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Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 56, Number 1, Winter 2014

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Founded in 1947

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- ***ALPO observations of the remote planets in 2012 and 2013***

. . . plus ALPO section news and much, much more!

Comet C/2012 S1 (ISON) with star trails as imaged by Van Macatee of Rutledge (near Atlanta), Georgia USA, on November 11, 2013. See imaging details on page 22.

33rd Annual Symposium on Telescope Science

Promoting Amateur Science and Professional-Amateur Collaboration in Astronomy

The Annual Symposium of the Society for Astronomical Sciences is the premier forum for astronomical research by amateur astronomers, students, and the professional researchers who utilize the data gathered by small-telescope users.

This year's Symposium will be a joint gathering of the Society for Astronomical Sciences, the American Association of Variable Star Observers, and the Center for Backyard Astrophysics.

Gathering these three organizations together will provide a wonderful chance for the small-telescope research community to share results and network with each other.

- Research Presentations
- Poster Paper Displays
- Guest Speakers
- Educational Workshops
- Amateur & Professional Astronomers
- New Product Introductions

Dates: **June 12-13-14, 2014**

Location: Ontario Airport Hotel, Ontario, CA

If you are involved in small-telescope research, or are curious about opportunities for amateur astronomers, students, and college observatories to contribute to astronomical knowledge, you will want to attend this Symposium.

Registration and other information is available at www.SocAstroSci.org.

Call for Papers:

We invite proposals for papers related to all aspects of small-telescope astronomical science and education. Submission instructions and format requirements, plus Proceedings from prior years and videos of technical presentations, are all available at the SAS website: www.SocAstroSci.org.

Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 56, No.1, Winter 2014
This issue published in December 2013 for distribution in both portable document format (pdf) and also hardcopy format.

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

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

For membership or general information about the ALPO, contact:

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

Founded in 1947

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Association of Lunar & Planetary Observers (ALPO)

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Meteorites Section: Dolores Hill
Computing Section: Larry Owens
Youth Section: Timothy J. Robertson
Historical Section: Tom Dobbins
Eclipse Section: Michael D. Reynolds
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Point of View
Making Things Better and Smoother for You

By Ken Poshedly, executive director, editor & publisher *The Strolling Astronomer*

Well, we've gone a few months and the ALPO house is still standing. No (major) blunders, at least not so far.

Instead, I believe some recent changes will make things better for our staff members and you, the membership.

The changes involve the volunteer staff who are the worker bees that make this organization tick. There's an additional acting assistant coordinator in the Lunar section, a retirement and a promotion in the Historical section and a slight shuffling of personnel in the Jupiter section — all of which should make us even more responsive to your needs, whether it's submitting images and observing reports or learning more about your chosen subjects of solar system study.

We're extremely proud to include in this issue of your Journal a detailed write-up about the late-great Comet ISON which only dispersed a few weeks ago while rounding the Sun. Authored by Carl Hergenrother of the ALPO Comets Section, this report is just another example of his prolific efforts to make sure that you know *everything* there is to know about these "dirty snowballs" that visit this part of our solar system. Carl's daily reports of Comet ISON's approach to the Sun and subsequent demise were just what was needed for those who needed that info for carrying out their own observing programs.

At this time, your ALPO board is discussing at which location we'll have the 2014 annual meeting — in San Antonio with the Astronomical League or at the Pisgah Astronomical Research Institute (PARI) near Brevard, North Carolina, a most beautiful facility that *every* astronomer – amateur or professional – should visit.

Finally, I personally would like to thank Carroll Iorg, president of the Astronomical League, and John Goss, vice president of the AL, for their monumental support of my efforts to make last summer's ALCon 2013 event in Atlanta the truly rewarding experience it turned out to be. See the December issue of the AL's *Reflector* magazine for more on that event.

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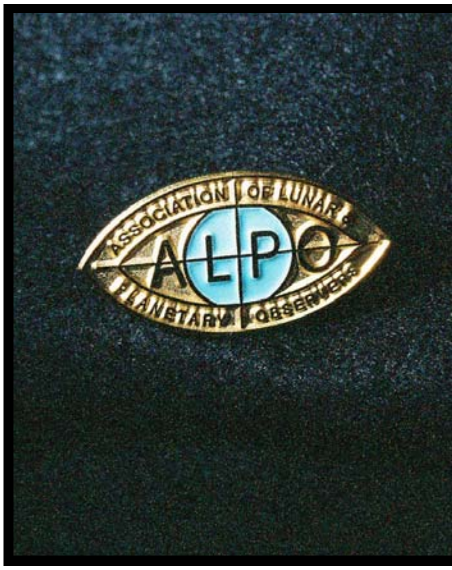

Announcing, the ALPO Lapel Pin

Now you can display your affiliation with our fine organization proudly with the new, colorful ALPO Lapel Pin.

With bright raised gold lettering against a recessed gold sandblast finish, each pin features the pupil of the ALPO "eye" in fluorescent aqua blue. A "pinch" clasp at the rear secures the pin in place. Pin dimensions are 1 $^{1}/_{8}$ in. by $^{9}/_{16}$ in.

Free for those who hold or purchase ALPO Sponsor level memberships.
Only $3.50 for those who hold or purchase Sustaining level memberships
Only $8.50 for all other ALPO members.
Not available to non-ALPO members.

Price includes shipping and handling.

Send orders to: ALPO, PO Box 13456, Springfield, IL 62791-3456. E-mail to: *matt.will@alpo-astronomy.org*

New E-mail Address for Walter Haas

Following separate e-mail communications from our own Matt Will and Robert Garfinkle, we are pleased to report that our Executive Director Emeritus Walter Haas continues to do well and is in good health.

Says Robert after a recent phone conversation with him, "Walter is doing fine and at 96-years of age, has no life-threatening illnesses. He is now in an assisted living facility in Las Cruses and no longer has an internet connection. But please feel free to send him a message via his daughter Mary Alba. He wants to hear from other ALPO members. In fact, he told me that the Astronomical League will be holding their meeting in Las Cruces in two years and he is looking forward to seeing many of us then."

Both Matt Will and Robert stated that Walter's daughter, Mary, will print out your messages and give them to her dad.

You can reach Mary (and Walter) at *dmvalba@hotmail.com*.

ALPO 2014 Conference

As of this writing (mid-December 2013), no decision has yet been reached on the location of the ALPO conference for 2014.

Either of two venues is being considered:

- The Pisgah Astronomical Research Institute (PARI) near Brevard, North Carolina, July 31 to August 2. A background story on this extremely fascinating and beautiful facility appeared in the September issue of Sky & Telescope magazine. More at *http://www.pari.edu/*

- As part of ALCon 2014 in San Antonio, Texas, July 9 thru 12.

  More at *http://www.astroleague.org/content/alcon-2014-san-antonio-tx-july-9-12*

Full details will be announced in JALPO56-2 to be issued in mid-March.

Huge Meteorite Pulled from Russian Lake

From the Sky & Telescope website

After spending most of the past year searching, divers on October 16 finally brought a half-ton fragment of the Chelyabinsk meteorite up from the murky bottom of Russia's Lake Chebarkul and onto dry land.

More at *http://www.skyandtelescope.com/news/Huge-Meteorite-Pulled-from-Russian-Lake-228116691.html*

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 post messages (either on the site or via your e-mail program), *alpocs@yahoogroups.com*

- To unsubscribe to the ALPOCS yahoo e-mail list, *alpocs-unsubscribe@yahoogroups.com*

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- Visit the ALPO Computing Section online at *www.alpo-astronomy.org/computing*

Lunar & Planetary Training Program

Tim Robertson, section coordinator
cometman@cometman.net

Those interested in this VERY worthwhile program (or even those who wish to brush up on their skills) should contact Tim Robertson at the following addresses:

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

Send e-mail to:
cometman@cometman.net

Please be sure to include a self-addressed stamped envelope with all correspondence.

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

ALPO Observing Section Reports

Mercury / Venus Transit Section

John Westfall, section coordinator
johnwestfall@comcast.net

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

Historical Section Staff Change

After many years of activity with both the ALPO and the BAA, our valued friend and member Richard Baum, now age 83, is retiring from his position as coordinator of the ALPO Historical Section.

The ALPO board of directors has approved Tom Dobbins, currently assistant coordinator, to become coordinator effective the beginning of the 2014 calendar year.

This will be Tom's third stint with the ALPO Historical Section. He was a co-coordinator from October 1999 through April 2001, and then assistant coordinator from February 2002 to present. Part 2 of Tom's paper on planetary telescopes appears in this issue of the ALPO Journal.

Richard Baum was appointed the ALPO Historical Section coordinator in February 2001, after having served as the ALPO Mercury Section coordinator from December 1977 through June 1996. He received the ALPO Walter H. Haas Observer Award in 2005.

Richard was director of the British Astronomical Assn's Terrestrial Planets Section from 1975-91, then director of its Mercury and Venus Section in 1991, then vice president of the BAA 1993-94.

He was awarded its Lydia A Brown medal for meritorious service to the BAA in 1988, and in 2006 the BAA's highest award, the Walter Goodacre medal.

Even with his leaving an official position in the ALPO, Richard retains an interest in the history of lunar and planetary work.

He has published papers in our own Journal of the ALPO, the Journal of the BAA, the Journal for the History of Astronomy; *Sky & Telescope* magazine, *Astronomy Now*, and Urania (Spain) and other publications. The Yearbook of Astronomy (regularly) and chapters to multi-authored publications.

He is the author of "The Planets: Some Myths and Realities" (1973), "In Search of Planet Vulcan, the ghost in Newton's clockwork universe" (with W J Sheehan) (1997), and "The Haunted Observatory" (2007). Richard has also contributed chapters to part publications. He has many biographical entries to The Biographical Encyclopedia of Astronomers (Springer) and Dictionary of Nineteenth Century British Scientists (4 vols. 2004).

Participated in *Vulcan* episode of Arthur C Clarke's *Mysterious World* TV series (1980) filmed in situ in France.

He recently completed a 17,000-word essay "Before Lunik: Imagination and the Other Side of the Moon" (now in peer reviewed by the BAA).

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Meteors Section

Robert 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

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

There were no new observations submitted for this period. We invite submissions to the Chelyabinsk Project and suggestions for new projects involving meteorites.

According to Dirk Ross (http://lunarmeteoritehunters.blogspot.jp/2013/11/mbiq-detects-ca-meteor-06nov2013.html), several bright possible meteorite-dropping fireballs were observed in the far western U.S. on September 16 and November 2, November 15 in the Midwest, and sightings from Oklahoma, Texas, Kansas, Missouri, Colorado, New Mexico November 16th. Fireballs in other regions include Bosnia on October 10th and November 1, and the November 15th bolide seen in Japan. None of these resulted in retrieval of meteorites by experienced meteorite hunters.

The Meteoritical Bulletin reported 230 new meteorite classifications approved by the Meteoritical Society's Nomenclature Committee since September 2013.

While most of these are meteorite finds from Northwest Africa (NWA), recovery of an April 23, 2013 fall from Germany was noted.

This was the "Braunschweig" L6 ordinary chondrite with fragments totaling 1300g. http://www.lpi.usra.edu/meteor/metbull.php?code=58083

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

Eclipse Section

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

18 October 2013 Penumbral Lunar Eclipse

A relatively-deep penumbral lunar eclipse was visible for a number of observers on the evening of 18 October 2013. This eclipse was the 52nd member of Saros 117, a 71-eclipse series in a sequence of 8 penumbral, 9 partial, 24 total, 7 partial, and 23 penumbral lunar eclipses (Espenak and Meeus, 2009). Saros 117 is now in its final penumbral lunar eclipse sequence. Several ALPO observers have sent preliminary reports. If you observed the eclipse, please send your information for inclusion so a final report may be issued.

3 November 2013 Solar Eclipse

The last eclipse of 2013 was a rare hybrid solar eclipse. With hybrid eclipses, part of the path sees an annular solar eclipse, whereas part of the path a total solar eclipse. This eclipse is the 23rd of Saros 143, which began 7 March 1617 and will end 23 April 2897. Saros 143 will see in sequence 10 partial, 12 total, 4 hybrid, 26 annular, and 20 partial eclipses (Espenak and Meeus, 2006). This was the first of four hybrids in Saros 143.

Please visit the ALPO Eclipse Section online at www.alpo-astronomy.org/eclipse

Comets Section

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

As 2013 draws to a close, the eyes of the comet world have been on comet C/2012 S1 (ISON) and its grazing passage of the Sun. For more on ISON, please see this issue's Feature Story.

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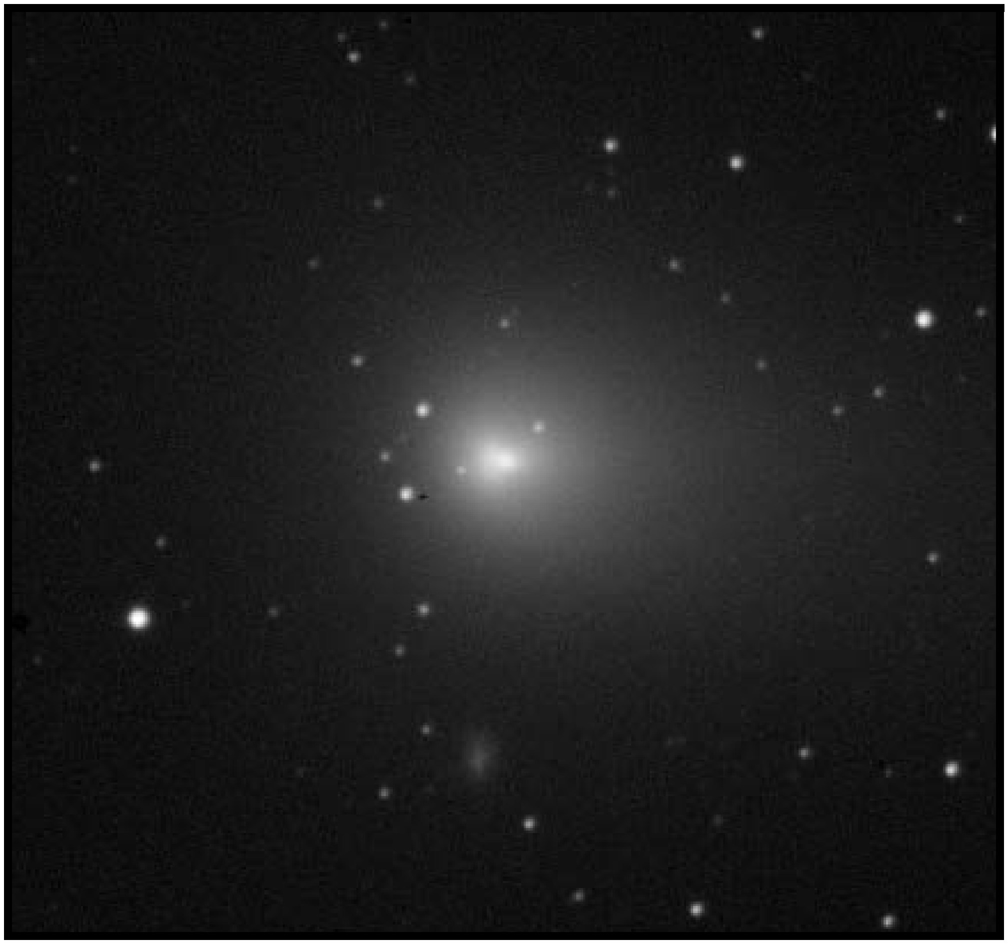
ISON has not been the only comet of interest lately. For a few weeks in November up to 5 comets were visible in small binoculars from dark sites. Periodic comet 2P/Encke peaked around magnitude 7 prior to its late November perihelion. Long-period comet C/2012 X1 (LINEAR) and newly discovered medium-period comet C/2013 V3 (Nevski) experienced multi-magnitude outbursts which brightened each comet to 8th and 9th magnitude, respectively. Finally, C/2013 R1 (Lovejoy) is giving ISON a run for the comet of the season as a borderline naked eye comet of 4-5th magnitude with a 2+ degree long tail visible in small telescopes.

The new year will bring many comet observing opportunities (with the discovery of new bright comets likely). As of this writing, no one is certain whether ISON will still be observable into 2014, but Lovejoy will start the year around 5-6th magnitude and still be visible in small telescopes (brighter than 10th magnitude) till March.



Comet C/2013 R1 (Lovejoy) as imaged by John Sabia at the Thomas G. Cupillari Observatory, Fleetville (north of Scranton), PA, USA, November 4, 2013, 08:18:36 UT. Equipment: 20 in. (0.5 m) f/8.1 RC Optical Systems Ritchey-Chrétien telescope with SBIG STL-1001E CCD camera; image 1 x 60 seconds. No other data provided.

Three additional long-period comets are expected to become brighter than 7th magnitude in 2014. Comet C/2012 K1 (PANSTARRS) will reach perihelion on August 27 at a distance of 1.05 AU from the Sun. Starting the year at 13th magnitude, the comet will brighten to 7th magnitude in June and July before passing solar conjunction (unfortunately on the far side of the Sun). When the comet emerges from the glare of the Sun in September it will be a 6th magnitude object only observable from the Southern Hemisphere. PANSTARRS should still be around 9th magnitude by the end of the year.

Our next comet was discovered only a few weeks ago (Nov. 12 UT) by Michael Ory at the Oukaimeden Observatory in Morocco at 18th magnitude. Comet C/2013 V5 (Oukaimeden) will reach perihelion on October 2 at a distance of 0.66 AU from the Sun. It is too early to sure, but the comet should be brighter than 10th magnitude by August and as bright as 5-6th magnitude in late September when it passes within 0.46 AU of Earth. Northern hemisphere observers will loss sight of the comet in mid-September but Southern observers will still be able to follow it into October.

Back in early October, Comet ISON made the news as it came close enough to Mars to allow NASA's Mars orbiting spacecraft to image it. Comet C/2013 A1 (Siding Spring) will pass even closer to Mars on October 19, 2014. Definitely expect to hear about this comet in the news as its ~150,000 km flyby of Mars will result in some high-resolution imaging. For us on Earth the comet should be a 7th magnitude object around its October 2 perihelion (r = 1.40 AU from the Sun). Again Southern observers will see this comet at its best as it will only become observable for Northern observers in November.

The next two comets may not become brighter than 10th magnitude but are

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worth mentioning. Short-period comet 209P/LINEAR will pass within 0.06 AU of Earth in late May at ~10-11th magnitude. Dust released by LINEAR during past orbits may result in a significant meteor shower on the night of May 24, 2014. The final comet is currently not a comet at all. Asteroid 2013 UQ4 was discovered by the Catalina Sky Survey on a very comet-like orbit with a period of hundreds of years. There is a good chance this asteroid is a comet that has either not turned on yet or its cometary activity is too weak to be seen. With its closest approach to the Sun on July 5 (1.08 AU) and to the Earth on July 10/11 (0.31 AU), 2013 UQ4 will be magnitude 12.9 if it remains inactive and possibly many magnitudes brighter if active.

As always, the ALPO Comet Section thanks those who have sent observations during 2013 and solicit new images, drawings and magnitude estimates during the coming year.

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

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

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

Solar Section

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

The main news about the Sun lately is that it is expected to flip its polarity before the end on 2013, according to a report from NASA

http://science.nasa.gov/science-news/science-at-nasa/2013/05aug_fieldflip

The Sun has gone through some very cyclical events since our last report. In our last report, we were at Carrington

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Rotation CR2137 and currently we are at CR2144.

During Cycle 24, solar southern hemisphere group counts were very low, but activity peaked on June 17 with the appearance of AR1175. Solar activity waned in July with no groups or sunspots and in September with no major flare activity. October and November had increased activity; in October, the far side of the Sun was very active, while the Earth-facing side was quiet.

Cycle 24 is being forecasted as the weakest solar cycle in the last 100 years. There are predictions that there will be a double peak, but the second peak has not yet arrived.

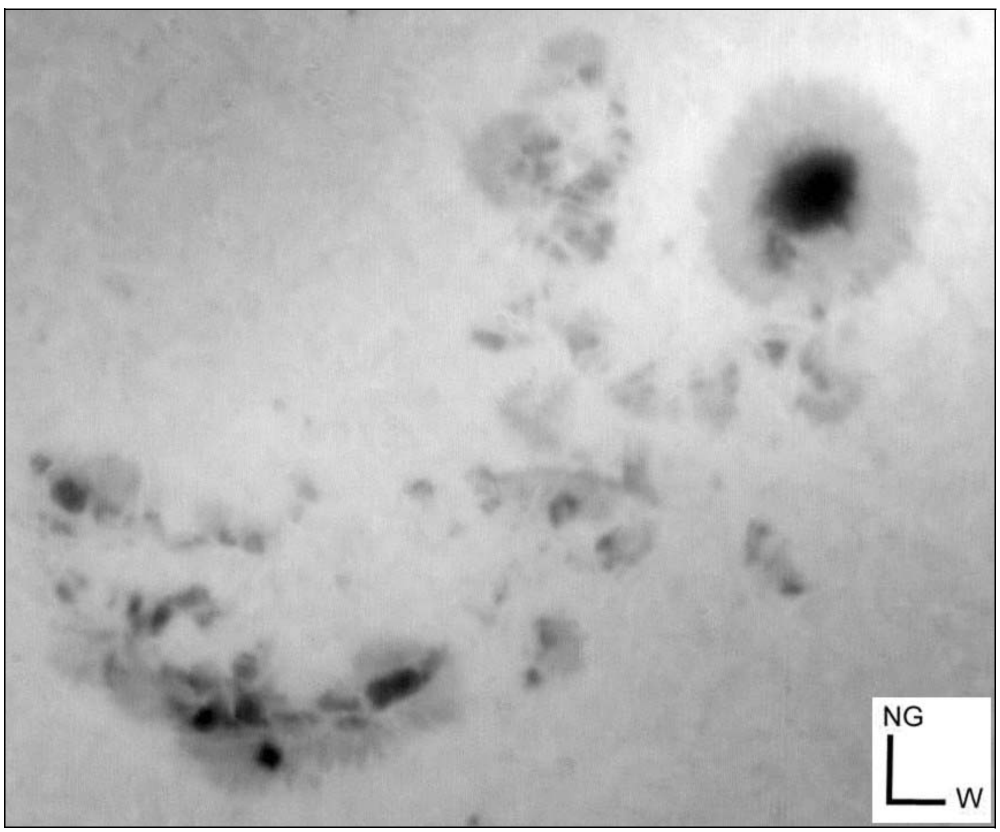
Keep up-to-date on Daily Space weather news at *www.spaceweather.com*

A chart of reported sunspot groups with flare activity and auroras that have transpired over the last 5.5 months accompanies this report.

If you are wondering how intense these flares are, visit *http://www.swpc.noaa.gov/NOAAscales/index.html#GeomagneticStorms* There, you'll see the NOAA Space Weather Scale of the Flare activity.

There was a partial solar eclipse on November 3, 2013, which most of the eastern U.S. & Canada saw a portion. {Editor's Note: See also the ALPO Eclipse Section report by Mike Reynolds earlier in this section.] We (about midway between Toronto and Montreal, Canada) saw a small bite taken out of the southern part of the Sun after the clouds

Partial solar eclipse imaged by Kim Hay at the Starlight Cascade Observatory, Yarker, Ontario, Canada. Image is clip from a movie using a Sony Handycam DCR-SX45. A small baader film filter was built using a plastic slide holder and attached with velcro over the lens.



Sunspot AR1890, one of the biggest Sunspots of Cycle 24, as imaged by ALPO member Jean-françois Coliac on November 7, 2013, 13:31 UT. Equipment: 120mm, f/7.5 refractor with 3x Barlow, -PL1M-W21. No further location or other details provided.

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disappeared. Temperatures were at -3 °C (27 °F), and windy on top of the Yarker, Ontario, ball diamond, but it was worth the viewing the Sun.

More exciting news is that two comets crashed into the Sun in August, and now we have two more comets heading towards the Sun — Comet Encke and Comet ISON. On November 21, the SDO and SOHO satellites caught images of both comets heading towards the Sun. ISON was due to arrive on November 28. By the time you read this, we'll have found out if survived and came out from around the other side of the Sun, and put on a western display in the sky.

There is a new book out by member Jamey L. Jenkins, *Observing the Sun- A Pocket Field Guide*, published by Springer and available at Amazon.com in hardbound and true electronic version. This is on my own book wish list.

If you're interested in a newsletter on solar activity called STCE (published by The Solar-Terrestrial Centre of Excellence), you can find it online at http://www.stce.be/newsletter

Keep up-to-date on the latest images and chats on solar activity by subscribing to the ALPO Solar Section e-mail list at http://groups.yahoo.com/neo/groups/Solar-ALPO/info . There are currently 320 members. We do collect images for archiving purposes. These can be up to 250 kb file of in either jpg or gif file format. They will be included in a Carrington Rotation set. Please include all observing equipment used, the Carrington Number, date, Universal Time of the image, and directions with North up. Looking forward to seeing your images and sketches.

