ISSN-0039-2502

# Journal of the Association of Lunar & Planetary Observers

Founded in 1947

## *The Strolling Astronomer*

Volume 60, Number 2, Spring 2018

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Online and in COLOR at http://www.alpo-astronomy.org

Lunar Eclipse Over Canada!!

(see page 2 for details)

The Society for Astronomical Sciences 2018 Symposium, a joint meeting with the Association of Lunar and Planetary Observers, will be held June 14-15-16, 2018 in Ontario California.

The purpose of this note is to remind you that the Call for Abstracts is active, and to announce that Symposium Registration is now open.

**Call for Abstracts:** Presentations and Posters are solicited on any topic that is relevant to small-telescope science: photometry, spectroscopy, astrometry of solar system objects, stars, and other objects; instrumentation and data analysis methods; and other related topics. The Call for Abstracts is available here. Abstracts should be sent to program@SocAstroSci.org. Important dates are:

- Abstracts due: March 15, 2018
- Authors will be notified of acceptance by March 22
- Accepted Papers for the Proceedings due by: April 26, 2018

If you have any questions regarding making a presentation, please contact us at program@SocAstroSci.org.

**Registration:** Symposium registration is now open, at https://socastrosci.z2systems.com/eventReg.jsp?event=7&

Registration is $60 (SAS and ALPO members) or $75 (non-members). The Registration fee includes two days of technical presentations (Friday and Saturday), lunchtime photometry and spectroscopy discussions, Sponsor and Vendor displays, and "Evening with the Pro's" (Thursday) at which Dr. Lance Benner will discuss recent results of radar observations of near-Earth asteroids, and Dr. Jessie Christiansen will discuss the TESS mission.

Two Workshops have been scheduled for Thursday ($50 each).

*Eclipsing Binaries "time of minimum" observation and analysis* will be presented by Bob Nelson and Dr. Dirk Terrell. The goal of this workshop is to get the participants "up to speed" on the practice of determining Times of Min/Max from their own time-series photometry. The discussion will cover the purpose and value of ToM measurements, observing procedures and pitfalls, methods of data analysis, and interpretation of the results.

*Detection of Transients in HII and Star Forming Regions Using Narrow-band Imaging* will be presented by Dr. John Bally. This workshop will support a pro/am collaboration in the search for transients within HII clouds and Star Forming Regions of the Milky Way. The project is well suited for the small telescope scientist. The discussion will include the science case, relevant examples of the phenomenon, and recommended observation procedures. Much of the discussion related to narrow-band filter observations will also be applicable to spectroscopy. We will pursue flux calibration of images and comparing ratios of images taken in O [III], S[II], N[II] H-alpha and H-beta and other filters to discover and alert the wider community to transient events of this nature. Advance-reading material will be provided May 1st.

The Closing Banquet will be held on Saturday evening ($40/person). Non-registered guests are welcome at the banquet.

If you have any questions about Registration, please contact us at Program@SocAstroSci.org.

**Hotel reservations**: The conference venue is the Ontario Airport Hotel & Conference Center (http://www.ontariocaairporthotel.com/). You must make your own reservations. The conference rate for lodging is $96/night (plus taxes). A link for hotel reservations will be put onto the SAS website shortly; or you can call the hotel at 909-980-0400.

# Journal of the Association of Lunar & Planetary Observers
## The Strolling Astronomer

Volume 60, No.2, Spring 2018
This issue published in March 2018 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

## Inside the ALPO



## Papers & Presentations



## ALPO Resources

## Inside the ALPO
# Member, section and activity news

## Association of Lunar & Planetary Observers (ALPO)

*Board of Directors*

Executive Director (Chair); Richard W. Schmude, Jr.
Associate Director; Julius L. Benton, Jr.
Member of the Board; Sanjay Limaye
Member of the Board; Michael D. Reynolds
Member of the Board; Ken Poshedly
Member of the Board; John E. Westfall
Member of the Board & Secretary/Treasurer; Matthew Will
Founder/Director Emeritus; the late Walter H. Haas

*Publications*

**Editor & Publisher:** Ken Poshedly

*Primary Observing Section & Interest Section Staff*

(See full listing in *ALPO Resources*)
**Lunar& Planetary Training Section:** Timothy J. Robertson
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**Venus Section**: Julius L. Benton, Jr.
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*Lunar Transient Phenomena;* Anthony Cook
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**Saturn Section:** Julius L. Benton, Jr.
**Remote Planets Section:** Richard W. Schmude, Jr.
**Eclipse Section**: Michael D. Reynolds
**Comets Section:** Carl Hergenrother
**Meteors Section:** Robert D. Lunsford
**Meteorites Section:** Dolores Hill
**ALPO Online Section:** Larry Owens
**Computing Section:** Larry Owens
**Youth Section:** Timothy J. Robertson

*Point of View*
## Comets Are Cool!

**By Carl Hergenrother, ALPO Comets Section Coordinator**

Why do we observe the objects that we do? Many of us concentrate on a few objects in our solar system. As the coordinator of the ALPO Comets Section, it should be no surprise that comets are one of my passions. Even before I ever saw a comet, or for that matter even looked through a telescope, I was intrigued by comets. Almost 40 odd years later, I remain intrigued. Maybe it's because a well-motivated and equipped observer can still discover a comet from his or her own backyard. Perhaps, it's because of their sometimes unpredictable behavior. Or it could be the history of the objects themselves. Not just when they formed, how they evolved and ended up on their current path through the solar system, but the story of their discovery, their discoverers and the people who recorded their observations.

Nowadays the majority of submissions to the our Comets Section are CCD images. This isn't a surprise since comets are beautifully photogenic. CCD images can be mined to provide a wealth of information such as brightness, color, coma morphology, tail morphology, and evidence of outburst, splitting and disintegration events. One of my goals for the ALPO Comets Section is to extract more information out of these images.

I occasionally hear that visual observations are not as desirable as CCD observations. Nothing could be further from the truth. Visual magnitude estimates are the primary observation type for producing lightcurves and following brightening trends. Visual magnitude estimates are also easy to make. How many observations can be made in only a few minutes time? I usually can't spend hours outside, but CAN find a few minutes to grab my binoculars, get dark-adapted, find my target comet, compare it to a few nearby stars and determine its magnitude. If you have more time to observe, making a sketch is also worthwhile and can pick out detail not seen in CCD images.

The second half of 2018 will see a number of reasonably bright comets. If you have the chance, go out and observe a few. The Comet Section will be waiting for your observations.

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## News of General Interest

Update: The report by ALPO Eclipse Section Coordinator Mike Reynolds about the August 21, 2017 "Great American Total Solar Eclipse" has been postponed until JALPO60-2 for release in June 2018.

### Our Cover: Lunar Eclipse Over Canada

With no images submitted for the January 31, 2018 lunar eclipse and the need for a cover image for our Journal, it was time to just see what's out "there" on the world wide web.

This issue's cover features a striking image taken by

A collage of images taken by Braden Ottenbreit of Saskatchewan, Canada, and published on the *Universe Today* web page, showing the transition of the super blue moon. Credit: @bradenottenbreit

By the way, *Universe Today* is owned and operated by Fraser Cain who also the host of several astronomy podcasts.

### ALPO Annual Conference

We received late confirmation that this year's ALPO annual conference will be a joint meeting with the Society for Astronomical Sciences Thursday through Saturday, June 14 through 16, in Ontario, California.

Details and contact information can be found on the inside front cover of this Journal. Please note that the deadline for submitting abstracts for papers to be presented will have passed by the time you see this notice. If you are interested in presenting a paper, please contact the meeting organizing committee directly at program@SocAstroSci.org

*The Observer's Notebook* podcast released on March 13 features a conversation between host Tim Robertson and conference coordinator Robert K. Buchheim.

More information here: https://soundcloud.com/observersnotebook/the-observers-notebook-the-2018-joint-conference-with-the-sas-and-the-alpo

New ALPO Lunar Domes Program coordinator and assistant coordinator Raffaello Lena (left) and Jim Phillips (right)

### ALPO Lunar Domes Program Reactivated

**By Richard Schmude, executive director, the ALPO**

It is my pleasure to announce the appointments of two individuals to resurrect our ALPO Lunar Domes Program, Raffaello Lena as acting coordinator and Jim Phillips as acting assistant coordinator. (The "acting" status will drop off by action of the board, as is the usual practice.)

*Raffaello Lena* (in his own words) -- I have been interested in the Moon since I was 10 years old (during the Apollo era) and have progressed from a small Newtonian telescope to high-quality scopes (6-inch Maksutov Cassegrain and a 5-inch refractor). Twenty years ago, I used my Polarex Unitron 100 mm, f/15 refractor. My old telescope is now a vintage object in my house. My first interest in lunar studies is represented by the lunar domes analysis and their classifications. Morever, I was the first Italian to document a lunar impact because it was simultaneously recorded also in Switzerland from other two observing sites (independent and simultaneous observation with a distance between the observatories > 500 km).

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I am interested in volcanism and thus in lunar domes. Thus, I worked intensively in this area of study and was impressed by lunar expert Charles Wood when we met in Rome. Among our discussions were different methods for determining the morphometric properties of lunar domes (diameter, height, flank slope, edifice volume) from image data or orbital topographic data, and for determining multispectral image data providing insights into the composition of the dome material

In addition, I was interested with some my friends in the GLR (Geological Lunar Research Group) to study geophysical models of lunar domes, which yield information about the properties of the lava from which they formed and the depth of the magma source regions below the lunar surface.

Lunar domes represent a clear testimony of the volcanic processes that occurred in our Moon. In fact, the differences in dome shapes and rheologic parameters raise broad questions concerning the source regions of the various dome types, allowing the knowledge of which differences in the lunar interior are responsible for the different lunar dome properties observed on the surface.The book "Lunar Domes: Properties and Formation Processes", which I co-authored, is a reference work on these elusive features, providing the methods used to study quantitatively these volcanic constructs (Springer *http://www.springer.com/it/book/9788847026360*

Besides the work cited above, I have published lunar articles in Icarus, Planetary Space Science, LPSC conferences, the Journal of the ALPO, Selenology, the Journal of the BAA and other American and Italian magazines. My outside interests include listening to jazz whenever possible and exploring Italy's volcanoes and mountainous geology. I hold a doctorate in pharmaceutical sciences from the

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University of Rome and currently work on food safety (Ministry of Health).

*Jim Phillips* (in his own words) -- I became interested in astronomy and space as soon as Sputnik went up and I remember standing outside with my parents looking for satellites in the 1950s. Following the manned space program and never missing a launch, I became very interested in the Moon. Reading Patrick Moore's "Guide to the Moon" solidified my interest in lunar observation.

I donated a collection of rare lunar maps and atlases to the College of Charleston with a six-figure value several years ago.

Although I started observing in September 1965 and have kept journals ever since, my first big telescope was an R.E. Brandt refractor of 8-inch aperture, homemade with a tube made from irrigation pipe.

Somewhere along the way I had learned about lunar domes and knew that the ALPO had had a lunar dome section at one point. I contacted the ALPO executive director at the time, John Westfall, to see if he had a finished catalog of domes which had been discovered and/or cataloged. I wanted to begin to search for new lunar domes at that point. John contacted me and said that the project had never been completed and suggested that I begin work on a new lunar dome survey, which I did.

Due to circumstances beyond my control, I ran into some problems and decided to work instead with Raffaello Lena and the GLR. My job was to image the Moon, looking for new domes while Raf and others in the GLR wrote up the articles. While others contributed to imaging the Moon, I discovered multiple new domes which had never been cataloged before.

My interest in assisting Raf at this time is to continue the work we were able to do together with others at the GLR to describe and catalog lunar domes.

I am an M.D. with boards in clinical pathology, surgical pathology and dermatopathology. I am married with three children. My wife is a dermatologist.

### *Call for JALPO Papers*

The ALPO appreciates articles for publication and encourages its membership to submit written works (with images, if possible).

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*

The service package upgrade to the ALPO web site by our internet service provider is about complete as of mid-March.

The ALPO Publications Section portion of the web site is still to be reloaded.

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*

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### Computing Section

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

Important links:

- To subscribe to the ALPOCS yahoo e-mail list, http://groups.yahoo.com/group/alpocs/
- To post messages (either on the site or via your e-mail program), alpocs@yahoogroups.com
- To unsubscribe to the ALPOCS yahoo e-mail list, alpocs-unsubscribe@yahoogroups.com
- Visit the ALPO Computing Section online at www.alpo-astronomy.org/computing

### Lunar & Planetary Training Program & Podcasts

**Tim Robertson, program coordinator**
cometman@cometman.net

*ALPO Lunar & Planetary Training Program*

This program currently has two active students at various stages of the program.

Our training program is a two-step venture and there is no time requirement for completing the steps. But I have seen that those students that 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.

The ALPO Lunar & Planetary Training 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, or "Basic Level", includes reading the ALPO's 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.

*Podcasts*

"The Observers Notebook" podcast program is a year old, and to-date I have recorded over 40 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 we can record longer, there is no time limit - the hosting service that I am using has unlimited space available for podcasts.

It takes a great amount of time and money to make and produce the podcast, thus far it has been done with the help of service called Patreon, and we currently have six 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 of $10, you receive a copy of the Novice

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Observers Handbook; and for $35 a month, you receive producer credits on the podcast and a year's membership to the ALPO.

You can help us out by going to the link below:

https://www.patreon.com/ObserversNotebook

The most recent podcasts that are online include Roger Veneble discussing the upcoming 2018 Mars Opposition, Carl Hergenrother talks about the bright Comets for 2018, Rik Hill came on and discussed the basics of Lunar & Planetary imaging, Richard Schmude talked about his goals as the new Executive Director for the ALPO in the coming years, and Sanjay Limaye talked about the professional and amauter collaboration in astronomy.

Upcoming topics include a fun conversation with astrophotographer Damian Peach, and Don Machholz talked about comet hunting and shared some stories of his 11 comet discoveries.

In addition, a few of the lectures given by ALPO members at the GRAM conference in October 2017 are also being released as individual podcasts as well. I am still hoping to get John McAnally of the ALPO Jupiter Section and Frank Melillo of the ALPO Mercury Section for podcast interviews.

If you have a subject that you would like to hear on the podcast, please drop me a note. I would like to have a discussion on the timing of Galiliean Eclipses. If any of you would be interested in discussing those subjects, please let me know.

A new podcast is released every two weeks, and if you subscribe to it via iTunes it will automatically be downloaded to your device.

The entire online library of "The Observers Notebook" podcasts is available at iTunes, Stitcher, and Goggle Play. Just search for "Observers Notebook". Or you can listen to it at the link below:

https://soundcloud.com/observersnotebook

For more information about the ALPO Lunar & Planetary Training Program or "The Observers Notebook" podcasts, contact Tim Robertson at: cometman@cometman.net, or Tim Robertson, 195 Tierra Rejada Rd #148, Simi Valley CA, 93065, or go to: www.cometman.net/alpo/

## ALPO Observing Section Reports

### Eclipse Section

**Mike Reynolds, section coordinator**
m.d.reynolds@fscj.edu

We expect to have a full report on the August 21, 2017 total solar eclipse ready for the winter issue of this Journal (DJALPO60-1).

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

### Mercury / Venus Transit Section

**John Westfall, section coordinator**
johnwestfall@comcast.net

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

### Meteors Section

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

The ALPO Meteors Section had a very successful fourth quarter of 2017 as the Orionids, Leonids, and Geminids all reached maximum activity during moon-free periods.

The Geminids were by far the most active, producing well over 100 shower members per hour for those who were able to watch from rural locations. And the year 2018 got off well with many fireball reports in January including one on the 16 over Michigan that provided many meteorites.

Two major showers are active during the second quarter of 2018; the Lyrids peak on April 22 under favorable conditions and the eta Aquariids will peak near May 7, but the last quarter Moon will obscure some of the fainter meteors.

Your section recorder has taken advantage of podcasts to verbally spread the news of upcoming major meteoric events. Tim Robertson does a great job asking interesting questions while I try my best not to bore the listener! Give these podcasts a try at:

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https://soundcloud.com/observersnotebook

Be sure to also check out the other interesting podcasts offered by the many sections of ALPO!

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.


Fresh meteorite recovered by Larry Atkins from the January 16, 2018 fall in the Hamburg, Michigan area. Note the empty hole where a chondrule was plucked out during atmospheric passage. Image credit: Larry Atkins.

### Meteorites Section

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

This report includes information about ALPO member contributions, meteorite highlights and new meteorite approvals from November 1, 2017 to January 29, 2018 from the Meteoritical Society's Nomenclature Committee. As this is being written, the spectacular January 16 witnessed fall from Michigan is undergoing analysis. Six stones were recovered quickly by experienced meteorite hunters Robert Ward (within 15 minutes!), Larry Atkins and Darryl Landry on snow and an ice-covered lake. We received several inquiries of suspected meteorites, all of which were terrestrial and did not require further analysis.

Aeolis Mons 001 iron-nickel meteorite on the surface of Mars. Note the blue-gray color and smooth texture compared to the surrounding rock. Image credit: NASA/JPL-Caltech/ASU

ALPO members who collect meteorites are encouraged to report unusual features in their meteorite samples. One recent example is a sample of Allende that contained an unusually large inclusion. The meteorite dealer was connected with researchers who specialize in the

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Aeolis Palus 001 and Aeolis Palus 002 iron-nickel meteorites discovered on the inner slope of Gale Crater by MSL Curiosity rover. Image credit: NASA/JPL-Caltech/ASU.

study of Calcium-Aluminum-Rich-Inclusions (CAIs). We received an inquiry about possible ablation spherules on a particular specimen of the Canyon Diablo IAB iron-nickel meteorite that may warrant additional research.

### *Meteorite News from Around the Solar System*

The Meteoritical Bulletin records officially recognized, classified meteorites of the world's inventory. As of January 29, 2018, it contains a total of 57448 meteorites. There were 282 new meteorites approved; most from hot desert regions and Antarctica. Newly approved meteorites include 190 ordinary chondrites; 28 carbonaceous meteorites; 1 enstatite chondrites; 4 R chondrites; 12 irons; 5 ureilites; 27 HEDs; 9 lunar; 2 Martian; 1 lodranite; 1 aubrite; 2 ungrouped achondrites. For more information and details: https://www.lpi.usra.edu/meteor/metbull.php Grove Mountains 090018 Antarctica (GRV 090018) was the smallest meteorite reported this period with a mass of only 1.46 grams. The largest meteorite approved was the 95 kilogram Aeolis Palus 003 iron identified on Mars,

Noteworthy are five iron-nickel meteorites found on Mars by NASA's Mars Science Laboratory's (MSL) Curiosity Rover. Their (now) official names are consistent with naming conventions for meteorites found on Earth; i.e. named for a nearby geographical feature and a number for each individual in "dense collection areas". In this case, Aeolis Mons and Aeolis Palus are part of Gale Crater: Aeolis Mons 001, Aeolis Mons 002, Aeolis Palus 001, Aeolis Palus 002 and Aeolis Palus 003. These were confirmed to be meteorites by MSL instruments Mastcam and the Remote Micro-Imager on ChemCam.

The intricate and dynamic tail of C/2016 R2 (PANSTARRS) is on display in this image taken on January 12 by Chris Schur with a 10” f/3.9 Orion astrograph and SBIG ST10XME CCD.

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**Ephemerides for Comets 21P/Giacobini-Zinner, 364P/PANSTARRS, C/2016 M1 (PANSTARRS) &C/2016 R2 (PANSTARRS)**

| Date | R.A. | Decl. | r (au) | d (au) | Elong. (deg.) | m1 | Max. El 40° N | Max. El 40° S |
|---|---|---|---|---|---|---|---|---|
| **Comet 21P/Giacobini-Zinner** | | | | | | | | |
| 2018 Apr 1 | 18 56.17 | +08 13.9 | 2.24 | 2.08 | 85 | 16.8 | 47 | 37 |
| 2018 Apr 11 | 19 11.45 | +11 15.0 | 2.15 | 1.91 | 89 | 16.3 | 51 | 37 |
| 2018 Apr 21 | 19 26.61 | +14 41.6 | 2.06 | 1.74 | 93 | 15.7 | 54 | 35 |
| 2018 May 1 | 19 41.69 | +18 34.3 | 1.97 | 1.58 | 96 | 15.1 | 58 | 31 |
| 2018 May 11 | 19 56.82 | +22 53.2 | 1.88 | 1.43 | 99 | 14.5 | 63 | 27 |
| 2018 May 21 | 20 12.11 | +27 37.3 | 1.79 | 1.30 | 100 | 13.9 | 68 | 22 |
| 2018 May 31 | 20 27.90 | +32 43.7 | 1.69 | 1.17 | 101 | 13.3 | 73 | 17 |
| 2018 Jun 10 | 20 44.74 | +38 08.9 | 1.60 | 1.06 | 101 | 12.6 | 78 | 12 |
| 2018 Jun 20 | 21 03.53 | +43 47.0 | 1.51 | 0.95 | 99 | 11.9 | 81 | 6 |
| 2018 Jun 30 | 21 26.01 | +49 30.6 | 1.42 | 0.86 | 97 | 11.2 | 79 | 0 |
| **Comet 364P/PANSTARRS** | | | | | | | | |
| 2018 Apr 1 | 08 49.07 | +39 25.2 | 1.48 | 0.78 | 111 | 18.4 | 89 | 11 |
| 2018 Apr 11 | 08 38.87 | +37 42.6 | 1.37 | 0.77 | 100 | 18.3 | 81 | 12 |
| 2018 Apr 21 | 08 34.94 | +35 25.6 | 1.26 | 0.74 | 91 | 17.9 | 70 | 15 |
| 2018 May 1 | 08 36.31 | +32 39.6 | 1.16 | 0.71 | 82 | 16.9 | 59 | 17 |
| 2018 May 11 | 08 41.45 | +29 23.0 | 1.06 | 0.67 | 75 | 15.8 | 48 | 19 |
| 2018 May 21 | 08 48.57 | +25 28.0 | 0.97 | 0.61 | 68 | 14.6 | 37 | 22 |
| 2018 May 31 | 08 55.07 | +20 40.5 | 0.89 | 0.54 | 61 | 13.4 | 25 | 24 |
| 2018 Jun 10 | 08 57.15 | +14 37.0 | 0.83 | 0.46 | 53 | 12.3 | 13 | 25 |
| 2018 Jun 20 | 08 49.09 | +06 41.3 | 0.80 | 0.37 | 45 | 11.4 | 0 | 25 |
| 2018 Jun 30 | 08 22.65 | -03 47.4 | 0.80 | 0.30 | 37 | 11.0 | 0 | 20 |
| **Comet C/2016 M1 (PANSTARRS)** | | | | | | | | |
| 2018 Apr 1 | 19 35.05 | -02 42.4 | 2.67 | 2.72 | 76 | 12.3 | 33 | 42 |
| 2018 Apr 11 | 19 39.45 | -04 25.7 | 2.61 | 2.49 | 85 | 12.0 | 34 | 49 |
| 2018 Apr 21 | 19 41.95 | -06 35.4 | 2.55 | 2.27 | 94 | 11.7 | 34 | 55 |
| 2018 May 1 | 19 41.99 | -09 22.4 | 2.50 | 2.05 | 104 | 11.4 | 34 | 59 |
| 2018 May 11 | 19 38.76 | -13 0.0 | 2.45 | 1.84 | 115 | 11.1 | 33 | 63 |
| 2018 May 21 | 19 31.11 | -17 43.3 | 2.40 | 1.64 | 127 | 10.8 | 31 | 68 |
| 2018 May 31 | 19 17.51 | -23 43.1 | 2.36 | 1.48 | 141 | 10.5 | 26 | 74 |
| 2018 Jun 10 | 18 56.04 | -30 54.4 | 2.32 | 1.36 | 155 | 10.3 | 19 | 81 |
| 2018 Jun 20 | 18 24.86 | -38 39.1 | 2.29 | 1.30 | 163 | 10.1 | 11 | 89 |
| 2018 Jun 30 | 17 43.80 | -45 45.5 | 2.26 | 1.30 | 155 | 10.1 | 4 | 84 |
| **Comet C/2016 R2 (PANSTARRS)** | | | | | | | | |
| 2018 Apr 1 | 04 29.33 | +37 21.9 | 2.63 | 2.96 | 61 | 10.6 | 44 | 0 |
| 2018 Apr 11 | 04 42.57 | +39 28.9 | 2.62 | 3.05 | 55 | 10.6 | 38 | 0 |
| 2018 Apr 21 | 04 57.91 | +41 30.7 | 2.61 | 3.14 | 49 | 10.7 | 32 | 0 |
| 2018 May 1 | 05 15.30 | +43 26.6 | 2.60 | 3.22 | 44 | 10.7 | 27 | 0 |
| 2018 May 11 | 05 34.72 | +45 15.7 | 2.60 | 3.28 | 40 | 10.7 | 23 | 0 |
| 2018 May 21 | 05 56.17 | +46 56.7 | 2.61 | 3.34 | 37 | 10.8 | 20 | 0 |
| 2018 May 31 | 06 19.62 | +48 28.1 | 2.61 | 3.39 | 34 | 10.8 | 17 | 0 |
| 2018 Jun 10 | 06 45.02 | +49 48.1 | 2.62 | 3.42 | 32 | 10.9 | 15 | 0 |
| 2018 Jun 20 | 07 12.28 | +50 55.0 | 2.64 | 3.45 | 31 | 11.0 | 14 | 0 |
| 2018 Jun 30 | 07 41.20 | +51 47.0 | 2.66 | 3.47 | 31 | 11.1 | 13 | 0 |

Visit the ALPO Meteorites Section online at www.alpo-astronomy.org/meteorite/

## Comets Section

**Report by Carl Hergenrother, section coordinator**
*chergen@lpl.arizona.edu*

While 2018 promises to deliver a number of bright comets for the average backyard observer, the second quarter of 2018 won't see any comets brighter than 10th magnitude. Even so, a number of just fainter than 10th magnitude comets are observable for CCD imagers and large aperture visual observers.

The brightest comets during the April-through-June quarter will be a pair of long-period PANSTARRS discoveries with relatively large perihelion distances.

