Milichius -Tobias Mayer region and 11 domes (H1-H11) in the Hortensius region, for a total of 33 domes (Lena & Phillips, 2019).

In this paper, we describe the results of a survey made on the T. Mayer region in order to characterize additional lunar domes, updating our lunar dome catalogue. Our survey focused on the search for small domes using, in addition to telescopic images, the Lunar Reconnaissance Orbiter (LRO) WAC imagery.

The current study describes a newly identified lunar dome, located to the west of T. Mayer crater, at coordinates 15.61° N and 29.95° W, which we designate M23. We examine the morphometric characteristics by making use of a combined photoclinometry and shape from shading approach (Lena et al., 2013; Wöhler, Lena & Phillips, 2007) and Lunar Reconnaissance Orbiter (LRO) WAC imagery, including the LOLA Digital Elevation Model (DEM) and GLD100 dataset. The obtained values are used to derive information about the physical parameters of dome formation providing a geological interpretation of our morphometric data.

Data Sources and Approach

The new global topographic map of the Moon obtained by the Lunar Reconnaissance Orbiter (LRO) is the principal source of topographic information used in this study. Associated topographic profiles were extracted using the Quickmap LRO global basemap ((http://target.lroc.asu.edu/da/qmap.html).

The morphometric data have been obtained using the Lunar Orbiter Laser Altimeter (LOLA) instrument on the Lunar Reconnaissance Orbiter (LRO) spacecraft with a grid size of 1/1,024 degrees (Smith et al., 2010) and the GLD100 dataset. Scholten et al. (2012) computed a digital terrain model at 100 m/pixel (named the LRO WAC Global Lunar DTM 100 m, properly shortened to the "GLD100" model) covering 79° S-79° N with a vertical accuracy of 10 m. This DEM has been constructed based on photogrammetric analysis of LRO WAC image pairs. To determine the morphometric properties of the dome we also make use of an image-based 3D reconstruction approach which relies on a combination of photoclinometry and shape from shading techniques (Lena et al., 2013; Horn, 1989). This method takes into account the geometric configuration of camera, light source, and the surface normal, as well as the reflectance properties of the surface to

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Also left-click on any hyperlinks in blue text within the text of this paper for additional information.

Observing Scales

Standard ALPO Scale of Intensity:
0.0 = Completely black
10.0 = Very brightest features
Intermediate values are assigned along the scale to account for observed intensity of features

ALPO Scale of Seeing Conditions:
0 = Worst
• 10 = Perfect

IAU directions are used in all instances.

Table 1. Observers and Number of Analyzed CCD Images

Observers	Images	Telescope
R. Barzacchi (Italy)	1	Dobsonian 477 mm
R. Benavides (Spain)	1	Schmidt Cassegrain 280 mm
H. Eskildsen (USA)	2	Refractor 254 mm
G. Heinen (Luxembourg)	3	Schmidt Cassegrain 235 mm
R. Lena (Italy)	3	Mak Cassegrain 180 mm
J. Phillips (USA)	3	TMB 254 mm refractor
C. Zannelli (Italy)	1	Schmidt Cassegrain 355 mm
M. Wirths (USA)	2	Dobsonian 400 mm

be reconstructed, as described in an previous article which appeared in this journal (Lena & Phillips, 2018).

Spectral analyses are based on the calibrated and normalized Clementine UVVIS reflectance data (Eliason et al., 1999). In this work, we also use data from the Chandrayaan-1 Moon Mineralogy Mapper instrument to derive spectral data that highlight mineralogical characteristics of lunar volcanic materials. The M^3 is an imaging reflectance spectrometer that can detect 85 channels between 460 to 3,000 nm, and has a spatial resolution of 140 and 280 meters per pixel (Isaacson et al., 2011). Data have been obtained through the M^3 calibration pipeline to produce reflectance with photometric and geometric corrections using image set taken during the optical period OP2C1.

Ground-Based Observations and WAC (LRO) Imagery

For the current study we have analyzed 16 CCD images reported in Table 1 made by Barzacchi, Benavides, Eskildsen, Heinen, Lena, Phillips, Zannelli and Wirths. The image shown in Fig. 1 displays the region around T. Mayer crater under different solar illumination angles. We have many more images in our archives.

The Lunar Reconnaissance Orbiter (LRO) WAC image (Fig. 2) displays the newly identified lunar dome designated M23. The image is shown in cylindrical projection, thus deleting the effect of foreshortening. Note that the dome displays a circular shape. Another image of M23 is shown in the Lunar Orbiter image (Fig. 3).

Morphometric Properties

Based on the LOLA DEM, dome M23 has a base diameter of 5.5 km ± 0.3 km. Its height, determined using the cross-sectional profile in E-W direction (Fig. 4) is 230 m ± 20 m, while the average slope angle is 4.70° ± 0.5°. Its volume above the adjacent lunar surface is estimated to be 2.7 km^3 assuming a parabolic shape. The 3D reconstruction of M23 is obtained using WAC mosaic draped on top of the global WAC-derived elevation model GLD100 (Fig. 5).

A well-known image-based method for 3D surface reconstruction from CCD telescopic images is shape from shading (SfS). It makes use of the fact that surfaces inclined to the light source appear brighter than surfaces inclined away from it. The iterative scheme used for photoclinometry and the SfS approach is described in our preceding works (Lena et al., 2013; Wöhler, Lena & Phillips, 2007; Wöhler, Lena et al., 2006). The height **h** of the dome was obtained by measuring the altitude difference in the reconstructed 3D profile between the dome summit and the surrounding surface, taking into account the curvature of the lunar surface. The average flank slope was determined according to the equation:

$$\text{slope} = \arctan 2h/D$$

The 3D reconstruction (Fig. 6) of M23 is produced using the CCD image taken by Carmelo Zannelli on May 25, 2018 at 21:36 UT.

Spectral analysis

For spectral analysis we utilise the Clementine UVVIS five-band data set. For all spectral data extracted in this study, the size of the sample area on the lunar surface was set to 1×1 km^2. Variations in soil composition, maturity, particle size, and viewing geometry are indicated by the reflectance R_{750} at 750 nm wavelength. Another important spectral parameter is the R_{415}/R_{750} ratio, which is correlated with the variations in TiO_2 content of mare soils.

A third spectral parameter, the R_{950}/R_{750} ratio, is related to the strength of the mafic absorption band, representing a measure for the FeO content of the soil and also of the optical maturity of mare and highland materials (Lucey et al., 1998). The Clementine UVVIS data reveal that M23 appears spectrally red. It has a 750 nm reflectance of R_{750} = 0.1329, a moderate value for the UVVIS color ratio of R_{415}/R_{750} = 0.5857, indicating a low TiO_2 content of less than 2 wt%, and a weak mafic absorption with R_{950}/R_{750} = 1.0233.

The Christiansen Feature (CF) from Diviner Lunar Radiometer Experiment/ Lunar Reconnaissance Orbiter (DLRE/ LRO) data was used for further analysis. Diviner produces thermal emissivity data, and can provide compositional information from three wavelengths centered on 8 µm which can be used to characterize the Christiansen Feature (CF), which is directly sensitive to silicate mineralogy and the bulk SiO_2 content.

For the study area, CF values of 8 µm are towards longer wavelength (8.35 µm), indicating less a silicic composition than a basaltic composition (Greenhagen et al., 2010). An average CF value of 8.16 µm is consistent with a mixture of plagioclase and some pyroxene, while the average CF values of maria basalts range from 8.3-8.4 µm.

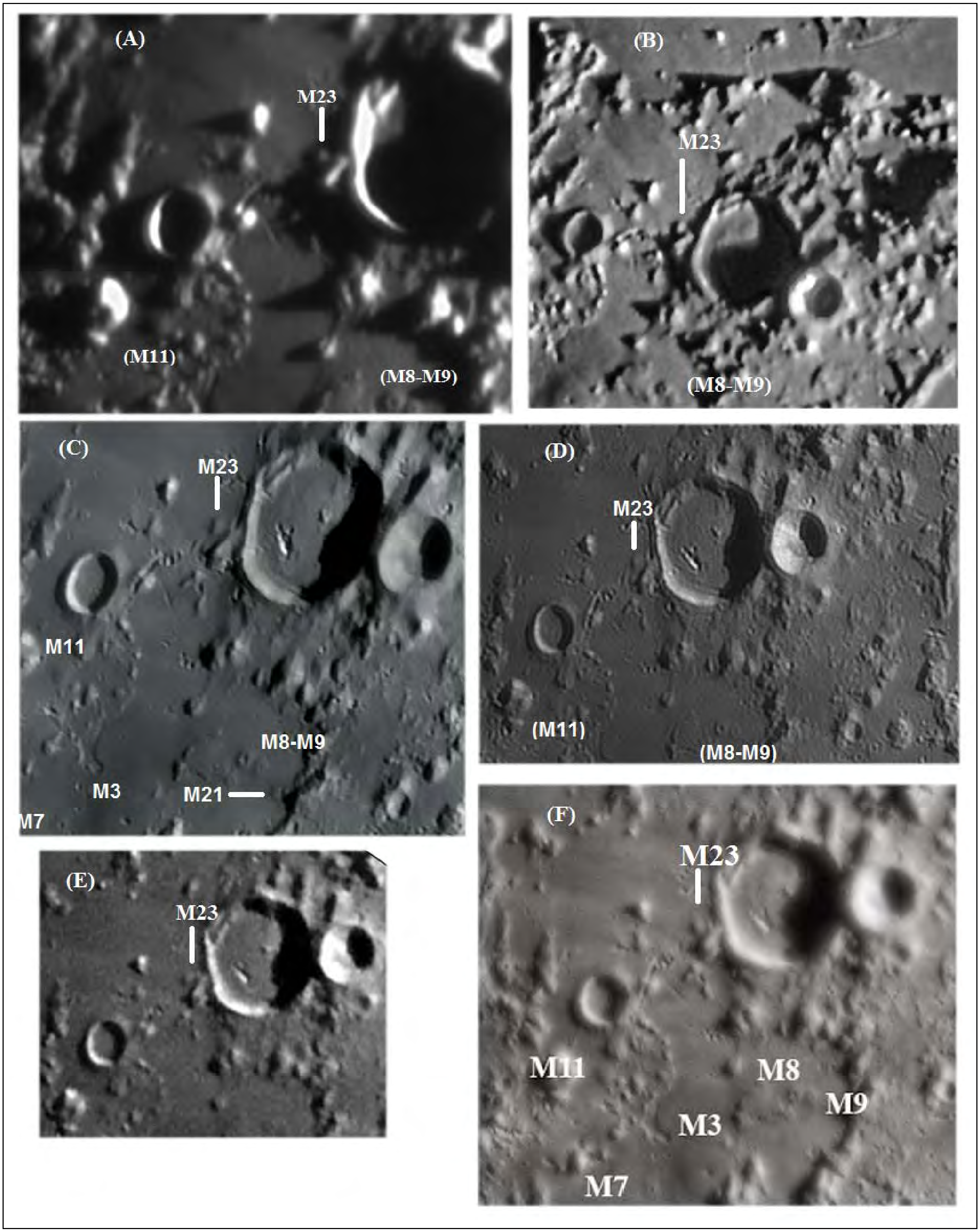

Figure 1. Ground-based observations of M23: selection of CCD images taken by (A) Phillips, (B) Heinen, (C) Zannelli, (D) Benavides, (E) Eskildsen, (F) Wirths.

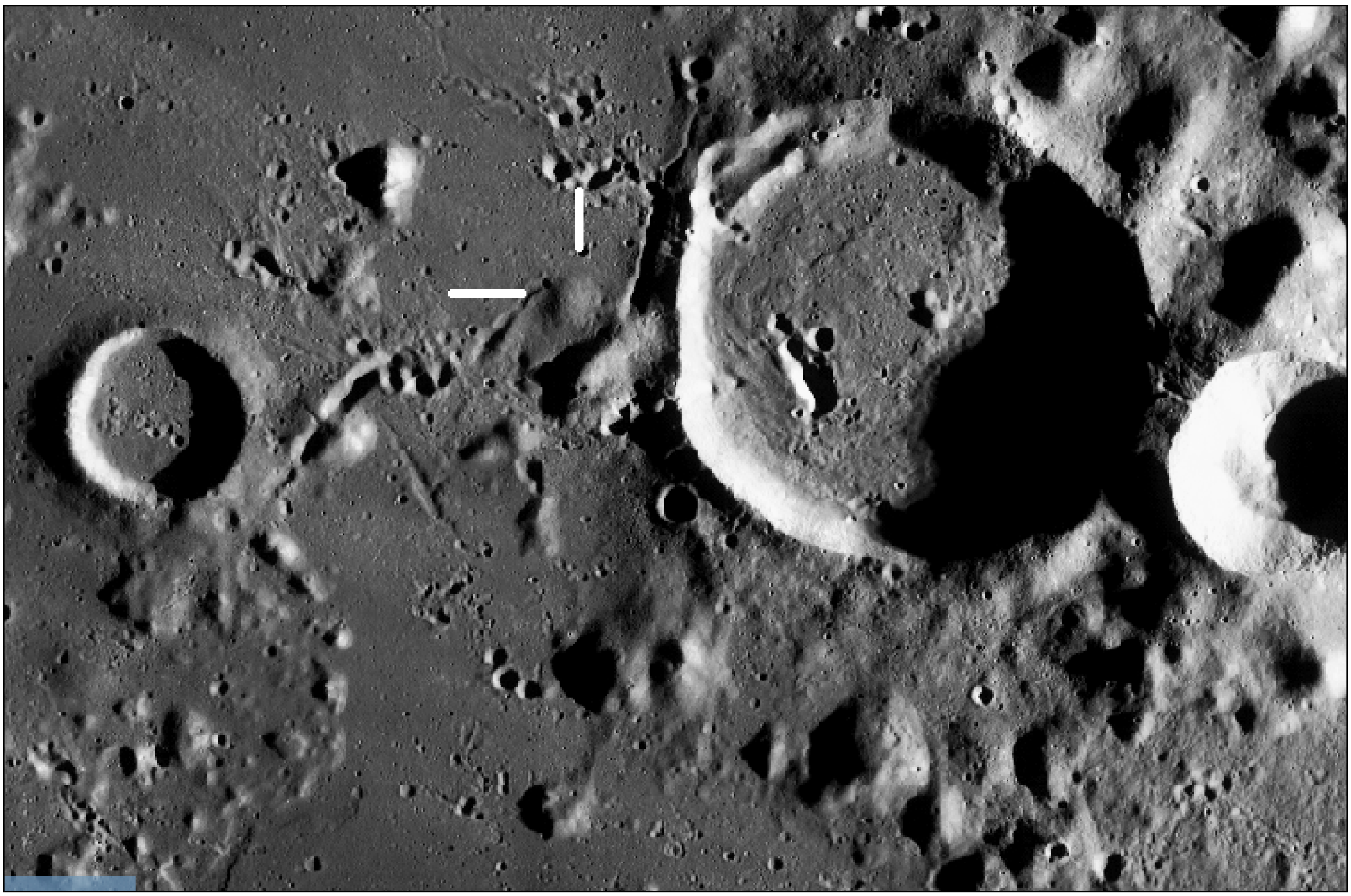

Figure 2. LROC WAC image of M23 (marked with white lines). The image is seen as cylindrical projection, displaying the circular shape of the dome.

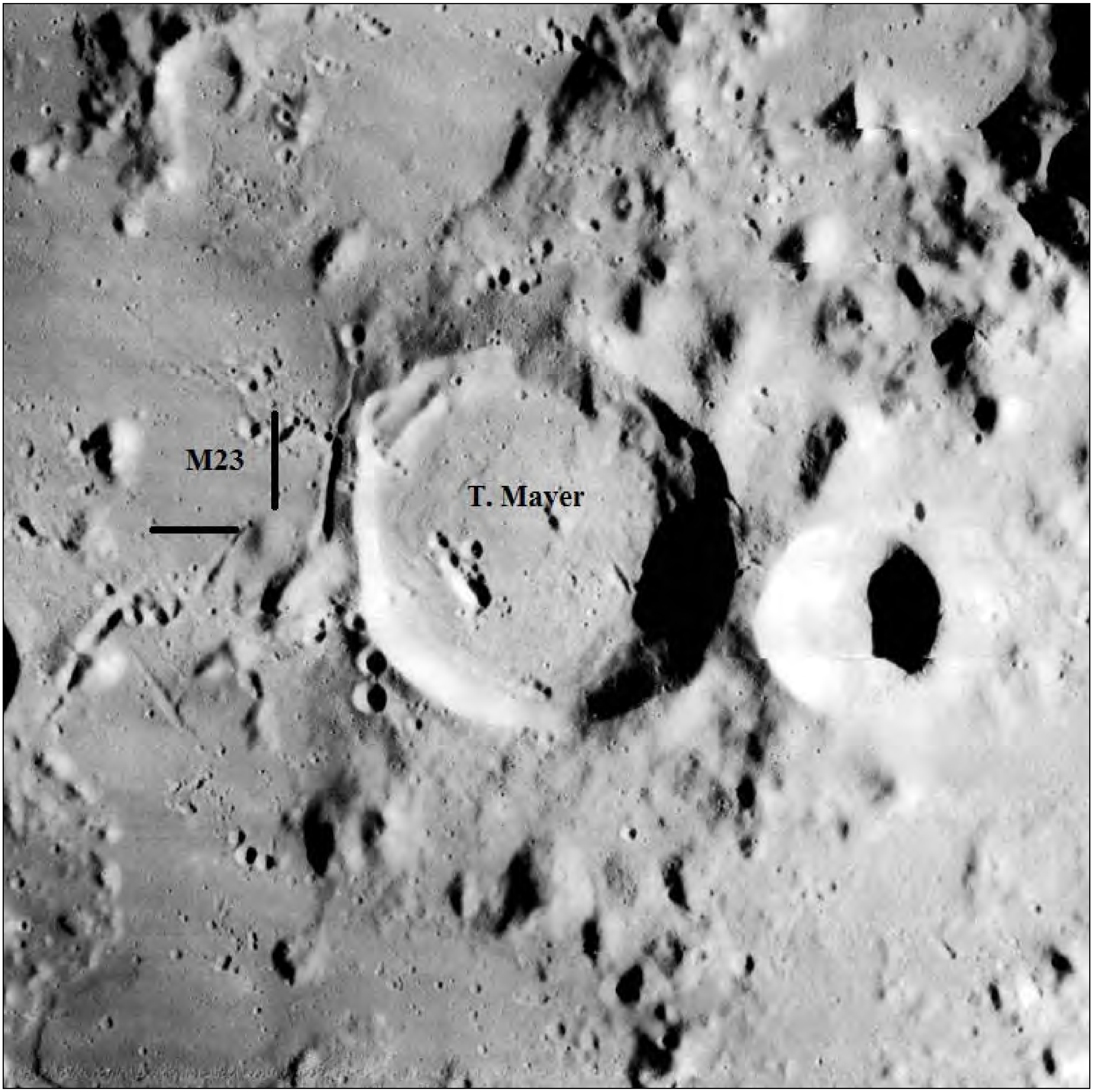

Figure 3. Lunar Orbiter image IV-133-H2 of M23 (marked with black lines).

