Inside this issue . . .

• ALCon 2012 information

• What's REALLY up with those Venusian clouds?

• Whole-disk brightness measurements of Mars

• A ‘Great White Spot’ on Saturn?

• The Remote Planets in 2010 and 2011 . . . plus reports about your ALPO section activities and much, much more!

Online image of the December 11, 2011 lunar eclipse taken by “Shutter Shooter” on the Gold Coast, Queensland, Australia. The first moon was taken at 10:30 pm local time, the second moon at 11:20 pm, the third moon 12:00 midnight and the last blood-red moon was taken at 1:15 a.m. According to his web page, a Pentax X90 12.1 megapixel digital camera was used for image-capture, and Adobe PhotoShop CS5 was used to stitch the photos together and added a small amount of contrast/brightness. Source: http://shutter-shooter.deviantart.com/art/Lunar-Eclipse-December-2011-273379748
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The Leo Trio (M65, M66 and NGC 3628) – Taken with the Orion ED102T CF Refractor, StarShoot Pro V2.0, Orion Atlas EQ-G, and Orion StarShoot AutoGuider. 23 x 10 minute exposures combined. Orion image.

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The Strolling Astronomer

Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 54, No.1, Winter 2012

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

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

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For membership or general information about the ALPO, contact:

Matthew Will
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

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- Mike Simmons, President, Astronomers Without Borders
- Dr. Donald Parker, ALPO, Planetary Astrophotographer
- Dr. Dave Crawford, Co-founder IDA (remote presentation)
- Wally Pacholka, TWAN, Landscape Astrophotographer
- Dr. Jason Steffen, Kepler Mission Scientist
- Dr. Mark Hammergren, Adler Asteroid Expert
- Dr. Philipp Heck, Field Museum Meteorite Curator
- Dr. Hasan Padamsee, Physics Professor/Playwright, Cornell Univ.
- Vivian Hoette, Astronomy Educator at Yerkes Observatory
- Jeff Talman, Artist, Star Sound Installation, “Nature of the Night Sky”
- Dr. David Blask, Expert in circadian disruption/cancer/light pollution
- David Eicher, Editor-in-Chief, Astronomy Magazine

**CALL FOR MATERIAL:**
Call for Material for commemorative “Celebrate Starlight” book and poster. Will be released at ALCon2012! Submissions accepted until March 1, 2012.

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**Celebrate Starlight Book**
We invite your astronomy organization to submit one to two pages describing its history. How do you want your association to be remembered? Let your organization’s achievements, members & outreach SHINE on these pages!

**Celebrate Starlight Poster**
This commemorative poster will be a montage of club logos, famous faces, astrophotos and special projects. We invite each organization to send its logo and any other pertinent images that they wish to have included in this very unusual poster.

What constructed image will the montage represent? Come to ALCon 2012 and find out!

---

**More information and registration:**
alcon2012.astroleague.org

**Special additions to the program:**
- Visual Moonbounce by OPTICKS on July 4! directed by Daniela De Paulis
- Creation’s Birthday, the play by Hasan Padamsee about Hubble and the birth of the Big Bang Theory

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**PARTNERS:**
- Adler Planetarium
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- Chicago Astronomical Society
- ALPO
- Astronomical League
- WASP
- Star Observer
- Ravinia Festival

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**StarShip Sail – July 5**
Registered Tall Ship Windy II, a 149 4-masted schooner. Evening sail to learn celestial navigation and mythology.
Greetings and welcome to 2012! - the year to end all years, at least if you believe the hype put forth by Hollywood regarding the so-called Mayan calendar prediction that come December 21, 2012, we’re all to experience the end of our planet.

My own belief is that most of us will be chuckling about the whole thing the morning of December 22, just like after the Y2K fiasco and the fears of worldwide computer crashes when 1999 left and 2000 entered. (Other than a few problems here and there, even “unprepared” computers survived nicely.)

Anyway, chances are that if it (the end of the Earth) does happen, it will not even be noticed by possible members of an ALPO-like group on another planet far, far away from us.

So what SHOULD we be looking forward to over the course of this year - and even after December 21? Besides Venus and Jupiter, both of which are currently available and beautifully placed each night for you post-sunset observers, some other highlights include the following:

• The solar transit of Venus on June 5 and 6. While the event will be best seen from locales in the Pacific Ocean, those in North America will be able to see at least the start of the transit. The next solar transit of Venus won’t be until 2117, so get your observing plans set now. For more, go to the NASA Eclipse Website at http://eclipse.gsfc.nasa.gov/OH/transit12.html.

• Eclipses: Look for an annular solar eclipse on May 20, a partial lunar eclipse on June 4, a total solar eclipse on November 13, and a penumbral lunar eclipse on November 28. Again, For more, go to the NASA Eclipse Website at http://eclipse.gsfc.nasa.gov/OH/transit12.html.
ALCon 2012 News

Look to the left of this page for a full-page ad with the latest info about this summer’s next astro get-together when the ALPO joins the Astronomical League in Chicago.

Dues Increase
By Matt Will
ALPO membership secretary/treasurer
matt.will@alpo-astronomy.org

Unfortunately, a fact of life is that the cost of doing business rises with time. No one likes having to pay more for the same product. However, even though the ALPO tries to absorb as much of the cost as possible in producing the ALPO Journal and maintaining the business of the ALPO, eventually some decisions have to be made. Below is the new ALPO membership dues structure. This is the first increase in dues that we have had in three years. Please note that the digital membership dues will not increase, but all other categories will. The ALPO has tried to make this increase as modest as our finances will allow and we hope that you will stay with us as the ALPO continues its mission to distribute information and data concerning amateur studies of the Solar System. The new rates take effect on January 1, 2012, and are listed below:

- $US 12 (Digital Journal; All countries; 4 issues, e-mail address required) No change.
- $US 20 (Digital Journal; All countries; 8 issues, e-mail address required) No change.
- $US 33 (Paper Journal; USA, Canada and Mexico; 4 issues)
- $US 60 (Paper Journal; USA, Canada and Mexico; 8 issues)
- $US 40 (Paper Journal; Other countries; 4 issues)
- $US 74 (Paper Journal; Other countries; 8 issues)
- $US 65 (Digital and Paper Journal; Sustaining Member; 4 issues, all countries)
- $US 130 (Digital and Paper Journal; Sponsor; 4 issues all countries)

Remember, there are two ways to join/renew:

- Complete and mail in a copy of your completed membership application from the back of this Journal.

We are also very grateful for the support of those who choose to become Sponsors ($120 for four issues) or Sustaining Members ($60 for four issues). Both Sponsors and Sustaining Members receive both paper and digital versions of this Journal.

Venus Volcano Watch
By Michael F. Mattei
micmattei@comcast.net

We’re down to the last suggested observing date for the Venus Volcano Watch — February 5. Watch for a bulge on the terminator where the uplifted sunlit clouds would show on the dark side of the terminator, and on the sunlit side, watch for bulges of circular cloud formation like the tops of cumulus clouds.

There are three volcanoes that are believed to be active; Maat Mons, Ozza Mons and Sapas Mons. All are near the equator centered near CM 165°. From research of cloud formations and lit clouds on the dark side and circular sunlit side clouds, it may be possible to deter-

<table>
<thead>
<tr>
<th>Date</th>
<th>Location from Terminator</th>
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<tr>
<td>5 Feb 2012</td>
<td>Volcanoes at the bright limb</td>
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mine if a volcano has erupted. A correlation of these observations can be made to locate volcanoes on the surface of Venus.

Observations should be made at all times because there may be many more volcanoes that could be active. I would be happy to receive observations, drawings, sketches, CCD images. Please be sure of the time in UT and location of observer.

See JALPO51, No. 1, page 21 for an article of the events and what they look like. You can find the article by going to http://www.alpo-astronomy.org/djalpo/51-1/JALPO51-1%20-%20Free.pdf.

ALPO Interest Section Reports

Web Services
Larry Owens,
Section Coordinator
Larry.Owens@alpo-astronomy.org

Follow us on Twitter, become our friend on FaceBook, or join us on MySpace.

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

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

Computing Section
Larry Owens,
Section Coordinator,
Larry.Owens@alpo-astronomy.org

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

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**Lunar & Planetary Training Program**
Tim Robertson, Section Coordinator
cometman@cometman.net

For information on the ALPO Lunar & Planetary Training Program, go to www.cometman.net/alpo; regular postal mail to Tim Robertson, 195 Tierra Rejada Rd. #148, Simi Valley CA, 93065; e-mail to cometman@cometman.net.

**Comets Section**
Gary Kronk, Section Coordinator
kronk@cometography.com

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

**Solar Section**
Kim Hay, Section Coordinator,
kim.hay@alpo-astronomy.org

Remember to visit the ALPO Solar Section webpage at www.alpo-astronomy.org/solarblog for information and updated observations.

**Meteors Section**
Report by Bob Lundsford,
Section Coordinator
lunro.imo.usa@cox.net

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**
Dolores Hill, Section Coordinator
dhill@lpl.arizona.edu

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

**Mercury Section**
Report by Frank J. Melillo,
Section Coordinator
frankj12@aol.com

The MESSENGER spacecraft continues to send back excellent surface images of Mercury. Just recently, the scientists had extended the mission after the first year expired in March 2012. There is a lot to learn yet, so hopefully the spacecraft will surprise us with many new discoveries.

The ALPO Mercury Section has been slow this year. Carl Roussell sent many excellent drawings while John Boudreau took many great images. In fact, some of his images are comparable with the MESSENGER. So far, the major features and the rayed craters are confirmed by the recent flybys. Once we get a full view of the surface of Mercury from all different angles, we can check further to see which other features can be seen from earth.

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

**Venus Section**
Report by Julius Benton,
Section Coordinator
jibaina@msn.com

Currently Venus appears in the western sky after sunset at apparent visual magnitude -4.0, steadily distancing itself east of the Sun as it eventually approaches Greatest Elongation East on March 27, 2012. During the 2011-12 Eastern (Evening) Apparition, Venus is passing through its waning phases (a progression from fully illuminated through crescentic phases) as observers witness the leading hemisphere of Venus at the time of sunset on Earth. In mid-January, the gibbous disk of Venus will be nearly 14 arc-seconds across and 80.0% illuminated. The Table of Geocentric Phenomena in Universal Time (UT) is presented here for the convenience of observers for the 2011-12 Eastern (Evening) Apparition.

Observers have already begun contributing images and drawings of Venus, and many more will surely follow in the months to come. Readers are reminded that high-quality digital images of the planet taken in the near-UV and near-IR, as well as other wavelengths through

| Geocentric Phenomena of the 2011-2012 Eastern (Evening) Apparition of Venus in Universal Time (UT) |
|----------------------------------|------------------|------------------|
| Superior Conjunction             | 2011             | Aug 16 (angular diameter = 9.6 arc-seconds) |
| Greatest Elongation East         | 2012             | Mar 27 (46° east of the Sun)               |
| Predicted Dichotomy              | 2012             | Mar 29.34 (exactly half-phase)             |
| Greatest Brilliancy              | 2012             | Apr 28 ($m_v = - 4.6$)                     |
| Inferior Conjunction             | 2012             | Jun 05 (angular diameter = 58.3 arc-seconds) |
polarizing filters, continue to be 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 images to the ALPO Venus Section as well as to the VEX website at:


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, which continues into 2011-12. Since Venus has a high surface brightness, it is potentially observable anytime it is far enough from the Sun to be safely observed.

The observation programs conducted 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 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 (e.g., 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).

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/.

The ALPO Lunar Topographical Studies Section (ALPO LTSS) received a total of 95 new observations from 12 observers during the July-September quarter. Ten contributed articles were published, and eight observations included extensive comments.

The Focus-On series in The Lunar Observer newsletter continued with articles on Plato, and Posidonius. Upcoming Focus-On subjects include Mare Humorum, Copernicus, and Archimedes.

Visit the following online web sites for more info:

- The Moon-Wiki: the-moon.wikispaces.com/Introduction
- Chandrayaan-1 M3: pds-imaging.jpl.nasa.gov/portal/chandrayaan-1_mission.html
- LROC: lroc.sese.asu.edu/EPO/LROC/lroc.php
- ALPO Lunar Topographical Studies Section moon.scopesandscapes.com/alpo-topo
- ALPO Lunar Selected Areas Program moon.scopesandscapes.com/alpo-sap.html
- ALPO Lunar Topographical Studies moon.scopesandscapes.com/alpo-topo
- 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/

Digital image of the gibbous planet Venus as imaged on January 2, 2012 at 19:09 UT by Orlando Benitez Sanchez of the Canary Islands. Equipment includes a 23.5 cm (9.25 in.) SCT and ultraviolet filter S = 6.0, Tr = 5.0. Apparent diameter of Venus is 13.1 arc-seconds, phase (k) 0.823 (82.2% illuminated), and visual magnitude -4.0. South is at top of image.