We are always looking for members to submit an article to the JALPO on solar imaging and solar phenomena. Please send to myself (*kim.hay@alpo-astronomy.org*) or to Ken Poshedly (*ken.poshedly@alpo-astronomy.org)*

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

Mercury Section

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

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

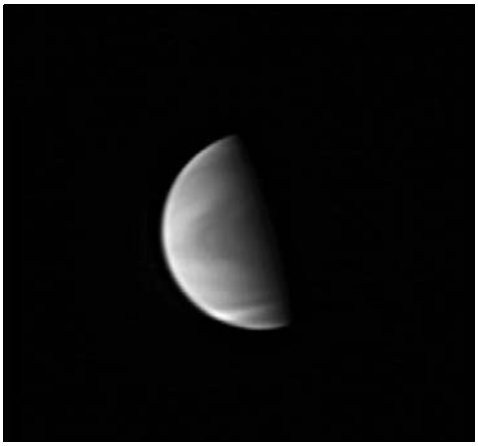
Venus Section

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

Venus reached greatest elongation on November 1 at apparent visual magnitude -4.5 and situated 47° east of the Sun, well-placed in the southwestern sky after sunset and reaching maximum brightness for the 2013-14 Eastern (Evening) Apparition on December 6th.

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.

The accompanying table of Geocentric Phenomena in Universal Time (UT) is presented here for the convenience of observers for the 2013-14 Eastern (Evening) Apparition for planning purposes.



Anthony Wesley of Murrumbateman, Australia, obtained this superb image of Venus at UV 350nm on October 12, 2013, at 07:18UT using a 36.8 cm (14.5 in.) Newtonian in good seeing nearly three weeks from predicted dichotomy. The bright limb band and radial and banded dusky markings are apparent. Apparent diameter of Venus is 20.3", phase (k) 0.587 (58.7% illuminated), and visual magnitude -4.3. South is at top of image.

So far, the ALPO Venus Section has amassed over 200 drawings and images of Venus for the current observing season.

Observers are again reminded that images are important and still needed by the Venus Express (VEX) mission, which started systematically monitoring Venus at UV, visible (IL) and IR wavelengths back in May 2006.

Geocentric Phenomena of the 2013-2014 Eastern (Evening) Apparition of Venus in Universal Time (UT)

Superior Conjunction	2013	Mar 28^{d} (angular diameter = 9.8 arc-seconds)
Predicted Dichotomy		Oct 31.14 (exactly half-phase predicted)
Greatest Elongation East		Nov 01 (Venus will be 47º east of the Sun)
Greatest Illuminated Extent		Dec 06 (m_v = –4.9)
Inferior Conjunction	2014	Jan 10 (angular diameter = 63.1″)

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Lunar Calendar for First Quarter 2014 (All Times UT)

Jan	01	11:14	New Moon
	01	21:00	Moon Perigee: 356900 km
	08	03:39	First Quarter
	09	11:26	Moon Descending Node
	13	08:14	Moon North Dec.: 19.5° N
	16	01:53	Moon Apogee: 406500 km
	16	04:52	Full Moon
	23	06:29	Moon-Mars: 3.9° N
	23	09:22	Moon-Spica: 1.4° S
	24	02:55	Moon Ascending Node
	24	05:19	Last Quarter
	25	14:18	Moon-Saturn: 0.6° N
	27	16:31	Moon South Dec.: 19.4° S
	29	02:36	Moon-Venus: 2.2° N
	30	09:58	Moon Perigee: 357100 km
	30	21:38	New Moon
Feb	05	12:41	Moon Descending Node
	06	19:22	First Quarter
	08	14:41	Moon-Aldebaran: 2.6° S
	09	15:21	Moon North Dec.: 19.3° N
	12	05:09	Moon Apogee: 406200 km
	14	23:53	Full Moon
	19	14:54	Moon-Spica: 1.7° S
	19	23:59	Moon-Mars: 3.3° N
	20	03:29	Moon Ascending Node
	21	22:39	Moon-Saturn: 0.3° N
	22	17:15	Last Quarter
	24	01:24	Moon South Dec.: 19.2° S
	26	05:23	Moon-Venus: 0.4° S
	27	19:52	Moon Perigee: 360400 km
	27	21:24	Moon-Mercury: 2.8° S
Mar	01	08:00	New Moon
	04	17:45	Moon Descending Node
	07	22:07	Moon-Aldebaran: 2.3° S
	08	13:27	First Quarter
	08	22:54	Moon North Dec.: 19.1° N
	11	19:46	Moon Apogee: 405400 km
	16	17:08	Full Moon
	18	20:38	Moon-Spica: 1.8° S
	19	03:14	Moon-Mars: 3.4° N
	19	06:30	Moon Ascending Node
	21	03:40	Moon-Saturn: 0.2° N
	23	07:28	Moon South Dec.: 19° S
	24	01:46	Last Quarter
	27	09:52	Moon-Venus: 3.6° S
	27	18:30	Moon Perigee: 365700 km
	30	18:45	New Moon

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

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:

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

Regular Venus program activities (including drawings of Venus in Integrated Light and with color filters of known transmission) are also valuable throughout the period that VEX is observing the planet.

On November 19, 2010 ESA's Science Program Committee approved the extension of VEX mission operations until December 31, 2014, so Pro-Am cooperation fortunately continues this apparition.

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 (for instance, categorization of dusky atmospheric markings, visibility of cusp caps and cusp bands, measurement of cusp extensions, monitoring for the Schröter phase effect

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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/*

Lunar Section

Lunar Topographical Studies / Selected Areas Program

Report by Wayne Bailey, program coordinator

wayne.bailey@alpo-astronomy.org

The ALPO Lunar Topographical Studies Section (ALPO LTSS) received a total of 135 new observations from 12 observers during the July-September quarter.

One contributed article was published in addition to numerous commentaries on images submitted.

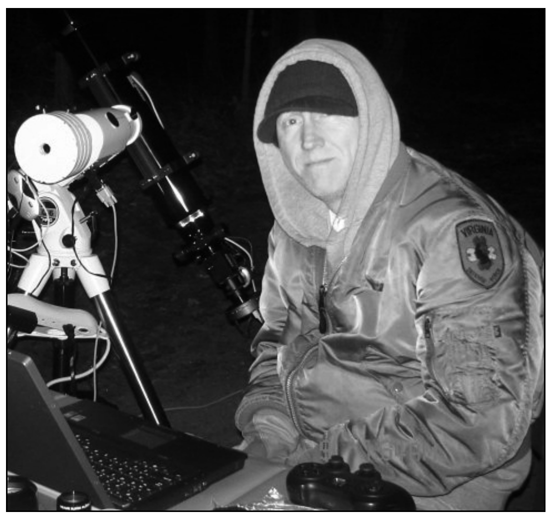
The *Focus-On* series in this sections's newsletter *The Lunar Observer* continued with an article on lunar domes and Mons Rumker. Upcoming *Focus-On* subjects will include Schickard-Wargentin, Aristarchus and Mare Frigoris.

NASA launched the LADEE (Lunar Atmosphere and Dust Environment Explorer) from the Mid-Atlantic Regional Spaceport at the Wallops Island Flight Facility on Sept. 6. It is now in lunar orbit and spacecraft commissioning activities are complete.

Lunar Section Staff Addition

The ALPO welcomes Jerry Hubbell as its newest staff member, specifically acting assistant coordinator of the Lunar Topographical Studies & Selected Areas Program. The selection was made by program coordinator Wayne Bailey and increases that program's staff to three persons, including assistant coordinator William Dembowski.

Jerry's duties will include the following;
• Serve as the primary person responsible preparing observations for archiving and entering them into the archive.
• Be a second point for receiving observations (in addition to Wayne).
• Have alternate responsibility for preparing "Focus On" articles for the *The Lunar Observer* newsletter and also this Journal.
• Take the lead role for either the Banded Craters or the Bright Lunar Rays sub-program.



Regarding his astronomy interests, Jerry says, "I have been an amateur astronomer since I was 14 with a keen interest in the Moon and in observing Jupiter and Saturn. I have been a visual observer using various refractors and my 10" Meade 2120 LX5 since 1987. I became keenly interested in astrophotography in 2008 and have been learning and practicing high-resolution lunar imaging and minor planet observing since 2010."

He obtained his Minor Planet Center Observatory code (I24) in 2010, has been a member of the AAVSO and the ALPO since 2010.

Jerry has contributed several lunar observations (images) to *The Lunar Observer* newsletter over the past three years and also has made nearly 100 minor planet observations and submitted them to the Minor Planet Center (MPC). His book *Scientific Astrophotography: How Amateurs Can Generate and Use Professional Imaging Data* was published by Springer Books in November 2012.

Professionally, Jerry starts a new position as vice president of engineering at Explore Scientific; he has over 32 years in the nuclear and utility industry and only recently left his position as a Nuclear Instrumentation & Controls and Software Engineer in the Nuclear Design Engineering group at Dominion (Virginia Power) to join Explore Scientific. At his new job, Jerry will be working on new product development and engineering program development and implementation.

Instrument commissioning and the Lasercom primary experiment were expected to be completed in mid-November. The spacecraft will then drop down to the lower lunar science orbit.

More information can be found at the LADEE website provided in the next page.

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Phillip M. Morgan, a longtime contributor to the ALPO Lunar Section and the BAA and one of our most active visual lunar observers passed away on July 25, 2013. He died peacefully, after a long illness, at age 64.

Mr. Morgan was a prolific contributor to the ALPO Lunar Section. In addition to his drawings, executed in a stipple technique, he also contributed a short tutorial on lunar drawing to the April 2009 issue of the ALPO Lunar section newsletter, "The Lunar Observer".

Despite his illness, which he never mentioned, he continued observing. His most recent contribution was received in March. Phil was a livestock farmer in Worcestershire, England, a very demanding job, so it's remarkable that he found so much time for observing.

He will be missed.

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Visit the following online web sites for more info:

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

Lunar Meteoritic Impacts

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

Lunar Transient Phenomena

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

Four Lunar Transient Phenomena (LTP) observations have come to light since the last LTP report and have been assigned weights on a scale of 1 (slight chance of being an LTP) to 5 (unquestionably a LTP). All but one lie at the weight 1 level and possibly have non-lunar origins as explained in "The Lunar Observer" (TLO) newsletters from May 2013 to Oct 2013. Nevertheless, it would be useful if observers could please check their images for these areas, at these dates and times.

- Aristarchus: 2013 Mar 29 UT 02:15-02:39 Mike Pyka (Katowice, Poland) noticed the crater to be strongly bright, perhaps more so visually than with a CCD. ALPO/BAA weight=1.
- Aristarchus: 2013 Apr 22 UT 01:39-02:37 Paul Zeller (Indianapolis, USA) observed visually two closely spaced NW wall dark bands to have a rusty-red hue. The color of these bands did not change over the period of the observing session. ALPO/BAA weight=2.
- Jansen D: 2013 Aug 23 UT 00:30-01:30 Peter Grego (Cornwall, UK) sketched a dusky area just E of this crater. Simulations show a depression here, but the shading is of a different shape. ALPO/BAA weight=1.
- Hermann D: 2013 Sep 01 UT 02:48 Maximillian Teodorescu (LPOD observation, Romania) imaged a dusky circular area to the SE of Hermann D. There is no depression here. ALPO/BAA weight=1.

Four candidate LTP from 2013: Apr 25 (E. Limb), May 13 (Aristarchus), Jul 18 (Maginus), and Oct 14 (E Limb), did not make it onto the LTP list, for reasons explained in the monthly TLO newsletter. We are grateful for all candidate LTP observations submitted for study and hope that our feedback will make it easier for future observers to recognise false effects in optics, our atmosphere, and in CCD images, which might resemble LTPs.

We would like very much to encourage those with high resolution imaging expertise, to take part in repeat illumination observations, to help eliminate past LTP by re-observing under similar lighting conditions. Images obtained in this way can then undergo computer simulations for chromatic aberration, atmospheric spectral dispersion, and seeing blur, which might perhaps explain some past LTP reports. Astronomers: Jay Albert, Maurice Collins, and Brendan Shaw regularly contribute observations and images in this way.

Dates and UTs on which to see features under similar illumination conditions to past LTPs, can be found at *http://users.aber.ac.uk/atc/tlp/tlp.htm*

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

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

Mars Section

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

Mars is well positioned in the morning sky for observation now. Still appearing small, it was 5.6 arc-seconds in apparent diameter on December 1 and 6.9 arc-seconds on January 1. Despite this small size, outstanding images have been obtained by a number of observers. A striking finding so far is the reappearance of some dark albedo features that haven't been seen in years. (See accompanying images to this report on this page. South is at the top and planetary east [celestial west] is at the left in all images.)

For details on the sky location and expected appearance of Mars, review the "pre-apparition report" in JALPO Vol. 55, No. 4 (Autumn 2013).

Join us in the Mars observers group on Yahoo at groups.yahoo.com/neo/groups/marsobservers/info .Note that this is a new web address, as Yahoo has changed its group addresses. If you type into your browser the previous Mars observers group address, you will be automatically redirected to this new one.

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

Minor Planets Section

Frederick Pilcher, section coordinator
fpilcher35@gmail.com

Some highlights published in the *Minor Planet Bulletin*, Volume 40, No. 4, 2013 October - December, are hereby presented. These represent the recent

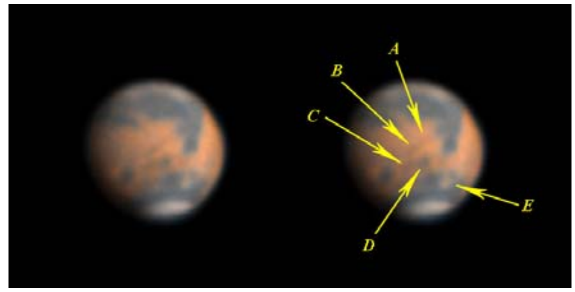

Figure 1. Composite RGB image made by Damian Peach on September 20, 2013, at 05:58 UT. The central meridian is 254 degrees. The left and right images are identical, the left one being included so as to show the features without interference by the arrows. Syrtis Major is the prominent dark area on the right (west) side of the image, while Iapygia and the Mares Tyrrhenum and Cimmerium areas comprise the dark areas across the top (south). The North Polar Cap is seen at the bottom. The arrows indicate unusual features. *A* is a dark streak across the Moeris Lacus and Nepenthes areas. *B* is combined Nubis Lacus and Nodus Laocoontis. *C* is Thoana Palus. These three areas have not been seen since the late 1900's, except that a very faint darkening in the area of B has been visible in recent apparitions. *D* is Nodus Alcyonius, which is relatively normal in appearance. *E* is an unusually light appearance of Umbra. It was bright in Damian's red image and absent in blue, suggesting that it is dust. This suggestion caused some disagreement and discussion among the Mars observers group. (Altitude 38 degrees, no other observing or equipment specifics provided.)

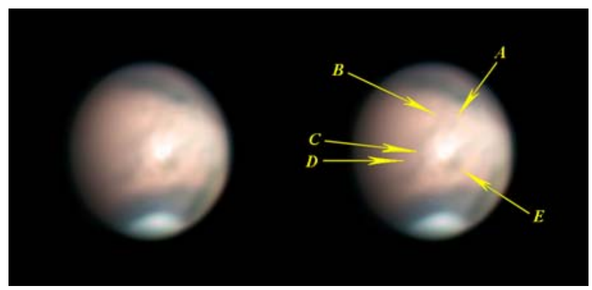

Figure 2. Composite RGB image made by Don Parker on November 8, 2013, at 10:31 UT. The central meridian is 204 degrees. The left and right images are identical, the left one being included so as to show the features without interference by the arrows. The bright central area is frost in Elysium, and a tiny dark spot in its center may be the summit of Elysium Mons. Mare Cimmerium is the large dark streak across the top (south) of the image. The arrows indicate unusual features. *A* is Pambotis Lacus, and *B* is the curved "Cyclopia" canal or "Cyclops." These two features have not been seen since the late 1900's. The dark Phlegra area is seen to be split into two parts: the eastern part (*C*) is the canal-like feature Hades I, while the western part (*D*) is the canal-like Styx. This change also has not been seen in a number of apparitions. *E* is Morpheos Lacus, which may be larger and darker than usual. (Newtonian reflector of 400 mm aperture at *f*/26, ASI 120 mm camera, stack of multiple images using Astrodon red, green, and blue filters. Seeing 3 to 4, transparency 4, altitude 47 degrees.)

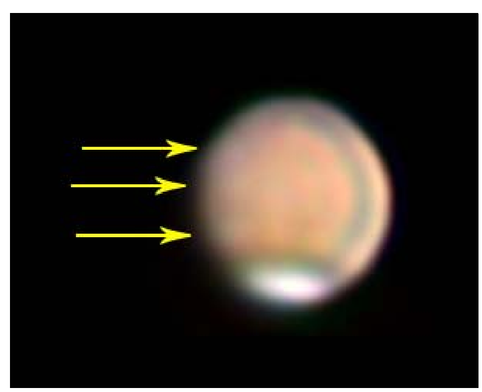

Figure 3. Composite RGB image made by Paul Maxson on October 12, 2013, at 12:50 UT. The central meridian is 141 degrees. This longitude of Mars often appears relatively featureless, because the dark albedo features are all very subtle. Unseen, Olympus Mons is right in the center of the image. The arrows point to three late afternoon clouds. The southernmost (the top one) is centered over Daedalia, the middle one over Tharsis, and the northernmost over the Tempe and Arcadia areas. The curved dark streak paralleling the right (western) edge of the image is a "ringing" artifact caused by contrast enhancement in image processing. (Dall-Kirkham reflector of 250 mm aperture at *f*/24, ASI 120 mm camera, stack of multiple red, green, and blue images.)

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achievements of the Minor Planets Section.

In the hours following the approach of 2012 DA14 within 34,000 kilometers of Earth, 2013 Feb. 15, Leonid Elenin and Igor Molotov, Keldysh Institute of Applied Mathematics, Russian Academy of Sciences, obtained a 10-hour lightcurve from their remotely operated observatory in New Mexico, USA. They found a rotation period of 9.5 hours and exceptionally large amplitude of 1.79 magnitudes. This complements a lightcurve covering the same time interval by Bruce L. Gary in Arizona.

Lorenzo Franco has published a complete spin-shape model for 38 Leda based on lightcurves at seven oppositions well-distributed around the sky. He finds a sidereal rotation period of 12.836164 +/- 0.000016 hours. The north rotational pole is near celestial longitude 160 degrees, latitude -17 degrees; or longitude 343 degrees, latitude -6 degrees.

As a note for general readers, the lightcurve inversion routine typically obtains two equally likely rotational poles at similar celestial latitudes but longitudes separated by about 180 degrees. Additional data, such as well-observed occultations, are commonly required to resolve this ambiguity. It should also be noted that the distinction between a “synodic rotation period” (all that can be found at a single opposition no matter how comprehensive are the data” and the “sidereal period” (which requires observations at several oppositions) as has been accomplished here.)

Linda French, Robert Stephens, and several colleagues have obtained rotation periods for 21 Trojan asteroids. These are identified in the tabulation below.

Lightcurves with derived rotation periods are published for 86 other asteroids. These have varying degrees of reliability. Some cases with low amplitudes in which it is especially difficult to resolve ambiguities between a suggested period and 1/2, 3/2, or twice that amount are labeled “A”. Trojan asteroids investigated by French et al. are labeled “T”. Finally, asteroids with second periods indicating a binary companion are labeled “B”.

These lightcurves are of asteroids numbered 26, 31, 158, 319, 417, 453, 461, 498, 604, 644, 681, 730 A, 806, 814, 904, 933, 966, 1175, 1269, 1318, 1355 A, 1378, 1396, 1412, 1465, 1860, 2038, 2050, 2146 T, 2150, 2276, 2448, 2546, 2566, 2911, 3332, 3391 T, 3422, 4068 T, 4106, 4436 A, 4497, 4501 T, 4507, 4527, 4531, 4765 B, 4902 T, 5040, 5041 T, 5123, 5211, 5284 T, 5285 T, 5436 T, 5828 B, 5899 B, 6479, 6487, 6545 T, 8024, 8893, 11351 T, 12052 T, 13229 T, 15436 T, 15502 T, 15535 T, 15621, 18046 T, 19020 T, 19204, 19977, 21601 T, 24451 T, 24478, 26074 B, 33908, 40203, 41185 A, 68216, 70126, 88141, 94608, 125742, 152756, 163249.

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

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

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

Jupiter Section

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

Several individuals have imaged Jupiter in 2013. Ed Grafton submitted a couple of excellent images showing the Great Red Spot and both equatorial belts on that planet. Jupiter had a nearly normal appearance in October. Jan Koet imaged a rare triple transit on October 13. I have received images from Jan Koet, Don Parker, Mike Hood, Gary Walker, Michel Jacquesson, Marc Delcroix, Trevor Barry, Manos Kardasis, James Willingham, Sean Walker, Chris Go and Vicky Go. I have received visual observations from Gianluigi, Brian Cudnik, Steve Gale and Detlev Niechoy.

This writer has begun measuring the brightness of Jupiter. Jupiter was close to its expected brightness on November 4.

The 2011-2012 apparition report has been submitted to two individuals for peer review. I am expecting this report to be published in early 2014. Once this report is published, I will start analyzing the data for the 2012-2013 apparition.

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

Galilean Satellite Eclipse Timing Program

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

A reminder that a schedule of Galilean satellite eclipses for the new apparition is available on the Jupiter page of the ALPO website (*http://alpo-astronomy.org*). We welcome observers to send us their timings of these events, using the observing form also available on the webpage.

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.

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Saturn Section

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

Saturn entered conjunction with the Sun on November 6, thereby ending the 2012-13 apparition. Observers should note that the planet should be favorably placed in the eastern sky before sunrise by the time you read this.

During the 2013-14 observing season, with the rings tilted about +22° toward Earth, the northern hemisphere of the globe and north face of the rings will be visible to better advantage than in several preceding apparitions. The following geocentric phenomena for 2013-14 apparition are presented for the convenience of readers for planning observations:

The accompanying table of geocentric phenomena for the upcoming 2013-14 apparition is presented for the convenience of readers who wish to plan their Saturn observing activities.

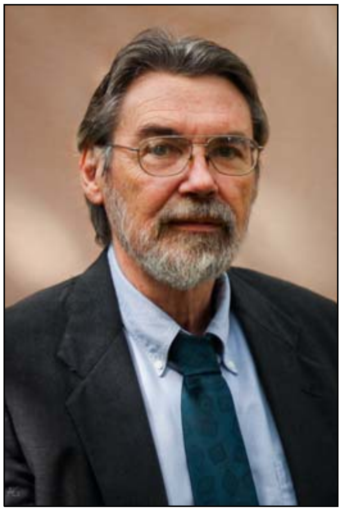
As of this update, observers have contributed over 700 images and drawings of Saturn for the 2012-13 apparition, and some have been quite impressive (see image accompanying this report). Imaging of multiple diffuse bright areas still occurred within the NTrZ in the aftermath of the great white North Tropical Zone (NTrZ) storm of 2010-11.

Bright spots have also been captured sporadically in the NTeZ and NNTeZ, as well as a recurring dark condensation just below the NTeZ near the north edge of the NTeB. Occasional small bright areas appeared in the EZn (Equatorial Zone, northern half) since mid-February, particularly obvious at IR wavelengths.

Of continuing interest have been amateur images of the remarkable hexagonal feature at Saturn's North Pole at different wavelengths. Views of the major ring components, including Cassini's and Encke's divisions, were much improved

Jupiter Section Staff Changes

Due to mounting work loads both professionally and personally, ALPO Board member and very active ALPO staff member Richard Schmude has decided to step down a bit to become assistant coordinator for the ALPO Jupiter Section, effective the end of this calendar year He will continue to produce the sections Jupiter apparition reports.



Stepping up to become acting coordinator is assistant coordinator of the ALPO Jupiter Section Ed Grafton.

Ed joined the ALPO over 10 years ago, supporting the ALPO Jupiter Section; his primary observing targets are Jupiter, Saturn, Mars and Uranus. Says Ed: "I have always been interested in astronomy, even as a child when I had a 3- inch toy telescope. In the early 1980s, I became interested in astrophotography and began imaging the planets with a C8 and film. By the 1990s, CCDs began to become affordable to amateurs and I began experimenting with electronic imaging with my C14 backyard observatory."

Ed graduated from Louisiana State University in 1973 with a BS in electrical engineering, then spent the next three years supporting Marshall Space Flight Center in Huntsville Alabama, working with a team of engineers defining the re-entry dynamics footprint of the Space Shuttle's solid rocket boosters.

In 1976, he moved to Houston, Texas, supporting the Johnson Space Flight Center. The majority of the next 25 years, Ed worked with a team of 400 engineers building and reconfiguring the Space Shuttle Mission Simulator; the primary astronaut training tool for the Shuttle missions. His group's primary function was test and integration of the IBM-developed Shuttle's flight computers software. Ed is currently retired in Houston, pursuing his hobbies of astronomy, gardening and homemade radio projects.