- C/2016 R2 (PANSTARRS) has already amazed CCD imagers over the past few months. This comet is very gas rich. In particular, it is rich in CO+. Similar to other CO+ rich comets such as C/1908 R1 (Morehouse) and C/1961 R1 (Humason), PANSTARRS possesses an intricate gas tail showing rapid changes on short timescales of only minutes. C/2016 R2 will reach perihelion on 2018 May 9 at 2.60 AU from the Sun. It is expected to be between 10th and 11th magnitude for the entire quarter. The comet passes through solar conjunction this quarter but is located far enough north of the Sun that it will remain visible and circumpolar.

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- The other bright long-period PANSTARRS comet is C/2016 M1 (PANSTARRS). While perihelion is not until 2018 August 10 at 2.21 AU, it may brighten to close to magnitude 10 in June. The comet will slowly move south and will transition to an object only observable from the southern hemisphere at around the same time it is peaking in brightness (late June).

The other two bright comets are short-period comets. One is only making its second observed return while the other has been known for much longer.

- The new one is 364P/ PANSTARRS (formerly P/2013 CU129). This is one of a small number of short-period comets with small perihelion distances and short periods of activity. Comet 364P is expected to be inactive for much of April. Though only as bright as 18th magnitude at the time, CCD imagers have an opportunity to observe a bare inactive comet nucleus. By May, the comet should be rapidly turning on. It reaches its brightest around its 2018 June 24 perihelion at 0.80 AU.Then it will be near magnitude 11 but only observable from the southern hemisphere.
- The last of the quarter's bright comets is 21P/Giacobini-Zinner. This long-followed comet was first discovered in 1900 by Michel Giacobini of Nice, France. After a missed return, it was rediscovered in 1913 by Ernst Zinner of Bamberg, Germany. Both discoveries were made visually. 2018 will mark its 16th observed return. It was last seen in 2012 and many long-time observers may remember observing it in the fall of 1985 just prior to Comet Halley. Though often a relatively bright comet, 21P is perhaps better known for being visited by the first cometary spacecraft mission, ICE (the International Cometary Explorer). It is also the parent of the Giacobinids or Draconids meteor shower which stormed in 1933 and 1946. This year, 21P will pass through perihelion on September 10 at 1.01 AU. At that time, it will be as bright as 6th-7th magnitude. This quarter, it starts at 16th magnitude and brightens to 11th magnitude by the end of June.

During the 2017 Nov-Dec and 2018 Jan period, the ALPO Comets Section received comet magnitude estimates for comets 24P/ Schaumasse, 62P/Tsuchinshan, C/ 2016 R2 (PANSTARRS) and C/ 2017 T1 (Heinze) from Salvador Aguirre and this writer. CCD images were also received for comets 47P/ Ashbrook-Jackson, 103P/Hartley 2, 117P/Helin-Roman-Alu, 143P/ Kowel-Mrkos, 174P/Echeclus, 176P/LINEAR, 188P/LINEAR-Mueller, 237P/LINEAR, 250P/ Larson, 352P/Skiff, 361P/ Spacewatch, C/2010 U3 (Boattini), C/2011 KP36 (Spacewatch), C/ 2013 US10 (Catalina), C/2014 B1 (Schwartz), C/2015 H2 (PANSTARRS), C/2016 N4 (MASTER), C/2016 R2 (PANSTARRS), C/2016 T3 (PANSTARRS), C/2016 X1 (Lemmon), C/2017 M4 (ATLAS), C/ 2017 O1 (ASASSN), C/2017 S3 (PANSTARRS), C/2017 T1 (Heinze), C/2017 T3 (ATLAS) and C/2017 U4 (PANSTARRS) from Charles Bell, Denis Buczynski, John Chumack, Manos Kardasis, Gianluca Masi, Mike Olason, Richard Owens and Chris Schur.

As always, the ALPO Comets Section solicits comet observations of all kinds for these and all comets, past and present. Please e-mail your observations to this section coordinator's e-mail address given at the beginning of this report.

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*

Please consider reporting all your comets observations, past and present, to ALPO Comets Section Coordinator Carl Hergenrother at the email address listed at the beginning of this report.

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

### Solar Section

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

Things have slowed in the ALPO Solar Section (ALPOSS) along with greatly decreased solar activity, which is to be expected. This is reflected in the report in this issue.

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The Section is indebted to Theo Ramakers for keeping up the archive while the ALPO website is down for upgrades. The report in this issue would not have been possible without Theo's diligent efforts! E-mail submissions keep coming in and, while much less than only a year ago, this due not so much to the website being down but bad weather at many of our member observatories and the very low activity of the Sun.

He reports that in 2017, ALPOSS observer submissions expanded our archive to 36,672 reports and images in 552 folders. Though solar activity has gone down significantly, submissions for CR2196 and CR2197 stayed pretty much constant (approximately 275 reports), whereas CR2198 saw a drastic drop to 162 reports. Spotless days stayed fairly constant over the period with 15, 16, and 14 spotless days for the three respective rotations. The year closed with a spotless day making 139 such days since the last solar maximum.

The ALPOSS (Theo) is currently working with the coordinator of the ALPO Eclipse Section, Mike Reynolds, to expand the folders for the Great American Eclipse with text reports to augment the great number of images supplied by observers to the Section.

Our e-mail list continues its important function as a vital communication link to observers under the watchful eye of Rick Gossett, giving observers a way of sharing observations during this website-outage period and providing the ALPOSS staff a means of promulgating information about solar and Section activity. Pam Shivak continues to keep our presence on FaceBook where a lot of our new members come from and where the ALPO has its own page.

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*

### Mercury Section

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

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

### Venus Section

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

*Editor's Note -- This abbreviated report will be followed by a fully, updated version in JALPO60-3 (June 2018).*

The accompanying Table of Geocentric Phenomena in Universal Time (UT) for the eastern (evening) Venus apparition is included here for the convenience of observers.

Readers of this Journal should be well-acquainted with our on-going 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 began in 2006 and ended in 2015. It was a tremendously successful Pro-Am effort involving ALPO Venus observers around the globe. Despite the fact that the mission already concluded, it is definitely not too late for those who observed during the 2017-18 Western (Morning) Apparition to still send their images to the ALPO Venus Section and the VEX website (see below). These observations remain important for further study and will continue to be analyzed for several years to come as a result of this endeavor.

The VEX website is at:

*http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=38833&fbodylongid=1856.*

**Geocentric Phenomena of the 2018 Eastern (Evening) Apparition of Venus in Universal Time (UT)**

| | |
|---|---|
| Superior Conjunction | 2018 Jan 09$^d$ 10$^h$ (angular diameter = 9.7″) |
| Greatest Illuminated Extent | Sep 22 00 UT ($m_v$ = –4.7) |
| Predicted Dichotomy | Aug15.22$^d$ (Venus is predicted to be exactly half-phase) |
| Greatest Elongation East | Aug 17 00 (46°) |
| Inferior Conjunction | Oct 27 11 (angular diameter = 61.8″) |

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### Lunar Calendar for April thru June 2018

| Date | UT | Event |
|---|---|---|
| Apr 03 | 10:14 | Moon-Jupiter: 4.2° S |
| 07 | 08:50 | Moon-Saturn: 2.1° S |
| 07 | 10:37 | Moon Extreme South Dec.: 20.3° S |
| 07 | 14:15 | Moon-Mars: 3.5° S |
| 08 | 01:32 | Moon Apogee: 404100 km |
| 08 | 03:18 | Last Quarter |
| 10 | 04:09 | Moon Descending Node |
| 15 | 21:57 | New Moon |
| 17 | 15:29 | Moon-Venus: 5.5° N |
| 20 | 10:44 | Moon Perigee: 368700 km |
| 21 | 03:38 | Moon Extreme North Dec.: 20.4° N |
| 22 | 17:46 | First Quarter |
| 23 | 08:19 | Moon Ascending Node |
| 29 | 20:58 | Full Moon |
| 30 | 13:16 | Moon-Jupiter: 4.1° S |
| May 04 | 16:31 | Moon-Saturn: 1.9° S |
| 04 | 19:00 | Moon Extreme South Dec.: 20.6° S |
| 05 | 20:35 | Moon Apogee: 404500 km |
| 06 | 03:24 | Moon-Mars: 3° S |
| 07 | 06:24 | Moon Descending Node |
| 07 | 22:09 | Last Quarter |
| 13 | 13:21 | Moon-Mercury: 2.5° N |
| 15 | 07:48 | New Moon |
| 17 | 14:11 | Moon-Venus: 4.8° N |
| 17 | 17:06 | Moon Perigee: 363800 km |
| 18 | 11:02 | Moon Extreme North Dec.: 20.7° N |
| 20 | 09:13 | Moon Ascending Node |
| 21 | 23:49 | First Quarter |
| 27 | 13:39 | Moon-Jupiter: 4.3° S |
| 29 | 10:20 | Full Moon |
| 31 | 21:20 | Moon-Saturn: 1.8° S |
| June 01 | 03:09 | Moon Extreme South Dec.: 20.7° S |
| 02 | 12:34 | Moon Apogee: 405300 km |
| 03 | 07:58 | Moon-Mars: 3.5° S |
| 03 | 08:39 | Moon Descending Node |
| 06 | 14:32 | Last Quarter |
| 13 | 15:43 | New Moon |
| 14 | 19:55 | Moon Perigee: 359500 km |
| 14 | 20:52 | Moon Extreme North Dec.: 20.8° N |
| 16 | 09:13 | Moon-Venus: 2.3° N |
| 16 | 13:50 | Moon Ascending Node |
| 20 | 06:51 | First Quarter |
| 23 | 14:47 | Moon-Jupiter: 4.6° S |
| 27 | 23:59 | Moon-Saturn: 2° S |
| 28 | 00:53 | Full Moon |
| 28 | 10:30 | Moon Extreme South Dec.: 20.8° S |
| 29 | 22:43 | Moon Apogee: 406100 km |
| 30 | 12:44 | Moon Descending Node |

**Table courtesy of William Dembowski and NASA's SkyCalc Sky Events Calendar**

A follow-up effort on Pro-Am effort is underway with Japan's (JAXA) *Akatsuki* mission that began full-scale observations back in April 2016, and although the mission is continuing well into 2018, the website for *Akatsuki* mission has "gone live" so that interested and adequately equipped ALPO observers can register and start submitting images.

More information will emerge in forthcoming reports in this Journal.

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

This will enable full coordination and collaboration 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 wishing to register to participate in the coordinated observing effort between the ALPO and Japan's (JAXA) *Akatsuki* mission should use 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

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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 visual drawings of the planet. Regular imaging of Venus in both UV, 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 (for example, 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).

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

*http://www.alpo-astronomy.org/gallery/main.php?g2_view=core.DownloadItem&g2_itemId=85642*

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 plane as a cooperative simultaneous observing endeavor with visual observers. Also, observers should undertake imaging of the planet at near-IR wavelengths (for example, 1,000 nm), 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.

The ALPO Venus Section encourages readers worldwide to join us in our projects and challenges ahead.

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 Wayne Bailey, program coordinator**
*wayne.bailey@alpo-astronomy.org*

The ALPO Lunar Topographical Studies Section (ALPO LTSS) received a total of 119 observations from 22 observers during the October-December quarter.

Fourteen contributed articles were published in addition to numerous commentaries on images submitted.

Bill Dembowski began an series of articles on lunar rays and the *Focus-On* series continued under Jerry Hubbell with an article on Dorsa-Wrinkle Ridges. Upcoming *Focus-On* subjects will be: Montes & Mons-Mountains & Mountain Ranges; Rima-Rilles; and Craters-Latest & Greatest.

All electronic submissions should now be sent to both me and Assistant Coordinator Jerry Hubbell (*jerry.hubbell@alpo-astronomy.org*). Hard copy submissions should continue to be mailed to me at the address listed in the ALPO resources section of the Journal.

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

*Lunar Meteoritic Impacts*

**Brian Cudnik, program coordinator**
*cudnik@sbcglobal.net*

The ALPO-Lunar Meteoritics Impact Search (LMIS) section continued to coordinate routine observations quarter-by-quarter into the new year. The main means of communication of observing interval dates and active annual showers had been the e-mail list-serve while the ALPO website underwent an upgrade.

Besides this section's continued ongoing support of the NASA-Marshall Space Flight Center's survey of the Moon to catalog meteoroid impacts, this ALPO section worked with the British Astronomical Association, NELIOTA (NEO Lunar Impacts and Optical TrAnsients) and others to monitor the Moon for meteor impacts during the annual Geminid meteor shower in December. This effort resulted in at least one report of a confirmed

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meteor impact which was observed by two groups in Brazil. The event occurred on 2017 December 14 at 07:13:46 UT. A second impact was also reported to have occurred at either 5:33:12.9 or 5:33:18.2 UT on December 14, but I have little information about this impact.

As of 15 February 2018, I am not aware of, nor have I received, any other reports of Geminid meteor impacts on the Moon.

The NELIOTA project, operated by the European Space Agency, has been in operation 379 days (as of this writing in early mid-February) and has recorded 31 lunar meteor impacts. More information can be found at https://neliota.astro.noa.gr/, then click on the "Data Access" button on the left side of the screen.

The section will continue coordinating observations in 2018 with several targeted meteor showers included in the observing plans. Check the ALPO website and/or join the Lunarimpacts listserve for more information. The next significant opportunity is the Lyrids in April, when the moon will be favorably placed as a waxing crescent in the evening sky at the time of the April 21 shower maximum.

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

*Lunar Transient Phenomena*

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

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.

A list of dates and UTs to observe repeat illumination events can be

Rimae  Gassendi as imaged by Jerry Hubbell, Locust Grove, VA, USA on January 7, 2012, 01:28 UT. Exposure and other data in the March 2018 issue of “The Lunar Observer”.

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found on: http://users.aber.ac.uk/atc/lunar_schedule.htm, and LTP observational alerts are given on this Twitter page: https://twitter.com/lunarnaut

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

### Lunar Domes

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

Greetings to all. My assistant Jim Phillips and I are glad to once more assist the ALPO with reports of our studies about lunar domes. As such, we ask all of you to please consider contributing your own information about these sometimes elusive features. No contribution is too small to be considered.

Electronic images, sketches and even text explanations are most welcome. In keeping with the need to be as scientifically accurate as possible, we ask that your reports include the following: your name, your specific observing location (street address, city and so forth; even geographic coordinates are good), date and time of the observation (Universal Time is best but local time is acceptable), equipment details including instrument type, size and other dimensions as appropriate, any filters used, ccd camera or webcam details, seeing conditions and transparency conditions, and finally, your own detailed comments about the subject dome or domes.

Please send all electronic reports to either me at raffaello.lena@alpo-astronomy.org or Jim Phillips at thefamily90@gmail.com

## Mars Section

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

The Red Planet is getting closer and the observing season is well underway. Amateur astronomers are monitoring it and have already submitted hundreds of images, drawings, and notes. On April 1, Mars will subtend 8.5 arc seconds in diameter; on May 1, it will subtend 11.1 arc seconds; and on June 1, it will subtend 15.3 arc seconds, which already will be larger than it appeared at the oppositions of 2010, 2012, and 2014. At closest approach on July 31, Mars will subtend 24.3 arc seconds, offering the best views we'll get until 2033.

You don't want to miss out on observing Mars this year, and starting now will enable you to develop expertise by the time of closest approach. The months prior to opposition are always less well-observed than the months after opposition, so your early observations will be much appreciated.

Remember that the use of colored filters will enhance your perception of details.

- Red filters like Wratten #25 enhance albedo contrast and enable you to see through most clouds of water ice, while the polar caps still appear bright.
- Green filters like Wratten #58 show clouds, but also show ground-level ice and fog that are not seen well in blue light.
- Deep blue or violet filters like Wratten #47 show scarcely any albedo features but do show clouds brightly and ground hazes faintly, though the polar caps still appear bright.

However, dust clouds are bright in red light. If you observe the planet sufficiently often that you recognize the usual albedo features, dust clouds will stand out in red light as unusual, bright features that often obscure the usual, dark albedo features. We emphasize the use of filters especially by visual observers, because most imagers already use them as an integral part of their observations.

Upon reading the 2007-8 apparition report that appeared in the last issue of the ALPO Journal and Richard Schmude's report in the present issue about the size of the North Polar Cap and the clouds of the north polar region, you will readily see how interested we are in transient features like dust storms, clouds and the extent of the polar caps. We also monitor the slow changes from apparition-to-apparition in the appearances of the albedo features. Please send us all your observations. You can post them directly into the files section of the Yahoo marsobservers group at https://groups.yahoo.com/neo/groups/marsobservers/info or send them directly to me at rjvmd@hughes.net , or just leave a message on the group's message list with a link to where you have

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posted them. We thank the many faithful contributing observers who have made our studies possible.

We'll soon have observations to add to the Mars Section's recent observations page at www.alpo-astronomy.org/mars. For detailed information about observing Mars, be sure to check out the Mars Observers' Cafe — find the link in the list on the right side of the Mars page on the ALPO website.

### Minor Planets Section

**Frederick Pilcher, section coordinator**
pilcher35@gmail.com

Some of the highlights published in the *Minor Planet Bulletin*, Volume 45, No. 1, 2018 January-March, are hereby presented. These highlights represent the recent achievements of the ALPO Minor Planets Section.

Brian Warner has made several improvements to the MPB web site. It is now possible to download any issue back to Volume 1, Number 1, 1973. Most of the individual papers in the many issues can now be downloaded as separate pdf files.

Brian Warner reports several asteroids with non-simple behavior. 2074 Shoemaker, with a well-established primary rotation period of 2.533 hours, may be a binary with uncertain orbital period 44.2 hours or perhaps 55.5 hours.

Another possible, but uncertain, binary (66146) 1998 TU3 with rotation period 2.3776 hours and orbital period perhaps 13.58 hours.

Minor planets 2012 TC4 and 2017 NH have tumbling behavior, that is, simultaneous rotations about two different axes with different periods. For 2014 TC4 the dominant and subordinate periods are 0.204 hours and 0.141 hours, respectively; and for 2017 NH 2.481 hours and 3.808 hours, respectively. For 2015 KN120 three different periods can be discerned, 46.3 hours, 9.107 hours, 7.448 hours. A full explanation for this strange behavior is not given.

In addition to asteroids specifically identified above, lightcurves with derived rotation periods are published for 212 other asteroids as listed below:

89, 153, 176, 393, 395, 418, 452, 576, 589, 593, 594, 643, 646, 676, 704, 728, 784, 838, 850, 874, 876, 888, 897, 952, 963, 1022, 1025, 1086, 1088, 1095, 1114, 1128, 1134, 1155, 1193, 1322, 1443, 1465, 1529, 1576, 1581, 1583, 1591, 1608, 1674, 1697, 1722, 1754, 1773, 1843, 1868, 1903, 1969, 2019, 2228, 2246, 2251, 2329, 2411, 2448, 2504, 2648, 2672, 2685, 2702, 2847, 2881, 2916, 2928, 2973, 3032, 3104, 3122, 3160, 3169, 3224, 3354, 3532, 3569, 3600, 3760, 3793, 3824, 3891, 3956, 3983, 4112, 4197, 4202, 4404, 4435, 4512, 4695, 4825, 4945, 4971, 4975, 5040, 5143, 5240, 5264, 5399, 5405, 5605, 5625, 5626, 5711, 5735, 5813, 6053, 6199, 6237, 6490, 6522, 7001, 7336, 7509, 7550, 8376, 8994, 9148, 9671, 10041, 10496, 11127, 11213, 11441, 11745, 11776, 12538, 13538, 14309, 15267, 15590, 15783, 17305, 17814, 18429, 19286, 20460, 21893, 23186, 23621, 24814, 25310, 25442, 25980, 29128, 29308, 29564, 31775, 31947, 32329, 33325, 35967, 41561, 42811, 56116, 69452, 83450, 87104, 90075, 96631, 114291, 132856, 138846, 138911, 138925, 141354, 141670, 142464, 143404, 190166, 203471, 232368, 237805, 246875, 252091, 265962, 305601, 326683, 333888, 366733, 416584, 422699, 427643, 457175, 459872, 489337, 494706, 496018, 1993 RA, 2004 TQ13, 2005 TF, 2006 BZ8, 2008 MH1, 2014 JO25, 2014 YC15, 2016 AA9, 2017 AG5, 2017 BJ30, 2017 BM31, 2017 BQ6, 2017 BS5, 2017 BS32, 2017 GK4, 2017 GQ6, 2017 JA2, 2017 MB1, 2017 OP68, 2017 PS25, 2017 PJ26,

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.

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The *Minor Planet Bulletin* is a refereed publication and that it is available online at *http://www.minorplanet.info/mpbdownloads.html*.

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 Ed Grafton, section coordinator**
*ed@egrafton.com*

Jupiter Section Assistant Coordinator John McAnally is coordinating central meridian (CM) transit timings of Jupiter's atmospheric features. Measuring CM transit times is an excellent way to become familiar with Jupiter's features and adds to the data base of when particular features or visible. Transit timing observations may be sent to John directly at *CPAjohnM@aol.com*

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

### Galilean Satellite Eclipse Timing Program

**Report by John Westfall, program coordinator**
*johnwestfall@comcast.net*

An Excel catalog of this program's observations from the 1975/76 through the 2000/01 Jupiter apparitions is available from this section coordinator. The read-only, two-megabyte file contains the results of 10,308 visual timings, with 20 entries for each timing.

The data are more detailed than given in the reports published in this Journal over the years, and include observed UT, delta-t, the predicted event time based on the Lieske E-2 ephemeris, as well as the observer name, instrument aperture, and observing conditions.

Contact John Westfall via e-mail at *johnwestfall@comcast.net* or via postal mail at 5061 Carbondale Way, Antioch, CA 94531 USA to obtain an observer's kit, also available on the Jupiter Section page of the ALPO website.

### Saturn Section

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

*Editor's Note -- This abbreviated report will be followed by a fully, updated version in JALPO60-3 (June 2018).*

Saturn entered conjunction with the Sun on December 21, 2017, thereby ending the well-observed 2016-2017 apparition and is now visible in the early morning sky.

The accompanying Table of Geocentric Phenomena for the 2018-19 Apparition in Universal Time (UT) is included here for the convenience of observers.

As the 2018-19 apparition began in January 2018, observers are reminded to be watchful for any new atmospheric phenomena that might suddenly appear. With the rings tilted as much as +26° toward our line of sight from Earth in 2018-19, observers will still have near-optimum views of the northern hemisphere of the globe and north face of the rings during the 2018-19 apparition.

Pro-Am cooperation with the Cassini mission continued during the previous 2016-17 apparition as NASA's unprecedented close-range surveillance of the planet for nearly

**Geocentric Phenomena for the 2018-19 Apparition of Saturn in Universal Time (UT)**

| | |
|---|---|
| Conjunction | 2017 Dec $21^{d}$ UT |
| Opposition | 2018 Jun $27^{d}$ |
| Conjunction | 2019 Jan $02^{d}$ |
| | |
| **Opposition Data for June 27, 2018:** | |
| Equatorial Diameter Globe | 18.3″ |
| Polar Diameter Globe | 161″ |
| Major Axis of Rings | 41.5″ |
| Minor Axis of Rings | 18.2″ |
| Visual Magnitude ($m_v$) | 0.0 |
| B =<br>Declination<br>Constellation | +26.0°<br>-22..5°<br>Ophiuchus |

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thirteen years, that started back on April 1, 2004, concluded its remarkable odyssey on September 15, 2017 when it plunged into Saturn's atmosphere.

For years to come, however, planetary scientists will be carefully studying the vast database of images and data gleaned from the Cassini mission, and ALPO Saturn observers who were participating in our on-going Pro-Am activities are reminded that observations and images obtained prior to the time the spacecraft entered Saturn's atmosphere last September should still be submitted for comparative analysis with Cassini results.

Furthermore, our conscientious Pro-Am efforts will not cease in 2018-19 as we regularly monitor atmospheric phenomena on Saturn and actively share our results and images with the professional community. Thus, anyone 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 new 2018-19 apparition as well as during the next observing season.

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 (that is, simultaneous observations). Also, while regular imaging of the Saturn is very important, far too many experienced observers neglect making visual numerical relative intensity estimates, which are badly needed for a continuing comparative analysis of belt, zone, and ring component brightness variations over time.

The ALPO Saturn Section thanks all observers for their dedication and perseverance in regularly submitting so many excellent reports and images. *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

### Remote Planets Section

**Report by Richard W. Schmude, Jr., section coordinator**
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Both Uranus and Neptune will be in the evening sky in late December. Neptune will reach conjunction in March and Uranus a month later. Astronomers have been able to image albedo features on both planets with 0.25 to 035 m (10 to 14 inch) telescopes in red and near infrared light.

The image of Uranus shown here was taken by Christophe Pellier on October 15, 2017 with a 0.25 m (10 inch) Gregorian telescope in "R + IR 610 nm+" light. The North Polar Cap (bright area) is on the right. A few years ago, there was just a bright belt surrounding the North Polar Region, but this area has filled in, resulting in the entire region appearing bright.

This writer and his student have also been busy collecting mostly ultraviolet brightness measurements of Uranus. At least one other observer (Jim Fox) is probably collecting B and V filter measurements of Uranus and Neptune.

[Editor's Note: skyandtelescope.com is a great source to find specific locations of sky objects.]

Finally, a reminder that the book *Uranus, Neptune and Pluto and How to Observe Them*, which was authored by this coordinator, 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) to order a copy.

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

### Notable Deaths

An obituary on the passing of comet discoverer Tom Bopp will appear in the next issue of this Journal.

*Feature Story:*

# *A Brief History of ALPO-Japan*

**By Takeshi (Ken) Sato, Hiroshima, Japan & member of ALPO-Japan and the ALPO**
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## Editor's Note

Surely, many of you have seen mention in these pages over the years of "ALPO-Japan", leading to confusion as to the relationship between the ALPO and ALPO-Japan. We present to you now the explanation of how ALPO-Japan started, how it grew and how it remains of major importance to solar system observers in Japan and other parts of the Far East. The ALPO-Japan website is at *http://alpo-j.asahikawa-med.ac.jp/Latest/*

## Founding and Early Years

In a science magazine for young people, "Kodomo no Kagaku", Isamu Hirabayashi, a high school student in Tokyo posed the following question to readers of the magazine in 1959: "If you are interested in observing the Moon and planets, please come and join me."