Lunar Section:

Lunar Topographical Studies / Selected Areas Program

Report by Wayne Bailey,
Program Coordinator
wayne.bailey@alpo-astronomy.org

Digital image of the gibbous planet Venus as imaged on January 2, 2012 at 19:09 UT by Orlando Benitez Sanchez of the Canary Islands. Equipment includes a 23.5 cm (9.25 in.) SCT and ultraviolet filter S = 6.0, Tr = 5.0. Apparent diameter of Venus is 13.1 arc-seconds, phase (k) 0.823 (82.2% illuminated), and visual magnitude -4.0. South is at top of image.
**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**
Dr. Anthony Cook,  
Program Coordinator  
tony.cook@alpo-astronomy.org

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

Finally, please visit the ALPO Lunar Transient Phenomena site online at http://alpo-astronomy.org/lunar/ltp.html.

**Mars Section**
Roger Venable,  
Section Coordinator  
rjvmd@hughes.net

Mars has crept westward in the morning sky so that now it is being studied by those who stay up late, not just those who get out of bed early. Quadrature was on December 2nd, and opposition will be on March 3rd. For more information on the current apparition, see the article, “The Current Apparition of Mars: 2011-2012,” in the Summer 2011 issue of this journal (Vol. 53, No. 3.)

Observations began in July and August with some controversy concerning the possible presence of dust clouds obscuring part of the surface (Figure 1.) The controversy is understandable, in that Mars was only 4.4 arc seconds in apparent diameter on these dates.

The season on Mars was late southern summer, a time when large dust storms frequently occur. Although some observers are convinced that Earth-based images showed dust clouds, most remain unconvinced, citing the small apparent size of the planet as a confounding factor. However, an August 4th

---

**Table Lunar Calendar for First Quarter, 2012 - All Times UT**

| Jan. 01 | 06:15 | First Quarter |
| Jan. 02 | 20:20 | Moon at Apogee (404,579 km – 251,394 miles) |
| Jan. 02 | 24:00 | Moon 4.8 Degrees NNW of Jupiter |
| Jan. 06 | 21:48 | Extreme North Declination |
| Jan. 09 | 07:31 | Full Moon |
| Jan. 14 | 01:00 | Moon 8.4 Degrees SSW of Mars |
| Jan. 16 | 09:08 | Last Quarter |
| Jan. 17 | 17:00 | Moon 6.1 Degrees S of Saturn |
| Jan. 17 | 21:29 | Moon at Perige (369,882 km – 229,834 miles) |
| Jan. 20 | 02:12 | Extreme South Declination |
| Jan. 21 | 13:00 | Moon 1.8 Degrees SSE of Pluto |
| Jan. 22 | 11:00 | Moon 4.7 Degrees NNW of Mercury |
| Jan. 23 | 07:41 | New Moon (Start of Lunation 1102) |
| Jan. 25 | 07:00 | Moon 5.5 Degrees NNW of Neptune |
| Jan. 26 | 14:00 | Moon 6.3 Degrees NNW of Venus |
| Jan. 27 | 23:00 | Moon 5.5 Degrees NNW of Uranus |
| Jan. 30 | 12:00 | Moon 4.4 Degrees NNW of Jupiter |
| Jan. 30 | 17:43 | Moon at Apogee (404,324 km – 251,235 miles) |
| Jan. 31 | 04:11 | First Quarter |
| Feb. 03 | 07:12 | Extreme North Declination |
| Feb. 07 | 21:55 | Full Moon |
| Feb. 10 | 04:00 | Moon 9.0 Degrees SSW of Mars |
| Feb. 11 | 18:33 | Moon at Perige (367,919 km – 228,814 miles) |
| Feb. 12 | 22:00 | Moon 6.0 Degrees SSW of Saturn |
| Feb. 14 | 17:05 | Last Quarter |
| Feb. 16 | 08:36 | Extreme South Declination |
| Feb. 17 | 22:00 | Moon 1.7 Degrees SSE of Pluto |
| Feb. 21 | 20:00 | Moon 5.5 Degrees NNW of Neptune |
| Feb. 21 | 22:36 | New Moon (Start of Lunation 1103) |
| Feb. 23 | 01:00 | Moon 5.6 Degrees NNW of Mercury |
| Feb. 24 | 08:10 | Moon 5.3 Degrees NNW of Uranus |
| Feb. 25 | 21:00 | Moon 3.2 Degrees N of Venus |
| Feb. 27 | 03:00 | Moon 3.8 Degrees NNW of Jupiter |
| Feb. 27 | 14:03 | Moon at Apogee (404,862 km – 251,570 miles) |
| Mar. 01 | 01:22 | First Quarter |
| Mar. 01 | 16:12 | Extreme North Declination |
| Mar. 07 | 24:00 | Moon 9.1 Degrees SSW of Mars |
| Mar. 08 | 09:41 | Full Moon |
| Mar. 10 | 10:03 | Moon at Perige (382,399 km – 225,184 miles) |
| Mar. 11 | 03:00 | Moon 5.9 Degrees SSW of Saturn |
| Mar. 14 | 14:12 | Extreme South Declination |
| Mar. 15 | 01:26 | Last Quarter |
| Mar. 16 | 02:00 | Moon 1.4 Degrees SSW of Pluto |
| Mar. 20 | 02:00 | Moon 5.6 Degrees NNW of Neptune |
| Mar. 22 | 12:00 | Moon 1.4 Degrees NNW of Mercury |
| Mar. 22 | 12:00 | New Moon (Start of Lunation 1104) |
| Mar. 22 | 20:00 | Moon 5.2 Degrees NNW of Uranus |
| Mar. 25 | 23:00 | Moon 3.0 Degrees N of Jupiter |
| Mar. 26 | 06:05 | Moon at Apogee (405,779 km – 252,139 miles) |
| Mar. 26 | 21:00 | Moon 2.0 Degrees SSE of Venus |
| Mar. 28 | 23:42 | Extreme North Declination |
| Mar. 30 | 19:41 | First Quarter |

Table courtesy of William Dembowski
composite image by the Mars Reconnaissance Orbiter showed unequivocally that western Hellas contained a regional dust cloud on that date. The images shown here are very good for such a tiny target, and attest to the skill of Jim and Paul in planetary imaging. South is up and planetary east is to the left in all of the images of this article.

By now, the North Polar Hood (NPH) has broken up and the North Polar Cap (NPC) is broad and bright. In addition to the clouds associated with the NPH, a number of orographic clouds, morning limb hazes, and thin clouds at far southern latitudes have been detected. Watch for the regression of the NPC during the first half of 2012. Figure 2 shows two of the finer images of the many that have been received so far.

Send your images, drawings, and descriptions directly to me at rjvmd@hughes.net, or post them on the Yahoo list at tech.groups.yahoo.com/group/marsobservers. New observers are always welcome.

Visit the ALPO Mars Section online at www.alpo-astronomy.org/mars.

Minor Planets Section
Frederick Pilcher,
Section Coordinator
pilcher@ic.edu

Brian Warner, Robert Stephens, and Alan Harris, after much hard work, have established a repository for lightcurves, analogous to that for astrometric measures, at the Minor Planet Center of the Smithsonian Astrophysical Observatory. To date nearly a million photometric data points have been archived, with the number increasing steadily.

Minor Planet Bulletin Vol. 38, No. 3, 2011 July-September, has published graphs of reduced magnitudes (corrected for changing Earth and Sun distances) versus phase angle for asteroids 158, 535, and 1342. These provide the most reliable values of the absolute magnitude H and phase function G ever obtained for these asteroids. Three new very long period rotators were announced: 846 Lipperta, 1641 hours; 1663 van den Bos, 740 hours; and 27810 Daveturner, 540 hours.

Lightcurves with derived rotation periods are published for 87 other asteroids, numbers 28, 33, 81, 126, 150, 161, 280, 283, 321, 334, 419, 434, 632, 862, 890, 902, 919, 933, 938, 948, 1019, 1080, 1177, 1318, 1383, 2047, 2120, 2650, 2715, 2802, 2869, 3152, 3237, 3252, 3266, 3388, 3447, 3511, 3577, 4175, 4290, 4452, 4464.
4490, 4970, 5168, 6384, 6493, 6577, 6619, 7187, 7579, 7781, 9190, 9233, 9549, 10779, 12265, 12466, 13578, 13822, 14790, 15154, 16562, 16694, 17939, 19131, 20936, 21056, 22696, 23336, 23766, 31485, 32505, 42612, 46784, 48470, 52266, 61461, 65739, 89550, 101771, 113567, 137605, 2001 GU8, 2010 JL33.

Some of these provide secure period determinations, some only tentative ones. Some are of asteroids with no previous lightcurve photometry, others are of asteroids with previous period determinations which may be consistent or inconsistent with the earlier values.

Minor Planet Bulletin Vol. 38, No. 2, 2011 April - June, contains lightcurves and rotation periods for 13 additional Trojan asteroids found by Linda French, Robert Stephens, and colleagues. A binned graph of rotation periods for 40 Trojan asteroids larger than 70 kilometers, most of those in that size range, is presented.

The Minor Planet Bulletin is a refereed publication and that it is available online at http://www.minorplanet.info/mpb-downloads.html. Annual voluntary contributions of $5 or more in support of the publication are welcome.

Jupiter Section
Richard W. Schmude, Jr.,
Section Coordinator
schmude@gdn.edu

Jupiter is well-placed for evening observation during January and February. Both of the equatorial belts are dark. Jupiter is also a few percent brighter than expected.

The 2009-2010 Jupiter report was published in JALPO53-4 (Autumn 2011). The 2010-2011 report is scheduled for publication in either the spring or summer issue of this Journal.

At least 60 people have submitted images or other observations of Jupiter during the current apparition. I am planning to start working on the 2011-2012 Jupiter apparition report in the spring of 2012.

One other plan that I have is that I would like to learn how to use the program “winjupos”. My goal is to measure the shape and size of Jupiter’s white oval storms. It will be interesting to see how these storms develop from one year to the next.

Please continue making images of Jupiter. I am also interested in methane band images and visual intensity estimates.

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

Galilean Satellite Eclipse Timing Program
John Westfall,
Assistant Jupiter Section Coordinator
johnwestfall@comcast.net

Figure 2. Two fine images taken during the present apparition. Upper image. RGB composite image and its component red, green, and blue images (left to right) taken by Damian Peach on November 18, 2011, circa 06:22 UT, using a 35 cm Schmidt-Caesarean and Luminaera-brand camera with filters. CM = 242°. Notice the brightness of Elysium (below center at the left.) Notice also that this bright area is adjacent to the Hybleus Extension in red and green, but in blue there is a slight gap between it and the Hybleus Extension. Thus, the red and green images show ground frost in western Elysium, while the blue image shows clouds around Elysium Mons in eastern (left) Elysium. Lower image. RGB composite image and its component red, green, and blue images (left to right) taken by John Boudreau on December 13, 2011, at 08:18 UT, using a 28 cm Schmidt-Cassegrain and Flea3 camera with filters. CM = 32°.
Inside the ALPO
Member, section and activity news

If you have not yet submitted your timings of the eclipses of the Galilean satellites for the past apparition (2010-2011), we would be happy to receive them. We have placed on the ALPO Jupiter Section webpage a schedule of satellite eclipses for the 2011-2012 Apparition of Jupiter.

As stated in the previous report for this ALPO observing section, three circumstances have come together to allow us to view something we see only rarely – both the beginnings and endings of the same eclipses of Europa. For the great majority of the time, we can see only disappearances and reappearances; the last very close to Jupiter’s limb. After opposition, we have the opposite, with the disappearances next to Jupiter’s limb and the reappearances well away from the planet.

Due to the lateness of this Journal, there are 28 remaining occurrences when we will be able to see these complete (beginning and ending) eclipses of Europa: 2012 January 16 - February 17; and 2012 August 06 - Oct 05.

We hope that some of our readers will watch and time some of these events. Normally, we must time Europa’s eclipse reappearances months after we time its disappearances. The table that accompanies this report gives the dates and terrestrial times (TT) of these events. (Subtract about one minute to convert TT to UT.)

New and potential observers are invited to participate in this worthwhile ALPO observing program. Contact John Westfall via regular mail at P.O. Box 2447, Antioch, CA 94531-2447 USA or e-mail to johnwestfall@comcast.net to obtain an observer’s kit, also available on the Jupiter Section page of the ALPO website.

Saturn Section
Julius Benton,
Section Coordinator
jlbaina@msn.com

Saturn presently appears at apparent visual magnitude +0.7, rising in the eastern sky during the early morning hours and attains sufficient altitude prior to sunrise for worthwhile viewing. The planet’s northern hemisphere and north face of the rings are now visible as the ring tilt toward Earth increases throughout the next several years, with regions south of the rings becoming progressively less favorable to view. Right now the rings are inclined about +15.0 toward Earth. The table of geocentric phenomena for the 2011-12 apparition is presented for the convenience of readers who wish to plan their Saturn observing activities.