Richard, who is a professor of chemistry at Gordon State College, Barnesville (near Atlanta), Georgia, and has authored three astronomy books for Springer Publishing, has been the ALPO Jupiter Section Coordinator from February 2001 until present.

He started out on staff as the ALPO Remote Planets Section coordinator in November 1990 and joined the ALPO board in July 1999, serving twice as executive director (July 2003 to July 2005, and August 2009 to July 2011) and twice as associate executive director (August 2002 to August 2003, and July 2007 to August 2009).

He also served as acting assistant coordinator for the ALPO Historical Section from July 1999 through August 2000 and then as acting coordinator of that section from August 2000 to February 2001.

In addition, Richard also served as the ALPO Youth Program Coordinator from November 2000 to February 2001 and became an assistant coordinator (photometry and polarimetry) for the ALPO Mars Section in March 2004.

Finally, the ALPO Board has unanimously approved to dispense with the ALPO Jupiter Section scientific advisor positions.

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this apparition due to the favorable ring tilt toward Earth of roughly +18°.

Observers are alerted to keep watching and imaging Saturn carefully throughout the rest of the apparition and into the 2013-14 observing season for current and possible newly emerging activity in the northern hemisphere of the planet.

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

Observers are urged to carry out digital imaging of Saturn at the same time that others are imaging or visually watching Saturn (i.e., simultaneous observations). Although regular imaging of Saturn is extremely important and highly encouraged, far too many experienced observers have neglected making visual numerical relative intensity estimates, which are badly needed for a continuing comparative analysis of belt, zone, and ring component brightness variations over time. So, this type of visual work is strongly encouraged before or after imaging the planet.

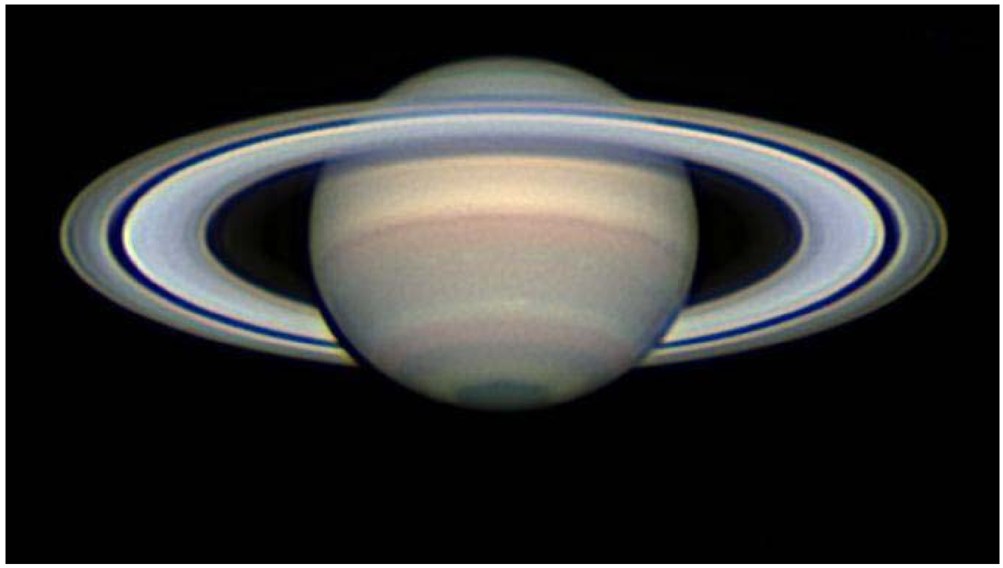

Image taken on April 15, 2013, at 16:20UT by Christopher Go observing from Cebu City, Philippines, using a 35.6cm (14.0 in.) SCT at RGB wavelengths. Notice the considerable detail on the globe of Saturn such as small white features within the NTrZ, an elongated white area in the NTeZ near the CM, as well as ring divisions at the ansae including Cassini's (A0 or B10), Encke's complex (A5), Keeler's (A8), and other "intensity minima" associated with the rings. Also notice the remarkable hexagonal feature at Saturn's North Pole. Seeing = 7.5, Transparency 3.0. Apparent diameter of Saturn's globe is 18.7" with a ring tilt of +18.2°. CMI = 298.4°, CMII = 19.9°, CMIII = 220.7°. S is at the top of the image.

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.

Geocentric Phenomena for the 2013-14 Apparition of Saturn in Universal Time (UT)	
Conjunction	2013 Nov 6^d
Opposition	2014 May 10^d
Conjunction	2014 Nov 18^d
Opposition Data:	
Equatorial Diameter Globe	18.6 arc-seconds
Polar Diameter Globe	16.6 arc-seconds
Major Axis of Rings	42.2 arc-seconds
Minor Axis of Rings	15.5 arc-seconds
Visual Magnitude (m_v)	0.1 m_v (in Libra)
B =	+21.6°
Declination	-15.4°

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

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

Remote Planets Section

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

Several individuals have made valuable observations of Uranus and Neptune in 2013. Christophe Pellier used a 0.25 m (10-in.) telescope to image albedo features on Uranus. He used a red and infrared filter to make his image. His image shows one of the polar regions

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being brighter than the rest of the planet. His image also does not show limb darkening. Mark Delcroix and F. Colas used a telescope at Pic du Midi Observatory in France to image Neptune and its moon Triton. This image shows that the south polar region is brighter than the other visible areas of that planet. These two used an infrared filter. Jim Fox and the writer have also measured the brightness of Uranus.

The writer is currently working on a review of Uranus brightness measurements which will be submitted to a major professional journal in 2014. The brightness measurements which ALPO members have made over the years will help professional astronomers better understand seasonal changes on Uranus. There are also plans to write a similar review about Neptune.

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

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

Commentary & Opinion

Editor's Note: What follows are two communications related to the paper and sidebar commentary by Anthony Mallama which appeared in JALPO55-4 (Autumn 2013). Each communication is followed by Mr. Mallama's own reply. Any subsequent comments on this subject should be addressed only to the pertinent individuals at the e-mail addresses provided.

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Commentary #1

Congratulations on your superb paper in the Autumn, 2013, JALPO. Regarding Degenhardt's papers, he requested my images of Io in transit back in 2010. When I discovered the gist of his research, I pointed out that my processed images were of little worth and sent him my raw calibrated FTS images. I am not sure that he used these, since he mentions "processed" in his papers.

It should be pointed out, however, that even raw stacked images would be of little value in any kind of photometric work. While the webcams used by most planetary imagers produce stunning qualitative images, they are notoriously non-linear and therefore should not be employed for photometric studies. An example is the Jovian fireball imaged simultaneously by Anthony Wesley and Christopher Go on 3 June, 2010. This demonstrated how dedicated amateurs can contribute significantly to science. While such finds would be virtually impossible without webcams, fireball's true intensity could not be accurately ascertained — owing to the limitations of those very webcams. Such work can only be done with single-frame flat, dark, and bias-calibrated images produced by cooled CCD cameras of known linearity.

Your caveats on amateur science were quite timely and much appreciated. Amateurs make significant contributions but their work should be directed and monitored by professional mentors as occurs with the ALPO and AAVSO. The October 19-25, 2013, issue of *The Economist* had illuminating (and frightening!) articles reviewing problems in modern scientific research.One striking fact was that the results found in 50-75% of published papers could not be reproduced! Even peer review often proves to be inadequate. Perhaps one solution is to allow free critiques of papers in subsequent issues, such as we are doing here!

Thank you again for your input and advice.

Best regards,

Don Parker
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****

Mr. Mallama's reply to Don Parker

Dear Don,

Thank you for your letter. The comments about your Jovian transit images used by the JEE lead author are very important. As you stated, there is no way to know what sort of 'processing' they underwent. I've received quite a few messages of support during my investigation into JEE and following the publication of my article. I am very glad to know that you and I also agree on most of the major points that I made.

Sincerely,

Tony Mallama

****

Commentary #2

Anthony Mallama published in JALPO Vol. 55, No. 4, pp 33-38 (Autumn 2013) an article "The Atmospheres of Io and Europa are Transparent." In this article, he presented strong evidence against the assertion by Degenhardt et al. (2010), (2013) that Io and Europa have dense atmospheres. In addition, he published an accompanying box, "When Amateur Science Goes Awry" (JALPO 55-4, p. 39). I can endorse the paper itself, but in my opinion, this box contains some inappropriate material.

In the pages of the JALPO, Mallama condemns the editors of the Proceedings for the 29th and 32nd annual conferences of the Society for Astronomical Sciences for not withdrawing some controversial papers. This is a conflict between Mallama and the editors of those Proceedings. The Proceedings are not associated in any way with the ALPO. Therefore, the ALPO cannot be held responsible for any

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material published in those Proceedings. I consider it inappropriate for Mallama to carry a personal conflict with the editors of the Proceedings into the pages of the JALPO.

Science is characterized as being falsifiable, and bad science is self-correcting. The hypothesis of dense atmospheres of Io and Europa by Degenhardt et al makes specific predictions which can be tested by observation, in this case by observational techniques already applied. Several different kinds of observations are presented by Mallama, all of which are contrary to the predictions by Degenhardt et al.

Now professional as well as amateur scientists make claims insufficiently supported by careful measurement. One spectacular recent case was by Pons and Fleischmann on cold fusion. As careful measurements by many other people failed to replicate the claims by Pons and Fleischmann, their claims have been falsified. No personal attacks were mounted, nor should they have been. The natural flow of scientific discussion was fully adequate to remove cold fusion from credibility.

An example from astronomy is by Adriaan van Maanen. Circa 1920, when evidence of the extragalactic nature of the spiral nebulae was accumulating, van Maanen published proper motions of individual stars in these nebulae which indicated greater-than-light-speed velocities if at extragalactic distances. Thus, van Maanen concluded the spiral nebulae are local. This assertion was vigorously disputed by Edwin Hubble, and in the subsequent years, van Maanen's proper motions could not be observed by others and were dismissed as spurious. Hubble, however, never engaged in a public diatribe against van Maanen or the editors of the journal in which he published.

The value of the "devil's advocate" in suggesting a controversial hypothesis should be properly appreciated. It forces people to make additional observations. Even in the case that the controversial hypothesis is not supported, our confidence of the correctness of the previously accepted view is improved.

An outstanding example of a controversial hypothesis stimulating a useful re-examination is the steady-state cosmology by devil's advocates Holye, Burbidge, Burbidge, and Narlikar in the 1950's and 1960's. By now, almost everyone rejects the steady-state hypothesis, but this rejection is made believable only by the great volume of new and improved data obtained in the past 50 years.

Degenhardt et al have played the devil's advocates for the atmospheres of Io and Europa. Anthony Mallama cites strong evidence against this dense atmosphere hypothesis. Degenhardt's suggestion — even if it does not withstand observational scrutiny — should not be categorically censored.

Mallama has suggested that the authors of the Proceedings have not refereed this paper properly. The refereeing process is properly done in complete confidence, not ex post facto and in public, and not by an outsider who may disagree with the publication content. To attack in the JALPO the editorial policy of a journal in no way associated with the ALPO is improper and not in good taste. It is sufficient to state the evidence from which Mallama believes that authors Degenhardt et al. are mistaken in their hypothesis. While endorsing his paper, I feel that his box, "When Amateur Science Goes Awry," is ill-considered and inappropriate in a scientific discussion.

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Degenhardt, S.; Gahrken, B.; Giacchini, B.; Iverson, E.; Scheck, A.; Timerson, B.; Miller, M.; Talbot, J.; and Trowbridge, D. (2013) "JEE 2012 observing campaign preliminary results" In Proceedings for the 32nd Annual Conference of the Society for Astronomical Sciences. Editors: B. D. Warner, J. Foote, and R. Buchheim, pp. 9-16. *http://www.socastrosci.org/images/SAS_2010_Proceedings.pdf*.

Frederick Pilcher
ALPO Minor Planets Section
pilcher@ic.edu

Mr. Mallama's reply to Frederick Pilcher

Dear Fred,

Thank you very much for your interest in the material that I published. I appreciate having the opportunity to clarify a few points.

No one should think that I 'condemn' the editor of the SAS Proceeding. Brian Warner is a preeminent amateur astronomer with accomplishments and awards to prove it. I am sure we agree that Mr. Warner is a terrific scientist and a fine person.

Your defense of JEE as devil's advocate is mistaken though. An associate of the group states that the anomalous dimming in mutual event light curves (the JEE effect) can be turned on or off by adjusting the user parameters of their data reduction program. After detailing this in a message to the leader of the JEE group back in 2009 the associate wisely distanced himself from the project. The JEE group leader, on the other hand, continued to generate JEE anomalies. He is still promoting these specious results four years later.

Your comparison of the JEE controversy to the Steady State versus Big Bang theory debate is interesting. I won't go into the details about why I disagree but I offer the following analogy instead. In your area of minor planet research, the JEE hypothesis would be like claiming that asteroids are made of whale blubber.

In closing, I want to emphasize that if I caused any friction between the ALPO and the SAS it was unintentional. There is much commonality between the two organizations and I am certain that both will continue to promote excellence in amateur scientific research.

Sincerely, Tony Mallama

Inside the ALPO
Member, section and activity news

Membership Report: Sponsors, Sustaining Members and Newest Members

by Matthew L. Will, ALPO Membership Secretary/Treasurer

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

As of November 15, 2013:

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A special thank-you to Julius (Trey) L. Benton, III, John McAnally, Louise Olivarez, Don Parker, John and Elizabeth Westfall, and Thomas R. Williams their very generous contributions over the past year that have exceeded the Sponsor level.

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NEWEST MEMBERS...

The ALPO would like to wish a warm welcome to those who recently became members. Below are persons that have become new members from August 12, 2012, through November 15, 2013, their locations and their interest in lunar and planetary astronomy. The legend for the interest codes is located at the bottom of the page. Welcome aboard!

Member Name	City	State	Country	Interests
Atul Agrawal	Lafayette	CA		1, 2, 4, 5, 6, 7, 8, C, H, I
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Robert Crews	Louisville	KY		5, 6, I
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Subes Emmanuel	Pouillon		France	
Theresa Fichera	Chicago	IL		
Mattia Galiazzo	Vienna		Austria	
Mitch Glaze	Erie	CO		
John Glover	Naperville	IL		0, 3, M
Kevin Halevan	Claremont	NH		
Scott Hallaron	Rochester	IL		
Kimberly Herman	Weatherford	TX		
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Terry Smiljanich	Gainesville	FL		
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Thierry Speth	Nilvange		France	
Greg Spradlin	Mesa	AZ		
Tom Stifler	Cumming	GA		0, 3, 5, 6, E, S
Todd Strackbein	Naples	FL		
(Larry) Lawrence Trutter	Springfield	IL		
Ian Walker	Wiltshire		United Kingdom	
Brian D Warner	Eaton	CO		
Michael E Wilson	Lansing	MI		0, 2, 3, 5, 6, A, H, X
Paul Wren	Scottsdale	AZ		
Paul A Zeller	Indianapolis	IN		3, 5, A, C, M, P, X

Interest Abbreviations

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

Feature Story: Comet C/2012 S1 (ISON)

From 'Comet of the Century' to 'Thanksgiving Turkey'

By Carl Hergenrother,
Acting Assistant Coordinator,
ALPO Comets Section
chergen@lpl.arizona.edu

Online Readers

Left-click your mouse on the e-mail address in blue text to contact the author of this article, and selected references also in blue text at the end of this paper for more information there.

Cover Image Details

Comet C/2012 S1 (ISON) with star trails as imaged by Van Macatee of Rutledge (near Atlanta), Georgia USA (33°33'49"N, 83°37'28"W) starting at 5:39 a.m. EDT, on November 11, 2013. Comet magnitude estimated at 7 to 8. Equipment: Explore Scientific 80mm APO Triplet, Canon T3i, Astor Tech Field Flattener, Orion EQ-G mount, Guided, un-filtered. The image is based on 6 RAW frames, 180 seconds each, at ISO 1600, CCD recorded 13 degrees C, custom White Balance. Stacked in Nebulosity, processed in PixInsight. PixInsight workflow included Cropping, Dynamic Background Extraction, Color Calibration, HDR Multi-scale Transform, Histogram Transformation, and ACDNR. The seeing was good (estimated 8 out of 10) and the Transparency was an very good at an estimated 5 out of 6. Source: Van Macatee, *van.macatee@evermore.biz*

Introduction

Since its discovery in late 2012, Comet C/2012 S1 (ISON) has been heralded as a possible naked-eye spectacle. Labeled by the media and even some comet researchers as the "Comet of the Century", a large-scale observing campaign was coordinated by NASA to study the comet. Due to the comet's close approaches to Mars, Mercury and the Sun, spacecraft in orbit around these bodies or dedicated to studying them were tasked with observing ISON. Unfortunately, rather than becoming a brilliant comet for the public to see, ISON played the part of "Thanksgiving Turkey" as it apparently disintegrated in the hours prior to perihelion. (Note: The comet's date of perihelion was Thanksgiving Day in the United States where the traditional Thanksgiving dinner consists of a main course of turkey. The word "turkey" is also a colloquialism for a flop or failure.) This article is an overview of Comet ISON's observed history and apparent demise. A scientific analysis of its apparition will be published in a future issue of this journal.

Discovery and Orbit

Comet ISON was first imaged on 2011 September 30 by the Pan-STARRS asteroid survey at the University of Hawaii. Over the next four months, Pan-STARRS and the Mount Lemmon Survey (MLS) at the University of Arizona imaged the comet on another six nights. On those nights, the comet was either not picked up by automated detection software or was indistinguishable from an asteroid and not flagged as interesting. On 2012 September 21, astronomers

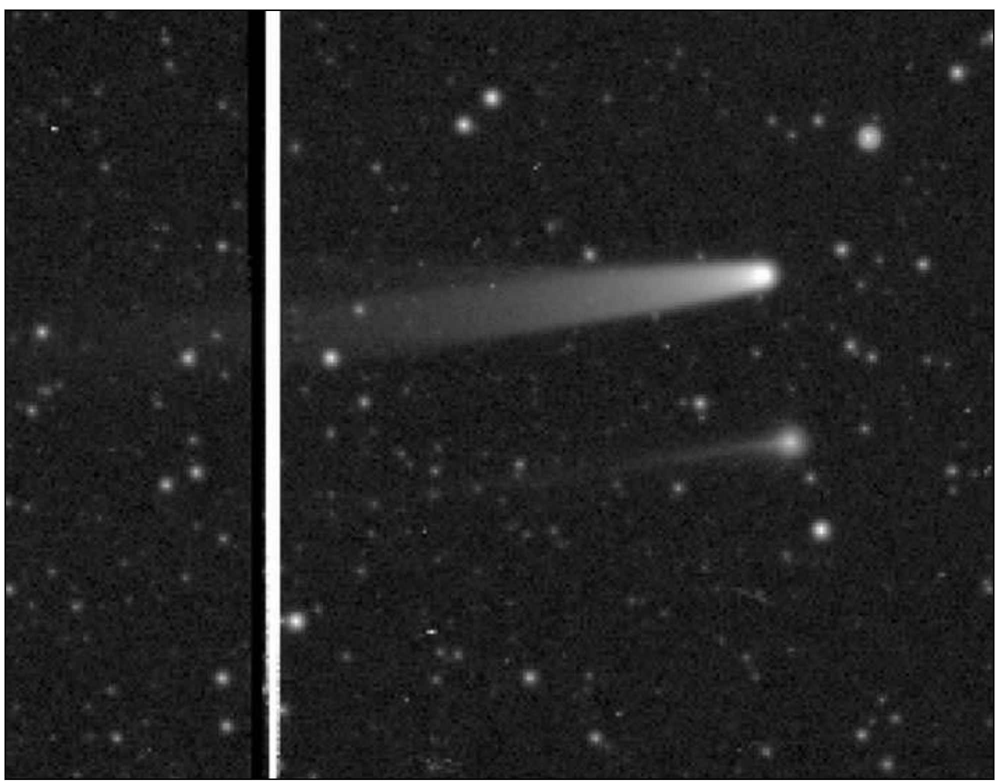

Figure 1, Comets ISON (top) and 2P/Encke (bottom) in a H1A image from NASA's STEREO spacecraft on November 25 at 03:19 UT. The thick saturation spike (top-to-bottom line) to the left of the comets is from the Earth-Moon system. Credit: NASA/STEREO.

Figure 2, Image of Comet ISON taken with the LASCO C2 imager on the NASA/ESA SOHO spacecraft on 2013 November 28 @ 17:36 UT or one hour prior to perihelion. Credit: NASA/ESA/SOHO.

Figure 3. ISON shows an extensive ion tail in this average of 4x180-s exposures from the Virtual Observatory robotic 0.43-m telescope in Ceccano, Italy taken on 2013 Nov. 14 UT. The diffuse glow to the left of the comet's tail is a faint galaxy. Credit: Gianluca Masi/Virtual Observatory.

Vitali Nevski of Belarus and Artyom Novichonok of Russia discovered ISON as a 17th magnitude object with a 0.4-m (16-in.) reflector of the International Scientific Optical Network (ISON) (Green 2012). Though at first the discoverers only suspected its cometary nature, additional follow-up observations with larger telescopes uncovered its true nature.

On 2012 September 24, the Central Bureau of Astronomical Telegrams announced the comet as C/2012 S1 (ISON) on Central Bureau Electronic Telegram (CBET) 3238. Thanks to some of the Pan-STARRS and MLS pre-discovery astrometry, the comet already had a well-defined orbit at the time of announcement. When discovered by Nevski and Novichonock, the comet was located at a distance of 6.29 AU from the Sun. The comet was 9.39 AU from the Sun, roughly the Earth-to-Saturn distance, when the first pre-discovery observation by Pan-STARRS was made. Excitement was high as ISON was predicted to approach to within 1.2 million km (0.75 million miles) of the surface of the Sun on 2013 November 28. The orbit was also similar to that of the Great Comet of 1680 and led to speculation that the two might be related. We now know that ISON's original orbit (before it was perturbed by the planets) is slightly hyperbolic and as a result, any relation to the 1680 comet is in doubt. A hyperbolic original orbit also means it is a dynamically new comet likely to be on its first trip into the inner Solar System.

Some of the greatest comets of recorded history have been sungrazing comets with very small perihelion distances. Though the perihelion distance of ISON is small, it is not related to the Kreutz family of sungrazing comets that produced such well-known comets as the Great Comets of 1843 and 1882, C/1965 S1 (Ikeya-Seki) and more recently C/2011 W3 (Lovejoy).

From Pre-discovery to Perihelion and Beyond

The initial forecasts of the brightness of ISON near perihelion were based on the comet's brightness at the time of discovery and extrapolated forward as if the comet were to brighten at a steady and "typical" rate for a long-period comet. Such predictions over a large range of heliocentric distances are fraught with uncertainty (for example, Comet Kohoutek). This is especially true for dynamically new comets like ISON, which have a history of brightening at slow rates.

To say the brightness behavior of ISON was like a roller coaster ride is an understatement. The comet's intrinsic brightness rose and fell in fits and starts (intrinsic magnitude is defined as the observed brightness normalized to distances of 1 AU from the Sun and Earth). At first the comet would seem to be doing well for a few months only to be followed by a few months of underperformance. As the comet approached the Sun, these "up and down" periods would alternate on the timescales of days. The following timeline summarizes its behavior and is based on visual and CCD observations posted on various online Yahoo groups (comets-ml, CometObs), comet photometry websites (International Comet Quarterly, Cometas de la LIADA) and the NASA Comet ISON Observing Campaign site.

- 2011 September to 2013 January – The comet brightened intrinsically at a steady rate. From Earth, the comet brightened from 19th to 15th magnitude as its heliocentric distance decreased from 9 to 5 AU. During this time the comet's tail was first observed.

- 2013 January to June – The brightening trend not only stopped around 5 AU from the Sun, but the comet started to fade intrinsically by nearly a magnitude as the heliocentric distance decreased to ~3 AU. From Earth, the comet continued to sport a short tail but its apparent magnitude actually faded a small amount from 15th to 16th magnitude.

- 2013 August to early October – For much of the summer, ISON was too close to the Sun for observation from Earth. When it was recovered after conjunction in early August a new rapid brightening trend has started. The trend would only last ~2 months before once again stopping near a heliocentric distance of 1.5 AU. By this time, the comet was at an apparent magnitude of 10-11.