Three high school students joined Hirabayashi. Their names are Hideyuki Karasawa, Masaharu Murakoshi and Norio Kaifu. Of these original four, Kaifu became a professional astronomer and later became the director of the National Observatory of Japan and the president of the International Astronomical Union. The other three have continued to be active amateur astronomers until now.

Many young amateurs joined this group and it became larger and stronger. This group of observers was originally named "Japan Lunar and Planetary Observers Network (JALPON)." But sometime later, however, that name was replaced by "ALPO-Japan (ALPO-J)."

Unfortunately, the new name leads some persons to the false belief that the "ALPO-J" is the Japanese branch of the American organization, the ALPO.

But as stated earlier, the ALPO-J is an independent organization initiated by four high school students in Tokyo. And returning now to the original name may cause larger trouble because the name ALPO-Japan is already known internationally.

In 1974, Makoto Adachi organized the Western Japan Branch of the ALPO-Japan. At first, lunar observing was the primary activity of the members of this branch. Later, interest in planetary observing became very strong.

The website of the western branch of the ALPO-Japan was started in 1996. But in 2008, the branch merged with the website of the ALPO-J headquarters. Shortly afterwards, the western branch of the ALPO-J ceased operations.

## Member Observations and Instruments

Telescopes used by the members of the ALPO-J in the organizations earliest days were self-made 8-cm (3-in.) and 10-cm (4-in.) Newtonian reflectors and commercial 5-cm (2-in.) or 6-cm (2.4 in.) refractors. The


The original four and other early members of the Japan Lunar and Planetary Observers Network (JALPON, later renamed the ALPO-J). This photograph was taken at Mr.Komori's house on Jan.10,1960. Mr. Komori served those young astronomers as an adviser.


Isamu Hirabayashi received the Highest Award of the Oriental Astronomical Assn on October 28,2017. *Photograph by Kuniaki Horikawa.*

members' telescopes became larger and larger over the years, and today, the largest is a 40-cm (16-in.) Newtonian owned by Isao Miyazaki.

Schmidt-Cassegrain telescopes of a slightly smaller aperture are being used by many members. The methods of observing was visual and drawing in early days. However, photographic observations increased gradually over the years and flourished during 1970s. At present, imaging with electronic cameras and computer technology is common, but a few most experienced observers are still making visual observations.

## Conferences and Publications

On August 24-25,1974, the First Jupiter Conference was held at Sendai Observatory, Sendai City. On September 9-10, 2017, the ALPO-J celebrated the 40th Jupiter Conference at Meiji University, Tokyo. This was an amateur/ professional conference because a fair number of ALPO-J members are now professional planetary scientists.

In 1981, the two-volume "Planet Guidebook" was published by the ALPO-J. The most important part of the book is the 150-page section by Hirabayashi about Jupiter, which describes details of various phenomena about our Solar System's largest planet. Most of observations used in this section of the book were made by ALPO-J members.

## The Oriental Astronomical Assn (OAA) and the ALPO-Japan

Like the ALPO-J, the OAA also has lunar and planetary observing sections. But some ask if the two organizations are rivals of each other. The answer if definitely not!

Many members of the ALPO-J are also members of the OAA. For instance, ALPO-J member Kuniaki Horikawa is also the current director of the Jupiter-Saturn Section of the OAA.

Also, Isamu Hirabayashi, president of the ALPO-J, was the recipient of the highest award of the OAA in 2017. Plus, he was the director of Jupiter-Saturn Section of the OAA from 1971 to 1989.

## Papers & Presentations:

# 19th Century Observational Astronomy Through the Engineer's Transit

**By Stephen Tzikas, ALPO Member**
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## Abstract

The following article reconstructs the observational environment of astronomy in the 19th century in the context of students and the use of engineering transits, specifically at Rensselaer Polytechnic Institute (RPI) as a benchmark because of a number of favorable circumstances there. I explore some insights on how amateurs of the 19th century, primarily engineering students, conducted amateur observing, and how civil engineering might have facilitated the rise of modern amateur observational astronomy. Three factors influenced the development of early amateur observational astronomy in the 19th century. These were the beginning of the industrial revolution, the growing availability of education, and the rise of the civil engineering student.

## Presentation

Rensselaer Polytechnic Institute is the oldest engineering institution in the United States. Early enrollment in the 19th century was primarily of civil engineering students, when civil engineering predominated and students could expect to have easy access to engineer transits. The emblem of RPI has a transit on it, and the yearbook is named *The Transit*. Both are a reflection of this strong tradition. The idea of the engineering student as the progenitor of observational amateur astronomy originated through my interest in the history of the Rensselaer Astrophysical Society (RAS). I had already written one article on its history found at *http://astro.union.rpi.edu/history.html*. Being founded in 1938, I wondered how observational astronomy was pursued at RPI before this. After all, RPI has a rich history back to 1824. After researching through the University's Polytechnic newspaper, the Institute's catalogs of course curricula, the historical archives of some of its prominent professors, and other miscellaneous documents, I came to some conclusions. In the process of discovering this past, I realized I was also reconstructing a history of observational student astronomy that just preceded and would help give birth to observational astronomy for the masses. It was quite an enlightening find. Moreover, RPI, located in Troy, NY, was at the center of the American Industrial Revolution, which began in Troy, NY and Paterson, NJ. Gurley Instruments, a renowned engineer's transit manufacturer, was also located in Troy, NY. My experience as an RPI engineer was fortunate in that I arrived in 1980, and could enjoy its just acquired 16-inch Ritchey and Chretien reflector in the Hirsch Observatory, which later in life led to my interest in the history of this observatory and astronomy at RPI.

Amateur astronomy, quite widespread and sophisticated today, grew considerably after World War II, when for example, advertisements for affordable telescopes started appearing in the early 1950s issues of *Sky & Telescope* magazine. For approximately 100 years before that, engineering students helped the


Figure 1. The W. & L. E. Gurley Building, in Troy, New York, is a classical revival structure that housed the W. & L. E. Gurley Company, a maker of precision measuring instruments, from its construction in 1862. The building was declared a Historic National Landmark in 1983. Gurley Precision Instruments still occupies the building and also rents space to RPI's Lighting Research Center (LRC). Established in 1988 by the New York State Energy Research and Development Authority (NYSERDA), the LRC is the world's leading center for lighting research and education. Photograph taken by author in November 2017

transition from a small number of professional observatories to astronomy for the masses. To understand the beginning of amateur astronomical observation in the 19th century, one needs to understand the context in which it found itself. Most people struggled to survive daily life in the early 19th century. As harsh as the industrial revolution could have been in its early years, it eventually provided for better lifestyles. Education made great progress during the 19th century, which allowed the emergence of the engineering student. At the beginning of that century, the majority of the people could neither read nor write. With the extension of the free-school system there has been a great positive change in education. College education improved too. However, it was not until after the Civil War that disposable incomes rose enough for people to enjoy more leisure and personal investment.


Figure 2. An advertisement for Gurley Instruments taken from the May 2, 1910 edition of the RPI student newspaper *The Polytechnic*. Courtesy of the Institute Archives and Special Collections, Rensselaer Polytechnic Institute, Troy, NY.

As noted, Troy, NY, was one of the industrial revolution centers in the United States. Troy was also home to Gurley Precision Instruments, founded in 1845. It had an association with RPI, as William Gurley himself was a civil engineering graduate of RPI. Lewis Ephraim Gurley, the younger Gurley brother, earned a B.A. from nearby Union College, and also joined the firm. By the second half of the 19th century, their firm was the largest manufacturer of engineering and surveying instruments in the United States. Upon visiting RPI, one will notice the widespread display cabinets containing antique Gurley engineering transits throughout the campus. This is a product of both its engineering heritage and Gurley's stature. Eventually, I acquired an 1891 Berger engineer's transit for which I could actually use as an instrument for observation. As rewarding as my observations were in modern suburbia, Troy of the 19th century would have had dark skies.

The 19th century Capital Region of New York offered a few other opportunities to the students at RPI. The Dudley Observatory completed construction in 1856. By 1876, this observatory was able to launch a significant program of research. Dudley Observatory's astronomers achieved world-class status in the field of astrometry, and made use of several high precision instruments. Troy was also home to its world famous music hall. Because of this cultural attraction, opera glasses, which are similar to binoculars, could be readily found, and would make a less costly alternative to telescopes and transits. It was in 1888 that science popularizer and journalist Garrett Serviss wrote *Astronomy With An Opera Glass*, a book that remained in print until 1961. In the wider context of 19th century astronomy, it was an incredible time of achievement. Solar System discoveries were frequent, spectroscopy developed, surveys grew more extensive, and instrumentation became more precise and powerful. Students would have focused on similar observational programs much like what amateurs do today, such as observations related to the Solar System, double stars, variable stars, and bright deep space objects. They may have used and developed sophisticated observational and sketching skills as well. Moreover, the RPI campus had the opportunity to view a total solar eclipse that crossed upstate New York on the morning of January 24, 1925.

The 19th century marked the rise of amateur astronomy societies all over the world. The field of astronomy was advanced by the creation of large astronomical organizations and publications. Organizations included the Royal Astronomical Society (1822), the American Association for the Advancement of Science (1848), the National Academy of Sciences (1863), and the American Astronomical Society (1899). Expeditions to observe eclipses were popular with both professional and amateur astronomers.

Having reviewed the context in which the early engineering student would have studied, the growth and program opportunities should also be reviewed. There were only about 30 universities in the United States in 1801 with about 3,000 students. In 1897, there were 472 with 155,091 enrolled students. Generous endowments and public grants placed


Figure 3 (above left). The author's 1891 Berger transit on tripod. If one is patient, antique transits can be found at reasonable prices. This full set-up, with hard case, cost only $100 from Craig's List in 2017.
Figure 4 (above right). The author's 1891 Berger transit offers approximately 40mm aperture for astronomical observation, and provides surprisingly crisp views of objects.

funds at their disposal. Explosive growth in the number of colleges occurred in bursts, especially in the early 20th century and after World War II. The Ph.D. spread to the United States in the 1800s. Prior to its development, Americans pursued doctoral study in European universities. In 1861, Yale University was the first American institution to award the degree. However, early pedagogy at universities was more hands-on and similar to what amateurs do today.

In the United States, civil engineers had to go abroad to study before RPI was established in 1824. Civil engineering included celestial and spherical astronomy, especially with its importance to navigation. On March 11, 1825, a code of by-laws consisting of 11 articles were passed at RPI. The by-laws required students to give lectures on astronomy, among other "hands-on" observational natural science topics with collected specimens, such as those from the fields of botany, zoology, and geology. It's not difficult to conclude that the conduct of the astronomy lectures would follow a similar pedagogy of direct celestial observation to understand the natural environment. The relatively large concentration of civil engineers meant that it would only be natural for them to point their quintessential engineer's transits to the sky at night, which would have made reasonable telescopes. Every one of those students on their free time likely turned their transits up to the night sky at least once in scientific curiosity, and probably a few pursued it with vigor.

In 1835, RPI conferred its first degree in civil engineering in the United States to four students. The curricula at universities followed more academic lines, at least in earlier parts of the century. While the archives of RPI show the requirement of a review or design thesis prior to the Civil War, the idea of the original research thesis evolved, with the inauguration of John Hopkins research university in 1876 to the "Big Science" university research programs found today, especially after the creation of the National Science Foundation in 1950. In the early period of transition from purely academic centers to research institutes, university pedagogy originally focused on natural science and observation. RPI enrollments began modestly: 25 students in 1826; 53 students in 1850: 181 students in 1875; 650 students in 1910; 1,240 students in 1925; 1,604 students in 1945; 3,987 students in 1950; and 6,995 students in 2013. As enrollments became sizeable in the 20th century, RPI created its first student astronomy organization in April 1938, the Rensselaer Astrophysical Society (RAS).

Nationally, enrollments did not necessarily equate to degrees. However, in 1870, there were 9,400 bachelor degrees awarded, no master degrees, and only one PhD. By 1890, bachelor degrees awarded rose to 15,500, master degrees to 1,000, and PhDs to 149. By 1950, bachelor degrees awarded amounted to 432,000, master degrees to 58,200, and PhDs to 6,600. By 1990, the million-bachelor degree awarded mark was breached. Today, over 10 times the number of degrees at the master and PhD levels is awarded annually as there was in 1950. That makes for tremendous interest in professional and amateur activities, regardless of the topic.

Astronomical observational books were contained in the RPI library collection, of which a selected few I have noted below. The Catalogue of the Library of the RPI in 1880 gave a flavor for the types of astronomy books to which students would have had access. In fact, some of the observational astronomy books of the period noted the engineer's transit as a practical telescope, and some of these books are available as free downloads from the Internet Archive. These fine books included:

- Air's *Mathematical Tracts on the Lunar and Planetary Theories and Figure of the Earth* (1831)
- Arago's *Popular Lectures on Astronomy* (1845)
- Brewster's *Ferguson's Astronomy, with Notes* (1817)
- Farrar's E*lementary Treatise on Astronomy* (1834)
- Gummere's *An Elementary Treatise on Astronomy* (1853)
- J.F.W. Herschel's *Treatise on Astronomy* (1841)
- Humboldt's *Cosmos; a Sketch of a Physical Description of the Universe* (1858)
- Kendell's *Atlas of the Heaven's* (1845)
- Loomis' *A Treatise on Astronomy* (1848)
- Mitchell's *Popular Astronomy* (1863)
- Mudie's *The Heavens* (1836)
- Norton's *Elementary Treatise on Astronomy* (1845)
- Rolfe and Gillet's *The Cambridge Course of Elementary Physics, Part III Astronomy* (1868)

- Vince's *Elements of Astronomy* (1811)
- Willard's *Astronography* (1854)
- Bartlett's *Elements of Spherical Astronomy* (1855)
- Chauvenet's *A Manual of Spherical and Practical Astronomy* (1871)
- Dick's *The Practical Astronomer* (1846)
- Greene's *An Elementary Treatise of Spherical Astronomy* (1876)
- Baily's *Catalogue of Stars of the British Association* (1845)

To test the practicality of the engineer's transit instrument, I acquired my own 1891 engineer's transit and conducted a few observations with it. I had no shortage of targets, and I selected similar ones to what an engineering student may have chosen. Via the naked eye, a student could already make variable star and meteor shower observations, and see a few star clusters like Ptolemy's Cluster, the Hyades, Coma Berenices (Melotte 111), the Pleiades, or the Double Cluster. By 1911, one could submit observations to the American Association of Variable Star Observers (AAVSO) and the American Meteor Society (AMS). With the transit, the observer had much more ability. These two organizations were the forerunners of a greater variety of observing programs offered by the Association of Lunar & Planetary Observers (the ALPO), founded in 1947, and the Astronomical League's observing certificates, which developed since 1967. The Webb Deep-Sky Society was established in 1967 and accepted deep space object and double star observations. In 1981, the founding of the Society of Amateur Radio Astronomers (SARA), allowed amateur radio astronomers to associate with each other and share observations.

Observations made with my 1891 Berger transit included many familiar targets including planets, the Moon, bright nebula and galaxies, and variable stars to dimmer magnitudes. With a filter one could see the Sun and its sunspots. I made my first observations on the evening of February 17, 2017, and the early morning of February 18, 2017. My tripod was sufficiently high enough for comfort. On February 17, I observed the crescent Venus, brilliant blue Rigel, and Betelgeuse's red color. Mars was an orange tiny disk past its last apparition. For the Orion Nebula, I saw at least three of the Trapezium Cluster stars. The Lambda Orionis cluster was visible, too. The Gamma Leporis double star of magnitudes 3.7 / 6.3 and wide separation was a beautiful sight. I just barely could reach Polaris, as higher altitudes were not possible on this transit as the instrument obstructs the telescope optical tube. On the morning of February 18, I observed Jupiter, the Moon, Beta Scorpii and Nu Scorpii. I would expect 19th century conditions to provide much darker skies, even if a few gas lamps or candle street lights existed. Observational notes could have included sketches and illustrations of the planets, Sun, aurora borealis, the Orion Nebula, and lunar features.

The student engineer, thus, had the means to be the driving force in early practical and observational astronomy that eventually opened to all as telescopes became affordable. Amateur observational astronomy by the masses is a relatively recent development. Knowing how the modern era of observational astronomy developed, being fortunate to be part of it as a baby boomer, and following the footsteps of students before me at RPI, is a feeling of fulfillment and satisfaction whenever I look up at the clear night sky.

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### Feature Story: ALPO Solar Section

# A Report on Carrington Rotations 2195 through 2198 (2017 09 12.7285 to 2017 12 30.93)

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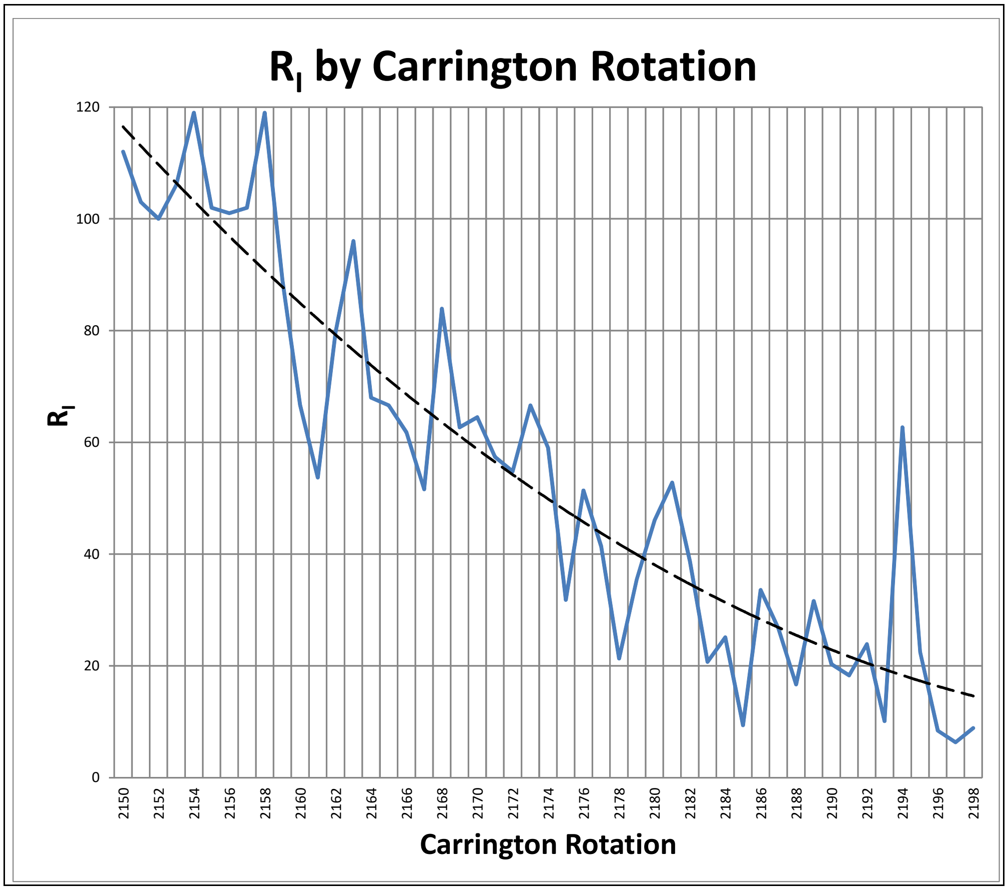



To our hard-copy readers: This paper can be viewed in full-color in the online (pdf) version of this Journal.

## Overview

Activity this reporting period was low to extremely low levels not seen in eight years. All predictions are for a continued decrease in activity to a minimum sometime in 2020. The only rotation with significant activity in this period was the first one, CR 2195. Then the activity fell to very low numbers as Plot 1 shows. There were no naked eye sunspots during this reporting period and no flares were reported beyond B-class in any rotation.

## Terms and Abbreviations Used In This Report

While this brief section is similar to the same in earlier reports it should be at least reviewed. As in previous reports, the ALPO Solar Section will be referred to as "the Section" and Carrington Rotations will be called "CRs". Active Regions are designated by the National Oceanic and Atmospheric Administration (NOAA) and will refer to all activity in all wavelengths for that region and will be abbreviated "AR" with only the last four digits of the full number being used. 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 WDC-SILSO (World Data Center - Solar Index and Long Term Solar Observations) at the Royal Observatory of Belgium. All times used here are Coordinated Universal Time and dates are reckoned from that. Dates will be expressed numerically, with month/day such as "9/6" or "10/23". Carrington Rotation commencement dates are from the table listed on the Section webpage on the ALPO website *http://alpo-astronomy.org/solarblog/wp-content/uploads/ephems/CNSun_2159_2306_A.pdf*

The terms "leader" and "follower" are used instead of "east" or "west" on the Sun to avoid misunderstandings. 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) if used at all, will be abbreviated as N, S, E and W.

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

**Table 1. 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 | | H-a | |
| | | 102mm, RFR | | CaK | |
| Richard Bosman | Enschede, Netherlands | 110mm, RFR | Basler Ace 1280 | | |
| | | 355mm, SCT | | | |
| Raffaello Braga | Milano, Italy | 112mm,RFR | PGR Chameleon mono 2.0 | H-a | digital images |
| Tony Broxton | Cornwall, UK | 127mm, SCT | N/A | w-l | drawings |
| Jean-Francois (Jeff) Coliac | France | 30mm, Projection | N/A | w-l | drawings |
| Gabriel Corban | Bucharest, Romania | 120mm, RFL-N | Point Grey GS3-U3 | H-a | digital images |
| | | | | w-l | |
| Brennerad Damacenco | Sao Palo, Brazil | 90mm, MCT | ASI224MC | w-l | digital images |
| Franky Dubois | West-Vlaanderen, Belgium | 125mm, RFR | N/A | visual sunspot reports | |
| Howard Eskildsen | Ocala, FL | 80mm, RFR | DMK41AF02 | w-l wedge | digital images |
| | | | | CaK | |
| Joe Gianninoto | Tucson, AZ | 115mm, RFR | N/A | w-l | drawings |
| | | 80mm, RFR | | H-a | |
| | | 90mm, MCT | | w-l, H-a | |
| 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 | | | |
| Bill Hrudey | Grand Cayman | 200mm, RFL-N | ASI174MM | w-l | digital images |
| | | 60mm, RFR | | H-a | |
| David Jackson | Reynoldsburg, OH | 124mm, SCT | N/A | w-l | drawings |
| Jamey Jenkins | Homer, IL | 102mm, RFR | DMK41AF02 | w-l | digital images |
| | | 125mm, RFR | | CaK | |
| Pete Lawrence | Selsey, UK | 102.5mm, RFR | ZWO ASI174MM | H-a | digital images |
| Monty Leventhal | Sydney, Australia | 250mm, SCT | N/A | w-l/H-a | drawings |
| | | | Canon-Rebel | H-a | digital images |
| Efrain Morales | Aguadilla, Puerto Rico | 50mm, RFR | Point Grey Flea 3 | H-a | digital images |
| German Morales C. | Bolivia | 200mm, SCT | N/A | visual sunspot reports | |
| Theo Ramakers | Oxford, GA | 80mm, RFR | ZWO ASI174MM | H-a | digital images |
| | | 11 in. SCT | DMK41AU02AS | w-l | |
| | | 40mm, H-a PST | DMK21AU03AS | H-a | |
| | | 40mm, CaK PST | | CaK | |
| Ryc Rienks | Baker City OR | 203mm, SCT | N/A | w-l | drawings |
| | | 40mm, H-a PST | | H-a | |
| Chris Schur | Payson, AZ | 152mm, RFR | DMK51 | CaK | digital images |
| | | | | w-l (CaK-offband continuum) | |
| | | 100mm, RFR | DMK51 | H-a | |
| 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 | Starkville MS | 60mm, RFR | N/A | W-L/H-a | drawings |
| | | | Malincam | W-L | digital images |
| James Kevin Ty | Manila, Philippines | TV101, RFR | ZWO-ASI 120MM | H-a | digital images |
| David Tyler | Buckinghamshire, UK | 178mm, RFR | ZWO | W-L | digital images |
| | | 90mm, RFR | | H-a | |
| Christian Viladrich | Nattages, France | 300mm, RFN | Basler 1920-155 | W-L | digital images |

NOTE: Telescope types: Refractor (RFR), Newtonian Reflector (RFL-N), Schmidt Cassegrain (SCT) Maksutov-Cassegrain (MCT), Meade Personal Solar Telescope (PST).

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, with a naked-eye spot generally being about 900-1,000 millionths for the average observer. The McIntosh Sunspot Classification used here is the one defined by Patrick McIntosh of NOAA (McIntosh 1981, 1989) and detailed in an article in the JALPO Volume 33 (Hill 1989). This classification system is also detailed by the author on the Section website at *http://www.alpo-astronomy.org/solar/W-Lft.html* in an article on white-light flare observation. This will be referred to as the McIntosh Class. The magnetic class of regions is assigned by NOAA and will be entered parenthetically after the McIntosh class or elsewhere referred to as "mag. class".

Lastly, 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 Archives. This can be accessed by going to the Solar Section webpage and following the Archives link at the top of the right sidebar. You can also go to the Archives through this link: *http://www.alpo-astronomy.org/gallery/main.php?g2_itemId=1699*

Section observers, their equipment and modes of observing are summarized in Table 1 on this page. While not all individuals necessarily contributed to this specific report, they have contributed to recent reports and are ALPO Solar Section members. This should be used as a reference throughout this report.

### 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

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

McIntosh, Patrick S., (1989) "The Classification of Sunspot Groups" Solar Physics, Vol. 125, Feb. 1990, pp. 251-267.

McIntosh, Patrick S., (1981) The Physics Of Sunspots. Sacramento Peak National Observatory, Sunspot, NM; L.E. Cram and J.H.Thomas (eds.), p.7.