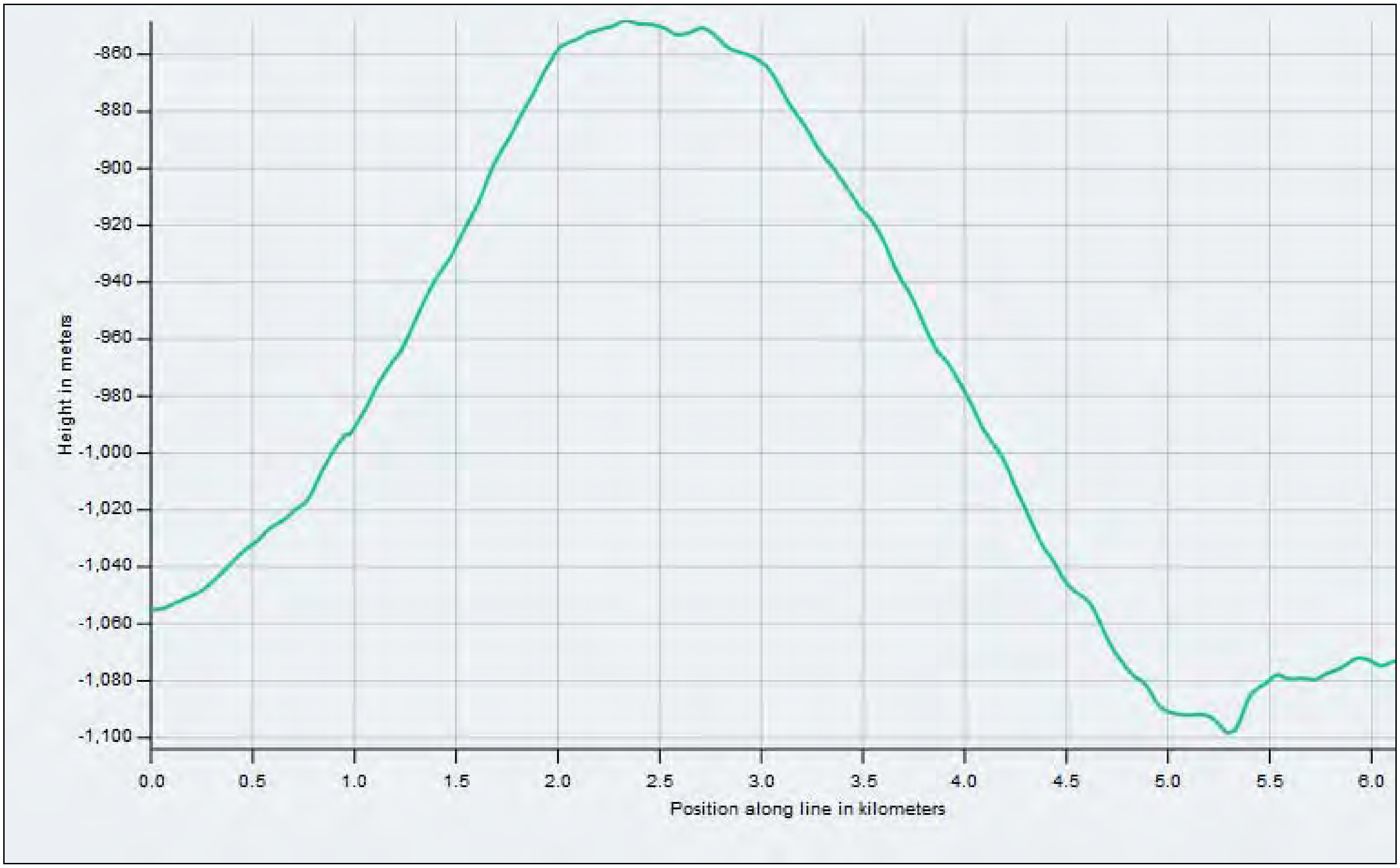

Figure 4. LOLA DEM. Cross-sectional profile in E-W direction of the dome M23.

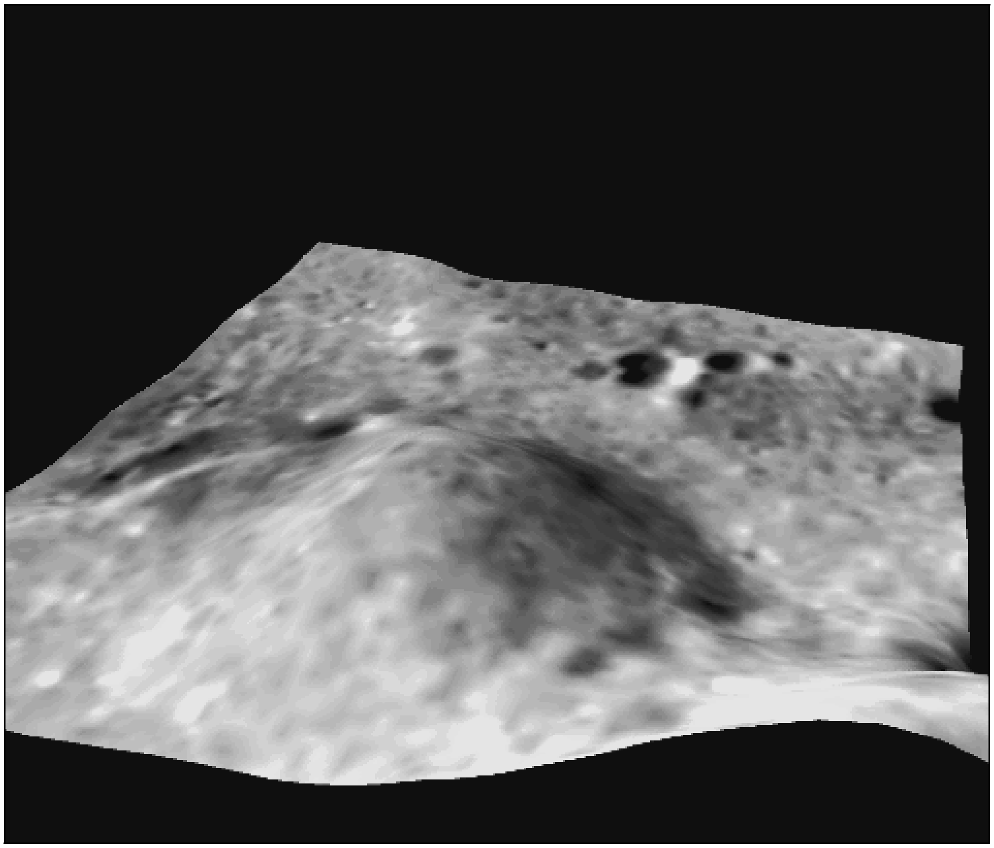

Figure 5.WAC image draped on top of the global LRO WAC-derived elevation model (GLD100). The elevation of the dome measures 230 m. The vertical axis is 7 times exaggerated.

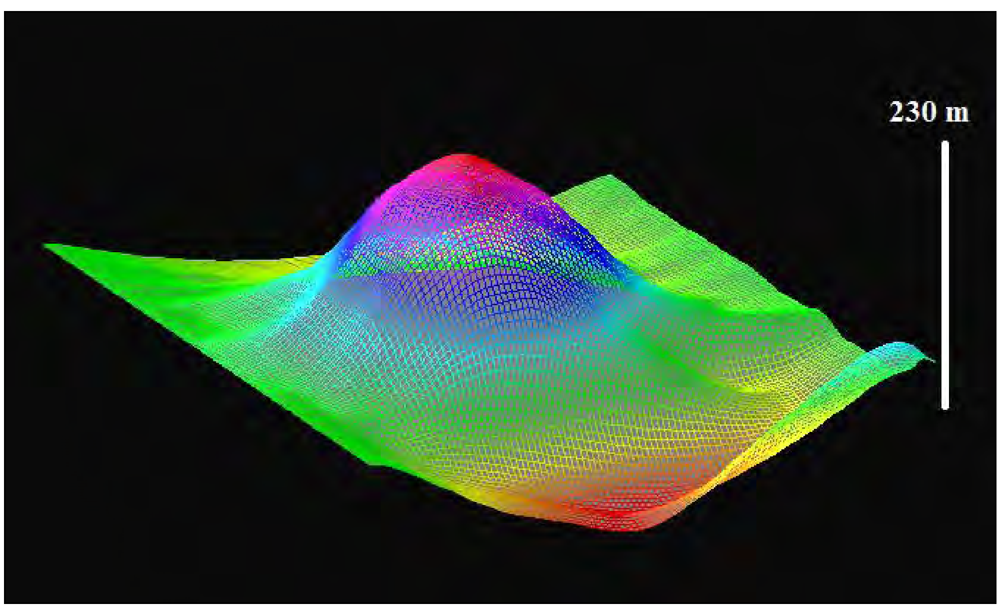

Figure 6. 3D reconstruction derived for the dome M23 based on the Shape from Shading (SfS) approach using the CCD image taken by Zannelli on May 25, 2018 at 21:36 UT (Fig. 1C). The vertical axis is 20 times exaggerated.

Furthermore, we have analyzed spectral data from the Chandrayaan-1 Moon Mineralogy Mapper (M^3) imaging reflectance spectrometer. We use a continuum removal method that enhances the profile of the 1,000 nm absorption band and more accurately shows the position of the band centre. We fit a straight line between 750 and 1,500 nm to remove the continuum (Fig. 7). The spectrum of the dome displays a narrow trough around 1,000 nm with a minimum wavelength at 980 nm and an absorption band at 2,080 nm, corresponding to a typical High-Ca pyroxene signature.

Pyroxenes are characterized by distinct absorption bands around 1,000 and 2,000 nm, with low-calcium pyroxenes displaying bands shifted to slightly shorter wavelengths, and high-calcium pyroxenes exhibiting bands at slightly longer wavelengths with increasing Ca and Fe (Besse et al., 2014). Olivine has a complex absorption near 1,000 nm, with no absorption at 2,000 nm. Therefore, olivine-rich lunar deposits are characterized by a broad 1,000 nm absorption band, which is enhanced relative to the 2,000 nm band. The 1,000 nm band center of lunar glass is generally shifted to longer wavelengths when compared to pyroxene, and the 2000 nm band center to shorter wavelengths.

Thus, two 1,000 and 2,000nm band centre positions of lunar glasses will typically appear closer together than those of pyroxenes (Besse et al., 2014).

Results and Discussion

Classification and Mode of Formation

Wilson and Head (2003) provide a quantitative treatment of dome-forming eruptions. This model estimates the yield strength, that is, the pressure or stress that must be exceeded for the lava to flow, the plastic viscosity yielding a measure for the fluidity of the erupted lava, the effusion rate E, that is, e. the lava volume erupted per second, and the duration T = V/E of the effusion process.

This model relies on the morphometric dome properties and several physical constants such as the lava density, the acceleration due to gravity, and the thermal diffusivity of the lava. The rheologic model applied to M23 yields a low effusion rate of 34 $m^3 s^{-1}$ and a high lava viscosity of 1.0×10^7 Pa s. It formed over a period of time of about 2.5 years. The magma rise speed amounts to U = 1.6×10^{-6} $m s^{-1}$ and the dike width and length to 130 m and 160 km, respectively.

The Clementine spectral data of the dome reveal a low TiO_2 content. According to the classification scheme for lunar domes (Lena et al., 2013) this steep dome belongs to class B_1. Class B domes consist of lavas of intermediate to high viscosity and low-to-moderate TiO_2 content, erupting at low to intermediate effusion rates. If the effusion process continues over a long period of time, steep flank slopes and high volumes may occur (class B_1), while short periods of effusion result in shallower edifices of lower volume (class B_2). If it is assumed that the vertical extension of a lunar dike is comparable to its length L (Jackson et al., 1997), than the magma which

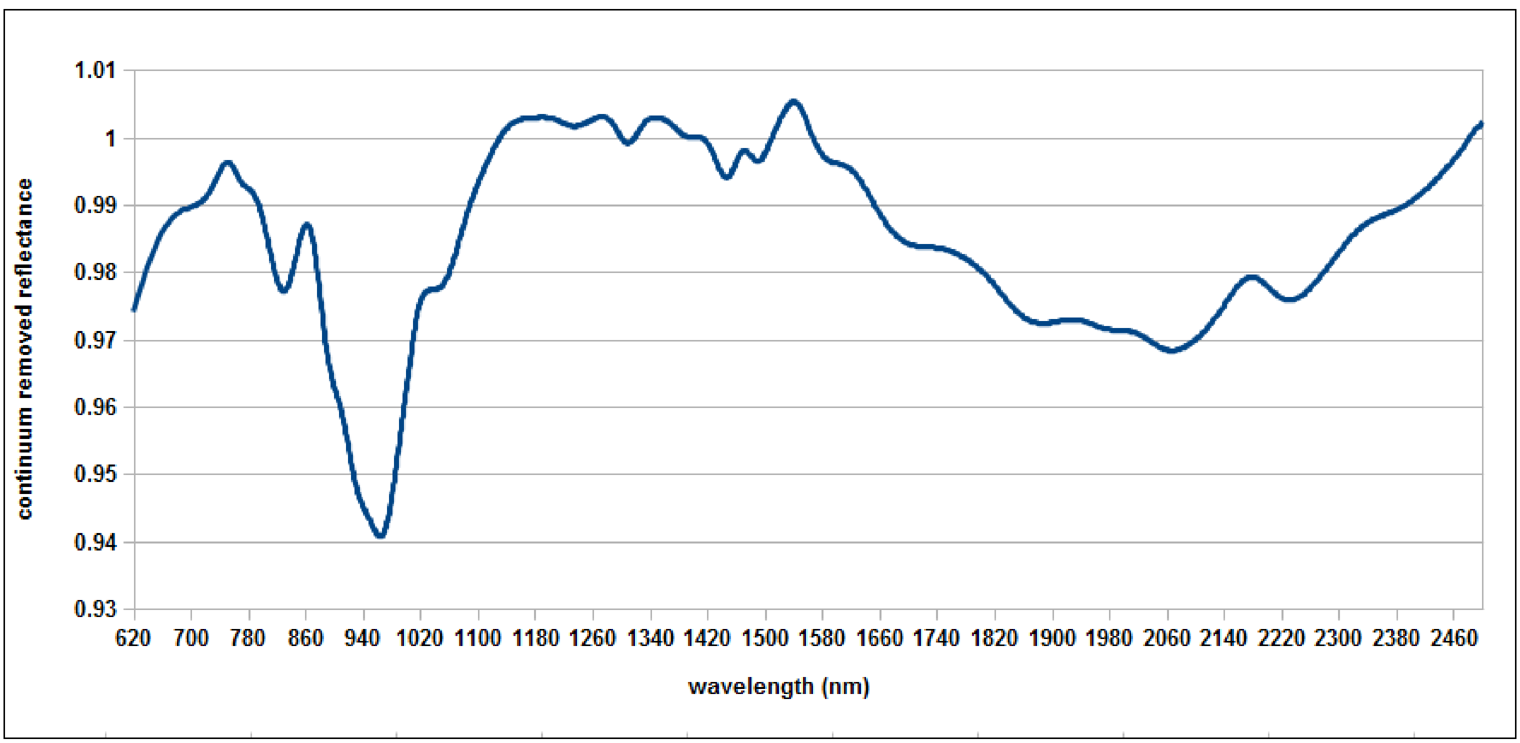

Figure 7. Spectral analysis of the dome M23.

formed M23 originated well below the lunar crust in the upper lunar mantle.

Three rheologic groups of effusive lunar mare domes differ from each other by their rheologic properties and associated dike dimensions, where the basic discriminative parameter is the lava viscosity (Lena e al., 2013). The first group R_1, is characterized by lava viscosities of 10^4 -10^6 Pa s, magma rise speeds of 10^{-5}-10^{-3} m s^{-1}, dike widths around 10-30 m, and dike lengths between about 30 and 200 km. Rheologic group R_2 is characterized by low lava viscosities between 10^2 and 10^4 Pa s, fast magma ascent (U > 10^{-3} m s^{-1}), narrow (W = 1-4 m) and short (L = 7-20 km) feeder dikes. The third group, R_3, is made up of domes which formed from highly viscous lavas of 10^6-10^8 Pa s, ascending at very low speeds of 10^{-6} - 10^{-5} m s^{-1} through broad dikes of several tens to 200 m width and 100-200 km length. With its high lava viscosity the dome M23 clearly belongs to rheologic group R_3.

Many effusive lunar domes do not display a summit vent at all when their associated conduits are plugged by the ascending lava, as it is the case for M23. In the wide T. Mayer-Milichius domes field (figs. 9 and 10), the domes termed M4, M11, and M12 (Milichius π) belong to class B_1 (Lena et al., 2013). M11

Lunar Dome Classification System

Effusive Domes

Class A domes are small and shallow and formed by high-TiO_2 lavas of low viscosity, erupting at high effusion rates over very short periods of time, resulting in edifices of low volume.

Class B domes consist of lavas of intermediate to high viscosity and moderate TiO_2 content, erupting at low to intermediate effusion rates. If the effusion process continues over a long period of time, steep flank slopes and high volumes may occur (class B_1), while short periods of effusion result in shallower edifices of lower volume (class B_2).