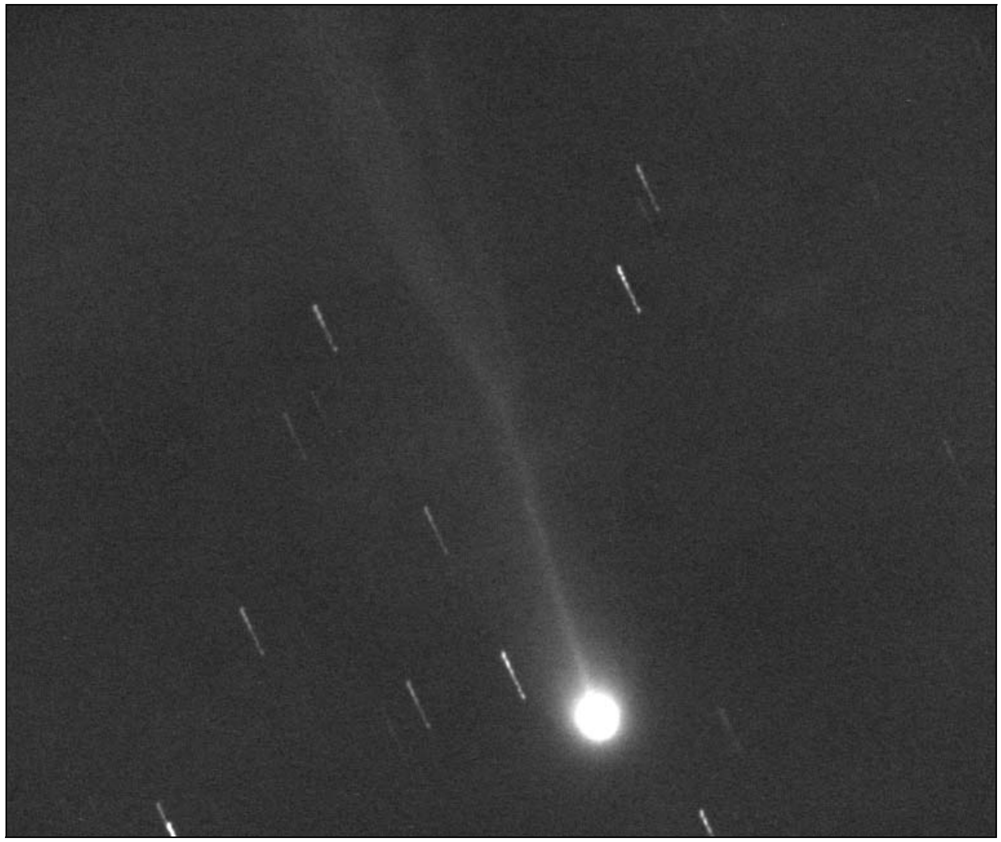

Figure 4. Complex ion tail structure can be seen in this average of 6x90-s exposures from the Virtual Observatory robotic 0.43-m telescope in Ceccano, Italy. The image was taken on 2013 Nov. 18 at 4:50 UT. Credit: Gianluca Masi/Virtual Observatory.

- 2013 early October to November 11 – As the comet moved from 1.5 to 0.7 AU from the Sun, it stayed roughly constant in intrinsic brightness. Due to the decrease in distance from the Sun and Earth, the comet brightened to 7th-8th magnitude as seen from Earth.

- 2013 November 11-22 – Multiple professional groups detected an outburst in the production rate of various molecules in the coma starting on November 11 UT (Biver et al. 2013, Crovisier et al. 2013, Opitom et al. 2013). By the 15th UT, visual observers were reporting a ~3-magnitude increase in brightness up to an apparent magnitude of ~5. Over the next 10 days, the comet's brightness would fluctuate by over a magnitude as a number of outbursts occurred. CCD observers were imaging a complex ion tail that extended over 5 degrees in length. To visual observers, the comet displayed a strongly condensed blue-green coma with a tail that extended over a degree – even in small binoculars. By November 21 UT, these outbursts seemed to subside as the comet moved to within 0.38 AU of the Sun.

- 2013 November 22-27 – During this period, ISON's distance from the Sun decreased from 0.38 to 0.16 AU. At this time, the comet was lost to Earth-based observers but could be followed in the STEREO H1A camera. The comet experienced a ~3-magnitude drop in intrinsic brightness as its period of outburst activity ceased.

- 2013 November 27-28 – The comet was now visible in the FOV of the SOHO LASCO C3 camera. Around November 27.0 UT, a major outburst occurred, resulting in a ~5-magnitude outburst in brightness. At the peak of the outburst around November 28.2 UT (~14 hours

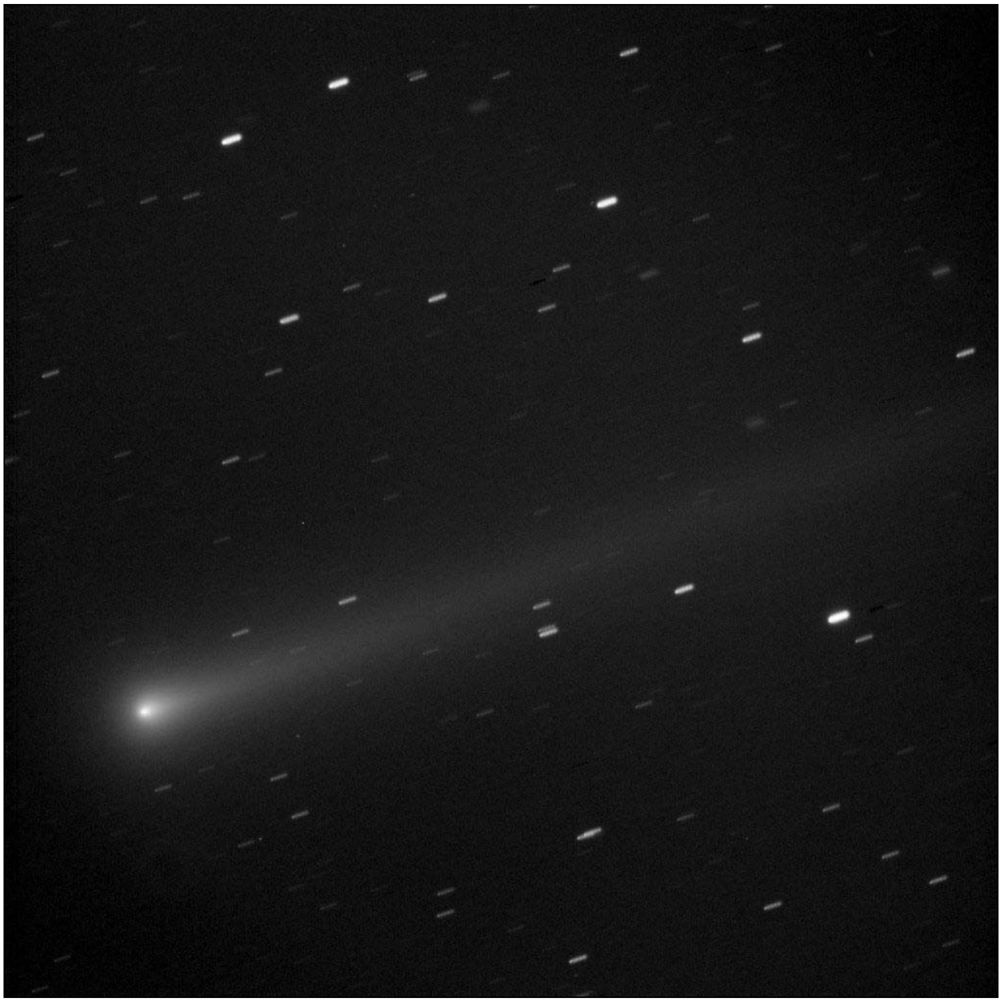

Figure 5. The dust tail of ISON is the highlight of this 6x60-s exposure taken by John Sabia on 2013 Nov. 04.40 UT.

prior to perihelion), the comet reached its peak apparent magnitude of -2.

- 2013 November 28 - After peaking at magnitude -2, the comet began a rapid decline in brightness. Also a few hours before perihelion, the coma started to elongate and lose condensation. Many small sungrazing comets observed by SOHO have shown a similar appearance, which has been interpreted as the complete disruption of the nucleus. By the time of perihelion, the comet was too faint to be observed by the Solar Dynamics Observatory (SDO) spacecraft.

- 2013 November 28 – December 9 – To the surprise of many, the comet reappeared after perihelion in the FOVs of STEREO and SOHO (for a short-period around perihelion the comet was behind the occultation disk used by the imagers to block the Sun). Rather than a healthy looking condensed comet, a diffuse cloud of remnant dust was observed moving away from the Sun. The lack of detection by SDO, radio telescopes in the days after perihelion, and modeling of ISON's post-perihelion dust cloud and tails all point to an end-of-dust/gas release in the hours around perihelion (Biver et al. 2013, Boehnhardt et al. 2013, Pesnell 2013, Sekanina 2013).

Current Status

At the time of writing (2013 December 9), a few visual observations of the remnant dust cloud have been reported, though no CCD observers have captured an image of the dust cloud. Based on the comet's brightness while in the STEREO H1A images and our experience with the remnants of other disappeared comets, ISON's dust may be followed by visual and CCD observers for many weeks.

The question of whether any sizable fragments of the nucleus still exist will wait till the comet is far enough from the Sun to be safely observed by large telescopes. By the time you are reading this, HST may have provided an answer to this question, as it is scheduled to image ISON in mid-December.

To put the demise of ISON in perspective, comet disintegrations are not rare events. SOHO has observed roughly 2000 small Kreutz sungrazing comets, and all but one disintegrated prior to perihelion (the exception being C/2011 W3 (Lovejoy) which disintegrated a day or two after perihelion). Even comets that don't get as close to the Sun as the sungrazers can disintegrate. Comet C/2013 G5 (Catalina), which was featured on the front cover of the Summer 2013 issue of this Journal, is an example of a comet that faded from view at a distance of ~1.6 AU while still inbound towards perihelion.

The mechanisms that cause the complete disruption of comet nuclei are still being debated. Possible mechanisms include breakup due to tidal forces, rapid rotation, gas pressure stresses, thermal stresses and erosion via gradual fragmentation and sublimation.

The story of Comet ISON is really only beginning. Due to the concerted work of amateur and professional observers from around the world, an immense amount of data was produced. Analysis over the next few years will undoubtedly unlock many of Comet ISON's secrets.

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Sekanina, Z. (2013). CBET 3731.

Figure 6. A composite of B, V and Rc band images taken by Bruce Gary on 2013 November 8 UT with a Celestron CPC 1100 (0.28-m), Optec 0.5x focal reducer and SBIG ST-10XME CCD. All exposure times were 20 seconds. Number of images used were 40 B, 30 V and 27 Rc. The FOV is 30'x19' with north up and east to the left. Credit: Bruce Gary.

Figure 7. Fig. 7. Another image by Bruce Gary taken with the same set-up as Figure 6 but on 2013 November 19 UT. The sharpest 11 20-second r' band exposures were used. MaxIm DL's digital development used to enhance contrast of small scale structure while reducing contrast of large scale structure. Credit: Bruce Gary.

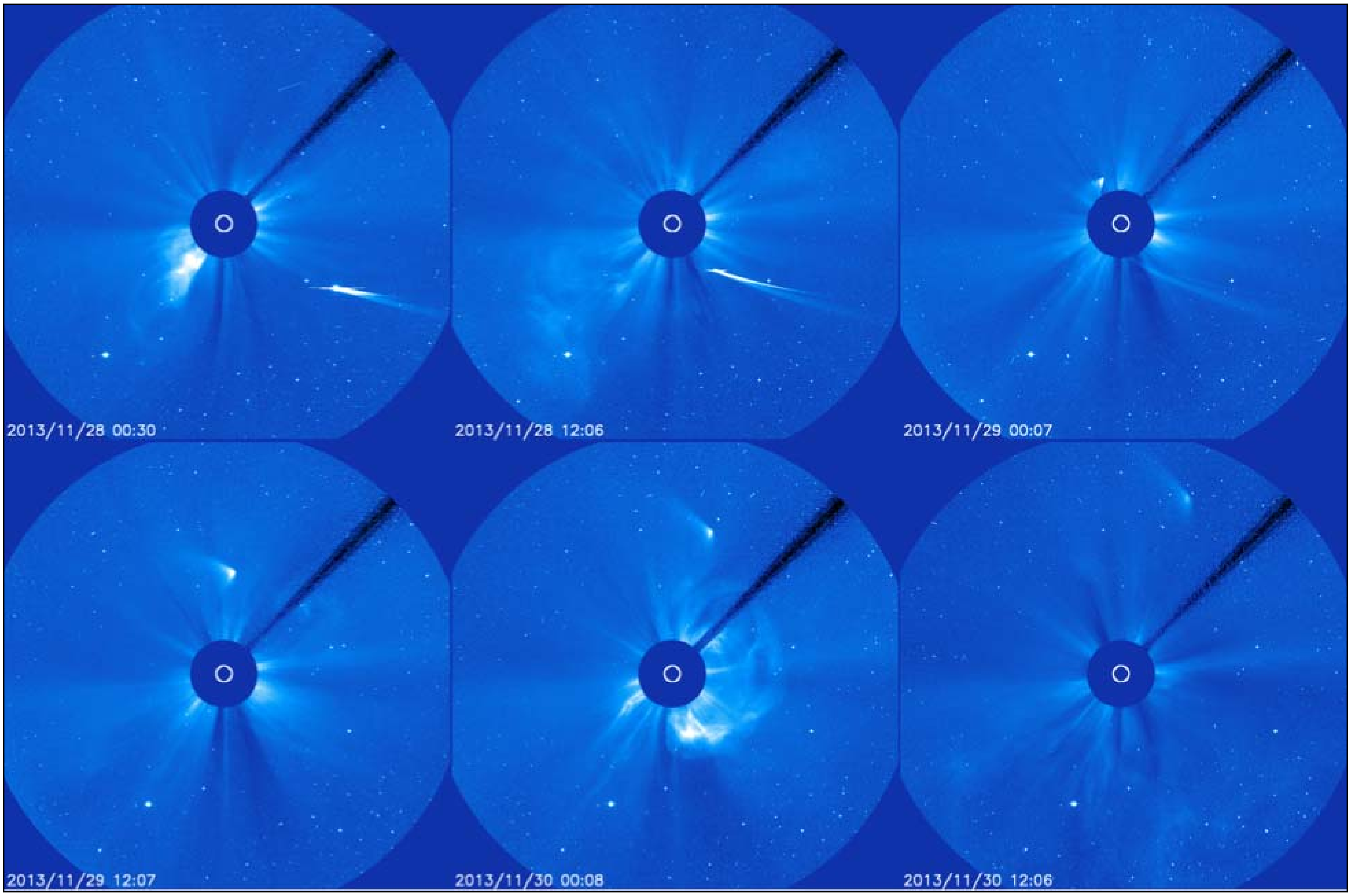

Figure 8. This mosaic consists of images taken by the SOHO LASCO C3 imager of ISON at 12 hour intervals between 2013 Nov. 28 00:30 UT and Nov. 30 12:06 UT. The transformation from healthy comet to remnant dust cloud is apparent. Credit: ESA/NASA/SOHO/LASCO.

Comet Report Form: Visual Observations

Send copies of these completed forms to:

Carl Hergenrother
ALPO Comets Section
Acting Assistant Coordinator
4101 North Sunnywood Place
Tuscon, AZ 85749

Please print or type the following: date of observation to 0.01 day, brightness to 0.01 magnitude, coma diameter to 0.01', and tail lengths to 0.01°. Each sheet should be devoted to only one comet, and any drawings or photographs that pertain to the observations on this sheet should be included.

Comet Designation: ____

Observer: ____

Address: ____

Date (UT)	Magnitude		Instrument				Coma		Tail		Sky	Rem
(yy/mm/dd.dd)	Mag.	Ref.	Apr (cm)	Type	F/	Pwr	Dia (°)	DC	Len (°)	PA (°)	LM	

Remarks

Feature Story:

The Recent Evolution of the Planetary Telescope: Part 2

By Thomas Dobbins,
coordinator, ALPO Historical Section
tomdobbins@gmail.com

This hereby completes Mr. Dobbins' exhaustive look back at telescopes used for planetary observations. Part 1 appeared in Journal of the Assn of Lunar & Planetary Observers, Vol. 55, No. 1 (Winter 2013).

Note to Readers

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Newtonian Reflectors

For the first four decades of the ALPO's existence, the overwhelming majority of members employed Newtonian reflectors. Justus von Liebig's invention of the silver-on-glass mirror combined with Leon Foucault's publication of the knife-edge test in the mid-19th century had made powerful telescopes affordable for the first time and made it possible for significant numbers of amateur astronomers (chiefly in Victorian and Edwardian Britain) to make valuable contributions to lunar and planetary science. A vast literature appeared that permitted anyone with a modicum of mechanical aptitude and perseverance to grind, polish, and figure a Newtonian primary mirror. Indeed, until the 1970s "walking around the barrel" was a rite of passage for generations of amateur astronomers.

Figure 1: The iconic Criterion RV-6 Dynascope (left) and the Edmund "Super Space Conqueror" (below) were the quintessential serious amateur telescopes for over a generation.

During the 1950s several firms in the United States appeared offering Newtonian reflectors of high quality and respectable size. Many of these firms were founded by amateur telescope makers ("ATMs") who managed to turn a hobby into a business. By the end of the decade, the 6-inch f/8 Newtonian reflector supported by a German equatorial mounting atop a metal pedestal had come to epitomize the serious amateur's telescope. Prominent commercial examples of these simple, robust instruments included the Criterion Manufacturing Company's RV-6 Dynascope and Edmund Scientific's "Super Space Conqueror" (Figure 1). One popular guidebook of the era sagely advised prospective telescope buyers that "a 6-inch reflector, at half the cost, will under good conditions perform as well as a 5-inch refractor and have a marked advantage for photography."[1] The valuable work on Jupiter conducted by like Arthur Stanley Williams (1861-1938) and Elmer J. Reese (1919-2010) attests to the fact that a 6-inch Newtonian could be a powerful tool in the hands of a talented observer.

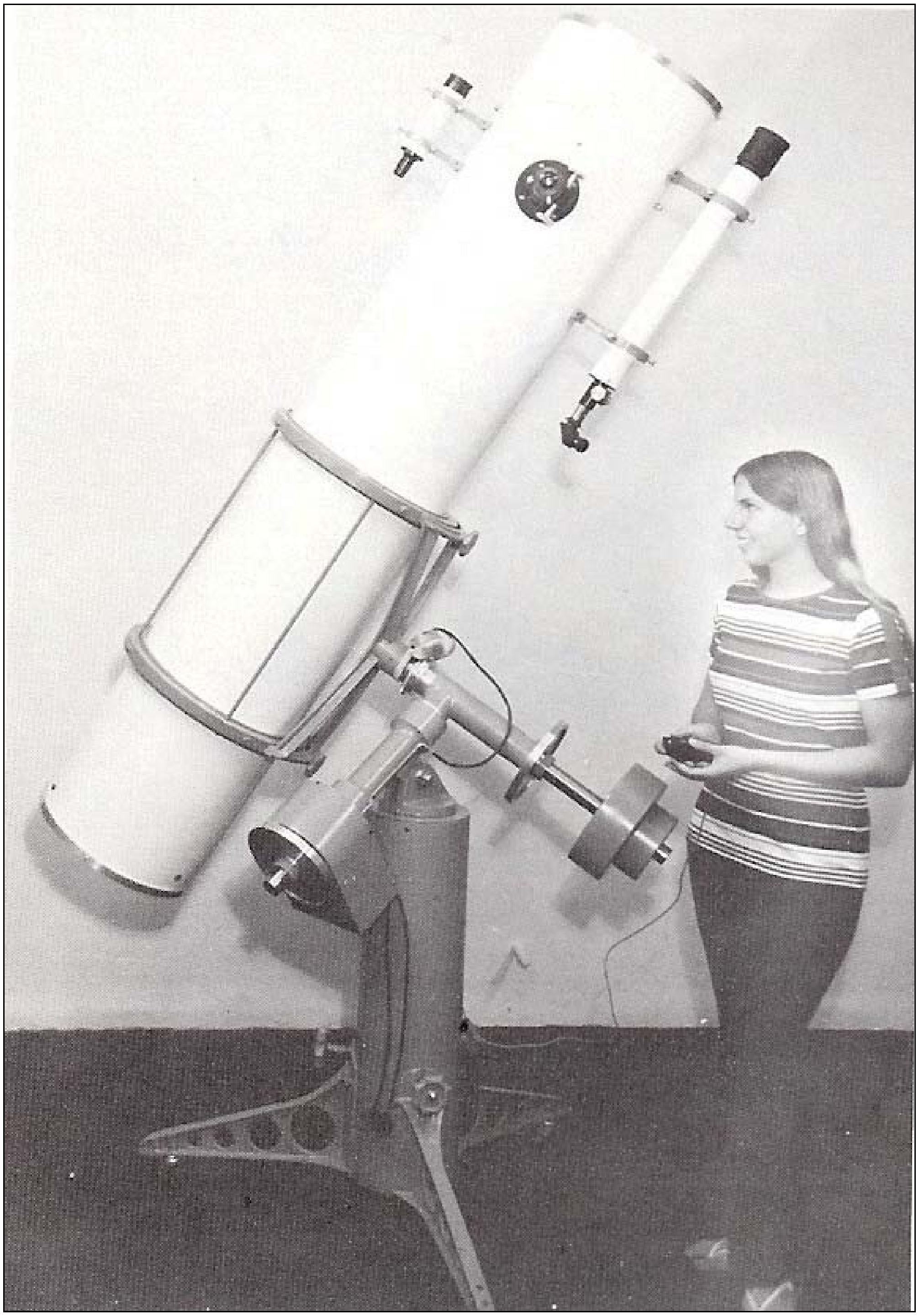

Figure 2: The Cave Optical Company's 12.5-inch "transportable" Newtonian embodied the limitations of the traditional design.

During this era focal ratios of f/7 to f/8 was the norm and Newtonians faster than f/6 were rarely encountered. Provided that optical quality was high, the modest (18% to 25%) central obstructions and forgiving collimation tolerances of such instruments resulted in excellent performance on the planets. However, 10 inches of aperture represented the limit of portability, although several manufacturers offered "transportable" 12.5-inch instruments that taxed the capacity of even the largest station wagons. (Figure 2)

During the late 1960s, John Dobson (b. 1915) of the San Francisco Sidewalk Astronomers introduced primitive large-aperture Newtonians featuring large, thin mirrors (thickness-to-diameter ratios of 1:10 to 1:15) made from porthole plate glass supported by a simple "sling," spiral-wound cardboard tubes, and rudimentary altazimuth mounts made of plywood or particle board. While this approach to telescope making constituted nothing less than an affront to the sensibilities of the many ATMs who turned out sophisticated, beautifully machined instruments rivaling the handiwork of any commercial firm, they introduced a generation of amateurs to the performance that only large apertures can provide. The Dobsonian design was commercialized in 1980 by the Coulter Optical Company, whose compact “Odyssey” telescopes combined thin primary mirrors, a fast focal ratio of f/4.5, and low prices that no conventional Newtonian of comparable aperture could touch -- a 13.5-inch at $395 and a 17.5-inch for $995.

Over the years the Dobsonian has benefitted from an array of refinements, notably truss tube construction and tracking capability provided by equatorial platforms or microcomputer controls. Efforts to optimize the Dobsonian have benefitted all Newtonian reflectors, however.

Prior to the advent of the Dobsonian, commercial Newtonian reflectors invariably employed primary mirrors with a standard thickness-to-diameter ratio of 1:6. Such mirrors are relatively easy to support and only require elaborate flotation cells in diameters larger than 10 inches. However, the low surface area-to-volume ratio of such a massive optic presents serious challenges to thermal equilibration, especially in rapidly falling evening temperatures. Until a mirror achieves thermal equilibrium with the surrounding air, a warmer boundary layer of convection is present near its surface. These “mirror currents” can degrade image quality every bit as much as atmospheric turbulence.

As early as 1972, the renowned British telescope maker E.J. Hysom conducted a careful series of experiments with mirrors of various diameters and thickness using a sensitive thermocouple.[2] Hysom determined that a 30mm (1.2 inch) thick mirror cools at a rate of 3.3°C per hour, while a 76mm (1.8-inch) thick mirror cools at a rate of only 0.9°C per hour. With the aid of a fan these rates could be increased by a factor of three.[3] Fans also make the air mass in the light path more thermally (and hence optically) homogeneous.[4]

Today cooling fans are integral components of many commercial reflectors and common after-market accessories. Combined with the thinner mirrors that are now the norm, they have all but overcome the principal shortcoming of the Newtonian reflector. The optician Robert F. Royce has recently introduced Newtonian primary mirrors of conical cross-section that have half the mass (and thermal inertia) of a conventional mirror yet do not require a complex flotation cell.[5] This clever innovation will no doubt be widely imitated in the future.

In a marketplace dominated by extremely compact catadioptric telescopes, focal ratios of f/4.5 to f/5 have become the norm for the current generation of commercial Newtonian reflectors. Far more sensitive to miscollimation that the classic f/8 Newtonian, for optimum performance these instruments require careful collimation using tools and techniques developed in recent years.[6] Although such fast focal ratios were long regarded as ill-suited to planetary work, in the hands of amateurs like Wes Higgins they have captured superb high-resolution lunar and planetary images.[7]

Tilted-Component Telescopes

Introduced in 1876 by the Viennese opticians Förster and Fritsch, the Brachyt telescope is an unobstructed reflector that features a pair of spherical mirrors tilted in such a fashion that the concave primary mirror is not obstructed by the convex secondary mirror. The astigmatism introduced by tilting the primary mirror is nullified by the oppositely directed astigmatism imparted by the similarly tilted secondary mirror. The Prokesch firm in Vienna produced Brachyts in modest apertures of 106mm (4.2 inches) and 160mm (6.3 inches) that were widely praised for their superb definition. Combining the perfect achromatism of the reflector with the refractor’s unobstructed light path to yield planetary images of unusually high contrast, these telescopes were produced until 1912 but never enjoyed widespread popularity. Hermann Klein (1844-1914), the director of the Cologne Observatory and author of many popular books and articles on astronomy, extolled their performance while expressing exasperation about their lack of success commercially, which he attributed entirely to their unconventional appearance.