Additional references used in the preparation of this report:

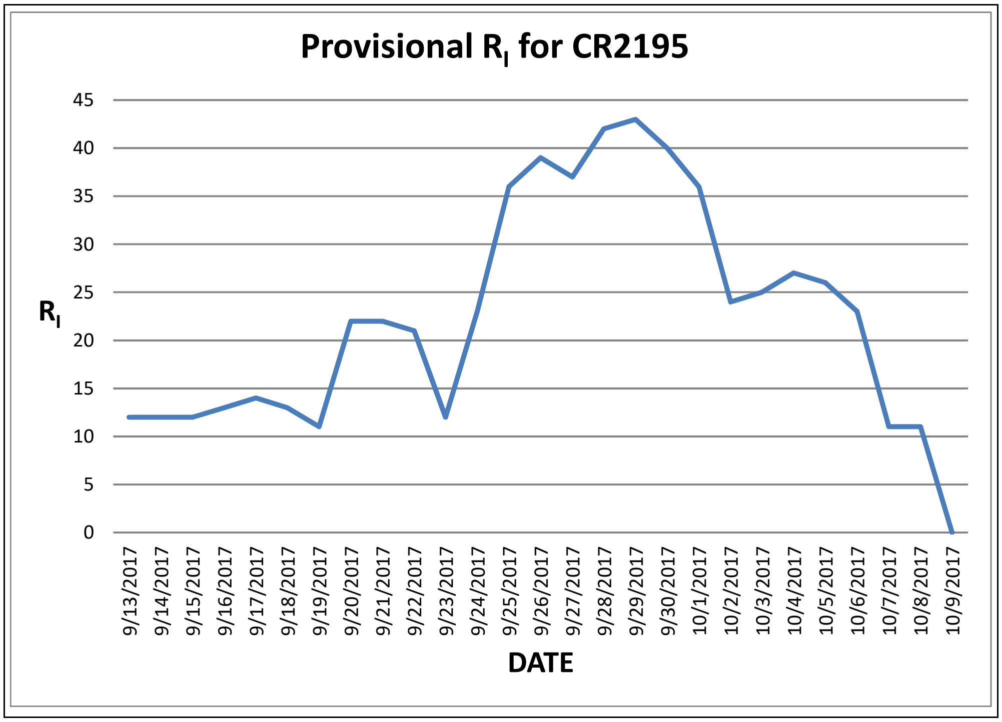
Solar Map of Active Regions
https://www.raben.com/maps/date

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/



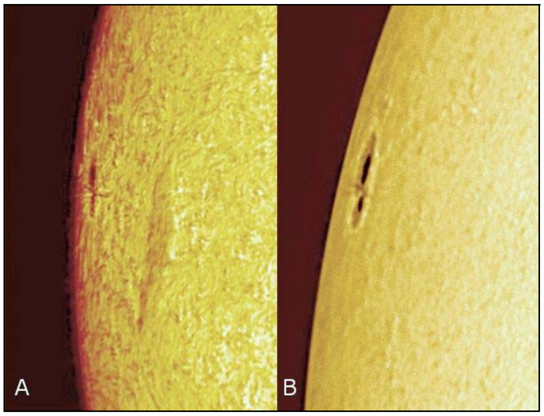



## Carrington Rotation 2195

### *Dates: 2017 09 12.73 to 2017 10 10.01*

*Avg.* $R_I$ *= 22.5*
*High* $R_I$ *= 43 (9/29)*
*Low* $R_I$ *= 0 (10/9)*

This rotation saw only four regions, none of which exceeded 300 millionths and this was the best activity of the reporting period! The largest and most active region one was AR 2683 which was first caught by Grassmann on 9/25 in both w-l and H-a (**Figure 1**). These images showed two umbrae in a single penumbra with the whole region preceded by a nice, broad filament. The region was not designated until late in the day, at which time it was Hkx, 260 millionths area (alpha). The next day we got a good high-resolution w-l look by Dave Tyler. He showed the two umbrae in a single umbra with a small, short light-bridge between the umbrae but contained within the penumbra (**Figure 2**). Ramakers got a CaK image of the three main regions on the Sun that day including AR 2683 in the upper left (**Figure 3**). There was little evolution over the next few days. The professional designation, and that of our observers, remained Hkx or Hhx except for Levinthal who on 9/28 classed it as Cki. Meridian passage was on 10/01, when AR 2683 reached 290 millionths (alpha) but only produced a dozen flares in 48 hours. Of the other three regions that exceeded 200 millionths, all were H-class. The only C and D class groups were when these other three regions were < 200 millionths area. AR 2683 divided into two spots shortly after meridian passage on 10/03. This is typical dissolution of a sunspot and the two pieces each reduced in size from that point. Ramakers compiled w-l and H-a histories for this region that very well summaries its evolution (**Figure 4** and **Figure 5**). Grassmann got a nice image of a prominence associate with the region as it was on the limb on 8/10 (**Figure 6**).





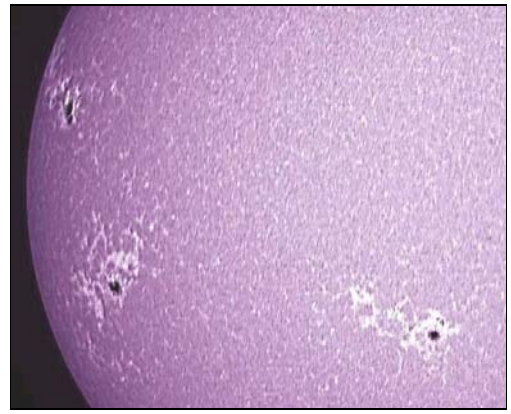
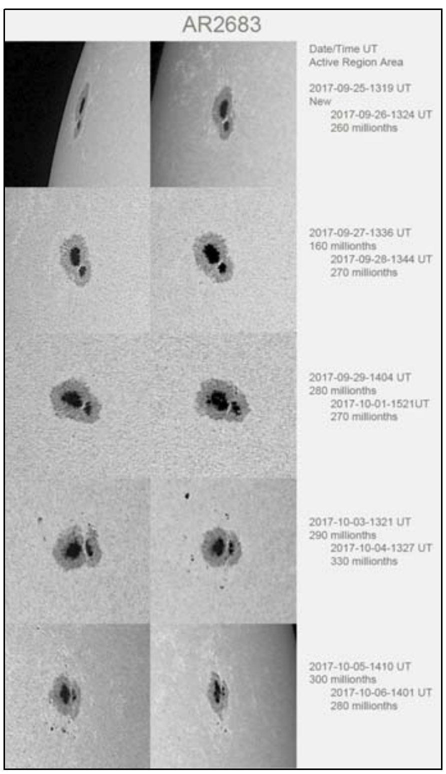
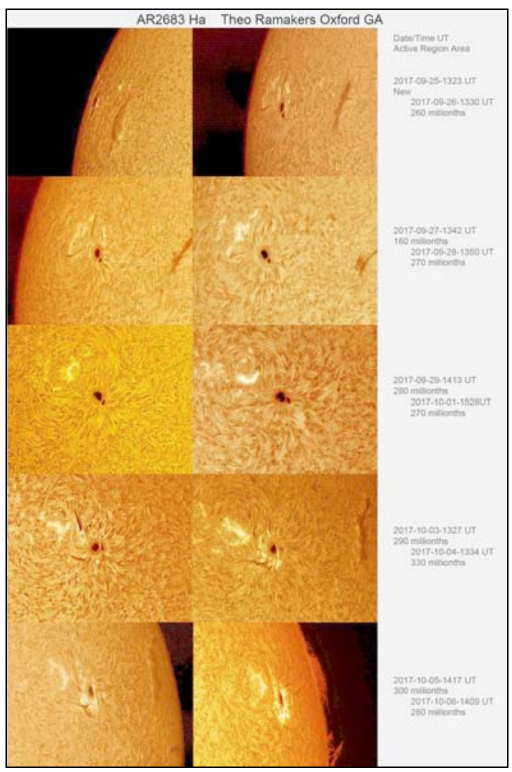


Figure 1. (above left) H-a (A) and w-l (B) images of AR 2683 on 9/25 at 11:25 UT (A) and 11:45 UT (B).
Figure 2. (above center) A w-l image of AR2683 by Tyler on 9/26 at 10:01 UT.
Figure 3. (Above right) CaK view of all 3 active regions AR2683 above on the limb, AR2682 below it and AR2681 on the right on 9/26 at 13:36 UT.



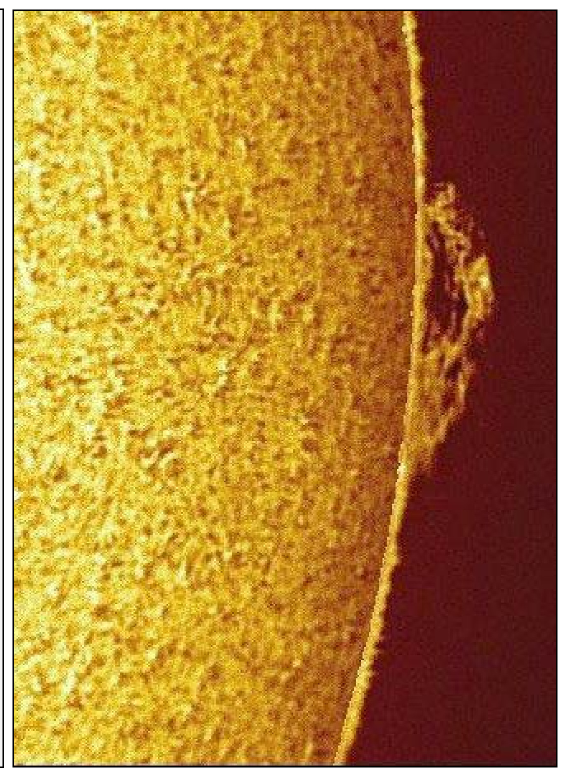
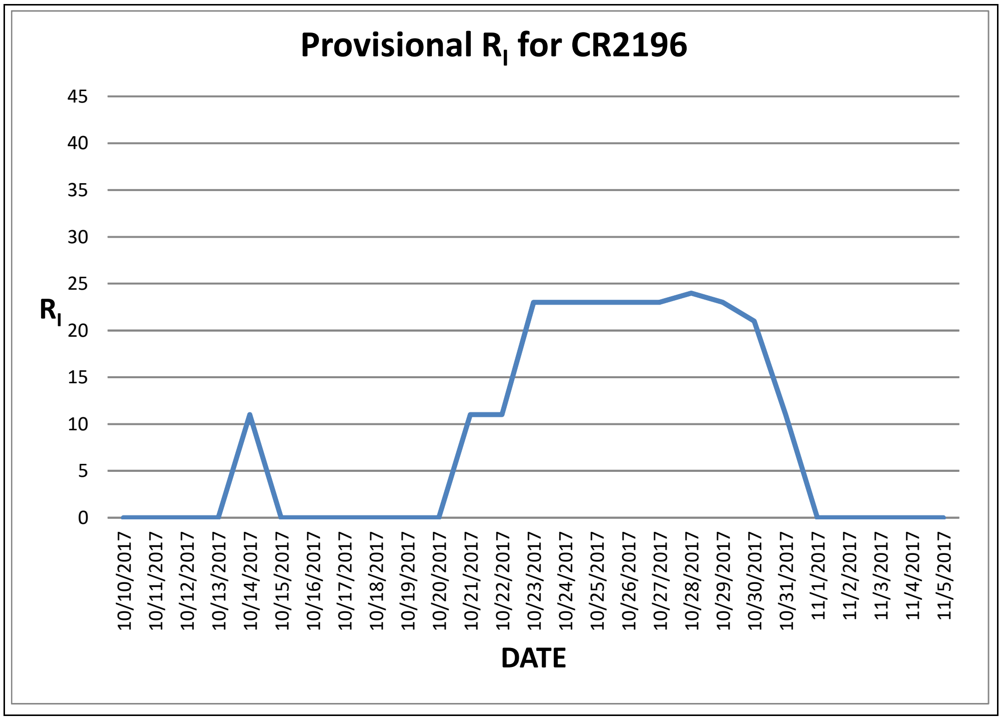



Figure 4. (above left) Ramakers w-l evolutionary history of AR2683.
Figure 5. (above center) Ramakers H-a evolutionary history of AR2683.
Figure 6. (above right) Limb prominence in H-a associated with AR2683 by Grassmann on 10/8 at 12:07 UT.



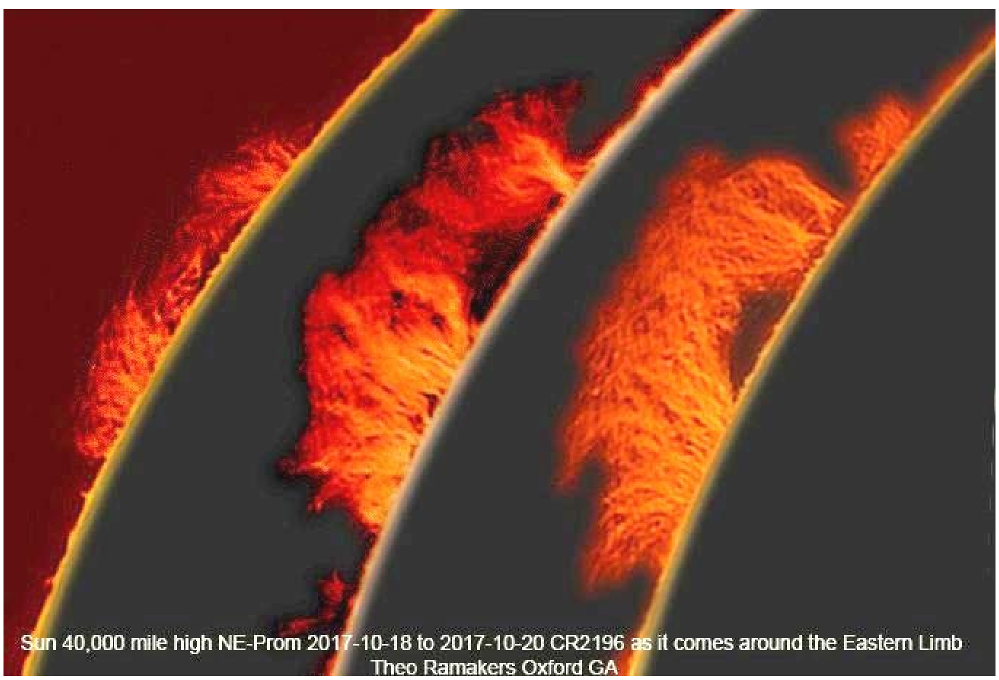




Figure 7. Three-day evolutionary history of a large prominence on the NE limb in H-a by Ramakers on 10/18-20.

## Carrington Rotation 2196

***Dates: 2017 10 10.01 to 2017 11 06.30***

*Avg. $R_I$= 8.41*
*High $R_I$ = 24 (10/28)*
*Low $R_I$ = 0 (15 days)*

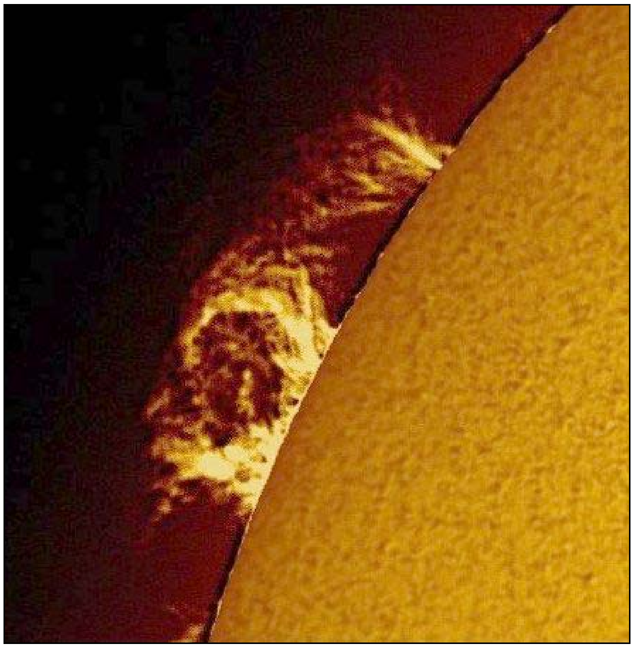
Of the three regions in this rotation, none attained an area as great as 100 millionths or classes other than A or H class. So most observers concentrated on observing prominences on the limb. This was fortunate, since on 10/18-20 we were treated to a very large prominence on the NE limb. Ramakers got a good time sequence of it spanning all three days (**Figure 7**). Maximum development was on 10/19 and we have some great images by Grassmann (**Figure 8**), Teske (**Figure 9**) and Levinthal (**Figure 10**). This prominence was so bright and large that the author was able to obtain an image using a handheld camera and an H-a PST (**Figure 11**)!

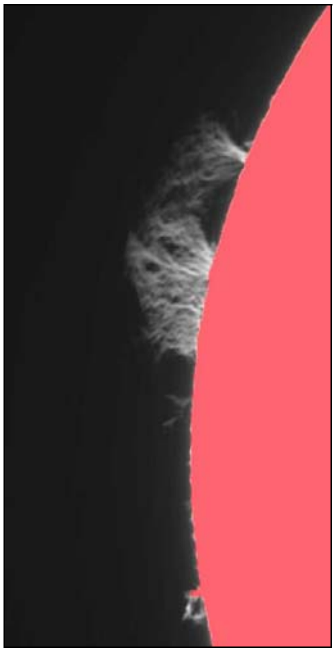
## Carrington Rotation 2197

***Dates: 2017 11 06.30 to 2017 12 03.61***

*Avg. $R_I$ = 6.33*
*High $R_I$ = 25 (11/17)*
*Low $R_I$ = 0 (17 days)*

Activity dropped further in this rotation to an average RI of only 6.33. Again, there were only three regions in this rotation and only one was worth mentioning, AR 2687, first observed by Grassmann on 11/14 as three centers of activity in H-a (**Figure 12**). It was listed as Cao of 50 millionths (beta). On 11/16, he showed the large plage area that comprised this region in CaK (**Figure 13**). This day was maximum development, as it was listed as Cao of 90 millionths (beta), but produced only a half-dozen flares in a 48-hour period. By meridian passage on 11/20, it was no more than a plage. However, on 11/20, a filament was observed on the disk that was very impressive. It formed a large open oval that was about the distance from Earth to Moon in long dimension. It is well seen in a Borman whole disk H-a image as it crossed the meridian (**Figure 14**). As these large filaments usually do, it changed little as it crossed the Sun and afforded observers days of something to record. Ramakers imaged it as it approached the limb on 11/28, which shows how little change took





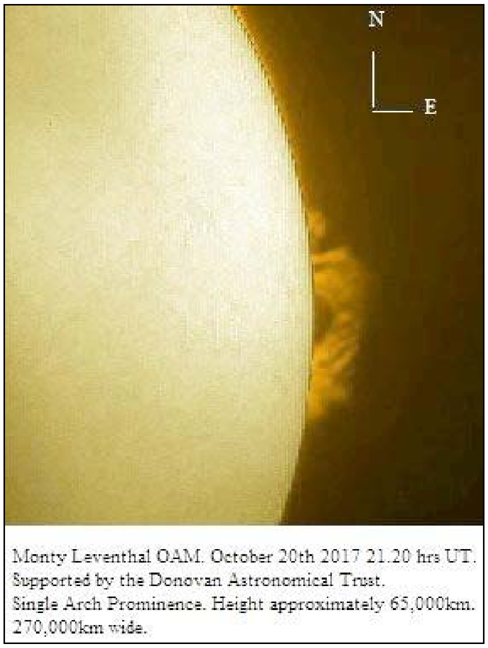
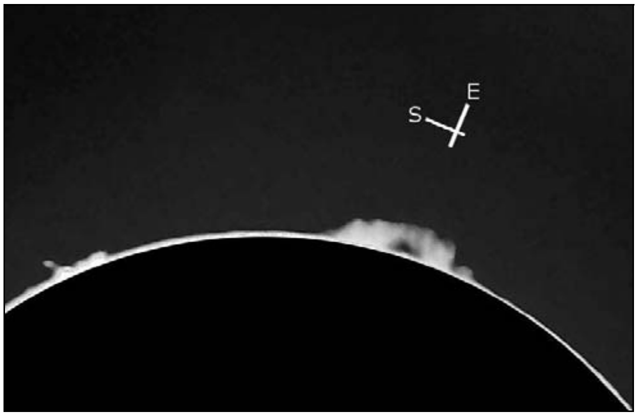



Figure 8. (above left) The large prominence on the NE limb as seen in H-a by Grassmann on 10/19 at 11:08 UT.
Figure 9. (above center) The same prominence on the NE limb as seen in H-a by Teske on 10/19 at 16:34 UT.
Figure 10. (above right) The NE limb prominence in H-a on 10/20 imaged by Leventhal at 21:20 UT.



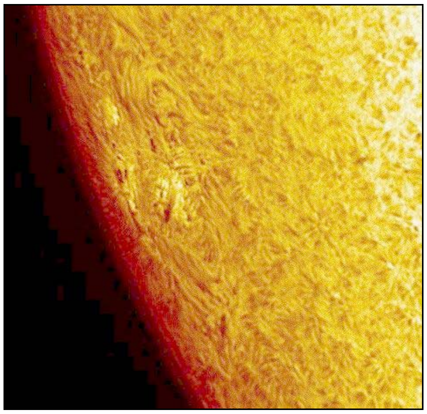
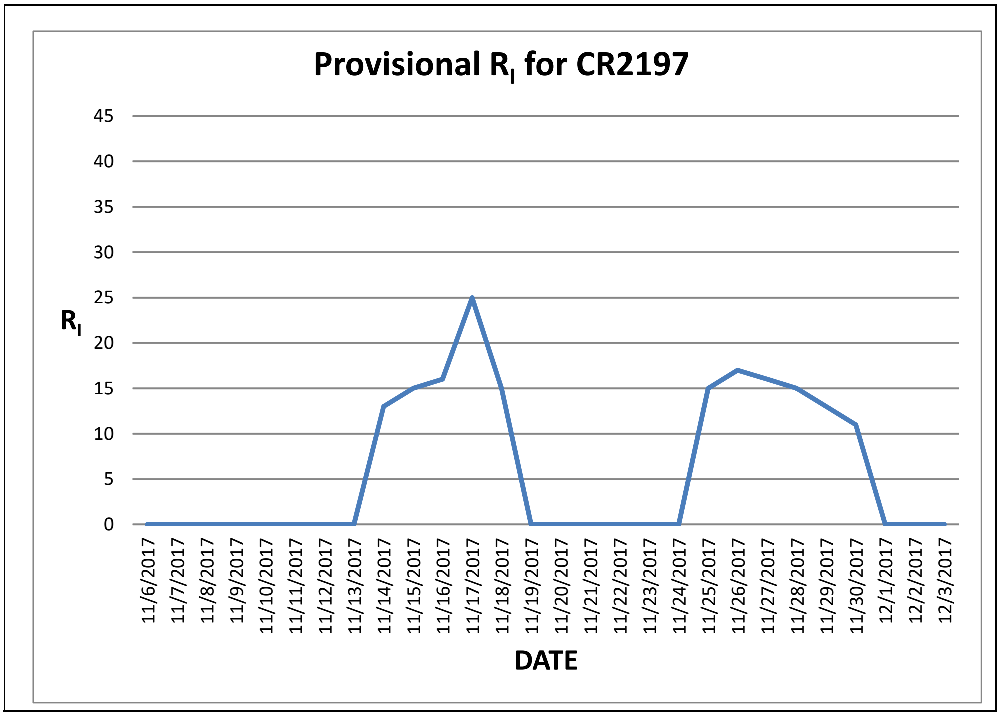



Figure 11. (above left) Image by Hill through an H-a PST of the NE limb prominence on 10/21 at 00:05 UT.
Figure 12. (above center) AR2687 on the limb in H-a by Grassmann on 11/14 at 12:03 UT.
Figure 13. (above right) CaK image of AR2687 by Grassmann on 11/15 at 12:00 UT.



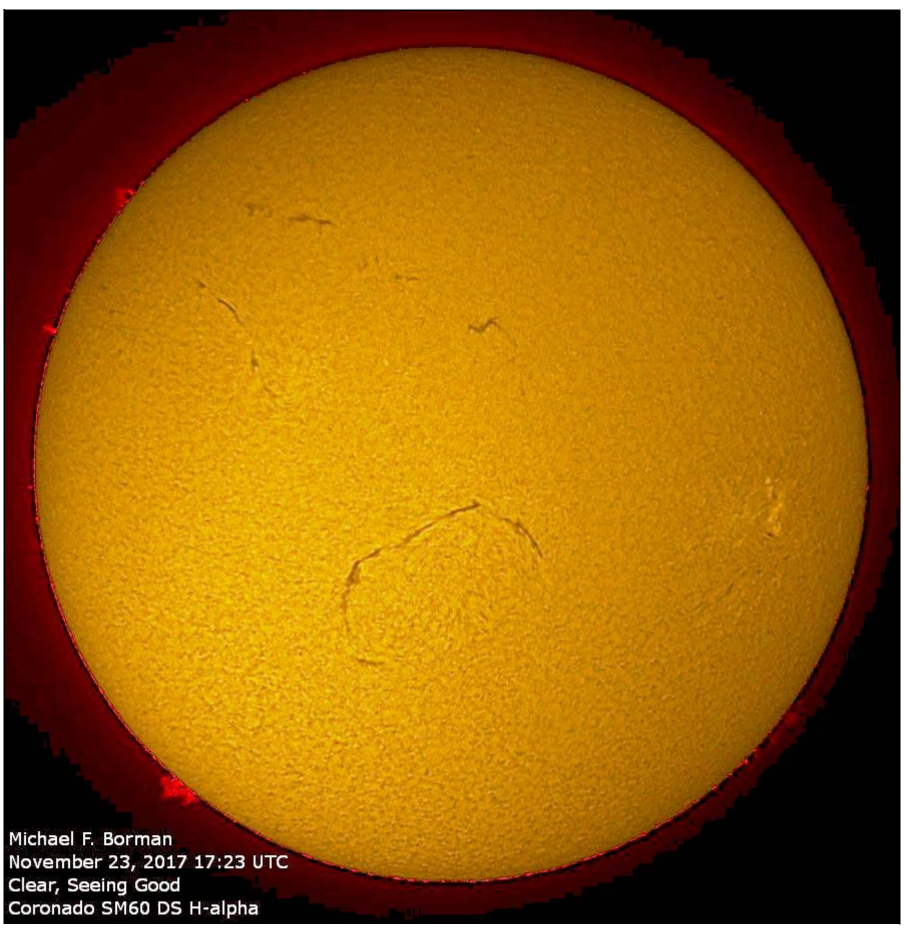




Figure 14. A Borman whole disk H-a image of the sun on 11/23 at 17:23 UT showing the large filament on the meridian. .

place (**Figure 15**). Grassmann shows it a day later as prominences on the limb (**Figure 16**).