As of this writing, observers have already been submitting images of the planet as it gradually becomes more favorable for study. The most notable highlight during the previous observing season was the emergence of a massive storm in the region of Saturn’s North Tropical Zone (NTrZ), first detected by ALPO observers in early December 2010, and was regularly observed and imaged ever since as the brightest feature seen on the planet in recent years. The NTrZ white “complex” exhibited considerable brightening over time, undergoing rapid evolution and differentiation into bright and dusky structures along its length. The storm progressively widened in latitude and underwent considerable longitudinal growth, eventually encircling the globe. Cassini images also dramatically showed how the storm rapidly

Table Completely Visible Eclipses of Europa by Jupiter, 2012

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evolved with time. Observations just received by ALPO observers at the beginning of the current apparition clearly show the morphologically complex remnants of the enormous storm, still apparently encircling the globe at the latitude of the NTrZ. It will be interesting to continue to follow the appearance of this feature throughout the 2011-12, watching for and documenting any changes or outbursts in the region.

As the inclination of Saturn's northern hemisphere toward the Sun increases, with subsequently greater solar insolation affecting these regions, conditions continue to be favorable for activity to develop similar to the NTrZ white storm. Color filter techniques can be used by visual observers to determine which visual wavelengths produce the best views of the NTrZ storm and other similar features that might emerge, and consistent digital imaging at visual, infrared, UV, and methane (CH₄) wavelength bands is particularly important.

The observation programs conducted by the ALPO Saturn Section are listed on the Saturn page of the ALPO website at www.alpo-astronomy.org/saturn. 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. 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.

Recent digital image showing the appearance of the massive, evolving NTrZ storm complex discovered in 2011 as it continues to encircle the globe of Saturn. Image was taken on January 1, 2012 at 06:15UT by Jim Phillips of Charleston, SC, using a 25.4 cm (10.0 in.) refractor in visible light (RGB) in fair seeing. Apparent diameter of Saturn's globe is 16.6 arc seconds with a ring tilt of +14.8°. CMI = 207.7°, CMII = 4.0°, CMIII = 52.1°. South is at the top of the image.

Several people have submitted high-quality observations of both planets during 2011. Jim Fox has submitted almost 20 high-quality brightness measurements of Neptune. This writer has made 12 brightness measurements of the planet Uranus. My measurements in early December indicate that Uranus was brighter in the infrared than what it was in October. This brightening may be due to the bright spot imaged by professional astronomers in late October.

The 2010-2011 Remote Planets report appears later in this Journal. I am planning to write the 2011-2012 Remote planets report sometime during the middle of 2012. In the meantime, please send me any observations of the remote planets as soon as possible.

A reminder that the book Uranus, Neptune and Pluto and How to Observe Them is now 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 http://www.alpo-astronomy.org/remote.

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**Table Geocentric Phenomena for the 2011-2012 Apparition of Saturn in Universal Time (UT)**

<table>
<thead>
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<th>Conjunction</th>
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<td>Opposition</td>
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<td>Conjunction</td>
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**Opposition Data:**

- Equatorial Diameter Globe: 19.0 arc-seconds
- Polar Diameter Globe: 16.9 arc-seconds
- Major Axis of Rings: 43.0 arc-seconds
- Minor Axis of Rings: 28.6 arc-seconds
- Visual Magnitude (m\(_{v}\)): 0.2 m\(_{v}\) (in Virgo)
- B = +13.7°
Scientific fraud is comparatively rare. A few “bad apples” do betray the lofty ideals of the profession. Motivated by careerism, prestige, money, or ideology, the perpetrators succumb to the temptation to tidy up experimental data, fudge statistics, and, in the most extreme cases, invent experiments or observations out of thin air. Such deceit can go undetected for months, years, or, in a few rare instances, even centuries. But on the whole, the scientific enterprise is an objective, self-correcting search for truth.

In science, self-deception is a problem of far more pervasive importance than outright fraud. Even the most rigorous training in objective observation confers no immunity from the desire to obtain a particular result. Conclusions can be unconsciously shaped in many subtle ways. Nor is self-deception a phenomenon that affects only individuals. Sometimes a whole community of investigators can share a common delusion.

There are few fields of scientific endeavor in which the human factor proved more intractable than the telescopic study of the planets. Gerard Kuiper (1905-1973), one of the leading lights of planetary science during the tumultuous generation that witnessed spacecraft replace telescopes as the principal instrument of planetary exploration, stressed that the planetary observer “should be totally disinterested in the outcome of his observation” and “divorce himself of all wishes, emotions, and recollections, and become an ‘instrument’ until the work is completed.” Of course, no such observer has ever existed.

During the long history of Earthbound planetary astronomy, no celestial object was the subject of more pervasive and persistent self-deception than our nearest planetary neighbor, Venus. By far the most beautiful of all the planets to the naked eye, at its brightest, Venus shines thirteen times brighter than Sirius, the brightest of all the fixed stars, and five times brighter than planet Jupiter. When there is no moonlight to interfere, Venus can cast shadows that are readily perceptible, especially when they fall on snow-covered ground. In a deep blue, transparent sky, Venus can even be spotted in broad daylight, particularly if the observer stands in a shaded place, such as a narrow street flanked by high buildings.

Soon after the invention of the telescope, astronomers came to regard Venus as the Earth’s “twin sister” because the two worlds are so similar in size and mass. Yet for all its brilliant splendor, Venus is a bitter disappointment for telescopic observers. Apart from displaying a characteristic array of Moon-like phases, the planet offers only a dazzling, monotonous cloudscape. As the Mariner 2 spacecraft approached Venus in 1962 on the first close-up reconnaissance mission to another planet, rocket designer and space visionary Krafft Ehricke (1917-1984) opined that “Venus might hold even more surprises than Mars.” How right he was.

The armada of spacecraft that followed Mariner 2 revealed that this unbroken overcast is much higher and thicker than any cloudbank on Earth, extending from 45 kilometers (27.9 miles) above the planet’s surface up to 70 kilometers (43.5 miles), with tenuous hazes present even at an altitude of 90 kilometers (55.9 miles). These bright clouds are composed of aerosols of corrosive sulfuric acid droplets mixed with unidentified particulates that may be elemental sulfur, the chlorides of iron or aluminum, or oxides of phosphorous. Beneath the cloud canopy, the atmosphere of Venus increases in density until at the surface it exerts crushing pressures equal to those at a depth of half-mile beneath the sea. Here, hellish temperatures hot enough to melt lead, tin and zinc prevail.

Through a telescope, only evanescent shadings of low contrast can be glimpsed in the uppermost layers of the atmosphere of Venus, which alone are accessible to our sight. Not...
surprisingly, few observers were enticed into making a protracted study of the planet. The greatest observational astronomer of the 18th century, Sir William Herschel (1738-1822), observed Venus on many occasions between 1777 and 1793, but never succeeded in discerning anything more than faint spots that “assumed often the appearances of optical deceptions” and were “extremely faint and changeable.”[3] Herschel’s contemporary, the German astronomer Johann Hieronymous Schroeter (1745-1816), observed Venus at every opportunity for nine years before he was able to detect a definite marking, and that was only a “filmy streak.”[4] Even the “eagle-eyed” William Rutter Dawes (1799-1868), who was renowned for his remarkable visual acuity, always found the planet devoid of markings. Based on this barren record, in 1852, William Herschel’s son Sir John Herschel (1792-1871) complained that Venus was the most difficult of all the planets to observe:

“The intense luster of its illuminated part dazzles the sight and exaggerates every imperfection of the telescope, yet we see clearly that its surface is not mottled over with permanent spots like the Moon; we notice in it neither mountains nor shadows, but a uniform brightness in which we may indeed fancy, or perhaps more than fancy, brighter or obscurer portions, but can never rest fully satisfied of the fact.”[5]

Venus proved especially disappointing through large telescopes, which often showed less detail than seemingly far less powerful instruments. At any given magnification, doubling the aperture of a telescope will increase the apparent brightness of a planet by a factor of four. However, low-contrast markings on a uniform background are best discerned under moderate levels of illumination, an attribute of human perception that psychologists call the “Weber-Fechner law.” Reducing the intense brightness of the image of Venus can reveal features that would otherwise go undetected, but finding the optimum magnification is a delicate balancing act.[6] The director of the British Astronomical Association’s Mercury and Venus Section, Hedley Robinson (1935-2007), cautioned prospective observers of Venus that “one can use too little magnification in the telescope and so render the image too bright to see detail, but too much magnification will kill the contrast and again render the delicate shadings invisible.”[7]

The comparative freedom from glare afforded by small apertures was no panacea, however. As in ethics, virtue seemed to consist of a mean between the extremes of very large and very small telescopes. William Frederick Denning (1848-1931), one of the most accomplished British amateur astronomers of the Victorian era, cautioned:

Accounts are sometimes published of very dark and definite markings seen with only 2 or 3 inches aperture. Such assertions are usually unreliable. Could the authors of such statements survey the planet through a good 10- or 12-inch telescope, they would see at once that they had been deceived. Some years ago I made a number of observations of Venus with 2-, 3- and 4.2-inch refractors and 4- and 10-inch reflectors, and could readily detect with the small instruments what certainly appeared to be spots of a pronounced nature, but on appealing to the 10-inch reflector, in which the view was immensely improved, the spots quite disappeared, and there remained scarcely more than a suspicion of the faint condensations which usually constitute the only visible markings on the surface.[8]

Simultaneous drawings of Venus by different observers often recorded bewilderingly incongruous markings, leading to a widespread attitude that they should all be taken with a few grains of salt. During the 1950s, one of the British Astronomical Association’s veteran planetary

Figure 2: William Frederick Denning.

Figure 3: The map of spurious permanent features on Venus based on observations by Stuyvaert and Niesten.
observers told the neophyte Alan Heath that he admired his drawings of Venus. "But I hardly ever see anything," Heath quizzically replied. "Precisely my point," was the rejoinder.

With its surface so effectively concealed from prying eyes, the axial rotation period of Venus remained one of astronomy's most uncertain parameters for centuries. Even at the dawn of the Space Age, the length of a day on Venus was still an almost embarrassing unknown that was often indicated with a question mark in textbooks.

The majority of observers favored an Earth-like rotation period. As early as 1667, Giovanni Domenico Cassini (1625-1712) announced a period of 23 hours 21 minutes. This value was confirmed by Schroeter in 1793. Following a two-year study, in 1841, the Jesuit astronomer Francesco de Vico (1805-1848) and his assistants at the Vatican Observatory managed to add just 22 seconds to Cassini's value. After nine years of observations at the Royal Observatory in Brussels, the Belgian astronomers Louis Niesten (1844-1920) and Charles-Émile Stuyvaert (1851-1908) endorsed the results of their Italian predecessors and even drew up a peculiar map of the planet's ephemeral markings. The quixotic Serbian astronomer Leo Brenner (1855-1928?), who imagined that he could glimpse oceans and coastlines through transient clearings in the cloud deck, offered a pedantically precise value of 23 hours 57 minutes 36.2396 seconds, a feat not too unlike a geologist determining the age of the Earth to the nearest minute.[9]

Despite what seemed to be a decent measure of agreement, these results failed to inspire a great deal of confidence, chiefly because they were difficult to reconcile with the fact that painstaking micrometer measurements had failed to detect the perceptible oblateness (polar flattening) that would result if Venus were really spinning so rapidly on its axis. (Measured from pole to pole, the Earth's diameter is 42 kilometers (26 miles) shorter than its diameter at the equator.)

In 1877, the year that he made the dramatic announcement of the presence of canali ("channels") on Mars, Giovanni Schiaparelli (1835-1910), the Director of the Brera Observatory in Milan, had turned his attentions to Venus. The observatory's 8.6-inch refractor was modest in size, but unsurpassed in optical and mechanical quality, a masterpiece made by the renowned Munich firm of Georg Merz (1793-1867). Rather than observing Venus at a modest elevation above the horizon during brief intervals in morning or evening twilight, Schiaparelli used the setting circles of the instrument's equatorial mount to flush his quarry from its hiding place high in the midday sky. The brilliance of Venus more than compensated for the veiling background luminance of the sky, and the reduced glare made the planet's delicate features stand out more prominently. Of paramount importance, Schiaparelli was able to keep Venus under continuous surveillance during observing sessions lasting many hours.

There was precious little to see, but day after day from November of 1877 to February of 1878, Schiaparelli managed to make out a dusky, shading parallel to the min, the boundary dividing the dark and sunlit portions of the disk, and diffuse bright oval spots near each of the horns or cusps of the crescent. The latter features had first been described in 1813 by the Bavarian astronomer Franz von Paula Gruithuisen (1774-1852), who thought they were polar snow caps despite their frequent variations in size, shape, and prominence.[10]

Although Schiaparelli was able to scrutinize these markings for up to eight hours at a time, they never exhibited the slightest motion relative to the terminator during his vigils. Dismissing the results of his predecessors, which he attributed to eyestrain and the power of suggestion, Schiaparelli in 1890 cited this lack of motion as evidence that Venus has a very slow "captured" rotation period of 225 terrestrial days, turning on its axis in the same interval that it takes to complete an orbit around the Sun.[11]

If this were true, the sunward face of the planet would be bathed in perpetual sunlight, while the opposite side would be shrouded in endless night.

