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The Strolling Astronomer

Volume 57, Number 3, Summer 2015

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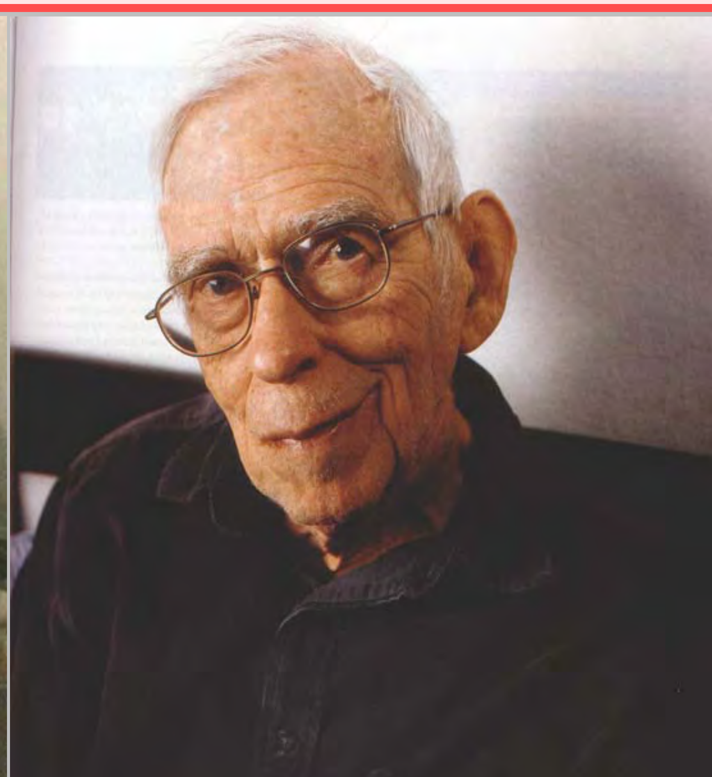

Founder and Executive Director Emeritus of
The Association of Lunar & Planetary Observers and Forever our Friend . . .

Walter H. Haas (1917 - 2015)

Tributes and Remembrances Inside This Issue

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JULY 6 - 11

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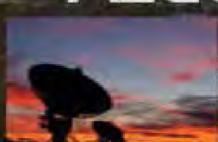

VERY LARGE ARRAY

APACHE POINT OBSERVATORY

DUNN SOLAR TELESCOPE

Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 57, No.3, Summer 2015
This issue published in June 2015 for distribution in both portable document format (pdf) and also 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.

For membership or general information about the ALPO, contact:

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ALPO Membership Secretary/Treasurer
P.O. Box 13456
Springfield, Illinois 62791-3456

E-mail to: matt.will@alpo-astronomy.org

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

Inside the ALPO

Point of View:

News of General Interest

ALPO Interest Section Reports

ALPO Observing Section Reports

Walter Haas: Tributes and Remembrances

Feature Stories

ALPO Resources

Inside the ALPO
Member, section and activity news

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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
Some Thoughts About Walter . . .

(Below are some thoughts by two of our board members about our dearly departed Walter H. Haas, who passed away on March 9.)

From Mike Reynolds, member of the board, coordinator, the ALPO Eclipse Section, and incoming executive director — In 197l, I attended my first ALPO meeting in Memphis. As a 16-year-old, I had been bitten by the astronomy bug. It was here that I met Walter Haas and learned about the ALPO… I had lots of questions, and Walter patiently answered them. I can remember thinking how wonderful it would be if I could one day aspire to be a member of the ALPO!

I went to college a couple of years later, earning my bachelor's in natural sciences and an astronomy and science education doctorate. My doctoral focus was the solar system; the ALPO and Walter had directed my interests.

Over the years since that Memphis meeting, I attended numerous ALPO meetings, always looking forward to seeing Walter and Peggy. Walter always was such a delight to talk to; he was genuinely interested in me as a person. Walter was always kind. Inspiring. Mentor. And friend . . .

From Matt Will, member of the board and ALPO secretary/treasurer — Whether more recently as our elder statesman for the ALPO or as our younger, more energetic executive director of the past, Walter Haas' presence will be greatly missed by many of us. Those of us with a long-time association with Walter will miss his intellectual capacity and his attention to detail in scientific analysis, his genial personality in mentoring amateurs in observing, and his organizational skills that ALPO staff all try to emulate today.

Walter's historic contributions to amateur astronomy I think, are best summed up by Richard McKim of the British Astronomical Association. He said of Walter upon his passing that Walter was "a great person, and one of the last links between what one could call the old and new worlds of astronomy." Certainly, Walter Haas was a singular force for amateur studies in Solar System astronomy, in its defining years.

A number of you have already made donations to the ALPO in memory of both Walter Haas and Don Parker. Online contributions can be made via the URL below:

https://www.astroleague.org/store/index.php?main_page=product_info&cPath=10&products_id=50&zenid=7vfjtfsce7miss48rh3tnnh4u6

Or you can mail your check to:

Matthew Will
ALPO Membership Secretary/Treasurer
P.O. Box 13456
Springfield, Illinois 62791-3456

Please make your check payable to "The ALPO" and add "Don Parker donation" in the lower left corner note of the check.

Inside the ALPO
Member, section and activity news

News of General Interest

Articles for Publication in This Journal

The ALPO appreciates articles for publications and encourages its general 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 regular addresses and e-mail address is in the ALPO Resources section of this Journal.

Memorial Donations to the ALPO

The ALPO wishes to thank all who have contributed funds in the names of both Walter Haas and Don Parker. Donations to the ALPO in their names are still being accepted.

Walter H. Haas — Contributions made in memory of the founder of our fine organization have so far totalled $2,400.

Below are the names of those contributors.

- Mike Hood
- Derald Nye
- Frederick Pilcher
- Louise Olivarez
- John and Beth Westfall
- Matthew Will

Don Parker — After his passing several months ago, several individuals made special donations to the ALPO in his memory. As of early March, those donations totaled over $1,725.

Below are the names of those persons who have contributed as of early March; an amended list will appear in the next issue.

- Jeff Beish
- Julius L. Benton, Jr.
- John Boudreau
- Mitch Glaze
- Lorne & Shirley Greenwood
- Mike Hood
- Coworkers of Kathleen (Parker) Greenwood (the Florida Office of Water Quality)
- Louise Olivarez
- John and Elizabeth Westfall
- Matthew Will

Donations to the ALPO in their names are still being accepted. There are two ways to contribute:

- Send your check or money order made payable to the ALPO to ALPO, P.O. Box 13456, Springfield, IL 62791-3456
- Donate by credit card on the Astronomical League online store at this URL: *https://www.astroleague.org/store/index.php?main_page=product_info&cPath=10&products_id=50&zenid=g29852ugiccivalvfgkjc5i185*

If paying by check, please write on the check's memo line "in memory of Walter Haas" or "in the memory of Don Parker." If paying online, there should be an option for "special instructions" where one can state that the donation is in the memory of Walter Haas or Don Parker.

ALPO Solar Section Correction

The CORRECT website address for the ALPO Solar Section e-mail list on Yahoo is *https://groups.yahoo.com/neo/groups/Solar-Alpo/info*

Please check into this worthwhile activity and participate actively.

ALPO Interest Section Reports

ALPO Online Section

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

We are sorry to announce that Assistant Coordinator Jonathan Slaton has left the organization due to circumstances which impact his ability to observe and contribute to the ALPO. We hope to see him rejoin in the future.

Follow us on Twitter, become our friend 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*

Inside the ALPO
Member, section and activity news

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

Computing Section

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

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

Tim Robertson, section coordinator
cometman@cometman.net

The ALPO Lunar & Planetary Training Program is open to all members of the ALPO, the 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.

I, Tim Robertson, as program coordinator, heartily welcome you to the ALPO and our training program and look forward to hearing from you!

To began the first phase of training at the basic level, interested persons should contact me at the following address:

Timothy J. Robertson
ALPO Training Program
195 Tierra Rejada #148
Simi Valley, California 93065

Or send e-mail to me at: cometman@cometman.net

For more information about the ALPO Lunar & Planetary Training Program, go to: www.cometman.net/alpo/

ALPO Observing Section Reports

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 Lundsford, section coordinator
lunro.imo.usa@cox.net

The last 6 months have been pretty quiet for meteor observers. Except for the Lyrids in mid-April there have not been any major showers peaking under optimal conditions since the Ursids back in December.

Meteor season finally kicks into high gear for observers in the northern hemisphere in July. Unfortunately the major showers of July are also obscured by a bright Moon.

Meteor observers are finally rewarded by the Perseids in August which peak on the 12/13, only one day before the New Moon. A better than average display is expected for the Perseids in 2015 as the regular material from comet 109P/Swift–Tuttle may be enhanced by material from the return of the comet in 1862.

The ALPO Meteors Section looks forward to your observations and photographs from this impressive display of celestial fireworks!

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

Meteorites Section

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

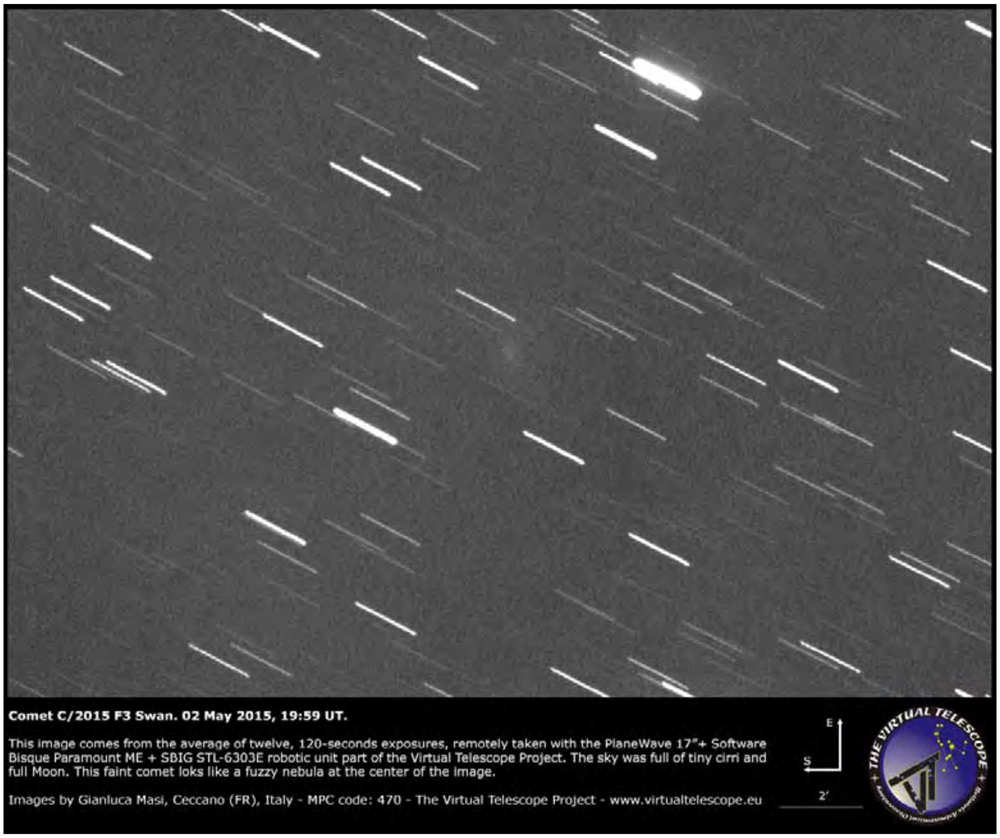
Visit the ALPO Meteorite Section online at www.alpo-astronomy.org/meteorite/

Comets Section

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

This summer brings the arrival of two comets bright enough for binocular or small telescope observers. Whether or not you'll be able to see these comets will depend on your location. Both comets

Inside the ALPO
Member, section and activity news



Fading fast! Comet C/2015 F3 (SWAN) was one of many comets observed in early 2015. A possible piece of Comet Liller, a bright comet seen in 1988, SWAN appears to be in the process of rapidly fading or even disintegrating as seen in this image by Gianluca Masi from Ceccano, Italy.

will be visible from the southern hemisphere but not from the northern hemisphere until later in the year. Both comets are also dynamically new, meaning the are comets from the Oort Cloud and making their first passage through the inner Solar System. Such objects are prone to being bright at large distances from the Sun and under performers near perihelion.

C/2014 Q1 (PANSTARRS) was discovered in August 2014 at 4.9 AU from the Sun (roughly Jupiter's distance). At discovery, extrapolations of its brightness behavior pointed towards PANSTARRS becoming as bright as 2nd magnitude. As of early May 2015, the comet had only brightened to magnitude 12.5. If its current brightening trend continues, it may max out at 5th-6th magnitude. Perihelion occurs on July 6 at a distance of 0.31 AU from the Sun. At that time, it will be too close to the Sun for Earth-bound comet watchers but will become visible to southern observers by late July. The comet should fade rapidly and may be fainter then 10th magnitude by mid-August. Predictions of the brightness of PANSTARRS are undoubtably uncertain so let's hope it outperforms this forecast.

The second comet, C/2013 US10 (Catalina), has been followed for nearly 1.5 years since its October 31, 2013 discovery at 8.3 AU from the Sun. As of early May, Catalina was magnitude 12.8. Perihelion occurs later this year on November 15 at 0.82 AU from the Sun, when it should have brightened to at least 8th magnitude. As for this summer, Catalina starts July at 11th magnitude and only visible from low northern latitudes and points further south. By mid-July it is solely a southern object as it brightens to 9th magnitude by the end of September. Catalina reappears in northern skies in December.

The Comet Section was very active over the first four months of 2015. Visual observations were submitted by Salvador Aguirre, Carl Hergenrother, Luis Mansilla, Gary Nowak, John Sabia, Willian Souza, Stephen Tzikas and Roger Venable. CCD images were contributed by Denis Buczynski, Geoff Chester, Jean-Francois Coliac, Carson Fuls, Carl Hergenrother, Rik Hill, Manos Kardasis, Gianluca Masi, Frank Melillo, John Sabia, Chris Schur and Emmanuel Subes.

The ALPO Comet Section solicits all observations of comets, including drawings, magnitude estimates, images and spectra. Drawings and images of current and past comets are being archived in the ALPO Comet Section image gallery at *http://www.alpo-astronomy.org/gallery/main.php?g2_itemId=4491*

Inside the ALPO
Member, section and activity news

Please send all observations and images to Carl Hergenrother at the e-mail address shown at the beginning of this section report.

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

Solar Section

Report by Kim Hay, section coordinator
kim.hay@alpo-astronomy.org

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

If you would like to send your sketches, or images of your observations, and have them archived in the Carrington Rotation periods, please send jpg or gif images no larger than 250 mb in size to myself (*kim.hay@alpo-astronomy.org*) Be sure to include all information on your image, and the CR number as well.

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

Well, I have some good news and some bad news about the MESSENGER spacecraft. First, the good news is that the spacecraft has mapped nearly 100 percent of the surface since its first orbit insertion in March 2011. It was meant to last a year, but scientists extended it for an additional year, and then two more years. It was a successful mission.

The bad news is that on April 30, the spacecraft crashed onto the surface of Mercury. During the past year, MESSENGER kept losing altitude while in orbit due to the planet's close proximity to the Sun. In other words, the Sun dragged the spacecraft toward a lower orbit. It had been rebooted to higher orbit a couple of times, but it finally ran out of fuel, so scientists had no choice but to let the spacecraft go. This is a happy ending, though, because the

Inside the ALPO
Member, section and activity news

MESSENGER was made to last this long, and the spacecraft had achieved its goal. The MESSENGER traveled more than 8 billion miles and took more than 250,000 images!

I hope many of you got a short glimpse of Mercury after sunset last spring. The Mercury section has received more observations this time around than the last two years! I also took some images of Mercury, which I rarely do in the evening sky. Normally, I take it during the morning apparition, where I find the seeing condition best. We are happy to welcome a new Mercury observer, Michel Legrand of France, who has submitted some fine drawings. It would be nice to see if some of the features he drew in his observations are comparable to the details that were seen in the MESSENGER images.

If you missed Mercury's last evening apparition, you may find it in the morning sky by the time you read this journal. It will not be the best appearance. The next evening apparition in August and September won't be so great either, due to an expected shallow angle of the ecliptic. However, the morning apparition in October will be the best of the year. More information on that to follow in the next issue. At the same time, while the MESSENGER spacecraft is no longer in orbit, your Mercury observations will be as important as ever. Please, send them in to the Mercury section.

We also need more drawings and images that will add to the professionalism of our apparition report.

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

Venus Section

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

Venus is quite conspicuous this spring in the western sky after sunset at apparent visual magnitude -4.0, moving eastward relative to the Sun as the 2014-15 Eastern (Evening) Apparition progresses.

The planet is passing through its waning phases (a progression from fully illuminated through crescent phases) as observers witness the leading hemisphere of Venus at the time of sunset on Earth. Venus will have attained Greatest Elongation East of 45.4° on June 6, 2015 and reach theoretical dichotomy (half phase) also on June 6th. The planet will reach greatest brilliancy on July 12, 2015 at visual magnitude -4.5.

The following Geocentric Phenomena in Universal Time (UT) is included here for the convenience of observers for the 2014-15 Eastern (Evening) Apparition:

Frank Melillo of Holtsville, NY, submitted this excellent UV image of Venus using 25.4 cm (10 in.) SCT on April 1, 2015 at 23:10 UT good seeing (S = 7). Banded dusky markings, plus a few subtle bright areas exclusive of the cusps, cusp caps and cusp bands, and a shaded irregular terminator in this UV image. The apparent diameter of Venus is 14.0", phase (k) 0.778 (77.8% illuminated), and visual magnitude -4.0. South is at top of image.

Geocentric Phenomena of the Upcoming 2014-15 Eastern (Evening) Apparition of Venus in Universal Time (UT)

Superior Conjunction	2014	Oct 25 (angular diameter = 9.7 arc-seconds)
Greatest Elongation East	2015	Jun 06 (Venus will be 45.4º East of the Sun)
Predicted Dichotomy		Jun 06.38 (exactly half-phase predicted)
Greatest Illuminated Extent		Jul 12 (m_v = -4.5)
Inferior Conjunction		Aug 15 (angular diameter = 63.1 arc-seconds)

As of this writing (in early March), the ALPO Venus Section has started receiving increasing numbers of drawings and images, with more expected as observers follow the planet as it attains a higher position above the western horizon this spring and summer.

ESA's Venus Express (VEX) mission, that started systematically monitoring Venus at UV, visible (IL) and IR wavelengths back in May 2006, ended its highly successful campaign early in 2015 as it made its final descent into the atmosphere of the planet. This was a very meaningful Pro-Am collaborative effort involving ALPO Venus observers around the globe, and those who actively participated are to be commended for their persistence and dedication.

Inside the ALPO
Member, section and activity news

Lunar Calendar for Third Quarter 2015 (All Times UT)

Jul	05	11:59	First Quarter
	06	01:21	Moon-Mars: 0.2° S
	06	06:32	Moon-Spica: 2.2° S
	06	09:50	Moon Ascending Node
	08	02:48	Moon-Saturn: 0.4° N
	10	17:29	Moon South Dec.: 19° S
	12	11:25	Full Moon
	13	08:27	Moon Perigee: 358300 km
	18	21:21	Moon Descending Node
	19	02:08	Last Quarter
	22	11:56	Moon-Aldebaran: 2° S
	23	15:36	Moon North Dec.: 18.9° N
	24	18:16	Moon-Venus: 4.9° N
	26	22:42	New Moon
	28	03:27	Moon Apogee: 406600 km
Aug	02	11:26	Moon Ascending Node
	02	13:27	Moon-Spica: 2.5° S
	03	10:02	Moon-Mars: 2.4° S
	04	00:50	First Quarter
	04	10:54	Moon-Saturn: 0.1° N
	07	04:26	Moon South Dec.: 18.8° S
	10	17:43	Moon Perigee: 356900 km
	10	18:09	Full Moon
	15	00:18	Moon Descending Node
	17	12:26	Last Quarter
	18	17:46	Moon-Aldebaran: 1.7° S
	19	22:12	Moon North Dec.: 18.8° N
	24	05:48	Moon-Venus: 6.3° N
	24	06:09	Moon Apogee: 406500 km
	25	14:13	New Moon
	29	13:14	Moon Ascending Node
	29	19:08	Moon-Spica: 2.7° S
	31	19:21	Moon-Saturn: 0.4° S
	31	23:43	Moon-Mars: 4.4° S
Sep	02	11:11	First Quarter
	03	13:10	Moon South Dec.: 18.6° S
	08	03:29	Moon Perigee: 358400 km
	09	01:38	Full Moon
	11	07:32	Moon Descending Node
	15	01:01	Moon-Aldebaran: 1.5° S
	16	02:05	Last Quarter
	16	05:15	Moon North Dec.: 18.6° N
	20	14:22	Moon Apogee: 405800 km
	24	06:14	New Moon
	25	17:41	Moon Ascending Node
	26	00:48	Moon-Spica: 2.8° S
	26	09:32	Moon-Mercury: 4.6° S
	28	04:46	Moon-Saturn: 0.8° S
	30	19:29	Moon South Dec.: 18.5° S

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

It should be pointed out that it is not too late for those who have not yet sent their images to the ALPO Venus Section and the VEX website (see below) to do so. Sought after also are drawings of Venus in Integrated Light and with color filters of known transmission. These collective data are 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.

The observation programs carried out by the ALPO Venus Saturn Section are listed on the Venus page of the ALPO website at *http://www.alpo-astronomy.org/venus* as well as in considerable detail in the author's ALPO Venus Handbook, which is available from the ALPO Venus Section. Observers are urged to carry out digital imaging of Venus at the same time that others are imaging or making visual drawings of the planet (i.e., simultaneous observations).

Although regular imaging of Venus in both UV, IR and other wavelengths is extremely important and highly encouraged, far too many experienced observers have neglected making visual numerical relative intensity estimates and reporting visual or color filter impressions of features seen or suspected in the atmosphere of the planet (for instance, categorization of dusky atmospheric markings, visibility of cusp caps and cusp bands, measurement of cusp extensions, monitoring for the Schröter phase effect near the date of predicted dichotomy, and looking for terminator irregularities).

Inside the ALPO
Member, section and activity news

Routine use of the standard ALPO Venus observing forms will help observers know what needs to 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 Section urges interested 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 82 new observations from 10 observers during the January-March quarter. Six contributed articles were published in addition to numerous commentaries on images submitted. The *Focus-On* series continued with an articles on Oceanus Procellaru-Reiner gamma and Hainzel. Upcoming *Focus-On* subjects include Rimae Sirsalis.

All electronic submissions should now be sent to both me and Acting Assistant Coordinator Jerry Hubbell (*jerry.hubbell@alpo-astronomy.org*).

Hard copy submissions should continue to be mailed to me at the address provided in the *ALPO Resources* section of this *Journal*.

Visit the following online web sites for more info:

- ALPO Lunar Topographical Studies Program *moon.scopesandscapes.com/alpo-topo*
- ALPO Lunar Selected Areas Program *moon.scopesandscapes.com/alpo-sap.html*
- The Lunar Observer (current issue) *moon.scopesandscapes.com/tlo.pdf*
- The Lunar Observer (back issues) *moon.scopesandscapes.com/tlo_back.html*
- Banded Craters Program: *moon.scopesandscapes.com/alpo-bcp.html*
- The Lunar Discussion Group: *tech.groups.yahoo.com/group/Moon-ALPO/*
- The Moon-Wiki: *the-moon.wikispaces.com/Introduction*
- Chandrayaan-1 M3: *pds-imaging.jpl.nasa.gov/portal/chandrayaan-1_mission.html*
- LADEE: *www.nasa.gov/mission_pages/ladee/main*
- LROC: *lroc.sese.asu.edu/EPO/LROC/lroc.php*
- GRAIL: *http://www.nasa.gov/mission_pages/grail/main/*

Lunar Meteoritic Impacts

Brian Cudnik, program coordinator
cudnik@sbcglobal.net

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

It was with great sadness that I learned of the passing of Walter Haas (1917-2015). Walter was a key person who encouraged me to take on the running of the LTP section at the ALPO, and was, despite his age, still submitting routine lunar observations until 2003. He kick-started modern interest in attempting to observe changes on the Moon with the famous paper, "Does Anything Ever Happen on the Moon". He had even made 47 observations of LTP himself, and you can attempt to observe what the normal appearances of these features should have been like when you see his name crop up in the monthly repeat illumination predictions (*http://users.aber.ac.uk/atc/tlp/tlp.htm*).

Walter also encouraged amateurs to work together simultaneously to look for evidence of impact flashes/flares at the Moon, many decades before the modern video impact flash era – a true pioneer in every sense.

On the question of "Does Anything Ever Happen on the Moon", well it now seems that it does, but mostly at the small meter scale, beyond the resolution of Earth-based astronomers. A team examining NASA LRO images, using automated image analysis software has found approximately 24,000 low-reflectance changes, approximately 2,000 high-reflectance changes, and discovered 225 fresh impact craters

Inside the ALPO
Member, section and activity news

(http://www.hou.usra.edu/meetings/lpsc2015/pdf/2325.pdf) – most of which are thought to be impact related. They have also found landslide features on steep slopes, the longest of which was at least 2 km long, and evidence for an ejecta pattern from a 18 m diameter fresh crater lying up to 30 km away. So you see, it is not beyond the realms of possibility that we might very occasionally spot a kilometer-scale "permanent" change when comparing Earth-based imagery taken many years/decades apart – providing they have similar illumination and high enough resolution.

Moving back down to the meter scale on the Moon, we have started an "armchair astronomer" program to look for differences between NASA LROC imagery taken at least a year apart, see: http://users.aber.ac.uk/atc/tlp/spot_the_difference.htm. At the moment, the program is in its infancy and may evolve into automated searches, though I suspect that we will still need human participation to help with the elimination of apparent changes from false detections due to cosmic ray effects or changes in shadow positions.

If you think that you see an LTP, please follow through the rigorous checklist also on that web site before contacting me.

Twitter LTP alerts are available on: http://twitter.com/lunarnaut.

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

Mars Section

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

The elongation of Mars has declined this winter and spring, and the planet now has an angular diameter of fewer than four arc seconds. With unique perseverance, Clyde Foster of South Africa continued to image it in the evening twilight after all others had stopped. Using an infrared filter to decrease atmospheric effects, he has shown with his images that no major dust storm occurred during the Martian dust season that just passed.

The last four apparitions have been aphelic, but the next one, centered in mid-2016, will be perihelic. Get ready for the best views of Mars that you have had since 2005.

Visit the ALPO Mars Section online and explore the Mars Section's recent observations: www.alpo-astronomy.org/mars

Minor Planets Section

Frederick Pilcher, section coordinator
pilcher35@gmail.com

Some of the highlights published in the *Minor Planet Bulletin*, Volume 42, No. 2, 2015 April-June, are presented. These represent the recent achievements of the ALPO Minor Planets Section.

Finding the sidereal rotation period, orientation of the spin axis, and shape of an asteroid by photometry requires observations at several different oppositions well distributed around the sky. The lightcurve inversion (LI) technique required find these parameters usually obtains two widely different solutions for the orientation of the spin axis and shape that cannot be resolved by photometry alone. IOTA's Brad Timerson and 13 collaborating authors report an occultation by 82 Alkmene on 2014 September 18 in which an accurate profile was observed. The profiles of both LI models at the time of the occultation can be predicted. Only the profile corresponding to a pole at celestial longitude 164 degrees, latitude -28 degrees matches the observation.

The ambiguity has been resolved. Brian Warner and Robert Stephens have also produced a lightcurve inversion model for 21028 1989 TO.

Tumbling behavior (simultaneous rotation about two different axes) has been found for minor planets 25076, 31832, and 374158.

Brian Warner has found strong evidence that 2014 WZ120 has a satellite companion, and weaker evidence that minor planets 1103, 2083, 3880, and 190208 possibly have satellites.

There are many different ways in which ambiguity may arise in the rotation period found in a set of photometric lightcurves. These become especially troublesome for Earth approaching asteroids in which the position in the sky and phase angle are both changing rapidly. One example in which additional observations removed the ambiguity is by Brian Warner, who observed 2340 Hathor at one of its very infrequent close approaches. The shape of the lightcurve changed from tri-modal (three maxima and minima per rotation) at phase angle 60 degrees to bimodal (the usual two maxima and minima per rotation) at phase angle 7 degrees, both in a period of 3.350 hours.

Other asteroids observed by Brian Warner for which it was not possible to resolve the ambiguity are 12538, 15786, 85804, 137032, 159533, 209924, 2005 SX4, and 2014 TV. These are only the most extreme cases. There are many others for which one particular period can be favored but others not entirely ruled out.