## Carrington Rotation 2198

***Dates: 2017 12 03.61 to 2017 12 30.93***

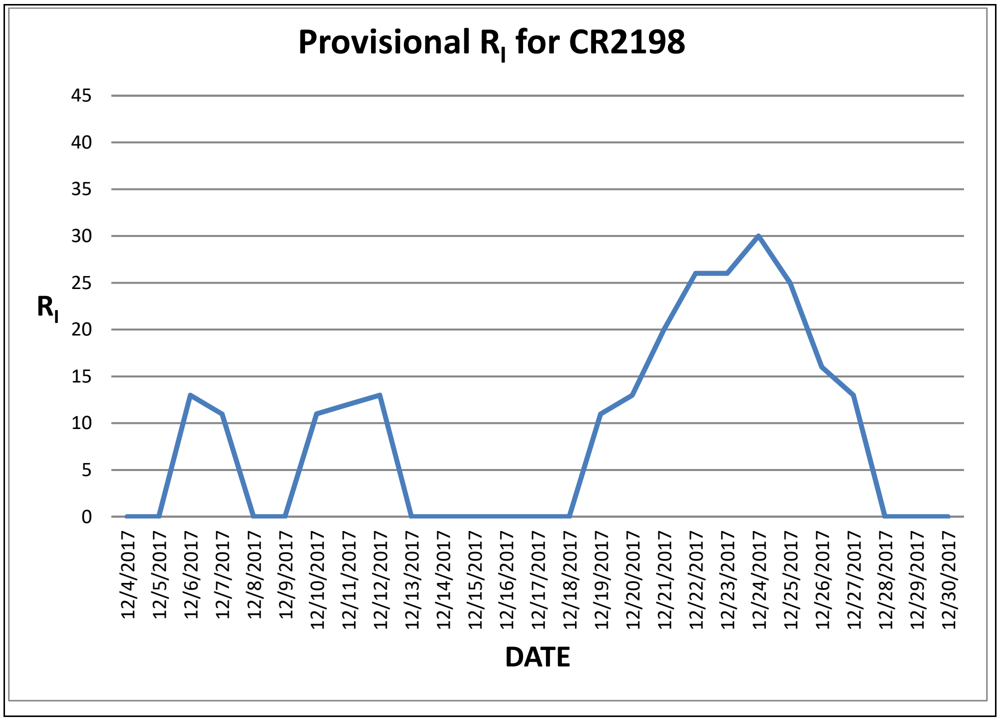
*Avg. $R_I$ = 8.89*
*High $R_I$ = 30 (12/24)*
*Low $R_I$ = 0 (13 days)*

Activity rose slightly this rotation to levels comparable to CR 2196. Only one of the three regions during this rotation developed beyond B-class and 20 millionths. This was AR 2692, which was first observed by as a Cao group of 70 millionths the first day as observed by Teske in w-l. Meridian passage was three days later when it had evolved to Dao, 90 millionths (beta), producing around a dozen small flares in a 48-hour period. Levinthal was the only one who observed it on this day, noting it as Dki. On 12/25, Bosman got the best image of it for its entire passage in CaK (**Figure 17**). It died on the solar disk before reaching the limb on 12/29 and was only a plage as it left on 12/30.

## Conclusion

Lastly, our new observer, Laura Schreiber, sent in her observations for the previous reporting period after the report was written. Two of these observations are of such excellent quality that I want to nevertheless present them here for the reader's enjoyment and edification. They are both of AR 2665 and of sub-arc-second quality (**Figure 18** and **Figure 19**). Great work Laura, and we look forward to seeing more of your images in the future!

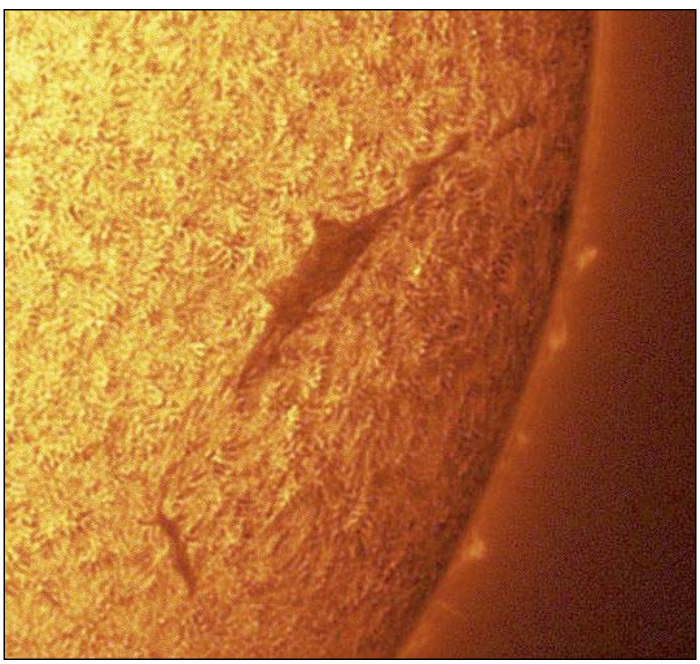
In closing, it bears repeating that we are heading into solar minimum predicted for 2020 but we are




already at very low levels. Many predictions are for a minimum stronger and longer and a next maximum weaker than any we have seen in over a century. It is up to solar observers to validate this with their observations and I would encourage one and all to note what activity there is. There are even predictions that we are heading into another Maunder-type minimum which would be very interesting but about as exciting as watching grass grow!

## Acknowledgements

The author would like to extend a special thanks to Assistant Coordinator Theo Ramakers, who provided the data for this report on DVD when it was unavailable through normal means. Without that help, this report would not have been possible.



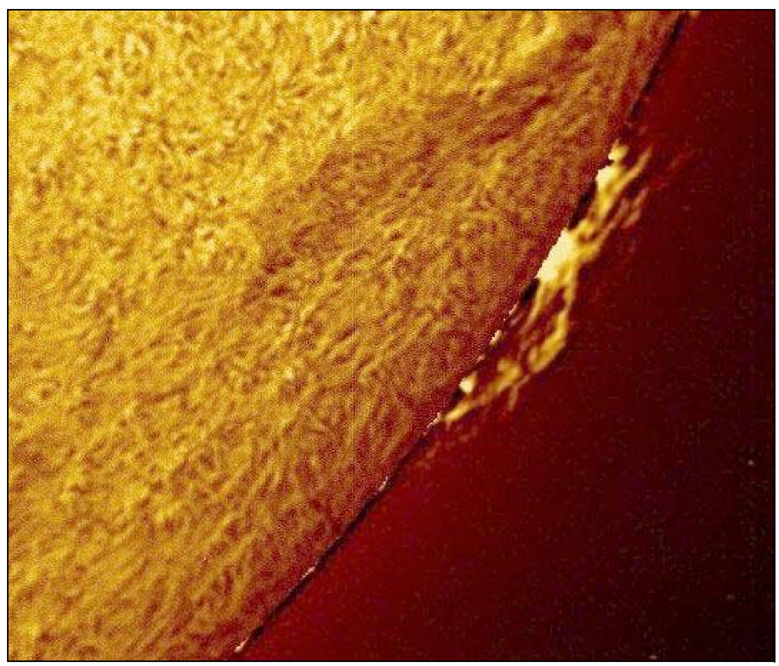


Figure 15. (above left) Ramakers H-a image showing the filament approaching the limb on 11/28 at 14:55 UT.
Figure 16. (above center) H-a image of parts of the filament on the limb in projection showing prominences. H-a image by Grassmann on 11/29 at 10:55 UT.

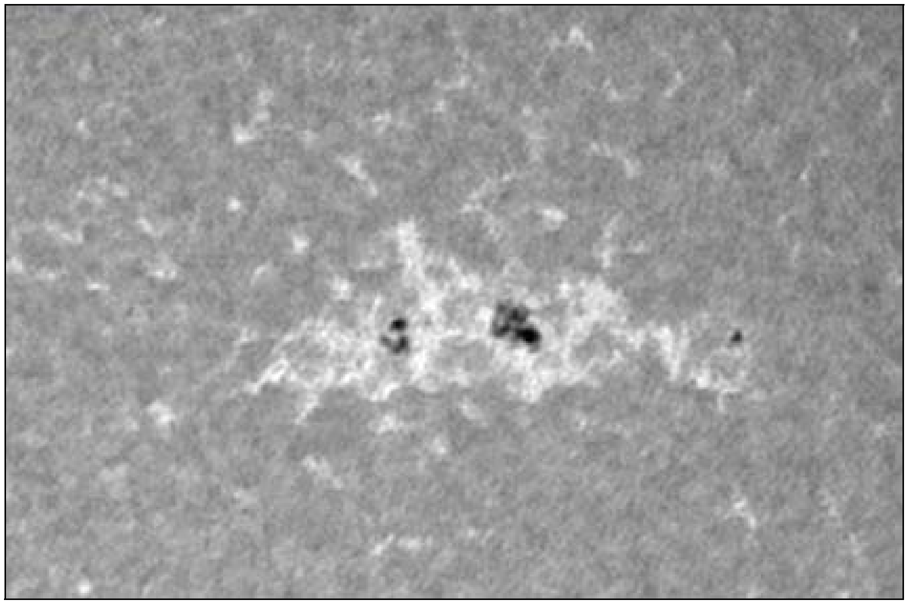
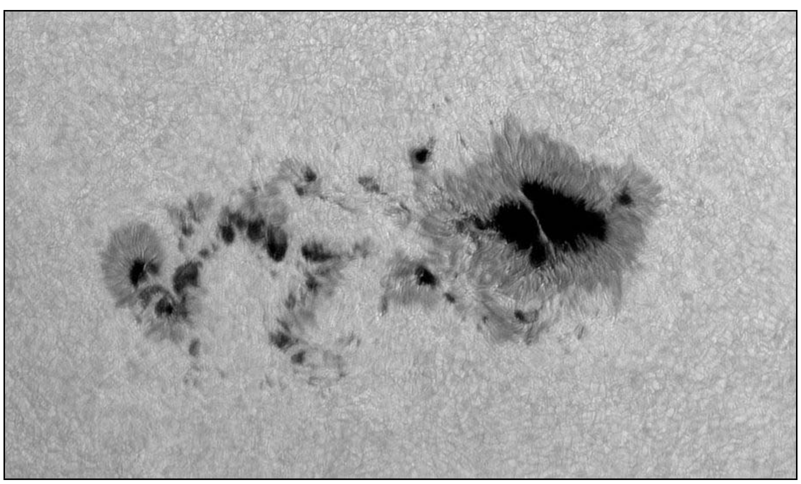


Figure 17. Bosman CaK image of 2692 on 12/25 at 00:00 UT.



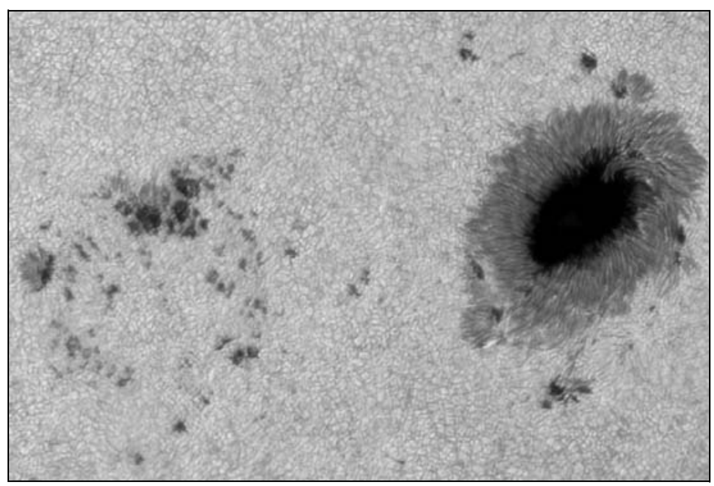


Figure 18. (above left) Sub-arc-second image of AR2665 by Schreiber on 7/09 at 08:27 UT.
Figure 19. (above right) Another sub-arc-second image of AR2665 by Schreiber on 7/13 at 06:23 UT.

# A.L.P.O. 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)

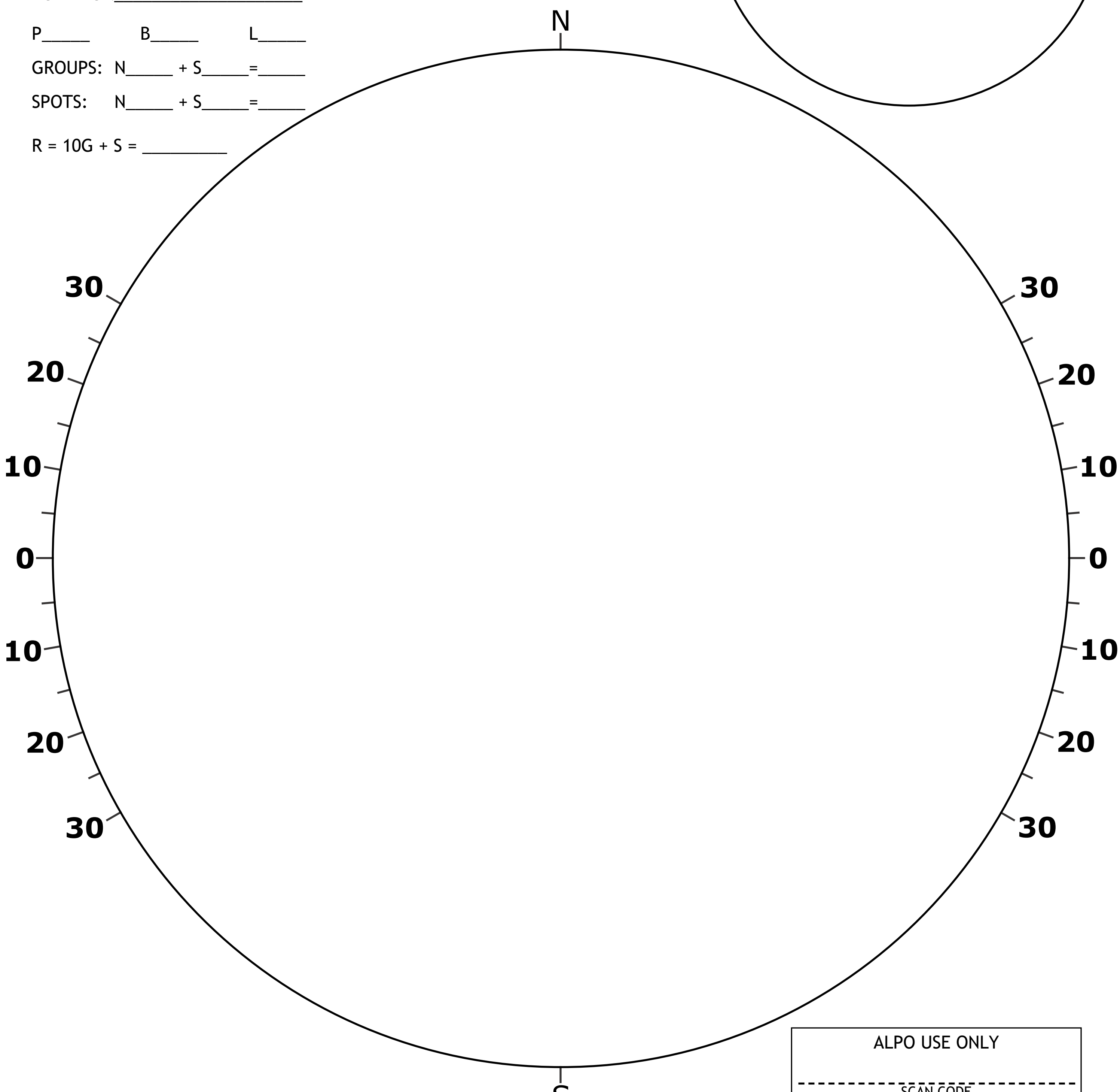
ROTATION_____________

P_____ B_____ L_____

GROUPS: N_____ + S_____=_____

SPOTS: N_____ + S_____=_____

R = 10G + S = _________




ALPO USE ONLY

SCAN CODE

A.L.P.O.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_______________________

### Feature Story: Venus

# Venus Volcano Observing List for Spring 2018

**By Mike Mattei, ALPO, BAA, AAVSO**
micmatt@hughes.net

The purpose of this watch is to see if the following three volcanoes are erupting and may cause a bulge or disturbance in the top of the cloud deck on Venus:

- Ozza Mons is at 4.5N, 201E,
- Maat Mons is at 194.6E, 0.5N
- Sapas Mons is at 8.5N, 188.3E.

With the volcanoes leaving the sunlit side of Venus and the planet about 12 degrees from the Sun (25 February) on the eastern side and heading for Greatest Elongation on 17 August and Inferior Conjunction on 27 October, observations can begin now, but pay careful attention to not get the Sun in your scope.

Times for observing the volcano area when presented on the side of the planet facing Earth are given in this list. Time is stated in Universal Time (UT, 00:00) unless listed otherwise stated and must be corrected for your location on Earth.

These values are produced using the *Guide 9.1 Project Pluto* planetarium program, with Venus surface features

**Table of Possible Atmospheric Disturbances on Venus Caused by Surface Volcanoes**

| Date | Ozza Mons | Maat Mons | Sapas Mons |
|---|---|---|---|
| **March 2018** | | | |
| 01 Mar 2018 | 05° from CM | 10° from CM | 12° from CM |
| 02 Mar 2018 | Beyond terminator E limb | Beyond terminator E limb | Beyond terminator E limb |
| 04 Mar @ 12h | 20° from bright limb | 15° from bright limb | 08° from bright limb |
| 05 Mar 2018 | 25° beyond CM | 20° beyond CM | 13° beyond CM |
| 06 Mar 2018 | On terminator | 08° from terminator | 10° from terminator |
| 08 Mar @ 12h | On the bright limb | On the bright limb | Beyond bright limb |
| 09 Mar @ 12h | 14° beyond CM | 10° beyond CM | On CM |
| 10 Mar 2018 | 11° before terminator | 16° from terminator | 21° from terminator |
| 12 Mar @ 16h | 10° from bright limb | On bright limb | Beyond bright limb |
| 13 Mar @ 16h | 16° beyond CM | 10° beyond CM | 06° beyond CM |
| 14 Mar @ 04h | 05° from terminator | 10° from terminator | 12° from terminator |
| 17 Mar 2018 | 30° from bright limb | 25° from bright limb | 18° from bright limb |
| 18 Mar 2018 | 35° from terminator | 40° from terminator | 46° from terminator |
| 18 Mar @ 12h | Beyond terminator | On terminator | 04° from terminator |
| 21 Mar 2018 | 20° from bright limb | 12° from bright limb | 05° from bright limb |
| 22 Mar 2018 | 20° beyond CM | 14° beyond CM | 11° beyond CM |
| 22 Mar @ 12h | On terminator | 06° before terminator | 11° before terminator |
| 25 Mar @ 04h | 20° from bright limb | 12° from bright limb | 08° from bright limb |
| 26 Mar @ 04h | 23° beyond CM | 15° beyond CM | 10° beyond CM |
| 26 Mar @ 16h | On terminator | 05° before terminator | 10° before terminator |
| 29 Mar @ 04h | 10° from bright limb | On bright limb | Beyond bright limb |
| 30 Mar @ 04h | 11° beyond CM | 06° beyond CM | On CM |
| 30 Mar @ 16h | 10° before terminator | 15° before terminator | 20° before terminator |
| | | | |
| **April 2018** | | | |
| 02 Apr @ 08h | 10° from bright limb | On bright limb | Beyond bright limb |
| 03 Apr @ 08h | 12° beyond CM | 08° beyond CM | 02° beyond CM |
| 03 Apr @ 20h | 05° before terminator | 12° before terminator | 13° before terminator |
| 06 Apr @ 12h | 10° from bright limb | On bright limb | Beyond bright limb |
| 08 Apr 2018 | On the terminator | 05° from terminator | 12° from terminator |
| 10 Apr @ 16h | On bright limb | On bright limb | Beyond bright limb |
| 11 Apr @ 16h | 18° beyond CM | 10° beyond CM | 08° beyond CM |
| 12 Apr @ 04h | Beyond terminator | 02° from terminator | 08° from terminator |
| 14 Apr @ 20h | On bright limb | On bright limb | Beyond bright limb |
| 15 Apr @ 20h | 20° beyond CM | 15° beyond CM | 08° beyond CM |
| 16 Apr @ 08h | 05° beyond terminator | On terminator | 04° before terminator |
| 19 Apr 2018 | 20° from bright limb | 15° from bright limb | On bright limb |
| 20 Apr 2018 | 22 beyond CM | 15° from CM | 10° from CM |
| 20 Apr @12h | 10° beyond terminator | 05° beyond terminator | On terminator |
| 23 Apr @04h | 20° from bright limb | 15° from bright limb | 08° from bright limb |

corrected, meaning the rotation of Venus is correct. (Venus rotates clockwise.)

Bright limb on west, term on east limb, d = degrees.

Look for cloud bulges on the bright limb and at the terminator, there could be a bulge in the cloud tops being illuminated on the dark side of the terminator. I believe at least one of these volcanoes can have super eruptions like Krakatoa in Indonesia, or even greater, which may effect the cloud tops on Venus.

A reference to my paper can be found here: "Strange Cloud Formations on the Terminator of Venus," Winter 2009 Journal of the Lunar & Planetary Observers, Volume 51, No. 1, Winter 2009, page 21.

Times here are set such that the area of the volcanoes is facing Earth in 2018.

**Table of Possible Atmospheric Disturbances on Venus Caused by Surface Volcanoes (Continued)**

| Date | Ozza Mons | Maat Mons | Sapas Mons |
|---|---|---|---|
| 24 Apr @ 2018 | 10° from CM | 05° from CM | 04° from CM |
| 24 Apr @ 12h | On terminator | 05 before terminator | 08° before terminator |
| 27 Apr @ 12h | 40° from bright limb | 35° from bright limb | 20 from bright limb |
| 28 Apr @ 12h | 10° from terminator | 15° from terminator | 23° from terminator |
| **May 2018** | | | |
| 01 May @ 12h | 30° from bright limb | 25° from bright limb | 18° from bright limb |
| 02 May @ 12h | 20° from terminator | 25° from terminator | 30° from terminator |
| 05 May @ 12h | 10° from bright limb | 05° from bright limb | Beyond bright limb |
| 06 May @12h | 15° from CM | 10° from CM | 05° from CM |
| 07 May 2018 | Beyond terminator | Beyond terminator | On terminator |
| 09 May @ 16h | 10° from bright limb | 05° from bright limb | Beyond bright limb |
| 11 May 2018 | On terminator | 05° before terminator | 10° before terminator |
| 14 May 2018 | 30° from bright limb | 22° from bright limb | 18° from bright limb |
| 18 May 2018 | 10 bright limb | 12° from bright limb | 08° from bright limb |
| 19 May @ 04h | 08° from terminator | 12° from terminator | 20° from terminator |
| 22 May @ 04h | 20° from bright limb | 12° from bright limb | 08° from bright limb |
| 15 May 2018 | 03° from terminator | 15° from terminator | 22° from terminator |
| 23 May @ 08h | 20° from terminator | 08° from terminator | 10° from terminator |
| 26 May @ 08h | 20° from bright limb | 12° from bright limb | 08° from bright limb |
| 30 May @08h | 10° from bright limb | On Bright limb | Beyond bright limb |

## *Papers & Presentations:*

# *ALPO Observations of Mercury During the 2016 Apparitions*

**By Frank J Melillo, coordinator, ALPO Mercury Section**
**E-mail:** *frankj12@aol.com*

## Abstract

There were six apparitions of Mercury in 2016. During the year, there were only three observers, who submitted a total of 15 drawings and images. They used telescopes ranging from 127 mm to 250 mm (5 to 10 inches) in aperture. The albedo features they detected have a modest degree of correspondence with images from the MESSENGER flybys and with the 1971 albedo chart prepared by Murray, Smith and Dollfus (Murray, Smith, and Dollfus, 1972).

## Background

There were three evening and three morning apparitions during the course of the year. The 2016 observations were made by three observers including this coordinator. The ALPO Mercury Section received far fewer observations than in recent years (Melillo, 2010b, 2011a, 2011b, 2013, 2014, 2015, 2016 and2017). In total, the three observers contributed 9 drawings, 4 regular CCD images and 2 web-cam images. For the second year in a row, Michel Legrand of France sent in the most observations, which are all drawings. This coordinator took 4 CCD images of fair resolution (*see Table 1*). In today's world, the webcam imager makes the best pictures, due to the stacking of many frames so that the signal-to-noise ratio is improved. Still, making drawings is a good way to show what one actually sees through an eyepiece.

As mentioned last year, the MESSENGER spacecraft is no longer in orbit around Mercury. The mission ended in April 2015 due to a lack of fuel and funding, and aging of the spacecraft. However, it provided many thousands of images that are still under study. One of the goals of the ALPO Mercury Section is to correlate any albedo features that we detect with the images made by MESSENGER. Already the spacecraft has provided verification that the white spots we have detected are the ejecta ray systems of craters, and some of the dark albedo features that we see are indeed dark areas of the surface (Melillo, 2010a). Here is a link to the MESSENGER website to follow up on those findings: *http://messenger.jhuapl.edu/index.html#page-top* .

## 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 a the end of this paper in blue text to jump to source material or information about that source material (Internet connection must be ON).

## Special Note

East is defined as the direction toward which a planet rotates, and in the case of Mercury, east on the planet is approximately the same direction as west on the sky. With north up as it is in the images in this paper, this east-west convention is the same as it would be if you were looking at a globe of Earth. When referring to east and west on Mercury, the author is using planetary map directions, not sky directions.

In this paper, the planetographic longitude convention, with increasing longitude toward planetary west, is used exclusively. This is the convention that ALPO Mercury and Mars observers have long used, and it differs from the planetocentric longitude system, in which longitude increases to the east.