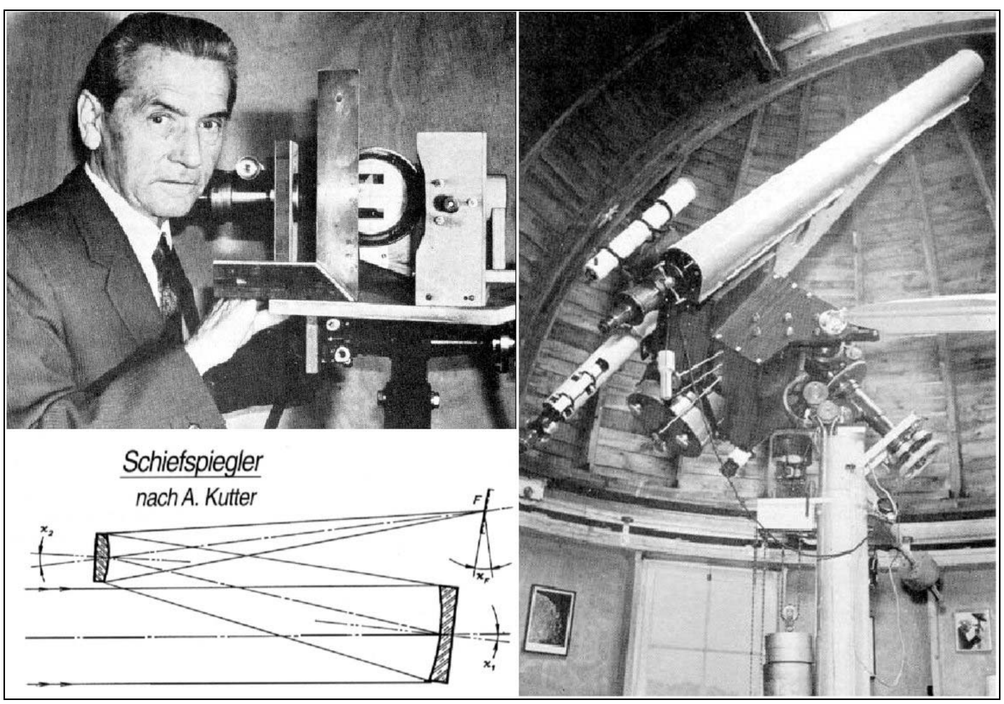

Figure 3: Anton Kutter (upper left) optimized the unobstructed Brachyt reflector design, shown in schematic form at lower left. At right is the 12-inch Schiefspiegler in Kutter’s private observatory in Biberach an der Riss, Germany.

An optimized version of the Brachyt known as the Schiefspiegler ("oblique reflector") or "neo-Brachyte" was introduced after the Second World War by the German filmmaker and amateur astronomer Anton Kutter (1904-1985). (Figure 3.) After thoroughly investigating the aberrations of a pair of tilted mirrors, Kutter designed a system that features a concave primary mirror with a focal ratio of f/12 combined with a convex secondary mirror with the same radius of curvature, yielding an effective focal ratio of f/20 that provides a generous image scale ideal for lunar and planetary observing. In apertures exceeding 6 inches controlling astigmatism requires mechanically deforming the secondary mirror or introducing a weak cylindrical lens near the focal plane.

Figure 4: Dall-Kirkam optics were used in most of the Cassegrain telescopes produced during the 1950s through the 1970s, including this 10-inch f/16 instrument made by the Cave Optical Company.

In modest apertures the Kutter Schiefspiegler was widely employed by German and Swiss amateurs. Details of Kutter's design reached an American readership in the pages of **The Strolling Astronomer** and **Sky & Telescope** during the 1950s.[8] A few hundred specimens have been made over the years by amateur telescope makers, but the design was never produced commercially in the United States as a complete instrument, although sets of optics were offered by several short-lived firms for mechanically inclined customers.

During the 1960s and 1970s several variations on the unobstructed reflector theme were devised by several American optical designers, notably the two-mirror "Yolo" and "Solano" designs of Arthur Leonard and the three-mirror systems of Richard Buchroeder. Although the performance of "tilted component telescopes" or "TCTs" on the planets is unsurpassed, interest in these instruments has waned in recent years. The optics of tilted-component telescopes are challenging both to fabricate and to collimate. Many have simply come to share the opinion of the renowned French optician Jean Texereau that if the diagonal mirror of a Newtonian reflector is kept small, planetary definition is so little compromised that "it is pointless to consider eliminating the obstruction by such crude measures as directing the image off-axis."[9]

Cassegrain Reflectors

The great appeal of the Cassegrain reflector is its remarkable compactness and portability. The inherent stability of its short, stubby tube combined with its large image scale make the Cassegrain particularly well-suited to high-resolution imaging despite the fact that all the designs suffer from a comparatively large central obstruction (typically 30% to

40%) that perceptively impairs the contrast of delicate planetary markings.

The classical Cassegrain design employs a concave parabolic primary mirror and a convex hyperbolic secondary mirror. Not only are these aspheric optical elements difficult to figure, they must be tested as a combination rather than separately, typically under autocollimation against a reference flat mirror at least as large as the primary mirror. Consequently, fabricating a set of classical Cassegrain optics has always represented a daunting task to all but the most talented amateur telescope makers and entails far more effort than making a Newtonian reflector. It is little wonder that the first volume of Scientific American's classic series **Amateur Telescope Making** featured a chapter entitled "How to Make a Cassegrain (And Why Not To)."[10] As late as 1923 the prominent British amateur Captain Maurice Anderson Ainslie (1869-1951) lamented that he knew of "no Cassegrain reflector of moderate aperture – say 8 or 10 inches – in regular use."[11]

Figure 5: A 5-inch f/20 Maksutov made by John Gregory riding piggyback atop a 4-inch refractor. This compact instrument created a sensation when it was displayed at the 1956 Stellafane convention.

During the early 1930s a variant of the Cassegrain that is much easier to figure and test was independently invented by Horace Dall (1901-1986) in Britain and Alan Kirkham (1909-1968) in the United States. The Dall-Kirkham design combines a concave ellipsoidal primary that can be null tested at its conjugate foci with a convex spherical secondary mirror that can be tested by interference fringes against a concave reference surface of the same radius of curvature. The vast majority of the Cassegrain reflectors produced by firms like the Cave Optical Company, The Optical Craftsmen, Coast Instruments, and Tinsley during the 1950s through the 1970s employed Dall-Kirkham optics (Figure 4). The design was revived in the 1990s by the Japanese firm Takahashi under the trade name "Mewlon." Produced in apertures of 180mm (7.1 inches), 210mm (8.3 inches) and 250mm (9.8 inches) with a focal ratio of f/12, these hand-crafted instruments feature comparatively modest central obstructions of as little as 28% and enjoy an excellent reputation among ardent planetary observers.

Maksutovs

The May 1944 issue of the **Journal of the Optical Society of America** featured a paper by the Russian optician Dmitri Maksutov (1898-1964) describing how meniscus lenses could be incorporated into a wide array of reflecting telescopes, permitting simple, easily fabricated spherical mirrors to be employed.[12] The Cassegrain configuration proved to be particularly well-suited to Maksutov's invention. The secondary mirror can be supported by the meniscus lens, eliminating the diffraction effects introduced by spider supports. Alternatively, a central spot on the surface of the meniscus lens can be aluminized to serve as the secondary mirror, a very attractive mode of construction because it eliminates the need for a third optical element.

In 1950 the American entrepreneur Lawrence Braymer (1901-1965) founded the Questar Corporation of New Hope, Pennsylvania for the express purpose of producing Maksutov-Cassegrain telescopes. The now classic 3.5-inch Questar entered serial production in 1954. Featuring an equatorial fork mounting with integral motor drive and a fitted leather case, the exquisite optical and mechanical quality of these jewel-like instruments soon earned them the reputation as the "Rolls Royce of telescopes." However their high price ($795 in 1954, corresponding to almost $6700 in 2012 currency) restricted sales to government agencies, educational institutions, and very wealthy individuals. A scaled-up 7-inch instrument was introduced in 1967, followed by the made-to-order Questar 12 in 1979.

The success of Questar inspired John Gregory (1927-2009) and Allan Mackintosh (b. 1911) to found the Maksutov Club in 1956. (Figure 5) This organization disseminated detailed optical specifications, shop techniques, and test procedures to amateur telescope makers and did much to promote the excellent reputation of the Maksutov-Cassegrain design. Nevertheless, Questar faced little competition. The California firm of Tinsley produced a small number of 5-inch Maksutov-Cassegrains during the 1960s, and several hundred 4- and 6-inch instruments were produced by short-lived firm Optical Techniques, founded in 1976 by disgruntled Questar employees.

Following the dissolution of the Soviet Union in 1991, Maksutov-Cassegrains produced by the Russian firms Intes (later Intes-Micro) and LOMO appeared on the market. Combining high optical quality with affordable prices, these instruments enjoyed immediate commercial success that inspired Meade Instruments to introduce the ETX family of inexpensive Maksutov-Cassegrains telescopes in 1996. During the last decade several Chinese firms have introduced an array of Maksutov-Cassegrains and all but eclipsed their Russian and American competitors.

Russian manufacturers supplemented their line of Maksutov-Cassegrains with Maksutov-Newtonians in apertures of 4 to 8 inches. Featuring focal ratios of f/6 to f/8 and comparatively small central obstructions, these instruments offer planetary performance rivaling apochromatic refractors of similar aperture. Curiously, interest in this design has waned in recent years, no doubt in large measure due to the fact that the Maksutov-Newtonian is not nearly as compact as its Cassegrain counterpart.

In apertures up to 8 inches or so both the Maksutov-Cassegrain and the Maksutov-Newtonian have earned an excellent reputation among ardent planetary observers. However, the performance of larger Maksutovs has almost invariably proved disappointing because the thick, massive meniscus lens has considerable thermal inertia and achieves thermal equilibrium with the surrounding air quite slowly, even with the aid of fans.

Figure 6: A 1965 advertisement for the 10-inch f/13.5 Celestron Schmidt-Cassegrain.

Schmidt-Cassegrains

The April 1962 issue of **Sky & Telescope** contained an article by R.R. Willey describing an unusually compact Schmidt-Cassegrain telescope consisting of a thin aspheric Schmidt corrector plate located near the focal plane of a fast spherical primary mirror rather than at its radius of curvature as in previous instruments of this type.[13] Willey's article inspired Thomas Johnson (1927-2012), the owner of a California electronics firm and an amateur telescope maker, to devise a proprietary method of producing Schmidt corrector plates from inexpensive float plate glass in large quantities at low cost. By 1965 the first Celestron Schmidt-Cassegrain telescopes ("SCTs") appeared on the market. (Figure 6) Equipped with equatorial fork mounts reminiscent of the Questar, these instruments were initially offered in apertures of 10, 12, 16, 20, and 22 inches. Intended for the institutional and professional market, they fetched prices three to four times higher than conventional reflectors. Nevertheless, they sold in sufficient quantity that Johnson's firm was able to gradually transition from electronics to telescope manufacturing.

In 1970 Celestron introduced a true “game changer” in the form of the C-8, a versatile, affordable 8-inch f/10 instrument specifically intended for the amateur market. Before the decade was out the Schmidt-Cassegrain had largely supplanted the Newtonian reflector as the instrument wielded by most serious amateur astronomers. Long-established manufacturers of traditional Newtonian reflectors on German equatorial mountings were driven out of business and a rival SCT manufacturer entered the field in the form of Meade Instruments.

Despite this paradigm shift, SCTs were deservedly viewed with disdain by many planetary observers until recent years. Their large (35 to 40%) central obstruction robs images of contrast and they are extremely sensitive to even a slight loss of collimation. However, these failings paled in comparison to the unit-to-unit variability in optical quality, particularly during the latter half of the 1980s. While some good specimens were produced, it was very much a hit or miss affair. Many SCTs were barely diffraction-limited and a considerable number were optically defective. During the late 1990s both the optical quality and the unit-to-unit consistency of SCTs improved dramatically due to improved fabrication techniques, more stringent quality control, and the increasingly sophisticated consumers. The old stigma is becoming a distant memory and today Schmidt-Cassegrains are employed by many of the world’s leading high-resolution imagers, notably Ed Grafton, Thierry Legault, Dave Tyler, and Damian Peach. Their results dispel any notion that SCTs of recent vintage are ill-suited to planetary work.

What The Future Holds

The evolution of the planetary telescope has followed Voltaire’s axiom that “the perfect is the enemy of the good.” The advent of webcam imaging irrevocably changed observing methods, largely relegating the visual observer to the status of a “telescopic tourist.” The new observing methods have in turn irrevocably changed notions of what constitutes a good planetary telescope. The contrast-robbing effects of a moderately large central obstruction that represented a serious handicap for the visual observer are not nearly as harmful for the webcam imager. Consequently, the long-focus Newtonian and the Schiefspiegler seem destined to become rare curiosities.

Today an aperture of 8 or even 10 inches is probably the minimum required for serious planetary work, and the finest high-resolution images are captured using apertures of 12 to 16 inches. Economically viable choices of instrument in these sizes are limited to Schmidt-Cassegrains and compact, comparatively fast Newtonians. Here lies the future of the planetary telescope.

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3. The beneficial effect of fans on the performance of reflectors is hardly a recent discovery. It has merely been rediscovered in recent years. An excellent article about the subject by Harvard College astronomer William Henry Pickering dating from 1930 was incorporated in **Amateur Telescope Making, Book Two,** New York: Scientific American (1937). pp. 611-613.

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5. See *http://www.rfroyce.com/conical/*

6. The seminal work on the subject was Vic Menard and Tippy d’Auria, **New Perspectives on Newtonian Collimation: Principles and Procedures**, Sarasota, Florida: Tectron Telescopes (1987). (*http://www.adamsavebooks.com/?page=shop/flypage&wt=1.00&product_id=71135*) For up to date instructions covering the use of laser collimators see Donald E. Pensack “Collimation and the Newtonian” **Amateur Astronomy Magazine**, Issue 77 (Winter 2003), pp. 27-32. (*http://www.iceinspace.com.au/63-390-0-0-1-0.html*)

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Feature Story:
Concentric Lunar Craters

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This paper by ALPO member and astrophotographer Howard Eskidsen is only one of many that were presented at ALCon 2013, held in Atlanta, Georgia.

Abstract

Fifty-five concentric caters were identified and measured for diameter, depth, toroid crest diameter, coordinates, and depth/diameter (d/D) ratios were calculated using Lunar Reconnaissance Orbiter data. Crater coordinates were reproducible to within 0.02°. Outer rim diameters (D) ranged from 2.3km to 24.2 km with the mean 8.2 km with error of ± 0.2 km. Inner toroid rim diameters (T) averaged 4.3 km, and calculated toroid to diameter ratios (T/D ratio) averaged 0.51. The d/D ratios for the concentric craters averaged 0.065, much shallower than the T/D ratio of 0.20 that is typical for non-concentric craters. Mean crater rim elevations were below the mean lunar radius of 1737.4 km with the mean 1.5 km lower than the mean lunar radius.

Table 1: Eastern Hemisphere Diameter Data

	Concentric Craters Study Data								
			LROC	Mean	Geodetic		Geodetic		Mean
		Wood	QuickMap	Crater	Crater Diameter		Toroid Dameter		Toroid
	Crater	Coordinates	Coordinates	Diameter	N-S km	W-E km	N-S km	W-E km	Diameter
1	Archytas G	0.4E 55.8N	0.53E 55.74N	7.0	6.98	7.05	4.33	4.57	4.5
2	Archytas G-b		0.48E 55.56N	4.3	4.12	4.56	2.11	2.30	2.2
3	Reaumur B CC	1.3E 4.5S	1.24E 4.52S	4.4	4.14	4.67	2.76	2.87	2.8
4	Egede G	6.8E 51.9N	6.93 E 52.00N	7.3	7.25	7.26	5.34	5.32	5.3
5	Pontanus E	13.3E 25.2S	13.25E 25.22S	12.5	12.4	12.60	7.68	8.65	8.2
6	Torricelli R CC	26.6E 6.4S	26.64E 6.38S	3.8	3.80	3.82	1.18	1.27	1.2
7	Beaumont P CC	29.6E 19.1S	29.63 E 19.14S	11.7	12	11.30	5.62	5.19	5.4
8	Fracastorius E		31.02 E 20.23S	11.9	11.23	12.63	4.18	4.67	4.4
9	Crozier H	49.4E 14.1S	49.38E 14.01S	10.7	11.13	10.23	5.70	4.34	5.0
10	Endymion SW CC	50.6E 51.7N	51.06E 51.68N	6.8	6.74	6.84	2.93	2.62	2.8
11	Apollonius N	64.0E 4.7N	63.76E 4.74N	10.5	10.63	10.33	5.78	5.32	5.6
12	Legendre CC	68.2E 27.5S	68.14E 27.81S	4.4	4.55	4.22	1.62	1.52	1.6
13	Dubyago CC	69.0E 3.7N	68.61E 3.67N	5.9	5.99	5.88	2.83	2.62	2.7
14	Schubert N CC	74.0E 2.0N	73.61E 1.33N	10.2	10.11	10.24	5.59	5.44	5.5
15	Humboldt CC	83.2E 26.5S	83.36E 26.55S	8.5	8.44	8.49	3.90	3.82	3.9
16	Hamilton CC	84.7E 44.2S	84.73E 44.39S	11.6	11.4	11.70	5.57	6.19	5.9
17	Jeans CC	94.4E 53.1S	94.61E 53.13S	24.2	23.03	25.30	15.51	16.98	16.2
18	Chamberlin CC	102.5E 58.8S	102.59E 58.67S	8.3	8.16	8.53	5.88	6.64	6.3
19	Pasteur CC	104.9E 11.8S	105.15E 11.96S	6.4	6.09	6.76	3.21	3.82	3.5
20	Jules Verne CC		143.76E 37.23S	5.6	5.60	5.61	2.97	3.03	3.0
21	Jules Verne CC SE	144.1E 37.5S	144.33E 37.40S	7.1	7.29	6.95	3.61	3.78	3.7
22	Geiger CC	159.0E 16.2S	159.01 E 16.11S	6.5	6.48	6.51	2.69	2.64	2.7
23	Vertregt K CC	172.6E 20.6S	172.69E 20.50S	9.2	9.07	9.38	4.83	5.86	5.3

Table 1A: Eastern Hemisphere Elevation/Depth Data

	Concentric Craters Study Data									
			LROC					Mean Rim	Central	Mean
		Wood	QuickMap	Geodetic Crater Rim Elevation				Elevation	Elevation	Crater
	Crater	Coordinates	Coordinates	North (m)	South (m)	West (m)	East (m)	(meters)	(meters)	Depth (km)
1	Archytas G	0.4E 55.8N	0.53E 55.74N	-2680	-2490	-2690	-2440	-2575	-3010	0.435
2	Archytas G-b		0.48E 55.56N	-2650	-2680	-2066	-2550	-2486.5	-2790	0.304
3	Reaumur B CC	1.3E 4.5S	1.24E 4.52S	430	560	640	495	531.25	270	0.261
4	Egede G	6.8E 51.9N	6.93 E 52.00N	-2510	-2630	-2500	-2640	-2570	-3130	0.560
5	Pontanus E	13.3E 25.2S	13.25E 25.22S	490	640	590	510	557.5	-290	0.848
6	Torricelli R CC	26.6E 6.4S	26.64E 6.38S	-2140	-2380	-2420	-2240	-2295	-2500	0.205
7	Beaumont P CC	29.6E 19.1S	29.63 E 19.14S	-1570	-1920	-1500	-1920	-1727.5	-2250	0.523
8	Fracastorius E		31.02 E 20.23S	-1760	-900	-1500	-1060	-1305	-2200	0.895
9	Crozier H	49.4E 14.1S	49.38E 14.01S	1000	190	410	910	627.5	-380	1.008
10	Endymion SW CC	50.6E 51.7N	51.06E 51.68N	-1450	-1560	-1570	-1570	-1538	-1780	0.243
11	Apollonius N	64.0E 4.7N	63.76E 4.74N	-110	800	380	430	375	-920	1.295
12	Legendre CC	68.2E 27.5S	68.14E 27.81S	-610	-625	-720	-670	-656.25	-900	0.244
13	Dubyago CC	69.0E 3.7N	68.61E 3.67N	-920	-810	-860	-945	-883.75	-1090	0.206
14	Schubert N CC	74.0E 2.0N	73.61E 1.33N	-1230	-1410	-1680	-1430	-1437.5	-1910	0.473
15	Humboldt CC	83.2E 26.5S	83.36E 26.55S	-3500	-3490	-3410	-3500	-3475	-4380	0.905
16	Hamilton CC	84.7E 44.2S	84.73E 44.39S	-1170	-900	-1020	-1030	-1030	-1680	0.650
17	Jeans CC	94.4E 53.1S	94.61E 53.13S	190	50	-320	-380	-115	-1000	0.885
18	Chamberlin CC	102.5E 58.8S	102.59E 58.67S	-1310	-1900	-1690	-1600	-1625	-2660	1.035
19	Pasteur CC	104.9E 11.8S	105.15E 11.96S	-920	-900	-1010	-1010	-960	-1130	0.170
20	Jules Verne CC		143.76E 37.23S	-1620	-1560	-1550	-1570	-1575	-1920	0.345
21	Jules Verne CC SE	144.1E 37.5S	144.33E 37.40S	-1420	-1530	-1360	-1700	-1502.5	-1760	0.258
22	Geiger CC	159.0E 16.2S	159.01 E 16.11S	110	30	-25	75	47.5	-235	0.283
23	Vertregt K CC	172.6E 20.6S	172.69E 20.50S	-1470	-1780	-1780	-1745	-1693.75	-2100	0.406

Concentric Craters

A small percentage of craters that would normally fall in the classification of simple craters show a curious inner ring (torus or toroid) that averages about 50% of the diameter of the outer ring (Wood, 1978). The crater sizes range from 2-20 km outer diameter with an average outer diameter around 8 km, though most fall within the 2-12 km diameter size. (Note sub-kilometer "bench" craters and multi-ringed basins are not being considered in this paper). They also tend to be shallower in depth than normal craters of similar size which would be expected to have a depth (d) to diameter (D) ratio around 0.2 (Trang et al., 2011).

Concentrics have a non-uniform distribution over the moon that is similar to the distribution floor-fractured craters. Seventy percent of them are found on the margins of maria, 20% in the smooth floors of lava-flooded crater, and 10% in pure highland areas. None are found in the central maria (Wood 1978). Their ages range from Pre-Imbrian (>3.85 Ga) to Eratosthenian (1.1-3.2 Ga), with most of the craters being of Imbrian age (3.2-3.85 Ga). Notably, however, no Copernican age (<1.1 Ga) craters are known to exist on the moon (Trang et al., 2011).

Most, but not all, of the toroid rims are concentric with the outer crater rims and the ratio of the toroid diameter (T) to the outer crater rim diameter (D) range from 0.2 to 0.9 (T/D ratio). Most of the T/D ratios range from 0.3 to 0.6 and average 0.5. While the outer rim margins craters this size are normally slightly concave, the outer margins of the toroid tends to be slightly convex and the area inside the torus is usually concave (Wood, 1979).

While the most notable concentrics have rounded, doughnut-like toroids, others have flattened inner mounds, and a few have sharp inner rims. The space or moat between the inner and outer rims varies in appearance, and a few have confluent lobes of rubble that may give the appearance of another ring between inner and out rings when viewed at low resolution.

Chuck Wood in his 1978 paper describes several variations of morphology. Most common are typified by Hesiodius A with the usual characteristics described above. Marth was described as appearing like a cratered dome. Some craters have elliptical inner and outer rings as typified by the crater in Struve, while others have a round outer ring and elliptical toroid such as Crozier H, which is also off center from outer ring. Craters such as Gruithuisen K have raised, rubbly moat area that resembles a third ring. A few craters are fractured and cracked, highly worn such as the concentric craters near Mons Jura, and have been described as having "bread crust" appearing interior. Garbart J is shown to have an inner rim that is low and inconspicuous while Chamberlain was described as having a high concentric "collar", but on LROC images looks as if it could possibly be a due to separate impacts.

Various mechanisms have been proposed to explain the formation of the concentric craters. Exogenic hypotheses include a fortuitous double impact either nearly simultaneously by tidally spilt object, a second smaller impact sometime later than the initial impact, or an impact into a layered target. Exogenic origins seem unlikely due to the non-uniform distribution of the craters, due to the presence of non-concentric craters in proximity to concentrics, and also due the lack of Copernican-age concentric craters (Trang, 2010).