In addition to asteroids specifically identified above, lightcurves with derived rotation periods are published for 108 other asteroids as listed below: 1, 12, 248, 254, 283, 349, 349, 409, 453, 465, 475, 477, 515, 549, 746, 757, 802, 1061, 1110, 1334, 1463, 1724, 1904, 1920, 1983, 2043, 2390, 2554, 2571, 2634, 2649, 2693, 2699, 2824, 3107, 3197, 3200, 3483, 3730, 3883, 3965, 4125, 4183, 4252, 4271, 4528, 4531, 4713, 4765, 4880, 4909, 5116, 5750, 5841, 6335, 6500, 6509, 7837, 9222, 9387,

Inside the ALPO
Member, section and activity news

10042, 10597, 10645, 14927, 18899, 20392, 24654, 29769, 31723, 32814, 36017, 40229, 52505, 53247, 53430, 54234, 68553, 70030, 85713, 86326, 90075, 96518, 99395, 100756, 103067, 136897, 162004, 163818, 175114, 214088, 410195, 413038, 415949, 416224, 418797, 2007 TG25, 2010 MR, 2014 RL12, 2014 RQ17, 2014 SC324, 2014 SM143, 2014 SQ261, 2014 TL17, 2014 TX57, 2014 UR, 2014 VM, 20014 VQ, 2014 VH2, 2014 WF201.

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 unitiated may realize. Observations of asteroids at multiple oppositions widely spaced around the sky are necessary to find axes of rotation and highly accurate sidereal periods.

The several issues of ambiguous periods, detection of satellites, and tumbling behavior will all be presented in a talk by the author at ALCon 2015.

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, acting section coordinator
ed@egrafton.com

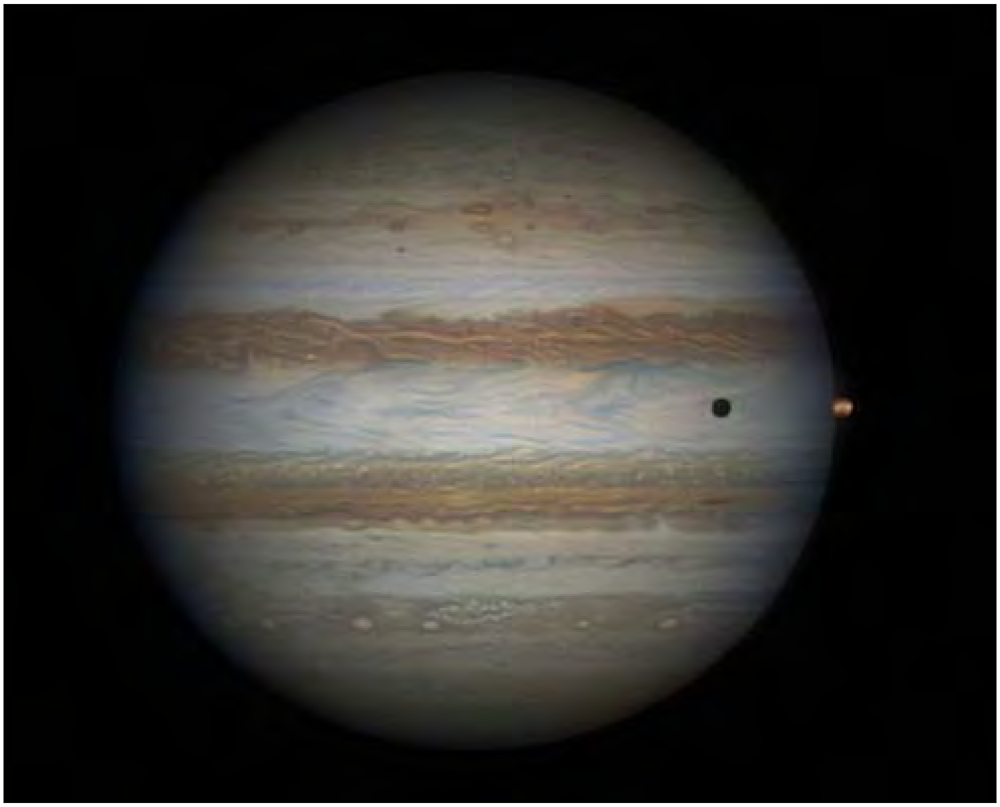


Image of Jupiter and it's moon Io on the limb. Image taken by Damian Peach on February 25th 2015. Note the detail visible on Io.

Jupiter will reach solar conjunction on August 26th when its apparent diameter will be about 30 arc seconds in diameter. Jupiter will be at its maximum distance from the Earth at this time, 6.4 astronomical units.

The Great Red Spot was captured by Christopher Go on March 5th 2015 with many features visible within the GRS. The image was compiled from approximately one hour of data collected and derotated using Winjupos software.

http://astro.christone.net/jupiter/grs20150305_cgo.jpg

Tables of mutual satellite prediction events for 2015 produced by Jean Meeus of the British Astronomical Association Computing Section can be found at the following online locations:

• Occultations — http://britastro.org/computing/handbooks_jocc2015.html

• Eclipses — http://britastro.org/computing/handbooks_jecl2015.html

The mutual satellite events presents the opportunity to obtain light curves of mutual satellite shadow transits and occultations.

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

(Editor's Note — The following text is repeated from the previous report as a reminder to observers interested in this

Inside the ALPO
Member, section and activity news

phenomena, but with the list of mutual events shortened as required.)

In 2015, Jupiter remains well north of the celestial equator throughout the apparition, favoring observers in the Earth's northern hemisphere. The 2014-2015 Jupiter Apparition is notable in that it includes a season of satellite mutual events - eclipses and occultations of the satellites by each other.

Mutual-event seasons take place every six years when the Earth and Sun cross the planet's equator and thus the planes of the orbits of its Galilean satellites. This mutual-event season contains almost 500 predicted events — 270 mutual occultations and 207 mutual eclipses. The remain mutual events include the following:

- 2015 Aug 13 – Last mutual event predicted (Io occults Europa)
- 2015 Aug 26 – Jupiter in conjunction with the Sun

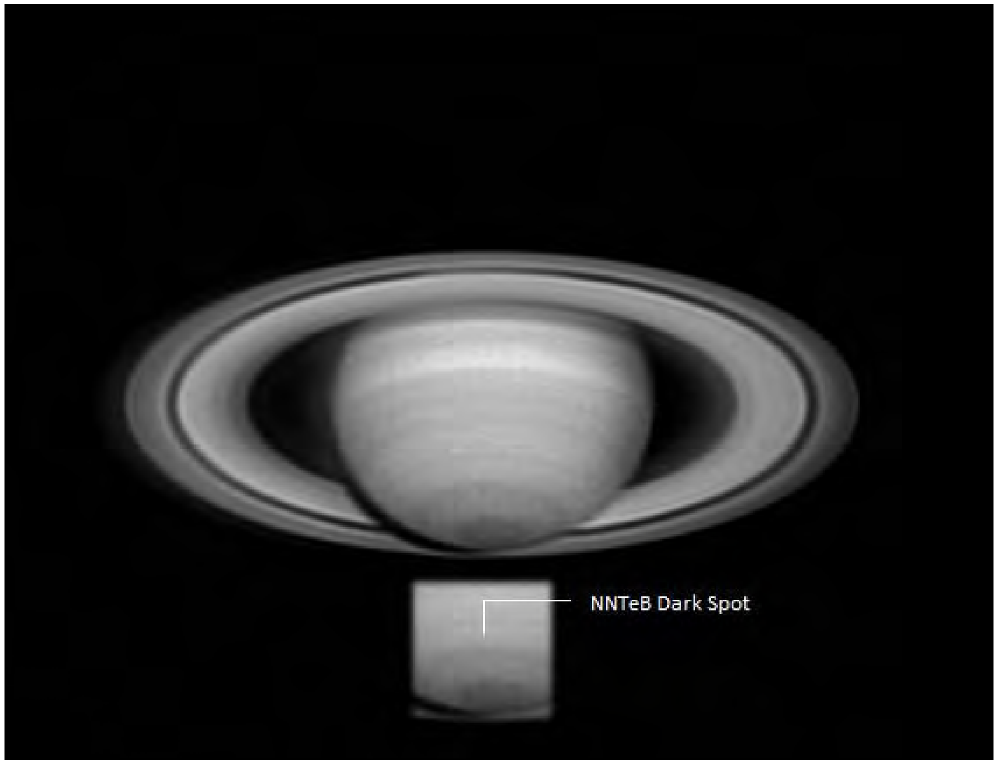
(*The last time the Earth crossed Jupiter's equator three times was during the 1919-20 Apparition.)

Satellite mutual events take many forms – eclipses versus occultations – but they also include total, partial and annular versions of both. You can simply view them, draw them, or take sequential photographs or videos of them. This program coordinator will be happy to receive these forms of observation (as well as your timings of the "normal" eclipses of the four satellites by Jupiter itself).

Furthermore, if you conduct sequential photometry of mutual events, your resulting "light curve" can provide the accurate mid-time, duration and "depth" (light drop) of the event, with potential scientific value in terms of refining the satellites' orbits.

You can find out more about observing these phenomena, obtain a schedule of events, and even learn how to participate in the "PHEMU15" event-photometry campaign (all this in English), at the website of the Institut de Méchanique Céleste et de Calcul des Éphémérides (IMCCE): www.imcce.fr/phemu. (Note that all photometric observations should be submitted to the IMCCE.)

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.



One of the first images of Saturn received during the 2014-15 apparition taken on February 20, 2015 at 18:21 UT by Trevor Barry observing from Broken Hill, Australia, using a 40.6 cm (16.0 in.) custom Newtonian at visual (RGB) wavelengths showing an extremely small white spot just north of the NEBn. Numerous belts and zones are seen on the globe, including the hexagonal North polar hexagon and the major ring components. Cassini's division (A0 or B10) clearly runs all the way around the circumference of the rings (except where the globe blocks our view of the rings); looking carefully at this image, it's reasonably easy to see the southern hemisphere of the globe through Cassini's division where it crosses the globe. Also visible is Encke's "complex" (A5), Keeler's (A8) gap, and other "intensity minima" at the ring ansae. The dark shadow of the globe on the rings is situated toward the East (left) in this image since it is prior to opposition [the shadow will shift to the West (right) after opposition]. Seeing = 6.0 and transparency was not specified. The apparent diameter of Saturn's globe was 16.6" with a ring tilt of +24.0º. CMI = 124.2°, CMII = 328.4°, CMIII = 73.7°. South is at the top of the image.

Saturn Section

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

Saturn reached opposition to the Sun on May 23 with the rings tilted about +24° toward Earth, affording near optimal views of the northern hemisphere of the globe and north face of the rings this apparition.

The planet is generally well-placed for viewing most of the night despite its more

Inside the ALPO
Member, section and activity news

southerly declination during 2015 for many northern hemisphere observers.

The accompanying table for the 2014-15 apparition are presented for the convenience of readers for planning observations.

As this report goes to press, the ALPO Saturn Section has received a little more than 100 images and visual observations, including reports of discrete white spot phenomena in the northern hemisphere just north of the NEB (North Equatorial Belt) as well as a small dark spot imaged sporadically in the NTeB (North Temperate Belt) during the apparition. Indeed, it will be interesting to if the aforementioned features persist or new ones emerge among Saturn's belts and zones as this apparition progresses for skillful observers who are imaging image the planet and to those making visual drawings. Readers are thus encouraged to keep Saturn under watchful surveillance in the months to come.

Our observing programs are listed on the Saturn page of the ALPO website at *http://www.alpo-astronomy.org/saturn* as well as in considerable 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 strongly encouraged to pursue digital imaging of Saturn at the same time that others are imaging or visually watching the planet (i.e., simultaneous observations). And while routine 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 appreciates the dedicated work by so many observers who regularly submit their reports and images. *Cassini* mission scientists, as well as other professional specialists, are continuing 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*

Geocentric Phenomena for the 2014-15 Apparition of Saturn in Universal Time (UT)	
Conjunction	2014 Nov 18^{d}
Opposition	2015 May 23^{d}
Conjunction	Nov 30^{d}
Opposition Data:	
Equatorial Diameter Globe	18.5 arc-seconds
Polar Diameter Globe	16.5 arc-seconds
Major Axis of Rings	41.9 arc-seconds
Minor Axis of Rings	17.2 arc-seconds
Visual Magnitude (m_v)	0.0 m_v
B =	+24.2°
Declination	-18.3°

Remote Planets Section

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

Please send any observation reports of Uranus, Neptune or Pluto to me as soon as possible. I will start writing the 2014-2015 remote planets apparition report no later than June.

Contributor Jim Fox recorded the final measurement of Uranus on about February 10, 2015. Jim Fox, Frank Melillo and the writer carried out brightness measurements of at least one of the three remote planets.

During June and July, Pluto will be visible most of the night. Uranus and Neptune will be visible in the early morning with Neptune being higher. I am hoping that people will continue to collect red and near infrared images of Uranus and Neptune.

During July 2015, the New Horizons spacecraft will fly past Pluto. This will be the first human-made spacecraft to visit that distant world. It would be nice to get brightness measurements of Pluto during the summer of 2015.

A small group including myself is working on a paper summarizing over 60 years of brightness measurements of Uranus. It is hoped that this paper will be published in a future issue of the professional journal *Icarus*.

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*.

Walter H. Haas (July 3, 1917 - April 6, 2015)

From *http://www.skyandtelescope.com/astronomy-news/walter-haas-1917-2015-04072015/#sthash.X7PNsXVj.dpuf*

Amateur astronomy has lost a true pioneer, a keen observer who founded the worldwide Association of Lunar and Planetary Observers.

By: Kelly Beatty | April 8, 2015

Sometimes astronomy advances thanks to group efforts and sometimes due to the perseverance of a single individual. In the passing of Walter Haas on April 6th, we have lost someone who excelled at both. He died at age 97 of natural causes in Las Cruces, New Mexico, where he had lived for decades.

Haas devoted his entire life to the study of the Moon and planets. Growing up in tiny New Waterford, Ohio, Haas showed an early interest in astronomy that blossomed after spending a summer in Jamaica assisting the renowned planetary observer William H. Pickering. "Pickering, an advocate of a geologically active Moon, had a profound influence on Walter's early thinking," notes S&T Contributing Editor Tom Dobbins. Only 17 at the time, Haas returned to earn an undergraduate degree at Mount Union College in Ohio, where he spent countless nights observing with the school's 10-inch Saegmuller refractor.

At a time when professional astronomers held little regard for amateur observers beyond their meteor and variable-star reports, Haas changed the paradigm. First, he published (in 1938, at age 21) his in-depth observations of brightness changes around major lunar craters. Then, four years later, he followed with a four-part, 76-page opus titled "Does Anything Ever Happen on the Moon?" that appeared in the Journal of the Royal Astronomical Society of Canada. These became the opening salvo in a lifelong quest "to arouse interest in a neglected branch of astronomy."

After World War II, Haas taught mathematics at the University of New Mexico in Albuquerque and crunched the numbers at White Sands Missile range before ending up at New Mexico State University in Las Cruces. He remained there from 1954 until his retirement in 1983.

His passion for solar-system observing never waned, and he typically devoted 500 hours per year to observing the Moon. On March 1, 1947, while still at UNM, he dispatched a self-produced 6-page newsletter titled The Strolling Astronomer. Haas already envisioned this simple missive becoming something bigger: it was subtitled "Association of Lunar and Planetary Observers" and branded with "Volume 1, Number 1." By the second issue, a month later, the budding ALPO had grown to 41 members. Within six years, the association boasted 350 members from all around the world.

Kind, gentle, and patient, Haas was nonetheless unfailingly meticulous and objective when observing — and he expected the same rigor of others, especially those who hoped to have their observations published in The Strolling Astronomer. Some of these contributors went on to careers in astronomy and planetary science in particular. "Walter Haas influenced generations of observers," notes longtime friend and science writer Trudy E. Bell, who proudly notes that her first article (aside from those in campus newspapers) appeared in the ALPO journal's June 1970 issue.

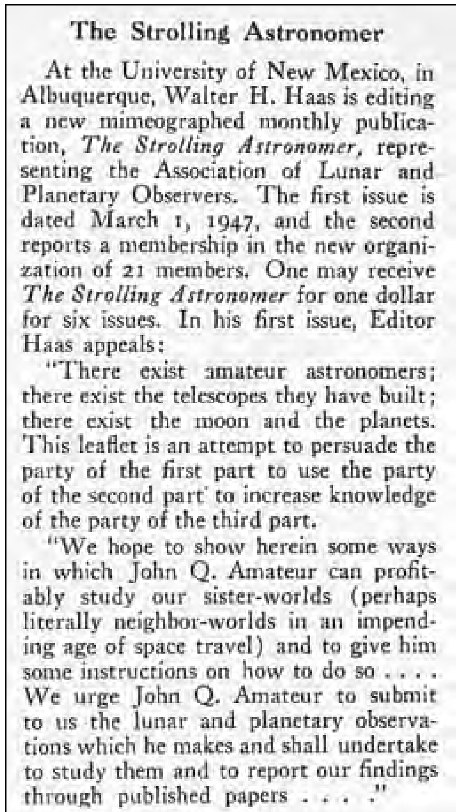
Meanwhile, the breadth and influence of ALPO itself flourished under Haas's leadership. More critically, the heightened visibility of amateur lunar and planetary observations paved the way for enduring professional-amateur collaborations (particularly in planetary studies) that continue today.

So does The Strolling Astronomer (now better known as the Journal of the Association of Lunar and Planetary Observers), the most recent issue of which includes articles on observing comets with giant binoculars and a review of claims for a dense atmosphere around Jupiter's moon Io.

Haas retired as ALPO's Executive Director in 1985 but continued to serve on its Board of Directors. In fact, notes ALPO's Matthew Will, Haas continued to assist his successor, Ken Poshedly, in the proofing and fact checking papers submitted to the journal until about seven or eight years ago. And he kept observing with his trusty 12½-inch Newtonian reflector, typically a couple of times per week, until being sidelined by a broken hip in 2004 (suffered after observing that year's transit of Venus).

Although in failing health recently, Haas remained mentally sharp. "Many of us owe an immeasurable debt of gratitude to Walter for shaping lunar and planetary astronomy for what it has evolved into today," reads the notice on ALPO's website.

Let's hope that, in the not-too-distant future, the current generation of planetary scientists finds a suitable crater on the Moon to bear the name Haas.



The Strolling Astronomer

At the University of New Mexico, in Albuquerque, Walter H. Haas is editing a new mimeographed monthly publication, *The Strolling Astronomer*, representing the Association of Lunar and Planetary Observers. The first issue is dated March 1, 1947, and the second reports a membership in the new organization of 21 members. One may receive *The Strolling Astronomer* for one dollar for six issues. In his first issue, Editor Haas appeals:

"There exist amateur astronomers; there exist the telescopes they have built; there exist the moon and the planets. This leaflet is an attempt to persuade the party of the first part to use the party of the second part to increase knowledge of the party of the third part.

"We hope to show herein some ways in which John Q. Amateur can profitably study our sister-worlds (perhaps literally neighbor-worlds in an impending age of space travel) and to give him some instructions on how to do so . . . . We urge John Q. Amateur to submit to us the lunar and planetary observations which he makes and shall undertake to study them and to report our findings through published papers . . . ."

he May 1947 issue of Sky & Telescope arried this announcement about the first ublication of The Strolling Astronomer, oon to become the *Journal of the ssociation of Lunar and Planetary Observers.*
ky & Telescope archives

Walter H. Haas (July 3, 1917 - April 6, 2015)

From http://cs.astronomy.com/asy/b/daves-universe/archive/2015/04/07/rip-walter-h-haas-lunar-and-planetary-champion.aspx

RIP Walter H. Haas, lunar and planetary champion

By: David Eicher | April 7, 2015

Very sad news this morning on the death of Walter H. Haas (1917–2015), founder and director emeritus of the Association of Lunar and Planetary Observers (ALPO), at the age of 97. Few astronomy enthusiasts did more over the past decades for amateur astronomy, heartily encouraging the study of the Moon and planets, careful observations and photography, and for years pushing for the now fully functional collaboration between amateur and professional astronomers.

Walter was always an exceptionally nice and encouraging force when I, as a teenager, got to know him — he always pushed me forward to follow my similar activities on the deep-sky side of the coin.

Walter will be greatly missed. Here is a release written and sent by Ken Poshedly, executive director of ALPO:

It is with great sadness that we let you know that we have been informed that Walter H. Haas, founder and director emeritus of our organization, the Association of Lunar and Planetary Observers, passed away on Monday morning, April 6, 2015, at 6:10 a.m. MDT (12:10 UT) of natural causes in Las Cruces, New Mexico, his hometown for many years.

Walter was born July 3, 1917. He founded the ALPO in 1947 and served as executive director until 1985.

He had been in gradually failing health recently, but his mind was still sharp as a tack.

Many of us owe an immeasurable debt of gratitude to Walter for shaping lunar and planetary astronomy for what it has evolved into today as well as shaping our own interest in the solar system and our lives.

Viewing will be at La Paz — Grahams Funeral Home, in Las Cruces, NM, on Monday, April 13 from 5 — 8 p.m. www.lapaz-grahams.com

Services will be held at First Presbyterian Church in Las Cruces, 200 W. Boutz, at 10 a.m., followed by a graveside service at 11 a.m.

Walter's daughter, Mary Alba, requests that in lieu of flowers, donations be made to your local hospice and the ALPO.

From Matt Will, membership secretary, the ALPO

I would like to thank everyone that expressed their condolences to our organization on the passing of our Founder and Executive Director Emeritus, Walter H. Haas. I have shared these condolences with Walter's daughter Mary.

In case you already haven't, you can check out the these websites for obituaries of Walter.

La Paz Graham Funeral Home *http://www.lapaz-grahams.com/fh/obituaries/obituary.cfm?o_id=3028828&fh_id=13379*

The Las Cruces Sun-News *http://www.legacy.com/obituaries/lcsun-news/obituary.aspx?n=walter-haas&pid=174618491&fhid=7157*

Again thank you all for sharing your kind words.

From Julius Benton, member of the ALPO board of directors, coordinator, the ALPO Venus and Saturn sections

A Personal Tribute to Walter

I remember well that first time I wrote to Walter Haas in 1969 expressing my interest in contributing observations of the moon, Saturn, and Venus to the ALPO, an organization where I had read in ***The Strolling Astronomer*** how useful they could eventually be to the scientific community. In that initial letter to Walter, I told him I was not really sure

Walter H. Haas (July 3, 1917 - April 6, 2015)

how much time I'd be able to spend observing since I had just graduated from college and was already enrolled in graduate school. His response, in what would become over the years his familiar "Walter Haas stationary" of hand-written messages on notebook paper, he warmly encouraged me to contribute whatever I could, understanding the rigors I was facing with advanced academic studies. His personable way of communicating with me left a lasting impression as I joined the ALPO that same year and started sending in observations. His philosophy of maintaining high standards for data integrity together with the informal atmosphere of the ALPO proved to be refreshing and wonderfully captivating, all attributable to Walter' special way of doing things that have meant so much to so many people who knew him. It was always easy to share different philosophical and scientific viewpoints with Walter, and the regular exchange of information and ideas with him always helped me improve as an observer and also as a person.

The first time met Walter in person was at the 1970 Astronomical League and ALPO conference in Memphis. He spent quite a bit of time with me discussing our mutual interests in Saturn. His enthusiasm for recording useful scientific observations was immediately contagious, and his influence motivated me even more about observing. I was surprised by a phone call from Walter one evening in early 1971 asking me if I would like to become the ALPO Saturn Recorder. I was flattered by the opportunity and gladly accepted the challenge, and it was only a year or two later that Walter also called and appointed me to an additional responsibility as ALPO Venus Recorder. I remain eternally grateful to him for the confidence he placed in me as I still lead those Sections after nearly 45 years. He always told me that Saturn was his favorite planet and I have many, many wonderful observations he sent me over the years, memories I will treasure always. His simple method for estimating latitudes at the eyepiece, as well as his methodology for recording the bicolored aspect of Saturn's rings, are some of his lasting contributions to the way we observe the planet that I'll always remember.

Although I am filled with sadness knowing my long-time friend and colleague Walter is no longer with us, his spirit lives on eternally in my heart. I will think of him every time I observe and image Saturn, now and in the years to come. He was my inspiration, and he taught me so much over the years. I miss him so very much.

From Richard W. Schmude, Jr., member of the ALPO board of directors, coordinator, the ALPO Remote Planets Section, assistant coordinator, the ALPO Mars and Jupiter sections

I first became familiar with Walter Haas after looking at one of his Mars papers published in the *Journal of the Royal Astronomical Society of Canada*. I believe that had published this paper either in the 1930s or early 1940s.

I first met Walter in 1988 at the ALCON88 meeting in Council Bluffs, Iowa. At about the same time I remember writing to him about early ALPO studies of the planet Uranus. He sent me several ALPO articles covering ALPO Uranus work. During a few years he would also send me his Jupiter and remote planet observations. Over the years, I have grown to appreciate the hard work that he did for our field. Walter was a great friend and he will be missed.

From Robert Lunsford, coordinator, the ALPO Meteors Section

It's another sad day as we hear the news of Walter's passing. He was very fond of meteor observing and enjoyed the meteor section newsletters I would send him.

Now we have lost 2 giants of the astronomical community and dear friends to many (Walter Haas and Don Parker).

From Kim Hay, coordinator, the ALPO Solar Section

Very sad news indeed. I met him once with a combined event with astronomical groups, very nice man.

He will be missed.

From Frank Melillo, coordinator, the ALPO Mercury Section

I'm sorry to hear Walter Hass passing. I met him first time at the ALCON 2001 in Frederick, MD. He was one of the first persons I spoke to and he was amazed of my Mercury and Venus images. He was well aware of my planetary work even back in the earlier 1980s that I became a member.

Please, accept my sympathy for our father of ALPO and he will be truly missed.

From Hazel McGee, president, the British Astronomical Assn

Walter Haas first joined the BAA in 1943 and has always taken an active interest in our work. As advised by then President Bill Leatherbarrow in the 2013 April BAA Journal, he recently gifted his personal set of the ALPO Journal, "The Strolling Astronomer" to the BAA, which stands in the UK as a memorial to his name. We extend our deepest condolences to his family and friends and to the ALPO in their loss.

Walter H. Haas (July 3, 1917 - April 6, 2015)

From John Goss, current president, the Astronomical League

Walter Haas was a Titan in amateur astronomy, especially in the planetary sciences side. Anyone who knew anything in the field knew about Walter. He inspired many to observe, to document, to analyze, and to report what the professionals could not or would not. He realized many years ago that amateurs not only could play but should play an important role in understanding our solar system.

I'm sorry that we no longer have the opportunity to meet with him again at this year's ALCon. Yes, Walter Haas will be missed.

From Bob Gent, past president, the Astronomical League

(Walter's) list of achievements was amazing, and yet, he was always such a kind person and so encouraging. He was a true inspiration to many of us. Based on his exceptional contributions to astronomy, he won the second Astronomical League award ever presented in 1952. He will be missed more than words can explain.

From Barb Yager, the Southern Cross Astronomical Society

Although I never had the pleasure of meeting Walter, I know my dear pal Don Parker M.D. proudly received his ALPO observing award from Walter a few years ago. When those two get together there will be a lot of debates on going from above.

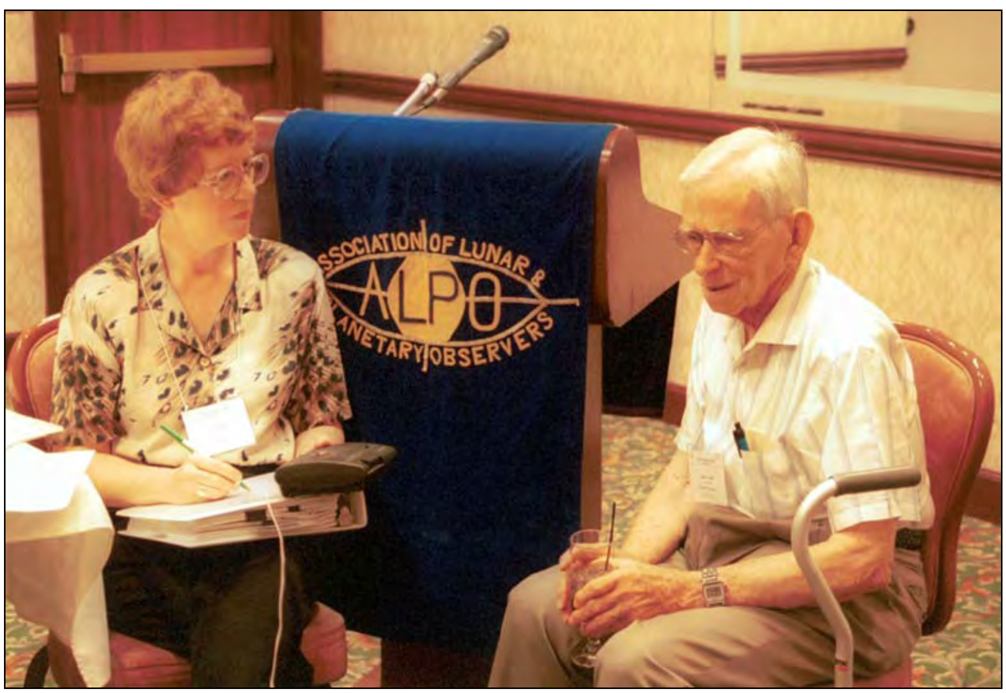
From Trudy E. Bell, author and writer about astronomy, etc.