The three observers used telescopes ranging in aperture from 127 mm to 250 mm (5 to 10 inches) (*see Table 2*). We find that larger apertures are not any more useful with Mercury because the planet is very bright, while unsteadiness of Earth's atmosphere is the limiting factor in our ability to discern detail. Larger apertures do not bypass the problem of poor atmospheric seeing. High-quality eyepieces, filters and observing skills used in combination will render Mercury a lot clearer,

**Table 1: Characteristics of the Apparitions of Mercury in 2016 (all dates UT)**

| Number and Type | Beginning Conjunction* | Greatest Elongation | Final Conjunction* | Aphelion | Perihelion |
|---|---|---|---|---|---|
| 1. Morning | 14 Jan (i) | 7 Feb | 23 Mar (s) | 21 Feb | 08 Jan |
| 2. Evening | 23 Mar (s) | 18 Apr | 09 May (i) T | | 05 Apr |
| 3. Morning | 09 May (i) T | 05 Jun | 07 Jul (s) | 19 May | 02 Jul |
| 4. Evening | 07 Jul (s) | 16 Aug | 12 Sep (i) | 15 Aug | |
| 5. Morning | 12 Sep (i) | 28 Sep | 27 Oct (s) | | 28 Sep |
| 6. Evening | 27 Oct (s) | 11 Dec | 28 Dec (i) | 11 Nov | 25 Dec |

* (i) is Inferior conjunction, (s) is Superior conjunction, T is Transit of the Sun.

**Table 2. Observers of Mercury in 2014**

| Observer | Location | Instrument* | Number & Type of Observation** | Apparition(s) Observed |
|---|---|---|---|---|
| Michel Legrand | La Baule-Escoublac, France | 21.0 cm RL | 8 D, 2 W | 2, 5, 6 |
| Frank Melillo | Holtsville, NY, USA | 25.0 cm SCT | 4 CCD | 2 |
| Tim Wilson | Jefferson City, MO, USA | 12.7 cm RL | 1 D | 2 |

* RL = Newtonian reflector, SCT = Schmidt-Cassegrain.
** D = Drawing, CCD = integrating CCD camera imaging, W = Webcam image.

thereby enabling detection of surface features (Boudreau, 2009). Images taken with webcams or CCD cameras can corroborate the features that are seen visually. A red filter such as a Wratten #25 or 610 nm long pass filter is the best choice of capturing surface markings in the images. For visual observations, an orange filter such as a Wratten #21 serves well. Observers often find that to see Mercury best, it must be observed through these filters in daylight. The filters darken the background sky. Some observers have used Venus as a guide to help find Mercury (Melillo, 2004).

The submitted observations of the 2016 apparitions are all described and displayed in this article.

## Apparition 1: Morning, 14 Jan - 23 Mar

After inferior conjunction with the Sun on 14 January, Mercury entered the morning sky. For a couple weeks, it appeared close to Venus in the pre-dawn hours. No observation reports were received for this apparition, perhaps because it was winter in our Northern Hemisphere. Mercury went through Superior Conjunction on 23 March.

## Apparition 2: Evening, 23 Mar - 09 May

This was Mercury's best evening appearance of the year, and the ALPO Mercury Section received more observation reports than for any other apparition of the year. Due to the angle between the ecliptic and the evening horizon for northern observers, Mercury appeared relatively high above the horizon after sunset and became easily visible with the naked eye. The observations are presented in *Figure 1*.

Michel Legrand, the most active observer of the year, started his observations of Mercury on 10 and 11 April (CM 249 and 253, respectively). On both nights, he drew Mercury at a gibbous phase with a large dusky feature in the northern hemisphere. This may be Solitudo Aphrodites, which is the darkest feature of the planet. Solitudo Aphrodites has been demonstrated by the MESSENGER spacecraft and by previous Mercury Section contributors. Legrand's original drawings convey the subtlety of the contrast on the planet's bright surface, a subtlety that is not practical to reproduce in print. Therefore, the author enhanced the contrast of his drawings, using Adobe Photoshop, for the purpose of publication.

Tim Wilson imaged Mercury on 13 April (CM=260°) when its face appeared 58% illuminated. On 16 April (CM=279°), this author imaged the planet when it was 44% illuminated. These images

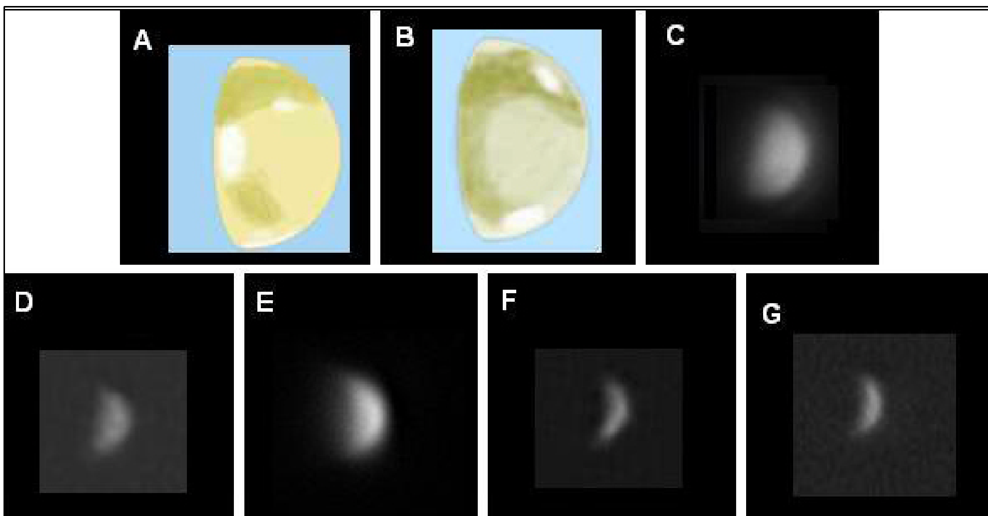



Figure 1. Five images and two drawings of Apparition 2. In this and in the other figures in this article, north is up and planetary east is to the right.
A. Drawing by Michel Legrand, 10 Apr 2016, 15:08 UT, CM 249 degrees. Contrast enhanced by Melillo.
B. Drawing by Michel Legrand, 11 Apr 2016, 13:10 UT, CM 253 degrees. Contrast enhanced by Melillo.
C. Image by Tim Wilson, 13 Apr 2016, 00:30 UT, CM 260 degrees.
D. Image by Frank J Melillo, 16 Apr 2016, 23:31 UT, CM 279 degrees.
E. Image by Michel Legrand, 18 Apr 2016, 19:24 UT, CM 289 degrees.
F. Image by Frank J Melillo, 23 Apr 2016, 23:48 UT, CM 317 degrees.
G. Image by Frank J Melillo, 24 Apr 2016, 23:50 UT, CM 323 degrees.

demonstrate the rapidly changing phase of Mercury. Greatest Eastern Elongation from the Sun, amounting to 20°, was reached on 18 April. On that date, with CM=289°, Legrand took a webcam snapshot and it, too, demonstrated the crescentic phase. The author again imaged Mercury on both 23 and 24 April (CM=317° and 323°, respectively) and these images showed Mercury as a narrower crescent. Unfortunately, albedo features in each of these images are so subtle as to be uncertain.

Mercury ended the evening apparition with inferior conjunction on 9 May.

## Apparition 3: Morning, 09 May - 07 Jul

Before Mercury entered the morning sky, it went through a special Inferior Conjunction in which observers in the U.S. were treated by Mercury's transiting the face of the Sun on 09 May. This was the first time since 1960 that an entire transit of Mercury was visible from the U.S. mainland. This author first witnessed a Mercury transit on November 10, 1973, and then waited 42½ years to see his second such event on May 9. If you missed this transit, you don't have to wait 42½ years for the next one -- only 3½ years after this last one, it will be on November 11, 2019.

This morning apparition was unfavorable for Northern Hemisphere observers, and no observations were received.

## Apparition 4: Evening, 07 Jul - 12 Sept

After the 07 July Superior Conjunction, Mercury moved into the evening sky. On 19 August, Mercury appeared 3½° below Jupiter with Venus 7° to its right, low in the western twilight. Mercury was the faintest of the three (magnitudes 0.4, -1.7, and -3.9, respectively) and binoculars made the conjunction appear even more impressive. Although this apparition had good elongation from the Sun, the angle of the ecliptic with the horizon at this time of year made the evening viewing poor for northern observers. No observations were received.

## Apparition 5: Morning, 12 Sept - 27 Oct

Mercury was favorably placed for Northern Hemisphere viewers in this, the best morning apparition of the year. Michel Legrand contributed all three observations of this apparition, on 03 October (CM=112°), 05 October (CM=122°) and 06 October (CM=127°). The observations are presented in *Figure 2*.

On these dates, having passed Greatest Elongation, Mercury appeared gibbous. Albedo features are clearly depicted in the drawings of 03 Oct and 05 Oct, but their correspondence to features on existing maps is not clear. These drawings may contribute to future maps of surface features.

In the 06 October drawing, the dark markings in the south may be Solitudos Jovis and Martis, which are prominent on this side of the globe. Also, Solitudo Horarum can be seen as a dark region in the northern hemisphere. It is interesting that the North Polar Region appeared bright in the 03 October drawing, but dark in the depictions of 05 and 06 October.

On 11 October, Mercury had a close conjunction with Jupiter, a mere ¾° apart. This time, Jupiter was at its dimmest at -1.7 magnitude while Mercury was shining brighter than average at -1.1 magnitude. It is unusual for Mercury to be nearly as bright as Jupiter during a close conjunction.

Mercury moved quickly to Inferior Conjunction with the Sun on 27 October.

## Apparition 6: Evening, 27 Oct - 28 Dec

This evening appearance was quite poor at the start, but Mercury became easily visible near the end of its apparition. Again, Michel Legrand was the sole observer, and he made two observations. Both observations are presented in *Figure 3*.

His first Mercury drawing was at a gibbous phase on 11 November (CM=289°). Mercury was seen to have a bright cap in the north polar region. In his second drawing, on 13 December (CM=081°), the planet appeared to have an illuminated fraction greater than 50 percent, even though the Greatest Elongation had occurred three days earlier.

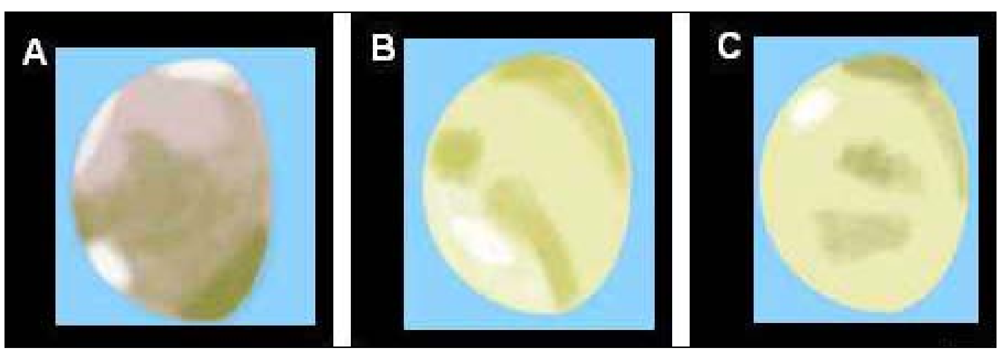



Figure 2. Three drawings of Apparition 5. The contrast of each one has been enhanced by Melillo.
A. Drawing by Michel Legrand, 03 Oct 2016, 08:40 UT, CM 112 degrees.
B. Drawing by Michel Legrand, 05 Oct 2016, 10:00 UT, CM 122 degrees.
C. Drawing by Michel Legrand, 06 Oct 2016, 09:50 UT, CM 127 degrees.

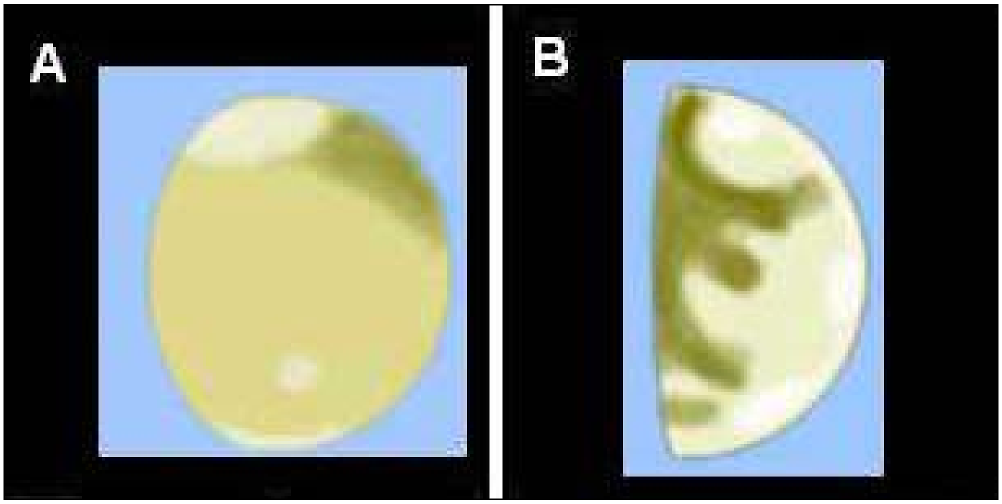



Figure 3. Two drawings of Apparition 6. The contrast of each one has been enhanced by Melillo.
A. Drawing by Michel Legrand, 11 Nov 2016, 14:30 UT, CM 289 degrees.
B. Drawing by Michel Legrand, 13 Dec 2016, 14:30 UT, CM 081 degrees.

(Mercury's time of dichotomy is often far removed from the time of Greatest Elongation, due to the ellipticity of its orbit.) In the Southern Hemisphere near the terminator, the dark feature may be Solitudo Martis, but this is uncertain. Other features in the drawing are not clearly correlated with features on existing albedo maps. Like other drawings and images, these two drawings may contribute to a future map of the albedo features of the planet.

Mercury underwent Inferior Conjunction with the Sun on 28 December.

## Conclusion

Despite the knowledge we have gained about its surface from the MESSENGER spacecraft, Mercury still proves to be one of the most difficult planets to study from Terra Firma. The conditions in which we observe it -- either low in a twilight sky or high in a daytime sky -- are not conducive to good seeing, so that the albedo features are not well-known despite hundreds of years of study. There is much to be learned. Images can confirm visual impressions, and the MESSENGER images can confirm our ground based images.

The best way to gather information about Mercury is simply to observe it as often as you can. The surface features will be different each time you look, as Mercury's appearance changes quickly from day-to-day and from apparition-to-apparition. Sometimes it is difficult even to find this elusive planet. The ALPO Mercury Section appreciates every Mercury observer for accepting the unique challenges that the study of this planet presents.

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ALPO MERCURY SECTION

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ADDRESS___________________________

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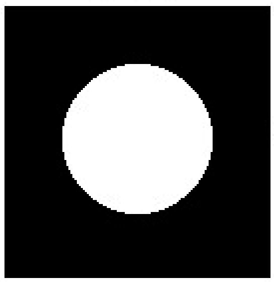
For Coordinator Only:

Sketch

NORTH



WEST

Central Meridian Longitude______°

DATE__________________
TIME (UT)______________
Telescope__________________________
Magnification_______________________
Filter(s)____________________________
Seeing (10-best/1-worst)______________
Visual Description:

Photo or CCD

DATE:_____________
TIME (UT):_________

Image 1

Central Meridian Longitude______°

Telescope:_____________________
Camera Type:___________________
Exposure:______________________
f/ratio:________________________
Filter:_________________________

Comments:

Date:_________________
TIME (UT):____________

Image 2

Central Meridian Longitude______°

Telescope_____________________
Camera Type___________________
Exposure______________________
f/ratio_______________________
Filter________________________

Comments:

Send all observations to: Frank J Melillo
ALPO Mercury Coordinator
14 Glen-Hollow Dr., E-#16
Holtsville, NY 11742

E-mail for questions, special observations and alerts: frankj12@aol.com

*Feature Story*

# *A Lunar Dome Near Encke Crater*

**By Raffaello Lena,**
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**ALPO Lunar Domes Program,**
*raffaello.lena@alpo-astronomy.org*
**Jim Phillips, Acting Assistant Coordinator, ALPO Lunar Domes Program,**
*thefamily90@gmail.com*

## Online Readers

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## Introduction

In this first report we examine a dome, termed Encke 1 (En1), recently identified using CCD terrestrial image, LROC WAC imagery and LROC WAC-based GLD100 dataset. The dome lies to the south of the crater Encke at coordinates 3.55° N and 36.73° W and has a base diameter of 33 x 30 km. 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 profile of the examined dome was extracted from the GLD100 database using the Quickmap LRO global basemap (*http://target.lroc.asu.edu/da/qmap.html*).

## Body

The dome was imaged by Mike Wirths under oblique solar illumination angle on February 26, 2018 at 00:40 UT using an 18" Starstructure dobsonian-driven (quartz Zambuto primary) f/4.5, ASI174mm camera, red filter and a 4x Powermate barlow (Figure 1).

The 3D reconstruction using WAC mosaic draped on top of the global WAC-derived elevation model (GLD100) is shown in Figure 2. Two non-volcanic hills are located on the top. The dome height, determined using the cross-sectional profile in E-W direction (Figure 3), amounts to 180 m, while the average slope angle $\xi$ corresponds to 0.62°. Its edifice volume was estimated of 74 km$^3$, assuming a parabolic shape.

Furthermore, the flat appearance of En1 suggests that the rising magmas did not build up a dome through a series of flows, but that it was more likely formed by rising magma collecting in a reservoir, forming a subsurface intrusion.The dome En1 is associated with two graben traversing its northeastern summit and the central summit, respectively (Figure 4).

We suggest that during the formation of the large dome, and as is the case of the well-known Valentine Dome, fracturing and faulting of the crust occurred, weakening the strength of the crust and thus facilitating the uplift of large volumes of crustal material visible as a large intrusive dome; hence the uplift resulted from the rise of magma that did not erupt onto the surface, producing a vertical rupture of the surface.

The resulting tensional stress resulted in the formation of the graben, and the dome was likely formed in a way similar to a terrestrial laccolith. Hence the magma accumulating beneath the surface produced not only an uplift of the surface rock layers but also induced failure in the overlying rock strata (fracturing). We have used the basic classification and mapping introduced in previous studies by GLR group, including the distinction between effusive domes and putative intrusive domes, based on physical modeling. These models have been routinely used for estimating the rheologic properties and dike geometries in previous studies by some of us and

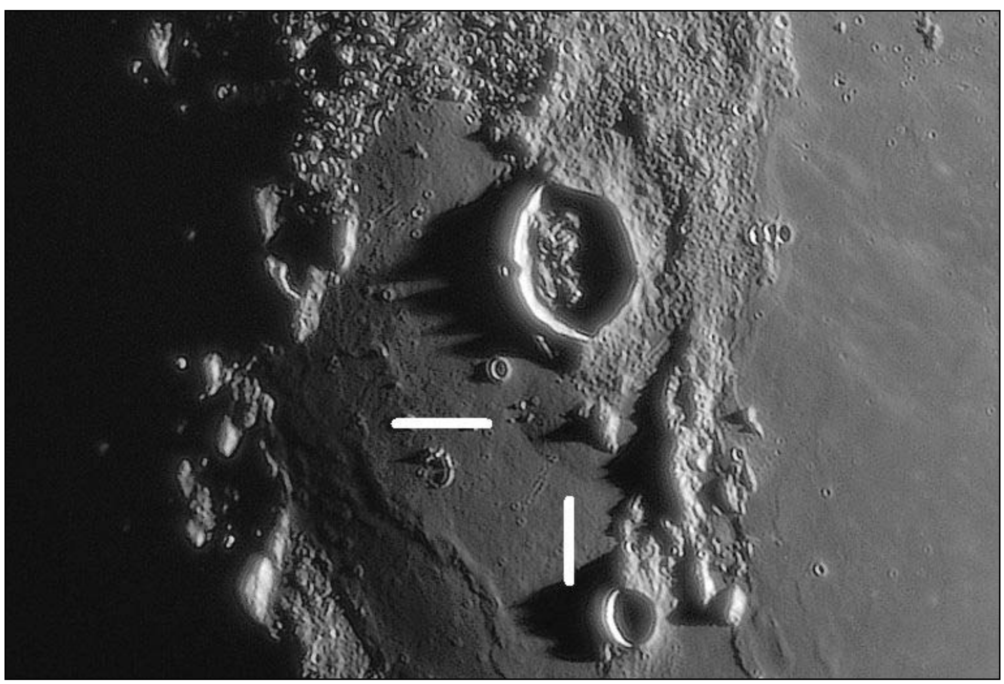

Figure 1. Image by Mike Wirths showing the dome, marked by white lines.

reported in the book published by Springer *Lunar Domes: Properties and Formation Processes*, where more detailed explanations can be found; a classification scheme and interpretation of origin for large domes and very low slope has been proposed, interpreting these domical objects or "swells" as the possible result of intrusive doming.

The first class (In1) comprises large domes of elongated size with diameters above 25 km, flank slopes of 0.2°-0.7° and characterized by the presence of linear rilles crossing the surface, 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°, and domes of class In3 have diameters of 13-20 km and flank slopes below 0.3°.

Due to its large diameter and edifice volume, the dome En1 matches the properties derived for putative intrusive dome belonging to group In1. The laccolith formation is characterized by three distinct stages. During the first stage, a thin sill-like unit undergoes lateral growth. The second stage consists of vertical growth caused by flexure of the overlying strata due to the pressurised magma. If the flexure-induced vertical uplift exceeds a few hundred metres, piston-like uplift of a fault-bounded block may occur during the third stage of laccolith formation.

The excellent image taken by Mike Wirths under oblique solar illumination displays En1 very well, demonstrating as that high resolution CCD imagery of the elusive lunar domes is useful for the recognition of non-cataloged domes. We have updated the catalog to include the dome En1. All ALPO members are encouraged to participate in this lunar dome project with their own observations.

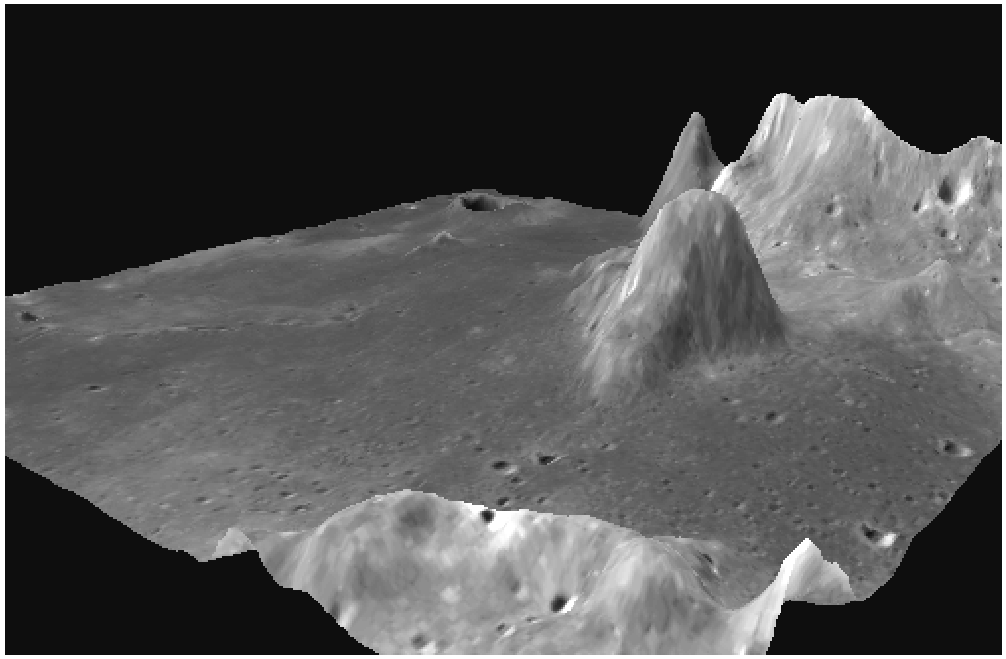

Figure 2. A 3D reconstruction of the dome En1. The elevation of the dome corresponds to 180 m. The hill rises to an elevation of 350 m.

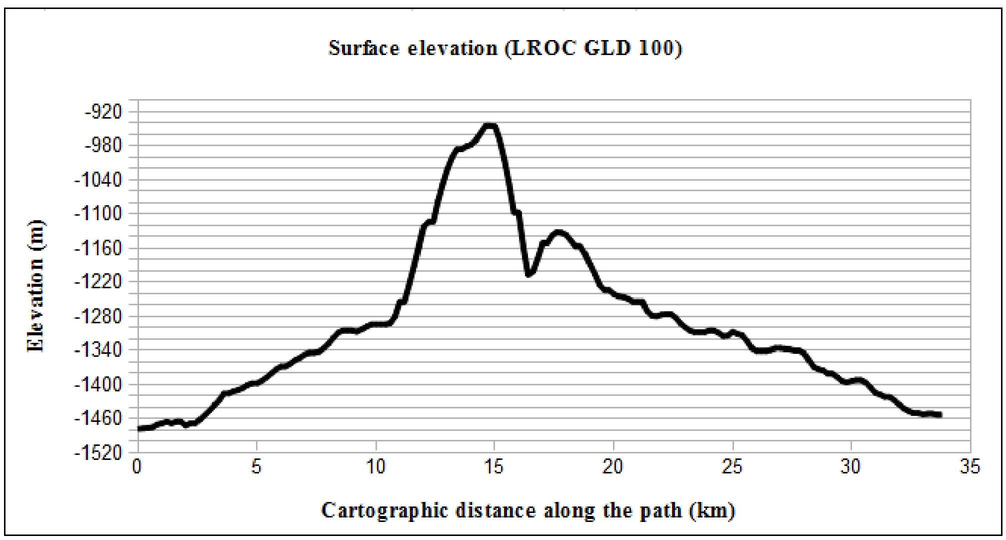


Figure 3. Cross-sectional profile in E-W direction of the dome En1.