Endogenic formation hypotheses include successive eruptions from same vent, symmetrical collapse of the outer rim, or cratering into extrusive domes. Another endogenic hypothesis involves volcanic modification of existing craters by distortion from intrusion of laccoliths below the surface or by extrusion of lava above the surface (Wöhler and Lena, 2009)

Any hypothesis for concentric crater formation must account for the following:

Table 2: Western Hemisphere Diameter Data

	Concentric Craters Study Data								
			LROC	Mean	Geodetic		Geodetic		Mean
		Wood	QuickMap	Crater	Crater Diameter		Toroid Dameter		Toroid
	Crater	Coordinates	Coordinates	Diameter	N-S km	W-E km	N-S km	W-E km	Diameter
24	MacMillan	7.8W 24.1N	7.85W 24.20N	6.8	6.83	6.72	4.10	4.33	4.2
25	Hesiodus A	17.0W 30.1S	17.08W 30.13S	14.4	14.44	14.36	7.13	6.60	6.9
26	Gambart J	18.2W 0.7S	18.21W 0.71S	7.1	7.24	7.04	3.55	4.54	4.0
27	Laplace E CC	21.2W 50.0N	21.25W 50.08N	7.0	6.63	7.37	4.14	4.29	4.2
28	Fontenelle D	23.3W 62.5N	23.43W 62.64N	15.7	15.54	15.90	7.26	7.10	7.2
29	Blancanus C CC	29.1W 66.2S							
30	Marth	29.3W 31.1S	29.35W 31.16S	6.5	6.41	6.64	3.04	3.05	3.0
31	La Condamine F CC	31.3W 57.2N	31.49W 57.35N	5.3	5.38	5.28	1.90	1.90	1.9
32	Hainzel H	33.1W 36.9S	33.16W 36.96S	10.0	9.22	10.73	3.25	4.53	3.9
33	Bouguer B CC	33.8W 53.5N	34.10 W 53.58N	6.6	6.68	6.51	3.24	3.25	3.2
34	Bouguer A CC	34.1W 53.2N	33.81W 53.01N	7.7	8.33	7.09	3.75	3.60	3.7
35	J. Herschel F CC	34.6W 57.7N	34.79W 57.91N	5.9	5.64	6.18	2.07	2.09	2.1
36	Gruithuisen M CC		42.01W 37.15N	4.2	4.12	4.36	2.06	2.07	2.1
37	Gruithuisen CC	41.4W 36.7N	41.55W 36.71N	5.6	5.29	5.90	3.55	3.77	3.7
38	Gruithuisen K	42.7W 35.3N	42.73W 35.38N	6.3	6.53	6.00	1.73	1.60	1.7
39	Clausius E CC	46.8W 35.4S	46.82W 35.40S	8.4	8.71	8.12	4.26	4.09	4.2
40	Mersenius S CC		46.60W, 17.80S	3.7	3.6	3.77	2.42	2.04	2.2
41	Mersenius M	48.3W 21.3S	48.56W 21.34S	5.2	5.25	5.20	2.38	2.70	2.5
42	Louville DA	51.6W 46.6N	51.72W 46.59N	10.7	10.86	10.61	7.67	7.64	7.7
43	Damoiseau BA	59.0W 8.3S	59.11W 8.28S	8.6	8.68	8.58	5.44	5.25	5.3
44	Damoiseau D		63.28W 6.44S	16.9	17.08	16.76	12.04	11.51	11.8
45	Lagrange T CC	62.0W 33.0S	62.37W 32.82S	8.3	8.06	8.50	4.07	4.11	4.1
46	Lagrange T	62.4W 32.9S	62.71W 32.97S	11.6	12.00	11.14	5.37	5.38	5.4
47	Markov CC	64.8W 52.6N	66.35W 52.68N	7.1	6.55	7.67	2.80	2.98	2.9
48	Crüger CC	65.7W 17.0S	65.84W 16.99S	2.3	2.29	2.26	1.31	1.47	1.4
49	Rocca F CC	67.1W 14.2S	67.29W 14.23S	3.2	3.34	2.97	1.29	1.18	1.2
50	Cavalerius E	69.9W 7.7N	70.04W 7.66N	9.2	9.05	9.26	4.00	4.18	4.1
51	Lavoisier A CC	75.0W 36.7N	74.99W 37.38N	2.7	2.77	2.67	1.32	1.34	1.3
52	Repsold A	77.5W 51.9N	76.98W 51.82N	7.8	7.83	7.75	4.97	4.75	4.9
53	Struve CC	77.7W 22.0N	78.87W 21.92N	6.2	6.87	5.53	2.80	2.07	2.4
54	Lavoisier CC	81.1W 38.4N	81.24W 38.34N	5.6	5.92	5.25	3.09	2.71	2.9
55	Minkowski CC	143.0W 56.6S	143.95W 56.31S	12.2	11.57	12.83	7.16	6.32	6.7
56	Apollo CC	154.2W 31.0S	154.06W 30.76S	11.6	11.66	11.47	5.83	5.79	5.8
57	De Vries CC	172.7W 20.6S							

- The non-uniform distribution of the concentric craters
- The lack of Copernican age craters.
- Presence of normal non-concentric craters of younger age in close proximity to some of the concentric craters.
- Presence of ejecta blanket remnants around several of the concentric craters.
- 5. Shallow depth compared to similar non-concentric craters
- Spectroscopic studies showing the interior composition to be very similar to the surrounding terrain.

Of the various hypotheses, volcanic modification of the crater appears to be most likely candidate, and spectral studies support the intrusive model. Trang (2011) describes the process: "The idea suggests that dikes have propagated into impact-induced fractures producing a laccolith. The laccolith grows, uplifting the crater floor. The inner torus is created either because impact melt in the center of the crater is inhibiting uplift or the floor relative to the sides, or inflation is followed by a large deflation or collapse." The process is further described by Wohler and Lena (2011): "At the bottom of the transient cavity, however, the flexural rigidity of the overburden and the overburden weight per unit area were reduced to 30% and 61% of their original values, respectively, according to the relations given in [4,10]. If the impact occurred during the magma intrusion phase, the thinned part of the overburden was probably unable to resist the pressurized magma, which in turn may have lifted up the crater floor, thus leading to the shallow crater depth. In this line of thought, the inner depression of the concentric crater is a remnant of the original bowl-shaped crater floor."

Table 2A: Western Hemisphere Elevation/Depth Data

	Concentric Craters Study Data									
			LROC					Mean Rim	Central	Mean
		Wood	QuickMap	Geodetic Crater Rim Elevation				Elevation	Elevation	Crater
	Crater	Coordinates	Coordinates	North (m)	South (m)	West (m)	East (m)	(meters)	(meters)	Depth (km)
24	MacMillan	7.8W 24.1N	7.85W 24.20N	-1750	-1770	-1710	-1740	-1742.5	-2180	0.438
25	Hesiodus A	17.0W 30.1S	17.08W 30.13S	-1040	-1020	-920	-900	-970	-2320	1.350
26	Gambart J	18.2W 0.7S	18.21W 0.71S	-895	-990	-960	-1070	-978.75	-1280	0.301
27	Laplace E CC	21.2W 50.0N	21.25W 50.08N	-3030	-3020	-2770	-2845	-2916.25	-3070	0.154
28	Fontenelle D	23.3W 62.5N	23.43W 62.64N	-2490	-2350	-2050	-2560	-2362.5	-3130	0.768
29	Blancanus C CC	29.1W 66.2S								
30	Marth	29.3W 31.1S	29.35W 31.16S	-905	-910	-930	-680	-856.25	-1195	0.339
31	La Condamine F CC	31.3W 57.2N	31.49W 57.35N	-2440	-2420	-2400	-2370	-2407.5	-2900	0.493
32	Hainzel H	33.1W 36.9S	33.16W 36.96S	85	390	320	-90	176.25	-520	0.696
33	Bouguer B CC	33.8W 53.5N	34.10 W 53.58N	-2540	-2670	-2540	-2240	-2497.5	-2790	0.293
34	Bouguer A CC	34.1W 53.2N	33.81W 53.01N	-2590	-2390	-2580	-2620	-2545	-2830	0.285
35	J. Herschel F CC	34.6W 57.7N	34.79W 57.91N	-2403	-2357	-2140	-2320	-2305	-2500	0.195
36	Gruithuisen M CC		42.01W 37.15N	-1870	-2070	-1980	-1840	-1940	-2120	0.180
37	Gruithuisen CC	41.4W 36.7N	41.55W 36.71N	-1705	-1730	-1800	-1730	-1741	-2060	0.319
38	Gruithuisen K	42.7W 35.3N	42.73W 35.38N	-1920	-2010	-1950	-1970	-1962.5	-2420	0.458
39	Clausius E CC	46.8W 35.4S	46.82W 35.40S	300	680	420	590	497.5	-200	0.698
40	Mersenius S CC		46.60W, 17.80S	-1830	-1780	-1700	-1790	-1775	-1970	0.195
41	Mersenius M	48.3W 21.3S	48.56W 21.34S	-2120	-2050	-1910	-2110	-1775	-2420	0.645
42	Louville DA	51.6W 46.6N	51.72W 46.59N	-1930	-2020	-1950	-1990	-1972.5	-2580	0.608
43	Damoiseau BA	59.0W 8.3S	59.11W 8.28S	-1400	-1310	-1370	-1410	-1372.5	-1910	0.538
44	Damoiseau D		63.28W 6.44S	0	-250	-100	-300	-162.5	-2800	2.638
45	Lagrange T CC	62.0W 33.0S	62.37W 32.82S	690	-410	300	-150	107.5	-430	0.538
46	Lagrange T	62.4W 32.9S	62.71W 32.97S	150	190	-380	-110	-37.5	-1030	0.993
47	Markov CC	64.8W 52.6N	66.35W 52.68N	-2170	-2030	-2080	-2020	-2075	-2230	0.155
48	Crüger CC	65.7W 17.0S	65.84W 16.99S	-1626	-1629	-1638	-1607	-1625	-1668	0.043
49	Rocca F CC	67.1W 14.2S	67.29W 14.23S	-1586	-1506	-1525	-1530	-1536.75	-1662	0.125
50	Cavalerius E	69.9W 7.7N	70.04W 7.66N	-1120	-1440	-1210	-1640	-1352.5	-2060	0.708
51	Lavoisier A CC	75.0W 36.7N	74.99W 37.38N	-1955	-1980	-2050	-2010	-1998.75	-2195	0.196
52	Repsold A	77.5W 51.9N	76.98W 51.82N	-1580	-1700	-1410	-1460	-1537.5	-2580	1.043
53	Struve CC	77.7W 22.0N	78.87W 21.92N	-1310	-1180	-1240	-1040	-1192.5	-1720	0.528
54	Lavoisier CC	81.1W 38.4N	81.24W 38.34N	-1930	-2060	-2025	-1880	-1973.75	-2340	0.366
55	Minkowski CC	143.0W 56.6S	143.95W 56.31S	-6520	-6370	-6610	-5700	-6300	-7090	0.790
56	Apollo CC	154.2W 31.0S	154.06W 30.76S	-3820	-3800	-3760	-3760	-3785	-5050	1.265
57	De Vries CC	172.7W 20.6S								

Purpose of current study

The current study was undertaken to use LROC data to obtain high resolution images, to determine coordinates of the crater centers, measure the diameters of the outer rim crests (D) and toroid rim crests (T), and the crater depths (d). The toroid/crater diameter (T/D) ratio and the dept (d)/diameter (D) ratios were calculated from the measured data.

Craters studied included the concentrics listed by Chuck Wood in 1978, most of the other craters listed in the http://the-moon.wikispaces.com/Concentric+Crater website (Wood et al., 2007), and a few other concentric craters discovered by internet search. One concentric, Fracastorius E, was accidently "discovered" while measuring another concentric; the "discovered" concentric, as usual, had already been described earlier by Chuck Wood, but was not in his original paper.

Methods

The craters were located on the LROC ACT-REACT QuickMap, the coordinates of the apparent center of the craters recorded and the diameters and depths measured and recorded. The diameter measurements were made by placing the QuickMap cursor over one rim crest and tracing a line (query path) through the center of the crater to the crest of the opposite side of the rim and reading the geodetic distance from the Path Query box. In some cases, where parts of the rim were obliterated in the desired area of measurement, the diameters were measured from northwest to southeast and from northeast to southwest and the averages taken. (Note: Geodetic distance was used since the cartographic distance was subject to cylindrical distortion.) Elevation plots were obtained from query paths drawn across the center of the crater (one from west to east and the other from north to south) that extended well beyond the outer crater rim, and elevation profiles were obtained from the Query Results box. Four rim elevation data points were obtained and two central crater elevation points were obtained. The deepest central crater elevation was subtracted from the mean of the rim elevation to determine the crater depth.

Eastern hemisphere diameter measurements and calculations are listed in Table 1 and elevation measurements and crater depth calculations are presented in Table 1A. Corresponding western hemisphere measurements are listed in Table 2 and Table 2A. Depth/diameter ratio and toroid diameter/crater

Table 3: Eastern Hemisphere Depth/Diameter and Toroid Ratio Calculations

	Concentric Craters Study Data							
			LROC	Crater			Toroid (T)	
		Wood	QuickMap	Depth (km)	Diameter	d/D		
	Crater	Coordinates	Coordinates	(d)	(D)	Ratio	Diameter	T/D Ratio
1	Archytas G	0.4E 55.8N	0.53E 55.74N	0.435	7.0	0.062	4.5	0.63
2	Archytas G-b		0.48E 55.56N	0.304	4.3	0.070	2.2	0.51
3	Reaumur B CC	1.3E 4.5S	1.24E 4.52S	0.261	4.4	0.059	2.8	0.64
4	Egede G	6.8E 51.9N	6.93 E 52.00N	0.560	7.3	0.077	5.3	0.73
5	Pontanus E	13.3E 25.2S	13.25E 25.22S	0.848	12.5	0.068	8.2	0.65
6	Torricelli R CC	26.6E 6.4S	26.64E 6.38S	0.205	3.8	0.054	1.2	0.32
7	Beaumont P CC	29.6E 19.1S	29.63 E 19.14S	0.523	11.7	0.045	5.4	0.46
8	Fracastorius E		31.02 E 20.23S	0.895	11.9	0.075	4.4	0.37
9	Crozier H	49.4E 14.1S	49.38E 14.01S	1.008	10.7	0.094	5.0	0.47
10	Endymion SW CC	50.6E 51.7N	51.06E 51.68N	0.243	6.8	0.036	2.8	0.41
11	Apollonius N	64.0E 4.7N	63.76E 4.74N	1.295	10.5	0.124	5.6	0.53
12	Legendre CC	68.2E 27.5S	68.14E 27.81S	0.244	4.4	0.056	1.6	0.36
13	Dubyago CC	69.0E 3.7N	68.61E 3.67N	0.206	5.9	0.035	2.7	0.46
14	Schubert N CC	74.0E 2.0N	73.61E 1.33N	0.473	10.2	0.046	5.5	0.54
15	Humboldt CC	83.2E 26.5S	83.36E 26.55S	0.905	8.5	0.107	3.9	0.46
16	Hamilton CC	84.7E 44.2S	84.73E 44.39S	0.650	11.6	0.056	5.9	0.51
17	Jeans CC	94.4E 53.1S	94.61E 53.13S	0.885	24.2	0.037	16.2	0.67
18	Chamberlin CC	102.5E 58.8S	102.59E 58.67S	1.035	8.3	0.124	6.3	0.75
19	Pasteur CC	104.9E 11.8S	105.15E 11.96S	0.170	6.4	0.026	3.5	0.55
20	Jules Verne CC		143.76E 37.23S	0.345	5.6	0.062	3.0	0.54
21	Jules Verne CC SE	144.1E 37.5S	144.33E 37.40S	0.258	7.1	0.036	3.7	0.52
22	Geiger CC	159.0E 16.2S	159.01 E 16.11S	0.283	6.5	0.043	2.7	0.41
23	Vertregt K CC	172.6E 20.6S	172.69E 20.50S	0.406	9.2	0.044	5.3	0.58

diameter ratios are listed in Table 3 for the eastern hemisphere and Table 3A for the western hemisphere.

All measurements were entered into Excel spreadsheet and calculations done using the spreadsheet formulas. Once all the data had been assembled and calculations done, each measurement was repeated. Any positional error greater than 0.02 degrees and any diameter error greater than 0.2km was measured a third and fourth time, and corrections were made as needed. The coordinates were also cross-checked with Chuck Wood's measurement and any discrepancies were again measured.

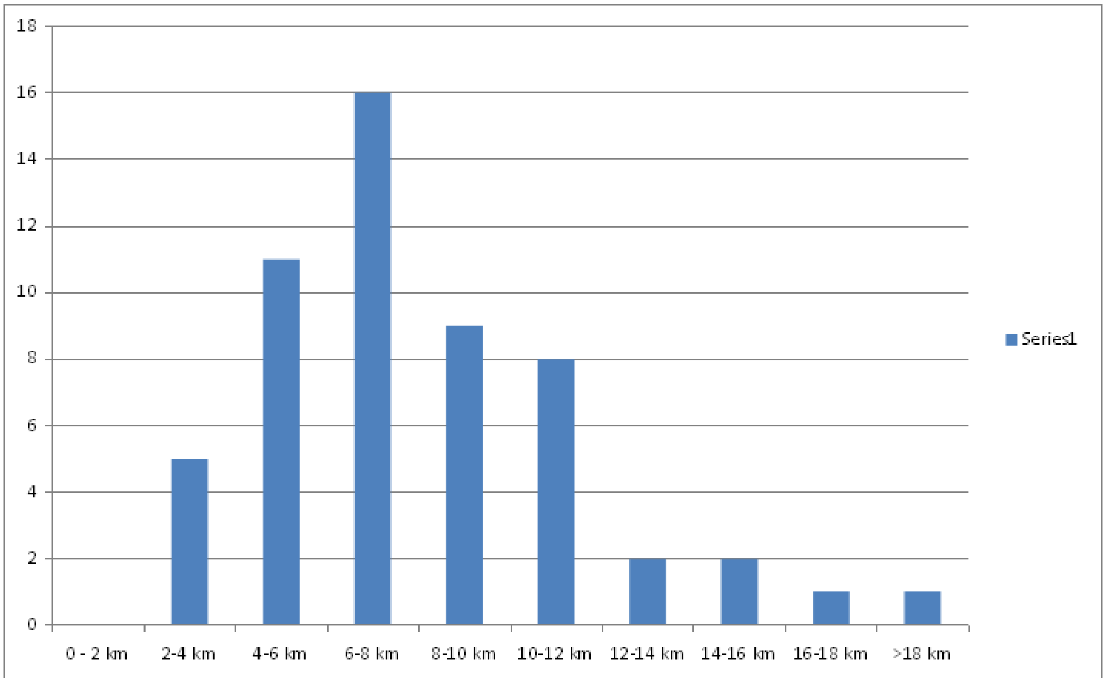
Images were obtained from LROC WMS Image Map set at the highest possible resolution of the orthographic projection, and a final image was assembled from four frames centered on the concentric using Photoshop Elements 6. Some touch up of brightness and contrast was done as well, and then the photo cropped to desired size. In order to cross check the coordinates, all of the craters were located on the Image Map by entering the coordinates from the spreadsheet into the latitude and longitude boxes in the Map Options box. Only one was found to be in error which was exactly one degree, and that was corrected. (See tables 1, 1A, 2, 2A, 3 and 3A.)

Table 3A: Western Hemisphere Depth/Diameter and Toroid Ratio Calculations

	Concentric Craters Study Data							
			LROC	Crater			Toroid (T)	
		Wood	QuickMap	Depth (km)	Diameter	d/D		
	Crater	Coordinates	Coordinates	(d)	(D)	Ratio	Diameter	T/D Ratio
24	MacMillan	7.8W 24.1N	7.85W 24.20N	0.438	6.8	0.065	4.2	0.62
25	Hesiodus A	17.0W 30.1S	17.08W 30.13S	1.350	14.4	0.094	6.9	0.48
26	Gambart J	18.2W 0.7S	18.21W 0.71S	0.301	7.1	0.042	4.0	0.57
27	Laplace E CC	21.2W 50.0N	21.25W 50.08N	0.154	7.0	0.022	4.2	0.60
28	Fontenelle D	23.3W 62.5N	23.43W 62.64N	0.768	15.7	0.049	7.2	0.46
29	Blancanus C CC	29.1W 66.2S						
30	Marth	29.3W 31.1S	29.35W 31.16S	0.339	6.5	0.052	3.0	0.47
31	La Condamine F CC	31.3W 57.2N	31.49W 57.35N	0.493	5.3	0.092	1.9	0.36
32	Hainzel H	33.1W 36.9S	33.16W 36.96S	0.696	10.0	0.070	3.9	0.39
33	Bouguer B CC	33.8W 53.5N	34.10 W 53.58N	0.293	6.6	0.044	3.2	0.49
34	Bouguer A CC	34.1W 53.2N	33.81W 53.01N	0.285	7.7	0.037	3.7	0.48
35	J. Herschel F CC	34.6W 57.7N	34.79W 57.91N	0.195	5.9	0.033	2.1	0.35
36	Gruithuisen M CC		42.01W 37.15N	0.180	4.2	0.042	2.1	0.49
37	Gruithuisen CC	41.4W 36.7N	41.55W 36.71N	0.319	5.6	0.057	3.7	0.65
38	Gruithuisen K	42.7W 35.3N	42.73W 35.38N	0.458	6.3	0.073	1.7	0.27
39	Clausius E CC	46.8W 35.4S	46.82W 35.40S	0.698	8.4	0.083	4.2	0.50
40	Mersenius S CC		46.60W, 17.80S	0.195	3.7	0.053	2.2	0.61
41	Mersenius M	48.3W 21.3S	48.56W 21.34S	0.645	5.2	0.123	2.5	0.49
42	Louville DA	51.6W 46.6N	51.72W 46.59N	0.608	10.7	0.057	7.7	0.71
43	Damoiseau BA	59.0W 8.3S	59.11W 8.28S	0.538	8.6	0.062	5.3	0.62
44	Damoiseau D		63.28W 6.44S	2.638	16.9	0.156	11.8	0.70
45	Lagrange T CC	62.0W 33.0S	62.37W 32.82S	0.538	8.3	0.065	4.1	0.49
46	Lagrange T	62.4W 32.9S	62.71W 32.97S	0.993	11.6	0.086	5.4	0.46
47	Markov CC	64.8W 52.6N	66.35W 52.68N	0.155	7.1	0.022	2.9	0.41
48	Crüger CC	65.7W 17.0S	65.84W 16.99S	0.043	2.3	0.019	1.4	0.61
49	Rocca F CC	67.1W 14.2S	67.29W 14.23S	0.125	3.2	0.040	1.2	0.39
50	Cavalerius E	69.9W 7.7N	70.04W 7.66N	0.708	9.2	0.077	4.1	0.45
51	Lavoisier A CC	75.0W 36.7N	74.99W 37.38N	0.196	2.7	0.072	1.3	0.49
52	Repsold A	77.5W 51.9N	76.98W 51.82N	1.043	7.8	0.134	4.9	0.62
53	Struve CC	77.7W 22.0N	78.87W 21.92N	0.528	6.2	0.085	2.4	0.39
54	Lavoisier CC	81.1W 38.4N	81.24W 38.34N	0.366	5.6	0.066	2.9	0.52
55	Minkowski CC	143.0W 56.6S	143.95W 56.31S	0.790	12.2	0.065	6.7	0.55
56	Apollo CC	154.2W 31.0S	154.06W 30.76S	1.265	11.6	0.109	5.8	0.50
57	De Vries CC	172.7W 20.6S		No rims or torus to measure, just undulating terrain.				