A great man. I was fortunate enough to hear him talk at several WAA/ALPO conventions in the late 1960s – especially the memorable SAC'68 convention in Las Cruces, and also to interview him at length in August 2003 for a profile published a year and a half later in Astronomy. Although by that time he was physically frail and using a walker, he was incisive in his questions to ALPO speakers. I still have the tape from the interview (my recollection is that I was just asking questions to which I had not already found answers in all the letters and other materials he had made available to me in that binder on my lap). He also played a unique role in my personal life – he published my very first-ever article (outside of the college newspaper), in *The Strolling Astronomer* (on the March 1970 total solar eclipse).

From Dick Hodgson, founder, the ALPO Minor Planets Section

I had not heard from other sources, so it was a surprise to me. It is a funny thing, but I was thinking about Walter a few days ago, and wondering about how life was going for him. Now I know. Walter was a great gentleman and guide to astronomy.

Walter made a big impact upon my life. In 1963, a few months after my wife Nancy and I married, we visited Walter and Peggy in New Mexico and enjoyed a wonderful supper in their home, followed by a little observing. In 1966 Walter appointed me as the ALPO Mercury Section Recorder, and gave me an opportunity to promote observations of the difficult-to-observe planet. It was a step for me into a career teaching astronomy, especially planetary astronomy. I also pushed observation of the minor planets in the late 1960's. In 1973, Walter appointed me to introduce an ALPO Minor Planets Section, and in response, to facilitate rapid response among asteroid observers, I founded the "Minor Planet Bulletin" (MPB) which now flourishes as an amateur-professional astronomy coalition under the skillful hand of Rick Binzel. Thank you, Walter, for all the positive waves you set in motion in many directions! The ALPO, now carried along by many diligent members, continues to expand our knowledge of planetary astronomy, building on the foundations Walter laid.



Trudy Bell with Walter during an interview in 2003 for a profile article of him in *Astronomy* magazine.

Walter H. Haas (July 3, 1917 - April 6, 2015)

My best wishes for the future to you and all the ALPO membership

From Ray Missert, last surviving charter member of the ALPO

I was saddened to hear of Walter's passing, but it does bring me some fond memories in having been privileged to know him, and in having been an early part of the ALPO observing-corps that he created, nurtured, and brought to such a fine lasting maturity.

I thought I would pass along here a few thoughts on those early years that came to mind as I was reading Walter's obituary. Although my active participation was so many years ago now, I can still remember, as a young observer in my high-school and early-college years, eagerly awaiting the arrival of the "Strolling Astronomer" issues, wondering what they might portend for new lunar and planetary observations. For me, Walter always had a knack for weaving a compelling narrative from member-contributions, that helped put what we were doing into the larger context of meaningful lunar-and-planetary explorations and studies. That was very motivating for me.

With the encouragement of Walter and others ALPO'ers, I learned to sketch-out details on the moon and planets, submitting some to the "Strolling Astronomer".

As you may be aware, the skies over Buffalo are none-too-kind to planetary observers (with its location nestled between two of the Great Lakes, the atmosphere around Buffalo is a great place for cloud-formation, and, perhaps more significantly, of wind-shears and turbulence!). None-the-less, using my homemade 6" Newtonian, and with some persistence, finer details on Jupiter, Saturn and the Moon would occasionally "pop-out", and I always felt honored and encouraged when Walter would publish some of my results.

Encouraged also by Walter to get in touch with fellow observers, I had some memorable correspondence in those days with fellow ALPO'ers Tom Cave and Elmer Reese, and a Japanese observer by the name of Watanabe (his first-name might have been Hideki, but I'm not certain). My correspondence with Elmer led to my presenting a paper of Elmer's on the "Time-Variations in the Brightness of the Four Galilean Moons" at the Astronomical League's Convention at Wellesley College, Massachusetts in the early '50's. With the paper-presentation as a motivation, a group of us from the local astronomy-club (the "Amateur Telescope Makers of Buffalo" (now the Buffalo Astronomical Association) motored over to Massachusetts. We had a great time while there. (Some conversations with Roland LaPelle there led to my incorporating his "circular" diagonal holder in my 6" Newtonian, eliminating the spikes on stellar images, and it worked out quite well).

All-in-all Walter was a wonderful mentor for me in those days. May his memory and his legacy live on wherever ALPO'ers gather.

From Antonin Rukl, author of "Atlas of the Moon" and many others

Thanks to the kind invitation from Ken Poshedly, I visited Atlanta in 2000 to give two presentations at that year's Peach State Star Gaze. Also in attendance at that event were various members of the ALPO.

For me this was a really remarkable event and a most valuable experience. Firmly saved in my memory are the meetings and my discussions with Walter Haas. It was a great privilege to meet this renowned person, known to me previously only from various literature. I remember him as a very friendly and wise man. And I fully agree that naming one lunar crater "Haas", as proposed recently by Kelly Beatty of Sky & Telescope magazine, could be an appropriate acknowledgement for Walter´s work. (I hope that the IAU would select a nearside site for the benefit of the Earthbound observers.)

(From left to right) Ken Poshedly, Antonin Rukl and Walter with the Atlanta Astronomy Club's 20-inch reflector at the AAC's observatory.

Feature Story: Venus

ALPO Observations of Venus During the 2009-2010 Western (Morning) Apparition

By Julius L. Benton, Jr., coordinator
ALPO Venus Section
jlbaina@msn.com

An ALPO Venus Section Observing Report Form is located at the end of this report.

Abstract

Eight observers from the United States, Canada, France, Germany, Italy, and Poland contributed digital images and visual observations (drawings and descriptive reports) to the ALPO Venus Section during the 2009-10 Western (Morning) Apparition. This report summarizes the results of the 114 total observations. Types of telescopes and accessories used in making the observations, as well as sources of data, are discussed. Comparative studies take into account observers, instruments, visual and photographic results. The report includes illustrations and a statistical analysis of the long-established categories of features in the atmosphere of Venus, including cusps, cusp-caps, and cusp-bands, seen or suspected at visual wavelengths in integrated light and with color filters, as well as digital images captured at visual, ultraviolet (UV), and infrared (IR) wavelengths. Terminator irregularities and the apparent phase phenomena, as well as results from continued monitoring of the dark hemisphere of Venus for the enigmatic Ashen Light are discussed.

Introduction

The ALPO Venus Section received 114 observations for the 2009-10 Western (Morning) Apparition, comprised of visual drawings, descriptive reports, and digital images from sixteen observers residing in the United States, Canada, France, Germany, Italy and Poland. Geocentric phenomena in Universal Time (UT) for this observing season are given in *Table 1*, while *Figure 1* shows the distribution of observations by month during the apparition. *Table 2* gives the location where observations were made, the number of observations submitted, and the telescopes utilized.

Observational coverage of Venus during this apparition was not nearly as good as in the immediately preceding 2010 Eastern (Evening) Apparition. Nevertheless, a few individuals began their monitoring of the planet early on, and one observer, Detlev Niechoy, sketched the crescent Venus only a couple of days after Inferior Conjunction, which occurred on October 29, 2010 [Refer to Illustration No. 001]. The observational reports upon which this report is based spanned the period starting October 31, 2010 through July 28, 2011, with 81.6% of the total contributions for January through June 2011. For the 2010-11 Western (Morning) Apparition of Venus, observers witnessed the trailing hemisphere of Venus at the time of sunrise on Earth (a progression from crescent through gibbous phases) as the planet passed

Terminology: Western vs Eastern

"Western" apparitions are those when an "inferior" planet (Mercury or Venus, whose orbits lie inside the Earth's orbit around the Sun) is **west of the Sun**, as seen in our morning sky before sunrise.

"Eastern" apparitions are those when that planet is **east of the Sun,** as seen in our sky after sunset.

All Readers

Your comments, questions, etc., about this report are appreciated. Please send them to: *poshedly@bellsouth.net* for publication in the next Journal.

Online Features

Left-click your mouse on:

The author's e-mail address in blue text to contact the author of this article.
The references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Observing Scales

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

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

Scale of Transparency Conditions:
Estimated magnitude of the faintest star observable near Venus, allowing for daylight or twilight

IAU directions are used in all instances.

through greatest brilliancy (-4.6 m_v), dichotomy, and maximum elongation from the Sun (47.0°). Observers are urged to try to carry out systematic observations of Venus when seeing conditions permit from conjunction to conjunction, and the ALPO Venus Section is quite fortunate to have a growing team of persistent, dedicated observers who have tried very hard to do that in recent observing seasons.

Figure 2 shows the distribution of observers and contributed observations by nation of origin for this apparition, where it can be seen that 37.5% of the participants in our programs were located in the United States, and they accounted for 25.4% of the total observations. Continued international cooperation took place during this observing season, whereby 62.5% of the observers resided outside the United States and contributed 74.6% of the overall observations. The ALPO Venus

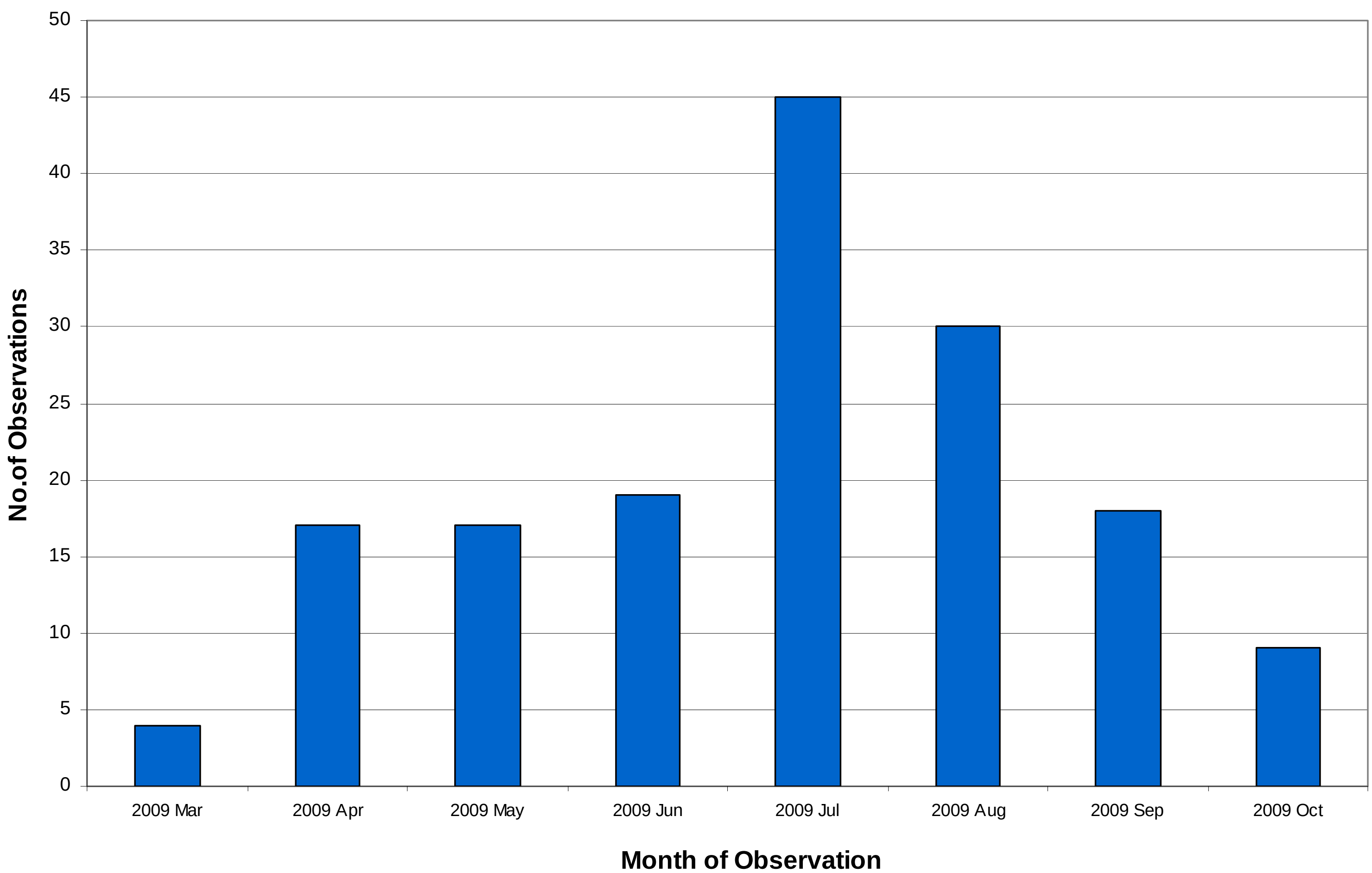
Table Geocentric Phenomena in Universal Time (UT) for the 2010-11 Western (Morning) Apparition of Venus

Inferior Conjunction	2010 Oct 29^d 01^h UT
Initial Observation	Oct 31 12:36
Greatest Brilliancy	Dec 04 10:005 ($m_V = -4.6$)
Dichotomy (predicted)	2011 Jan 08 06:43:12 (08.28^d)
Greatest Elongation West	Jan 08 16:00 (47.0°)
Final Observation	Jul 28 11:10
Superior Conjunction	Aug 16 00
Apparent Diameter (observed range): 61.8" (2010 Oct 31) ↔ 9.9" (2011 Jul 28)	
Phase Coefficient, ***k*** (observed range): 0.007 (2010 Oct 31) ↔ 0.985 (2011 Jul 28)	

Figure 1

Distribution of Observations By Month During the 2009-10 Western (Morning) Apparition of Venus

159 Total Observations Submitted By 16 Observers in 2009-10



Section welcomes a widening global team of observers in the future.

The types of telescopes used to observe and image Venus are shown in *Figure 3*. All observations submitted were made with telescopes of at least 9.0 cm (3.5 in.) in aperture. During the 2009-10 Western (Morning) Apparition of Venus, the frequency of use of classical designs (refractor and Newtonian) was only 14.9%, while utilization of catadioptrics (Schmidt-Cassegrain and Maksutov-Cassegrain) was 85.1%. All visual and digital observations were performed under twilight or daylight conditions, generally because more experienced Venus observers have found that viewing the planet during twilight or in full daylight substantially reduces the excessive glare associated with the planet. Also, viewing or imaging Venus when it is higher in the sky substantially cuts down on the detrimental effects of atmospheric dispersion and image distortion prevalent near the horizon.

The writer expresses his gratitude to the eight observers who made this report possible by regularly sending in their drawings, descriptive reports, and digital images of Venus in 2009-10. Readers who wish to follow Venus in coming apparitions are urged to join the ALPO and start participating in our observational studies. There is no doubt that the brightness of Venus makes it an easy object to find, and around the dates of greatest elongation from the Sun, it can be as much as 15 times brighter than Sirius and can even cast shadows when viewed from a dark, moonless observing site. Getting started in the Venus Section programs requires only minimal aperture, ranging from 7.5 cm (3.0 in.) for refractors to 15.2 cm (6.0 in.) reflectors.

Table 2: ALPO Observing Participants in the 2009-10 Western (Morning) Apparition of Venus

Observer and Observing Site	No. Obs.	Telescope Used*
Benton, Julius L. Wilmington Island (Savannah), GA	27	9.0 cm (3.5 in.) MAK
Frassati, Mario Crescentino, Italy	1	20.3 cm (8.0 in.) SCT
Jakiel, Richard Lithia Springs (Atlanta), GA	1	30.5 cm (12.0 in.) SCT
Malinski, Piotr Warsaw, Poland	2	20.3 cm (8.0 in.) SCT
Mattei, Michael Littleton, MA	1	20.3 cm (8.0 in.) SCT
Niechoy, Detlev Göttingen, Germany	93	20.3 cm (8.0 in.) SCT
Roussell, Carl Hamilton, Ontario, Canada	13	15.2 cm (6.0 in.) REF
Viladrich, Christian Paris, France	13	15.2 cm (6.0 in.) REF
Total No. of Observers	8	
Total No. of Observations	114	
*REF = Refractor, SCT = Schmidt-Cassegrain, MAK = Maksutov-Cassegrain		

Observations of Atmospheric Details on Venus

The methods and techniques for visual studies of the especially faint, elusive "markings" in the atmosphere of Venus are described in detail in ***The Venus Handbook***, available from the ALPO Venus Section in printed or pdf format. Readers who maintain archives of earlier issues of this Journal may also find it useful to consult previous apparition reports for a historical account of ALPO studies of Venus. [See "References" on page 31.]

Most of the drawings and digital images used for this analytical report were made at visual wavelengths, but several observers routinely imaged Venus in infrared (IR) and ultraviolet (UV) wavelengths. Some examples of submitted observations in the form of drawings and images accompany this report to help readers interpret the level and types of atmospheric activity reported on Venus this apparition.

Represented in the photo-visual data for this apparition were all of the long-established categories of dusky and bright markings in the atmosphere of Venus, including a small fraction of radial dusky features, described in the literature cited earlier in this report. *Figure 4* shows the frequency of identifiable forms of markings seen or suspected on Venus. Most observations referenced more than one category of marking or feature, so totals exceeding 100% are not unusual. At least some level of subjectivity is inevitable when visual observers attempt to describe, or accurately represent on drawings, the variety of highly elusive atmospheric features on Venus, and this natural bias had some effect on the data represented in *Figure 4*. It is assumed, however, that conclusions discussed in this report are, at the very least, quite reasonable interpretations.

Figure 2

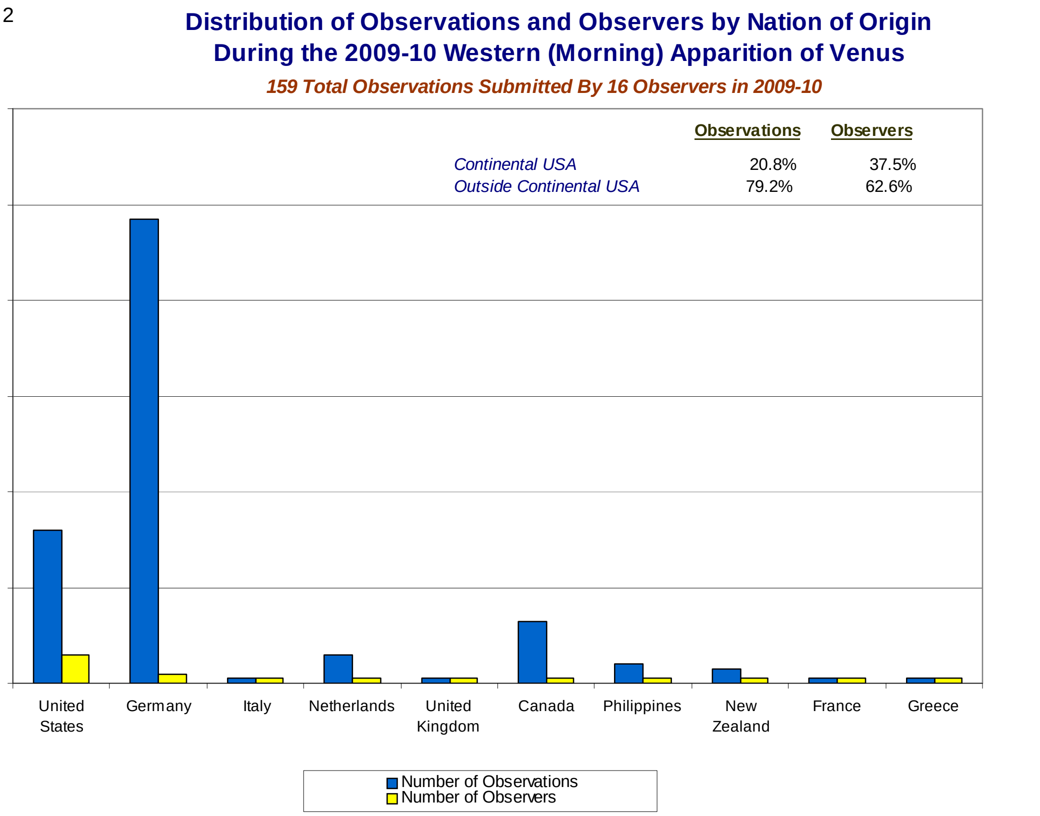
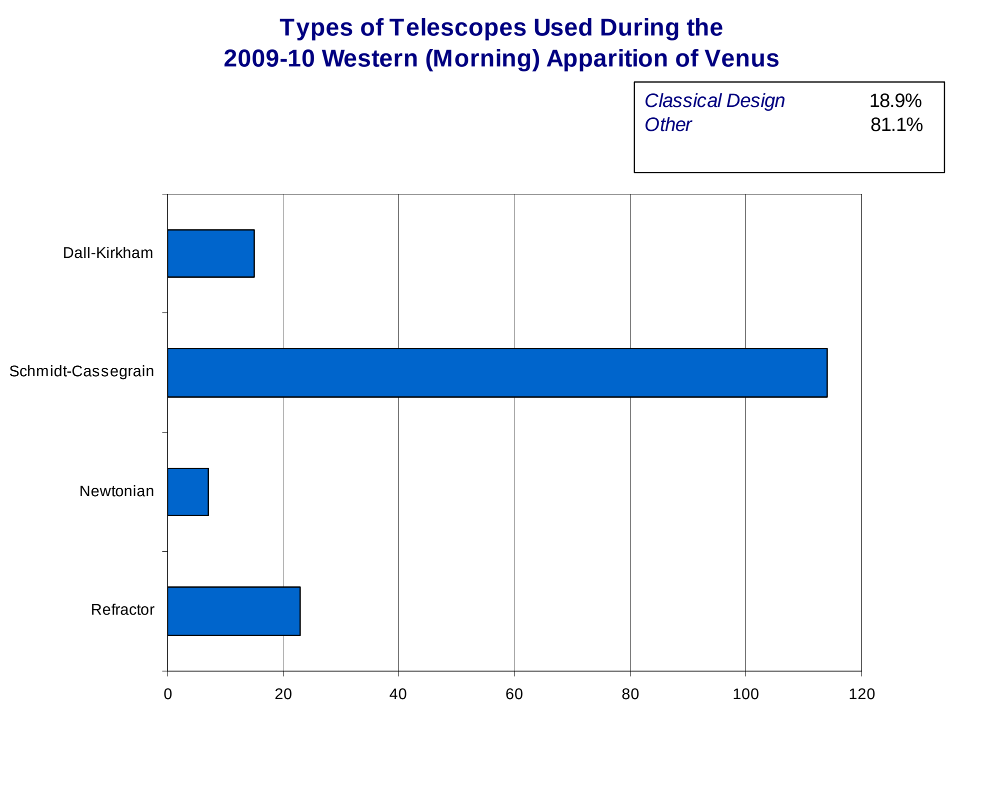


Figure 3



***General Caption Note for Illustrations 1-28**. REF = Refractor, SCT = Schmidt-Cassegrain, NEW = Newtonian, DALL = Dall-Kirkham; UV = Ultra Violet light; Seeing on the Standard ALPO Scale (from 0 = worst to 10 = perfect); Transparency = the limiting naked-eye stellar magnitude.*

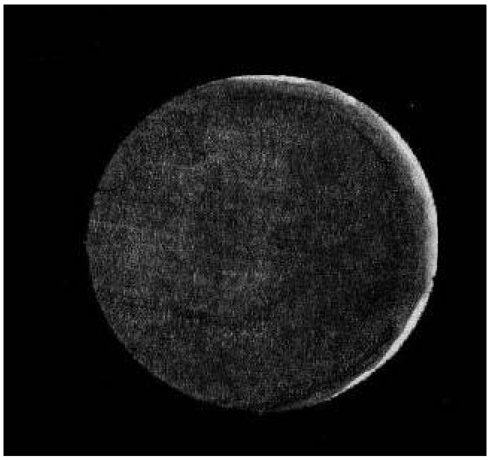


Illustration 001. 2009 Mar 31 12:51 UT, Detlev Niechoy, Göttingen, Germany, 20.3 cm (8.0 in.) SCT, Drawing @ 225X W25 (red) filter, Seeing 4.0 (interpolated), Transparency (not specified), Phase (k) = 0.014, Apparent Diameter = 59.2”, Drawing shows very thin crescent of Venus just 4 days after Inferior Conjunction; S is at the top of the image.

Illustration 002. 2009 Apr 19 16:13 UT, Michael Mattei, Littleton, MA, 35.6 cm (14.0 in.) SCT, IR filter 807nm, Seeing 4.5, Transparency (not specified), Phase (k) = 0.147, Apparent Diameter = 47.6”, IR image of bright crescent of Venus with terminator shading; S is at the top of the image.

The dusky markings of Venus’ atmosphere are always troublesome to detect using normal visual observing methods, and this well-known characteristic of the planet is generally independent of the experience of the observer. When color filters and variable-density polarizers are utilized as a routine practice, however, views of cloud phenomena on Venus at visual wavelengths are often measurably improved. Without neglecting vital routine visual work, the ALPO Venus Section urges observers to try their hand at digital imaging of Venus at UV and IR wavelengths. The morphology of features captured at UV and IR wavelengths is frequently quite different from what is seen at visual regions of the spectrum, particularly atmospheric radial dusky patterns (in the UV) and the appearance of the dark hemisphere (in IR). Similarities do occasionally occur, though, between images taken at UV wavelengths and drawings made with blue and violet filters. The more of these that the ALPO Venus Section receives during an observing season, the more interesting are the comparisons of what can or cannot be detected visually versus what is captured by digital imagers at different wavelengths.

Figure 4 illustrates that in only 4.6% of the observations submitted this apparition the dazzlingly bright disc of Venus was considered as being completely devoid of atmospheric features [Refer to Illustrations No. 002 and 003]. When dusky features were seen or suspected, or imaged, on the brilliant disc of Venus, the highest percentage was Banded Dusky Markings” (93.1%), followed by “Amorphous Dusky Markings” (82.8%),”Irregular Dusky Markings” (66.7%) [Refer to Illustrations No. 004 thru 011, 022, 023, and 027] and “Radial Dusky Markings” (2.3%) [Refer to Illustration No. 024], whereby the latter are normally only revealed in UV images.

Terminator shading was reported in 97.7% of the observations, as shown in *Figure 4*. Terminator shading normally extended from one cusp of Venus to the other, and the dusky shading was progressively lighter in tone (higher intensity) from the region of the

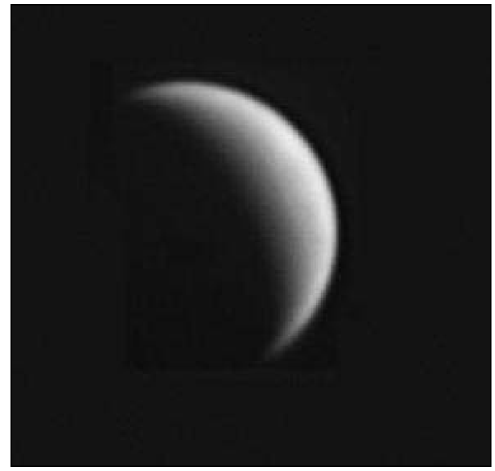


Illustration 003. 2009 May06 13:43-13:48 UT, Paul Maxson, Phoenix, AZ, 25.4 cm (10.0 in.) DALL, IR and UV wavelengths, Seeing (not specified), Transparency (not specified), Phase (k) = 0.295, Apparent Diameter = 36.2”, View of the crescent Venus in UV; no obvious features other than terminator shading and bright limb band; S is at the top of the image.