The prior year, Schiaparelli had announced that after eight years of observations, he had determined that Mercury turns but once on its axis once during each orbit of the Sun, a claim that was not only uncritically accepted but widely acclaimed. Indeed, there were sound theoretical reasons for doing so. In 1877, George Howard Darwin (1845-1912), the son of the famous naturalist, had published an exhaustive mathematical study demonstrating that the tides raised by
The Earth on the primordial molten Moon had gradually slowed our satellite's spin until it turned on its axis in the same period that it takes to complete one circuit around the Earth. Darwin coined the terms “tidal friction” and “captured rotation” to describe this mechanism and its consequence. Indeed, as early as 1865 the American mathematician Daniel Kirkwood (1814-1895) had speculated that the immense tides raised by the nearby Sun ought to have braked Mercury's rotation until it became equal to its year of 88 terrestrial days.

Many of the astronomers who had not hesitated to embrace Schiaparelli's synchronous rotation period for Mercury were reluctant to accept his claims about the rotation of Venus. After all, the tidal pull that the Sun exerts on Venus is not nearly as strong as its influence on Mercury, and the Earth, which rotates fairly rapidly, is not too much farther from the Sun than Venus. If Venus does keep one hemisphere constantly facing the Sun, the doubters argued, it would be a world of harsh extremes. The dense, cloud-laden atmosphere should have frozen out long ago on its frigid nighttime hemisphere. Schiaparelli's suggestion that violent winds blowing steadily from the sunward side could moderate extremes of temperature around the entire globe and allow the atmosphere to persist just didn't ring true.

The immobility of the bright patches on Venus observed by Schiaparelli did suggest another possibility, however. An experiment conducted at the Munich Observatory in 1897 by the Swiss astronomer Walter Villiger (1872-1938) using “artificial planets” cast grave doubts on the reality of the features depicted in Schiaparelli's numerous drawings of Venus.[12] Villiger placed 2-inch diameter balls 400 meters (137.8 feet) away from a 5-inch telescope. Viewed from that distance, the balls had the same apparent size as Venus, and they were illuminated by a spotlight that could be moved to show a sequence of phases. To simulate different surface textures, some of the balls were made of plaster of Paris, while others were smooth rubber that were painted matte white.

Villiger asked his experimental subjects to take turns at the eyepiece of the telescope and sketch what they saw. These featureless spheres evoked perceptions of the same non-existent markings from the majority of his subjects. The most common spurious features were dusky linear shadings parallel to the terminator, narrow, bright bands adjacent to the limb, and bright cusp caps near the tips of the crescent.[13] Villiger's experiment was a convincing demonstration that even the most skilled observers can fall victim to optical illusions.

Despite the seeds of doubt planted by Villiger's experiment, Schiaparelli was held in very high esteem by his contemporaries and his word carried considerable weight. Corroborating observations of stationary markings on Venus were soon reported by Henri Perrotin (1845-1912) of the Nice Observatory. Perrotin, it should be noted, had been one of the first astronomers to confirm not only Schiaparelli's elaborate canal network on Mars, but also the curious proclivity of some canals to form duplicate parallel twins. This phenomenon, called gemination by Schiaparelli, was almost universally regarded as an optical illusion of some sort.
If anyone was even more eager than Perrotin to confirm Schiaparelli's findings, it was Percival Lowell (1855-1916). Although Lowell will always be best remembered for his studies of Mars, he also made controversial observations of other planets, especially Venus. He followed closely in Schiaparelli's footsteps, elaborating on (some might be tempted to say “embellishing”) his work. As Schiaparelli's failing eyesight forced him to abandon observing, Lowell aspired to become the successor of the Italian astronomer he so ardently admired. If expectation were ever the father of illusion, the stage was set.

In the summer of 1896, Lowell had just installed a superb new 24-inch refractor in a dome atop Mars Hill overlooking the town of Flagstaff, Arizona. He had time to kill as he waited for Mars to make its next close approach in December, so on August 21, he had his first look at the small, gibbous disk of Venus in daylight, emulating Schiaparelli's preferred method of observing the planet. Although Venus was riding high in a brilliant late morning sky, he found the image “too bright and badly shattered by air currents” at the modest magnification of 140X. Lowell knew that the smaller the aperture of a telescope, the higher the probability that the light path through the overlying atmosphere will be optically homogenous at any given instant. To reduce the effects of atmospheric turbulence, he reduced the aperture of his telescope using a huge iris diaphragm that he had fitted to the cell of his refractor's objective lens.[14]

During the course of the next few days a confusing array of dusky streaks and spots began to emerge. By early October, they had assumed a form resembling the spokes of a wheel radiating from a central hub. This characteristic pattern, however, could only be seen distinctly when the aperture was stopped down to a diameter of 1.6 to 3 inches.

Lowell and his assistants took turns sketching the planet, but none of their depictions closely resembled Lowell's, except for those of his secretary and mistress, Wrexie Louise Leonard. Far from being discouraged, Lowell claimed that the impressions of a neophyte like Wrexie were compelling evidence that the features were objectively real because an utter novice is a “blank slate” free of preconceived ideas and prejudices.[15]

Rather than soft, nebulous shadings, Lowell claimed that the markings on Venus were “surprisingly distinct; in the matter of contrast, as accentuated in good seeing as the markings of the Moon, and owing to their character much easier to draw; in the matter of contour, perfectly defined throughout, their edges being well marked and their surfaces well differentiated in tone from one another, some being much darker than others.”[16] He boldly asserted that these markings were “not only permanent, but permanently visible whenever our own atmospheric conditions are not so poor as to obliterate all detail on the disk.”[17]

Rather than transient clearings in the cloud canopy, Lowell imagined that the spokes and nodes were permanent surface features, “rock or sand weathered by eons of exposure to the Sun” seen through the “diaphanous straw-colored veil” of a dense but strangely transparent, cloudless atmosphere. This notion was very difficult to reconcile with the well-established fact that Venus has a...
singly high albedo, reflecting about 77% of incident sunlight. This reflectivity was known to be consistent with cumulus or stratus clouds, so accepting Lowell’s findings required discarding one of the few attributes of Venus about which there was universal agreement, namely that the planet is substantially covered by a thick blanket of clouds.

Despite Lowell’s claim that these markings constituted irrefutable proof of the synchronous rotation period proposed by Schiaparelli, his reports were greeted with almost universal derision and elicited a flurry of caustic remarks. After Lowell’s sketches of the planet were displayed at a meeting of the Royal Astronomical Society, the outspoken Captain William Noble (1828-1904) commented: “I do not know whether Mr. Lowell has been looking at Mars until he has got Mars on the brain, and by some transference transcribed the markings to Venus.”[18]

One Lowell’s most doggedly persistent and effective critics, the Greco-French astronomer Eugène Antoniadi (1870-1944), commented disdainfully that he would refrain from even discussing the Venus discoveries emanating from Lowell Observatory, whose observers, “forgetting Venus is decently clad in a dense atmospheric mantle, cover what they call the ‘surface’ of the unfortunate planet with the fashionable canal network.”[19] He was quick to point out that Lowell always depicted the central hub of the spoke system in the precisely same location regardless of the planet’s changing phase, as if Venus always presented the same face to the Earth and not the Sun as Lowell claimed.

Lowell quickly launched a counterattack, employing a tactic that had served him well in arguments with critics of his intricate network of Martian canals. He insisted that it was the unsurpassed tranquility and transparency of the atmosphere over his Arizona observing site, located at an elevation of 7,000 feet, that allowed him to see as “perfectly distinct and unmistakable” planetary markings that had eluded observers who did not enjoy the advantage of his “see-level.”

Lowell put on a brave public face but he was plagued by self-doubt. The barrage of criticism soon took its toll and for more than three years he would be sidelined with “neurasthenia,” the term used at the end of the 19th century to describe what we would now call depression. He retired to his father’s house in Boston for the prescribed “rest

With Lowell out of commission, the task of defending the spoke system fell to Andrew Ellicott Douglass (1867-1962), who was appointed “Assistant Charge” during Lowell’s absence. Douglass mounted a spirited defense of his employer, goading critics with jibes like:

Figure 9: Sketches by Lowell of Venus near superior conjunction in 1896.
career of this strong-willed, egotistical man. For a time Lowell would attribute the spokes to “optical effects of a curious and – astronomically speaking – of a hitherto unobserved character.”[22]

Yet when Lowell resumed observing Venus the following year, the spokes reappeared, staring back at him “with a definiteness to convince the beholder of an objectiveness beyond the possibility of an illusion.”[23] Never again would Lowell openly question the reality of these “peculiar and distinctive” markings, and he ultimately concluded that the hub of the spoke system was located near the point on Venus where solar heating was most intense, leading to a “funnel-like rise of hot stagnant air, creating a partial vacuum,” that was “filled by draughts of cold air from the night side coming in from all sides of the periphery, thus giving rise to a spoke system.”[24]

Lowell's habit of severely stopping down the aperture of his telescope gave his optical system a tiny exit pupil, the image of which was recorded on his eyepiece as a circular beam of light. Employing a magnification of 140X with the aperture reduced to a diameter of only 1.6 to 3 inches yielded exit pupils ranging from less than 0.3 mm (0.01 in.) to little more than 0.5 mm (0.02 in.) in diameter. Narrow exit pupils make defects in the lens of an observer's eye stand out, as none other than Douglass himself had pointed out in an article entitled “Atmosphere, Telescope, and Observer” that appeared in the June 1897 issue of Popular Astronomy magazine:

Perhaps the most harmful imperfection of the eye is the lack of homogeneity within the more dense transmitting media, either the lens or membranes, presumably the former. Under proper conditions the lens displays irregular circles and radial lines, the whole resembling a spider-web structure... These become visible when the pencil of light entering the eye is extremely minute and of the proper brilliancy, by the casting of their own shadows, as it were, on the retina and the absence of light from other parts of the pupil to drown them.[25]

Although Douglass never explicitly identified this “spider-web structure” as the source of Lowell's network of spokes on Venus, he was in Lowell's employ at the time and to do so would probably have been far too blatant an indiscretion.[26]

While there can be no doubt that Lowell's spokes and nodes were literally in the eye of their beholder, was the source of the illusion located in the lens of his eye, as Douglass may have suspected? An even more plausible explanation was proposed soon after I published a popular account of Lowell's Venus observations in Sky & Telescope magazine in 2002. Several ophthalmologists quickly pointed out that by stopping down the aperture of his telescope so severely, Lowell may have effectively converted it into an optical system resembling an ophthalmoscope, the instrument used to examine the concave interior surface of the eye opposite the lens, the ocular fundus.[27] An ophthalmoscope shines a narrow pencil of light through the pupil of the eye and incorporates a perforated inclined mirror or a beamsplitter that permits the examiner to look along the axis of this incident beam of light with the aid of a low-power microscope.

The ocular fundus is the only part of the human body where the vascular network can be observed directly and non-invasively. Examining the ocular fundus has considerable value to physicians because its appearance provides information vital for diagnosing pathological conditions of the eye like glaucoma and can also reveal early signs of systemic disorders like diabetes, hypertension, and intracranial disease.
Lowell’s sketches of Venus remained that the spokes and nodes depicted in peculiarity noted by Antoniadi — namely would convincingly explain the surface of our neighbor world. This vascular features of his own retina onto saw, but he was probably transferring the may have accurately recorded what he unremitting effort to keep centered. He light only half a millimeter in diameter and sending a rather intense beam of cast by enormous tube of his telescope 3 inches, he was perched in the shadow that when Lowell observed Venus in daylight with the objective of his telescope stopped down to a diameter of 3 inches, he was perched in the shadow cast by enormous tube of his telescope and sending a rather intense beam of light only half a millimeter in diameter into his eye, which must have required unremitting effort to keep centered. He may have accurately recorded what he saw, but he was probably transferring the vascular features of his own retina onto the surface of our neighbor world. This would convincingly explain the peculiarity noted by Antoniadi — namely that the spokes and nodes depicted in Lowell’s sketches of Venus remained stationary with respect to the Earth rather than the Sun. It is also notable that Lowell’s sudden death in 1916 was caused by a cerebral hemorrhage, usually the culmination of severe hypertension. In persons suffering from hypertension or exposure to high altitudes, the retinal blood vessels are often dilated and more prominent.

When Lowell “rediscovered” the spoke system in 1903, he realized that far more compelling evidence than drawings would be required to convince his detractors. The spectrograph offered a hopeful way to tackle the problem.

The measurement of Doppler shifts was emerging as one of the very cornerstones of 20th century astronomy. If a planet is rotating, one limb will approach the observer as the other recedes, both at the same velocity. The wavelength of light reflected from the morning and evening limbs will be displaced by the same amount but in opposite directions, causing any absorption lines in the spectrum to shift. Light from the approaching limb will be shifted toward the blue end of the spectrum, while light from the receding limb will exhibit an equal shift toward the red end of the spectrum. The magnitude of these opposing shifts will be proportional to the radial velocity of the planet’s axial spin.

Lowell surmised that a failure of Doppler shifts to appear in spectrograms of the limbs of Venus would lend credence not only to Schiaparelli’s captured rotation period, but also to his own much-ridiculed visual observations as well. He commissioned the Pittsburgh telescope maker John Brashear (1840-1920) to build a state-of-the-art spectrograph and hired a recent graduate of Indiana University, Vesto Melvin Slipher (1875-1916), to master the instrument’s operation.