Class C domes are formed out of low-TiO_2 (class C_1) or high-TiO_2 (class C_2) lavas building up edifices of large diameter but shallow flank slope. These at shapes are due to low lava viscosities and high effusion rates.

Class D comprises the very complex, shallow but large and voluminous edifices Arago α and ß, which were most probably formed during several subsequent effusion stages, while classes A-E describe simple, likely monogenetic effusive domes.

Class E domes represent the smallest volcanic edifices formed by effusive mechanisms (diameter < 6 km). In analogy to class B, the class E domes are subdivided into subclasses E_1 and E_2, denoting the steep-sided flank slope larger than 2° and the shallow edifices of this class, respectively.

Class G comprises the highland domes, which have highland-like spectral signatures and high flank slopes of 5°–15°, represented by Gruithuisen and Maairan highland domes.

Class H is represented by the non-monogenetic Marius domes, subdivided into three different classes. Small domes of less than 5 km diameter belong to subclass H_1. The irregular shapes of domes of subclass H_2 with more than 5 km diameter and flank slopes below 5° indicate a formation during several effusive episodes. Domes of subclass H_3 have diameters comparable to those of monogenetic class B_1 domes, but their flank slopes are all steeper than 5° and reach values of up to 9°.

Putative Intrusive Domes

Lunar domes with very low flank slopes differ considerably from the more typical lunar effusive domes. Some of these domes are exceptionally large, and many of them are associated with faults or linear rilles of presumably tensional origin, while they do not show summit pits. A reliable discriminative criterion is the circularity of the dome outline: these domes are elongated and with low slopes (< 0.9°). The putative intrusive domes have circularity values below 0.8, while the circularity is always higher than 0.9 for the effusive domes having flank slopes below 0.9° and displaying effusive vents.

Class In1 comprises large domes with diameters above 25 km and flank slopes of 0.2°–0.6° and have linear o curvilinear rilles traversing the summit.

Class In2 is made up by smaller and slightly steeper domes with diameters of 10-15 km and flank slopes between 0.4° and 0.9°.

Class In3 comprises low domes with diameters of 13-20 km and flank slopes below 0.3°.

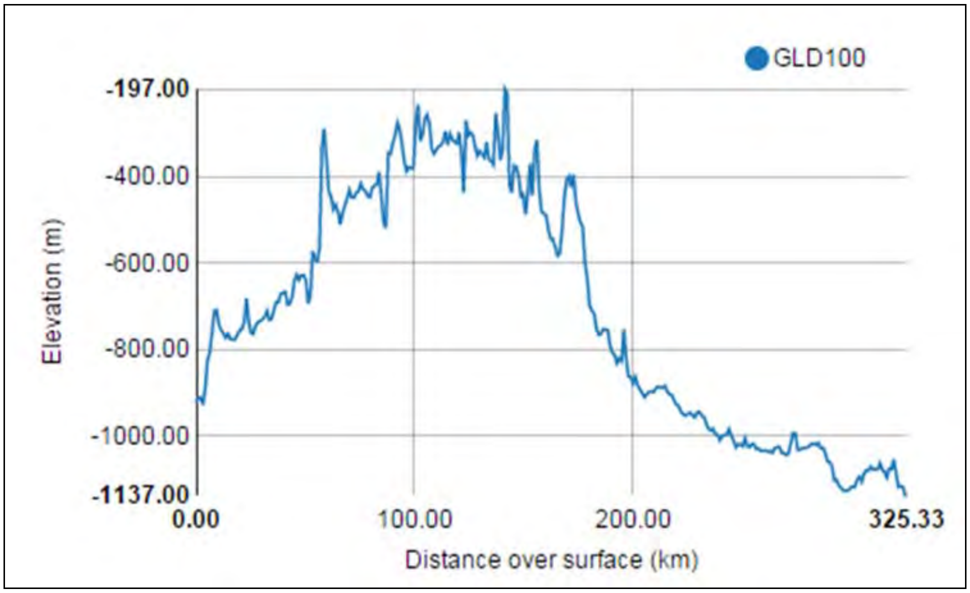

Figure 8. Topographic profile of the Milichius - T. Mayer - Hortensius shield based on GLD100.

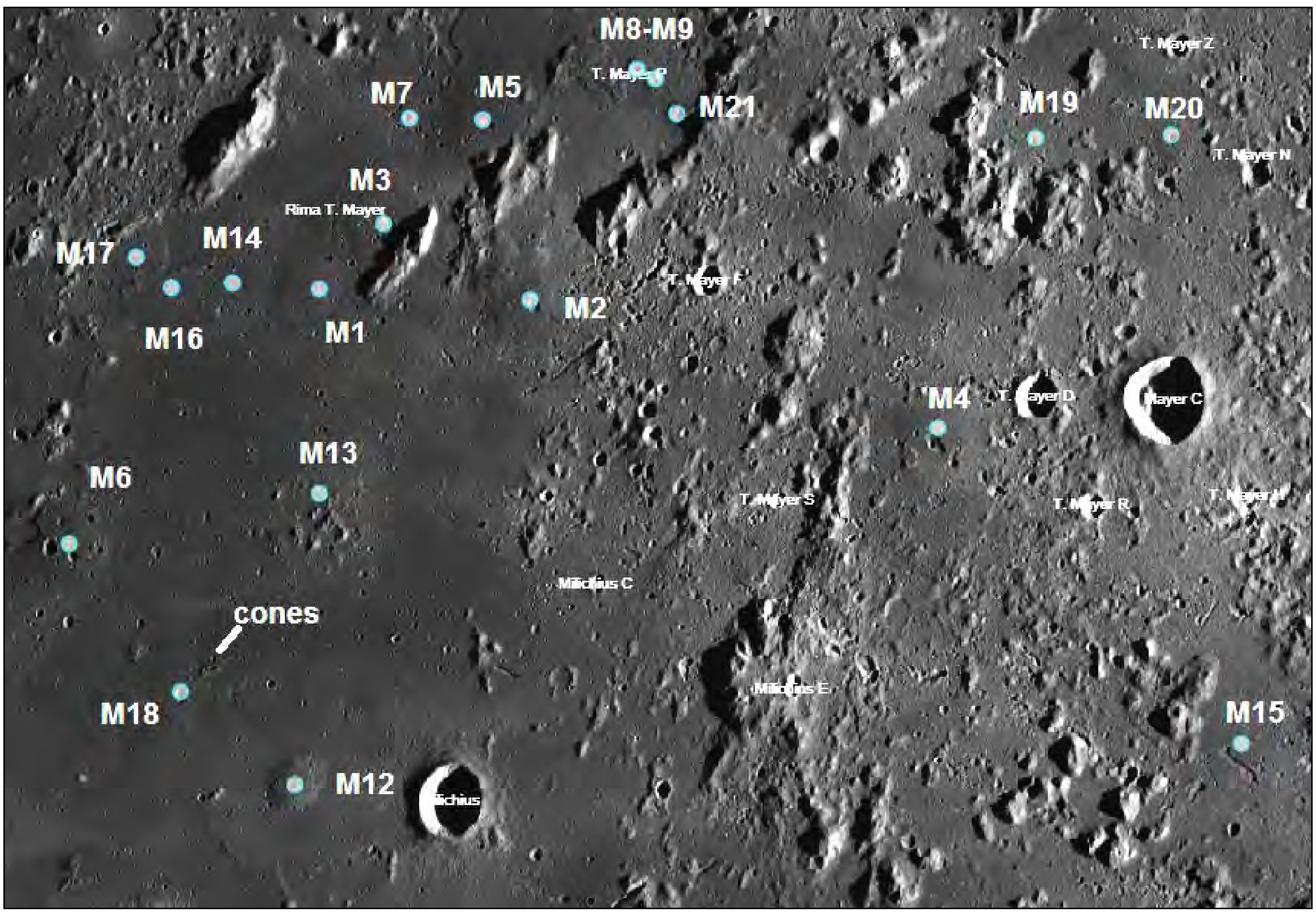

Figure 9. Map of the volcanic features of the Milichius - T. Mayer - Hortensius shield (Part 1).

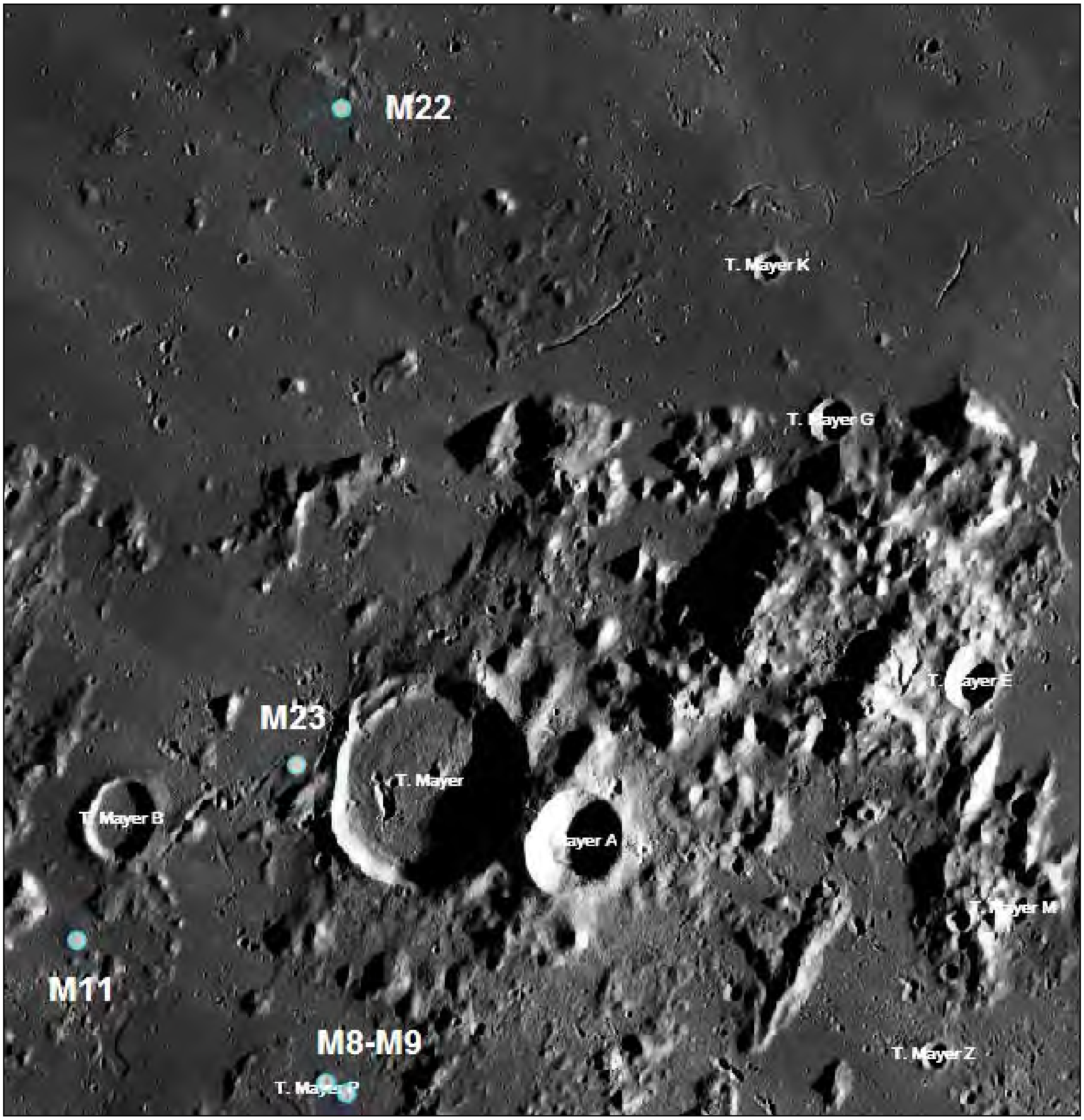

Figure 10. Map of the volcanic features of the Milichius - T. Mayer - Hortensius shield including newly identified dome M23 (Part 2).

consists of spectrally red low-TiO_2 material, like M23. The formation conditions of M4, M11, and especially M12 (Milichius π) are believed to be similar to those encountered in the Hortensius dome field, regarding the observed spectral and morphometric properties. Possibly these domes formed simultaneously with the Hortensius domes (Lena et al., 2013), which formed during the Eratosthenian period 3.2-1.1 billion years ago (Wilhelms & McCauley, 1971).

The domes termed Hortensius 2-6 (Fig. 11) also belong to class B_1 according to their steep slopes (>2°) and moderate to high volumes (Lena et al., 2013; Lena & Phillips, 2019). The dome H5 is by far the steepest mare domes examined with flank slopes of up to 5.3°. M4 has a diameter of 15.3 km, a height of 170 m and an average flank slope of 1.7°. M11 has a diameter of 6 km, a height of 150 m resulting in an average flank slope of 2.6°. The well-known Milichius π (M12) has a diameter of 9.7 km, a height of 230 m and an average flank slope of 2.72°. For M4, M11 and M12 the rheologic parameters reported in previous studies (Lena et al., 2013; Wöhler, Lena & Phillips, 2007; Wöhler, Lena et al., 2006) are 2.6×10^5, 1.4×10^6 and 5.6×10^6 Pa s for the lava viscosity, E = 239, 42 and 70 $m^3 s^{-1}$ for

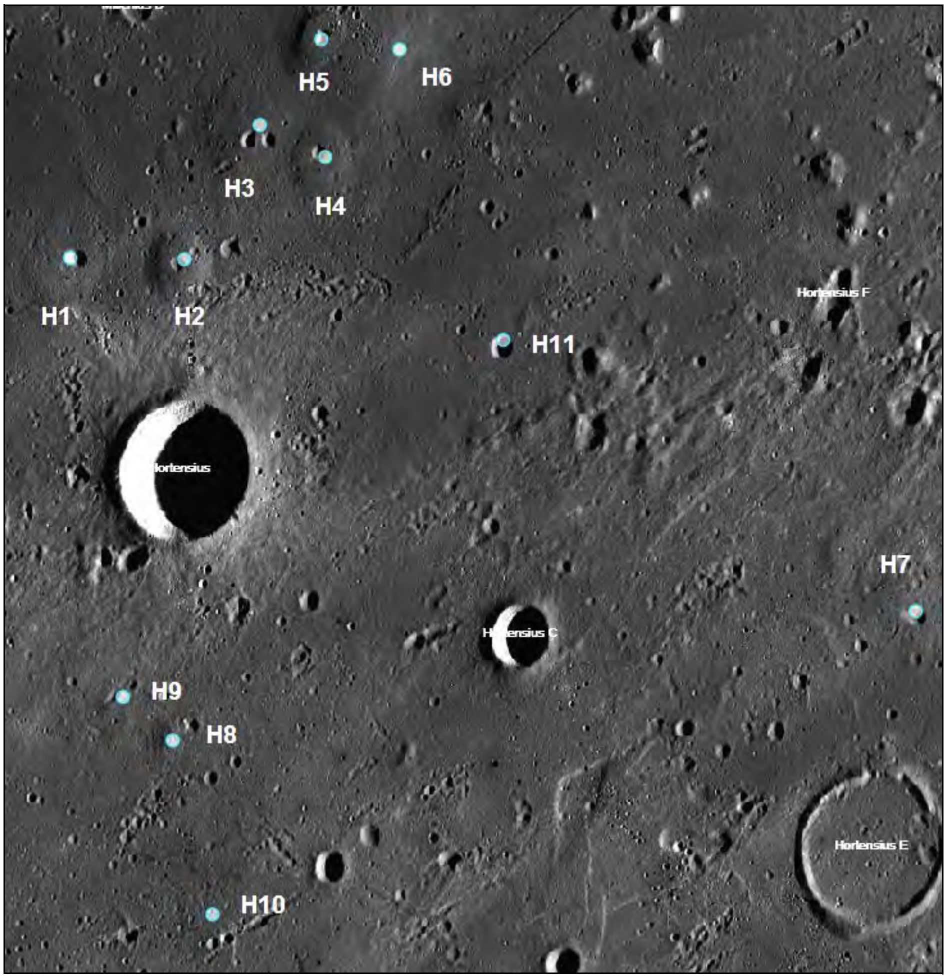

Figure 11. Map of the volcanic features of the Milichius - T. Mayer - Hortensius shield (Part 3).

the effusion rate, and T = 2.78, 1.75 and 4.9 years for the duration of the effusion process, respectively. M23 reveals higher viscosity values than the class B_1 Milichius domes M4, M11 and M12, while the effusion time and the effusion rates are somewhat lower. It is possible that these differences were caused by a somewhat lower eruption temperature occurring for M23, thus a higher crystallinity of the lava and higher viscosity of the magma.

The described domes, including M23, belong to the large Milichius - T. Mayer - Hortensius shield as introduced by Spudis et al. (2013), which also describes the association of large topographic prominences in the lunar maria with concentrations of small volcanic features such as domes, pit craters, cones and rilles. These large, broad topographic features are interpreted as shield volcanoes, a previously unrecognized style of lunar volcanic activity. Clusters of small domes (such as the Hortensius and Milichius domes) are located mostly along the margins of the shield. The examined volcanic shield is one of the largest identified by Spudis et al. (2013) extending almost 330 km in E-W direction and about 1000 m high (Fig. 8).

Our new, comprehensive map of the area includes 34 domes characterized by their spectral and morphometric properties. The map is based on LRO WAC imagery and is presented in three parts (figs. 9-11).

Other low-profile domes may be present in this region, but new images are necessary in order to confirm as yet unverified observations of the potential domes.

Statistical analysis

All of the examined Milichius - T. Mayer - Hortensius domes are part of a larger volcanic province. Shield volcanoes typically have both radial and circumferential fissure zones, which serve as pathways for magma to get to the surface and erupt lava. Parasitical cone and dome building often occurs near the summit and on the flanks of such features during the latter stages of shield growth (Spudis et al, 2013).