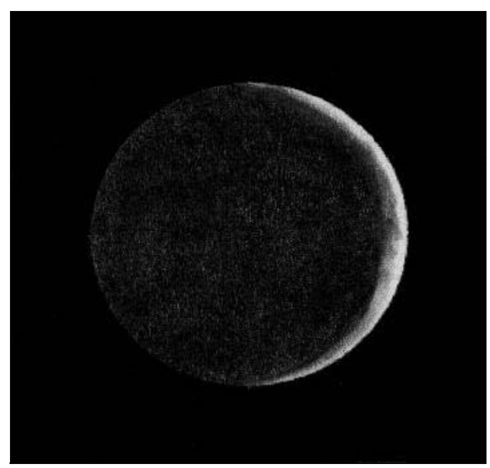


Illustration 004. 2009 Apr 12 10:18 UT, Detlev Niechoy, Göttingen, Germany, 20.3 cm (8.0 in.) SCT, Drawing @ 225X W47 (violet) filter, Seeing 3.0 (interpolated), Transparency (not specified), Phase (k) = 0.083, Apparent Diameter = 53.0”, Drawing depicts thin crescent with amorphous dusky features and terminator shading; S is at the top of the image.

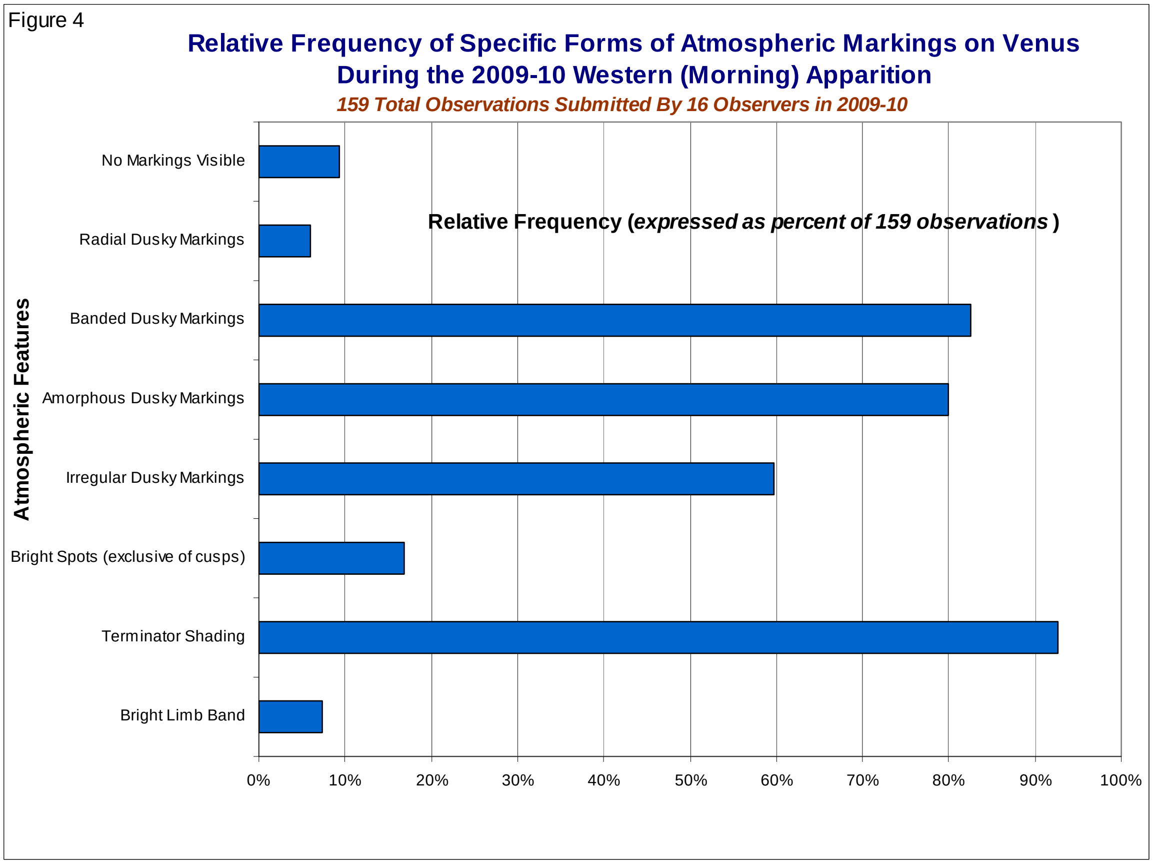


Figure 4
Relative Frequency of Specific Forms of Atmospheric Markings on Venus
During the 2009-10 Western (Morning) Apparition
159 Total Observations Submitted By 16 Observers in 2009-10
Relative Frequency (expressed as percent of 159 observations)
Atmospheric Features
No Markings Visible
Radial Dusky Markings
Banded Dusky Markings
Amorphous Dusky Markings
Irregular Dusky Markings
Bright Spots (exclusive of cusps)
Terminator Shading
Bright Limb Band
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

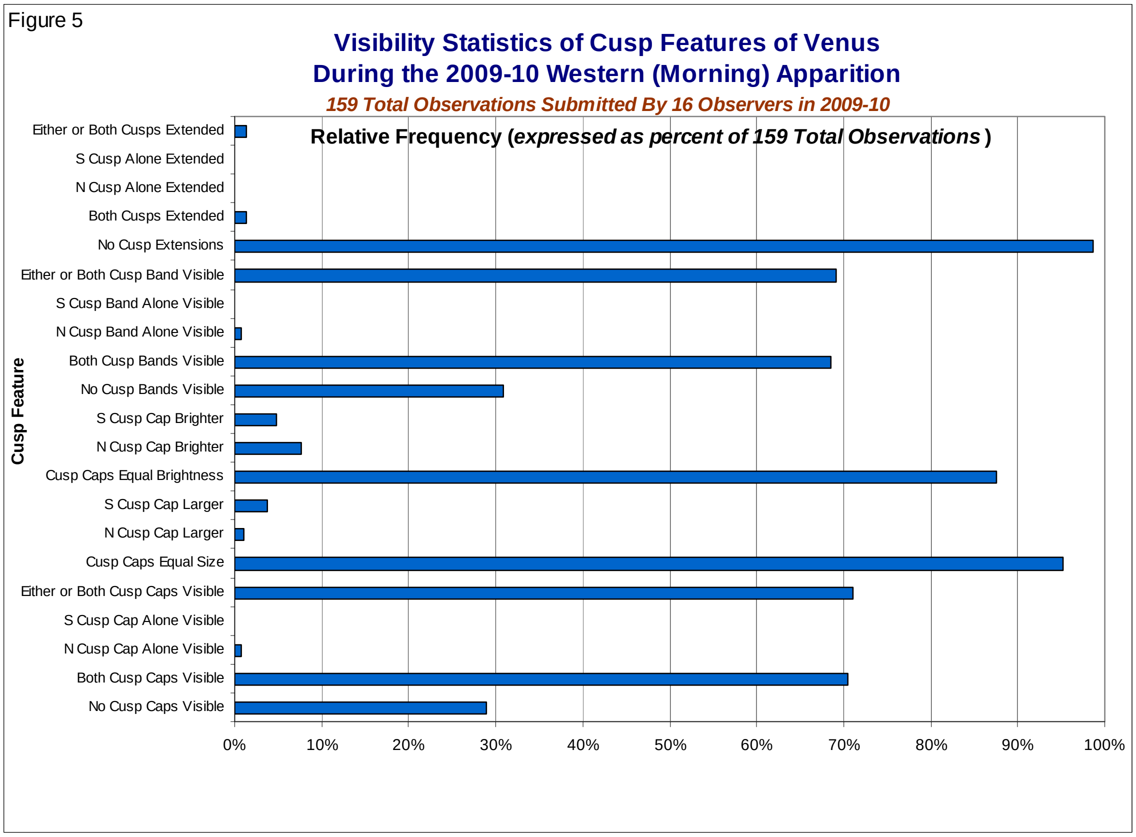


Figure 5
Visibility Statistics of Cusp Features of Venus
During the 2009-10 Western (Morning) Apparition
159 Total Observations Submitted By 16 Observers in 2009-10
Relative Frequency (expressed as percent of 159 Total Observations)
Cusp Feature
Either or Both Cusps Extended
S Cusp Alone Extended
N Cusp Alone Extended
Both Cusps Extended
No Cusp Extensions
Either or Both Cusp Band Visible
S Cusp Band Alone Visible
N Cusp Band Alone Visible
Both Cusp Bands Visible
No Cusp Bands Visible
S Cusp Cap Brighter
N Cusp Cap Brighter
Cusp Caps Equal Brightness
S Cusp Cap Larger
N Cusp Cap Larger
Cusp Caps Equal Size
Either or Both Cusp Caps Visible
S Cusp Cap Alone Visible
N Cusp Cap Alone Visible
Both Cusp Caps Visible
No Cusp Caps Visible
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

terminator toward the bright planetary limb. Many observers described this upward gradation in brightness as ending in the Bright Limb Band. A considerable number of images at visual wavelengths showed terminator shading, but it was most obvious on many UV images [Refer to Illustration No. 025].

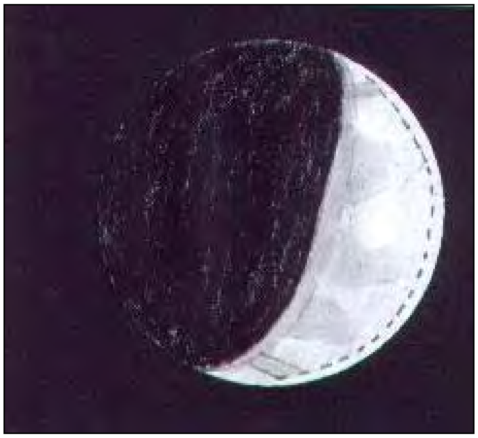


Illustration 005. 2009 May 12 16:07-16:25 UT, Carl Roussell, Hamilton, Ontario, Canada, 15.2 cm (6.0 in.) REF, Drawing @ 200-400X Integrated Light, W25, W58, W47 filters, Seeing 6.0, Transparency (not specified), Phase (k) = 0.342, Apparent Diameter = 33.0", Excellent drawing shows banded dusky markings, cusp caps, cusp bands, terminator shading, and the bright limb band complete from cusp-to-cusp; S is at the top of the image.

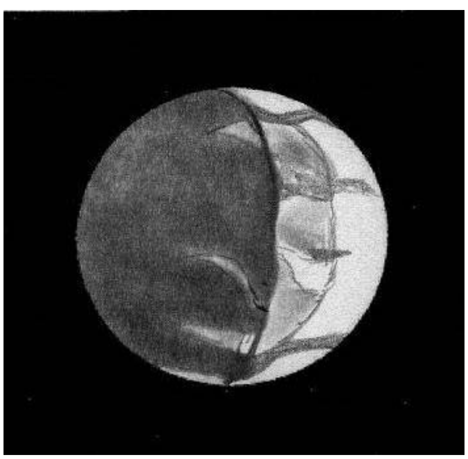


Illustration 006. 2009 May 23 02:53 UT, Detlev Niechoy, Göttingen, Germany, 20.3 cm (8.0 in.) SCT, Drawing @ 82X to 225X Integrated Light, Seeing 4.0 (interpolated), Transparency (not specified), Phase (k) = 0.415, Apparent Diameter = 28.5", Banded and irregular dusky markings are represented in this drawing along with cusp caps, cusp bands, and terminator shading; Ashen Light was claimed to be definitely seen on at least a portion of the otherwise dark hemisphere; S is at the top of the image.

The mean numerical relative intensity for all of the dusky features on Venus this apparition averaged about 8.7. The ALPO Scale of Conspicuousness (a numerical sequence from 0.0 for "definitely not seen" up to 10.0 for "definitely seen") was used regularly, and the dusky markings in *Figure 4* had a mean conspicuousness of ~3.8 throughout the apparition, suggesting that the atmospheric features on Venus were within the range from very indistinct impressions to fairly strong indications of their actual presence.

Figure 4 also shows that "Bright Spots or Regions," exclusive of the cusps, were seen or suspected in 21.8% of the submitted observations and images. As a normal practice, when visual observers detect such bright areas, it is standard practice for to denote them on drawings by using dotted lines to surround them.

This apparition, observers regularly used color filter techniques when viewing Venus, and when results were compared with studies in Integrated Light, it was evident that color filters and variable-density polarizers improved the visibility of otherwise indefinite atmospheric markings on Venus.

The Bright Limb Band

Figure 4 illustrates that a little over two-thirds of the submitted observations (92.0%) this apparition referred to a very conspicuous "Bright Limb Band" on the illuminated hemisphere of Venus. When the Bright Limb Band was visible or imaged, it appeared as a continuous, brilliant arc running from cusp to cusp 86.2% of the time, and interrupted or only marginally visible along the limb of Venus in 13.8% of the positive reports. The bright limb band was more likely to be incomplete in UV images than those captured in the visible spectrum as well as submitted drawings. The mean numerical intensity of the Bright Limb Band was 9.8, seemingly a bit more obvious when color filters or variable-

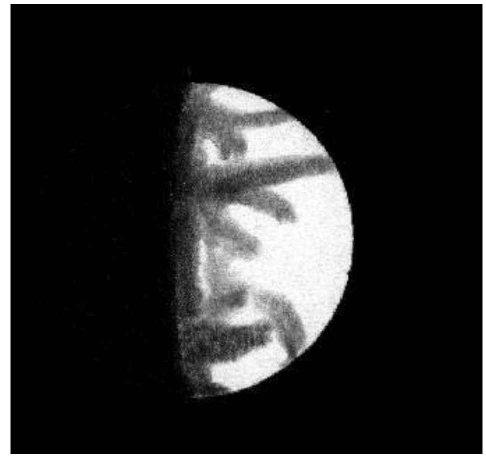


Illustration 007. 2009 Jun 13 08:28 UT, Detlev Niechoy, Göttingen, Germany, 20.3 cm (8.0 in.) SCT, Drawing @ 225X W25 (red) filter, Seeing 3.0 (interpolated), Transparency (not specified), Phase (k) = 0.535, Apparent Diameter = 22.1", Banded and irregular dusky markings appear on this drawing including obvious terminator shading; Venus reached point of theoretical dichotomy (half-phase) on June 6th; S is at the top of the image.

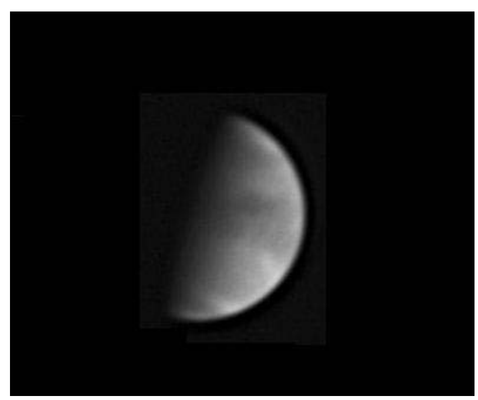


Illustration 008. 2009 Jun 23 10:50 UT, Rick Schrantz, Nicholasville, KY, 25.4 cm (10.0 in.) NEW, Schuler UV filter, Seeing (not specified), Transparency (not specified), Phase (k) = 0.584, Apparent Diameter = 20.0", Detailed UV image with obvious banded dusky markings blending into terminator shading, and bright areas exclusive of the cusp regions; S is at the top of the image.

density polarizers were used. This very bright feature, usually reported by visual observers this apparition [Refer to Illustration No. 005], was also seen on a fairly large number of digital images of Venus received [Refer to Illustration No. 021].

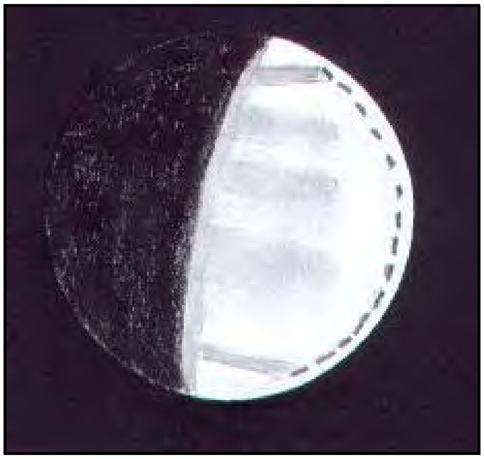


Illustration 009. 2009 Jun 23 14:25-14:50 UT, Carl Roussell, Hamilton, Ontario, Canada, 15.2 cm (6.0 in.) REF, Drawing @ 200-400X Integrated Light, W25, W58, W47 filters, Seeing 7.0, Transparency (not specified), Phase (k) = 0.585, Apparent Diameter = 20.0”, Drawing depicts banded dusky markings, cusp caps, and cusp bands; S is at the top of the image.

Terminator Irregularities

The terminator is the geometric curve that separates the brilliant sunlit and dark hemispheres of Venus. A deformed or asymmetric terminator was reported in 58.4% of the observations. Amorphous, banded, and irregular dusky atmospheric markings often seemed to merge with the terminator shading, possibly contributing to some of the reported incidences of irregularities. Filter techniques usually improved the visibility of terminator asymmetries and associated dusky atmospheric features. Bright features adjacent to the terminator can occasionally take the form of bulges, while darker markings may appear as wispy hollows [Refer to Illustration No. 007].

Cusps, Cusp-Caps, and Cusp-Bands

When the phase coefficient, k, is between 0.1 and 0.8 (the phase coefficient is the fraction of the disc that is illuminated), atmospheric features on Venus with the greatest contrast and overall prominence are consistently sighted at or near the planet's cusps, bordered sometimes by dusky cusp-bands. Figure 5 shows the visibility statistics for Venusian cusp features for this apparition.

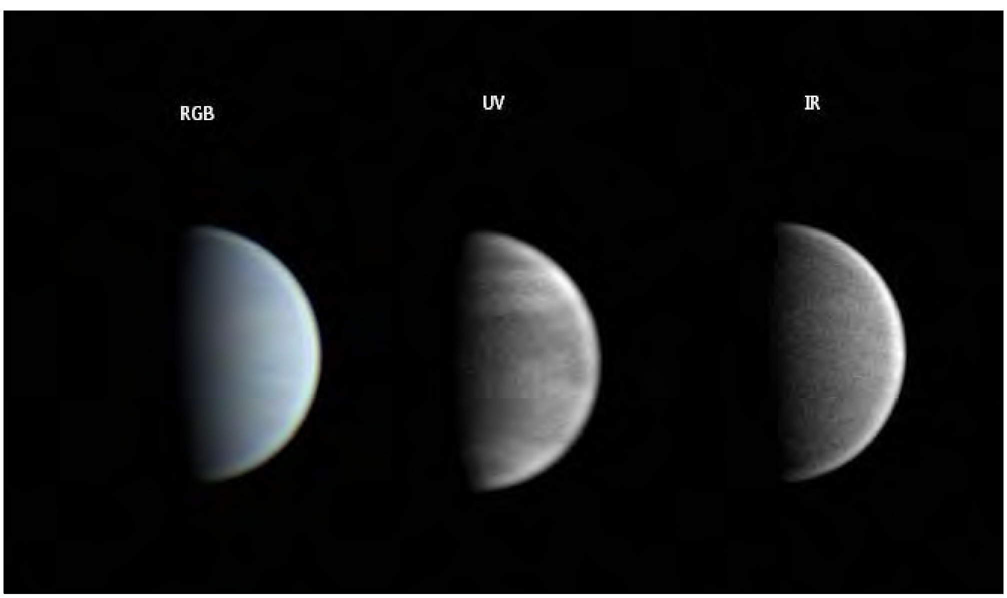


Illustration 010. 2009 Jun 25 21:05-21:11 UT, Tomio Akutsu, Cebu City, Philippines, 35.6 cm (14.0 in.) SCT, RGB, UV, IR filters, Seeing 5.0, Transparency 3.0, Phase (k) = 0.595, Apparent Diameter = 19.5”, Compare appearance of banded and amorphous dusky markings, terminator shading and the bright limb band in these detailed images in RGB, UV, and IR wavelengths; S is at the top of the image.

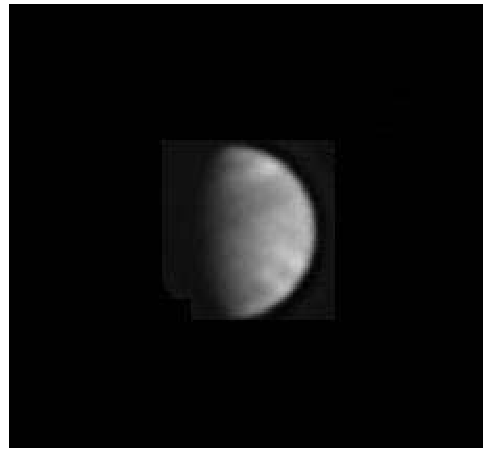


Illustration 011. 2009 Jul 06 13:31-13:32 UT, Paul Maxson, Phoenix, AZ, 25.4 cm (10.0 in.) DALL, UV (335nm) filter, Seeing (not specified), Transparency (not specified), Phase (k) = 0.641, Apparent Diameter = 17.8”, Banded and radial dusky features, as well as several bright regions exclusive of the cusps, are quite prominent in UV; S is at the top of the image.

Illustration 012. 2009 Jul 19 13:10-13:15 UT, Frank Melillo, Holtsville, NY, 25.4 cm (10.0 in.) SCT, UV filter, Seeing 6.5, Transparency (not specified), Phase (k) = 0.692, Apparent Diameter = 16.1”, Notice amorphous dusky features; first report of an unusual bright spot toward the S (adjacent the bright limb of Venus); S is at the top of the image.

When the northern and southern cusp-caps of Venus were reported this observing season, Figure 5 graphically shows that these features were equal in size the majority (94.7%) of the time and

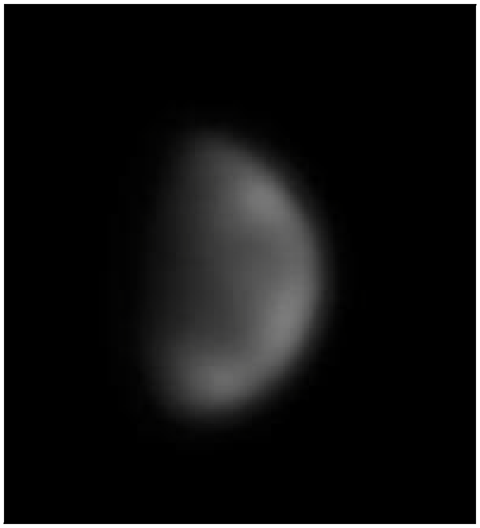


Illustration 013. 2009 Jul 19 02:52 UT, George Tarsoudis, Alexandropoulis, Greece, 25.4 cm (10.0 in.) NEW, UV filter, Seeing (not specified), Transparency (not specified), Phase (k) = 0.690, Apparent Diameter = 16.2", Notice amorphous dusky features; bright spot along the S limb; S is at the top of the image.

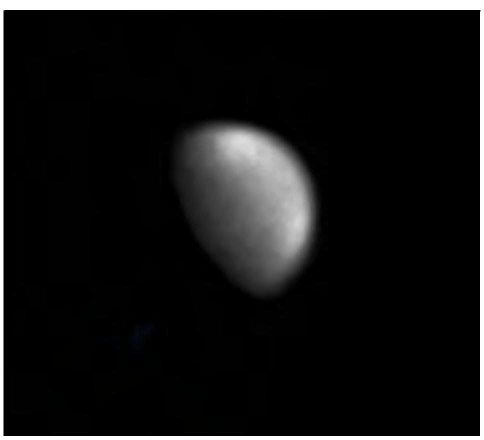


Illustration 014. 2009Jul19 10:57 UT, Willem Kivits, Siebengewald, The Netherlands, 35.6 cm (14.0 in.) SCT, RGB and UV filters, Seeing (not specified), Transparency (not specified), Phase (k) = 0.691, Apparent Diameter = 16.2", UV image clearly depicts the brilliant southern hemisphere white spot on the limb of Venus; amorphous dusky markings are apparent as well; S is at the top of the image.

in brightness in 96.1% of the observations. Also, there were several instances when the southern and northern cusp-caps were larger and brighter than each other. Both cusp-caps were visible in 86.2% of the observational reports, and their mean relative intensity averaged 9.8 during the observing season. Dusky cusp-bands were detected flanking the bright cusp-caps in 86.2% of the observations when cusp-caps were visible. When seen, the cusp-bands displayed a mean relative intensity of about 7.6 (see Figure 5) [Refer to Illustrations No. 006, 026 and 028].

Cusp Extensions

In 98.7% of the visual observations submitted during the apparition, no cusp extensions were reported in integrated light or with color filters beyond the 180° expected from simple geometry (see Figure 5). While Venus was passing through its crescent phases following inferior conjunction on October 29, 2010, rare instances of cusp extensions were detected from time to time, ranging from 3° to 12°, but not particularly noticeable on any contributed drawings and rather vague in images submitted. Experience has shown that cusp extensions are notoriously troublesome to image because the sunlit regions of Venus are overwhelmingly brighter than faint cusp extensions, but observers are still encouraged to try to record these features using digital imagers in upcoming apparitions.

Estimates of Dichotomy

A discrepancy between predicted and observed dates of dichotomy (half-phase) is often referred to as the "Schröter Effect" on Venus. The predicted half-phase occurs when $\boldsymbol{k} = 0.500$, and the phase angle, $\boldsymbol{i}$, between the Sun and the Earth as seen from Venus equals 90°. Although theoretical dichotomy occurred on January 8, 2011 at 08.28^{d}, visual dichotomy estimates were not submitted during this apparition.

Dark Hemisphere Phenomena and Ashen Light Observations

The Ashen Light, reported the first time by G. Riccioli in 1643, is an extremely elusive, faint illumination of Venus' dark hemisphere. Some observers describe the Ashen Light as resembling Earthshine on the dark portion of the Moon, but the origin of the latter is clearly not the same. It is natural to presuppose that Venus should ideally be viewed against a totally dark sky for the Ashen Light to be detectable, but such circumstances occur only when the planet is very low in the sky where poor seeing adversely affects viewing. The substantial glare from Venus in contrast with the surrounding dark sky is a further complication. Nevertheless, the ALPO Venus Section continues to receive reports from experienced observers, viewing the planet in twilight, who are convinced they have seen the Ashen Light, and so the controversy continues. There were no digital images that were submitted suggesting the presence of the Ashen Light during 2009-10 Western (Morning) Apparition, but as shown in *Table 3*, three visual observations by Detlev Niechoy called attention to its occurrence in Integrated Light (no filter) during November and December with a 20.3 cm (8.0 in.) SCT [Refer to Illustration No. 006].

Venus observers are encouraged to monitor the dark side of Venus using digital imagers to try to capture any illumination that may be present on the planet, ideally as part of a cooperative simultaneous observing endeavor with visual observers.

Since the instrumentation and methodology are not really complicated, the ALPO Venus Section also

Table 3: Ashen Light Observations During the 2010-11 Western (Morning) Apparition of Venus

UT Date and Time		X	k	Observational Notes
2010 Nov 14	10:33	225	0.085	Ashen Light suspected in W47 filter.
2010 Nov 27	07:57	225	0.203	Ashen Light suspected in Integrated Light (no filter).
2010 Dec 04	06:16	225	0.264	Ashen Light is definite in Integrated Light (no filter), and with W15 and W25 filters.

encourages observers to pursue systematic imaging of the planet in the near-IR. At these wavelengths, the hot surface of the planet becomes quite apparent and occasionally mottling shows up in such images, which are attributed to the presence of cooler, dark, higher-elevation terrain and warmer, bright, lower surface areas in the IR. Piotr Malinski of Warsaw, Poland submitted a 1000nm IR image of the crescent of Venus on November 15, 2010 at 04:39UT which just barely showes the dark hemisphere [Refer to Illustration 019.]