Slipher’s careful work failed to detect any Doppler shifts, a result that Lowell did not hesitate to tout as “completely confirmatory of Schiaparelli’s period and of my visual work.”[28] Slipher, however, was far more cautious than his employer and refused to go out on a limb. He readily conceded that a 24-hour spin could not have escaped detection, but, citing the limited resolution of the Brashear spectrograph and the errors inherent in his measurements, he was unwilling to offer anything more precise than a conclusion that Venus turns slowly on its axis, probably not faster than once every 30 days.[29]

Adherents of a rapid rotation period cited the possible sources of error in the spectrographic method. First, if the rotational axis of Venus were obliquely inclined to our line of sight, the apparent velocity of approach and recession of the planet’s limbs would be considerably reduced. Second, if the prevailing atmospheric currents were sufficiently rapid in the general direction of the planet’s nighttime hemisphere, Doppler shifts might be masked.

While Slipher’s spectrograms of Venus proved inconclusive, a few years later he would employ the Brashear spectrograph to investigate “spiral nebulae,” then widely regarded as clouds of material swirling around comparatively nearby stars, perhaps nascent planetary systems. This work led to the most important discovery ever made at the Lowell Observatory, the unexpectedly high Doppler shifts of these objects. Within a decade, nearly all astronomers would realize that the spiral nebulae were other galaxies or “island universes,” receding from one another at velocities of hundreds — or even thousands — of miles per second. The chain of events that led to the most fundamental astronomical revelation of the 20th century — an expanding universe far

A central artery sends a diverging network of blood vessels from a feature called the “optic cup” to supply blood to the retina. The veins that drain the retina also converge at this location. Formerly known as “Purkinje’s tree” after the Bohemian physiologist Jan Purkinje (1787-1869) who first described their structure, this branching network of blood vessels is uncannily similar in appearance to Lowell’s depictions of the spokes of Venus. All of these vascular structures overlie the photoreceptors, so patients undergoing an ophthalmoscopic examination are often able to see the shadows cast by their retinal blood vessels, especially when the light source is in motion.

Bear that morsel in mind and consider that when Lowell observed Venus in daylight the embark of his telescope stopped down to a diameter of 3 inches, he was perched in the shadow cast by enormous tube of his telescope and sending a rather intense beam of light only half a millimeter in diameter into his eye, which must have required unremitting effort to keep centered. He may have accurately recorded what he saw, but he was probably transferring the vascular features of his own retina onto the surface of our neighbor world. This would convincingly explain the peculiarity noted by Antoniadi — namely that the spokes and nodes depicted in Lowell’s sketches of Venus remained...
more immense than anyone had dared to imagine — began with the pursuit of illusory markings on our closest planetary neighbor, markings that were in reality probably located only a fraction of a millimeter in front of the rods and cones of Percival Lowell’s retina!

From the rotation of Venus to the expansion of the universe, the ridiculous to the sublime, a charming twist, perhaps, to an otherwise tragic tale. But by now you must be wondering if this is a story without a hero, let alone a happy ending. A hero would appear from a most unexpected quarter, but only after a lapse of more than half a century. In the interim, an unexpected discovery pointed to a way forward when visual observers were facing a dead end.

In striking contrast to the vague, elusive shadings accessible to the visual observer, Venus exhibits prominent features in ultraviolet light. The existence of these markings was first established by Frank Ross (1874-1960), a pioneer in the photography of the planets through monochromatic filters.[30] Using the 60-inch reflector at Mount Wilson Observatory, in 1927, Ross photographed Venus in six regions of the visible spectrum as well as in infrared and ultraviolet light. An infrared filter seemed to offer the greatest promise because of the ability of infrared light to penetrate atmospheric haze, providing the clearest views of the Earth’s surface from aircraft flying at high altitudes. Even though aviation was in its infancy, infrared filters were already routinely employed in aerial photography.

To Ross’ surprise, the photographs of Venus taken through an infrared filter were every bit as bland as those taken in visible light, but ultraviolet photographs at wavelengths of 340 to 370 nanometers captured a wealth of detail owing to localized concentrations of a UV-absorbing substance in the planet’s upper cloud deck.[31] The identity of this material is still uncertain, but the best candidates seem to be elemental sulfur or compounds of sulfur and chlorine. This was the first time that photographs had recorded planetary markings that had eluded visual observers. The UV features took the general form of dusky bands at middle latitudes that ran roughly perpendicular to the terminator. A dark equatorial band was often present, usually sporting a diverging forked tail that formed a characteristic horizontal Y-shaped marking or chevron.

The UV features also appeared, albeit with greatly subdued contrast, in photographs taken through a violet filter that transmitted wavelengths of 380 to 400 nanometers, at the threshold of perceptibility to the normal human eye. This fact spurred British astronomer Patrick Moore (b. 1923) to suggest that the ability of some individuals to see deeper into the ultraviolet might account for the vexing differences in the depictions of Venus by visual observers:

In the autumn of 1953, an interesting but very rough experiment...
was carried out by four planetary observers - R.M. Baum, J.B. Hutchings, C.D. Reid, and myself. Using a spectroscope, we found that Baum's eyes were unusually sensitive to light of short wavelength; Hutchings' and Reid's more normal, and my own rather insensitive. The significance of this is that Baum sees the streaky, cloudlike features clearly, and Hutchings and Reid with difficulty, while to me, they are invisible.[32]

Moore's inference was supported by the experience of the British astronomer Ewen Whitaker (b. 1922). Following cataract surgery, an operation that involved implanting plastic lenses to replace his yellowed and progressively beclouded ones, Whitaker determined with the aid of a monochromator that he beclouded his eyes, Whitaker determined that in France the gulf separating professional and amateur astronomers was never very wide. A number of great French planetary astronomers began their careers as amateurs, some never forsaking their amateur status. The great Eugène Antoniadi, for instance, always referred to himself simply as an "astronomer volontaire de l'Observatoire Meudon." It was natural, therefore, for Camichel and Boyer to continue their association following the war, when Boyer embarked on a career in colonial Africa as Chief Magistrate at Dahomey (now Cotonou) and finally as President of the Bench at Brazzaville in the Congo, a position he held from 1955 until his retirement in 1963.

At Brazzaville, located only four degrees south of the equator, the planets were favorably placed for observation high in the sky and the humid atmosphere was often exquisitely free of turbulence. Realizing his opportunity, Boyer constructed a 10-inch reflecting telescope around a primary mirror made by the renowned optician Jean Texereau. The resulting instrument was optically superb but rode atop a rather rudimentary mounting. Boyer asked Camichel to suggest observing projects. It so happened that Camichel was photographing Venus in the ultraviolet at the time, and he proposed that his friend also attempt to do so.

Lacking a clock drive, Boyer's telescope was ill-suited to taking photographs of the planets, which required exposures several seconds in duration. Using parts from a Meccano erector set, the resourceful amateur cobbled together an ingenious device for moving his camera at precisely the right rate across the focal plane of his telescope. In August and September of 1957, when the air was unusually dry at Brazzaville, he began to photograph Venus, which was then well-placed in the evening sky. He employed a deep blue-violet filter that transmitted wavelengths shorter than 450 nanometers and Kodak Micro-File film, a high-contrast, fine-grained emulsion that is painfully slow by today's standards.

The Venus images in Boyer's photographs were extremely small and aesthetically unappealing, capturing far less detail than the photographs taken by Ross three decades earlier. Yet Boyer was soon able to discern the same dusky patch, becoming infatuated by the idea of depositing a sealed envelope describing his discovery with the French Académie des Sciences. Not everyone was able to see the pattern in his tiny images. In a 1992 interview with William Sheehan, the eminent French planetary observer Audouin Dollfus (b. 1924) recalled: "I examined the images carefully. They did not seem to me completely convincing at the time."

But with Camichel's unflagging support Boyer persisted. The four-day rotation became his idée fixe. In fact, he did no other astronomical work of any real importance. His first published article, co-authored by Camichel, appeared in the popular magazine L'Astronomie in 1960, followed by papers in the prestigious journals Annales d'Astrophysique and the Comptes Rendus de l'Académie des Sciences. They failed to attract much attention or to elicit many comments.

Recognition of Boyer's discovery was agonizingly slow. In the meantime, in 1962 radar impulses bounced off Venus by radio telescopes in the United States and the Soviet Union revealed a very slow 243-day retrograde rotation period for the solid body of the planet, a finding that seemed utterly incompatible with a four-day rotation for the upper atmosphere. It is hard to imagine that the atmosphere of Venus could rotate 60 times faster than the underlying surface because the fastest winds ever clocked on Earth move five times slower than our planet's rotation rate. When Boyer and Camichel submitted a paper on the four-day rotation to Icarus, the leading international journal of planetary science, shortly after the announcement of the radar results, one of the referees, a rising star among planetary scientists named Carl Sagan (1934-1996), rejected it on the grounds that "the four-day rotation is theoretically impossible and shows how foolish the work of the inexperienced amateur can be."

In 1962, Dollfus and his colleagues Jean Rosch and Jean-Claude Pecker persuaded the International Astronomical Union to organize a world-wide photographic surveillance of Venus in the ultraviolet, carried out at several
The sheer plethora of markings confused matters."

Dollfus' insight that low-resolution rather than detailed "can't see the forest for the trees" images were a help rather than a hindrance to Boyer is supported by the experiences of the only visual observer who can claim some measure of credit in independently discovering the rotation period of the atmosphere of Venus, Pennsylvania amateur Rodger W. Gordon (b. 1940). In the November 1962 issue of the newsletter of his local astronomy club, the Lehigh Valley Amateur Astronomical Society, Gordon published a brief account of his observations of Venus early the previous summer, accompanied by cautious disclaimers: "Needless to say, I don't have much confidence in my findings; but for what they are worth, Venus rotates in about four Earth-days... It would not be surprising if I am considerably off the mark, as many others certainly have been."

Unaware of Boyer's results, at every opportunity, Gordon had observed Venus with a violet filter through 4- and 6-inch telescopes. Rather than sketching the planet, he simply assigned a value to the changing duskiness of the terminator region on an arbitrary numerical scale. When the intensity estimates obtained over a span of 10 weeks were plotted on a graph, a sine wave with four- to five-day period appeared. Gordon recalls that when the radar results of a 243-day retrograde rotation period were announced later that year, "I was sorry I ever wrote the article and felt like crawling into a hole!"

Boyer the magistrate made exceptionally judicious use of the meager facts at his disposal. When Dollfus was asked if he thought Boyer had been justified in divining the four-day rotation period from his 1950s images or had merely been lucky, he hesitated a few moments before responding: "Difficult to say. In between. As an amateur, he had more freedom. He was not tied to the same high standards of rigor that he would have been as a professional."

Boyer had taken a chance and stepped out on a limb. Three centuries of study had produced a legacy pathetically barren of results. The field had been all but abandoned when a persistent, single-minded amateur made one of the last important discoveries in the history of Earth-based planetary astronomy. For all its many foibles, the human factor, it would seem, is indispensable after all.

References
1. For an excellent collection of case studies of scientific fraud see William Broad and Nicholas Wade, Betrayers of the Truth: Fraud and Deceit in the Halls of Science (New York: Simon and Schuster, 1982).
3. William Herschel, Philosophical Transactions, 83 (1793), 201-209.
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British Astronomical Association, 105, 3 (1995), 144-147. Long dismissed as illusions, the cusp caps appear in images taken by the Mariner, Pioneer Venus, and Galileo spacecraft as brilliant polar hazes towering above the main cloud deck. Generations of visual observers also reported dusky cusp collars bordering the cusp caps. Images from the Pioneer Venus probe suggest that these features are rings of cooler clouds located at about 70 degrees north and south latitude that are roughly concentric with the planet’s poles.


14. During a surprise visit to a meeting of the British Astronomical Association in 1910, Lowell gave a brief talk that included the remark: “It has been said that the best Indian of all is the dead Indian, and so the most perfect aperture you can use is no aperture at all. Just as you get down to nothing, so your image will improve.” See “Report on the Meeting of the Association, March 30, 1910,” pp. 287-289.


25. This article was reprinted in Amateur Telescope Making Advanced (New York: Scientific American, 1937), pp. 585-605.

26. In personal correspondence with the authors, Macalester College astronomer Sherman W. Schultz, who maintained a private optometry practice for 40 years, noted that an opaque disk containing a suitably illuminated pinhole one millimeter or less in diameter placed in front of the eye can reveal the presence of pre-cataract opacities in the lens. These defects in the lens of the eye often take the form of a striated radial pattern that resembles Lowell’s spoke system and may account for the curious results of the “artificial planet” experiments conducted by the German amateur astronomer W.W. Spangenberg in 1952. In a fashion similar to the experiments performed by Villiger and Douglass half a century earlier, Spangenberg’s subjects viewed smooth, featureless balls through small telescopes. Some recorded cruciform patterns reminiscent of Lowell’s radial spoke system.