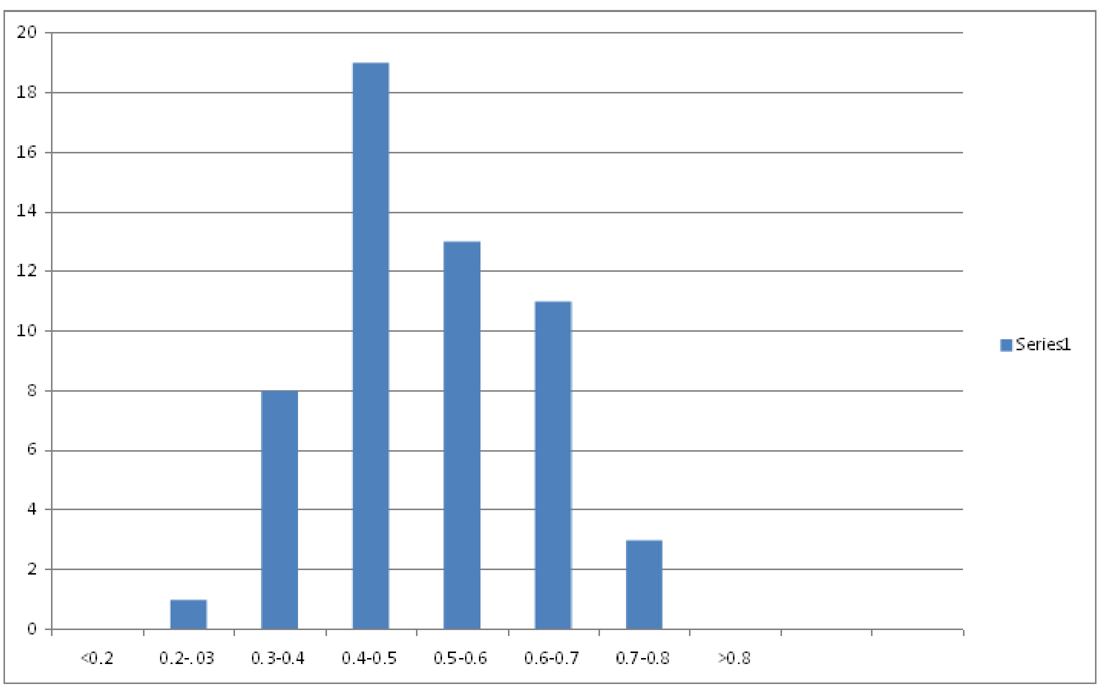
Graph A: Diameter Distribution

D	# Craters
0 - 2 km	0
2-4 km	5
4-6 km	11
6-8 km	16
8-10 km	9
10-12 km	8
12-14 km	2
14-16 km	2
16-18 km	1
>18 km	1
	55



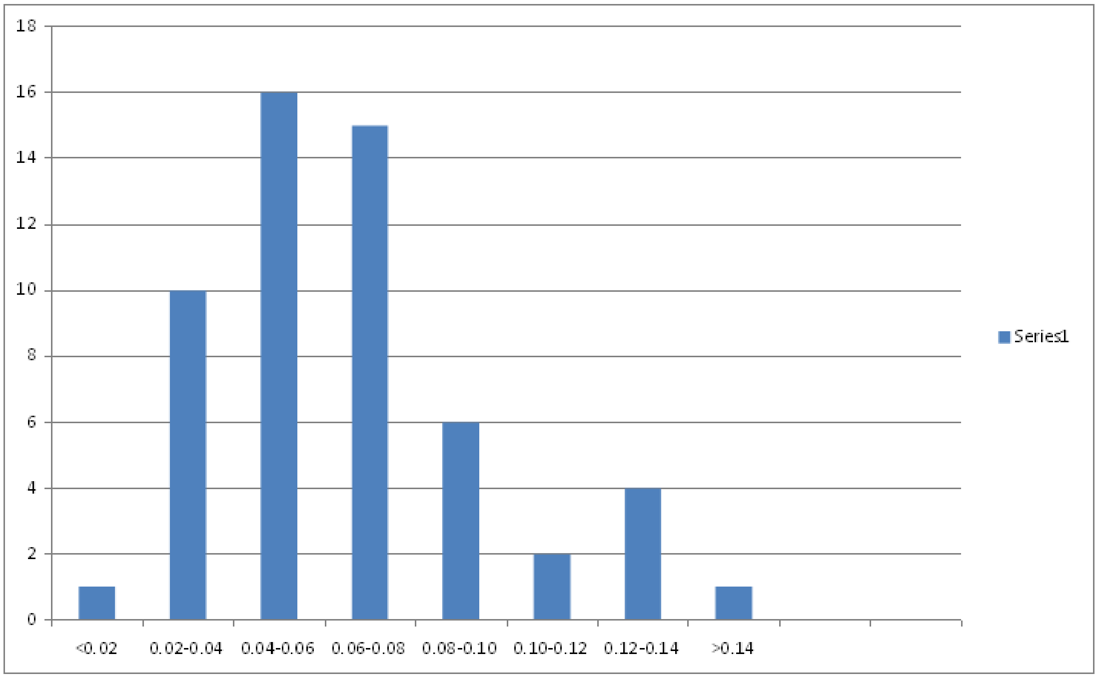
Graph B: Toroid/Diameter Ratios

T/D Ratio	# Craters
<0.2	0
0.2-.03	1
0.3-0.4	8
0.4-0.5	19
0.5-0.6	13
0.6-0.7	11
0.7-0.8	3
>0.8	0
	55



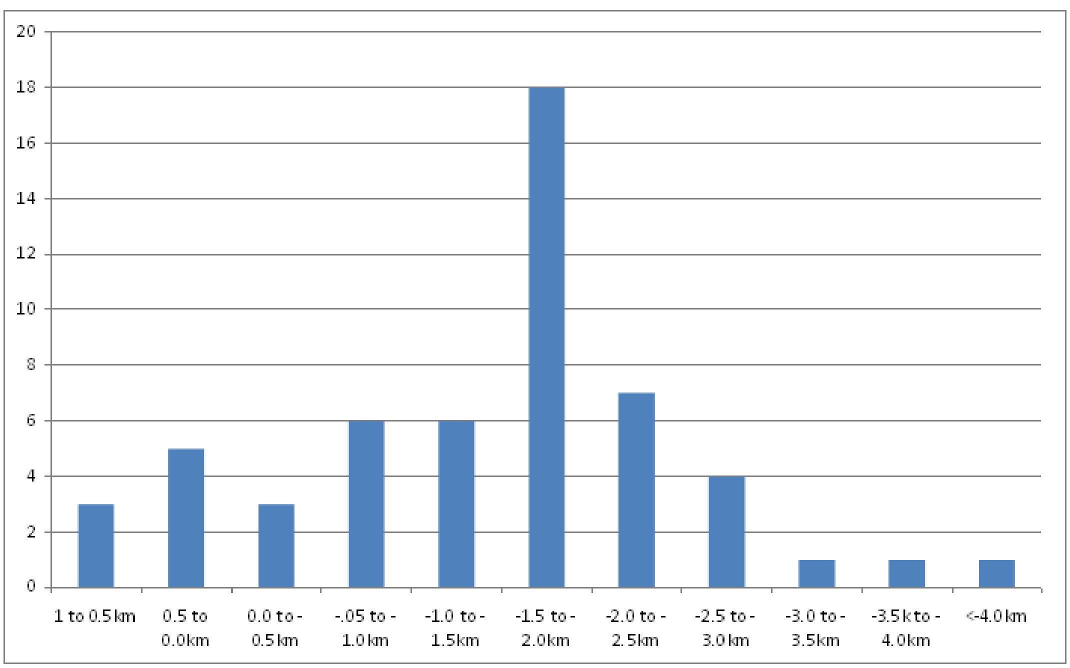
Graph C: Depth/Diameter (d/D) Ratio Distribution

d/D Ratio	# Craters
<0.02	1
0.02-0.04	10
0.04-0.06	16
0.06-0.08	15
0.08-0.10	6
0.10-0.12	2
0.12-0.14	4
>0.14	1
	55



Graph D: Mean Lunar Elevation of Crater Rims

Mean Rim Elevation	# Craters
1 to 0.5km	3
0.5 to 0.0km	5
0.0 to -0.5km	3
-.05 to -1.0km	6
-1.0 to -1.5km	6
-1.5 to -2.0km	18
-2.0 to -2.5km	7
-2.5 to -3.0km	4
-3.0 to -3.5km	1
-3.5k to -4.0km	1
<-4.0km	1
	55



Discussion

Of 57 concentric craters listed on various articles and websites, 55 were measured for rim elevation and diameter, toroid diameter, and depth. Depth/diameter calculations from those data were accurate to two significant figures, and the coordinates for their location were within ±0.02°. Two of the initially listed craters (29 and 57) could not be verified as concentric craters and were excluded from calculations, while seven others (6, 19, 36, 37, 40, 48, and 49) were included in the calculations, but could possibly be something other than a concentric crater.

The 55 craters measured had an average diameter of 8.2 km with nearly half of the craters (27) measuring between 4km and 8km. All of the craters were greater than 2 km diameter, but only 6 craters were greater than 12 km. The largest concentric measured 24.2km; this skewed the mean to the right. (See Graph A.)

The mean toroid diameter was 4.3km and the mean toroid/diameter (T/D) ratio was 0.51. All were between 0.2 and 0.8; only one crater had a ratio smaller than 0.3, and three craters had T/D ratios greater than 0.7. (See Graph B.)

Depth/Diameter (d/D) ratios were considerably shallower than would be expected from a typical crater of the same size as the concentric craters. Normally a d/D ratio of 0.2 would be expected, but the mean d/D of the concentrics measured was 0.065 with only seven craters with a d/D ratio greater than 0.10. The deepest concentric crater had a d/D of 0.156. (See Graph C.)

Thirty-seven of the 55 craters measured had rim elevations between 0.5km and 2.5km below the lunar mean radius of 1737.4 km (per LROC ACT REACT QuickMap), with a distribution peak in the -1.5 to -2.0 km elevation range. The highest mean crater rim elevation was 0.627km above the mean lunar radius (Crozier H) while the lowest rim elevation was recorded in the South Pole-Aitkins Basin at a depth of -6.3 km (near Minkowski). The elevation distribution is consistent with the distribution of the majority of the craters along the margins of maria which are mostly on the near side of the moon. (See Graph D.)

Conclusion

Images of concentric craters from the LROC WMS Map and measurements from the LROC ACT-REACT QuickMap were used to measure crater coordinates, crater rim (D) and toroid (T) diameters, and T/D rations crater rim elevation and crater depths (d) were measured, and used to calculate d/D ratios of each of the selected concentric craters using the latest data available from the Lunar Reconnaissance Orbiter.

The mean rim diameter of 8.2 km is within limits of error of Wood's (1978) mean of 8.3km, while the mean T/D ratio of 4.3 is slightly lower his ratio ~0.5. Several of the concentrics had indistinct and irregular toroid margins that added uncertainty to their measurements.

Measurements of crater rim elevations and depth allowed the d/D ratios to be calculated to two significant figures. The mean d/D was 0.065 which is considerably shallower than the d/D ratio of ~0.2 for ordinary craters of similar size. This suggests that modification of the interiors of the craters occurred after formation and is consistent with the currently favored hypothesis of igneous intrusion for the origin of concentric craters. However, it is possible that not all of the concentric craters formed in that manner. For example, the concentric crater near Chamberlin looks very much like a fortuitous second smaller impact within an older crater.

There is much more to be learned about these fascinating craters by more detailed study of each individual crater and their context to further characterize their morphologies and from spectral analysis of their interiors and surroundings.

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Feature Story: Minor Planets

Something Old, 'Something New': Three Binary Discoveries From the Palmer Divide Observatory

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This paper was published initially in *The Minor Planet Bulletin* Vol. 40, No. 3 (July-September 2013).

Its publication here is meant to demonstrate the good work being done by the ALPO Minor Planets Section and to inspire and recruit others to likewise participate.

While five-dollar contributions are most welcome, you may access *The Minor Planet Bulletin* at no charge online at *http://www.minor-planet.info/mpbdownloads.html*.

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Abstract

Analysis of new CCD photometric observations in early 2013 of the Vestoid asteroid 4383 Suruga and Hungaria asteroid (53432) 1999 UT55 showed that the two are binary systems. A review of data from 2005 for the Hungaria asteroid 4440 Tchantches indicates that the original analysis probably overlooked a satellite.

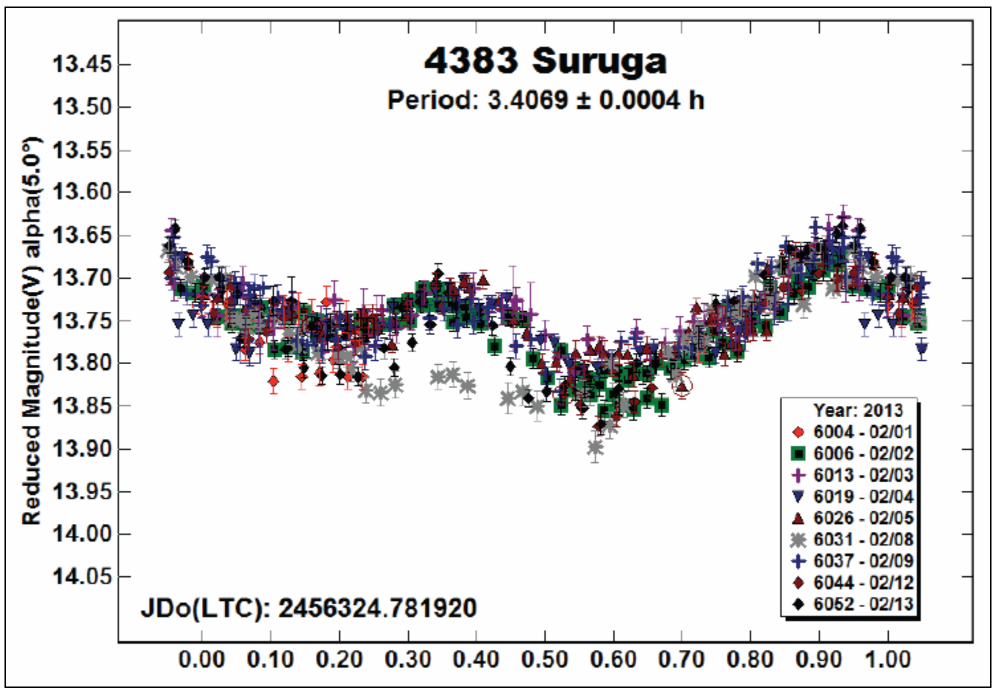

Figure 1. The unsubtracted lightcurve of 4383 Suruga.

Discussion

The Palmer Divide Observatory (PDO) observing program concentrates on the Hungaria asteroids. As such, CCD photometric observations of (53432) 1999 UT55 were made in early 2013. If a Hungaria asteroid is not available, then one of the five telescopes at PDO is used to observe other targets, either near-Earth asteroids (NEAs) or objects in the asteroid lightcurve database (LCDB; Warner et al, 2009) that have poorly-defined rotation periods. The latter was the case for 4383 Suruga, a Vestoid member, which was observed in 2013 February. Email discussions prompted a review of the original 2005 data set from PDO for the Hungaria asteroid 4440 Tchantches. As detailed below, all three objects were found to be binary systems.

All exposures in 2013 were guided, unfiltered, and 240 seconds. The images were measured in *MPO Canopus*. The dual-period feature in that program, based on the FALC algorithm developed by Harris et al. (1989) was used to subtract one of the periods from the data set in an iterative process until both periods remained stable. For the 2013 data sets, night-to-night calibration was accomplished using the Comp Star Selector feature in *MPO Canopus*. Catalog magnitudes for the comparison stars were derived from J-K to BVRI formulae developed by Warner (2007) using stars from the 2MASS catalog (Skrutskie et al, 2006). A description of this method was described by Stephens (2008).

Three figures are presented for each asteroid. The first shows the *unsubtracted* data set, meaning that the effects of the satellite have not been removed. The second figure shows the lightcurve of the primary, i.e., after removing the effects of the satellite. The third figure shows the lightcurve after removing the rotation of the primary, thus revealing the mutual events and other features due to the satellite. The latter often includes an upward bowing between the events, indicating an elongated satellite that is tidally locked to its orbital period.

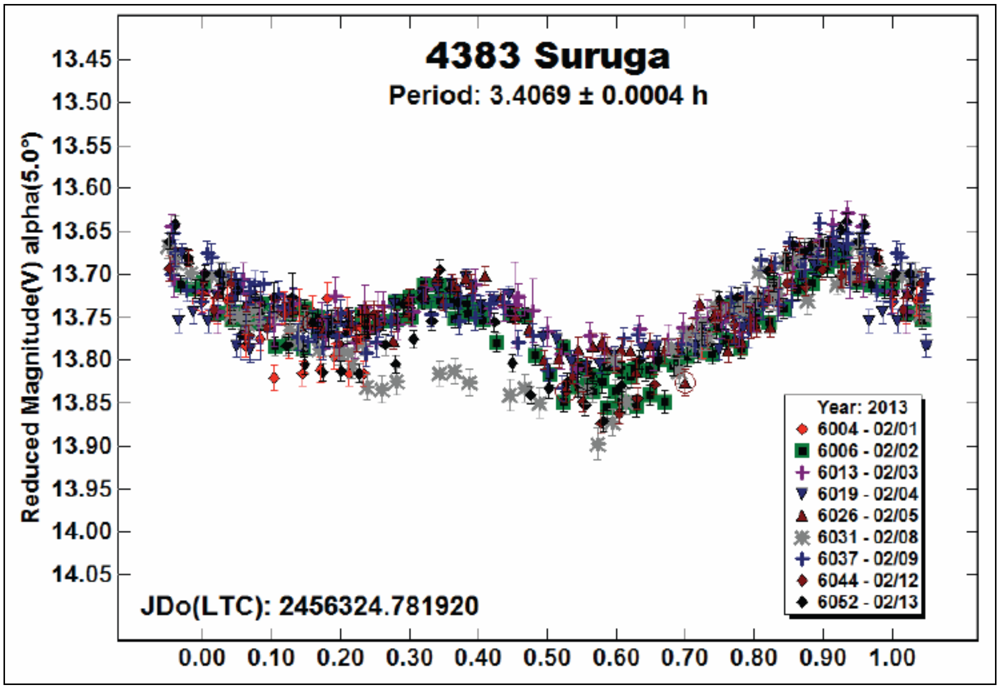

Figure 2. The lightcurve for the primary of 4383 Suruga.

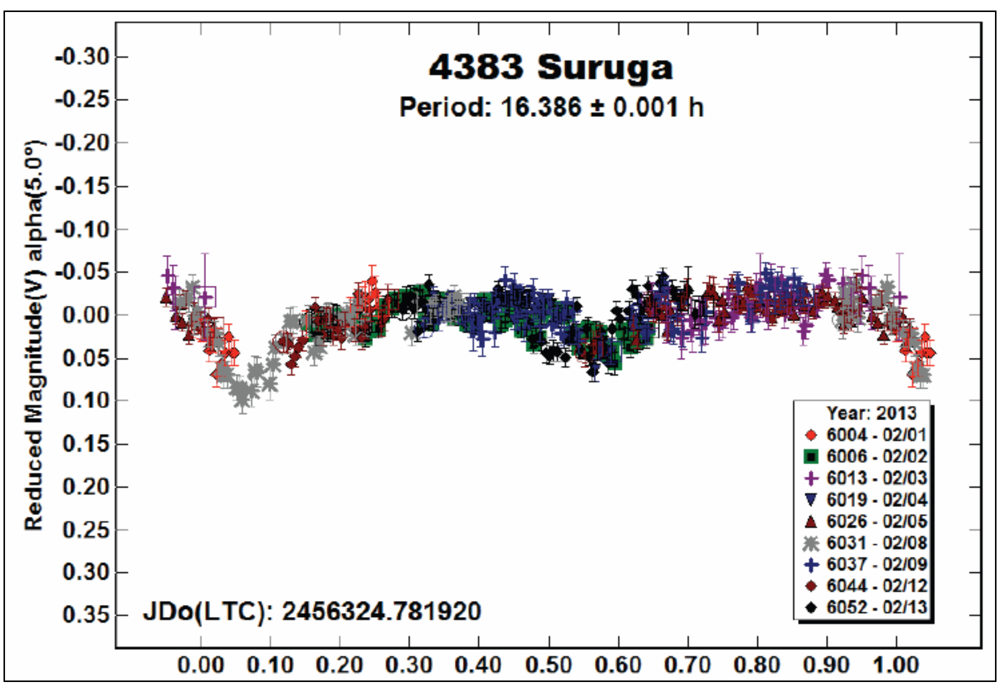

Figure 3. The lightcurve of 4383 Suruga showing the mutual events due to the presumed satellite.

4383 Suruga Observations of 4383 Suruga were made from 2013 Feb 2-13. Initial observations were made with a 0.35-m Schmidt-Cassegrain and Finger Lakes FLI-1001E CCD camera. When indications of a satellite were seen in those first data sets, the target was moved to a 0.5-m Ritchey-Chretien with FLI-1001E to improve the signal-to-noise ratio. Data on the order of 0.01-0.02 mag are usually required for reliable detections of mutual events (occultations and/or eclipses) caused by a satellite.

The results of the analysis are shown in Figures 1-3. The period of the primary is 3.4068 $\pm$ 0.0003 h with an amplitude of 0.14 $\pm$ 0.01 mag, indicating a nearly spheroidal shape. The orbital period of the satellite is 16.386 $\pm$ 0.001 h. The depths of the events are 0.1 and 0.05 mag. The shallower of the two is used to estimate the secondary-primary size ratio. In this case, the result is Ds/Dp $\geq$ 0.21 $\pm$ 0.02. Hasegawa et al. (2012) reported a period of 3.811 h and no indication of the object being binary.

4440 Tchantches This Hungaria asteroid had been observed several times before at PDO (Warner 2006, 2009, 2011) and by Behrend et al. (2002). In those cases, a period of about 2.78 h was reported. In Warner et al (2006), the possibility that the asteroid was binary was discussed and, based on an extensive observing campaign, the results were considered inconclusive.

Email discussions on an unrelated matter in 2013 put the original 2005 data set from PDO under review. In 2005, the observations were not calibrated from night-to-night but strictly relative, meaning that the assignment of zero points was arbitrary. The original plot using only PDO data seemed "suspicious" and so a new analysis was done whereby the zero points were shifted until a minimum RMS value from the Fourier analysis was found. This improved the fit from the original analysis significantly. Figure 4 shows the revised lightcurve. While relatively noisy, it did show signs similar to those caused by a satellite, i.e., somewhat prolonged and subtle deviations from the average curve.

Figure 6 shows a typical upward bowing with some "dips" spaced about 0.5 rotation phase apart. While the data are somewhat noisy, the result is considered sufficient to say that this is a binary asteroid. Assuming this is the case, the orbital period is 18.69 ± 0.05 h and the secondary-primary size ratio is Ds/Dp ≥ 0.25 ± 0.03. The primary rotation period was refined to 2.78836 ± 0.00004 h with an amplitude of 0.29 mag. This would make it among the more elongated primaries within the small binary population. Assuming an equatorial view and simple triaxial ellipsoid, the a/b ratio is about 1.3:1.

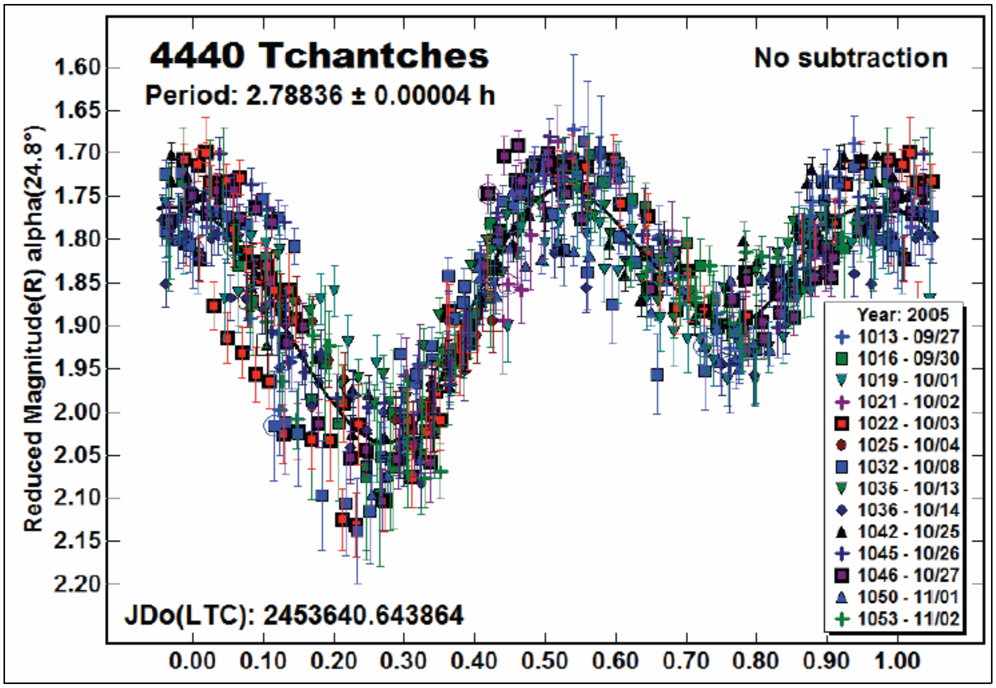

Figure 4. The unsubtracted lightcurve for 4440 Tchantches.