Based on our data collected during a survey started 15 years ago, domes of different shapes and slopes occur together, belonging to different lunar

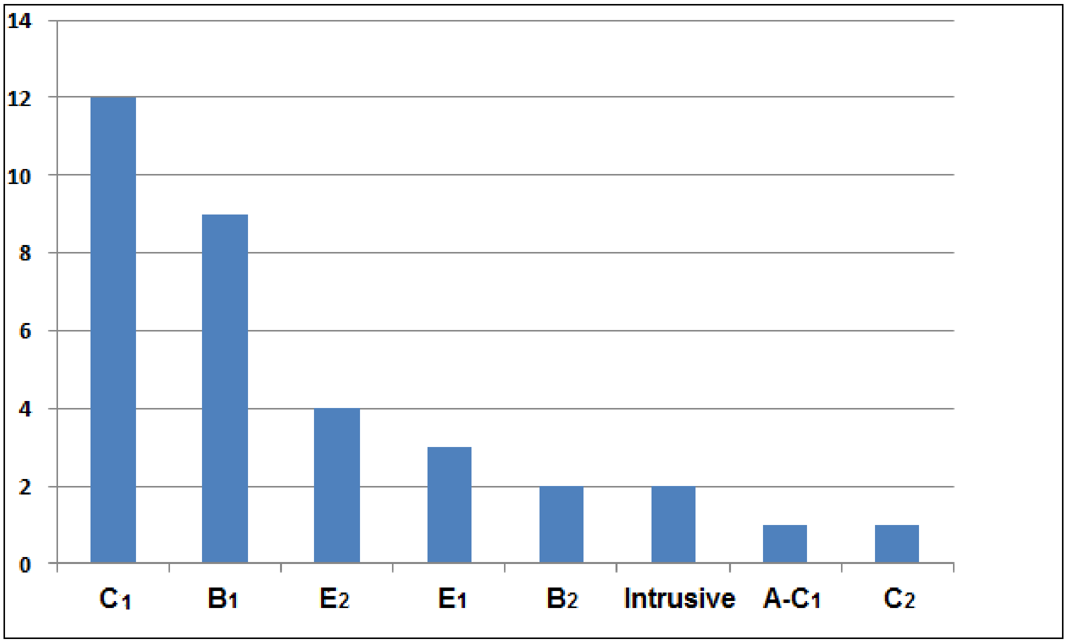

Figure 12: distribution of the domes classes in the Milichius - T. Mayer - Hortensius shield.

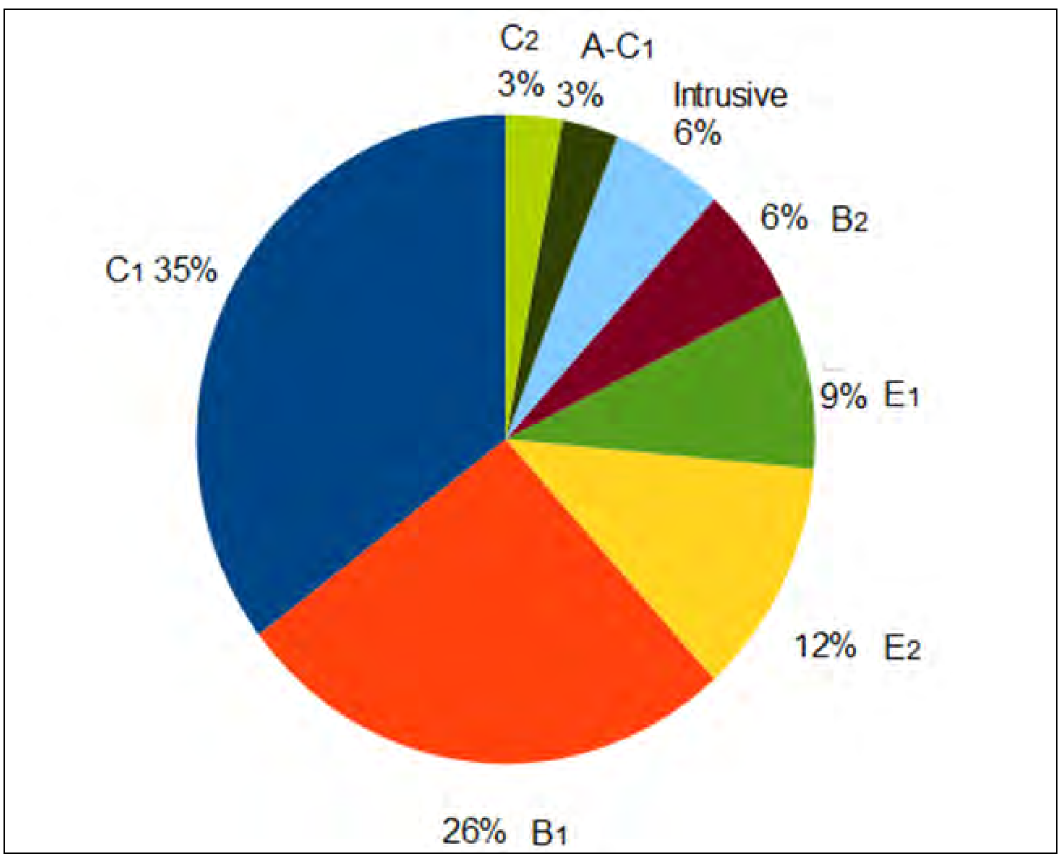

Figure 13. Distribution (%) of the domes classes in the Milichius - T. Mayer - Hortensius shield.

domes classes (Fig. 12). Most of these domes belong to class C_1 and B_1 (61.7%), with 35% of these domes in class C_1 and 26% in class B_1. The others domes belong to class E_2 (12%), E_1 (9%), B_2 (6%), while two domes belong to class C_2 and between class A-C_1. Only 6% of the identified structures (M13 and M22) are interpreted as putative intrusive domes (Fig. 13).

We have updated the lunar dome survey catalogue and maps based on terrestrial CCD telescopic images. They are available online at: *http://hortdomes.blogspot.com/*

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ALPO Lunar Dome Observation Form

Submit electronically (attach images and scanned drawings to e-mail) to:
Raffaello.Lena@alpo-astronomy.org
or via regular mail to:
Raffaello Lena
Cartesio 144 D
00137 Rome, Italy

Observers Name:	**Last:**					**First:**				
Date: (UD)	**Month:**			**Day:**				**Year:**		
Time: (UT)	**(UT) Hours:**					**(UT) Minutes:**				
Colongitude:										
Region Observed:										
Telescope:	**Size (Inches or Cm.):**					**Type:**				
Eyepieces Used:									**Filters:**	
Seeing (Circle)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Transparency:										
Type of Observation (list details):	**Visual:**					**Photographic:**				

Domes Observed (Positions)

Xi	Eta	OR	Lunar Long.	Lunar Lat.

Notes: (**Include observer location here (City, State, and Country):** Use back if necessary):

Papers & Presentations

Rheita E and Rio Cuarto: Oblique Craters in Two Worlds

By Francisco Alsina Cardinali and Alberto Anunziato
albertoanunziato@yahoo.com.ar

Discussion

The usual explanation for the strange Rheita E crater (66 kilometers long by 32 kilometers wide) is that it is three superimposed craters that would have formed at the same time, since there are no traces of internal walls, although its formation truly remains an enigma.

Could it be a tangential crater produced by an oblique impact? For planetary geology, the characteristics of an elongated crater are: uprange and downrange rims depressed, crater elliptical and ejecta concentrated in the crossrange directions, and when the impact is at angles <5°, a significant portion of the impactor may ricochet off the surface and produce a second crater downrange and in the downrange direction the crater becomes highly elongated.

These ricocheted fragments can be up to half the size of the initial impactor and skip the target surface with much of their pre-impact velocity, creating a characteristic pit formed by the decapitation of the impactor itself and not by ejecta.

Elongated craters produced by oblique grazing impacts have been identified not only on the Moon (as Rheita E in Figure 1), but also on Mercury, Venus and Mars, but never on Earth until 1989. In October of that year, the then-Captain of the Argentine Air Force, Rubén Lianza, flying a Pampa airplane in the Cordoba skies observed a peculiarly depressed terrain which stood out from the cultivated fields that surrounded it. The now-Commodore had discovered a formation of several elliptical craters that indicated a tangential meteorite impact formed thousands of years ago.

Rubén Lianza himself is an amateur astronomer, which led him to realize the importance of what he had discovered.

Unlike the Moon, which has no atmosphere, climate or tectonic plates, there are very few impact craters on our changing Earth that retain their shape. And none of the known craters on Earth have the elliptical shape that indicates the impact of a meteorite at a very closed angle, that is, less than 15 degrees.

The Argentine elite pilot had discovered the first tangential craters on the surface of our planet (Figure 2), and even subsequently picked up a meteorite fragment of the chondritic type in situ. Two years later, a scientific expedition led by Peter Schultz (Brown University, Rhode Island, US), who is one of the world's most important planetary geologists, confirmed the discovery of the first oblique craters on the Earth's surface. The announcement was made in the journal *Nature* in a communication signed by Rubén Lianza and Peter Schultz in the January 16, 1992 issue, followed by publications in *Planetary Report* and *Sky & Telescope*.

The pleasure of observing Rheita E was an auspicious occasion to remember a similar crater in our country, discovered by a friend. In the image taken in an observing session of the Sociedad Lunar Argentina, we can also see the notorious Rheita Vallis, which has been traditionally interpreted as a secondary crater chain formed by ejecta during the formation of the Mare Nectaris basin.

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Figure 1 (Left) Crater Rheita E and its adjacent Vallis Rheita. Photo and instrumentation details unknown.

Figure 2 (Below) The Rio Cuarto craters in Córdoba Province, Argentina at coordinates 32°52.7'S 64°13.4'W. (Photo credit: Planetary and Space Science Centre University of New Brunswick (Canada)).

Feature Story

A Preview of the 2019 – 2021 Perihelic Apparition of Mars

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Introduction

The most colorful of planets has begun a perihelic apparition that will be the second best apparition since 2003. Observers all over the world will have good views. You will want to make Mars a priority in your 2020 observing plans.

The Apparition

Salient dates of the apparition, together with magnitude and apparent diameter on those dates, are listed in Table 1. Traditionally, the observing season has been considered to start when the apparent diameter of Mars reaches 6 arc seconds and to end when it declines to that size. The beginning and end of the observing season given in Table 1 reflect that tradition. For many visual observers, 6 arc seconds remains a reasonable limit, but some imagers have been making useful observations of dust storms, clouds, and polar cap changes when Mars is as small as 4 arc seconds in diameter. Furthermore, many modern amateurs use instruments larger than those available to previous generations, so that the 6 arc second limit may seem obsolete.

This is a perihelic apparition, so that Mars will appear bright to the naked eye and large in the eyepiece. The only opposition since 2003 in which Mars appeared this large and bright was the 2018 apparition. As Table 1 indicates, the brightness at opposition will be -2.62 magnitude, while at closest approach to Earth it will be slightly less bright at magnitude -2.57 magnitude. This is slightly less brilliant (0.16 magnitudes fainter) than Mars was when at its brightest during the 2018 apparition. Note that when Jupiter is at opposition on July 14, 2020, the gas giant will be of magnitude -2.8, so Mars will not outshine it in 2020.

Table 1. Important Dates of the 2019 – 2021 Apparition

yyyy-mm-dd*	Event	Mag	Diam**
2019-09-02	Opening conjunction	1.73	3.50
2020-03-19	Observing season begins	0.92	6.00
2020-06-21	Western quadrature***	-0.35	10.72
2020-09-09	Retrograde motion begins	-2.02	20.20
2020-10-06	Closest approach	-2.57	22.57
2020-10-14	Opposition	-2.62	22.33
2020-11-15	Retrograde motion ends	-1.64	17.32
2021-01-22	Eastern quadrature***	0.26	8.50
2021-03-10	Observing season ends	1.05	6.00
2021-10-08	Ending conjunction	1.64	3.56

* Dates are in universal time.
** “Diam” is the apparent subtended diameter in arc-seconds.
*** Quadratures are determined as the dates when the actual separation in the sky is 90 degrees, rather than the separation as measured with reference to the celestial equator.

Online Features

Left-click your mouse on:

- The authors’ e-mail addresses in blue text to contact them.
- The hyperlinks and source material references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Table 1 indicates that the closest approach to Earth will occur eight days before opposition. This is due to the opposition's occurrence somewhat after Mars's perihelion. For the same reason, Mars will appear larger and brighter at western quadrature than it will at eastern quadrature.

Figure 1 graphs the Martian apparent diameter and magnitude as they change with the progression of this apparition. At close apparitions such as this one, the observing season is longer than it is at aphelic apparitions — 357 days in 2020 (about as long as the 358 days in 2018), and better than the 341 days in 2016.

Mars in the Sky

During apparitions that have the closest oppositions, such as the 2018 apparition, the planet Mars usually has a southerly declination in Earth's sky for most of the observing season. In contrast, during this apparition Mars will be south of the Celestial Equator until July 12, 2020, when it enters the northern sky, where it will stay throughout the rest of the apparition. Its declination will be +5.3 degrees at its opposition on July 27, 2020, but the most northerly declination of +24.9 degrees will not occur until April 24, 2021. The changes in declination as the

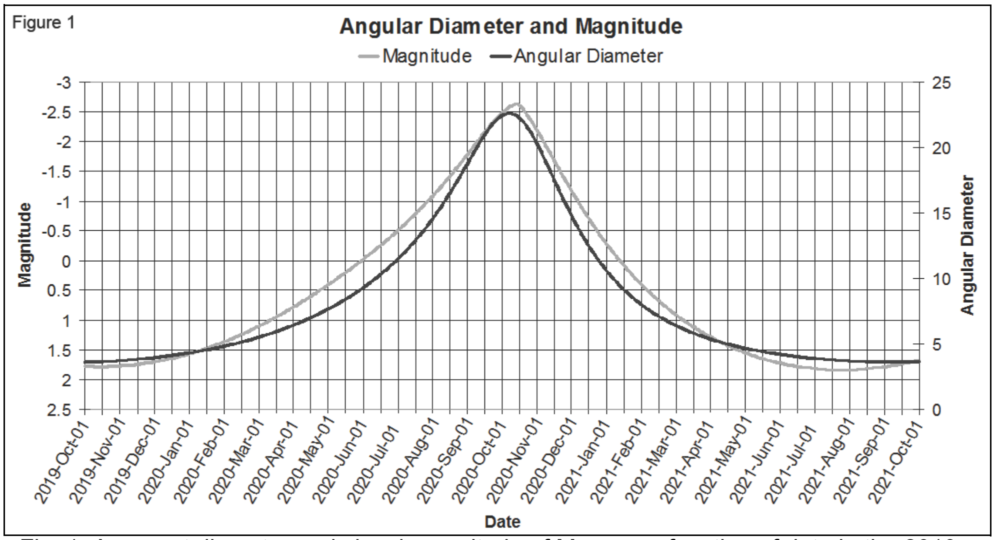
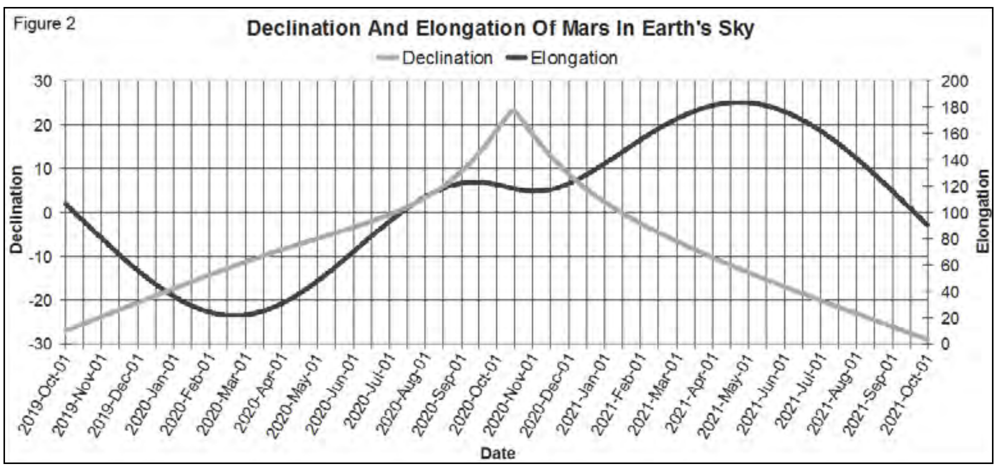


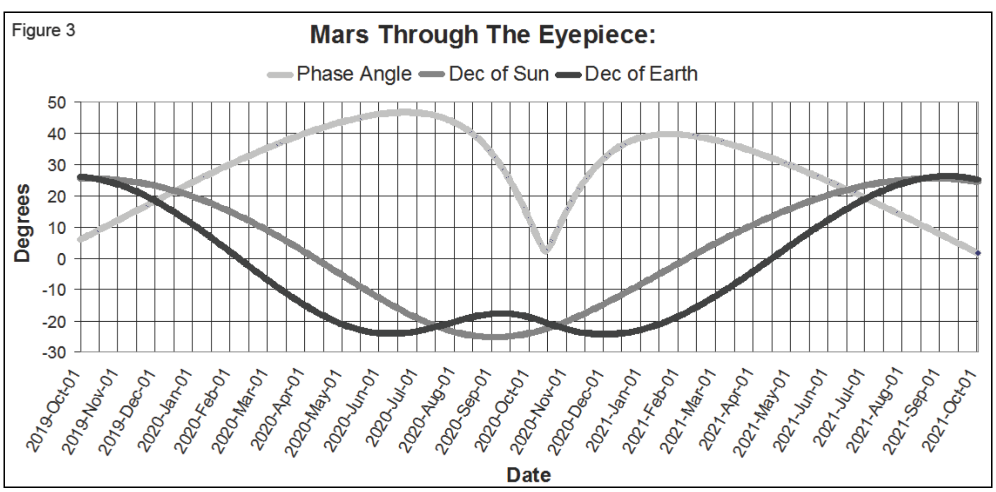
Fig. 1. Apparent diameter and visual magnitude of Mars as a function of date in the 2019-2021 apparition.

Fig. 2. Declination and elongation of Mars as a function of date in the 2019 - 2021



apparition.

Fig. 3. The phase angle, declination of the Sun and declination of Earth as a function of date in the 2019 - 2021 apparition.



apparition progresses are graphed in Figure 2. Although observers in Earth's Southern Hemisphere are favored during the early months of the apparition and northern observers are favored in the latter months, there will be good views for all observers in the best observing days near opposition, as the planet will be near the Celestial Equator.