27. The authors are indebted to the Mount Vernon, Ohio eye surgeon Roger H. Sherman, MD, and Phillip Steffey of Daytona Beach, Florida, for independently offering these insights.


Abstract
A total of 33 whole-disc V-filter brightness measurements of Mars are summarized in this report. The data are consistent with Mars being dimmer than expected in 2010. Hellas became "brilliant" later in 2010 than in 1995. The brightness data and the delayed brightening of Hellas are consistent with that planet having less cloud/frost cover in 2010.

Introduction
People have noted bright areas on Mars for well over 100 years. As an example, Antoniadi mentioned Schiaparelli’s description, in the 1880s, of Hellas as appearing brilliant especially when it was near the edge of Mars’ disc (Antoniadi, 1975, 92). Similar descriptions of Hellas were made in 1980, 1995 and 2010 (Asada et al., 2010, CMO 370-374), (McKim 1984, 2005).

Attempts have been made to study the average cloud coverage on different dates throughout the Martian year. Beish and Parker (1988, 373), for example, carried out a study of Martian clouds between the 1960s and 1980s. They found that both morning and evening limb clouds were more abundant during late northern spring on Mars than at other times. Parker and co-workers (1999, 3) also report that discrete clouds were more abundant on Mars in 1996-1997 than in the two previous apparitions. McKim (1999) published an extensive review of dust clouds on Mars based largely on telescopic observations. He classified these storms based on size. McKim (1999, 136) shows that dust storms are more frequent at Ls ~ 270° than at other times. (The areocentric longitude, Ls, defines seasons on Mars; the start points for the spring, summer, fall and winter seasons for Mars’ northern hemisphere are Ls = 0°, 90°, 180° and 270°, respectively).

Method and Materials
An SSP-3 solid-state photometer along with a 0.09 meter (3.5 inch) Maksutov telescope and a filter that was transformed to the Johnson V system were used in making all brightness measurements. More information about the equipment can be found elsewhere (Schmude, 1992), (Optec, 1997). The following comparison stars and corresponding magnitudes (in parentheses) were used: alpha-Arietis (2.00), epsilon-Tauri (3.53), iota-Geminorum (3.79) and mu-Leonis (3.90). Magnitudes are from Iriarte et al. (1965) and Westfall (2008). Table 1 shows the brightness measurements of Mars made in 2009-2010. In all cases, these values were corrected for both atmospheric extinction and color transformation. The two-star method was used in evaluating color transformation corrections (Hall and Genet, 1988).

Results
Positional data of Mars in the Astronomical Almanac (2007, 2008) along with brightness measurements made in 2009-2010 were used in computing observed minus predicted (o – p) magnitude values based on Mallama’s model. These values are plotted in Figure 1B. The uncertainty for each value is approximately three times the diameter of the filled circles in the figure.

Figure 1A shows a graph of brightness measurements versus the date. Mars reached a peak brightness of about magnitude -1.4 near opposition in 2010.

In spite of recent studies of clouds and dust on Mars, little is known about the relative cloud, dust and frost coverage on Mars from one year to the next. For example, one may ask “Does Hellas get brighter at the same Ls value each year?” or “Is the seasonal increase in cloud covering the same every year?” To answer these questions, quantitative brightness data are needed.

One way to monitor long-term changes of cloud and frost coverage on Mars is with photometric measurements. This is because condensate clouds and frost cause that planet to be brighter. For example, according to Mallama’s brightness model, (Mallama, 2007, Table 8) Mars is about 0.06 magnitudes brighter at 50° < Ls < 130° than at 230° < Ls < 310°. Much of this brightness increase is due to the large number of limb clouds that develop on Mars at 50° < Ls < 130°. Therefore, brightness measurements are one method of making quantitative measurements of cloud and frost coverage on Mars.

Mallama (2007) has published a model that predicts the brightness of Mars in filters transformed to the Johnson U, B, V, R and I system. His model incorporates brightness changes caused by both longitude and seasonal cloud/frost changes. This model is based on data collected between 1954 and 2006.

In this report, brightness measurements made during the 2009-2010 apparition are reported and are compared to predicted values (Mallama, 2007). The seasonal brightness of Hellas is also examined. The objectives of the current study are: 1) yield data on the overall brightness of Mars in 2009-2010, 2) measure the affects (if any) of the redistribution of dust as a result of dust storms during conjunction and 3) compare the observed brightness to the predicted brightness to see if Mars was brighter or dimmer than expected.

By Richard W. Schmude, Jr.,
schmude@gdn.edu

Feature Story
Whole-Disk Brightness Measurements of Mars: 2009-2010

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During the early months of the apparition, before February 2010 (Ls ~ 45°), the observed brightness of Mars was close to the predicted values. Therefore, any redistribution of dust from dust storms that may have occurred during conjunction had little effect on the brightness. Starting in February, 2010 Mars was dimmer than
Figure 1. A: A graph of the measured brightness of Mars versus the date in 2009-2010; all brightness measurements were made with an SSP-3 solid-state photometer and a filter transformed to the Johnson V system. B: A graph of the observed minus predicted brightness, in magnitudes, versus the date in 2009-2010. C: A drawing of Mars made by the writer on May 1, 1995 at 3:40-4:02 UT with a 0.09 m refractor at 250 X, seeing = 7, Ls = 92°, longitude of the central meridian (or λ) = 198° W, disc center = 20° N. D: A drawing of Mars made by the writer on May 16, 2010 at 2:13-2:28 UT with a 0.12 m refractor at 200 X, seeing = 7, Ls = 91°, λ = 177° W, disc center = 21° N. E: April 22, 2010 (2:17 UT) by Don Parker, green filter (520 nm) Ls = 81°, λ = 45° W. F: May 5, 2010 (0:37 UT) by Don Parker, green filter (520 nm), Ls = 87°, λ = 257° W. G: May 27, 2010 (1:06 UT) by Don Parker, green filter (520 nm), Ls = 96°, λ = 53° W.
<table>
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<tr>
<th>Date</th>
<th>Solar Phase Angle (degrees)</th>
<th>Longitude of Central Meridian</th>
<th>L_s (degrees)</th>
<th>Brightness (magnitudes)</th>
<th>Comparison Star</th>
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<td>May 30.391, 2009</td>
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<td>275</td>
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<td>α-Arietis</td>
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<td>310</td>
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<td>8.2</td>
<td>83° W</td>
<td>49</td>
<td>-1.11</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>Feb. 18.115</td>
<td>15.5</td>
<td>272° W</td>
<td>53</td>
<td>-0.88</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>Feb. 20.236</td>
<td>17</td>
<td>297° W</td>
<td>54</td>
<td>-0.83</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>Feb. 21.085</td>
<td>17.6</td>
<td>235° W</td>
<td>54</td>
<td>-0.82</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>March 5.050</td>
<td>24.4</td>
<td>115° W</td>
<td>60</td>
<td>-0.62</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>March 6.041</td>
<td>24.9</td>
<td>103° W</td>
<td>60</td>
<td>-0.58</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>March 7.043</td>
<td>25.4</td>
<td>94° W</td>
<td>61</td>
<td>-0.50</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>March 12.061</td>
<td>27.7</td>
<td>55° W</td>
<td>63</td>
<td>-0.29</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>March 16.122</td>
<td>29.3</td>
<td>40° W</td>
<td>65</td>
<td>-0.18</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>March 19.088</td>
<td>30.3</td>
<td>1° W</td>
<td>66</td>
<td>-0.08</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>March 20.128</td>
<td>30.7</td>
<td>5° W</td>
<td>66</td>
<td>-0.05</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>March 31.167</td>
<td>33.7</td>
<td>277° W</td>
<td>71</td>
<td>0.21</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>April 1.083</td>
<td>33.9</td>
<td>239° W</td>
<td>72</td>
<td>0.15</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>April 13.099</td>
<td>35.9</td>
<td>131° W</td>
<td>77</td>
<td>0.32</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>April 17.083</td>
<td>36.4</td>
<td>88° W</td>
<td>79</td>
<td>0.42</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>April 26.099</td>
<td>37.1</td>
<td>9° W</td>
<td>82</td>
<td>0.74</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>April 29.065</td>
<td>37.3</td>
<td>328° W</td>
<td>84</td>
<td>0.76</td>
<td>ι-Geminorum</td>
</tr>
<tr>
<td>May 9.115</td>
<td>37.4</td>
<td>250° W</td>
<td>88</td>
<td>0.83</td>
<td>μ-Leonis</td>
</tr>
<tr>
<td>May 18.119</td>
<td>37.3</td>
<td>166° W</td>
<td>92</td>
<td>0.91</td>
<td>μ-Leonis</td>
</tr>
<tr>
<td>May 25.163</td>
<td>37.1</td>
<td>114° W</td>
<td>95</td>
<td>1.06*</td>
<td>μ-Leonis</td>
</tr>
<tr>
<td>May 26.083</td>
<td>37.1</td>
<td>76° W</td>
<td>96</td>
<td>1.07</td>
<td>μ-Leonis</td>
</tr>
<tr>
<td>June 8.082</td>
<td>36.3</td>
<td>310° W</td>
<td>102</td>
<td>1.16</td>
<td>μ-Leonis</td>
</tr>
<tr>
<td>June 21.102</td>
<td>35.2</td>
<td>191° W</td>
<td>107</td>
<td>1.31</td>
<td>μ-Leonis</td>
</tr>
</tbody>
</table>

* Difference in air mass between Mars and the comparison star exceeded 0.3 air masses and, hence this measurement is somewhat uncertain.
expected. (Note that if the o – p value is greater than zero Mars is dimmer than expected.) Table 2 summarizes the average o – p brightness values of Mars, in magnitudes, for different ranges of the $L_0$ values for the 2007-2008 and 2009-2010 apparitions. During 2009-2010, Mars was dimmer than expected for $45^\circ < L_0 < 107^\circ$. This may have been due to a lower coverage of clouds and/or ground frost in 2010 than between 1954 and 2006. Mars was also a bit dimmer than expected for $45^\circ < L_0 < 90^\circ$ during the 2007-2008 apparition.

One feature that may be sensitive to seasonal changes is Hellas. This is a large depression in Mars' southern hemisphere. During warm or low-humidity winters, Hellas may not get as bright as in other winters. This in turn would affect Mars' brightness. Accordingly the writer examined his 1995 drawings and notes of Hellas along with those of others (Minami et al., 1995, CMO155, 157-158, 162-164), (Asada et al., 2010, CMO 370-374), (McKim, 1984, 2005). (Essentially, Hellas starts becoming bright during northern spring or southern fall). It first appears bright only when it is near the limb or terminator but as the temperature drops it becomes bright even near the central meridian. Since Hellas is in the southern hemisphere, winter begins at $L_0 = 90^\circ$.

Descriptions of how Hellas brightened in 1980, 1995 and 2010 are given in Table 3. There is a sizable difference between 1995 and 2010. During 2010, Hellas did not get bright at the disk center until $L_0 = 83^\circ$; however, Hellas was bright at the disc center in 1995 when $L_0 = 65^\circ$. Therefore, Hellas brightened much later in 2010 than in 1995. This is consistent with Mars being dimmer in 2010 than in 1995.

Figures 1C and 1D show two drawings of Mars made by the writer. These drawings were made on May 1, 1995 and May 16, 2010, respectively. Mars is at nearly the same orientation and season in both drawings. Note that the May 1, 1995 drawing shows three bright areas on the left and right edges of Mars, but that the May 16, 2010 drawing shows no bright areas on the left and right edge of Mars. Figures 1E-1G show green light images recorded by Don Parker in 2010. Parker captured some cloud activity but the clouds are not very thick. These drawings and images are consistent with Mars being dimmer than expected in April and May of 2010.

Figure 2 shows three blue filter images of Mars taken in May and June of 2010. Note the lack of bright limb clouds in the images.

**Conclusion**

During 2010 ($45^\circ < L_0 < 107^\circ$) Mars was dimmer than expected. The largest discrepancy occurred after $L_0 = 90^\circ$. This may be due to a lower number of clouds in mid-2010 than during the 1990s. Hellas grew brighter at a later seasonal date in 2010 compared to 1995 and this is also consistent with Mars being dimmer in 2010.

**Acknowledgements**

The writer would like to thank Truman Boyle, Alan Bolton and Sally Bolton for their assistance.