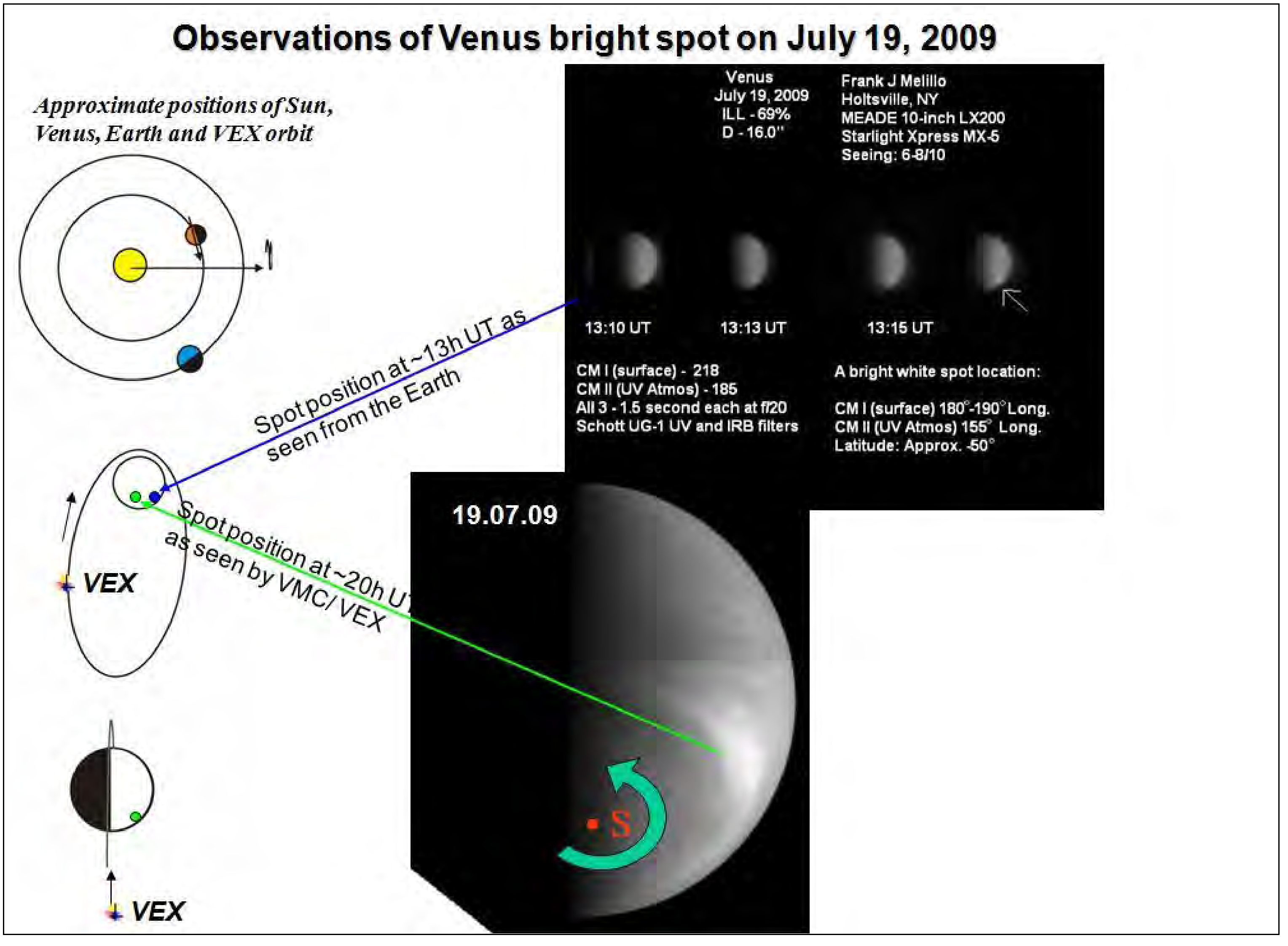


Illustration 015 (comparison of Illustration 012 by fjm with VEX 20:00UT image). 2009 Jul19 ~20:00UT VMC/VEX image of Venus compared with image by Frank Melillo on same date between 13:10 and 13:15 UT, N is up in all images in this illustration for comparison purpose. *Images provided courtesy Sanjay Limaye and European Space Agency's (ESA) Venus Express (VEX) Mission*

There were no instances when the dark hemisphere of Venus allegedly appeared *darker* than the background sky during the 2009-10 Western (Morning) Apparition, a phenomenon that is probably nothing more than a spurious contrast effect.

Simultaneous Observations

The atmospheric features and phenomena of Venus are elusive, and it is not unusual for two observers looking at Venus at the same time to derive somewhat different impressions of what is seen. Our challenge is to establish which features are real on any given date of observation, and the only way to build confidence in any database is to increase observational coverage on the same date and at the same time. Therefore, the ideal scenario would be to have simultaneous observational coverage throughout any apparition. Simultaneous observations are defined as independent, systematic, and standardized studies of Venus carried out by a large group of observers using the same techniques, similar equipment, and identical observing forms to record what is seen. While this standardized approach emphasizes a thorough visual coverage of Venus, it is also intended to stimulate routine digital imaging of the planet at visual and various other wavelengths, such as infrared and ultraviolet. By these exhaustive efforts, we would hope to be able to at least partially answer some of the questions that persist about the existence and patterns of atmospheric phenomena on Venus.

Amateur-Professional Cooperative Programs

Observers are reminded that images are still needed by the Venus Express (VEX) mission, which started systematically monitoring Venus at UV, visible (IL) and IR wavelengths back in May 2006. This Professional-Amateur (Pro-Am) effort continues, and observers should submit

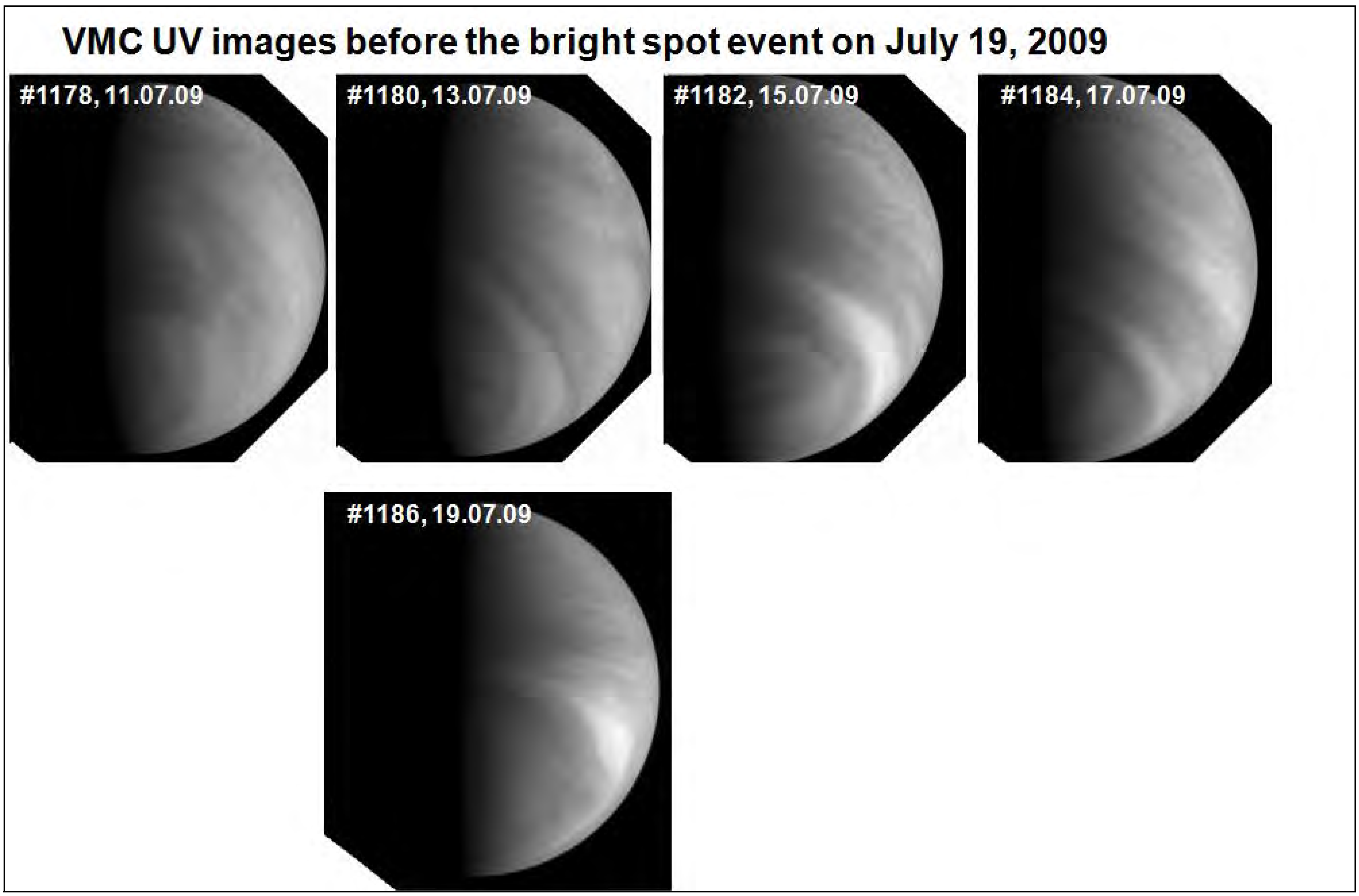


Illustration 016. 2009 Jul 19, VEX images of Venus from 2009 Jul 11 thru 2009 Jul 19, where the spot emerged on 2009 Jul 15, four days prior to reports of the feature by ALPO observers; N is at the top of these images. *Images provided courtesy Sanjay Limaye and European Space Agency's (ESA) Venus Express (VEX) Mission.*

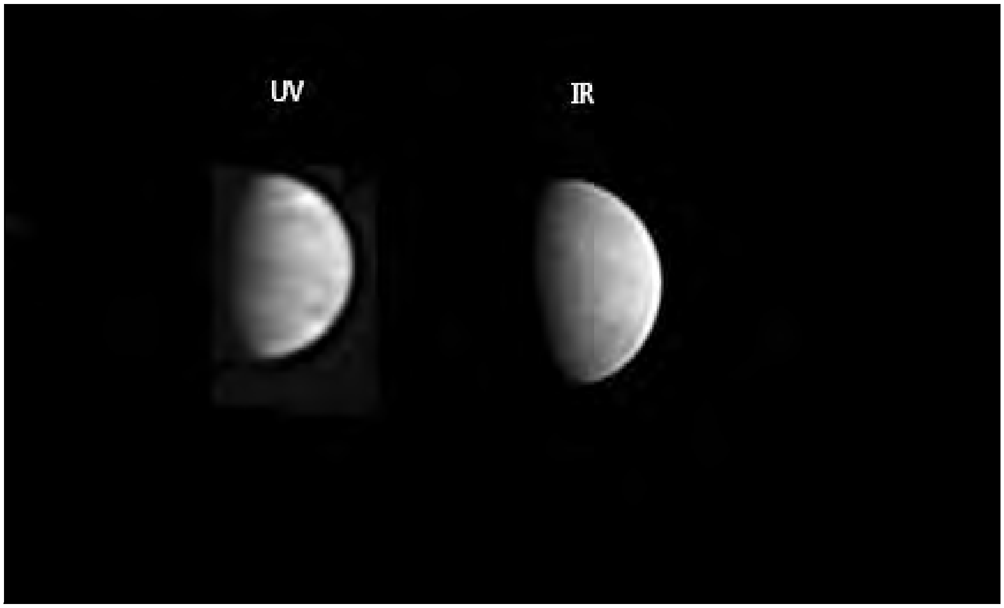


Illustration 017. 2009 Jul 20 12:51-13:00 UT, Paul Maxson, Phoenix, AZ, 25.4 cm (10.0 in.) DALL, UV (335nm) and IR (742nm) filters, Seeing (not specified), Transparency (not specified), Phase (k) = 0.695, Apparent Diameter = 16.0", UV image shows banded, amorphous and irregular dusky markings, as well as continued evolution of the bright spot near the limb; note that the bright spot is not obvious in IR (and dusky features are not as apparent in IR); S is at the top of the image.

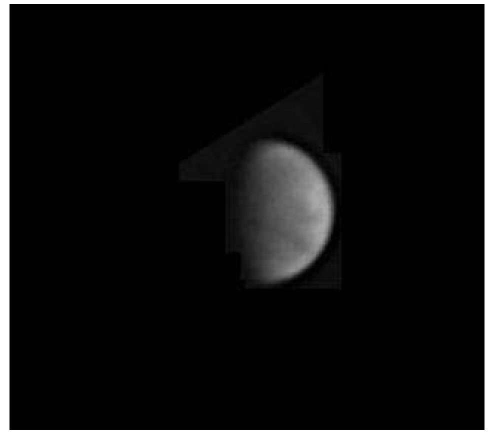


Illustration 019. 2009 Jul 22 12:50-12:54 UT, Paul Maxson, Phoenix, AZ, 25.4 cm (10.0 in.) DALL, UV (335nm) filter, Seeing (not specified), Transparency (not specified), Phase (k) = 0.703, Apparent Diameter = 15.8", UV image shows banded and amorphous dusky markings, cusp caps, cusp bands; S is at the top of the image.

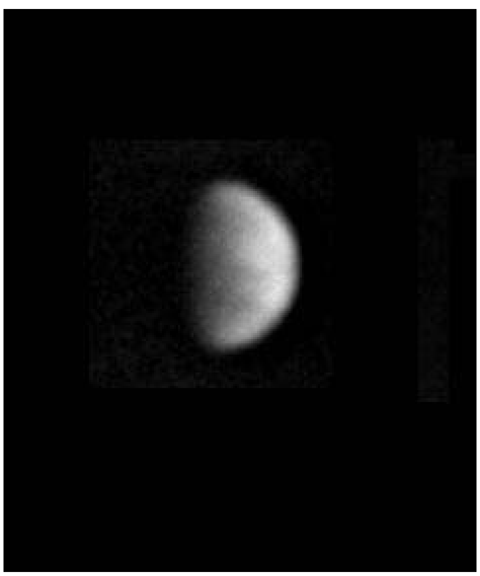


Illustration 018. 2009 Jul 22 06:52-17:00 UT, David Arditti, Middlesex, UK, 35.6 cm (14.0 in.) SCT, UV (320-390nm) filter, Seeing (not specified), Transparency (not specified), Phase (k) = 0.702, Apparent Diameter = 15.8", UV image shows banded and amorphous dusky markings, cusp caps, cusp bands; S is at the top of the image.

images to the ALPO Venus Section as well as to the VEX website at:

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

Regular Venus program activities (including drawings of Venus in Integrated Light and with color filters of known transmission) are also valuable throughout the period that VEX is observing the planet. On November 19, 2010 ESA's Science Program Committee approved the extension of VEX mission operations until December 31, 2014, so pro-am cooperation continues at the present time. The ALPO Venus Section looks forward to continued successful Pro-Am cooperation during the mission, and observers throughout the world are welcome to participate.

Conclusions

Analysis of ALPO observations of Venus during the 2009-10 Western (Morning) Apparition showed that vague shadings on

Illustration 020. 2009 Jul 24 13:57 UT, Donald C. Parker, Miami, FL, 25.4 cm (10.0 in.) DALL, UV (355nm) filter, Seeing 6.0, Transparency (not specified), Phase (k) = 0.710, Apparent Diameter = 15.6", UV image shows amorphous and irregular dusky markings; bright spot is apparent along the southern limb (4 days after initial reports on July 19th by other observers), S is at the top of the image

the disc of the planet were periodically apparent to visual observers who utilized standardized filter techniques to help reveal the notoriously elusive atmospheric features. Indeed, it is often very difficult to be sure visually what is real and what is merely illusory at visual wavelengths in the atmosphere of Venus. Increased confidence in visual results is improving as more and more program participants are attempting simultaneous observations. Readers and potential observers should realize that well-executed drawings of Venus are still a vital part of our overall program as we strive to improve the opportunity for confirmation of highly elusive atmospheric phenomena, to introduce more objectivity, and to standardize observational techniques and

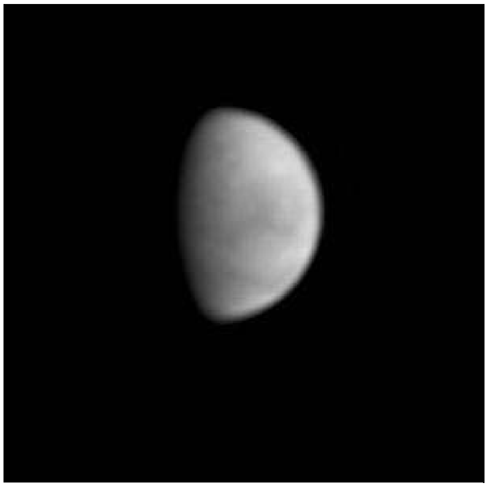


Illustration 021. 2009 Jul 27 03:32-04:00 UT, Jean-Pierre Prost, Marseille, France, 25.4 cm (10.0 in.) DALL, IR 642nm, IR 1000nm, UV, Seeing (not specified), Transparency (not specified), Phase (k) = 0.719, Apparent Diameter = 15.3”, Amorphous dusky markings and mottling is apparent in UV wavelengths, terminator shading, cusp caps and cusp bands, and somewhat incomplete bright limb band; S is at the top of the image.

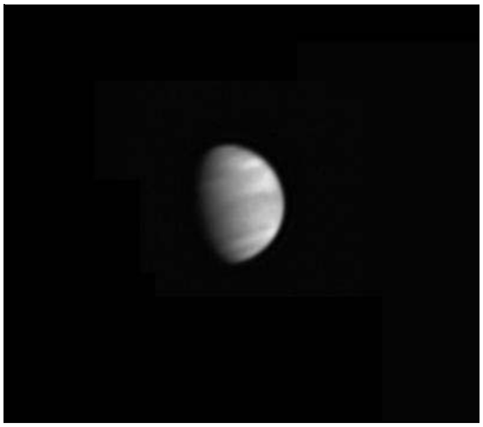


Illustration 022. 2009 Aug 08 04:24 UT, Torsten Hansen, Reichau Boos, Germany, 20.3 cm (8.0 in.) NEW, UV filter, Seeing (not specified), Transparency (not specified), Phase (k) = 0.760, Apparent Diameter = 14.3”, Superb image showing banded dusky markings in UV; S is at the top of the image.

methodology. It is especially good to see that to a greater extent Venus observers are contributing digital images of the planet at visual, near-UV, and near-IR wavelengths. It is also meaningful when several observers working independently, with some using visual methods at the same time others are employing digital imaging, to produce comparable results. For example, atmospheric banded features and radial (“spoke”) patterns depicted on drawings often look strikingly similar to those captured with digital imagers at the same date and time.

Many of our best UV images have been sought after by the professional community, and cooperative involvement of amateurs and professionals on common projects took another step forward with the establishment of the Venus Amateur Observing Project (VAOP) in 2006 coincident with the Venus Express (VEX) mission, which continues at least until the end of 2014.

Active international cooperation by individuals making regular systematic, simultaneous observations of Venus remain our main objective, and the ALPO Venus Section encourages interested readers to join us in our many projects and challenges in the coming years.

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Illustration 023. 2009 Aug 11 12:28-12:31 UT, Paul Maxson, Phoenix, AZ, 25.4 cm (10.0 in.) DALL, Integrated Light (no filter), Seeing (not specified), Transparency (not specified), Phase (k) = 0.771, Apparent Diameter = 14.0”, Superb images showing banded dusky markings in UV; S is at the top of the image.

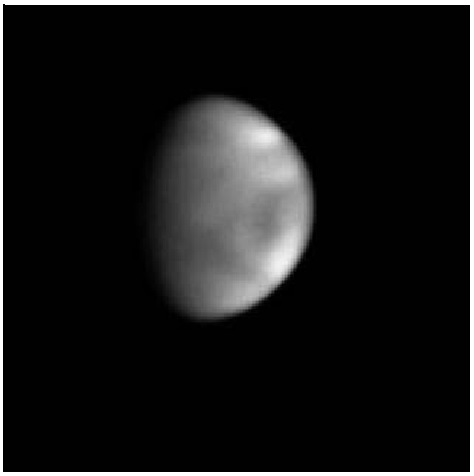


Illustration 024. 2009 Aug 14 04:43 UT, Paolo Lazzarotti, Massa, Italy, 31.5 cm (12.4 in.) NEW, 350nm UV filter, Seeing 3.0, Transparency 5.0, Phase (k) = 0.779, Apparent Diameter = 13.8”, Bright areas along limb in UV with radial, banded and amorphous dusky markings in this detailed image; S is at the top of the image.

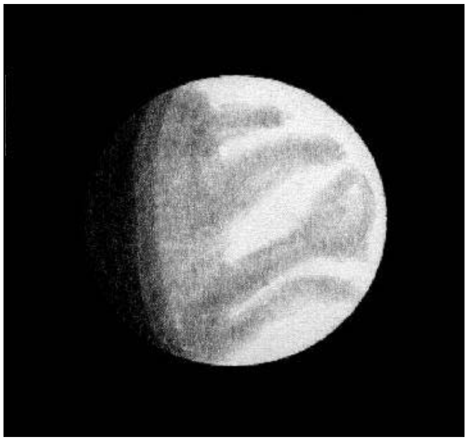
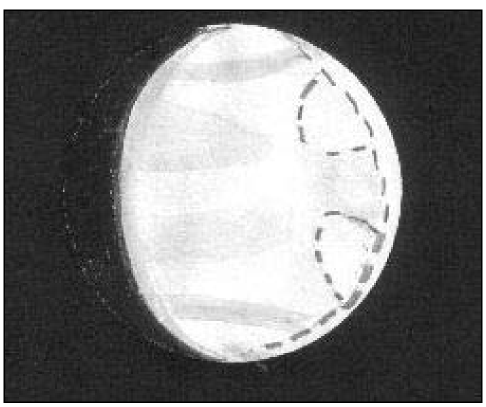


Illustration 025. 2009 Aug 27 04:21 UT, Detlev Niechoy, Göttingen, Germany, 20.3 cm (8.0 in.) SCT, Drawing @ 225X W15 (yellow) filter, Seeing 4.0 (interpolated), Transparency (not specified), Phase (k) = 0.818, Apparent Diameter = 12.9”, Drawing shows terminator shading with associated dusky banded features on gibbous disk of Venus; S is at the top of the image.

Illustration 026. 2009 Sep 01 19:20-19:45 UT, Carl Roussell, Hamilton, Ontario, Canada, 15.2 cm (6.0 in.) REF, Drawing @ 200-400X Integrated Light, + alternating W25, W58, W47 filters, Seeing 5.0, Transparency (not specified), Phase (k) = 0.833, Apparent Diameter = 12.6”, Drawing shows suspected diffuse bright spots in conjunction with the bright limb band, as well as banded dusky



markings, cusp caps and cusp bands; S is at the top of the image.

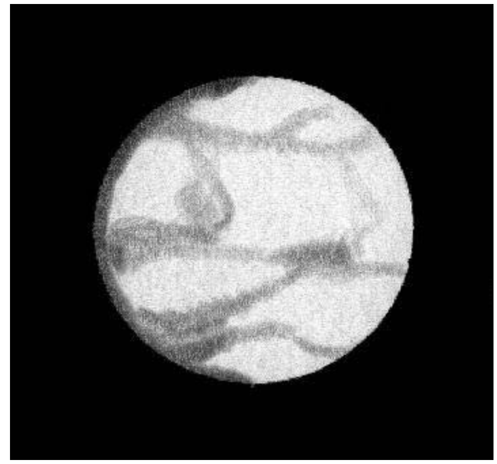


Illustration 027. 2009 Sep 27 10:23 UT, Detlev Niechoy, Göttingen, Germany, 20.3 cm (8.0 in.) SCT, Drawing @ 225X Integrated Light (no filter), Seeing 3.0 (interpolated), Transparency (not specified), Phase (k) = 0.895, Apparent Diameter = 11.5”, Terminator shading with banded and irregular dusky markings depicted in this drawing; S is at the top of the image.

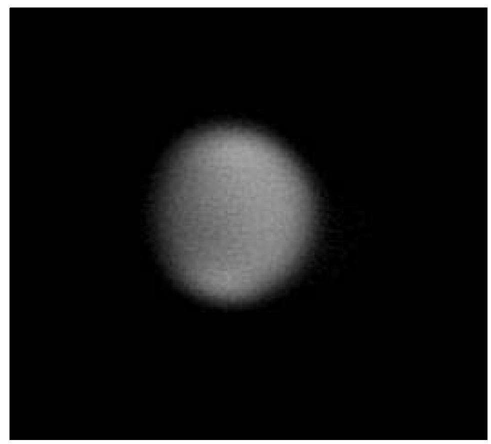


Illustration 028. 2009 Oct 15 21:06-21:08 UT, Tomio Akutsu, Cebu City, Philippines, 35.6 cm (14.0 in.) SCT, UV and IR filters, Seeing 4.0, Transparency 4.0, Phase (k) = 0.930, Apparent Diameter = 10.9”, Aside from vague amorphous dusky markings, both cusp caps are quite noticeable in this UV image of the nearly full disk of Venus. S is at the top of the image.

Feature Story

A Preview of the 2015 – 2017 Apparition of Mars

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Introduction

Mars is now rising before the Sun each morning, as a new apparition has begun. We are expecting to see its albedo features better than we've seen them since 2005. There will be many clouds visible in the first half of the apparition, and some dust storms in the second half – perhaps even a planet-encircling storm. As always, we'll be watching its changing polar caps as its seasons evolve, and its changing tilt and phase as Earth overtakes it in revolution. We will also be looking for the slow changes in albedo features that have been documented during the last 120 years. What will we find this apparition?

With its high contrasts of ocher, aquamarine, and snow white, Mars is the most colorful planet. It also presents the best view of any astronomical surface except our Moon. Whether you study it for science, for personal edification, or for awe, you will find it to be special. Visual observers have traditionally considered an apparent diameter of 6 seconds of arc to be the minimum size at which useful observations can be made. During recent apparitions, however, images have often been made with Mars appearing as small as 4.5 arc seconds. In early 2015, Clyde Foster continued to image the planet as the apparent diameter declined to 3.9 arc seconds, and thereby was able to demonstrate the nonoccurrence of large dust storms through the heart of the dust season.

The ALPO Mars Section seeks your observation reports. In each apparition we receive about two thousand images, drawings, and descriptive reports, and every one is studied and archived. Many observers post their images and drawings in the photos section of our Mars observers group at *https://groups.yahoo.com/neo/groups/marsobservers/info* and post their comments and descriptions on the message board there. Alternatively, you can send your observation directly to Roger Venable at *rjvmd@hughes.net* .

Online Features

Left-click your mouse on:

- The author's e-mail address in blue text to contact the author of this article.
- The references in blue text to jump to source material or information about that source material (Internet connection must be ON).

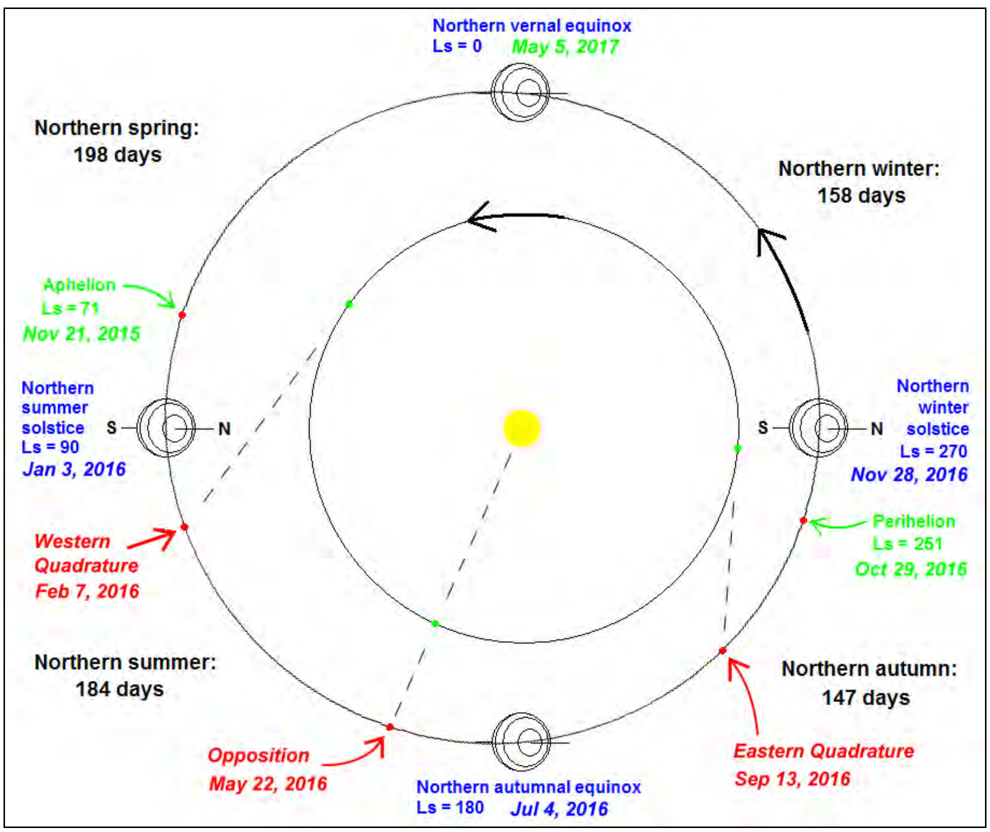

Figure 1. The orbits of Mars (larger circle) and Earth (smaller circle) are drawn to scale, but the depictions of the Sun, Mars, and Earth are exaggerated in size. Notice that the two orbits are not concentric, as that of Mars is oval in shape. The axial tilt of Mars as related to its seasons is illustrated. Notice the variation in the length of the Martian seasons, related to the eccentric orbit and to the deviation of the direction of axial tilt from the major axis of the ellipse of its orbit. Southern seasons are not mentioned, but they are opposite the northern seasons. The locations of Mars and Earth with regard to the opposition and the eastern and western quadratures of the coming apparition are depicted. Notice that the prime observing time will be late northern summer and early northern autumn.