Mars in the Telescope

After the apparent size of the planet's disc, the next most important characteristic of the planet's appearance is its oval shape. The phase (Sun-Mars-Earth) angle will peak at 46.6 degrees before opposition on June 21, 2020, and at 39.6 degrees after opposition, on January 22, 2021. This is graphed in Figure 3. The fraction of the planet's disc that appears to be illuminated by the Sun is lowest when the phase angle is highest. The fraction illuminated begins and ends the apparition with values near 1.0 and has a similar value at opposition. The lowest values of fraction illuminated are at quadrature: 0.844 before opposition and 0.885 after opposition. The unilluminated crescent of the planet, called the “illumination defect”, is on the preceding side of the planet before opposition and on the following side of the planet after opposition. The unilluminated part of the planet cannot be seen or imaged, though on rare occasions very high clouds have been imaged over it.

Knowledge of the location of the illumination defect helps the observer interpret what he is seeing. The declinations of the Earth and Sun in the Martian sky are graphed in Figure 3 and can be compared to the simulated views in Figure 4. Thoughtful interpretation of these figures will tell the observer whether his view of the polar caps is affected by the location of the illumination defect. For example, on March 18, 2020, the Earth has a southern declination in the Martian sky so that one might see the South Pole if it is illuminated by the Sun. However, the Sun on that date has a northern declination, indicating that the South

Figure 4. Jeff Beish's diagrams of expected appearances of Mars during the observing season of 2019-2021.

Pole is not illuminated, and so cannot be seen, though part of the South Polar Cap will be visible as indicated in Figure 4. Because the areocentric declination of Earth is more negative than that of the Sun for most of the apparition, the illumination defect extends "behind" the South Pole for much of the apparition. Only during a three-month period ending near the time of opposition can one see the actual southern limb of the planet. Thus, the polar caps are often partially obscured by the illumination defect, and may display peculiar shapes that an observer can understand by knowing the location of the illumination defect.

The seasons of Mars are the next important characteristic of the planet that observers should witness. The season of the Martian year can be understood simply by following the areocentric declination of the Sun in Figure 3. At the beginning of the observing season on March 19, 2020, the areocentric declination of the Sun is positive, and it is declining, indicating that Mars is in northern summer and southern winter. The equinox on April 8 marks the beginning of northern autumn, and the next solstice is September 2, which marks the beginning of northern winter and southern summer. Lastly, northern spring and southern autumn will begin on February 7, 2021.

Figure 3 shows that in the beginning and the ending parts of the observing season the North Pole will be tilted toward the Earth. During the central part of the observing season the South Pole will be tilted toward Earth, as indicated by the areocentric declination of the Earth (also shown in Figure 3). This will render the albedo features of the south temperate latitudes readily visible.

The simulated images in Figure 4 show the expected appearance of the planet at intervals during the coming apparition. Celestial south is up and celestial west (the preceding side) is to the left in these depictions. Notice how the apparent axial tilt of the planet changes during the apparition as the Earthly perspective on it changes.

Polar Caps and Surface Frosts

The South Polar Cap (SPC) is large early in the observing season, but is partly hidden by the illumination defect. The SPC will have shrunken to a small size by the time of closest approach, and remains small for the rest of the observing season (Figure 4). As the SPC shrinks, look for Novus Mons, a white frosty area left behind as the SPC recedes, centered at longitude 315 degrees and latitude 72 degrees south. It should be best seen in early August 2020. Novus Mons means "new mountain" and its other name is "the Mountains of Mitchel." These alpine names were given because early observers considered it likely that frost would linger in a mountainous area as the SPC receded. It is now known that the area is not particularly mountainous.

Around the time of opposition, observers can detect that the small, residual SPC is not centered exactly on the South Pole. This can be discerned by comparing its visibility from night to night, as it will be nearer the southern limb of the planet on some nights than on others.

Another interesting feature of the Southern Hemisphere is the white frost that is often seen in Hellas and Argyre. Because this is most likely to be seen in early northern summer, the best chance of seeing it during this apparition occurs as you read this, in the very early days of the apparition.

Clouds

Polar hoods are cloud zones that develop over the polar cap during late summer and persist through winter, sometimes into early spring. In the northern Martian hemisphere, it will be interesting to watch the insidious development of the North Polar Hood during the few weeks before and after the northern autumnal equinox on April 8, 2020. It should break up and dissipate in the few weeks before and after the start of northern spring on February 7, 2021. The South Polar Hood forms as the North Polar Hood dissipates, and then breaks up as the North Polar Hood forms.

There are relatively few clouds visible on Mars during southern spring and summer, the seasons that will constitute most of the coming observing season. Nevertheless, a few discreet clouds and occasional morning limb hazes are likely. Clouds are best detected by observing or imaging with a blue filter. Ground hazes and frosts are often best seen with a green filter. (With a red filter, most clouds are hard to see, but surface albedo features stand out strongly.)

Dust Storms

It is exciting to detect a dust storm and to monitor its development. They can be seen at any season of the Martian year. With the improvements in instruments and imaging methods in the last few decades, we have been detecting more

Table 2. Greatest Elongations of Deimos

Date UT	HH:MM UT	Sub-Mars Longitude on Earth at Elong Time*	E or W	PA[x]	Angle Sep[ς]
2020-Sep-08	20:05	98	E	54	69
2020-Sep-09	11:15	130	W	234	70
2020-Sep-10	02:25	2	W	53	70
2020-Sep-10	17:35	134	E	233	70
2020-Sep-11	08:40	93	W	54	71
2020-Sep-11	23:50	39	E	234	71
2020-Sep-12	15:00	171	E	54	71
2020-Sep-13	06:10	58	W	233	71
2020-Sep-13	21:15	76	E	54	72
2020-Sep-14	12:25	153	W	234	72
2020-Sep-15	03:35	21	W	54	72
2020-Sep-15	18:45	111	E	233	73
2020-Sep-16	09:50	116	W	54	73
2020-Sep-17	01:00	16	E	234	73
2020-Sep-17	16:10	148	E	54	74
2020-Sep-18	07:20	81	W	233	74
2020-Sep-18	22:25	53	E	54	74
2020-Sep-19	13:35	176	W	234	74
2020-Sep-20	04:45	44	W	54	74
2020-Sep-20	19:50	89	E	234	75
2020-Sep-21	11:00	139	W	54	75
2020-Sep-22	02:10	7	W	234	75
2020-Sep-22	17:15	126	E	54	75
2020-Sep-23	08:25	103	W	234	76
2020-Sep-23	23:35	29	E	54	76
2020-Sep-24	14:40	162	E	234	76
2020-Sep-25	05:50	66	W	54	76
2020-Sep-25	21:00	66	E	234	76
2020-Sep-26	12:05	161	W	54	77
2020-Sep-27	03:15	30	W	234	77
2020-Sep-27	18:25	102	E	54	77
2020-Sep-28	09:30	125	W	234	77
2020-Sep-29	00:40	7	W	54	77
2020-Sep-29	15:50	139	E	234	77
2020-Sep-30	06:55	89	W	54	77
2020-Sep-30	22:05	43	E	234	78
2020-Oct-01	13:15	175	E	54	78
2020-Oct-02	04:20	52	W	234	78
2020-Oct-02	19:30	80	E	54	78
2020-Oct-03	10:35	148	W	234	78
2020-Oct-04	01:45	16	W	54	78
2020-Oct-04	16:55	116	E	234	78
2020-Oct-05	08:00	111	W	54	78
2020-Oct-05	23:10	21	E	234	78
2020-Oct-06	14:15	154	E	54	78

dust storms than in the past. For example, in the 2007-8 apparition, Earth-based observers not only detected and monitored the great planet-encircling dust storm of that apparition, but also detected seven other dust storms, of which five were well-monitored.

Mars has been well observed since 1893, and the first planet-encircling dust storm was detected 15 years later in 1908. The last such storm was observed during the most recent apparition. A total of 12 global dust storms have been detected over the last 126 years with a 10.5-year mean interval between them. However, there was a 32-year period with no global dust storms (1923 to 1955) and there were four within six years: 1970, 1972, 1974, and 1975 (McKimm, 1999). It remains unclear whether the likelihood of observing another such storm is related to the length of time since the last one.

During each apparition there are some reports of dust storms that are not borne out by follow-up observations. It is important to remember the three cardinal features of dust storms:

- They are bright in red light.
- They obscure the usual albedo features.
- They move, from sol to sol.

Unless all three of these characteristics are seen, one might refer to a suspected dust feature as a "possible" dust storm.

To identify and monitor a dust storm, the use of a red filter is very helpful for both visual observers and imagers. Changes in the storm's obscuration of underlying albedo features should be recorded as the observer studies the region's appearance from night to night.

Occasionally, exceptional dust features can be seen that do not meet these criteria. For example, narrow streaks of dark dust stand out prominently against the polar caps, which can be unambiguously identified as dust

Table 2. Greatest Elongations of Deimos (Continued)

2020-Oct-07	05:25	75	W	234	78
2020-Oct-07	20:35	57	E	54	78
2020-Oct-08	11:40	170	W	234	78
2020-Oct-09	02:50	39	W	54	78
2020-Oct-09	17:55	95	E	235	78
2020-Oct-10	09:05	134	W	54	78
2020-Oct-11	00:10	1	W	235	78
2020-Oct-11	15:20	131	E	55	78
2020-Oct-12	06:30	98	W	235	77
2020-Oct-12	21:35	35	E	55	77
2020-Oct-13	12:45	167	E	235	77
2020-Oct-14	03:50	60	W	55	77
2020-Oct-14	19:00	72	E	235	77
2020-Oct-15	10:10	157	W	55	77
2020-Oct-16	01:15	24	W	235	77
2020-Oct-16	16:25	108	E	55	76
2020-Oct-17	07:30	119	W	235	76
2020-Oct-17	22:40	13	W	55	76
2020-Oct-18	13:50	144	E	235	76
2020-Oct-19	04:55	83	W	55	76
2020-Oct-19	20:05	49	E	235	75
2020-Oct-20	11:10	178	W	55	75
2020-Oct-21	02:20	47	W	235	75
2020-Oct-21	17:30	85	E	55	75
2020-Oct-22	08:35	142	W	235	74
2020-Oct-22	23:45	10	W	55	74
2020-Oct-23	14:55	122	E	235	74
2020-Oct-24	06:00	106	W	55	73
2020-Oct-24	21:10	26	E	235	73
2020-Oct-25	12:15	159	E	56	73
2020-Oct-26	03:25	69	W	236	73
2020-Oct-26	18:35	63	E	55	72
2020-Oct-27	09:40	165	W	236	72
2020-Oct-28	00:50	33	W	56	72
2020-Oct-28	16:00	99	E	236	71
2020-Oct-29	07:05	128	W	56	71
2020-Oct-29	22:15	4	E	236	71
2020-Oct-30	13:25	136	E	56	70
2020-Oct-31	04:30	92	W	236	70
2020-Oct-31	19:40	40	E	56	69

* Sub-Mars longitude is the longitudinal meridian on Earth from which the greatest elongation event will be on the observer's meridian at elongation time, in degrees. E or W is the east or west designator of that Earth longitude (not the designator of the direction from Mars of the elongation).

× PA is the position angle of Deimos with respect to the center of Mars, measured in degrees, with zero as directly north and 90 degrees as directly east, referenced to the sky plane (not in planet-referenced directions).

ʕ Ang Sep is angular separation from the center of Mars in the sky plane, measured in arc seconds.

deposits. Rarely, a dust storm will be composed of dark dust that is not bright in red light, but can be seen to obscure albedo features and change from sol to sol. Such dark dust storms are generally small and transient (Venable, 2017).

The Moons of Mars

At a favorable apparition such as this one, it is likely than many observers will be able to detect the moons of Mars visually. Detecting Phobos and Deimos is very difficult during unfavorable apparitions. The problem, of course, is not due to the intrinsic faintness of the moons, but rather to the brightness of the nearby planet. There are two ways in which visual observations of the moons are impaired by the brightness of Mars. First, the sky is bright very near the planet, due to scattering in the Earth's atmosphere. Second, the eye's sensitivity to faint light is down-regulated by the bright field of view when it includes the planet. Attempts to image the moons are not affected by the second of these factors, and so we receive more images of them than we do visual reports.

High magnification is essential in order to observe the moons. A motor-driven mounting with a hand controller for fine telescope movements may necessary, in order to accurately place the disc of Mars slightly beyond the edge of the field of view. An occulting bar placed at the focal plane of the eyepiece is another tool that some have used to good advantage.

Generally, success in seeing the moons depends on planning to observe when they are at greatest elongation from the planet. Deimos is far easier to see than Phobos, even though it is intrinsically fainter, as it is farther from the edge of the planet's disc. Deimos is 2.95 Mars-diameters from the edge of the planet's disc when at greatest elongation. It may be detectable for one to three hours before and after the time of greatest elongation, depending on the observing conditions and the telescope aperture. Table 2 gives the UT dates and times of all of the greatest elongations of Deimos that occur during the period around

Mars's opposition in which the planet has an apparent diameter of greater than 20 arc-seconds. Only a fraction of them will be observable from any one longitude of Earth. The table lists the Earth longitude from which each elongation will occur on the local meridian, from where it can be best seen. We recommend that you limit your observation attempts to those Deimos elongations that occur within 45 degrees of your meridian.

Should you wish to try to see Phobos, contact coordinator Roger Venable for information about favorable times for your location, or use the JPL Horizons ephemeris generator (as Roger does) to generate the predictions.

Table of Potential Observational Events

Table 3 of this article, compiled by Jeff Beish, lists the important things to be alert for as you observe the Red Planet during this apparition. *The New Internet Mars Observer's Handbook* (Beish, 2019) provides more details about features that may be observed.

Reporting Your Observations

The ALPO Mars Section is eager to receive your reports of your observations, whether you make images, drawings, or written descriptions. It is easiest for us if you send them directly to coordinator Roger Venable at rjvmd@hughes.net , We also encourage you to post them in the ALPO online image gallery by sending them to Theo Ramakers at mars@alpo-astronomy.org

There are observing forms available online for those who would benefit from assistance in compiling a report. Find them on the ALPO website, at www.alpo-astronomy.org . On that page, click on "Mars Section" in the list of ALPO sections in the left sidebar. Then, on the Mars Section page, look in the list in the right sidebar under "Mars Observing Form."

With your report, be sure to include your name, location, the universal time of your observation (not your local time), brief descriptions of your instrument(s), filters used, and estimates of the quality of seeing and transparency. Your interpretations of your findings are also welcome.

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Table 3. Calendar of Events — Mars, 2019-2021

DATE	PHYSICAL	REMARKS
2019 Sep 02	Ls 74.3°	**Conjunction.** Mars is behind the Sun ~2.675 AU.
2019 Oct 08	Ls 90° De 25.0° Ds 24.8° RA 12:10 Dec 0.0° A. Dia 3.6”	**Solstice - Northern Summer/Southern Winter.** Orographic clouds over the Tharsis volcanoes – W-Cloud present? Local seasonal clouds should wrap around Syrtis Major and be prominent in Lybia. White cloud and Ice-fog activity? Discrete clouds? NPC remnant? Lemuria (210° W, 82° N) detached from NPC? Any other detachments (projections at 135° W and 290° W) near NPC remnant, NPC Width ~18° ±4°.
2020 Mar 20	Ls 169.1° De -11.9° Ds 4.5° RA 19:37 Dec -22.3° A.Dia 6”	**Apparition begins** for observers using 4-inch to 8-inch apertures telescopes and up. Begin low-resolution CCD imaging. Views of surface details not well defined. Is the North Polar Hood present? Does SPH or frost cover should begin to clear and darken. Are W-clouds present? South cap emerges from darkness of Winter. SPH thinning and forms "Life Saver Effect"?
2020 May 09	Ls 197.6° De -21.7° Ds -7.3° RA 21:59 Dec -14.2° A.Dia 8”	SPC shrinking. Syrtis Major darkens and continues to shrink. W-clouds possible. Surface details increasing in contrast Hellas the features Zea Locus and dark? SPC Novissima Thyle (300°-330°W) projection present? (SPC width ~52° ±6°).