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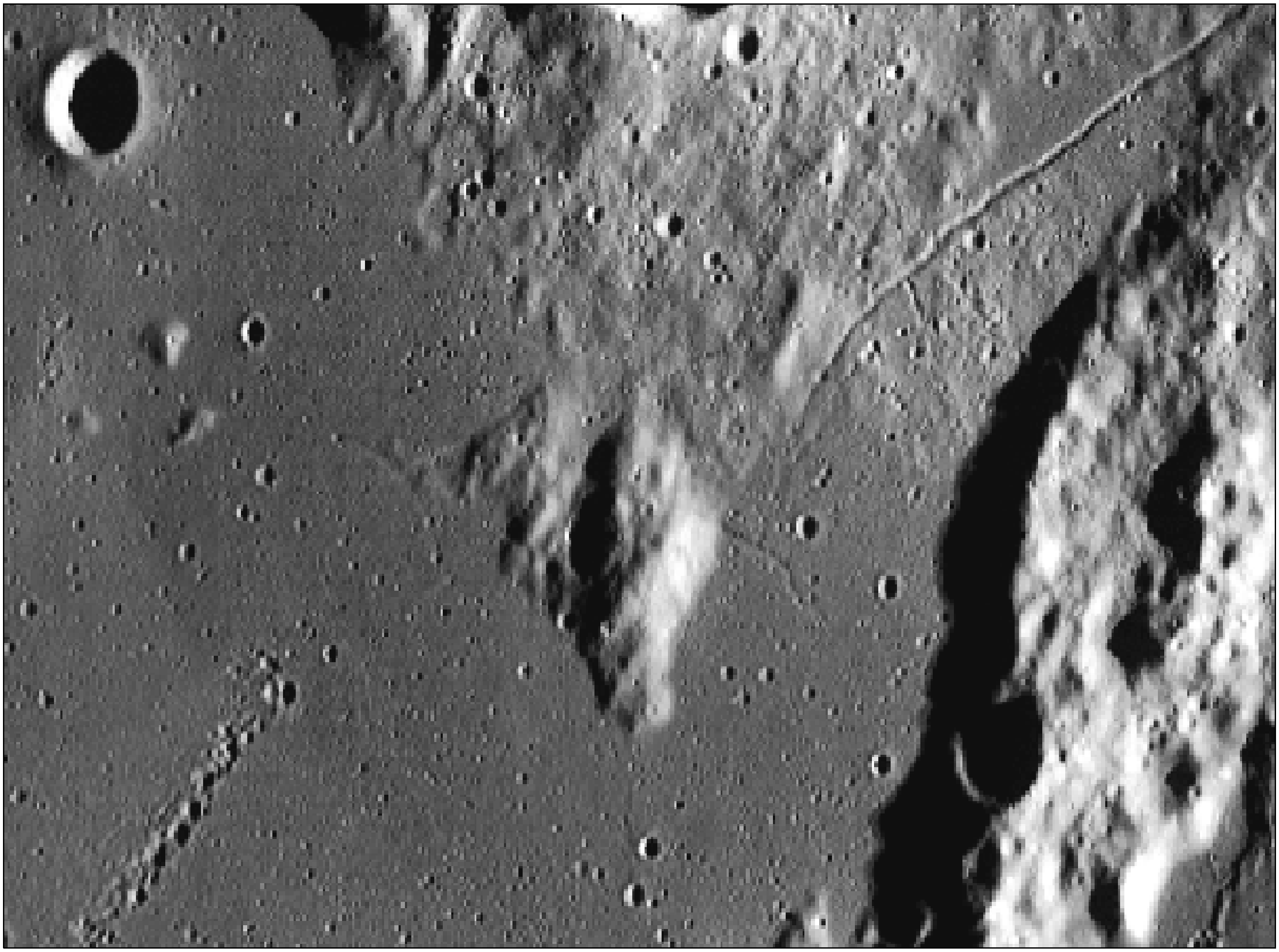

Figure 4. WAC imagery of dome En1. The graben traversing the summit are detectable.

# 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

<table>
<tr><td>Observers Name:</td><td colspan="5">Last:</td><td colspan="5">First:</td></tr>
<tr><td>Date: (UD)</td><td colspan="3">Month:</td><td colspan="4">Day:</td><td colspan="3">Year:</td></tr>
<tr><td>Time: (UT)</td><td colspan="5">(UT) Hours:</td><td colspan="5">(UT) Minutes:</td></tr>
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**Domes Observed (Positions)**

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

## Feature Story

# The North Polar Region of Mars in 2016

**By Richard W. Schmude, Jr., Assistant Coordinator, ALPO Mars Section (photometry and polarimetry)**
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## Abstract

This paper describes observations of Mars' North Polar Region. The remnant North Polar Cap has extended to a mean latitude near 82° N throughout most of the 20th and early 21st centuries. Deposited dust, however, may affect the perceived size of this cap. In 2016, clouds were scarce in the North Polar Region until late summer. On March 10-11, 2016 an annular cloud was imaged near 100° W, 65° N. Examples of similar clouds imaged in previous years are summarized.

## Introduction

The remnant North Polar Cap (rNPC) probably reaches its size during late spring. During 2013-14, Schmude (2014a) showed it did not shrink after the summer solstice during 2013-14. This is consistent with the remnant cap having a thickness of 1.8 km (Barlow, 2008, 76, 78) and not continuing to shrink after the temporary cap sublimes.

The rNPC has been measured for almost two centuries. Flammarion (2015, p. 98) states Beer and Mädler report rNPC latitudes of 80.8° N, 82.3° N and 81° N on April 1, April 16 and May 1, 1839. These dates correspond to approximate areocentric longitude, $L_s$, values of 97°, 104° and 111°. (The Areocentric longitude defines the seasons on Mars with 0°, 90°, 180° and 270° being the beginning of northern spring, summer, fall and winter, respectively.)

Flammarion also reports these two also stated that the summer cap diameter never went below 12° to 14°. This is consistent with modern results.

Flammarion (2015, p. 386) also states Schiaparelli reports five measurements in 1886 and 1888 consistent with a mean latitude of 85.6° N. Schiaparelli also noted the rNPC had "spiral bands coming from the North Pole" in late 1891. This is near $L_s$ = 100°. Schiaparelli's observations of spiral bands are consistent with modern spacecraft images of this feature. Nevertheless, his mean cap latitude is smaller than expected. Lowell (1905) reports his micrometer measurements. He lists a longitude for each cap latitude measurement and, hence, his data may be used to get an accurate shape of the rNPC in 1903. Antoniadi drew a map of the North Polar Region in his book "The Planet Mars". The remnant cap extends to 82° N and is centered at ~89° N, ~270° W (Antoniadi, 1930, 1975, plate 5). This is consistent with modern results.

Slipher (1962) reports this feature is centered 1° from the pole towards 290° W whereas Fischbacher et al. (1969) draws it centered at the north pole but elongated in the 0° W to 180° W direction. Dollfus (1973) carried out micrometer measurements of the cap in April 1950 and reports his results in his Figure 10. More recently, McKim (1985) reports frequent hazes near the rNPC and a mean latitude of 84.7° N in early 1982.

Two observers (L. Aerts and T. Osawa) are reported to have seen a serrated edge for the cap. This is consistent with an MGS image of that feature (Clifford et al. 2000). Parker et al. (1983) drew a 1982 map of the rNPC having a mean latitude of 83° N. They also report it extended 0.75° less than in 1980. Parker et al. (1999) report that it was larger in 1984 during $L_s$ = 80°-100° than in previous years. They attribute this to five localized aphelic dust storms. After $L_s$ = 100°, the results in Parker et al. (1999) are consistent with the rNPC returning to a normal size.

### Online Features

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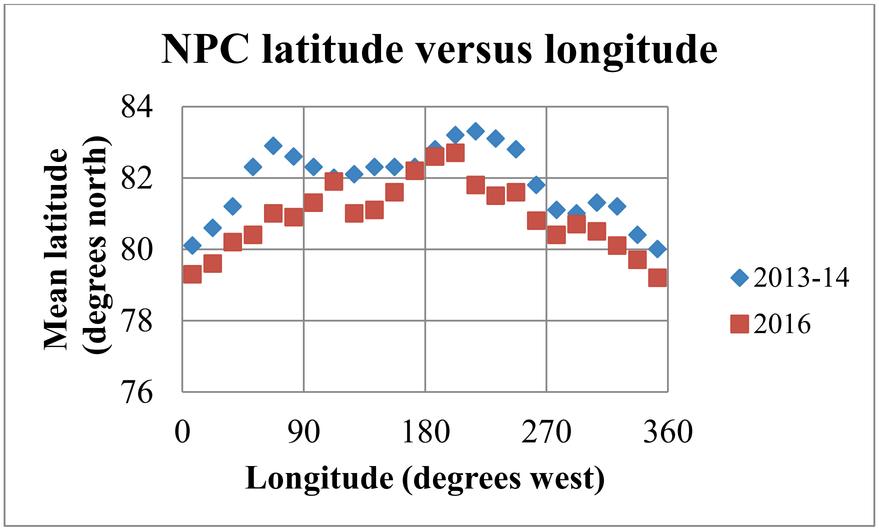
Clouds often develop in the North Polar Region during late spring and summer. For example, de Vaucouleurs (1969) reports he observed four types of cloud activity in 1937 and 1969. These include the North Polar haze cap, unusual cloud systems on the disc, persistent clouds near the sunset limb and clouds seen in projection above the sunrise terminator. He also reports temporary cloud formations increased sharply near $L_s$ ~175° during 1937 and 1969.

Beish and Parker (1990) carried out a survey of condensate and dust clouds covering the time period 1969-1984. They report the seasonal frequencies of several types of clouds. Wang and Ingersoll (2002) analyzed Mars Global Surveyor data to study clouds near the remnant cap. They also report cloud development increases during late summer. Tamppari et al. (2008) carried out a study of water ice optical depths between March 1999 and May 5, 2003. They report water ice optical depths were low during late spring and early summer but increased afterwards.

One interesting cloud which develops in the North Polar Region has a spiral or circular shape. Gierasch et al. 1979 report Viking imaged four spiral clouds in 1978. These were all imaged in the polar region during $L_s$ = 104° – 139°. They had diameters of between 150 and 500 km. Wang and Ingersoll (2002) describe

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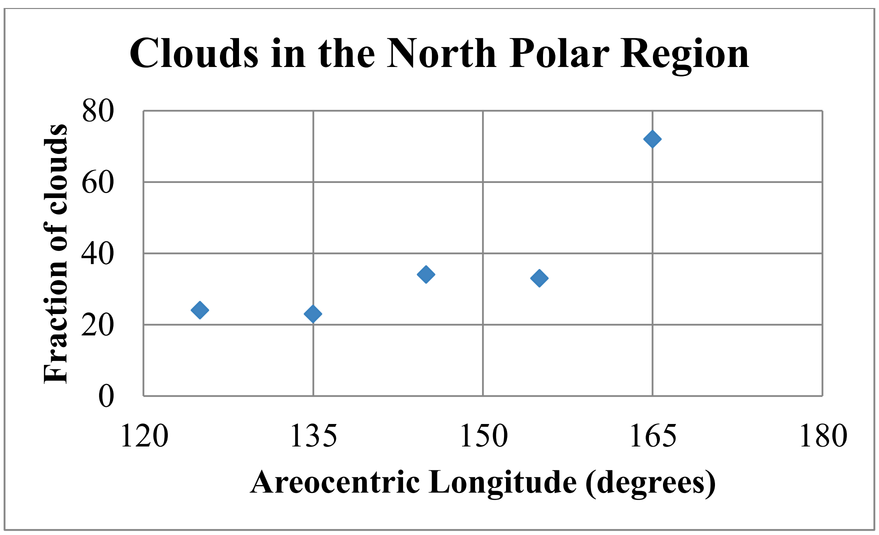


B

Figure 1A: A graph of mean latitude of the remnant North Polar Cap versus longitude for the 2013-14 and 2016 apparitions. B: A graph of the fraction of clouds/hazes observed in the North Polar Region versus the areocentric longitude of the Sun as seen from Mars. A value of 90° and 180° for the areocentric longitude of the Sun correspond to the beginning of northern summer and northern fall, respectively.

about two dozen spiral-like storms which occur during $L_s$ = 35° – 183°.

In this paper, I will focus on the large features, about 1,000 km across, which have a ring shape. I will call these "annular clouds" since this is how they are described (www.msss.com/mars_images/moc/2005/09/12/). These are reported to form in the morning and weaken or break up in the afternoon. They are not true cyclones (www.msss.com/mars_images/moc/2005/09/12/).

## Methods and Materials

Images from the ALPO-Japan Latest website (alpo-j.asahikawa-med.ac.jp/indexE.htm) were examined for clouds and were used in making polar cap measurements. Only red and near-infrared images were used in cap measurements.

Images from Malin Space Science Systems, Inc. (www.msss.com/msss_images/subject/weather_reports.html) were also examined for annular clouds and changes in the rNPC.

The software package WinJUPOS (Hahn and Mettig, 2016) was used in making measurements in the same way as in the previous apparition (Schmude, 2014a). Essentially the southern edge of this feature was measured at each longitude range. After all measurements were made, average latitudes were computed for 24 different longitude ranges starting with 0°-15° W. Finally, the mean latitude was computed from the 24 mean equally-weighted values.

## Results

### *Remnant North Polar Cap*

The rNPC was measured from December 28, 2015 to May 6, 2016. The angular size, in arc-seconds, and (sub-Earth latitude in ° N) of Mars during this time ranged from 5.4 (25.4) to 16.8 (13.5); these values are from (JPL Ephemeris Generator at https://ssd.jpl.nasa.gov/horizons.cgi). Therefore, Mars was not as well-placed for rNPC studies as in the previous apparition. The overall mean cap latitude for Ls = 82°-142° was 80.9° N. This is 1° farther south than the previous apparition (Schmude, 2014a). This discrepancy is examined later. The mean rNPC latitudes in 2013-14 and 2016 are shown in Figure 1A. In both years, it extended farthest south near 0° W. This is consistent with a Mars Global Surveyor image of this feature (Clifford et al., 2000).

I examined measured latitudes of the rNPC in previous years. Two types of analysis were carried out depending on the data. When longitude values were given for cap latitude measurements, the method employed was "all longitudes". In essence, the mean rNPC latitude was determined by computing a mean from each longitude range and, hence, the latitude value for each longitude range was given an equal weight. When longitude values were not reported for latitude measurements, the method employed was called "all points". In this case, each latitude measurement is given an equal weight in computing the mean cap size. The "all longitudes" values are more reliable. This is because the rNPC is not circular and, hence, if some longitudes are not represented the mean latitude would not be accurate. The first reliable remnant cap measurement is considered to be the one computed from Lowell's 1903 measurements. The computed mean longitudes since 1903 are summarized in Table 1. The overall mean latitude for 1903-2016 is 81.6° N based on the nine "all longitude" values. This is consistent with 82° N - the value reported from a multi-decade study by Baum and Martin (1973). This is evidence the rNPC has kept nearly the same size during most of the 20th and early 21st centuries.

**Table 1. Size of the Remnant North Polar Cap (rNPC).**

| Year | Mean Latitude | Method | Source |
|---|---|---|---|
| 1903 | 81.8° N | All longitudes | Lowell (1905) Lowell Obs. Bull. No. 19 (Reanalysis) |
| 1950 | 81.9° N | All longitudes | Analysis of Figure 10 in Dollfus (1973)[a] |
| 1965 | 80.5° N | All points | Capen & Capen (1970) |
| 1967 | 82.4° N | All points | Capen & Capen (1970) |
| 1982 | 81.8° N | All points | Iwasaki et al (1984) Reanalysis of Figure 1 based on red filter images |
| 1982 | 82.5° N | All points | Beish and Parker, 1988, p. 189 for $L_s$ = 86°-130° |
| 1984 | 82.6° N | All points | Parker et al (1999) |
| 1995 | 80.6° N | All longitudes | Re-analysis of July 1995 HST red images |
| 1997 | 82.1° N | All longitudes | Iwasaki et al (1999) analysis of dimensions in their Figure 3 |
| 1997 | 81.1° N | All longitudes | Reanalysis of HST color images May 17, 1997 |
| 2013-2014 | 81.9° N | All longitudes | Schmude (2014a) |
| 2016 | 80.9° N | All longitudes | Current work |
| *Mean* | *81.6° N* | | |
| 1905-1971 | 82° N | Probably all longitudes | Baum & Martin (1973) |
| 1978 | 81.4° N | All longitudes | VO image in Bass et al. (2000) |

[a] Both dots and circles were used in determining the mean latitude value. It was found that there was no statistical difference between these values. The dots and circles represented measurements from the north-south and east-west dimensions of the rNPC.

### *Clouds*

Earth-based images of Mars were examined for clouds northwards of ~60° N. Cloud frequencies, in 10° increments in Ls starting with 120°-130°, were measured. The results are plotted in Figure 1B. Essentially, the fraction of clouds remained relatively low until about Ls = 160°. Afterwards, the number of clouds increased by over a factor of two. This is consistent with spacecraft data collected in 1999-2001 (Wang and Ingersoll, 2002) and with the visual observations of de Vaucouleurs (1969).

### *Annular Clouds*

Figure 2A shows an early annular cloud imaged by the Hubble Space Telescope. Figures 2B and 2C show two images of an annular cloud which formed in March 2016. The 2016 cloud was centered at ~100° W, 65° N. One day later it drifted in the northeast direction at an estimated mean speed of 3 m/s. It was not visible on a March 12 mosaic (Malin et al. 2016a). Previously imaged annular clouds are listed in Table 2. They all formed at Ls = 116°-134°.

Images from ALPO-Japan Latest website (*alpo-j.asahikawa-med.ac.jp/indexE.htm*) were examined for large annular clouds during 2010. None were found; however, there were not many images posted on this site for the period Ls = 116°-134°. Movies made between July 5, 2010 and August 22, 2010 from (Malin, 2010a-g) were examined. No definite annular clouds were detected. A poorly organized feature may have developed on August 16, 2010, but was not visible afterwards. Therefore, it is concluded that no large annular cloud developed in 2010 for Ls = 116°-134°.

## Discussion

Figure 1A shows the mean cap latitude during late spring and summer for 2013-14 and 2016. In order to determine whether there is a statistical difference between the cap measurements made in 2013-14 and 2016, the t-test was used (Larson & Farber, 2006, p. 418). Essentially, a t-test was carried out for each of the mean cap latitudes for the 24 longitude ranges starting with 0°-15° W. At a confidence level of $\alpha$ = 0.05, it was found there was no statistical difference between 16 of the 24 mean latitudes for the two years. This was due to the small number of measurements (usually between 8 and 12) made in 2016 for many of the longitude ranges. There was a statistical difference for the other 8 sets of latitude values. Therefore, it is not clear that there is a statistical difference for the two years. Two factors that may

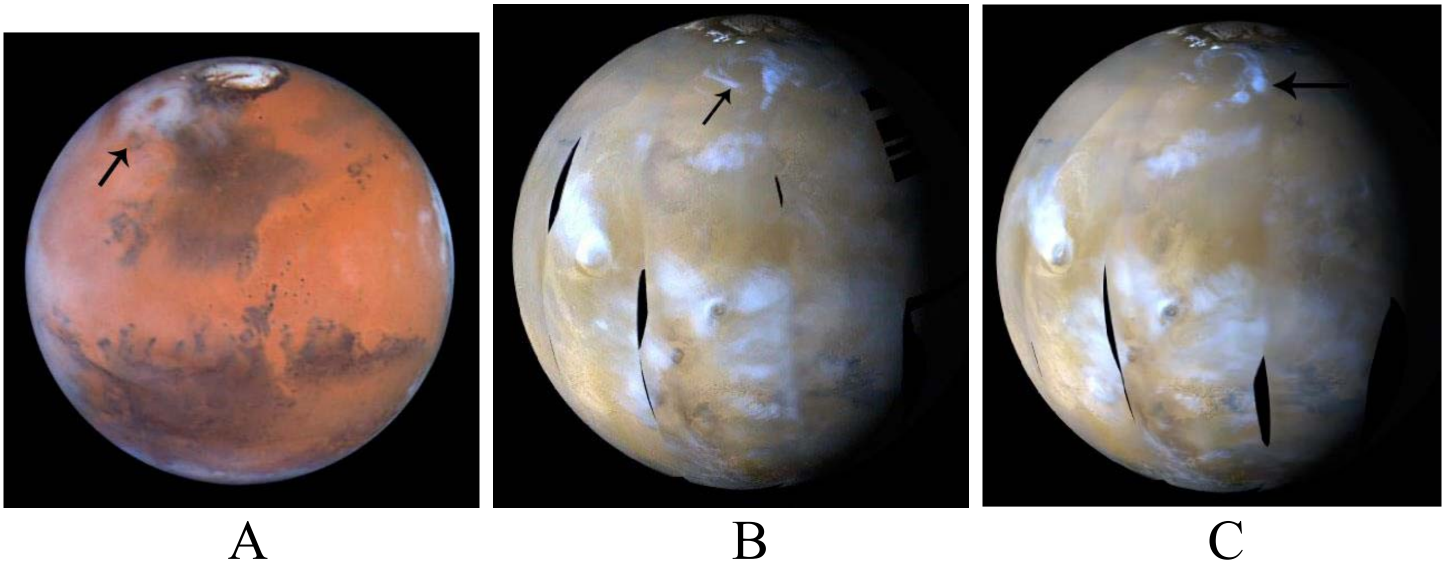


Figure 2: Image of annular clouds on Mars; see arrows. A: An Hubble Space Telescope image made on May 17, 1997; B: An image made by the Mars Color Imager (MARCI) onboard the Mars Reconnaissance Orbiter on March 10, 2016; C: An image made by the Mars Color Imager (MARCI) onboard the Mars Reconnaissance Orbiter on March 11, 2016 (Malin et al., 2016a).

cause a change in cap latitudes are dust and clouds.

Close-up images of the rNPC were examined for dust (Malin Space Science Systems, Inc.: (*www.msss.com/msss_images/subject/weather_reports.html*). The remnant cap, at longitudes of ~80° W, ~260° W and ~310° W are shown in Figure 3 for 2014 and 2016. Essentially, larger dark areas were present on the 2014 cap compared to 2016. The most obvious difference is near 310° W. No significant change took place in this area over several days in 2014 and 2016; therefore, deposited dust, and not dust clouds, may be what caused the dark areas. Furthermore, the dark spot in 2014 may be the result of deposited dust covering a larger area than in 2016 (Malin et al. 2014a, 2016a). The larger dark spots in 2014 would lead to smaller cap size measurements.

**Table 2. Annular Clouds Imaged Near the NPC**

| Date First Observed | Longitude & Latitude | $L_s$ Observed | Source |
|---|---|---|---|
| Mar. 10, 2016 | ~100° W, 65° N | 121° | Malin et al. (2016a) |
| Apr. 29, 2014 | 120° W, 65° N | 123° | Schmude (2014b) |
| July 3, 2012 | 30° W, 60° N | 134° | McKim, (2013) |
| June 24, 2012 | 93° W, 64° N | 129° | McKim, (2013) |
| May 27 2012 | 129° W, 61° N | 116° | Schmude (2014b) |
| Sept. 6, 2008 | ~80° W, ~70° N | 123° | Malin et al. (2008) |
| Oct. 15, 2006 | ~100° W, ~60° N & ~130° W, ~60° N | 121° | a |
| Nov. 27, 2004 | ~100° W, ~65° N | 121° | b |
| Jan. 19, 2003 | 95° W, 66° N | 124° | Morton, 2004 |
| Mar. 2, 2001 | 95° W, 70° N | 124° | Morton, 2004 |
| Apr. 27, 1999 | 85° W, 63° N | 130° | Morton, 2004 |
| May 17, 1997 | 80° W, ~70° N | 119° | c |

[a]See: www.msss.com/mars_images/moc/2006/11/07/
[b]See: www.msss.com/mars_images/moc/2005/09/12/index.html
[c]See http://www.archive.seds.org/hst/97-23.html

Clouds may also affect rNPC measurements. Schmude (2016, p. 8) report several clouds covering the southern edge of the shrinking North Polar Cap during spring. These will introduce error. These clouds apparently dissipate by early summer since none of them were visible in MRO videos made between April 28 and May 25, 2014 (Malin et al. 2014b-e) and between March 21 and April 17, 2016 (Malin et al. 2016b-e). Occasional condensate and dust clouds, however, covered parts of the remnant cap.

Large annular clouds have been imaged in every Mars summer (Ls = 116°-134°) since 1997 except in 2010. Their mean location is 100° W, 65° N. This lies in an area that has a higher elevation than nearby areas in the North Polar Region (Barlow, 2008, Figure 3.6). The thermal inertia, which is a measure of how fast an area heats up during the morning hours, is lower near where these features develop than in other nearby areas (Barlow, 2008, Figure 4.22). Essentially, ground temperatures rise faster near 100° W, 65° N than in other nearby areas in the North Polar Region. Therefore, the higher elevation and lower thermal inertia may enhance the development of the large annular clouds in Table 2. Wang and Ingersoll (2002) give a similar explanation for the preferential development of spiral clouds in the 0° - 90° W sector.

The best time to image annular clouds for the 2018 apparition was between January 15, 2018 (Ls = 115°) and February 25, 2018 (Ls = 135°). At this time, Mars' disc diameter grew from 5.1 to 6.5 arc-seconds and the sub-Earth latitude dropped from 12.5° N to 2.1° N (JPL Ephemeris Generator at *https://ssd.jpl.nasa.gov/horizons.cgi)*

Since annular clouds seem to develop near 100° W, the central meridian longitude should have been near 50°-70° W. In this way the clouds would have been closer to the morning edge. Unfortunately, the central meridian during early 2018 is on the afternoon side of Mars.

## Acknowledgements

The writer would like to thank the following individuals for the use of their images: T. Akutsu, C. Foster, C. Go, M. Hood, T. Horiuchi, P. Maxson, Mitika & Nichols, E. Morales-Rivera, T. Olivetti, A. Soares, M. Sparrenberger, M. Valimberti and A. Wesley. He is also grateful to the library staff at Gordon State College for their assistance in obtaining articles.