The ALPO's ongoing compilation of Mars observations from all over the world is a continuation of the International Mars Patrol organized in 1962 by Chick Capen when he was the ALPO Mars Section Recorder.

The Apparition

Mars goes through a 15.8-year cycle of apparitions consisting of three perihelic apparitions followed by four aphelic apparitions. The period of optimal observing is longer in the perihelic apparitions, and the apparent angular diameter of the planet is larger. The present apparition might be thought of as the first perihelic apparition in a group of three, but it is actually a transitional apparition as opposition occurs near Mars's autumnal equinox. The number of days that its apparent diameter stays above 6 arc seconds – 341 days – will be longer than it was last apparition (289 days) but briefer than in the coming perihelic apparition of 2017-2019 (358 days.) Table 1 shows some salient dates of the present apparition. Figure 1 depicts the orbital relationships of Earth and Mars that will prevail during the time of best observing, which is the central part of the apparition.

Figure 1 includes L_S numbers for the four seasons and the perihelion and aphelion. L_S is the areocentric longitude of the Sun, measured from the northern vernal equinox by which the zero point of L_S is defined. It designates the season on Mars, and thereby suggests the expected axial tilt, with the seasonal propensity to clouds and dust storms. Notice that Figure 1 depicts the orbits as seen from north of the orbital plane. It shows Mars's North Pole, which may be tilted toward or away from Earth depending on the positions of the two planets in their orbits.

Observers are helpful when they include the L_S information together with the central meridian, date, time, and telescope information that they report. L_S is often written Ls, with a small letter 's' instead of a subscript letter 's.'

Mars in the Sky

Figure 2 graphs the elongation and declination versus the date, and includes the phase angle. The elongation from the Sun is the fundamental parameter showing our progression through the apparition, as elongation of 180 degrees occurs at the time of opposition, in late May 2016.

The declination of the planet has a big impact on its observability. As shown in Figure 2, during the middle of the apparition a substantially negative declination will bring optimal observing to observers located in Earth's Southern Hemisphere. However, the southern declination will never be so severe as to discourage observers in the Northern Hemisphere. In contrast, the northerly declinations that will occur very early in the apparition and very late in the apparition may discourage observers in the Southern Hemisphere, because Mars will be very low in their skies after sunset and before sunrise, with the accompanying problems of poor seeing and twilight.

Phase angle peaks at the times of quadrature. Observers who wish to make polarized measurements or images will find that positive (horizontal) polarization

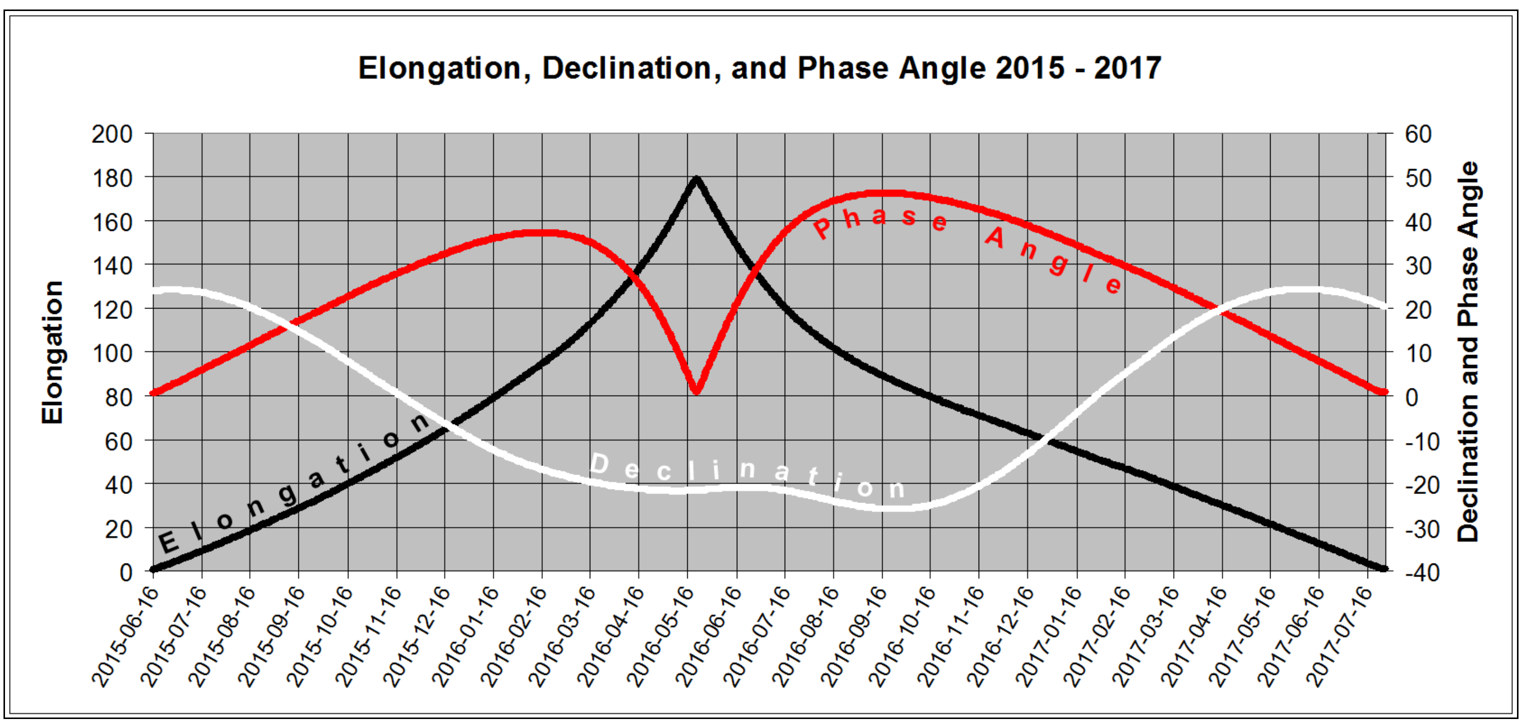

Figure 2. The elongation of Mars from the Sun, the declination of Mars in Earth's sky, and the phase angle of Mars as seen from Earth, during the present apparition. Opposition occurs where the elongation is 180 degrees and the phase angle has a sharp minimum near zero.

is greatest when the phase angle is greatest, and negative (vertical) polarization is present when the phase angle is less than about 20 degrees.

The Appearance of the Planet

Our closest approach to Mars will not be on the date of opposition (May 22nd), but rather a few days later, due primarily to the eccentricity of its orbit, as it swings toward its perihelion after opposition. At closest approach on May 30, Mars will be 18.61 arc seconds in apparent diameter. This is an improvement over the 2013-2015 apparition, in which its diameter peaked at 15.2 arc seconds, but it is still smaller than the 25 arc second diameter seen in 2003. Its brightness will peak at magnitude -2.06, as compared to -1.48 last apparition. Figure 3 graphs the apparent diameter and magnitude during the apparition. The curves of apparent angular diameter and magnitude are not exactly inverse of one another because the apparent diameter is a function solely of its distance from Earth, while the brightness is a function of the distances from both the Earth and the Sun.

Inspection of Figure 1 reveals that the North Pole of Mars will be tilted toward Earth continuously before opposition. Though this tilt decreases around the time of opposition, Earth rapidly overtakes Mars after opposition so that the North Polar tilt increases after opposition, and it is not until September 24, 2016, that the planet's axis becomes perpendicular to our line of sight. This is depicted graphically in Figure 4. Study of Figure 4 will tell the observer much about the observability of the polar areas as related to their tilt toward Earth and their illumination by the Sun. For example, note that on August 1, 2016, Mars's North Pole is tilted about 15 degrees toward Earth (so that Earth has a positive declination in the Martian sky), but we still cannot see the North Pole because it is not illuminated by the Sun, due to the Sun's negative declination in the Martian sky. Jeff Beish has prepared simulations of the appearance of the planet at intervals, and these are presented in Figure 5. In addition to the clarity of their display, these simulated images are useful to help understand the effects of the declinations of Earth and Sun as graphed in Figure 4.

Dust Storms

We want to document the occurrences of dust storms. They can occur at any time of the Martian year, so we should always be alert to this possibility. Indeed, small storms are detected by amateurs in every season. However, the ten great planet-encircling dust storms that have been observed have begun at L_S 204 at the earliest and L_S 312 at the latest, with a mean of L_S 255 for the time of onset. (See Figure 1 to make an estimate of where in the present apparition these longitudes will occur.) Thus, a planet-encircling dust storm could start as early as August 15, 2016, with a mean expectation of November 4, 2016, and a latest expectation of onset of February 5, 2017. Watch for this as Mars traverses the evening sky late in the apparition.

It is often difficult to be sure that an unusual appearance of surface features is due to dust, versus water ice clouds, poor seeing, or image artifacts. Observers

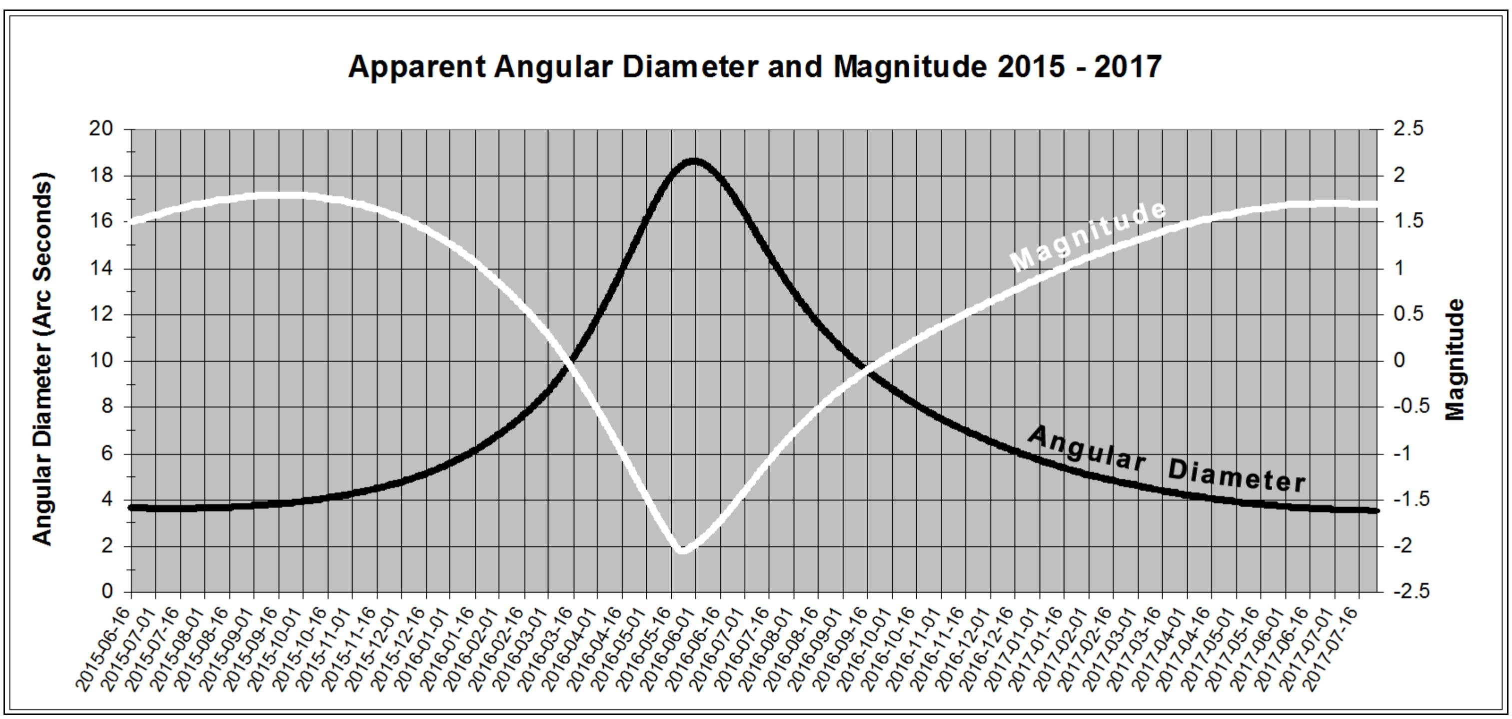

Figure 3. The apparent angular diameter and the magnitude of mars during the present apparition.

should keep in mind that dust is bright in red light, and if it is dense it is often slightly brighter than the red deserts of Mars; and that it moves, changing location from day to day; and that it obscures albedo features. Unless an unusual feature has these characteristics, there may be disagreement among observers concerning whether a feature is a dust cloud.

A condition of clear atmosphere with a higher than usual amount of negative polarization has been shown to be related to fine atmospheric dust, of which the particles are smaller than those of opaque dust storms but larger than those of the permanent dust haze that pervades the atmosphere. It has been suggested that such a condition may precede the development of large, opaque dust storms (Ebisawa and Dollfus, 1992). There are many open questions about this possibility. Faithful polarimetric imaging of Mars is encouraged, in an attempt to elucidate this phenomenon.

Clouds

Clouds are very dense in Tharsis, Arcadia, and Amazonis from about L_S 70 to L_S 123, the heart of the cloudy season. This period will transpire over about 3 months early in the apparition, centered on the time of western (morning) quadrature. However, scattered clouds will be visible across the planet during most of the apparition. Sometimes a bright cloud is mistaken for a polar cap and *vice versa*, so be careful in identifying them.

The South Polar Hood will become visible in early 2016, appearing to be less intensely white than the North Polar Hood. It will dissipate rapidly during the weeks right after the Northern Autumnal Equinox of July 4, 2016. The North Polar Hood will be visible by the start of 2017, and will dissipate during May 2017, while Mars appears very low in the sky after dusk.

"Jaeschke's cloud" is the high-latitude, terminator cloud that was first detected by ALPO member Wayne Jaeschke (pronounced, "Jeh'-skee") in 2012. It was at about 45 degrees S latitude, and though faint, it appeared to project beyond the terminator. It can be seen only when the morning terminator is visible – that is, after opposition. Since it has only been seen from L_S 85 to 96, and this range of Ls is before opposition in the present apparition, Jaeschke's cloud will not be visible this apparition. Nevertheless, it is reasonable to look for high clouds beyond the sunrise terminator any time after opposition. Such clouds are very faint, and may require brightening of the image to be detected. Roger Venable recommends that observers check each of their images for terminator clouds by examining a brightened version of the image during processing (Venable, Jeaschke, *et al*, 2014.)

The Largest Volcanos in the Solar System

Olympus Mons often can be imaged as a spot either slightly brighter or slightly darker than its surroundings. When surrounded by a large dust storm or by clouds, it appears as a dark spot, as do the Tharsis Montes. As such, these great

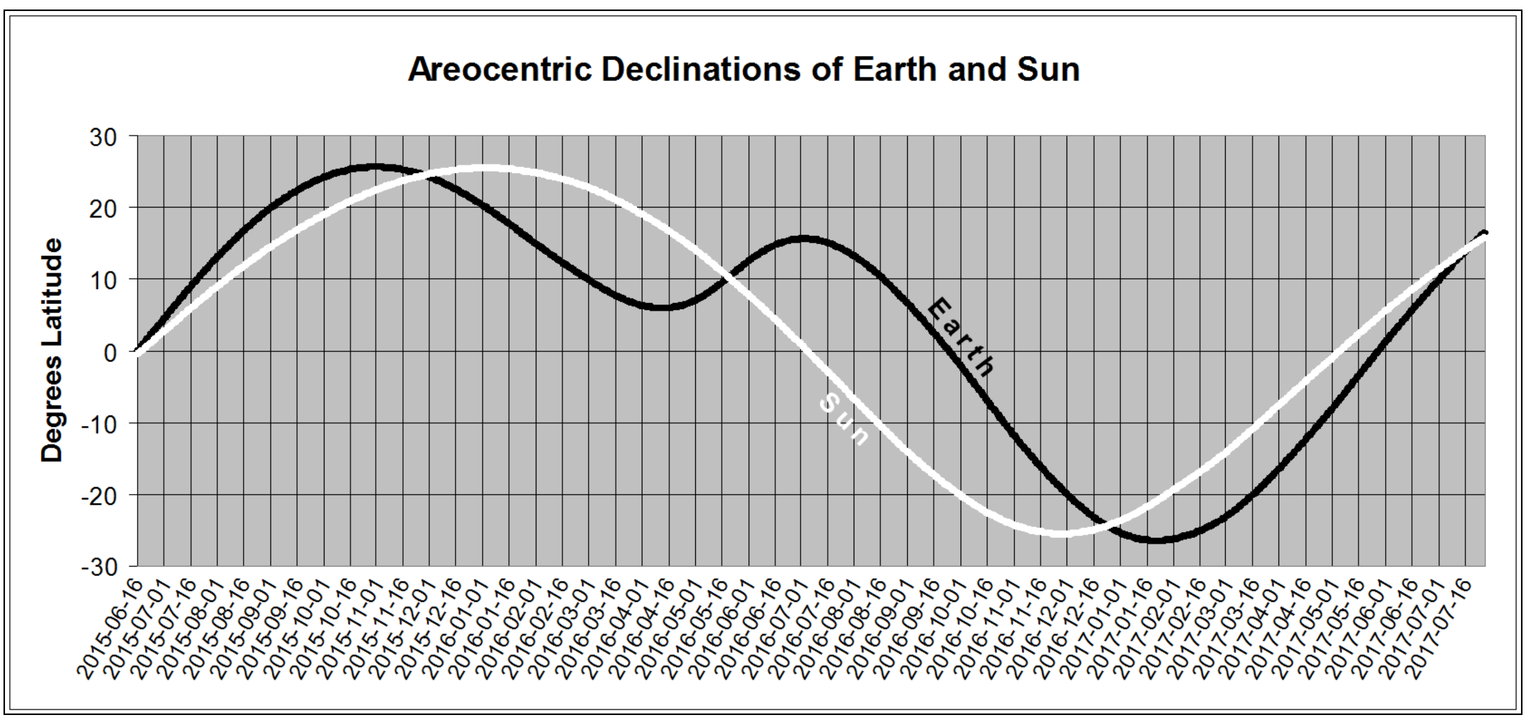

Figure 4. The declinations of the Earth and the Sun in the Martian sky during the present apparition.

volcanos have been detected visually as well as in images. Orographic clouds, when present, are usually found to the northwest of each mountain. John Westfall has suggested that Olympus Mons might be detected in images or visually when it is on the terminator, as its slope at such times will make it brighter than its surroundings. To date, it has not been detected on the terminator, but the prospect of doing so remains as an interesting challenge.

Elysium Mons was seen as a tiny dark spot during the 2007 dust storm, in only a few images by Damian Peach and by Don Parker.

Specular Reflections

Flashes of specular reflections from the surface have been seen a number of times, but have not been reported in the last several apparitions. Observers are encouraged to monitor the planet for them. The development of techniques to make such monitoring effective is an area open to investigation by interested observers.

Occultations

Occultations of stars by Mars have the potential to reveal information about the atmospheric density and cloud heights. In principle, chemical constituents of the atmosphere may be detected by spectroscopy. The best information will be obtained when the star is observed on the terminator side rather than the sunlit limb side, as the signal-to-noise ratio will be better on that side. Amateurs should attempt to observe these events – it remains to be seen how much good science can be extracted from such observations. Upcoming occultations can be discovered by using David Herald's *Occult* software (Herald, 2015.)

Two occultations of bright stars will occur during this apparition. These are presented in Table 2, and the regions of Earth from which they can be seen are presented in Figure 6. Notice that the better of these events will happen soon, visible from Japan.

Occultations involving Mars are not commonly observed but are fascinating to see. There will be two Lunar occultations of Mars this apparition. Their zones of visibility are depicted in Figure 7. These events make for great pictures, and especially great video. However, we are unaware of any scientific knowledge that can be gleaned from them.

The lunar occultation of December 6, 2015, can be seen before sunrise from central Africa and the southern part of the Arabian Peninsula, and from islands in the western Indian Ocean. It will be visible in daylight from the southern tip of India, Sri Lanka, the southernmost part of Indonesia, and most of Australia. As seen from Nairobi, Kenya, the occultation will occur over a period of about 14 seconds centered on 00:29:56 UT, and the reappearance will be at 01:29:04 UT. The Sun will be well below the horizon, and will not interfere observation from Nairobi.

The lunar occultation of January 3, 2017, can be seen from Honolulu, Hawaii, in the western sky shortly after sundown, and from islands in the northwestern Pacific Ocean. It will be visible in daylight from the Philippines, Indonesia, the northwestern coast of Australia, part of Southeast Asia, and southern India. Interestingly, a Lunar occultation of Neptune occurs right before this occultation of Mars. As seen from Honolulu, the disappearance of Neptune behind the Earth-lit side of the crescent Moon will be at 04:38:17 UT, and it will take only 7 seconds for the limb to cover that distant planet. The Sun will be only 8 degrees below the horizon, so that the bright twilight may interfere with detection of Neptune. Neptune will reappear at 05:46:09 UT, and then Mars will disappear over a period of 13 seconds centered on 08:02:57 UT, while only 3.5 degrees above the horizon. The reappearance of Mars will not be observable from Hawaii.

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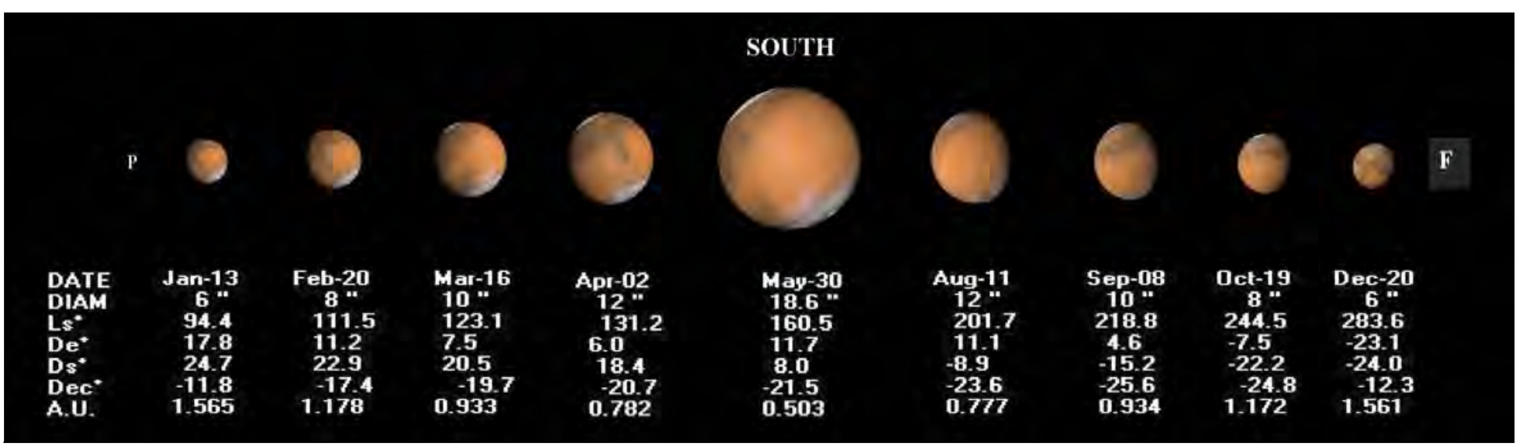

Figure 5. Computer generated simulations of the appearance of Mars as seen from Earth, showing its relative apparent size, its axial tilt, and its phase defect, during the present apparition. Provided by Jeff Beish.

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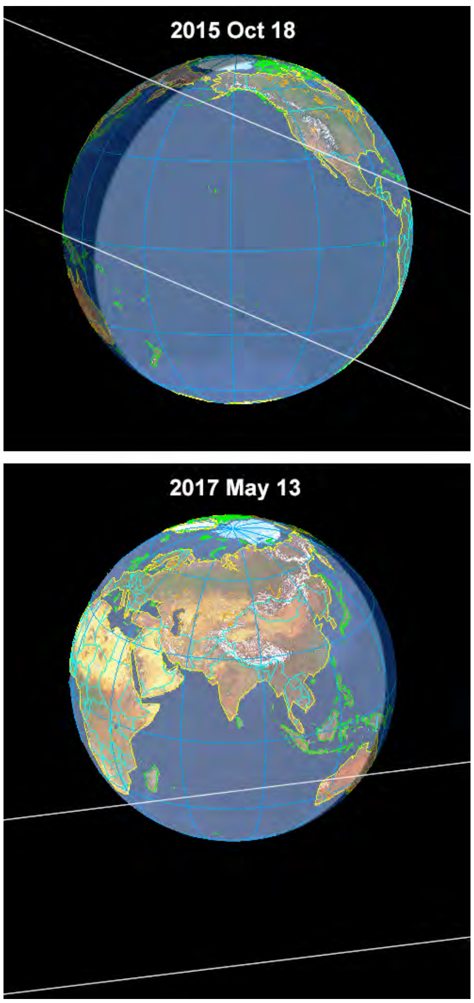

Figure 6. In each diagram, the area between the two white, parallel lines is the area from which the occultation of the star might be seen. Generally speaking, the occultations can be seen only from the Earth's night side, which is the thin, dark crescent at the left edge of the 2015 October 18 depiction of Earth, and at the right edge of that of 2017 May 13.

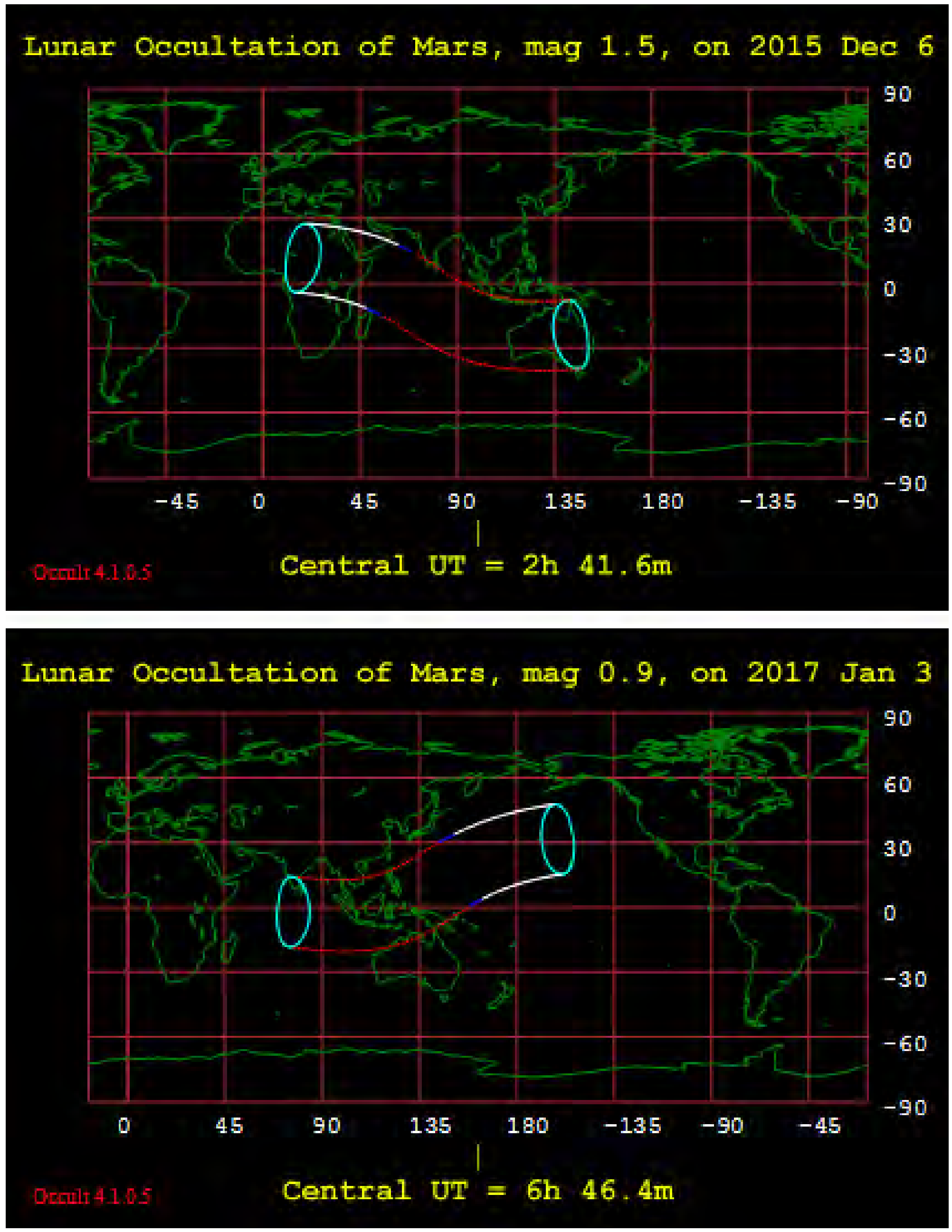

Figure 7. The areas from which the two Lunar occultations of Mars can be seen. White lines are the edges of the occultation path for locations that will have a nighttime view of the event. Red lines indicate that the event occurs during daylight, and blue lines indicate a twilight event. The ovals at the left ends of the paths bound areas from which the disappearance is not visible but the reappearance is visible. The ovals at the right ends of the paths indicate areas from which the disappearance is visible but the reappearance would be below the horizon.