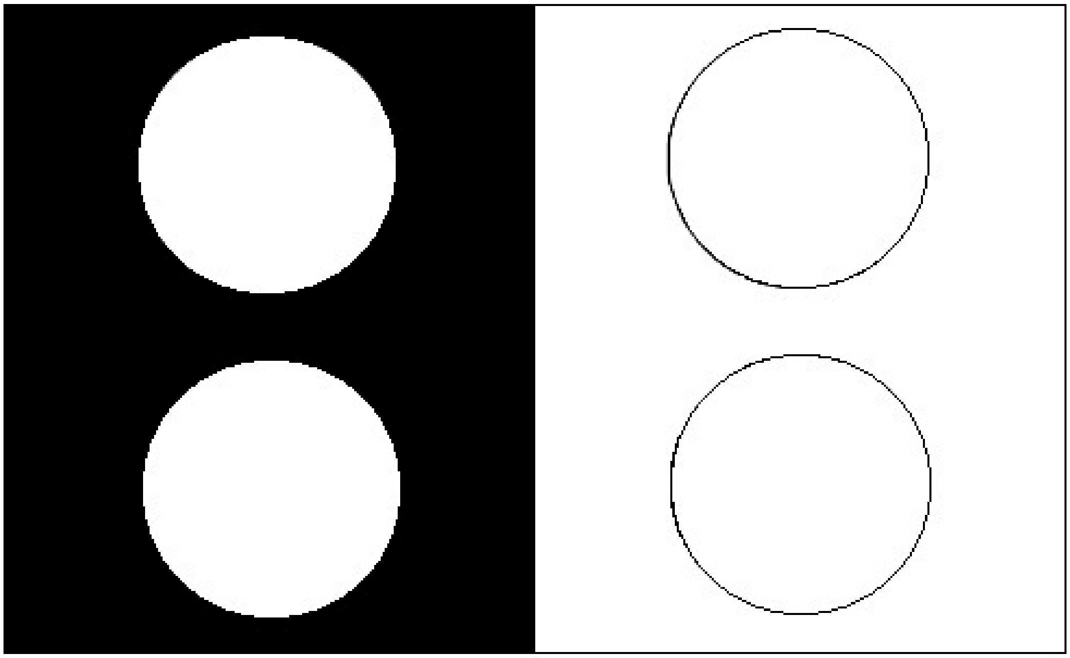
Table 3. Calendar of Events — Mars, 2019-2021 (Continued)

2020 Jun 07	Ls 215.1° De -23.6° Ds -13.9° RA 23:14 Dec -7.6° A.Dia 9.7"	**Mars at quadrature.** Bright SPC projection Novissima Thyle (300°W - 330°W) Areographic longitude. Dark rift Rima Augusta connected from 60° to 270° longitude. Rima Australis visible in SPC (290°-350°W)? W-clouds possible. SPC bright projection Argenteus Mons (10°W-20°W). SPC Dust clouds in Serpentis-Hellespontus, in Noachis? (SPC width ~44° ±3°).
2020 Jun 12	Ls 218.2° De -23.6° Ds -15.0° RA 23:27 Dec -6.4° A. Dia 10"	Bright SPC projection Novissima Thyle (300°W - 330°W) Areographic longitude. Dark rift Rima Augusta connected from 60° to 270° longitude. Rima Australis visible in SPC (290°-350°W)? W-clouds possible. SPC bright projection Argenteus Mons (10°W-20°W). SPC Dust clouds in Serpentis-Hellespontus, in Noachis? (SPC width ~44° ±3°).
2020 Jul 07	Ls 172.4° De -12.8° Ds 3.2° RA 19:57 Dec -22.4° A.Dia 12"	SPC rapid retreat. Novus Mons small, bright, and high-contrast. Rima Australis widens. SPC isolated bright spot at 155° longitude? Any white patches near -20° latitude may brighten. Atmosphere of Mars very clear during Ls 240°- 250°. Occasional morning limb hazes. Dust clouds? Note: Several "planet-encircling dust storms have been reported during this season at 24° Ls. (SPC width ~28° ±3°).
2020 Aug 02	Ls 250° De -19.8° Ds -23.2° RA 01:14 Dec 3.7° A.Dia 14.7"	**Mars at Perihelion** . SPC in rapid retreat. Novus Mons smaller. Dust clouds expected over Serpentis-Hellaspontus (Ls 250° - 270°). Syrtis Major beginning to narrow. Frost in bright deserts? Orographic clouds (W-clouds) possible. Elysium and Arsia Mons bright? Note: Several "planet-encircling dust storms have been reported during this season. High probability 255° Ls. (SPC width ~ 24° ±3°).
2020 Sep 03	Ls 270° De -17.3° Ds -24.8° RA 01:49 Dec 6.7° A.Dia 19.2"	**Solstice - Northern Winter/Southern Summer.** W-clouds present? NPH extends 50° N? Decreased number of White clouds. "Syrtis Blue Cloud"? White areas in deserts? Dust clouds in south until 270° Ls? Watch for planetary system clouds bands. Orographic cloud over Arsia Mons? Syrtis Major is narrow. (SPC width ~ 17° ±2°).
2020 Sep 09	Ls 274.2° De -17.5° Ds -25.2° RA 01:50 Dec 6.8° A.Dia 20.1"	**Retrogression Begins.** W-clouds present? NPH extends 50° N? Decreased number of White clouds. "Syrtis Blue Cloud"? White areas in deserts? Dust clouds in south until 270° Ls? Watch for planetary system clouds bands. Orographic cloud over Arsia Mons? Syrtis Major is narrow. (SPC width ~ 17° ±2°).
2020 Oct 06	Ls 291.0° De -19.1° Ds -23.0° RA 01:32 Dec 6.0° A.Dia 22.6"	**Mars at Closest Approach.** Bright SPC projection Novissima Thyle (300°W - 330°W) Areographic longitude. Dark rift Rima Augusta connected from 60° to 270° longitude. Rima Australis visible in SPC (290°-350°W)? W-clouds possible. SPC bright projection Argenteus Mons (10°W-20°W). SPC Dust clouds in Serpentis-Hellespontus, in Noachis? (SPC width ~10° ±2°).
2020 Oct 13	Ls 295.2° De -20.0° Ds -22.3° RA 01:23 Dec 5.5° A.Dia 22.4"	**Mars at Opposition.** Bright SPC projection Novissima Thyle (300°W - 330°W) Areographic longitude. Dark rift Rima Augusta connected from 60° to 270° longitude. Rima Australis visible in SPC (290°-350°W)? W-clouds possible. SPC bright projection Argenteus Mons (10°W-20°W). SPC Dust clouds in Serpentis-Hellespontus, in Noachis? (SPC width ~10° ±2°).

Table 3. Calendar of Events — Mars, 2019-2021 (Continued)

2020 Nov 14	Ls 314.1° De -23.7° Ds -17.9° RA 00:57 Dec 5.2° A.Dia 17.7"	**Retrogression Ends.** Bright? Is SPC remnant visible in mid-summer? High probability of dusty storm at 315° Ls. Orographic cloud over Arsia Mons? Topographic cloud over (SPC width ~10° ±2°).
2020 Dec 18	Ls 333.2° De -23.4° Ds -10.9° RA 01:20 Dec 9.0° A.Dia 12'	Hellas Ice-fog activity? Topographic cloud over NPC large hood present. W-Cloud? Orographic cloud over Arsia Mons? (SPC width ~10° ±2°).
2021 Jan 05	Ls 342.9° De -21.9° Ds 7.1° RA 01:47 Dec 12.1° A.Dia 10'	Hellas Ice-fog activity? Topographic cloud over NPC large hood present. W-Cloud? Orographic cloud over Arsia Mons? (SPC width ~10° ±2°).
2021 Jan 30	Ls 355.8° De -18.3° Ds 1.8° RA 02:34 Dec 16.5° A.Dia 8'	NPC large hood (NPH) present. Discrete (white) clouds and white areas should be seen. Syrtis Major begins to expand to its east. Topographic cloud over Libya?
2021 Feb 08	Ls 0° De -16.6° Ds 0.1° RA 02:53 Dec 19.9° A.Dia 7.4'"	**Equinox - Northern Spring/Southern Autumn**. North Polar Hood (NPH) breaking up, North Polar Cap (NPC) should be exposed.
2021 Mar 12	Ls 15.9° De -9.4° Ds 6.6° RA 04:09 Dec 22.5° A.Dia 6'"	North Polar Hood (NPH) breaking up and North Polar Cap (NPC) should be exposed. and Argyre bright?
2021 Oct 08	Ls 109.8°	**Conjunction.** Mars is behind the Sun ~2.629AU.

ALPO Mars Section Observation



Top: Time (UT):________________ **Bottom:** Time (UT):________________
CM:____________° W CM:____________° W
Filter:________________(W / S) Filter:________________(W / S)

Date (UT):________________ Observer:________________
Time (UT):__________ - __________ Address:________________
CM:__________° W - __________° W
D_E:__________° - L_S:__________° Observing Station:________________
Dia. ("):__________ k (phase): __________
Telescope:______ f/______ (in. / cm. ; RL . RR . SC) E-mail (optional):________________
Magnification:______x ______x ______x
Filters:________________(W / S)
Seeing (0-10):______ Antoniadi (I-V):______
Transparency (1-6):______(Clear / Haze / Int. Clouds)
Blue (Violet) Clearing (0-3):__________

Notes

(Continue on back if needed)

Papers & Presentations

Timing Jupiter's Satellite Eclipses: The 2013-14 Apparition

By: John E. Westfall, Program Coordinator, Galilean Satellite Eclipses

EDITOR'S NOTE: John submitted this report before he passed away in July 2018. Questions or comments on this report should be directed to the ALPO Jupiter Section Coordinator Richard Schmude at: *schmude@gordon-state.edu*

Abstract

During the 2012/13 Jupiter apparition, three observers made 40 visual timings of the eclipses of Jupiter's four Galilean satellites - Io, Europa, Ganymede and Callisto. We compare the means of their observed eclipse disappearance and reappearance times with the predictions of the IMCCE (Institut de Méchanique Céleste et de Calcul des Éphémérides) E-5 ephemeris (IMCCE; Lieske, 1998).

Introduction

The apparition covered here is the 36th observed by the ALPO Jupiter Section's Galilean Satellite Eclipse Timing Program, which conducts visual timings of the eclipses by Jupiter of the four Galilean satellites Io, Europa, Ganymede and Callisto.

Our observers timed the "last speck" visible when a satellite entered Jupiter's shadow (disappearance) and the "first speck" visible when it emerged from eclipse (reappearance). Each satellite's mean disappearance and reappearance timings were then averaged to determine if its position corresponded to its ephemeris. (Our 1998/99 apparition report [Westfall 2009] described in detail our method of reduction; see also our most recent report [Westfall 2018.]) We have compared our reduced timings with the IMCCE predictions, using the INPOP13C planetary theory and Lieske E-5 satellite theory.

All Readers

Your comments, questions, etc., about this report are appreciated. Please send them to: the author's email address.

Online Features

Left-click your mouse on:

The author's e-mail address in blue text to contact the author of this article.

The references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Table 1. Circumstances of the 2013/14 Jupiter Apparition

Apparition		Observing Season	
Initial solar conjunction	2013 JUN 19, 16h	First eclipse timing§	2013 AUG 17 (+59d)
First maximum phase angle	2013 OCT 11, 05h (11.15°)	Last eclipse timing§	2014 MAY 01 (-84d)
Closest approach to Earth†	2014 JAN 04, 18h (D = 46.8")	Duration	257 d
Opposition to the Sun*	2014 JAN 05, 21h (δ = +22.7°)	Solar Elongation Range	043°W – 065°E
Second maximum phase angle	2014 APR 02, 05h (11.02°)	Sources: Meeus 2016; *Astronomical Almanac*, 2013 and 2014 editions; JPL *HORIZONS* website. Dates and times throughout this report are in Universal Time (UT).	
Final solar conjunction	2014 JUL 24, 21h		
Zenocentric latitude of Sun	+2.69° - +0.96°	* δ = Jupiter's declination at opposition. † D = Jupiter's equatorial diameter in arc-seconds. § In parentheses are the number of days after initial solar conjunction (+) or before final solar conjunction (-).	
Zenocentric latitude of Earth	+2.64° - +1.05°		

Table 1 lists the pertinent dates and other circumstances of the 2013/14 Apparition.

This apparition saw the zenocentric northerly latitudes of the Sun and Earth decrease to the point where Callisto could undergo eclipses by Jupiter (the satellite's new eclipse cycle ran from 2013 Jul 28 through 2016 Jul 21). The reduction of the solar latitude also meant that Io, Europa and Ganymede entered and exited Jupiter's shadow at less oblique angles than in recent apparitions.

Jupiter's high northerly declination at opposition favored our observers, all of whom were located in the Earth's northern hemisphere.

Observations and Observers

The 40 timings received for 2013/14 brought our 36-apparition total to 11,144 observations, but show a decrease from the 75 received for the

2012/13 Apparition. Table 2 gives descriptive statistics for the 2013/14 observations.

There remains an imbalance between the number of observations made following opposition and of those made before. This inequality is understandable, given the inconvenience of observing after midnight, but the statistical significance of our results would be improved were the observations more evenly distributed.

Table 3 lists the participants in our program during 2013/14, with their nationalities, instrument apertures and number of timings, both short-term and long-term.

It is pleasing to see that all our observers have continued with our program for multiple apparitions.

The contributors used moderate-size telescopes in the aperture range 6-15 cm (2.3-6 in.). The mean aperture, weighted by number of observations, was 13.3 cm (5 in.).

Table 2. Number of Eclipse Timings, 2013/14 Apparition

Number of Timings	40
Timings before Opposition	17 (42%)
Timings after Opposition	23 (58%)
Disappearance Timings	16 (40%)
Reappearance Timings	24 (60%)

Table 3. Participating Observers, 2013/14 Apparition

Observer and Telescope					ALPO Timing Program Total	
I.D. No.	Name	Nationality	Telescope Aper. (cm)	Number of Timings (total)	Number of Apparitions	Number of Timings
1a 1b	Büttner, D.	Germany	6 10	6 1 (7)	18	132
2	Hays, R.H., Jr.	USA (IL)	15	29	23	389
3	Westfall, J.	USA (CA)	12.7	4	33	609
Mean Number of Timings per Observer				13.3		

Table 4. Timing Residual Statistics, 2013/14 Apparition

Quanitity	Satellite			
	Io	Europa	Ganymede	Callisto
Disappearances: Number of Timings	7 (7)	5 (5)	3 (3)	1 (1)
Disappearances: Mean	+96.7±2.3s	+105.0±3.8s	+271.3±10.7s	+308.0s
Disappearances: Median	+99.0s	+103.0s	+266.0s	-
Reappearances: No. of Timings	9 (7)	7 (6)	5 (4)	3 (3)
Reappearances: Mean	-96.4±2.3s	-111.3±2.1s	-264.5±6.3s	-334.7±51.0s
Reappearances: Median	-99.0s	-111.0s	-264.5s	-378.0s
(Disap.+Reap.)/2: Means	+0.1±1.6s	-3.2±2.1s	+3.4±6.2s	-
(Disap.+Reap.)/2: Medians	0.0s	-4.0s	+0.8s	-

Numbers of timings in parentheses are the number of timings used in the analysis after those with unusually large residuals (most often due to poor observing conditions) were omitted.

Timings Analysis: Satellite Positions

The individual eclipse timings made by our participants in 2013/14 are listed in Table 5 at the end of this report. Table 4 summarizes the eclipse timings made in this period, with the means, standard errors of the means, and medians of the differences ("residuals") between our timings and the IMCCE E-5 ephemeris. All the residuals were corrected for oblique contact with Jupiter's shadow at disappearance and reappearance, using the formula $R' = R \cos \beta'$, where R' is the corrected residual, R the original residual, and β' the zenographic latitude of the satellite relative to Jupiter's shadow.

This correction made a difference of 1-3 seconds for Io, 6-13 seconds for Europa, 27-83 seconds for Ganymede, but ranged from 80 to 302 seconds for Callisto.

Conclusion

The analysis of our program's timings made during the 2013/14 Jupiter apparition shows that the times of eclipses by Jupiter of Io, Europa and Ganymede did not differ significantly from the IMCCE E-5 ephemeris. Due to the limited number of observations we can make no conclusion regarding the agreement of Callisto's position relative to its ephemeris.

We thank the observers who contributed timings during 2013/14.

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Table 5. Galilean Satellite Eclipse Timings, 2013/14 Apparition

UT	LD	Lat	ObN	STB	Dif
Io Disappearances					
30817	13	+15	2	001	+93
30902	17	+14	2	000	+92
30925	20	+14	2	000	+105
31018	22	+13	2	000	+94
31025	22	+13	2	000	+106
31103	22	+13	2	000	+102
31119	20	+12	2	000	+104
Io Reappearances					
40106	1	+11	3	000	+6
40113	4	+11	3	100	-62
40120	8	+11	2	000	-94
40122	9	+11	2	010	-104
40129	12	+10	2	000	-103
40212	17	+10	2	000	-100
40228	20	+9	2	000	-103
40307	21	+9	2	200	-87
40425	19	+8	1a	010	-94

UT	LD	Lat	ObN	STB	Dif
Europa Disappearances					
31010	34	+27	2	000	+127
31118	30	+25	2	100	+124
31129	26	+25	2	100	+113
31213	18	+24	2	100	+113
31216	16	+24	1a	020	+102
Europa Reappearances					
40110	4	+23	1a	002	-93
40204	22	+22	1b	000	-119
40226	32	+21	2	000	-123
40330	34	+19	2	000	-118
40406	34	+19	2	000	-112
40416	32	+18	1a	000	-112
40501	29	+18	2	000	-125
Ganymede Disappearances					
30922	49	+39	2	000	+375
31210	32	+34	2	000	+319
31224	16	+33	2	100	+304

UT	LD	Lat	ObN	STB	Dif
Ganymede Reappearances					
31028	20	+36	2	000	-321
40115	12	+31	3	200	-200
40212	42	+29	1a	000	-317
40327	55	+25	1a	000	-277
40411	52	+24	2	000	-297
Callisto Disappearances					
31020	94	+60	2	000	+610
Callisto Reappearances					
40112	14	+46	3	100	-333
40129	48	+43	2	000	-540
40406	94	+34	2	000	-458

Column headings: UT = Universal Time, expressed as ymmdd, where y is the last digit of the year; LD = distance of satellite from Jupiter's limb in arc seconds; Lat = zenographic latitude of satellite on Jupiter's shadow cone in degrees; ObN = observer number as in Table 3; STB = observing conditions, where S = seeing, T = transparency and B = field brightness, all expressed in terms of 0 = condition not perceptible, 1 = condition perceptible but does not affect accuracy and 2 = condition perceptible and does affect accuracy; and Dif = (observed – calculated) eclipse time in seconds. Underlined timings were excluded during analysis due to unusually large differences from the other observations, usually due to unfavorable observing conditions. Note that these "raw" residual values have not been corrected for oblique contact with Jupiter's shadow.

Papers & Presentations

ALPO Observations of the Remote Planets in 2018-2019

By Richard Schmude, Jr.,
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Abstract

This report summarizes over 90 brightness measurements made of Uranus and Neptune with filters transformed to the Johnson U, B and V system. The brightness values of both planets are close to those in the previous apparition. Several individuals submitted high-resolution images and drawings of both planets. A new bright belt on Uranus was imaged in November 2018 by Damian Peach and by professional astronomers operating the Hubble Space Telescope. Mean magnitude values and belt latitudes are reported.

Introduction

Several individuals submitted high-quality images, spectra and brightness measurements of Uranus and Neptune during the second half of 2018 and early 2019. In 2018, this writer also presented a report to the Society of Astronomical Sciences (SAS) about the work the ALPO Remote Planets Section has done since 1991 (Schmude, 2018b). Four important results, reported here, are the trend in brightness measurements of both planets in visible wavelengths, the computation of magnitude values from spectra, latitude measurements of bright belts on Uranus and an image showing a bright spot on Uranus near the south edge of the bright North Polar Region.