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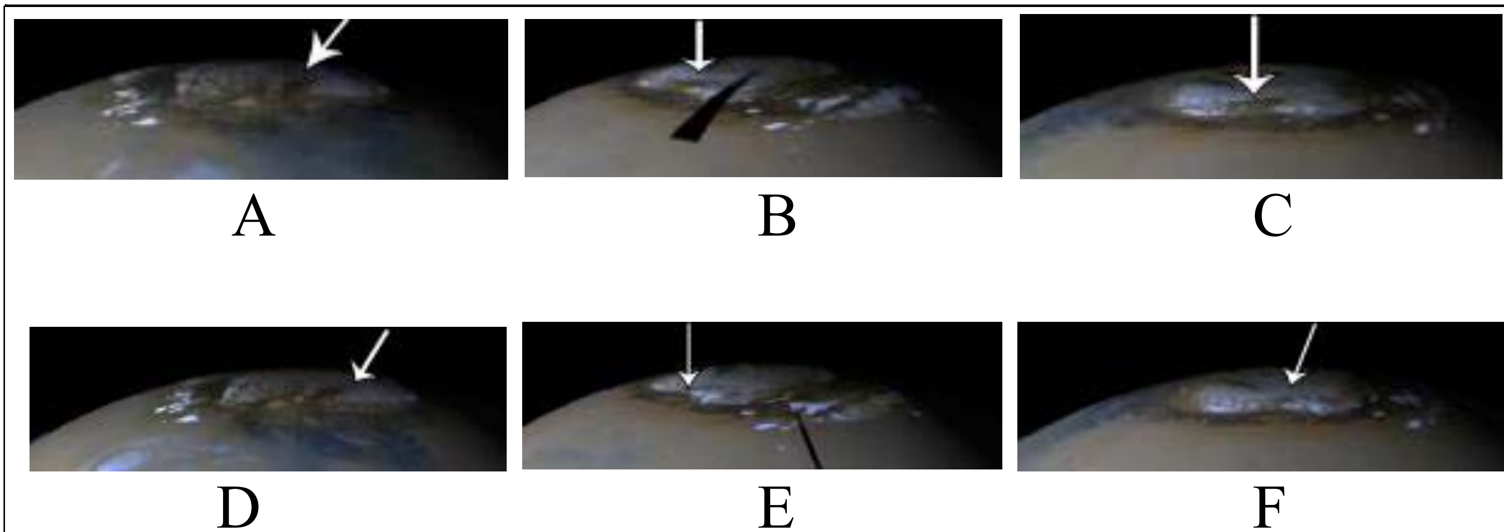


Figure 3: Image of the remnant North Polar Cap of Mars made by the Mars Color Imager (MARCI) onboard the Mars Reconnaissance Orbiter A - C: images made on April 22, 2014 when the central meridian longitude was near 80°, 260° and 310° W, respectively (Malin et al., 2014a); D - F: images made on March 9, 2016 when the central meridian longitude was near 80°, 260° and 310° W, respectively (Malin et al., 2016a). Arrows point to the larger dark areas in 2014 compared to 2016.

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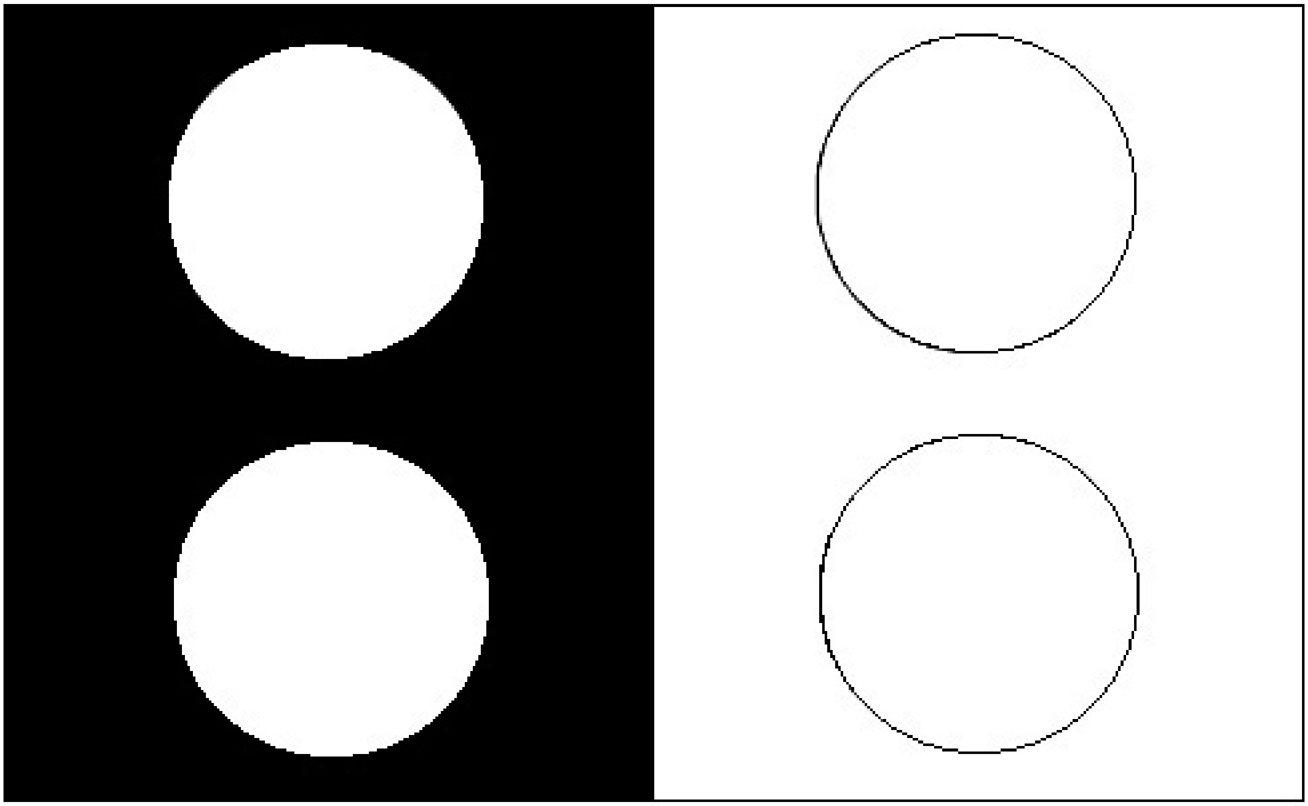
# A.L.P.O. Mars Section Observation



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Notes

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### Feature Story:

# Galilean Satellite Eclipse Timings: The 2009 - 2010 Apparition

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## Abstract

*During the 2009 - 2010 Jupiter apparition, four observers made 73 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 the reappearance times with the predictions of the IMCCE (Institut de Méchanique Céleste et de Calcul des Éphémérides) E-5 ephemeris.*

## Introduction

The apparition covered here is the 32nd observed by the ALPO Jupiter Section's Galilean Satellite Eclipse Timing Program, consisting of 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 described in detail our method of reduction, which also cited the reports for the previous apparitions. [Westfall 2009: 40, 42, 48; see also Westfall 2012, 2015, 2016a, 2016b, and 2017.]) We have compared our reduced timings with the Institut de Méchanique Céleste et de Calcul des Éphémérides (IMCCE) predictions, using the INPOP13C planetary theory and Lieske E-5 satellite theory.

**Table 1. Circumstances of the 2009-2010 Jupiter Apparition**

| Apparition | | Observing Season | |
|---|---|---|---|
| Initial solar conjunction | 2009 JAN 24, 06h | First eclipse timing§ | 2009 APR 07 (+73d) |
| First maximum phase angle | 2009 MAY 17, 14h (11.51°) | Last eclipse timing§ | 2010 JAN 14 (-45d) |
| Opposition to the Sun* | 2009 AUG 14, 18h (δ = -15.2°) | Duration | 282d |
| Closest approach to Earth† | 2009 AUG 15, 03h (D = 48.9") | Solar Elongation Range | 057°W-035°E |
| Second maximum phase angle | 2009 NOV 10, 03h (11.38°) | Sources: Meeus 2015; *Astronomical Almanac*, 2009 and 2010 editions; JPL *HORIZONS* website. Dates and times throughout this report are in Universal Time (UT). | |
| Final solar conjunction | 2010 FEB 28, 11h | | |

* 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 (-).

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Table 1 lists the pertinent dates and other circumstances of the 2009 - 2010 Apparition.

## Observations and Observers

The 73 timings received for 2009 - 2010 brought our 32-apparition total to 10,864 observations, and show a welcome increase from the 53 received for the 2007/09 Apparition. Table 2 gives descriptive statistics for the 2009 - 2010 observations.

Compared with 2007 - 2009, there is a greater imbalance between the

**Table 2. Number of Eclipse Timings, 2009 - 2010 Apparition**

| | |
|---|---|
| Number of Timings | 73 |
| Timings before Opposition | 24 (33%) |
| Timings after Opposition | 49 (67%) |
| Disappearance Timings | 27 (37%) |
| Reappearance Timings | 46 (63%) |

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 2009 - 2010, with their nationalities, instrument apertures and number of timings, both short-term and long-term.

**Table 3. Participating Observers, 2009 - 2010 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 |
| 1 | Abbott, A.P. | Canada | 15 | 3 | 11 | 34 |
| 2a<br>2b | Büttner, D. | Germany | 6.3<br>10 | 5<br>5 (10) | 15 | 107 |
| 3a | Hays, R.H., Jr. | USA (IL) | 13 | 4 | 20 | 298 |
| 3b | | | 15 | 20 (24) | | |
| 4a<br>4b | Westfall, J. | USA (CA) | 12.7<br>35.6 | 1<br>35 (36) | 29 | 524 |
| Mean Number of Timings per Observer | | | | 18.2 | | |

**Table 4. Timing Residual Statistics, 2009 - 10 Apparition**

| Satellite and Event | Quantity | Satellite and Event | Quantity |
|---|---|---|---|
| **Io** | | **Ganymede** | |
| 1D: No. of Timings | 11 (9) | 3D: No. of Timings | 5 (4) |
| 1D: Mean | +91.6±2.3s | 3D: Mean | +276.0±15.0s |
| 1D: Median | +89.0 | 3D: Median | +280.0s |
| 1R: No. of Timings | 22 (19) | 3R: No. of Timings | 9 (8) |
| 1R: Mean | -97.3±2.0s | 3R: Mean | -204.8±10.8s |
| 1R: Median | -99.0s | 3R: Median | -195.5s |
| (1D+1R)/2: Means | -2.9±1.5s | (3D+3R)/2: Means | +35.6±9.2s** |
| (1D+1R)/2: Medians | -5.0 | (3D+3R)/2: Medians | +42.2s |
| **Europa** | | **Callisto** | |
| 2D: No. of Timings | 7 (6) | 4D: No. of Timings | 4 (3) |
| 2D: Mean | +76.7±6.8s | 4D: Mean | +317.3±11.7s |
| 2D: Median | +71.5s | 4D: Median | +327.0s |
| 2R: No. of Timings | 11 | 4R: No. of Timings | 4 |
| 2R: Mean | -131.6±4.3s | 4R: Mean | -335.0±21.4s |
| 2R: Median | -129.0s | 4R: Median | -341.0s |
| (2D+2R)/2: Means | -27.4±4.0s** | (4D+4R)/2: Means | -8.8±12.2s |
| (2D+2R)/2: Medians | -28.8s | (4D+4R)/2: Medians | -7.0s |

Satellites are designated: 1 = Io, 2 = Europa, 3 = Ganymede and 4 = Callisto; D = disappearance, R = reappearance. Numbers of timings in parentheses are the numbers used in the analysis after those with unusually large residuals (most often due to poor observing conditions) were omitted. In the right-hand column, values are the means of means or medians of the three apparitions weighted equally; * shows a mean observed-predicted difference that is significantly different from 0 at the 5-percent level, while ** shows one that is significant at the 1-percent level.

It is pleasing to see that all our observers, although small in number, have continued with our program for 11 or more apparitions.

The contributors all used moderate-size telescopes in the aperture range 2.4 - 14 in. (6.3 - 35.6 cm). The mean aperture, weighted by number of observations, was 9.1 in. (23.2 cm).

## Timings Analysis: Satellite Positions

The individual eclipse timings made by our participants in 2009 - 2010 are listed in Table 6 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 at most a few seconds for Io and Europa, but could reach over a minute for Ganymede and several minutes for Callisto.

In 2009 - 2010, Io closely followed the IMCCE E-5 ephemeris. Europa,

**Table 5. Comparison of Mean Residuals, Mallama et al. 2010 and ALPO, 2009/10 Apparition**

| | Mean Residual (sec) | |
|---|---|---|
| Satellite | Mallama *et al.* 2010 | ALPO |
| Io | -2.6±4.3 | -2.9±1.5 |
| Europa | -24.1±6.8 | -26.4±2.2 |
| Ganymede | +31.7±13.7 | +35.6±9.2 |
| Callisto | -6.5±16.5 | -8.8±12.2 |

however, continued its long-known deviation from the E-5 model. Rather unusually, the observed position of Ganymede also was significantly different from the ephemeris. Finally, Callisto did not differ significantly from its ephemeris.

The independent CCD-photometric Galilean satellite eclipse-timing program coordinated by Antony Mallama observed 41 eclipses during the 2009 - 2010 Jupiter apparition (Mallama et al. 2010). We have compared their results with the IMCCE E-5 ephemeris, have calculated residuals for each type of eclipse event, and then averaged their disappearance and reappearance residuals for each satellite, as done above for the ALPO visual observations.

The Mallama et al. program's disappearance and reappearance residuals were based on mid-disappearance and mid-reappearance, rather than the "last speck" and "first speck" times of the ALPO program. However, the means of the CCD disappearance and reappearance mean residuals should be comparable to ours, and the mean

**Table 6. Galilean Satellite Eclipse Timings, 2009 - 10 Apparition**

| UT | LD | Lat | ObN | STB | Dif |
|---|---|---|---|---|---|
| **Io Disappearances** | | | | | |
| 90407 | 17 | -3 | 4b | 200 | -8 |
| 90516 | 23 | -1 | 4b | 100 | +100 |
| 90608 | 23 | -0 | 4b | 101 | +104 |
| 90624 | 22 | +0 | 4b | 100 | +91 |
| 90701 | 20 | +0 | 4b | 201 | +85 |
| 90703 | 19 | +1 | 3b | 100 | +88 |
| 90710 | 17 | +1 | 4b | 101 | +89 |
| 90717 | 15 | +1 | 3b | 000 | +96 |
| 90726 | 11 | +1 | 3b | 000 | +85 |
| 90802 | 7 | +1 | 4b | 201 | +37 |
| | | | 3b | 000 | +86 |
| **Io Reappearances** | | | | | |
| 90818 | 3 | +2 | 4b | 100 | -33 |
| 90825 | 6 | +2 | 4b | 100 | -93 |
| 90827 | 7 | +2 | 4b | 000 | -86 |
| 90828 | 8 | +2 | 2b | 021 | -99 |
| | | | 2a | 021 | -75 |
| 90903 | 11 | +2 | 4b | 001 | -114 |
| | | | 3a | 000 | -110 |
| 90910 | 14 | +3 | 4b | 100 | -101 |
| 90912 | 15 | +2 | 3b | 000 | -104 |
| 90926 | 19 | +3 | 4b | 100 | -110 |
| 90928 | 20 | +3 | 3b | 110 | -93 |
| 91005 | 22 | +3 | 3b | 000 | -107 |
| | | | 4b | 100 | -93 |
| 91012 | 23 | +3 | 4b | 100 | -88 |
| 91019 | 23 | +4 | 4b | 200 | -84 |

| UT | LD | Lat | Ob N | STB | Dif |
|---|---|---|---|---|---|
| **Io Reappearances – continued** | | | | | |
| 91021 | 23 | +4 | 3a | 000 | -91 |
| 91104 | 23 | +4 | 4b | 100 | -104 |
| 91120 | 22 | +5 | 4b | 000 | -87 |
| 91129 | 21 | +5 | 3b | 000 | -92 |
| 91206 | 20 | +5 | 3b | 000 | -98 |
| | | | 4b | 101 | -95 |
| 00114 | 12 | +6 | 3b | 200 | -68 |
| **Europa Disappearances** | | | | | |
| 90521 | 38 | -6 | 3a | 100 | +57 |
| 90528 | 38 | -6 | 4b | 100 | +102 |
| 90629 | 33 | -4 | 4b | 101 | +92 |
| 90717 | 23 | -4 | 3b | 000 | +67 |
| 90724 | 18 | -3 | 1 | 000 | +70 |
| | | | 3b | 000 | +73 |
| 90731 | 13 | -3 | 4b | 201 | +25 |
| **Europa Reappearances** | | | | | |
| 90818 | 4 | -2 | 4b | 100 | -143 |
| 90825 | 10 | -2 | 4b | 100 | -117 |
| 90828 | 13 | -2 | 2b | 021 | -146 |
| | | | 2a | 021 | -121 |
| 90905 | 19 | -1 | 3b | 000 | -130 |
| 90912 | 24 | -1 | 1 | 110 | -128 |
| 90919 | 28 | -1 | 4b | 100 | -148 |
| 90922 | 30 | -1 | 2b | 020 | -152 |
| | | | 2a | 020 | -110 |
| 91108 | 37 | +2 | 3b | 000 | -134 |
| 00103 | 22 | +4 | 3b | 000 | -118 |

| UT | LD | Lat | Ob N | ST B | Dif |
|---|---|---|---|---|---|
| **Ganymede Disappearances** | | | | | |
| 90704 | 49 | -2 | 4b | 201 | -75 |
| 90809 | 9 | +1 | 3b | 100 | +265 |
| 91019 | 16 | +7 | 2a | 201 | +240 |
| | | | 2b | 201 | +297 |
| 91103 | 18 | +8 | 4b | 000 | +308 |
| **Ganymede Reappearances** | | | | | |
| 90627 | 7 | -3 | 3b | 001 | -190 |
| | | | 4b | 101 | -133 |
| 90816 | 4 | +1 | 4a | 221 | -163 |
| 90914 | 40 | +4 | 1 | 110 | -196 |
| 90921 | 46 | +4 | 4b | 000 | -254 |
| 91020 | 60 | +7 | 3a | 000 | -196 |
| 91202 | 52 | +10 | 3b | 100 | -224 |
| 91209 | 49 | +11 | 4b | 110 | -244 |
| 00114 | 29 | +14 | 3b | 100 | -186 |
| **Callisto Disappearances** | | | | | |
| 90611 | 104 | +2 | 4b | 101 | +327 |
| 90919 | 30 | +15 | 2a | 210 | +244 |
| | | | 2b | 210 | +304 |
| 91109 | 64 | +22 | 4b | 100 | +357 |
| **Callisto Reappearances** | | | | | |
| 90628 | 45 | +3 | 4b | 101 | -322 |
| 90903 | 47 | +12 | 4b | 001 | -368 |
| 90920 | 78 | +14 | 3a | 100 | -290 |
| 91126 | 95 | +23 | 4b | 100 | -410 |

***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. Note that these "raw" residual values have not been corrected for oblique contact with Jupiter's shadow.

residuals of both programs are listed in Table 5.

When multiple CCD timings were made for the same event, they often agreed with each other to within a second. Thus we have high confidence in the CCD results and conclude that their residuals consistently reflect real differences between the satellites' positions and the IMCCE E-5 ephemeris. The Mallama et al. and the ALPO results agreed well within their uncertainty limits.

## Conclusion

The analysis of our program's timings made during the 2009 - 2010 Jupiter apparition showed the following:

- The times of eclipses by Jupiter of Io and Callisto did not differ significantly from the IMCCE E-5 ephemeris.
- Europa's observed timings, however, disagreed significantly from the ephemeris, its eclipse times averaging about 26 seconds earlier than predicted
- Ganymede's eclipses averaged over a half-minute later than the ephemeris.
- Our mean residuals for the four satellites did not disagree significantly with the independent CCD timings made by Anthony Mallama and his associates during the 2009/10 Apparition.

We thank the observers who contributed timings during 2009 - 2010, and hope that they continue with our program. We also invite others who are interested in this visual observing program, which requires only modest-sized telescopes, to contact the program coordinator (John Westfall at *johnwestfall@comcast.net*, 5061 Carbondale Way, Antioch, CA 94531 USA). He will be happy to furnish interested observers with a copy of observing instructions, a timing report form, and a table of Galilean satellite eclipse predictions for the coming apparition.

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

### Lunar Selected Areas Program

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

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### Lunar Banded Craters Program

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

### Lunar Domes Program

- Acting Coordinator; Raffaello Lena, Cartesio 144 D, 00137 Rome, Italy; raffaello.lena@alpo-astronomy.org
- Acting 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

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

- Coordinator; Dr. Anthony Charles Cook, Institute of Mathematical and Physical Sciences, University of Aberystwyth, Penglais, Aberystwyth, Ceredigion. SY23 3BZ, United Kingdom; tony.cook@alpo-astronomy.org
- Assistant Coordinator; David O. Darling, 416 West Wilson St., Sun Prairie, WI 53590-2114; DOD121252@aol.com

### Mars Section

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

- Coordinator; Roger J. Venable, MD, P.O. Box 117, Chester, GA 31012; rjvmd@hughes.net
- Assistant Coordinator (photometry and polarimetry); Richard W. Schmude, Jr., 109 Tyus St., Barnesville, GA 30204; schmude@gordonstate.edu
- Assistant Coordinator; Jim Melka, 14176 Trailtop Dr., Chesterfield, MO 63017; jtmelka@yahoo.com

### Minor Planets Section

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

- Coordinator; Frederick Pilcher, 4438 Organ Mesa Loop, Las Cruces, NM 88011; fpilcher35@gmail.com
- Scientific Advisor: Alan W. Harris, 4750 Walnut St, Suite 205, Boulder, CO 80301; harrisaw@att.net
- 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

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

- Coordinator; Ed Grafton, 15411 Greenleaf Lane, Houston, TX 77062; ed@egrafton.com
- Assistant Coordinator (Apparition Reports); Richard W. Schmude Jr., 109 Tyus St., Barnesville, GA 30204; schmude@gordonstate.edu
- Assistant Coordinator/Program Coordinator, Galilean Satellite Eclipses; John E. Westfall, 5061 Carbondale Way, Antioch, CA 94531; johnwestfall@comcast.net
- Assistant Coordinator, Transit Timings; John McAnally, 2124 Wooded Acres, Waco, TX 76710; CPAJohnM@aol.com
- Assistant Coordinator, Newsletter; Craig MacDougal, 821 Settlers Road, Tampa, FL 33613; macdouc@verizon.net

### Saturn Section

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

- Coordinator; Julius L. Benton, Jr., Associates in Astronomy, P.O. Box 30545, Wilmington Island, Savannah, GA 31410; ; jlbaina@msn.com (preferred) and jbenton55@comcast.net

### Remote Planets Section

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

- Coordinator; Richard W. Schmude, Jr., 109 Tyus St., Barnesville, GA 30204; schmude@gordonstate.edu

### Comets Section

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

- Coordinator; Carl Hergenrother, 4101 North Sunnywood Place, Tuscon, AZ 85749; chergen@lpl.arizona.edu
- Assistant Coordinator; Gary Kronk, 153 Samarra Estates Dr, Fenton, MO 63026; gkronk@gmail.com

### Meteors Section

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

- Coordinator; Robert D. Lunsford, 1828 Cobblecreek St., Chula Vista, CA 91913-3917; lunro.imo.usa@cox.net
- Assistant Coordinator; Robin Gray, P.O. Box 547, Winnemuca, NV 89446; sevenvalleysent@yahoo.com

### Meteorites Section

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

- Coordinator; Dolores Hill, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721; dhill@lpl.arizona.edu

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## ALPO Publications

### The Monograph Series

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

ALPO monographs are publications that we believe will appeal to our members, but which are 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

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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.

- **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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  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:** *(1) ALPO Mars Observers Handbook,* from the Astronomical League Sales, temporarily out of stock. *(2) Observing Forms;* send SASE to obtain one form for you to copy; otherwise send $3.60 to obtain 25 copies (send and make checks payable to "Deborah Hines", see address under "Mars Section").

- **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) *Jupiter*, the ALPO section newsletter, available from Craig MacDougal at *macdouc@verizon.net;* (3) *ALPO_Jupiter*, the ALPO Jupiter Section e-mail network; to join, send a blank e-mail to *ALPO_Jupiter-subscribe@yahoogroups.com* (4) *Timing the Eclipses of Jupiter's Galilean Satellites* free at http://www.alpo-*astronomy.org/jupiter/GaliInstr.pdf*, report form online at http://www.alpo-*astronomy.org/jupiter/GaliForm.pdf*;

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send SASE to John Westfall for observing kit and report form via regular mail. (5) *Jupiter Observer's Startup Kit*, $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 (includes postage & handling); send check or 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 Newsletter*, 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, 1828 Cobblecreek St., Chula Vista, CA 91913-3917.

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# THE ASSOCIATION
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The Association of Lunar & Planetary Observers (ALPO) was founded by Walter H. Haas in 1947 and incorporated in 1990 as a medium for advancing and conducting astronomical work by both professional and amateur astronomers who share an interest in Solar System observations. We welcome and provide services for all individuals interested in lunar and planetary astronomy. For the novice observer, the ALPO is a place to learn and to enhance observational techniques. For the advanced amateur astronomer, it is a place where one's work will count and be used for future research purposes. For the professional astronomer, it is a resource where group studies or systematic observing patrols add to the advancement of astronomy.

Our Association is an international group of students that study the Sun, Moon, planets, asteroids, meteors, meteorites and comets. Our goals are to stimulate, coordinate, and generally promote the study of these bodies using methods and instruments that are available within the communities of both amateur and professional astronomers. We hold a conference each summer, usually in conjunction with other astronomical groups.

We have "sections" for the observation of all the types of bodies found in our Solar System. Section coordinators collect and study submitted observations, correspond with observers, encourage beginners, and contribute reports to our quarterly Journal at appropriate intervals. Each section coordinator can supply observing forms and other instructional material to assist in your telescopic work. You are encouraged to correspond with the coordinators in whose projects you are interested. Coordinators can be contacted either via e-mail (available on our website) or at their postal mail addresses listed in our Journal. Members and all interested persons are encouraged to visit our website at *http://www.alpo-astronomy.org*. Our activities are on a volunteer basis, and each member can do as much or as little as he or she wishes. Of course, the ALPO gains in stature and in importance in proportion to how much and also how well each member contributes through his or her participation.

Our work is coordinated by means of our quarterly periodical, the *Journal of the Assn. of Lunar & Planetary Observers*, also called *The Strolling Astronomer*. Membership dues include a subscription to our Journal. Two versions of our Journal are distributed — a hardcopy (paper) version and an online (digital) version in "portable document format" (pdf) at considerably reduced cost.

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