**References**


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Figure 2. A: May 5, 2010, (0:39 UT) by Don Parker, blue filter (480 nm) $L_0 = 86.5^\circ, \lambda = 258^\circ$ W; B: May 27, 2010 (1:01 UT) by Don Parker, blue filter (480 nm) $L_0 = 96.2^\circ, \lambda = 52^\circ$ W; C: June 14, 2010 (1:28 UT) by Don Parker, blue filter (480 nm) $L_0 = 104.3^\circ, \lambda = 245^\circ$ W. South is at the top and west is to the right in all images.
Table 2: Summary of Observed Minus Predicted (o – p) Brightness Measurements for Different Ranges of the Areocentric Longitude (Ls) of Mars for the 2009-2010 Apparition*

<table>
<thead>
<tr>
<th>Ls range</th>
<th>Average o – p brightness, magnitudes (number of measurements) 2007-2008 Apparition</th>
<th>Average o – p brightness, magnitudes (number of measurements) 2009-2010 Apparition</th>
</tr>
</thead>
<tbody>
<tr>
<td>180°-225°</td>
<td>-0.040 (2)</td>
<td>---</td>
</tr>
<tr>
<td>225°-270°</td>
<td>-0.032 (1)</td>
<td>---</td>
</tr>
<tr>
<td>270°-315°</td>
<td>---</td>
<td>0.015 (2)</td>
</tr>
<tr>
<td>315°-0°</td>
<td>-0.015 ± 0.007 (16)</td>
<td>-0.001 (1)</td>
</tr>
<tr>
<td>0°-45°</td>
<td>0.008 ± 0.0003 (95)</td>
<td>-0.003 ± 0.005 (6)</td>
</tr>
<tr>
<td>45°-90°</td>
<td>0.012 ± 0.006 (7)</td>
<td>0.024 ± 0.002 (19)</td>
</tr>
<tr>
<td>90°-107°</td>
<td>---</td>
<td>0.050 ± 0.012 (5)</td>
</tr>
</tbody>
</table>

In all cases, the uncertainty is the standard deviation divided by the square root of the number of measurements. The number of measurements is given in parentheses.

Table 3: Development of Hellas During 1980, 1995 and 2010 at Different Values of Mars’ Areocentric Longitude (Ls)*

<table>
<thead>
<tr>
<th></th>
<th>50° &lt; Ls &lt; 60°</th>
<th>60° &lt; Ls &lt; 70°</th>
<th>70° &lt; Ls &lt; 80°</th>
<th>80° &lt; Ls &lt; 90°</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>bright on ml and el</td>
<td>very bright on ml</td>
<td>very bright on ml</td>
<td>bright at dc at Ls = 82°</td>
</tr>
<tr>
<td>1995</td>
<td>bright on ml and el</td>
<td>bright at dc</td>
<td>bright at dc</td>
<td>bright at dc</td>
</tr>
<tr>
<td>2010</td>
<td>dull</td>
<td>suspect white veil</td>
<td>bright at el, southern part is brighter than northern part</td>
<td>bright at dc at Ls = 83°</td>
</tr>
</tbody>
</table>

* In the table above, “ml” = morning limb, “el” = evening limb and “dc” = disk center.
Abstract

Saturn changed its face during the 2010-11 season. A white spot discovered in the North Temperate Belt (NTB) on December 5, 2010 by the Cassini spacecraft was followed by amateur astronomers throughout the entire apparition. This storm is enormous and similar to a Great White Spot (GWS) that spread rapidly around the Saturn globe. Also, it is comparable to the GWS cycle that occurred 27-30 years in Saturn's northern hemisphere. A question arises whether or not this storm fits into the cycle.

Introduction

Since the invention of the telescope, observers have noticed periodic disturbances, spots and ovals in the Saturnian atmosphere. These features tend to be small and sometimes even go unnoticed. Most of the time, the activity may never be large enough to be followed by most observers. Unlike Jupiter, with almost continuous disturbances, Saturn features tend to be somewhat hazier and are often in poor contrast. There are several reasons for the differences in atmospheric features between the two planets. First, Saturn is nearly twice the distance away from us and from the Sun, so it appears smaller and duller, plus Saturn is cooler and less active internally, so less activity is triggered. Also, the atmosphere is hazier so that most disturbances may be hidden.

This doesn’t mean that there is nothing to see. Saturn may still offer surprises along the road. What appears first is the subtle spot that can turn into a monstrous storm. This feature is often white, circular in shape and is large enough to cover a large area. When this appears, we call it the Great White Spot (GWS).

We don’t know the true nature of the GWS. It is a sudden appearance of ammonia crystals high above the visible layers of the atmosphere. The GWS is the brightest feature on the planet’s globe when exposed to sunlight. The GWS is the only feature that can change Saturn’s appearance suddenly. We are so familiar with Jupiter’s disturbances that there is no comparison with Saturn. When the GWS appears, the attention of amateur and professional astronomers worldwide is drawn to it more than any other objects in the sky. Nothing can be better than the GWS when it is visible on the disk during the night’s observing run. But, how often can the GWS appear? A person can be lucky if he witnesses the GWS at least twice in his lifetime!

Table 1: Saturn’s Great White Spot in History

<table>
<thead>
<tr>
<th>Date</th>
<th>Ecliptic Longitude</th>
<th>Location</th>
<th>Latitude</th>
<th>Discoverer &amp; Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1876 Dec. 27</td>
<td>332</td>
<td>EZn</td>
<td>+5.0</td>
<td>Asaph Hall Washington, DC</td>
</tr>
<tr>
<td>1903 Jun 15</td>
<td>308</td>
<td>NTZ</td>
<td>+38</td>
<td>E. E. Bernard Yerkes Obs.</td>
</tr>
<tr>
<td>1933 Aug. 3</td>
<td>313</td>
<td>EZn</td>
<td>+5.0</td>
<td>Will Hay England</td>
</tr>
<tr>
<td>1960 Mar 31</td>
<td>287</td>
<td>NNTz</td>
<td>+58</td>
<td>J.H. Bothman South Africa</td>
</tr>
<tr>
<td>1990 Sept. 25</td>
<td>288</td>
<td>EZn</td>
<td>+08</td>
<td>Stuart Wilbur Las Cruces, New Mexico USA</td>
</tr>
</tbody>
</table>
The appearance of the GWS is rare indeed — there are only five documented appearances of the GWS; 1876, 1903, 1933, 1960 and 1990, all of which occurred in the Saturnian northern hemisphere. The cycle is roughly 27-30 years apart. Saturn goes around the Sun in 29.5 Earth years. It seems that the GWS cycle is pretty well established.

Saturn goes through two solstices and two equinoxes during each orbit, just as the Earth does, but each season lasts just over seven years. When Saturn reaches its autumnal equinox, which represents 0 degree ecliptic longitude, autumn arrives in the northern hemisphere. The vernal equinox at 180 degrees ecliptic longitude when spring arrives in the northern hemisphere and the summer solstice at 270 degrees ecliptic longitude, summer arrives in the northern hemisphere. This repeats every Saturnian year.

When summer arrives in the northern hemisphere at 270 degrees ecliptic longitude, it gets the maximum sunlight. When this occurs, the direct sunlight may trigger disturbances in the northern hemisphere, though initially, it might take some time for the atmosphere to heat up. A little later in the summer season, the direct sunlight may have some impact on energy and cause enormous plumes high up in the atmosphere to develop. This has occurred at every passage since 1876. (Before that year, the observations were very sporadic.) The only explanation is that this may be a seasonal effect.

When Saturn enters a certain part of the orbit after the northern summer solstice, the GWS bursts into view.

The first well-known report of the GWS occurred December 7, 1876, when Saturn was at 332 degrees ecliptic longitude. It lay along the Equatorial Zone north (EZn) discovered by Asaph Hall of Washington, DC. A second GSW was reported on June 15, 1903, when Saturn was at 308 degrees ecliptic longitude. This time, it lay further north along the North Temperate Zone (NTZ) discovered by E.E. Bernard of Yerkes Observatory. A third GWS was first seen August 3, 1933, when Saturn was at 313 degrees ecliptic longitude. Again, it lay along the EZn discovered by Will Hay of England. A fourth one was discovered March 31, 1960, when Saturn was at 287 degrees ecliptic longitude. It lay along the North North Temperate Zone (NNTZ) near the North Polar Region discovered by J. H. Botham of South Africa. The last official document of the GWS occurred September 25, 1990, when Saturn was at 288 degrees ecliptic longitude. It lay along the EZn which was discovered by Stuart Wilbur of New Mexico.

According to five well-known documents of the GWS, all occurrences were within the range of 288 – 332 degrees ecliptic longitudes. That is roughly between early to mid-summer in the northern hemisphere. In the late 1980s, Saturn was entering the ecliptic longitude range. We then expected another outbreak of the GWS according to the 27-30 year cycle because 29 years have passed without any white spots being reported. A short article, “A White Oval Watch”, published by this author in the JALPO Vol. 33, No. 7-
9 July 1989 issue alerted many observers of a possible upcoming GWS. Later the following year in September 1990, sure enough, a small round feature suddenly appeared along the Equatorial Zone north (EZn) and it developed into a GWS. Saturn was within this ecliptic longitude range and it appeared right on schedule, according to the 27-30 year cycle.

Can We Call the Storm 2010 - 2011 a Great White Spot?

This author describes just a general appearance of the white spot. Many more details of the spot itself will appear in a future JALPO issue.

Saturn reached the vernal equinox (180 degrees ecliptic longitude) in August 2009 when spring arrived in the northern hemisphere. In October 2010, Saturn emerged from behind the Sun, thus marking the beginning of the 2010-2011 observing season. It was early spring in the northern hemisphere. In early December, something was detected by the Cassini spacecraft and some radio signals from the storm that was possibly forming were reported.

On December 9, 2010, several amateur astronomers braved the cold morning to report an unusual spot in the North Temperate Zone (NTB). Obviously, it became a brilliant intense white spot that caused much attention in many astronomical communities.

Two weeks after the first sighting, the white spot developed a tail-like feature on one side. Amateur and professional astronomers around the world got a real treat. They reported that the white spot was starting to stretch out because of strong winds in the upper atmosphere. The white spot was no longer a spot, but developed into a large white band that stretched around the Saturnian globe. After many months, the bright band overlapping the original sight of the spot continued to spread around the globe for the second time. Mottling and many smaller spots were seen within the bright band. The visibility of the storm showed no sign of declining and the contrast continued to be strong. The best part of all is that the storm lasted throughout the entire apparition and kept many amateur and professional astronomers busy. The storm of 2010-2011 appeared very similar to the GWS.

Conclusion

After the GWS appearance in 1990, we looked ahead to see whether or not we could predict another outburst of the GWS. Saturn’s northern hemisphere will reach the summer solstice in May 2017, and it will then enter the 288 degrees – 324 degrees ecliptic longitude range where all five GWSs were seen in the past. If everything holds true, we can expect another outburst sometime during 2017 – 2021.

The 27-30 year cycle seems to be well established based on the GWS’s history. But in addition to that, there is also another cycle which suggests an appearance every 57 years. The GWS spot alternated between the equatorial regions and to fairly high northern latitudes each time they appeared. In 1876, 1933 and 1990, the GWS was located in the equatorial region. All three appearances were 57 years apart. On the other hand, in 1903 and 1960, the GWS appeared at much higher latitudes in the north. Also, both are 57 years apart. Can we expect the next one to appear at a higher latitude in 2017 (1960+57 = 2017)? Either way, with a simple calculation like this, it seems like the GWS can be predicted quite easily. As of December 1, 2010, the next possible appearance of a GWS is still years away, or at least we can expect it toward the end of this decade.

Because it was early spring in the northern hemisphere, nobody expected anything major to happen in the atmosphere. Saturn was at 195 degrees ecliptic longitude and it was way ahead of its time for the GWS to appear during the 27-30 year cycle. By analogy, the Martian global dust storms occur more frequently during perihelion when it is the closest to the Sun while summer approaching the southern hemisphere. And yet in 2001, the global dust storm encircled the planet way ahead of the season. This may also apply to Saturn that the white spot occurred the same way ahead of the season. The storm of 2010-2011 appeared to behave like a Great White Spot and it was no different from the other five of the past.

How can the white spot of 2010-2011 be fitted into the 27-30 year cycle when it’s only 20-21 years since 1990 when the last one occurred? Nobody knows for sure! But there is reason to believe that the white spot was the same phenomena as the previous ones in 1876, 1903, 1933, 1960 and 1990. Certainly, the 2010-2011 is in advance in Saturn’s GWS season with respect to the previous (early springtime against summer time) storms. If this is not the case, can we expect the real one to occur in 2017-2021? We’ll see! The Great White Spot Watch will be announced later this decade!

References


Sanchez, A, 2011, Personal communication.

Westfall, J. E., 2011, Personal communication.
Abstract

This report summarizes observations of Uranus and Neptune in 2010-2011. The selected normalized magnitudes of Uranus for the 2010-2011 apparition are: B(1,0) = -6.56 ± 0.05, V(1,0) = -7.134 ± 0.009, R(1,0) = -6.77 ± 0.02 and I(1,0) = -5.61 ± 0.05. The corresponding values for Neptune are: B(1,0) = -6.59 ± 0.03 and V(1,0) = -7.00 ± 0.03. Several people report faint albedo features on Uranus while others report no irregularities except for limb darkening.

Introduction

Professional astronomers published several new studies of Uranus and Neptune during late 2010 and early 2011. For example, Luszcz-Cook et al (2010) summarized near-infrared images of Neptune made on July 26 & 28, 2007 with the Keck Telescope. They reported that two bright clouds, visible in the images, were centered at latitudes of 89.07° S and 87.84° S. At times, they appeared as a single cloud. Each cloud appeared bright with a diameter of about 500 km. This group concluded that these clouds were at pressures greater than 0.4 bars (or 0.4 atmospheres). In addition to these studies, members of the ALPO also carried out recent studies of Uranus and Neptune.