Table 1 lists the characteristics of Uranus and Neptune during their 2018-2019 apparitions. Table 2 lists the individuals who submitted material during the 2018-2019 apparition.

During May 2019, this writer's digital Uranus/Neptune folder may have been deleted accidently during a computer upgrade. My apologies if I have not mentioned someone who submitted observations.

Photoelectric Photometry

Jim Fox, Christophe Pellier and this writer made over 90 brightness measurements of Uranus and Neptune during this apparition. Table 3 summarizes the comparison stars and the respective magnitude values used. Jim Fox used SAO 92659 and HD 217877 as comparison stars for Uranus and Neptune, respectively. This writer used HD 012140 as a comparison star for his V-filter measurements of Uranus on July 27 and September 19. He used ι-Ari and σ-Aqr as comparison stars for his U-filter measurements of Uranus and Neptune, respectively. Jim Fox used o-Psc and 85-Aqr as check stars for his Uranus and Neptune measurements, respectively. His mean measured magnitudes for o-Psc are V = 4.28 and B = 5.23. These values are close to those in Table 3. His mean 85-Aqr magnitude measurements are V = 6.68 and B = 6.68, which are also close to those in Table 3. Meanwhile, this writer used ι-Ari and γ-Ari as check stars for V- and U-filter measurements of Uranus and 83-Aqr for U-filter measurements of Neptune. He measured mean magnitude values of V = 5.10 (ι-Ari), U = 3.73 (σ-Aqr) and U = 5.75 (83-Aqr). These values are

Table 1. Characteristics of the 2018-2019 Apparitions of Uranus and Neptune[a]

Parameter	Uranus	Neptune
First conjunction date (2018)	April 18	March 4
Opposition date (2018)	October 24	September 7
Angular diameter in arc-seconds (opposition)	3.7	2.4
Sub-Earth latitude (opposition)	43.6° N	25.2° S
Right Ascension (opposition)	1h 55m	23h 7m
Declination (opposition)	11.1° N	6.8° S
Second conjunction date (2019)	April 22	March 7

[a]Data are from the *Astronomical Almanac* for the years 2018 and 2019.

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The references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Table 2. Contributors of Images to the *ALPO Japan Latest* Website (2019) and Those Who Submitted Observations to this Writer in 2018-2019

Observer (country)	Type[a]	Instrument[b]	Observer (country)	Type[a]	Instrument[b]
Abel, P. G. (UK)	D	0.51 m DK	Maniero, A. (Italy)	I	0.36 m DK
Akutsu, T. (Japan)	I	0.32 m RL	Martins, W. (Brazil)	I	0.31 m RL
Abgarian, M. (Belarus)	I	0.36 m KC	Melillo, F. (USA)	I	0.25 m SC
Checco, A. (USA)	I	0.33 m RL	Milika-Nicholas (Australia)	I	0.36 m SC
De Gregorio, P. (Italy)	I	0.23 m SC	Minagawa, N. (Japan)	I	0.23 m SC
Deconinck, M. (France)	W	0.25 m DK	Morales-Rivera, E. (Puerto Rico, USA)	I	0.31 m SC
Delcroix, M. (France)	I	0.32 m RL	Morozov, K. (Belarus)	I	0.36 m KC
della Vecchia V. (Italy)	I	0.20 m SC	Morrone, L. (Italy)	I	0.28 m SC
Estes, B. (USA)	I	1.52 m RL	Olivetti, T. (Thailand)	I	0.51 m DK
Fox, J. (USA)	PP, S	0.25 m SC	Peach, D. (UK)	I	1.0 m
Fremond, D. (France)	I	0.31 m RL	Pellier, C. (France)	I, S	0.31 RL & 0.50 m RC
Garrido, M. J. (Spain)	I	0.28 m SC	Puerto, L. F. (Spain)	I	0.28 m SC
Goryachko, Y. (Belarus)	I	0.36 m KC	Rockl, R. (Germany)	I	0.36 m SC
Gray, D. (UK)	D	0.42 m DK	Schmude, R. Jr. (USA)	PP	0.20 m MC
Hill, R. (USA)	I	0.20 m MC	Sedrani, R. (Italy)	I	0.36 m SC
Kardasis, M. (Greece)	I	0.35 m	Sussenbach, E. (Netherlands)	I	0.20 m SC
Lewis, M. R. (UK)	I	0.44 m RL	Susesnbach, J. (Netherlands)	I	0.20 m SC
Maksymowicz, S. (France)	D	Several			

[a]Type of Observation: I = image, PP = photoelectric photometry, S = spectra, D = drawing, W = watercolor painting,

[b]Telescope type: MC = Maksutov-Cassegrain; SC = Schmidt-Cassegrain, DK = Dall-Kirkham, KC = Klevtsov-Cassegrain, RL = Reflector, RC = Ritchey-Chretian

Table 3. Comparison and Check Stars Used for This Report

Star	Star Brightness in Magnitudes			Right Ascension	Declination	Source
	U filter	B filter	V filter			
SAO 92659	–	6.240	5.940	1h 51m	11.04° N	a
ο-PSC	–	5.220	4.260	1h 45m	9.16° N	a
HD 217877	–	7.260	6.680	23h 04m	4.80° S	a
85-AQR	–	6.690	6.690	23h 06m	6.06° N	a
HD 012140	–	6.260	6.070	1h 59 m	12.30° N	b
ι-Ari	6.732	6.030	5.109	1h 57m	17.82° N	b
γ-Ari	3.725	3.842	3.880	1h 54m	19.29° N	b
σ-AQR	4.640	4.790	4.825	22h 31m	10.68° S	c
83-AQR	5.776	5.783	5.424	23h 05m	7.69° S	d

[a] "MICA V. 2.0 USNO" from J. Fox [b] Westfall (2008)

[c] "Jim Fox took these values from SIMBAD in about 2013. [d] SIMBAD star database

consistent with those in Table 3. The close agreement between measured and accepted magnitude values for the check stars is evidence for the reliability of the brightness measurements for both planets to within stated uncertainties.

Jim Fox reports transformation coefficients of –0.0499 and 0.072 for the V and B filters, respectively. This writer measured a transformation coefficient of –0.037 for the V filter. He used a transformation coefficient of –0.0224 for U-filter measurements.

Tables 4 and 5 list individual brightness measurements of Uranus and Neptune, respectively. This writer corrected all of these values for atmospheric extinction and color transformation (Hall and Genet, 1988). Typical extinction corrections of 0.008 and 0.014 magnitudes were made for Fox's V- and B-filter measurements. These are based on assumed extinction coefficients of k_V = 0.23 and k_B = 0.38 magnitudes/air mass. These values are probably too high because they are for Barnesville, Georgia USA, which is at an elevation of ~0.25 km. Mayhill, New Mexico USA, on the other hand, is at an altitude of 2.0 km. (Preliminary mean extinction coefficients of k_V = 0.12 and k_B = 0.16 magnitude/ air mass were measured from some Mayhill data). Normalized brightness measurements were computed using the procedure described by Schmude (2008, p. 166). Table 6 summarizes mean normalized brightness values of both planets. Uncertainties were computed in the same way as is described in Schmude (2015, pp. 49, 51).

The brightness values for Uranus are within 0.02 magnitudes to those in the previous apparition (Schmude, 2019, p. 67). The B – V color index of that planet, 0.53, is close to historical values

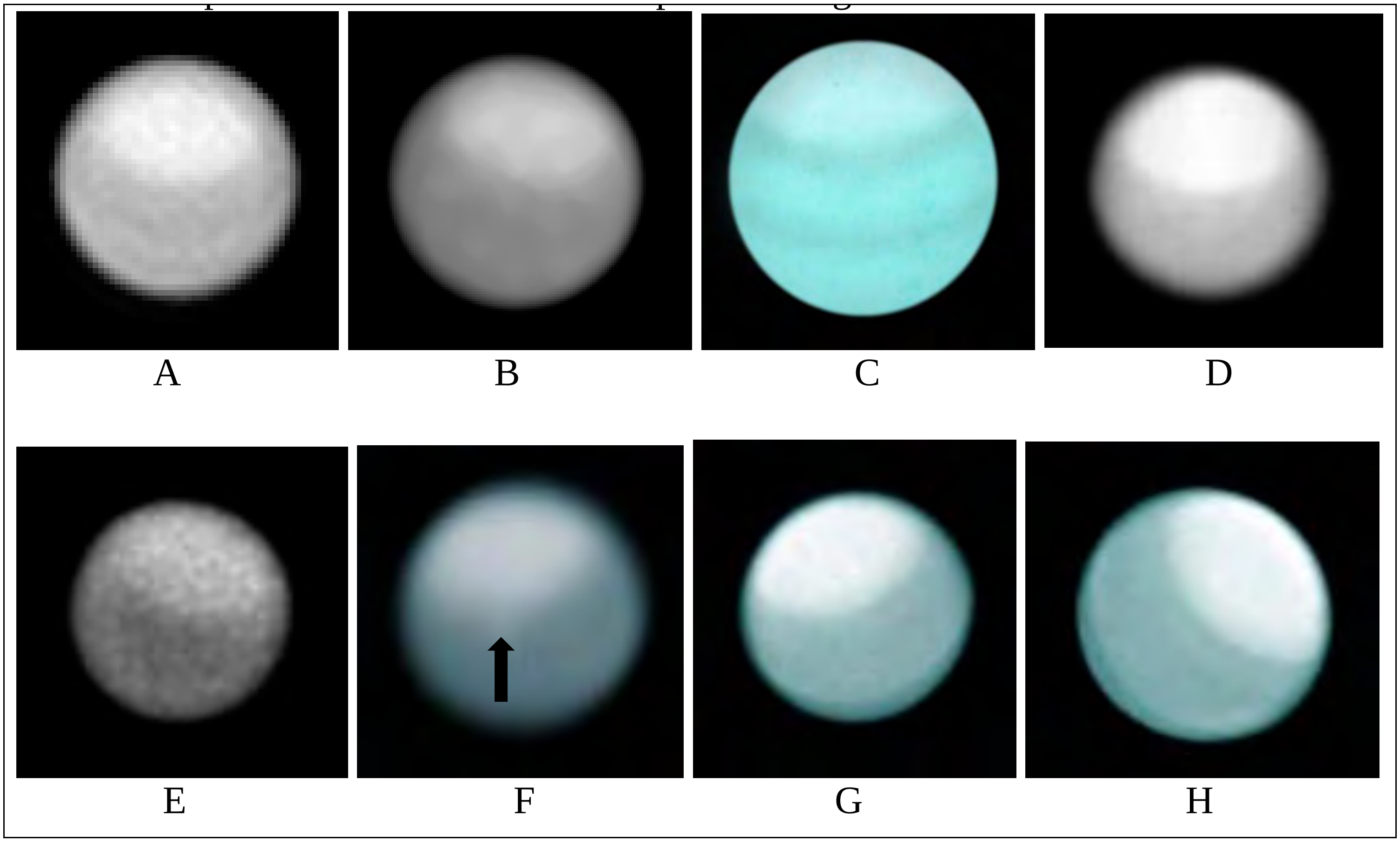

Figure 1. Images of Uranus made during late 2018. A-August 11 (2:16.9 UT) by C. Pellier, 0.50 m Ritchey Chretien, IR 685+ filter; B-September 21 (23:20 UT) by M. Abgarian, Y. Goryachko and K. Morozov, 0.36 m Klevtsov-Cassegrain, RG 610 filter; C-September 23 (22:41 UT) by P. Abel, 0.51 m Dall-Kirkham, 540 X; D-October 8 (3:42 UT) by A. Checco, 0.33 m RL, IR 685 filter; E-October 9 (16:01.7 UT) by T. Akutsu, 0.32 m RL, IR 685 filter; F-October 22 (5:44.6 UT) by B. Estes, 1.52 m RL at Mt. Wilson, Baader IR 685 filter; G-November 26 (1:49.2 UT) by D. Peach and the Chiliscope team, IR 685 filter; H-November 27 (2:15.5 UT) by D. Peach and the Chiliscope team. North is near the top in all images.

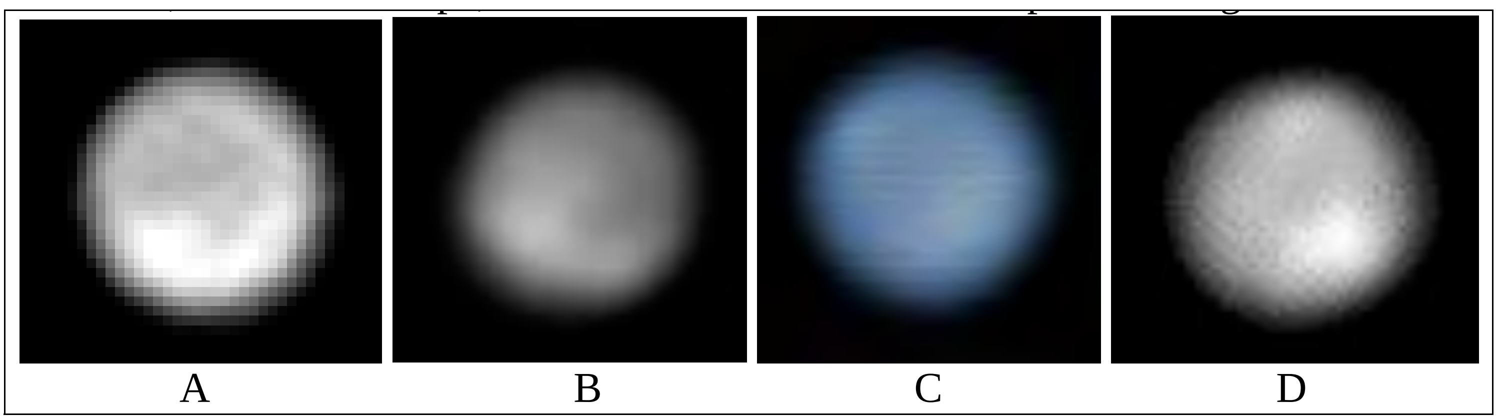

Figure 2. Images of Neptune made in 2018: **A**-August 16 (0:23.1 UT) by C. Pellier, R+IR filter; **B**-September 15 (22:22.5 UT) by L. Morrone, 0.28 m SC, R+IR 610 nm filter; **C**-October 22 (4:48.6 UT) by B. Estes, 1.52 m RL, Baader IR 685 nm filter; **D**-November 19 (18:16 UT) by M. Kardasis, 0.35 m telescope, RIR 610 nm. North is at the top in all images.

(Schmude, 2008, p. 17), (Mallama et al. 2017). Harris (1961, p. 299) reports a U – B value of 0.28, which used along with his B – V and V (1,0) values corresponds to U (1, α) = -6.35. This is a bit brighter than the corresponding 2018 value. The measured U – B value for 2014-2018 is 0.31 (Schmude, 2015, p. 54; 2017, p. 67; 2018a, p. 83; 2019, p. 67). Therefore, Uranus appears to have undergone only a small increase in brightness in the U filter.

Over the last five years, Neptune has grown ~0.03 magnitudes brighter in blue and green wavelengths (Lockwood, 2019), (Schmude, 2015, p. 54; 2017, p. 67; 2018a, p. 83; 2019, p. 67). Schmude (2018b) reported Neptune's V-filter brightness trend since 1991. The late 2018 results are a continuation of a brightening trend that started in the 1990s. The B – V color index in Table 6 is similar to the historical value (Schmude, 2008, p. 62), (Mallama et al., 2017). Harris (1961, p. 299) reports a U – B value of 0.21. The mean measured U – B value for 2014 - 2018 is 0.15. The U (1, α) value of Neptune, based on the information in Harris (1961) is -6.25, which is almost 0.2 magnitudes dimmer than the corresponding 2018 value. This is consistent with the brightness trend of that plane in the V-filter (Schmude, 2018b), (Lockwood, 2019).

Spectra

Christophe Pellier submitted spectra of Uranus and Neptune along with whole-disk magnitude values of Uranus. He reports B and V filter magnitude values of 6.25 and 5.79, respectively for December 9, 2018. He computed these values from spectra. He used four different comparison stars (HD11592, HD3088, HD3861 and HD7047) along with the procedure from the AAVSO CCD Manual to make color corrections. Since his comparison stars are near Uranus, the writer believes extinction corrections are negligible. Karkoschka (1994, 1998) also successfully computed B- and V-filter magnitudes of several planets from spectra. The normalized magnitudes, based on Pellier's values, are V (1, α) = -7.12 and B (1,α) = -6.66, which are close to the selected values in Table 6. His spectra cover the wavelength range 350 - 950 nanometers (nm). He also shows spectra of Uranus and Neptune side-by-side. The spectra are similar but Uranus has an absorption feature near 700 nm, which Neptune lacks. The lower resolution of the Neptune spectrum may be the cause of this discrepancy (Pellier, 2019).

Jim Fox submitted both absorption and emission spectra of Uranus. He recorded the absorption spectrum on January 26, 2019 and it shows several methane absorption features. His emission spectrum shows two emission peaks at wavelengths near 453 and 527.8 nm. He recorded a second emission spectrum on January 25, 2019, which shows an emission peak at 557.73 nm; Jim suggests this last peak may be from singly ionized oxygen.

Disk Appearance

During late 2018, several individuals imaged Uranus and Neptune using telescopes as large as 60 inches (1.52 meters). They used either red or near-infrared filters transmitting wavelengths near 700 nanometers. Albedo features usually show up better at this wavelength than at the shorter ones. In addition to this, professional astronomers used the Hubble Space Telescope to image Uranus and Neptune (Villard and Saravia, 2019). Figure 1 shows selected images of the planet Uranus and Figure 2 shows selected images of the planet Neptune. Blake Estes imaged a bright area on Uranus (Figure 1F arrow) on October 22 using the 1.52 m (60-in.) telescope at Mt. Wilson Observatory in southern California near 36° N, 310° W. The Hubble Space Telescope (HST) imaged a similar feature in November 2018 (Villard and Saravia, 2019). Luigi Morrone may have also imaged it on September 16, 2018 (ALPO Japan Latest website).