Feature Story

Whole-Disk Brightness Measurements of Mars: 2011-2012

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Abstract

Brightness measurements of Mars made between mid-2011 and mid-2012 are reported. The main findings are that Mars was a little brighter than expected during late northern winter but was near its expected brightness afterwards. The Hellas region had a nearly equal brightness in 2010 and 2012 during northern Martian spring. It was, however, brighter in 2012 than in 2010 during early northern summer. This may explain why Mars was dimmer than expected in early Martian summer of 2010 but near its expected brightness during this season in 2012.

Introduction

Mallama (2007, 404) combines brightness measurements of Mars made in 1954, 1958, 1960 - 1961, 1963 - 1965 and 1991 - 2006 to construct models of its brightness in filters transformed to the Johnson U, B, V, R and I system. Hereafter, these time increments are called the "reference period". More recently, the writer reported his 2007-2008 and 2009-2010 brightness measurements (Schmude 2009, 29; 2012, 25). In 2010, Mars is reported to be 0.024 to 0.050 magnitudes dimmer during its late northern spring and early northern summer. A lower number of observed clouds than in the reference period may be the cause.

The objective of this study is to report brightness measurements of Mars made between mid-2011 and mid-2012. Clouds cause that planet to brighten. Therefore, monitoring its brightness is one way of determining overall cloud abundances. Brightness measurements may also yield information on the amount of atmospheric dust and the presence or absence of large albedo features. Moreover, a multi-decade brightness study may yield information on Martian climate changes. The author has measured the brightness of Mars since 1991 and plans to continue these measurements to at least 2031.

Table 1: Characteristics of Mars During Its 2011-2013 Apparition

Date of first conjunction	February 4, 2011 [a]
Date of opposition	March 3, 2012 [a]
Date of second conjunction	April 18, 2013 [a]
Right Ascension (at opposition)	11h 06.3m [a]
Declination (at opposition)	+10.28° [a]
Brightness (at opposition, central meridian = 60° W)	Stellar magnitude = -1.31 [b]
Season in northern hemisphere (at opposition)	Late spring (L_S = 78°) [a]
Sub-Earth latitude (at opposition)	+22.4° [a]
Angular diameter (at opposition)	13.9 arc seconds [a]

[a] From the Astronomical Almanac

[b] Computed from the values in Mallama (2007, pp. 409-411).

Online Features

Left-click your mouse on:

- The author's e-mail address in blue text to contact the author of this article.
- The references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Table 1 lists characteristics of the 2011 - 2013 Mars apparition. In this paper, an apparition is the time between two successive conjunctions. The areocentric longitude (Ls) is the angle between Mars and its Vernal Equinox measured from the Sun. Therefore, the beginning of northern spring, summer, fall and winter for Mars start at Ls = 0°, 90°, 180° and 270°, respectively.

Mars reached areocentric longitudes of 315°, 0°, 45°, 90° and 135° on the respective dates of June 21, 2011; September 14, 2011; December 18, 2011, March 30, 2012 and July 5, 2012. Between mid-2011 and mid 2012, Mars's northern hemisphere went from late winter to mid-summer. Based on previous studies, Mars goes from having few discrete clouds in late northern winter to having many clouds in early northern summer (Beish, and Parker, 1988, p. 373), (Parker et al., 1999, p. 3). Therefore brightness measurements are one way of accessing this.

Method and Materials

An SSP-3 solid-state photometer along with filters transformed to the Johnson V and R system were used in making all

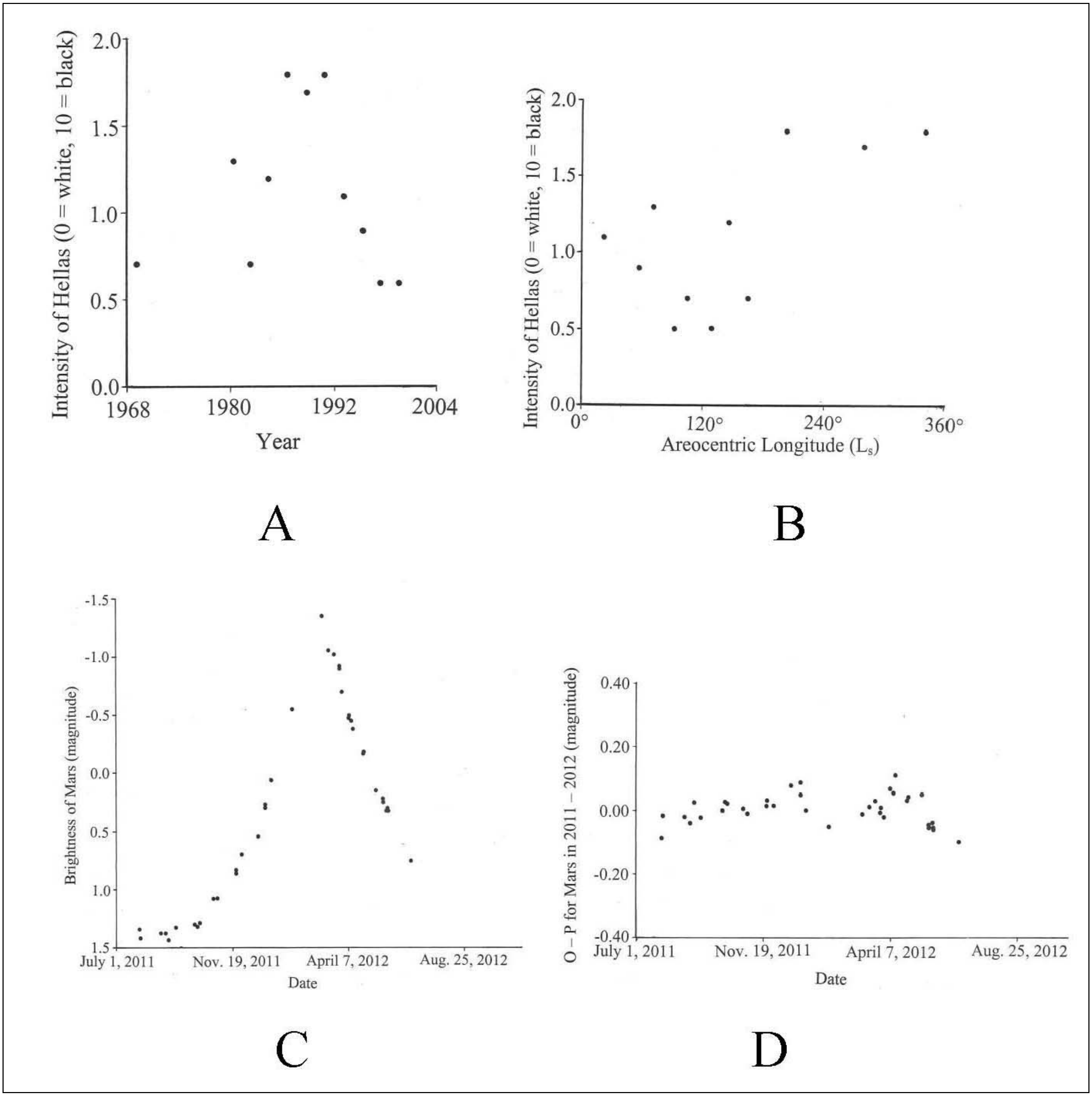

Figure 1. Graph A shows the average intensity estimates of Hellas plotted over time. All estimates are average values published in British Astronomical Association Mars reports (Collinson, 1970, p. 53), (McKim, 1984, 205; 1985, 42; 1987, 146; 1989, 224; 1991, 273; 1992, 255; 1995, 126; 2005, 324; 2006, 178; 2007, 321). The intensity scale is: 0 = white and 10 = black. Graph B shows the same intensity estimates as in Graph A except they are plotted against the areocentric longitude on opposition day. Graph C shows the observed brightness values of Mars plotted against the date. All observed measurements are on the Johnson V scale. Graph D shows the observed minus predicted (O - P) brightness of Mars (in magnitudes) plotted against the date. The predicted brightness values are based on Mallama (2007, 409-411). If the O - P value is positive, it means that Mars is fainter than what it was predicted to be.

Table 2: Brightness Measurements of Mars During 2011 and 2012

Decimal Date (UT)	Filter	Central Meridian Longitude (° W)	Brightness (Stellar Magnitudes)	Comparison Star
July 29,405, 2011	V	295	1.35	Epsilon-Tauri
July 30.401	V	284	1.42	Epsilon-Tauri
Aug. 24.410	V	45	1.38	Iota-Geminorum
Aug. 29.401	V	353	1.38	Iota-Geminorum
Sept. 2.397	V	313	1.44	Iota-Geminorum
Sept. 10.401	V	237	1.33	Iota-Geminorum
Oct. 3.421	V	21	1.30	Iota-Geminorum
Oct. 6.425	V	354	1.32	Iota-Geminorum
Oct. 8.422	V	333	1.29	Iota-Geminorum
Oct. 25.414	R	166	-0.16	Iota-Geminorum
Oct. 26.413	V	156	1.08	Iota-Geminorum
Nov. 1.413	V	156	0.98	Iota-Geminorum
Nov. 24.449	V	249	0.83	Iota-Geminorum
Nov. 24.464	V	255	0.86	Iota-Geminorum
Dec. 1.453	V	183	0.70	Iota-Geminorum
Dec. 19.445	V	11	0.55	Iota-Geminorum
Dec. 30.343	V	230	0.30	Iota-Geminorum
Dec. 30.364	V	238	0.28	Iota-Geminorum
Jan. 5.439, 2012	V	208	0.07	Epsilon-Bootis
Jan. 30.443	V	340	-0.55	Epsilon-Bootis
March 6.313	V	337	-1.36	Epsilon-Bootis
March 14.192	V	225	-1.06	Mu-Leonis
March 21.140	V	146	-1.02	Mu-Leonis
March 27.125	V	88	-0.90	Mu-Leonis
March 27.172	V	105	-0.92	Mu-Leonis
March 30.065	V	40	-0.70	Mu-Leonis
April 8.081	V	325	-0.49	Mu-Leonis
April 8.101	V	332	-0.48	Mu-Leonis
April 10.111	V	317	-0.45	Mu-Leonis
April 12.169	V	320	-0.38	Mu-Leonis
April 24.186	V	216	-0.17	Mu-Leonis
April 25.113	V	181	-0.18	Mu-Leonis
May 11.119	V	34	0.16	48-Leo
May 19.097	V	311	0.26	48-Leo
May 19.129	V	322	0.23	48-Leo
May 23.096	V	272	0.33	48-Leo
May 24.083	V	258	0.31	48-Leo
May 24.107	V	266	0.33	48-Leo
June 21.093	V	353	0.75	Upsilon-Leonis

measurements. A 0.09 m Maksutov telescope was also used. More information about the equipment may be found elsewhere (Optec, 1997), (Schmude, 1992a, 20; 2008, Chapter 5).

The transformation coefficients are V = -0.0555 and R = -0.021 and are based on the two-star method (Hall and Genet, 1988, 199-200). All measurements are corrected for extinction and color transformation. They are listed in Table 2. The brightness values for Epsilon-Tauri, Epsilon Bootis and Mu-Leonis are from Iriarte et al. (1965, 26-28); and those for Iota-Geminorum, Upsilon-Leonis and 48-Leonis are from Westfall (2008) who cites Mermilliod (1991).

Hellas is believed to be a good indicator of seasonal changes on Mars and, hence, may help with the interpretation of brightness data. Essentially, it brightens near Ls = 80° and returns to a normal appearance near Ls = 150°. Figure 1A shows average intensity estimates of this area based on the scale of 0 = white to 10 = black. All values are averages from (Collinson, 1970, p. 53), (McKim, 1984, 205; 1985, 42; 1987, 146; 1989, 224; 1991, 273; 1992, 255; 1995, 126; 2005, 324; 2006, 178; 2007, 321). The author's intensity values for 1988 and 1990-91 (Schmude, 1989, 409; 1992b, 121) are in agreement with those reported by McKim. Figure 1B shows the same intensity values but arranged according to the Ls value on opposition day. Hellas is brightest near Ls = 90°. Increased cloud cover is probably responsible for this. Keep in mind Hellas is in Mars's southern hemisphere and, hence, Ls = 90° is the winter solstice. Images, drawings and comments from P. Abel, M. Adachi, T. Akutsu, J. Berdejo, M. Delcroix, H. Einaga, I. Falcon, J. Ferreira, C. Gargiulo, S. Ghomizadeh, C. Go, Y. Goryachko, C. Hernandez, R. Hill, T. Ikemura, M. Jacquesson, W. Jaeschke, M. Kardasis, A. Kazemoto, T. Kumamori, A. Lasala, S. Maksymowicz, P. Masuri, S. Mogami, E. Morales Rivera, K. Morozov, T. Olivetti, D. Parker, D. Peach, C. Pellier, J. Poupeau, K. Sasaki, I. Sharp, G. Tarsoudis, A. Yamazaki, S. Yoneyama, K. Yunoki and C. Zannelli along with three issues of communications of Mars Observations 394, 396, 398 (Asada et al., 2012) are the basis for the Hellas brightness estimates in Table 3.

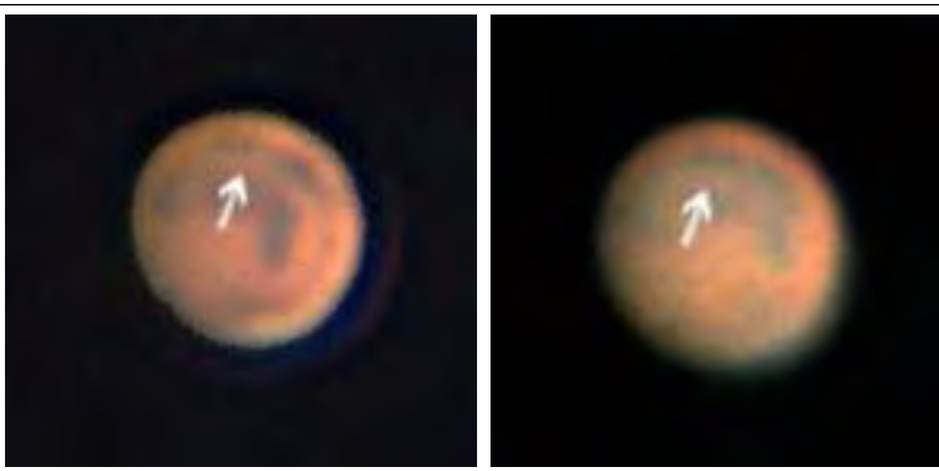

Figure 2. Both images show Mars with a dust storm and with south at the top. They were made by Paul Maxon. Image A was made on August 4, 2011, at 12:48 UT and Image B was made a day later at 12:38 UT The white arrow points to the dust storm.

Results and Discussion

Figure 1C shows a graph of the measured brightness of Mars plotted against the date. As expected, the brightness rises until it peaks near opposition and afterwards, it falls. (Keep in mind that the more negative the stellar magnitude value, the brighter the object.) Figure 1D shows the observed-minus-predicted (O - P) brightness value (in stellar magnitudes) plotted against the date. If the O - P value is positive, it means that Mars is fainter than what it was predicted to be. The predicted brightness values are from Mallama (2007, 409-411). The data show some scatter which may be caused by the large distances between the comparison star and Mars. This leads to greater extinction uncertainties.

Table 4 summarizes average O - P values for the brightness of Mars during different seasons. The table covers three apparitions between 2007 and 2012. Mars is a bit brighter than expected during late northern winter (315° < Ls < 360°) in 2011. One possible reason for this is the dust storm which took place during early August of 2011 [See Figure 2]. A dust storm may cause Mars to brighten 0.1 magnitude or more (Schmude, 2002, 105). This storm reached a length of ~3500 km on August 6 (Ls = 340°) which makes it a regional storm according to the classification scheme proposed by McKim (1999, 119). It is not visible in S. Mogami's August 14 image of Syrtis Major. According to Parker et al. (1999, 7), dust clouds are very rare for 330° < Ls < 360°. Therefore, this storm may have affected the July 29 and 30 measurements. Both of these were brighter than expected. According to McKim (1999, 125), most regional dust storms observed up to 1993 lasted at least six days. One regional storm lasted from December 1, 2003 to January 23, 2004 (Schmude et al. 2004, 40).

Table 3. Summary of the Brightness of Hellas During 2010 and 2012.

L_S Range	Year	Morning Limb CM ≤ 266° W	Disc Center 266° W < CM < 335° W	Evening Limb CM ≥ 326°	Source
50-60	2012	---	2.0	2.0	Com. 394 [b], images [c]
60-70	2012	1.5	1.5	2.0	images [c]
70-80	2012	1.5	1.5	1.5	images [c]
80-90	2012	1.0	1.0 or 1.5	1.5	Com. 396 [b], images [c]
90-100	2012	a	0.5	0.5	Com. 398 [b], images [c]
100-110	2012	a	0.0	1.5	images [c]
110-120	2012	a	1.0	1.0	images [c]
90-100	2010	---	1.0	1.0	images [c]
100-110	2010	---	0.5	---	images [c]

NOTES: The brightness scale is as follows: 2.0 = Hellas has no brightening, 1.5 = Hellas is slightly bright or has a thin veil, 1.0 = Hellas is bright but less brilliant than a polar cap, 0.5 = Hellas is as bright as a polar cap and 0 = Hellas is brighter than a polar cap.
In this table, CM = central meridian longitude.)

[a] The phase defect hides most of Hellas; see (Asada et al., 2012, Com. 394)

[b] Asada, T., Minami, M., Murakami, M., Nakajima, T. and Nishita, A., International Society of Mars Observers (ISMO), Communications 394, 396 and 398 (2012).

[c] Images posted at: http://alpo-j.asahikawa-med.ac.jp/Latest/Mars.htm.

Therefore this storm may have also affected measurements in late August.

Mars was near its expected brightness during early and late spring of 2011-2012 (September 14, 2011 to March 30, 2012). Therefore, the number of clouds during that time was probably similar to that in the reference period and in the two previous apparitions.

The average O - P values for early summer changed between 2010 and 2012. Essentially, the O - P value was near zero for that season in 2012 but was 0.05 magnitude higher than expected in 2010. Therefore, the number of clouds in mid-2012 rose compared with 2010.

Images of Hellas along with reports from Asada et al. (2012) are used to determine its seasonal brightness. A five-step scale is used for estimating brightness, where 2.0 = no brightening compared to a cloud-free situation, 1.5 = a little brightening, 1.0 = significant brightening but Hellas is less brilliant than a polar cap, 0.5 = Hellas is as bright as a polar cap and 0.0 = Hellas is brighter than a polar cap. In almost all cases, when Hellas had a 1.0, 0.5 or 0.0 brightness value for (76° < Ls < 101°), it was much

Table 4. Summary of Average O - P Values, 2007 through 2012

Range of L_S	Season	Average O – P 2007-2008	Average O – P 2009-2010	Average O – P 2011-2012
315 – 0	Late winter	-0.015 ± 0.007	-0.001 ± 0.03	-0.027 ± 0.015
0 – 45	Early spring	0.008 ± 0.0003	-0.003 ± 0.005	0.010 ± 0.009
45 – 90	Late spring	0.012 ± 0.006	0.024 ± 0.002	0.017 ± 0.018
90 – 135	Early summer	---	0.050 ± 0.012	0.005 ± 0.019

Table 5. Possible Dust Storms on Mars During 2011-2012

Date	Location	Source	Comment
Aug. 4-6, 2011	Hellas, Iapygia, Utopia and other areas	P. Maxon's image and comments; see Figure 2	Probable regional storm; Bright in red light
Jan. 1 to Feb. 22, 2012	Southern edge of NPC near 210° W; longest dimension is east to west	Images by D. Parker and E. Morales Rivera	Local dust storm(s) or bright ice on NPC; Bright in red light
March 17, 2012	Lemuria	D. Parker's image and comment	Slightly bright in red light
March 18, 2012	Baltia	Image by Y. Goryachko and K. Morozov;. Image by M. Kardasis	Slightly bright in red light
March 21, 2012	Possible dust in Lemuria	D. Parker's image and comments	Slightly bright in red light
March 22, 2012	Ophir Candor	S. Kowollik's image and comments	This area is often bright without dust; slightly bright in a red light image by D.Peach on March 21
March 23	Mare Boreum	D. Peach's RGB image	Not visible in D. Parker's March 24 image
March 29	Near NPC and Cecropia	C. Gargiulo. S. Ghomizadeh, D. Peach, C. Pellier, I. Sharp	Bright in red light; cuts across dark collar. The collar has a normal appearance on April 2
March 29 – April 2, 2012	Near edge of North Polar Cap	J. Melka's images and comments	Probable dust storm but is close to limb
May 10, 2012	Sinus Sabaeus and Pandorae Fretum	J. Melka's image and comments	Slightly bright in red light and near the limb

brighter in blue than in red light. This is consistent with the presence of condensate clouds instead of ground frost or dust clouds. It will be interesting to see if this trend continues for Ls > 101° in future apparitions. Table 3 summarizes brightness results. During the second half of northern spring, Hellas behaved like what it did in 2010. During early summer (90° < Ls < 110°), Hellas was a little brighter in 2012 than in the previous apparition. This is consistent with the average O - P values in 2010 and 2012.

Suspected local dust storms were reported on a few dates and these are listed in Table 5. In many cases, these storms covered dark areas like the North Polar Collar and were bright in red light. These storms probably did not affect Mars' brightness much though due to their small sizes.

Acknowledgements

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Feature Story:

A Synoptic Study of the Jovian Cloud Bands

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Abstract

The frequency of zonal cloud banding on Jupiter as a function of latitude is reported. Analysis of Hubble Space Telescope images shows that several bands are missing or displaced from the latitude ranges where they might be expected. Some high latitude zone-like bands are also identified. Several HST images acquired during the most recent fading of the South Equatorial Belt show the South Equatorial Belt Zone connecting directly to the South Tropical Zone. Some asymmetries in the Jovian atmosphere are also noted.

Introduction

The most conspicuous features on the disk of Jupiter are its alternating dark belts and bright zones. Bands are most prominent near the equator but they can also be detected at high latitudes. The greater reflectivity of the zones is due to high altitude ammonia ice clouds (Ingersoll et al. 2004) while the belts indicate the absence of such clouds. Thus the zones, which are more dynamically active than the belts, are the focus of this paper.

Why do ammonia clouds form at certain latitudes but not at others? A partial explanation involves the Jovian jet streams. Spacecraft data show fast moving jets (Limaye et al. 1982) that appear to delineate the boundaries between belts and zones. That association is evident in Figure 1 where wind velocity profiles are superposed on images of the cloud bands and it is especially apparent in the equatorial region. The directionality of the jets indicates that the zones are anti-cyclonic air masses and that the belts are cyclonic flows. Thus the jet streams appear to be a geometric framework for the belt and zone phenomenon.

This paper addresses the global relationship between jet streams and cloud bands. Section 2 describes the measurement of zones on Hubble Space Telescope (HST) images collected over the lifetime of the spacecraft mission. Section 3 reports on the comparison between jet stream latitudes and the presence of zones. Several zone-like cloud (ZLC) bands located at high latitudes are also described. In section 4 of this paper, some asymmetries in the Jovian atmosphere are noted. Section 5 illustrates an unbroken path between bright clouds in the South Equatorial Belt Zone (SEBZ) and the STropZ by way of the GRS hollow.

Zone Measurements

Two hundred HST Wide Field Planetary Camera images of Jupiter were selected from the ***MAST*** archive. These data sample the planet's appearance from UV through near-IR wavelengths in a consistent format during a period of 15 years. When Jupiter was imaged repeatedly within a few hours, just one image per filter was selected until the planet rotated by about 120° or 180°. Likewise, when the same planetary longitude was imaged repeatedly over the course of a few days, only one image was selected. Data taken during and shortly after the impact of Comet Shoemaker-Levy 9 were not used. Thus, we sampled Jupiter as uniformly as the data would allow. A list of the HST images used for this study is available from the corresponding author.

Each selected image was marked by all three investigators to indicate the planetographic latitude boundaries of every zone. Distinctly visible zones were given a weight of 1.0 and uncertain zones were weighted 0.5. These latitude results are illustrated in Figure 2. Three zones are apparent northward of the equator at 20°, 30° and 40° latitude. These are the NTropZ, the NTZ and the N2TZ, respectively. Notice that the NTropZ is displaced about 5° toward the equator at ultraviolet wavelengths below 300 nm and thus is somewhat anomalous. Southward of the equator, only the STropZ is strongly visible, although there are hints of other zones as far as -70° latitude. The measurements of zones on methane band images do not appear to be different from other visible and near-infrared results. Thus, the remainder of the analysis excludes UV wavelengths but includes all other data.

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Association Between Cloud Bands and Jet Streams

Nomenclature

Before embarking on a comparison of the cloud bands and the jet streams, it is useful to define the terms that will be employed because the naming convention for these phenomena can be confusing. An example is the "North North North North North North Temperate Belt", which would refer to the seventh belt north of the equator.

For the analysis in this section we have chosen to simplify this nomenclature using the concept of a *domain* which combines corresponding jets, belts and zones into individual units. Rogers (1995) describes them as follows: "Each domain consists of a belt and a zone … The belt is bounded by a rapidly moving prograding … jetstream on the equatorward side and a retrograding … jetstream on the poleward side… The prograding jetstream marks the boundary of the domain …".

For example, the first domain north of the equator begins at +7.2° and extends to +23.7°. The belt between about +7° and +17° is the North Equatorial Belt and the zone between +17° and +23° is the NTropZ. Even this simplification leaves 13 domains to be considered so we number them N0 – N6 proceeding northward from the equator and S0 – S5 proceeding to the south.

Conventional Zones

While Figure 2 illustrates the zones visually, more information is revealed by computing the *fraction of measurements* where a zone was identified as a function of latitude. This result is plotted at 0.1° resolution in Figure 3. The background shading represents cyclonic and anti-cyclonic atmospheric circulations. Zones located outside of anti-cyclonic regions are indicated in red because they are anomalous according to the jet stream paradigm of cloud formation. A table listing the values plotted in Figure 3 is available from the corresponding author.

There are 14 prominent maxima outside of the EZ having fractions ranging from almost 100 percent to just a few percent. Proceeding northward from the equator, the zones in domains N0, N1 and N2 are contained in their expected latitude ranges while there is no zone evident in N3.

South of the equator, a conspicuous zone is located in the belt region of domain S0. This is the well-known SEB Zone (SEBZ). The observed zones in S1, S3 and S4 are located at expected zone latitudes but that in S2 is not.

High-Latitude Zone-Like Bands

Beyond domain N3 in the north, there are four additional bright zone-like cloud (ZLC) bands located in cyclonic regions where dark belts are supposed to exist. The most northerly of these ZLCs is at +65°. Likewise, beyond domain S5 in the south, there is a ZLC band near latitude -68°.

The ZLC bands are not bracketed by a pair of jets where the poleward component is prograde and the equatorward component is retrograde. Thus, the ZLCs occur in regions where ammonia clouds are not expected and they are not conventional zones as described by the jet stream paradigm.