Table 1 lists characteristics of Uranus and Neptune during their 2010-2011 apparitions. The people who submitted observations of these planets are summarized in Table 2. This report summarizes brightness measurements and drawings/images made of Uranus/Neptune during 2010 and early 2011.

Brightness Measurements

Three different methods were used in measuring the brightness of Uranus and Neptune. These three were photometric photometry, visual photometry and photographic photometry. The results from these methods are summarized.

Photometric Photometry

Jim Fox and the writer made brightness measurements with an SSP-3 solid state photometer along with filters transformed to the Johnson B, V, R and I system. More information on the equipment can be found elsewhere (Optec., Inc, 1997), (Schmude, 1992, 20; 2008, Chapter 5). Jim Fox used 21-Piscium and Mu-Capricorni as the comparison stars for all of his Uranus and Neptune measurements, respectively. The writer used Lambda-Pisces and Iota-Aquarii as the comparison stars for all of his Uranus and Neptune measurements, respectively. The comparison stars and their brightness values are summarized in Table 3.

Table 4 and 5 summarize brightness measurements made of Uranus and Neptune. The date, observer’s initials, filter, measured brightness value and normalized magnitude value are listed in columns 1-5 and 6-10 in each table. Values of the normalized magnitudes, B(1,α) and V(1,α) are computed as:

\[ B(1,\alpha) = B - 5.0 \times \log(r \times \Delta) \]  

(1)

\[ V(1,\alpha) = V - 5.0 \times \log(r \times \Delta) \]  

(2)

In these equations, B and V are the B filter and V filter brightness value, r is the planet-Sun distance and \( \Delta \) is the planet-Earth distance. Both r and \( \Delta \) are in astronomical units. Extinction and color transformation corrections are included in all brightness measurements.

Jim Fox used 25-Piscium as a check star for his Uranus measurements. The average measured brightness of 25-Piscium are 6.292 (V filter) and 6.342 (B filter). The V filter result is close to the accepted value, but the B filter value is 0.07 to 0.08 magnitudes fainter than the accepted value.

Table 1: Characteristics of the 2010 - 2011 Apparitions of Uranus, Neptune and Pluto

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Uranus</th>
<th>Neptune</th>
<th>Pluto</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opposition date</td>
<td>Sept. 21, 2010</td>
<td>Aug. 20, 2010</td>
<td>June 25, 2010</td>
</tr>
<tr>
<td>Angular diameter (opposition)</td>
<td>3.7</td>
<td>2.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Sub-Earth latitude (opposition)</td>
<td>11.3° N</td>
<td>28.5° S</td>
<td>44.6° S</td>
</tr>
<tr>
<td>Right ascension (opposition)</td>
<td>23h 56.2m</td>
<td>21h 58.7m</td>
<td>18h 16.7m</td>
</tr>
<tr>
<td>Declination (opposition)</td>
<td>-1° 16m</td>
<td>-12° 52m</td>
<td>-18° 15m</td>
</tr>
</tbody>
</table>

aData are from the Astronomical Almanac for the years 2007 - 2009
Figure 1. The V(1,a) values for Uranus and Neptune measured since 1991.
than the accepted value. There are no stars brighter than magnitude 10 near 21- or 25-
Pscium (Sinnott and Perryman, 1997, p. 1279). Therefore, this discrepancy is not due to a nearby star. As a result, an uncertainty of 0.05 magnitudes is reported for the selected B(1,0) value of Uranus.

Jim Fox’s comparison star for Neptune, Mu-Capricorni, is listed as a suspected variable (Westfall, 2008). It is not listed as a variable star, however, in Sky Catalogue 2000.0 (Hirshfeld et al, 1991) or in Millennium Star Atlas (Sinnott and Perryman, 1997). Jim’s check star for Neptune, Iota-Aquarii, is not listed as a variable star (Westfall, 2008). The average brightness measurement, in stellar magnitudes, for Iota-Aquarii are 4.283 ± 0.003 (V filter) and 4.214 ± 0.003 (B filter). These values are close to the values in Table 3. Because of the good agreement between the measured and accepted brightness values of Iota-Aquarii, the writer concludes that any variability of Mu-Capricorni at the time that the Neptune measurements were made is less than 0.03 magnitudes. An uncertainty of 0.03 magnitudes is reported for the selected B(1,0) and V(1,0) values of Neptune.

Linear fits of V(1,α) and α for Uranus and Neptune to V(1,α) = V(1,0) + C(V × α) are:

\[ V(1,α) = -7.131 - 0.0016α \] Uranus (3)

Values of V(1,0) for both planets are close to V(1,α) values. The values of C(V, the solar phase angle coefficients, are negative. This is strange and is probably due to the limited accuracy of the values combined with the small range of solar phase angles. Based on previous Earth-based studies, Uranus and Neptune have very low C(V values (Schmude, 2008, 17, 62). As in previous studies, the writer assumed that any change in brightness due to the solar phase angle is negligible. Accordingly, the writer reports V(1,α) = V(1,0), B(1,α) = B(1,0) and so forth.

Figure 1 shows the V(1,α) values for Uranus and Neptune measured since 1991. Each apparition average is shown as a line that is equal to the range of the uncertainty. There is a chance that Uranus reached a minimum brightness during its equinox (Meess, 1997, p. 332) in late 2007 and is starting to brighten again.

Visual Photometry

Patrick Abbott, Phil Plante, Carl Rousell and the writer report brightness estimates of Uranus and Neptune. The selected Vvis(1,0) values for the 2011-2011 apparition are -7.1 (Uranus) and -7.1 (Neptune). These values are based on 65 brightness estimates of Uranus and 36 estimates of Neptune. The value of Vvis(1,0) is computed as:

\[ V_{vis}(1,0) = V_{mag} - 5.0 \times \log[r \times \Delta] \] (5)

In this equation Vmag is the estimated brightness. The values of r and Δ are defined in equation 1.

Photographic Photometry

Gus Johnson reports the brightness of Uranus as being equal to magnitude 6.3 from photographs. His brightness estimate is close to the expected B filter value.

Drawings and Images

Several people observed and imaged limb darkening on Uranus. Venable did not image any albedo feature on Uranus except for limb darkening in spite of excellent seeing conditions (Figure 2A). The limb darkening was symmetrical. The limb darkening was also symmetrical on August 21, 2010 (Figure 2B). The limb darkening, however, was wider near the southern limb in Frassati’s drawing (Figure 2C). The limb darkening was more pronounced in blue light than in red light on July 18, 2010 (figures 2D and 2E).

Several people reported faint albedo irregularities on Uranus. Plante reports that Uranus’ preceding hemisphere was brighter than the following one on both September 13 and October 10, 2010. On both dates, he used a 0.64 m (25 inch) reflector. He also

Table 2: Contributors to this Reporta

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<thead>
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<th>Name (location)</th>
<th>Type of Observationb</th>
<th>Telescopec</th>
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<td>Roger Venable (GA, USA)</td>
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aThe following people contributed valuable observations to the ALPO Japan latest website and are not listed above: Dave and Gail Bleser, Cristina Cellini, Fabrizio Contigliozzi, Marc Delcroix, David Gray, Carlos Hernandez, Toshihiko Ikemura, Akira Kazemoto, Kazuyoshi Maeda, Stauslas Maksymowicz, Satoshi Mogami, Efrain Morales, Pavel Presnyakov, Delcroix, David Gray, Carlos Hernandez, Toshihiko Ikemura, Akira Kazemoto, Kazuyoshi Maeda, Stauslas Maksymowicz, Satoshi Mogami, Efrain Morales, Pavel Presnyakov, Seiichi Yoneyama and Kenkichi Yunoki. The following observer contributed to the Arkansas Sky Observatory archive: Geoff Chester.
bType of observation: C = Color, D = drawings, DN = descriptive notes, I = images, PP = photoelectric photometry, Ph P = photographic photometry, VP = visual photometry
cTelescope: first quantity lists the diameter and the one or two upper case letters lists the type according to: B = binoculars, C = Cassegrain, Me = Mewlon, RL = reflector, RR = refractor and SC = Schmidt-Cassegrain
A few 2010 visible light images display Uranus’ polar flattening. Any polar flattening in Venable’s image is less than 0.01. Pellier’s August 21 image shows a polar flattening of between 0.02 and 0.03. Peach’s September 27 Uranus images show a polar flattening of 0.02. The images are consistent with a polar flattening of 0.02 ± 0.01.

Peach’s September 25, 2010 image of Neptune shows faint albedo features. The most distinct feature is a bright area near the south pole. His image was taken with a 0.35 m (14 inch) Schmidt-Cassegrain telescope with a long-pass red filter. His image is consistent with a polar flattening of about 0.03. This is near the accepted value (Astronomical Almanac, 2009).

Satellites
Delcroix recorded an unfiltered image of Uranus and its four brightest moons on September 19, 2010. He reports brightness values, in stellar magnitudes, of Ariel (13.88), Umbriel (14.36), Titania (13.46) and Oberon (13.80). He also reports a brightness value of 5.7 for Uranus. His Uranus brightness measurement is about 0.1 magnitudes brighter than other V filter measurements made in September 2010. His comparison star, 3UC 178-294705, has a brightness of magnitude 15.7. From these measurements, the writer computes brightness differences (compared to Titania) in stellar magnitudes of: Ariel – Titania = 0.42; Umbriel – Titania = 0.90; Oberon – Titania = 0.34. The value of 0.34 magnitudes for Oberon – Titania is a little high compared to previous results (Schmude, 2010, p. 48). This is consistent with Oberon becoming a little dimmer.

Acknowledgements
The writer is grateful to Truman Boyle for his assistance. He is also grateful to all of the people who submitted observations in 2010-2011.

Table 3: Comparison and Check Stars Used in Photometric Studies of Uranus and Neptune

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bIriarte et al (1965)

hHarishfeld et al (1991)

Figure 2. Drawings of Uranus by Venable (A and B) and Frassati (C, D and E).

References


Table 4: Brightness Measurements of Uranus Made in 2010 and Early 2011

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aInitials: JF = Jim Fox; RS = Richard Schmude, Jr.
bJim Fox used 21-Piscium as the comparison star and Richard Schmude, Jr. used lambda-Piscium as the comparison star.
Table 5: Brightness Measurements of Neptune Made in 2010

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aInitials: JF = Jim Fox; RS = Richard Schmude, Jr.
bJim Fox used μ-Capricorni as the comparison star and Richard Schmude, Jr. used ι Aquarii as the comparison star

Table 6: Selected Normalized Magnitudes for Uranus and Neptune

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<th>Parameter</th>
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<th>Number of Measurements</th>
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<td>B(1,0)</td>
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<td>V(1,0)</td>
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<td>-7.00 ± 0.03</td>
<td>24</td>
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Benton, J.L. ...................................... jlbaina@msn.com
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Brasch, K.R. ................................ m_brasch@earthlink.net
Baum, R. ........................................... ronaldjake27.co.uk
Cook, A. ........................................ tony.cook@alpo-astronomy.org
Cudnik, B. ........................................ cudnik@sbcglobal.net
Darling, D.O. ..................................... DOD121252@aol.com
Dembowski, W. ................................ dembowski@zone-vx.com
Dobbins, Tom ................................... tomdobbins@gmail.com
Garfinkle, R.A. .................................. rgarf@earthlink.net
Garrett, L.S. ....................................... atticaowl@yahoo.com
Grafton, E. ....................................... ed@egrifton.net
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Hill, R. ........................................... rhill@jpl.arizona.edu
Jakiel, R. ......................................... rjakiel@earthlink.net
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Kronk, G. ......................................... kronk@cometography.com

Larson, S. ....................................... siarson@lpl.arizona.edu
Limeaye, S. ...................................... sanjayl@ssec.wisc.edu
Lunsford, R.D. ..................................... luno.ro.imo.usa@cox.net
MacDougall, C. ................................... macdou@verizon.net
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Melillo, F. ...................................... frankj12@aol.com
Melka, J. .......................................... jtmelka@yahoo.com
Owens, L. ........................................ larry.owens@alpo-astronomy.org
Parker, D.C. ..................................... park3232@bellsouth.net
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Poshely, K. ...................................... ken.poshedly@alpo-astronomy.org
Reynolds, M. .................................... mreyold@fscj.edu
Robertson, T.J. ................................... cometman@cometman.net
Sanchez-Lavega, A. ......................... wupsala@bic00.bi.ehu.es
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- Saturn (Benton): Introductory information for observing Saturn, including observing forms and ephemerides, can be downloaded for free 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 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.

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 85641-2309.

- 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 leaguestales@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 85641-2309.
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People, publications, etc., to help our members

- **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.

Other ALPO Publications
Checks must be in U.S. funds, payable to an American bank with bank routing number.

- **An Introductory Bibliography for Solar System Observers. No charge.** Four-page list of books and magazines about Solar System objects and how to observe them. The current edition was updated in October 1998. Send self-addressed stamped envelope with request to current ALPO Membership Secretary (Matt Will).

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

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