Damian Peach and others imaged thin bright belts on Uranus (see Figures 1G and 1H). He also imaged a third faint belt located just south of the southern edge of the bright North Polar Region. This belt is also visible in an HST image taken in November 2018 (Villard and Saravia, 2019). For this report, I have named it the North Temperate Belt. Table 7 lists the measured latitudes of the bright belt edges. The south edge of the NPR is consistent with the historical values (Schmude, 2018b, p. 247), but the Equatorial Belt is a few degrees south compared to previous years. The faint northern edge of this feature may be the cause of this apparent southern shift. In late 2017, it had a higher contrast (Schmude, 2019, p. 65) than a year later as shown in Figures 1G and 1H.

Several individuals imaged faint albedo features on Neptune. The most commonly reported feature was a general brightening on the southern limb. Blake Estes imaged a small bright spot near Neptune's equator on October 22; it is at the upper left edge in Figure 2C.

Satellites

Several observers imaged the four brightest moons of Uranus and the

Table 4. Brightness Measurements of Uranus During the 2018-2019 Apparition

Date (2018)	Filter	Magnitude X (+)	Magnitude X(1, α) (–)	Comp. Star	Date (2018 or 2019)	Filter	Magnitude X (+)	Magnitude X(1, α) (–)	Comp. Star
July 27.299		5.802	7.176		Nov. 4.163	B	6.230	6.620	
July 27.311		5.802	7.176		Nov. 11.111	V	5.745	7.144	
July 27.327		5.799	7.178		Nov. 11.111	B	6.26	6.630	
July 27.341		5.811	7.167		Nov. 28.116	V	5.742	7.150	
July 27.368		5.797	7.181		Nov. 28.117	B	6.250	6.640	
July 27.383	V	5.809	7.169	HD 012140	Dec. 21.110	V	5.788	7.137	
Sept. 19.143		5.710	7.181		Dec. 21.110	B	6.290	6.630	
Sept. 19.154		5.691	7.200		Dec. 25.102	V	5.795	7.136	
Sept. 19.172		5.698	7.193		Dec. 25.102	B	6.300	6.630	
Sept. 19.183		5.710	7.181		Dec. 31.077	V	5.797	7.145	
Sept. 21.112		6.580	6.309		Dec. 31.078	B	6.310	6.640	
Sept. 21.128		6.579	6.310		Jan. 4.081	V	5.797	7.152	
Sept. 21.147		6.603	6.286		Jan. 4.082	B	6.330	6.620	
Sept. 21.163		6.570	6.319		Jan. 20.069	V	5.853	7.126	SAO 92659
Oct. 3.106		6.572	6.306		Jan. 20.070	B	6.360	6.620	
Oct. 3.120	U	6.581	6.294	ι-Ari	Jan. 24.080	V	5.841	7.145	
Oct. 3.131		6.590	6.288		Jan. 24.081	B	6.350	6.640	
Oct. 4.105		6.622	6.255		Jan. 25.089	V	5.840	7.148	
Oct. 4.116		6.532	6.345		Jan. 25.090	B	6.360	6.620	
Oct. 4.129		6.579	6.298		Jan. 26.098	V	5.841	7.149	
Oct. 4.140		6.599	6.278		Jan. 26.098	B	6.340	6.650	
Oct. 11.215	V	5.712	7.161		Jan. 31.082	V	5.853	7.146	
Oct. 11.215	B	6.240	6.630		Jan. 31.083	B	6.360	6.640	
Oct. 28.166	V	5.719	7.152		Feb. 8.097	V	5.851	7.163	
Oct. 28.167	B	6.230	6.640	SAO 92659	Feb. 8.097	B	6.370	6.650	
Oct. 29.174	V	5.726	7.145		Feb. 9.096	V	5.878	7.137	
Oct. 29.174	B	6.240	6.640		Feb. 9.097	B	6.390	6.620	
Nov. 4.162	V	5.737	7.136		Mar. 7.049	V	5.885	7.169	ι-Ari

Table 5. Brightness Measurements of Neptune During the 2018-2019 Apparition

Date (2018)	Filter	Magnitude X (+)	Magnitude X(1, α) (–)	Comp. Star	Date (2018)	Filter	Magnitude X (+)	Magnitude X(1, α) (–)	Comp. Star
Sept. 9.168	V	7.674	7.014	HD 217877	Oct. 12.083	U	8.230	6.472	σ-Aqr
Sept. 9.169	B	8.095	6.593		Oct. 14.012	U	8.251	6.452	
Sept. 12.194	V	7.693	6.996		Oct. 14.025	U	8.277	6.426	
Sept. 12.195	B	8.101	6.588		Oct. 14.040	U	8.260	6.443	
Sept. 17.188	V	7.668	7.021		Oct. 28.103	V	7.703	7.013	HD 217877
Sept. 17.188	B	8.050	6.639		Oct. 28.103	B	8.130	6.586	
Oct. 5.047	U	8.359	6.337	σ-Aqr	Oct. 29.147	V	7.706	7.011	
Oct. 5.060	U	8.276	6.420		Oct. 29.147	B	8.062	6.655	
Oct. 5.074	U	8.259	6.437		Nov. 4.133	V	7.709	7.014	
Oct. 5.088	U	8.248	6.448		Nov. 4.133	B	8.104	6.619	
Oct. 6.146	V	7.702	6.996	HD 217877	Nov. 26.083	V	7.745	7.004	
Oct. 6.147	B	8.101	6.597		Nov. 26.083	B	8.130	6.619	
Oct. 11.188	V	7.704	6.997		Nov. 28.081	V	7.721	7.030	
Oct. 11.189	B	8.101	6.600		Nov. 28.081	B	8.121	6.630	
Oct. 12.009	U	8.261	6.441	σ-Aqr	Dec. 21.069	V	7.773	7.007	
Oct. 12.024	U	8.245	6.457		Dec. 21.069	B	8.214	6.566	
Oct. 12.037	U	8.257	6.445		Dec. 25.074	V	7.761	7.024	
Oct. 12.053	U	8.266	6.436		Dec. 25.075	B	8.160	6.625	
Oct. 12.067	U	8.262	6.440						

Table 6: Summary of Mean Normalized Magnitude Values for Uranus and Neptune (Uncertainties are computed in the same way as is described in Schmude (2015, pp. 49, 51))

Planet	U(1, α) [n]	B(1, α) [n]	V(1, α) [n]	B – V	U – B
Uranus	–6.30 ±0.02 [11]	–6.63 ± 0.02 [17]	–7.159 ±0.02 [28]	0.53	0.32
Neptune	–6.43 ±0.03 [13]	–6.61 ±0.02 [12]	–7.01 ±0.01 [12]	0.40	0.18

Table 7. Latitudes of the Bright Belts on Uranus in Late 2018 (Based on measurements from images by C. Pellier, D. Peach, the HST and Goryachko and co-workers)

	North Polar Region	Equatorial Belt	North Temperate Belt
South edge	43° N	5° S	29° N
North edge	–	1° N	34° N

brightest moon of Neptune, but no brightness measurements were obtained.

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The writer would like to thank everyone who submitted measurements, images and drawings related to the remote planets.

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Interest Sections

Lunar & Planetary Training Program

http://www.alpo-astronomy/training

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Online Section

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Observing Sections

Eclipse Section

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Mercury/Venus Transit Section

http://www.alpo-astronomy.org/transit

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Meteors Section

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Solar Section

http://www.alpo-astronomy.org/solar

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Mercury Section

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Venus Section

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Lunar Section

Lunar Topographical Studies Program

http://moon.scopesandscapes.com/ALPO_Lunar_Program.htm

Lunar Selected Areas Program

http://moon.scopesandscapes.com/alpo-sap.html

Lunar Banded Craters Program

http://moon.scopesandscapes.com/alpo-bcp.htm

ALPO Resources

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- Assistant Coordinator; Jim Phillips, 101 Bull St., Charleston, SC 29401-1712; thefamily90@gmail.com

Lunar Meteoritic Impacts Search Program

http://www.alpo-astronomy.org/lunar/lunimpacts.htm

- Coordinator; Brian Cudnik, 11851 Leaf Oak Drive, Houston, TX 77065; cudnik@sbcglobal.net

Lunar Transient Phenomena Program

http://www.alpo-astronomy.org/lunar/LTP.html; also http://www.LTPresearch.org

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Minor Planets Section

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- Scientific Advisor; Dr. Petr Pravec, Ondrejov Observatory, Astronomical Institute, Academy of Sciences, Cz-25 165 Ondrejov, Czech Republic; ppravec@asu.cas.cz
- Asteroid Photometry Coordinator; Brian D. Warner, Center For Solar System Studies, 446 Sycamore Ave, Eaton, CO 80615; brian@MinorPlanetObserver.com

Jupiter Section

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Saturn Section

http://www.alpo-astronomy.org/saturn

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Remote Planets Section

http://www.alpo-astronomy.org/remote

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ALPO Publications

The Monograph Series

http://www.alpo-astronomy.org/publications/Monographs page.html

Publications too lengthy for publication in *The Strolling Astronomer*. All are available online as a pdf files. NONE are available any longer in hard copy format. There is NO CHARGE for any of the ALPO monographs.

- **Monograph No. 1.** *Proceedings of the 43rd Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, August 4-7, 1993. 77* pages. File size approx. 5.2 mb.
- **Monograph No. 2**. *Proceedings of the 44th Convention of the Association of Lunar and Planetary Observers. Greenville, South Carolina, June 15-18, 1994. 52* pages. File size approx. 6.0 mb.
- **Monograph No. 3**. *H.P. Wilkins 300-inch Moon Map.* 3rd Edition (1951). Available as one comprehensive file (approx. 48 megabytes) or five section files (Part 1, 11.6 megabytes; Part 2, 11.7 megabytes; Part 3, 10.2 megabytes; Part 4, 7.8 megabytes; Part 5, 6.5 mb)
- **Monograph No. 4.** *Proceedings of the 45th Convention of the Association of Lunar and Planetary Observers. Wichita, Kansas, August 1-5, 1995.127* pages. Hard copy $17 for the United States, Canada, and Mexico; $26 elsewhere. File size approx. 2.6 mb.
- **Monograph No. *5.*** *Astronomical and Physical Observations of the Axis of Rotation and the Topography of the Planet Mars. First Memoir; 1877-1878.* By Giovanni Virginio Schiaparelli, translated by William Sheehan. 59 pages. Hard copy $10 for the United States, Canada, and Mexico; $15 elsewhere. File size approx. 2.6 mb.
- **Monograph No. *6.*** *Proceedings of the 47th Convention of the Association of Lunar and Planetary Observers, Tucson, Arizona, October 19-21, 1996.20* pages. Hard copy $3 for the United States, Canada, and Mexico; $4 elsewhere.File size approx. 2.6 mb.
- **Monograph No. 7.** *Proceedings of the 48th Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, June 25-29, 1997.76* pages. Hard copy $12 for the United States, Canada, and Mexico; $16 elsewhere.File size approx. 2.6 mb.

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- **Monograph No. 8**. *Proceedings of the 49th Convention of the Association of Lunar and Planetary Observers. Atlanta, Georgia, July 9-11,1998.122* pages. Hard copy $17 for the United States, Canada, and Mexico; $26 elsewhere.File size approx. 2.6 mb.

- **Monograph Number 9**. *Does Anything Ever Happen on the Moon?* By Walter H. Haas. Reprint of 1942 article. 54 pages.Hard copy $6 for the United States, Canada, and Mexico; $8 elsewhere.File size approx. 2.6 mb.

- **Monograph Number 10.** *Observing and Understanding Uranus, Neptune and Pluto*. By Richard W. Schmude, Jr. 31 pages. File size approx. 2.6 mb.

- **Monograph No. 11**. *The Charte des Gebirge des Mondes* (Chart of the Mountains of the Moon) by J. F. Julius Schmidt, this monograph edited by John Westfall. Nine files including an accompanying guidebook in German. Note files sizes:
  Schmidt0001.pdf, approx. 20.1 mb;
  Schmidt0204.pdf, approx. 32.6 mb;
  Schmidt0507.pdf, approx. 32.1 mb;
  Schmidt0810.pdf, approx. 31.1 mb;
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  Schmidt1719.pdf, approx. 22.2 mb;
  Schmidt2022.pdf, approx. 21.1 mb;
  Schmidt2325.pdf, approx. 22.9 mb;
  SchmidtGuide.pdf,approx. 10.2 mb

ALPO Observing Section Publications

Order the following directly from the appropriate ALPO section recorders; use the address in the listings pages which appeared earlier in this booklet unless another address is given.

- **Solar:** *Guidelines for the Observation of White Light Solar Phenomena*, *Guidelines for the Observing Monochromatic Solar Phenomena* plus various drawing and report forms available for free as pdf file downloads at *http://www.alpo-astronomy.org solarblog*.

- **Lunar & Planetary Training Section:** *The Novice Observers Handbook* $15. An introductory text to the training program. Includes directions for recording lunar and planetary observations, useful exercises for determining observational parameters, and observing forms. Available as pdf file via e-mail or send check or money order payable to Timothy J. Robertson, 195 Tierra Rejada Rd., #148, Simi Valley, CA 93065; e-mail *cometman@cometman.net*.

- **Lunar:** (1) *The ALPO Lunar Selected Areas Program Handbook* (hardcopy, $17.50). Includes full set of observing forms. (2) *Observing forms*: Send a SASE for a hardcopy of forms. Both the Handbook and individual observing forms are available for download (as pdf files) at *moon.scopesandscapes.com/alpo-sap.html*. Use of observing forms will ensure that all requested information is included with observations, but are not required. Various lists and forms related to other Lunar section programs are also available at *moon.scopesandscapes.com*. NOTE: Observers who wish to make copies of the observing forms may instead send a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the ALPO lunar SAP section. Observers should make copies using high-quality paper.

- **Lunar**: *The Lunar Observer*, official newsletter of the ALPO Lunar Section, published monthly. Free at *http://moon.scopesandscapes.com/tlo.pdf* or send SASE to: Wayne Bailey, 17 Autumn Lane, Sewell, NJ 08080.

- **Venus (Benton):** Introductory information for observing Venus, the comprehensive *ALPO Venus Handbook*, as well as all observing forms and ephemerides, can be conveniently downloaded as pdf files at no cost to ALPO members and individuals interested in observing Venus as part of our regular programs at *http://www.alpo-astronomy.org/venus*.

- **Mars:** Free resources are on the ALPO website at *www.alpo-astronomy.org* . Click on "Mars Section" in the left column; then on the resulting webpage, look for links to resources in the right column including “Mars Observing Form”, and "Mars Links". Under “Mars Links”, click on "Mars Observers Cafe", and follow those links to The New “Internet Mars Observer's Handbook.”

- **Minor Planets (Derald D. Nye):** *The Minor Planet Bulletin*. Published quarterly; free at *http://www.minorplanetobserver.com/mpb/default.htm*. Paper copies available only to libraries and special institutions at $24 per year via regular mail in the U.S., Mexico and Canada, and $34 per year elsewhere (airmail only). Send check or money order payable to “Minor Planet Bulletin”, c/o Derald D. Nye, 10385 East Observatory Dr., Corona de Tucson, AZ 8564I-2309.

- **Jupiter:** *(1) Jupiter Observer’s Handbook*, from the Astronomical League Sales, temporarily out of stock. (*2*) *ALPO_Jupiter*, the ALPO Jupiter Section e-mail network; to join, send a blank e-mail to *ALPO_Jupiter-subscribe@yahoogroups.com* (3) *Jupiter Observer’s Startup Ki*t, $3 from Richard Schmude, Jupiter Section Coordinator.

- **Saturn (Benton):** Introductory information for observing Saturn, including all observing forms and ephemerides, can be conveniently downloaded as pdf files at no cost to ALPO members and individuals interested in observing Saturn as part of our regular programs at *http://www.alpo-astronomy.org/saturn*. The former *ALPO Saturn Handbook* was replaced in 2006 by *Saturn and How to Observe It* (authored by Julius L. Benton) and it can be obtained from book sellers such as *Amazon.com*.

- **Meteors:** (1) *The ALPO Guide to Watching Meteors* (pamphlet). $3 per copy (postage & handling); check/money order to Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114; phone 816-DEEP-SKY (816-333-7759); e-mail *leaguesales@astroleague.org*. (2) *The ALPO Meteors Section Newslette*r, free (except postage), published quarterly (March, June, September and December). Send stamps, check or money order for first class postage to cover desired number of issues to Robert D. Lunsford, 14884 Quail Valley Way, El Cajon, CA 92021-2227.

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People, publications, etc., to help our members

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The missing ones will be posted as soon as possible.

1. Go to alpo-astronomy.org, then click on the “ALPO Section Galleries” link near the top of the right side-bar.

2. Next, click on the Publications Section icon, then click on the ALPO Journals icon.

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Vol. 46 (2004) Nos. 1, 2, 3, and 4
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Vol. 49 (2007) Nos. 1, 2, 3, and 4
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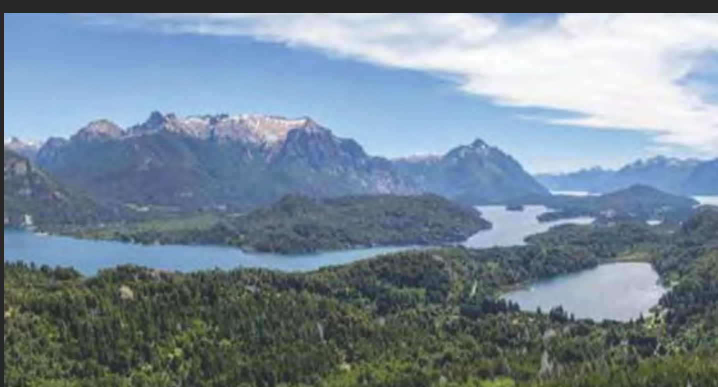

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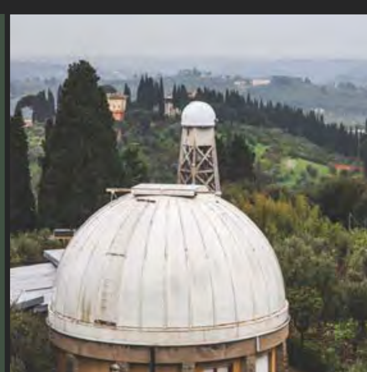

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