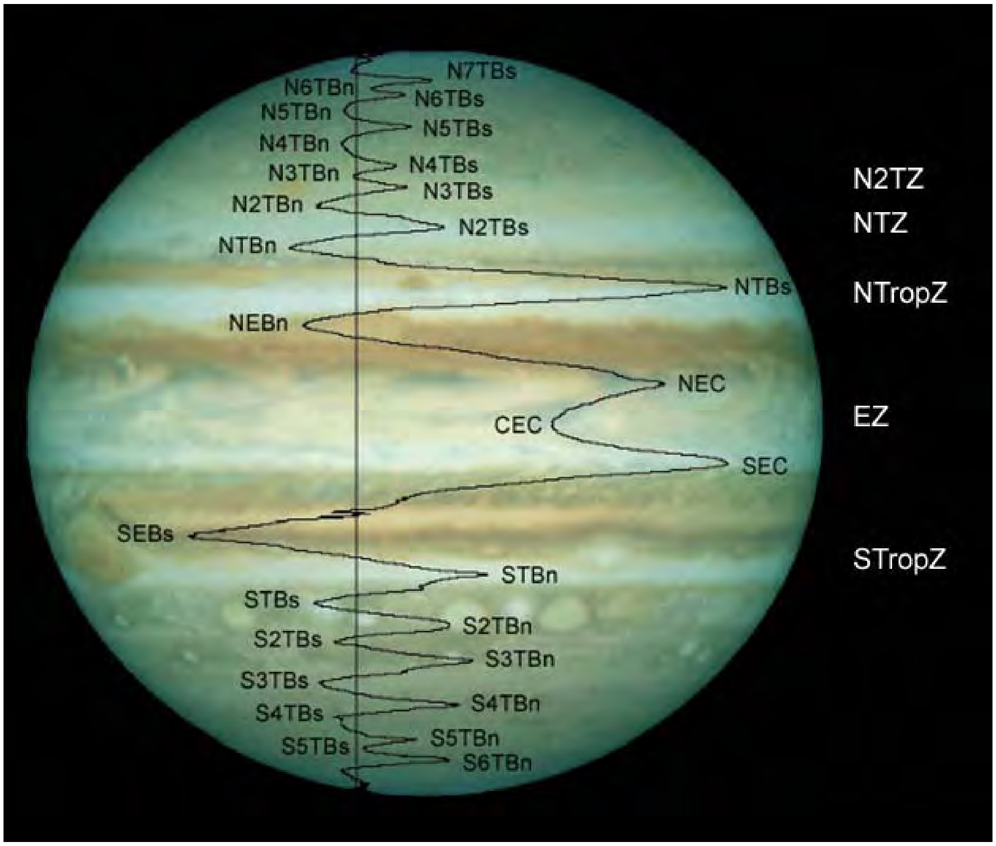

Figure 1. Wind speed profile plotted over an image of Jupiter. The jet streams (extremes of the wind profile) are aligned with boundaries of cloud belts in the equatorial region. The original image was retrieved from http://www.nasa.gov/centers/goddard/images/content/384952main_WINDS_pic.JPG (wind profile from Porco et al., 2003). The labels indicating the North North Temperate Zone (NNTZ), North Temperate Zone (NTZ), North Tropical Zone (NTropZ), Equatorial Zone (EZ) and South Tropical Zone (STropZ), as well as those of the jet streams, were added for this paper. The Great Red Spot (GRS) is visible at the far left below the equator and several white ovals are seen below the STropZ.

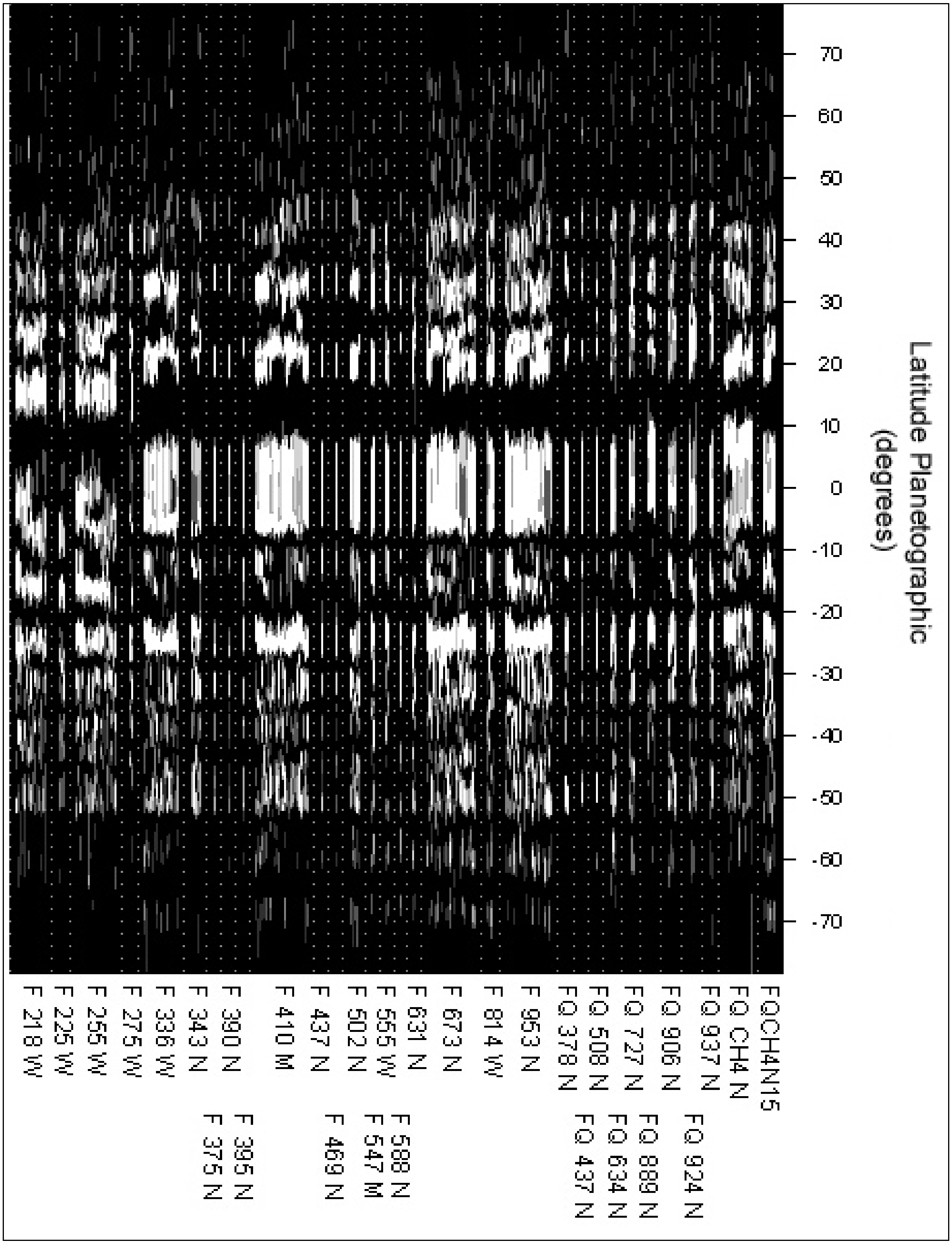

Figure 2. Latitudinal extents of observed zones. The whiteness of each column represents the average of the three authors' measurements of zones for one HST image. Wavelengths of the filters increase along the horizontal axes from 218 to 953 nm. These are followed by methane bands designated by "FQ". Data for the different filters are separated by dashed lines.

These cloud bands can only be characterized roughly from HST images (see Figure 4) because of the foreshortening at their high latitudes. Those toward the north pole tend to have a ragged appearance while the southern ZLC is generally more uniform.

Atmospheric Asymmetries

While measuring the HST images, the following asymmetries in the Jovian atmosphere were observed.

1. Belt widths decrease very rapidly toward the poles, but zones narrow more slowly, as shown in Table 1 and Figure 5. The slope of belt width exceeds that of zone width by three standard deviations, indicating that they differ significantly with a likelihood of more than 99%.

2. A north-south asymmetry is evident in high latitude jets. The pole-side jet of N5 is at 63.8° while that of S5 is -66.9° which constitutes a 3.1° skew. For domains N0 and S0, however, the latitudes of the jets on the equator side are exactly symmetrical in latitude at +7.2° and –7.2°.

3. Another hemispheric asymmetry worth noting is the placement of the GRS and the White Ovals south of the equator (Figure 1). The Little Red Spot is the only corresponding feature in the northern hemisphere.

4. As indicated by Figure 3, there is an extremely deep minimum in the zone fraction as measured over a portion of domain N0. None of the three authors ever recorded a bright cloud band between 14.6° and 14.9°. This complete absence of bright banding is unique within 70° of the equator.

South Equatorial Belt Zone

The SEBZ is visible in Figure 1 as the bifurcation of the SEB. This zone-within-a-belt was identified in about 40% of the HST measurements. On many images taken in 2008 and 2009, the SEBZ

Table 1: Zone and Belt Widths

Domain	Zone (km)	Belt (km)	Zone/Belt Ratio
N6	3,226	2,693	1.198
N5	5,335	4,765	1.120
N4	4,704	5,611	0.838
N3	3,012	2,629	1.146
N2	4,024	4,908	0.820
N1	4,613	8,396	0.549
N0	7,474	10,780	0.693
S0	7,855	13,555	0.580
S1	4,631	6,617	0.700
S2	4,500	3,512	1.281
S3	6,110	5,527	1.105
S4	7,033	3,344	2.103
S5	4,747	2,798	1.697

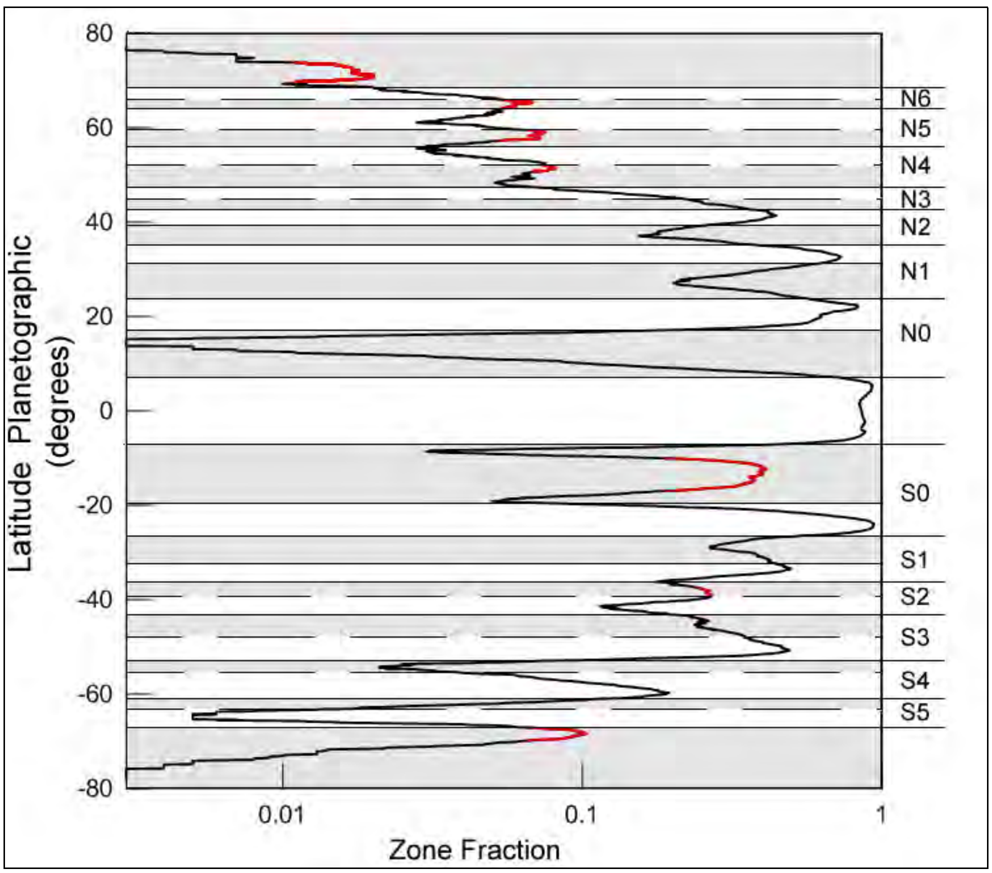

Figure 3. The fraction of measurements where a zone was identified. Grey shading indicates the latitude ranges where zones are expected according to the jet stream paradigm. The red portions of the graph highlight zones or ZLC bands located outside of anti-cyclonic latitude ranges. Note that the profiles for all the zones, except the EZ, are rather strongly peaked instead of fitting squarely into strict latitudinal boundaries. Solid horizontal lines indicate the established jet latitudes while additional dashed horizontal lines were derived by analyzing the wind speed profile in Figure 1 of this paper.

connects to the STropZ by way of the GRS hollow, as shown in Figure 6. The continuous white cloud band crosses the SEBs (see Figure 1 also) which is the fastest retrograde jet stream on Jupiter. This phenomenon coincided with the fading phase of the SEB fade/revival cycle of 2008-2010 (Pérez-Hoyos et al, 2012 and references therein).

Summary and Discussion

Measurement of 200 HST images by the 3 authors resulted in a database of Jovian zone frequency as a function of latitude. The locations of these bright cloud bands were compared to predictions from the jet stream paradigm. Some zones were found to be missing from latitudes where they might be expected and several zone-like cloud bands were identified where they are not expected. In recent years, new hypotheses have been put forward to explain the deficiencies of the jet stream paradigm. However, the goal of this paper is to report empirical results derived from observations rather than to examine theories in detail, so further discussion of these discrepancies is beyond its scope.

Besides observed zone locations, several other notable characteristics of the Jovian atmosphere were reported. These include the changing width of belts and zones as a function of latitude, a north-south asymmetry in the latitudes of poleward jets, the predominance of large spots and ovals in the southern hemisphere, and a total absence of bright zonal clouds between 14.6° and 14.9° north.

Finally, a continuous white cloud band connecting the SEBZ with the STropZ by way of the GRS hollow was reported. This phenomenon was observed during the fading phase of the SEB fade/revival cycle of 2008-2010.

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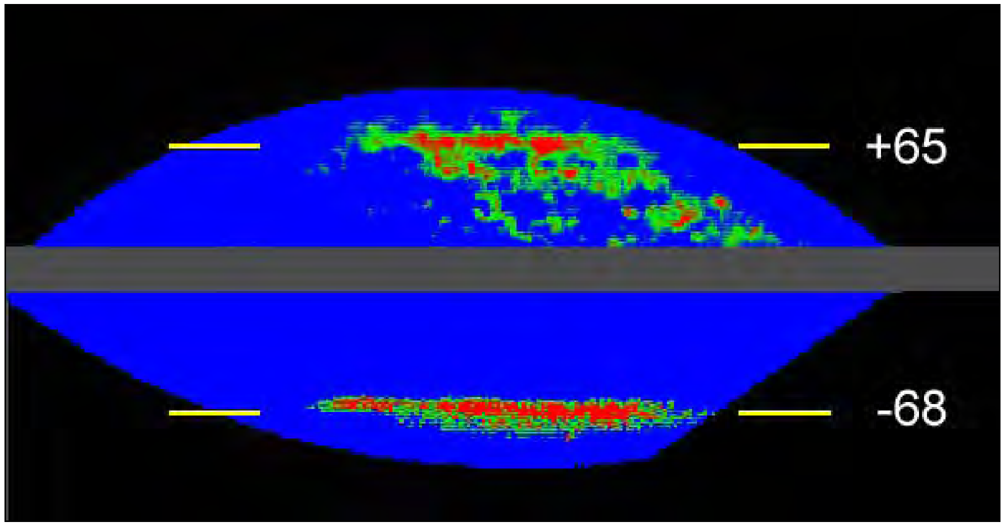

Figure 4. Horizontal lines bracket ZLC bands at the latitudes indicated on the right in this composite image of the north and south polar regions. Adjustments for limb-darkening have been applied and intensities were mapped in false color with red indicating brighter (whiter) clouds. The northern segment is from HST image u2yh0201t, acquired on 1995 October 7 through the F953N filter. The southern part is from u41g011gr, taken on 1997 September 18 through the F410M filter.

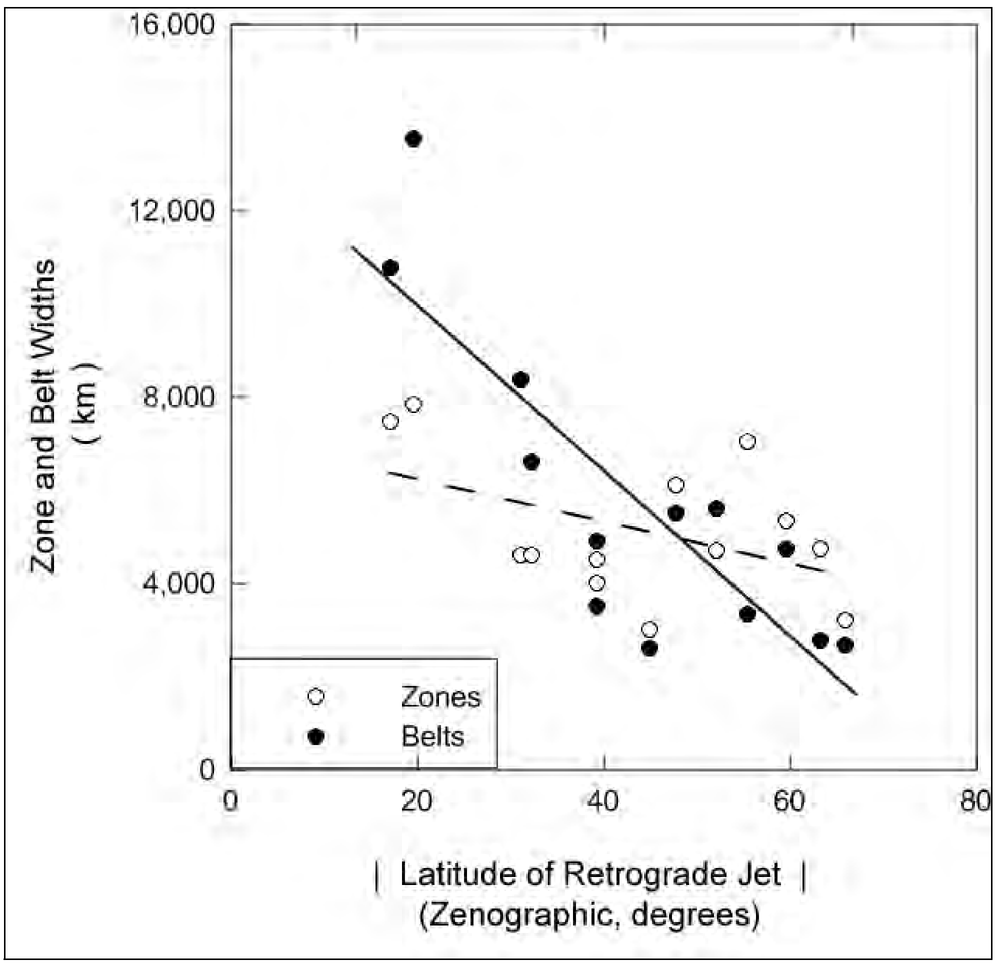

Figure 5. Belt widths decrease sharply toward the poles but zone widths do not. The rate of decrease is significantly different.

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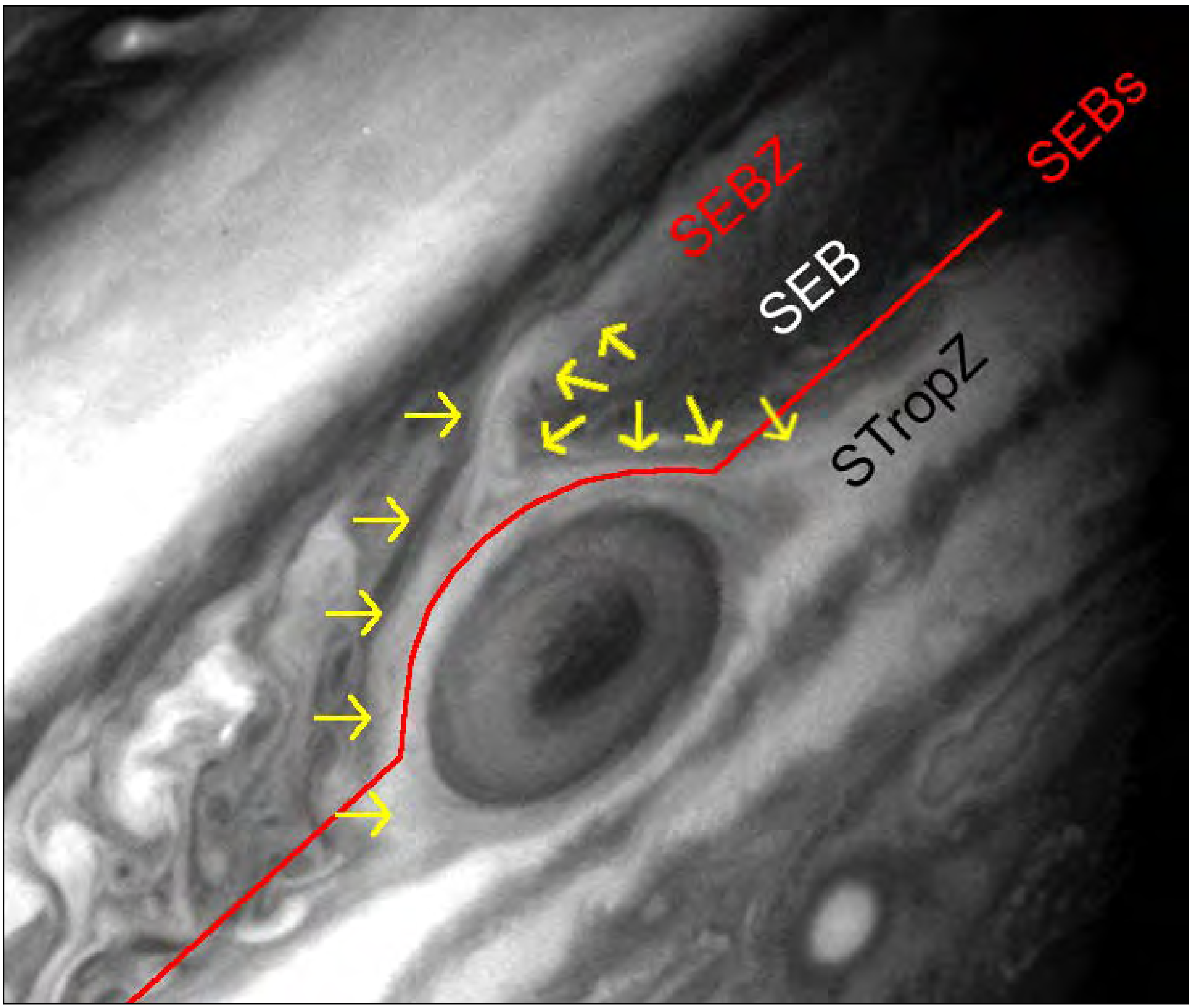

Figure 6. The white clouds of the SEBZ and STropZ are continuous across the SEBs jet stream as shown by the light-colored arrows. The GRS hollow, referred to in the text, is the ring of white clouds that surrounds the darker GRS. HST image ua0n0304m was acquired on 2008 May 5 with the F410M filter.

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Eclipse Section

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ALPO Publications

The Monograph Series

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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 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

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People, publications, etc., to help our members

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;
  Schmidt1113.pdf, approx. 22.7 mb;
  Schmidt1416.pdf, approx. 28.2 mb;
  Schmidt1719.pdf, approx. 22.2 mb;
  Schmidt2022.pdf, approx. 21.1 mb;
  Schmidt2325.pdf, approx. 22.9 mb;
  SchmidtGuide.pdf,approx. 10.2 mb

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- **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 (Bailey):** (1) *The ALPO Lunar Selected Areas Program* ($17.50). Includes full set of observing forms for the assigned or chosen lunar area or feature, along with a copy of the *Lunar Selected Areas Program Manual.* (2) observing forms, free at *http://moon.scopesandscapes.com/alpo-sap.html*, or $10 for a packet of forms by regular mail. Specify *Lunar Forms*. 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,

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published monthly. Free at *http://moon.scopesandscapes.com/tlo.pdf* or $1.25 per hard copy: send SASE with payment (check or money order) to: Wayne Bailey, 17 Autumn Lane, Sewell, NJ 08080.

- **Lunar (Jamieson):** *Lunar Observer's Tool Kit*, price $50, is a computer program designed to aid lunar observers at all levels to plan, make, and record their observations. This popular program was first written in 1985 for the Commodore 64 and ported to DOS around 1990. Those familiar with the old DOS version will find most of the same tools in this new Windows version, plus many new ones. A complete list of these tools includes Dome Table View and Maintenance, Dome Observation Scheduling, Archiving Your Dome Observations, Lunar Feature Table View and Maintenance, Schedule General Lunar Observations, Lunar Heights and Depths, Solar Altitude and Azimuth, Lunar Ephemeris, Lunar Longitude and Latitude to Xi and Eta, Lunar Xi and Eta to Longitude and Latitude, Lunar Atlas Referencing, JALPO and Selenology Bibliography, Minimum System Requirements, Lunar and Planetary Links, and Lunar Observer's ToolKit Help and Library. Some of the program's options include predicting when a lunar feature will be illuminated in a certain way, what features from a collection of features will be under a given range of illumination, physical ephemeris information, mountain height computation, coordinate conversion, and browsing of the software's included database of over 6,000 lunar features. Contact *harry@persoftware.com*

- **Venus (Benton):** Introductory information for observing Venus, including observing forms, can be downloaded for free as pdf files at *http://www.alpo-astronomy.org/venus*. The *ALPO Venus Handbook* with observing forms included is available as the *ALPO Venus Kit* for $17.50 U.S., and may be obtained by sending a check or money order made payable to "Julius L. Benton" for delivery in approximately 7 to 10 days for U.S. mailings. The *ALPO Venus Handbook* may also be obtained for $10 as a pdf file by contacting the ALPO Venus Section. All foreign orders should include $5 additional for postage and handling; p/h is included in price for domestic orders. 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 Venus section. Observers should make copies using high-quality paper.

- **Mars:** *(1) ALPO Mars Observers Handbook,* send check or money order for $15 per book (postage and handling included) 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) 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*, $15 from the 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) *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*; 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 observing forms and ephemerides, can be downloaded for free as pdf files at *http://www.alpo-astronomy.org/saturn*; or if printed material is preferred, the *ALPO Saturn Kit* (introductory brochure and a set of observing forms) is available for $10 U.S. by sending a check or money order made payable to "Julius L. Benton" for delivery in approximately 7 to 10 days for U.S. mailings. The former *ALPO Saturn Handbook* was replaced in 2006 by *Saturn and How to Observe It* (by J. Benton); it can be obtained from book sellers such as *Amazon.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 Saturn Section.

- **Meteors:** (1) *The ALPO Guide to Watching Meteors* (pamphlet). $4 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 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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- ***An Introductory Bibliography for Solar System Observers.*** **No charge.** Four-page list of books and magazines about Solar System objects and how to

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- ***ALPO Membership Directory.*** Provided only to ALPO board and staff members. Contact current ALPO membership secretary/treasurer (Matt Will).

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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.

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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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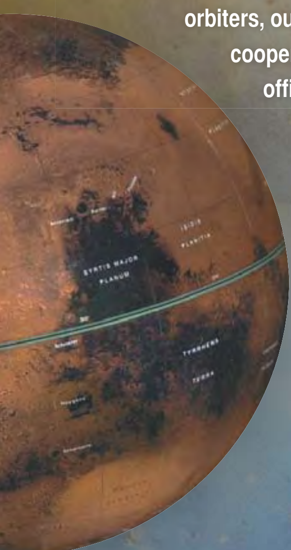

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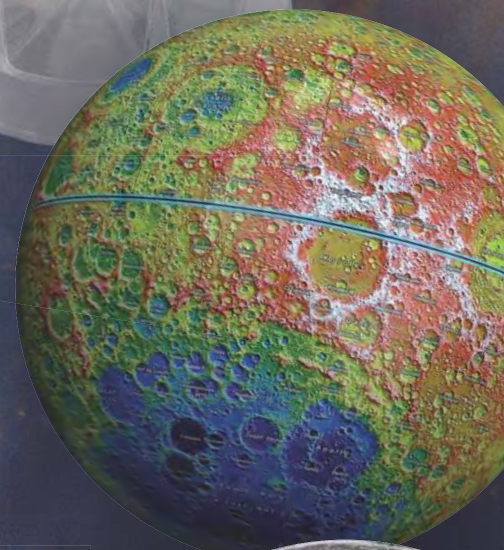

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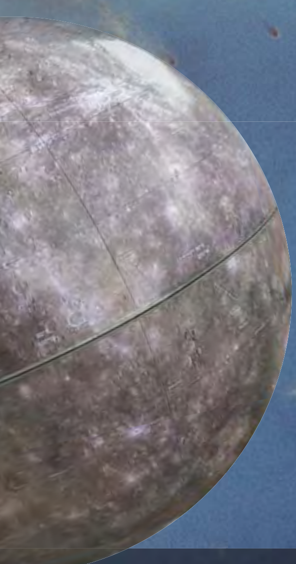

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