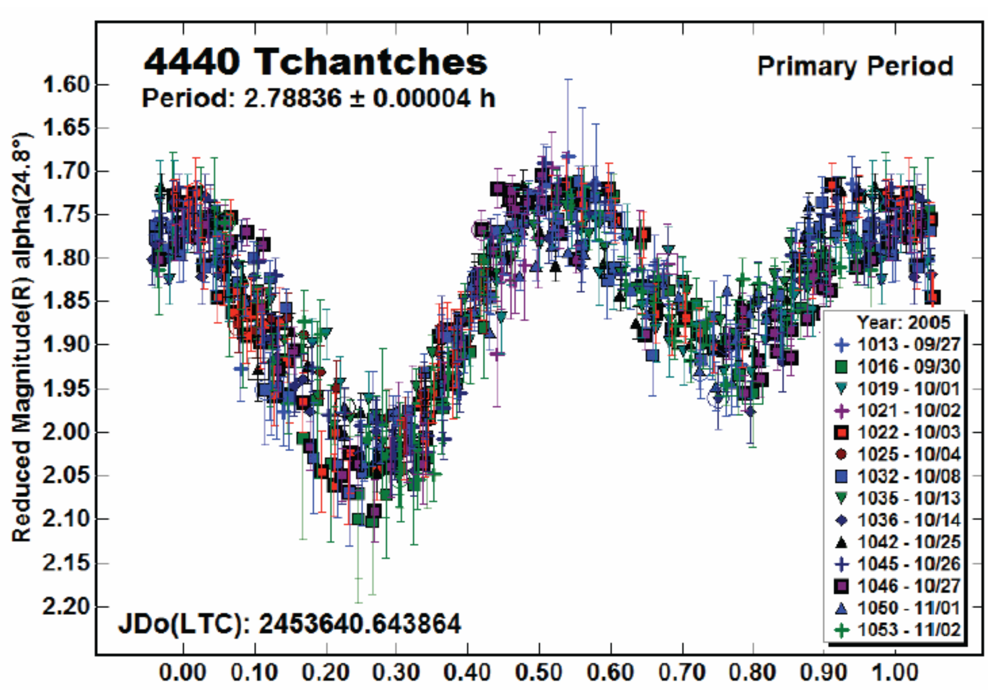

Figure 5. The primary lightcurve for 4440 Tchantches.

(53432) 1999 UT55 This Hungaria was observed for the first time from PDO from 2013 Jan 1-12. The 0.5-m Ritchey-Chretien with FLI-1001E CCD camera was used for all observations. Figure 7 shows what appeared to be a very noisy lightcurve, but still with some of the usual signs of a satellite. Part of the problem was that the asteroid was fainter than predicted and so the data are noisier than usually preferred.

The primary rotation period is P = 3.330 ± 0.002 h and amplitude A = 0.10 ± 0.01 mag. The orbital period of the satellite is 14.10 ± 0.01 h. The estimated secondary-primary size ratio is Ds/Dp ≥. 0.23 ± 0.02.

Acknowledgements

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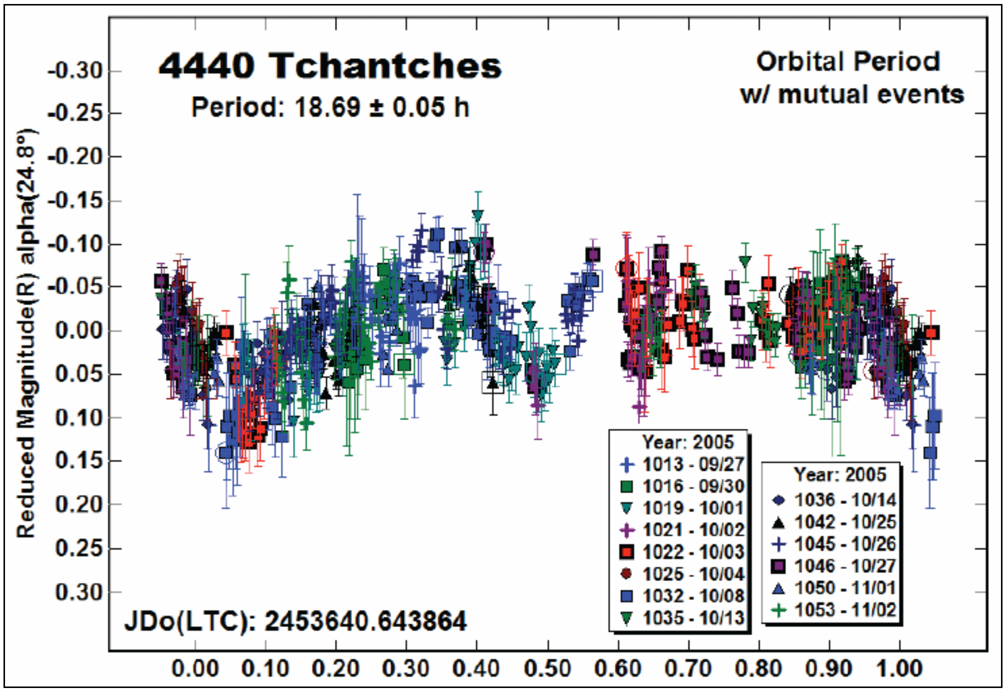

Figure 6. The lightcurve for 4440 Tchantches showing the effects of the satellite: an upward bowing indicating an elongated body and “dips” due to occultations and/or eclipses.

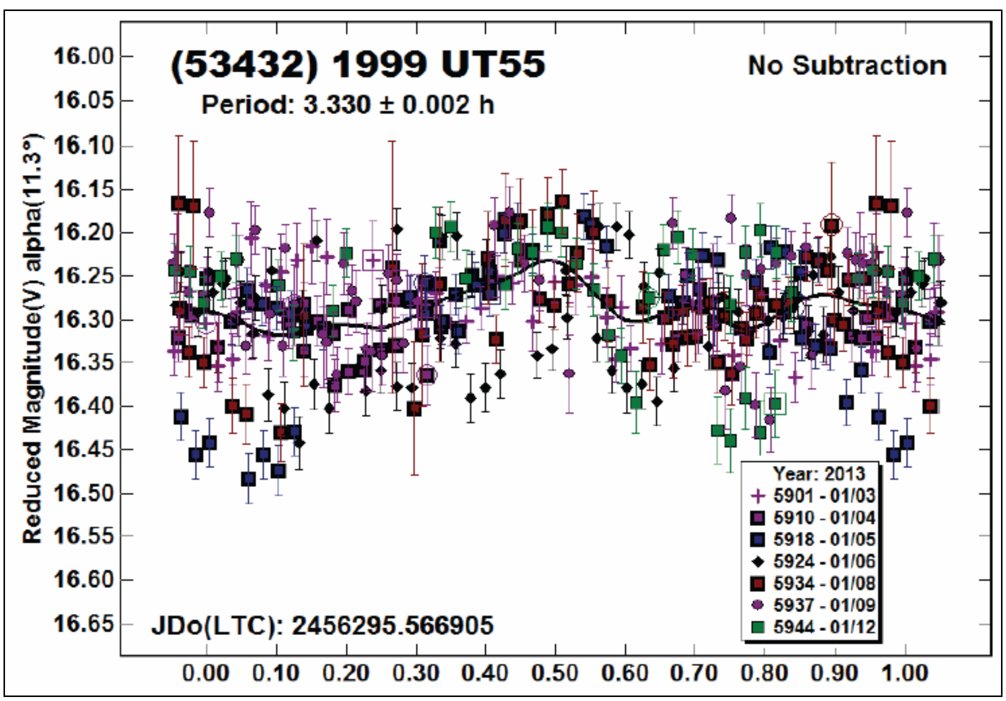

Figure 7. The unsubtracted lightcurve for (53432) 1999 UT55.

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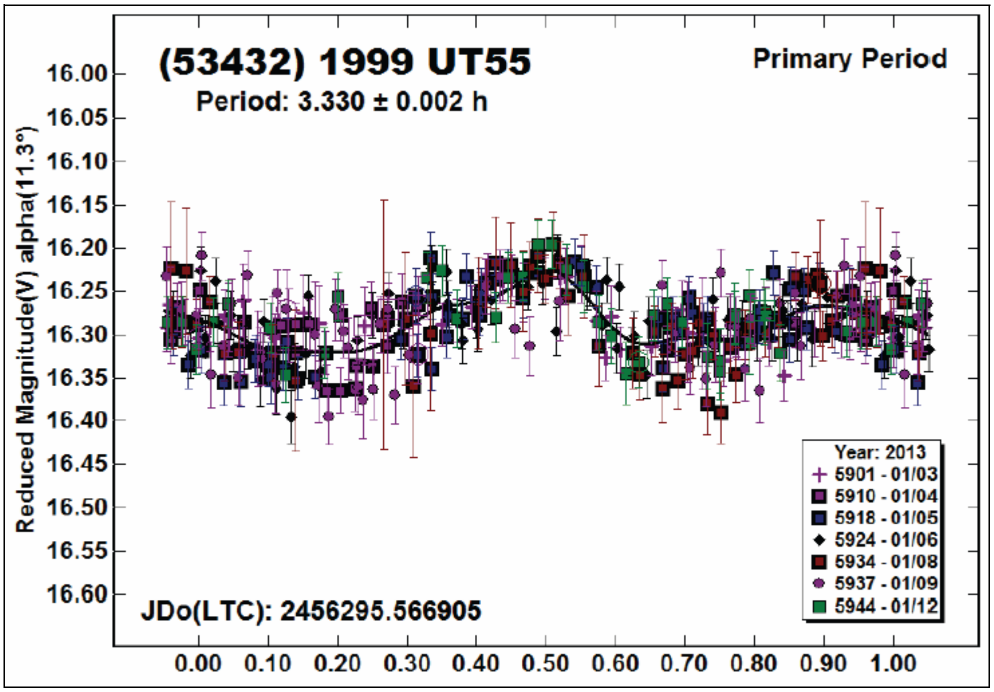

Figure 8. The lightcurve of (53432) 1999 UT55 showing the rotation of the primary.

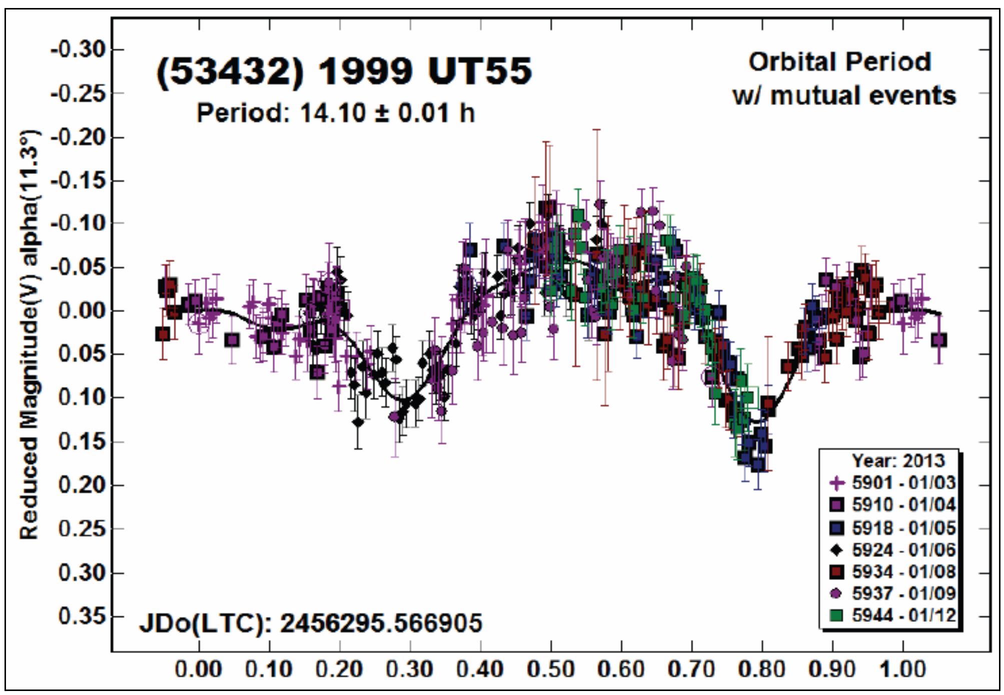

Figure 9. The lightcurve for (53432) 1999 UT55 showing mutual events due to the presumed satellite.

Feature Story:

ALPO Observations of the Remote Planets in 2012-2013

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Abstract

This report summarizes observations of Uranus and Neptune which were submitted to the writer in late 2012 and early 2013. Several near-infrared images of both planets show albedo features. Uranus shows bright belts whereas Neptune shows a large bright area south of 32° S. The selected normalized magnitude values of Uranus are: B(1,0) = -6.645 ± 0.009, V(1,0) = -7.117 ± 0.007, R(1,0) = -6.81 ± 0.02 and I(1,0) = -5.63 ± 0.05. The corresponding values for Neptune are: B(1,0) = -6.621 ± 0.009 and V(1,0) = -7.005 ± 0.009.

Introduction

During 2012, professional astronomers reported several new Uranus and Neptune findings. For example, Irwin and coworkers (2012) report that the CH_3D/CH_4 ratio on Uranus is 2.9 x 10^{-4} with an uncertainty of about 25%.

This is significant because it gives us information on the deuterium to hydrogen ratio. Deuterium is an isotope of hydrogen having one neutron (instead of zero neutrons for normal hydrogen). The CH_3D/CH_4 ratio will give astronomers a better understanding of Uranus's atmosphere.

In a second report, Sromovsky and coworkers (2012) report the drift rate of features between 60° N and 78° N is 4.3°/hour westward with respect to Uranus's interior. They also report that the bright spots south of 60° N appear as streaking bands whereas those farther north are bright spots resembling cumulus clouds. This group bases this finding on Hubble, Gemini and Keck telescope images.

In a third study, French and Showalter (2012) carried out a computer simulation of the movement of the inner moons of Uranus. They report the moons Cupid and Belinda will cross orbits within 10^3 to 10^7 years. They also report two more moons, Cressida and Desdemona, will cross orbits within the next 10^7 years.

Members of the Association of Lunar & Planetary Observers also made important contributions to our knowledge of the remote planets. I will summarize these.

Table 1 lists characteristics of Uranus and Neptune during their 2012-2013 apparitions. Those who submitted observations of these planets are summarized in Table 2. This report summarizes brightness measurements and images made during 2012 and early 2013.

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Your comments, questions, etc., about this report are appreciated. Please send them to: *ken.poshedly@alpo-astronomy.org* for publication in the next Journal.

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Brightness Measurements: Photoelectric 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 is located elsewhere (Optec., Inc, 1997), (Schmude, 1992, 20; 2008, Chapter 5). The transformation coefficients for Jim Fox's equipment are 0.0749 and –0.050 for the B and V filters, respectively. The transformation coefficients for the writer's equipment are –0.0555, –0.024 and –0.117 for the V, R and I filters, respectively. The comparison stars and their brightness values are summarized in Table 3.

Table 1: Characteristics of the 2012 - 2013 Apparitions of Uranus and Neptune[a]

Parameter	Uranus	Neptune
First conjunction date	Mar. 24, 2012	Feb. 19, 2012
Opposition date	Sept. 29, 2012	Aug. 24, 2012
Angular diameter (opposition)	3.7 arc seconds	2.4 arc-seconds
Sub-Earth latitude (opposition)	19.5° N	27.9° S
Right ascension (opposition)	00h 25m	22h 15m
Declination (opposition)	+01° 50m	-11° 30m
Second conjunction date	Mar. 29, 2013	Feb. 21, 2013

[a]Data are from the Astronomical Almanac for the years 2012 - 2013 and from the JPL Ephemeris located at *http://www.alpo-astronomy.org*

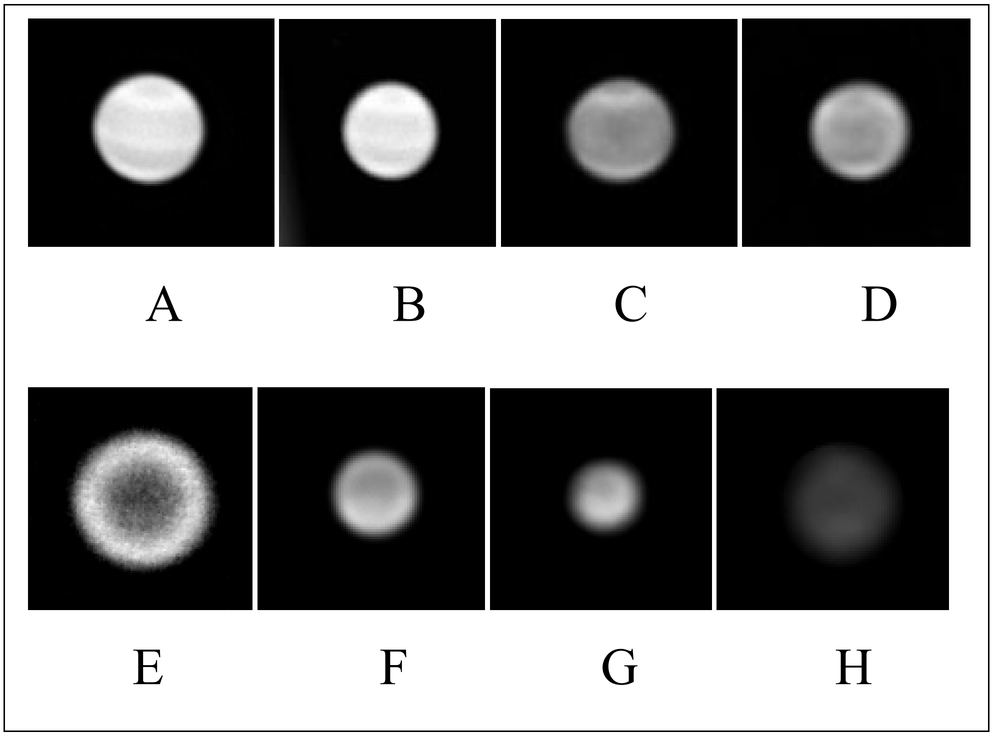

Figure 1: Images of Uranus and Neptune. A: Uranus taken on August 8, 2012 at 1:39.5 UT at wavelengths greater than 685 nm by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory; B: Uranus taken on August 10, 2012 at 2:33.1 UT at wavelengths greater than 685 nanometers by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory; C: Uranus taken on September 8, 2012 by Damian Peach with a 0.36 m Schmidt-Cassegrain telescope at wavelengths greater than 685 nm; D: Uranus taken on September 14, 2012 by Flavius Isac with a 0.25 m Schmidt-Cassegrain telescope with an IR 685 nm filter; E: Uranus taken on August 7, 2012 at 1:17.6 UT with a methane band filter by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory; F: Neptune taken on August 7, 2012 at wavelengths greater than 685 nanometers by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory G: Neptune taken on August 9, 2012 at 0:10.7 UT at wavelengths greater than 685 nanometers by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory; H: Neptune taken on August 27, 2012 at 22:30 UT by G. Maravelias and M. Kardasis with the 1.29 meter telescope at Skinakas Observatory in Greece.

Tables 4 and 5 summarize brightness measurements 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. Values of the normalized magnitudes, $B(1,\alpha)$ and $V(1,\alpha)$ are computed in the same way as in Schmude (2012, pp. 33-38). Extinction and color transformation corrections are included in all brightness measurements in the same way as is described in Schmude (2008, pp. 161-168).

Jim Fox and the writer used specific comparison and check stars for their Uranus measurements. Jim and Richard used 44-Piscium and lambda-Piscium as the comparison star, respectively. Jim used HD1367 as a check star. The writer computed brightness values of 7.112 ± 0.005 and 6.193 ± 0.002 for the B and V filter magnitudes of this star based on Jim's data. These values are in excellent agreement with those in Table 3.

Jim used 38-Aquarii and Iota-Aquarii as the comparison and check star for his Neptune measurements, respectively. Once again, the writer computed average B and V filter magnitude values for Iota-Aquarii from Jim's data. The corresponding values are 4.203 ± 0.002 and 4.277 ± 0.002 for the B and V filters, respectively. These values are in good agreement with those in Table 3. The close agreement between measured and literature magnitude values of the check stars for the Uranus and Neptune measurements is evidence that Jim's brightness values have a high degree of accuracy.

Table 6 lists selected normalized magnitudes for Uranus and Neptune. As in previous studies, the effect of the solar phase angle was assumed to be negligible. The V-filter normalized magnitude value of Uranus in 2012-2013 is dimmer than in the previous year (Schmude, 2013). The B-filter value, however, is brighter in 2012-2013 than in the previous year. It will be interesting to see if this trend continues in 2013-2014. The normalized magnitudes of Neptune are nearly the same as in 2011-2012 (Schmude, 2013).

Linear fits of $B(1,\alpha)$ and $V(1,\alpha)$ versus α for Uranus and Neptune based on data in Tables 4 and 5 are:

$$B(1,a) = -6.582 - 0.02\alpha \quad \text{Uranus} \quad (1)$$

$$V(1,a) = -7.092 - 0.0132\alpha \quad \text{Uranus} \quad (2)$$

$$B(1,a) = -6.657 + 0.0258\alpha \quad \text{Neptune} \quad (3)$$

$$V(1,a) = -7.016 + 0.0086\alpha \quad \text{Neptune} \quad (4)$$

Brightness Measurements: Visual Photometry

Patrick Abbott and the writer made brightness estimates of Uranus and Neptune. The selected $V_{vis}(1,0)$ values for the 2012-2013 apparition are –7.2 (Uranus) and –7.2 (Neptune). These values are based on 33 brightness estimates of Uranus and 19 estimates of Neptune. The value of $V_{vis}(1,0)$ is computed in the same way as in Schmude, 2012, pp. 33-38.

Table 2: Contributors to the ALPO Remote Planets Section in 2012-2013[a]

Name (location)	Type of Observation[b]	Telescope[c]	Name (location)	Type of Observation	Telescope
P. Abbott (Canada)	VP	B	T. Legault (France)	I	1.0 m
K. Bailey (UK)	D, DN	0.25 m RL	S. Maksymowicz (France)	D, DN	0.15 to 0.31 m
J. Boudreau (USA)	I	0.28 m	G. Maravelias (Greece)	I	1.29 m
F. Colas (France)	I	1.0 m	M. Mattei (USA)	I	---
J. L. Dauvergne (France)	I	1.0 m	F. Melillo (USA)	I	---
M. Delcroix (France)	I	1.0 m	C. Pellier (France)	I	0.25 m
F. Emond (France)	I	---	J. P. Prost (France)	I	0.35 m SC
J. Fox (USA)	PP	0.25 m SC	R. Schmude, Jr. (USA)	PP, VP	Several
M. Kardasis (Greece)	I	1.29 m	C. Viladrich (France)	I	1.0 m

[a]The following people contributed valuable observations to the ALPO Japan Latest website and are not listed above: P. Abel, P. Bayle, G. Bianchi, D. Gray, T. Ikemura, F. Isac, A. Kazemoto, A. Lasala, A. Medugno, S. Mogami, A. Obukhov, D. Peach, J. J. Poupeau, E. Punzo, S. Quaresima, H. Sasse, J. Sussenbach, G. Tarsoudis and A. Yamazaki. The following observer contributed to the Arkansas Sky Observatory archive: P. Maxson.

[b]Type of observation: D = drawings, DN = descriptive notes, I = images, PP = photoelectric photometry, S = Spectra, VP = visual photometry.

[c]Telescope: first quantity lists the diameter and the one or two upper case letters lists the type according to: B = binoculars, C = Cassegrain, DK = Dall Kirkham, RL = reflector, and SC = Schmidt-Cassegrain.

Drawings and Images

Astronomers submitted several images of Uranus and Neptune made in near-infrared light (wavelengths greater than 685 nanometers). Several are shown in Figure 1.

Although albedo features are visible on both planets in near-infrared wavelengths, this was usually not the case in visible wavelengths. Several images of Uranus show two bright belts which I call the Equatorial Belt and the North Temperate Belt. The writer measured the planetographic latitudes of these belts on four images of Uranus made by Marc Delcroix and coworkers (August 8 and 10), Damian Peach (September 8) and Flavius Isac (September 14).

The average latitude range for the Equatorial Belt is 2° S to 13° N and the corresponding range for the North Temperate Belt is 45° N to 59° N. An uncertainty of 3° is selected for these values.

Neptune had a different appearance than Uranus. Unlike Uranus, Neptune did not display bright belts. Instead it had a large bright area south of 32° S. The estimated uncertainty is 6°.

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

Comparison Star	Brightness (in stellar magnitudes)				Source
	B filter	V filter	R filter	I filter	
44-Piscium	6.606	5.778	—	—	a
HD1367	7.114	6.19	—	—	a
Lambda-Piscium	4.71	4.49	4.30	4.20	b
38-Aquarii	5.314	5.431	—	—	a
Iota-Aquarii	4.200	4.266	—	—	a

[a] http://simbad.harvard.edu/simbad/

[b] Iriarte et al (1965).

Satellites

Frank Melillo recorded an unfiltered CCD image of Uranus and its moons Titania and Oberon on September 24, 2012. He reports that Titania is 0.25 magnitudes brighter than Oberon. He bases this on an analysis of the image he took.

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Table 4: Brightness Measurements of Uranus Made in 2012 and Early 2013

Date	Obs.[a]	Filter	Brightness (magnitudes)[b]		Date	Obs.[a]	Filter	Brightness (magnitudes)	
			Meas. (+)	Normalized (–)				Meas. (+)	Normalized (–)
Aug. 9.308	JF	V	5.861	7.092	Nov. 3.071	RS	I	7.310	5.624
Aug. 9.308	JF	B	6.349	-6.604	Nov. 3.083	RS	R	6.069	6.865
Aug. 16.311	JF	V	5.891	-7.052	Nov. 3.095	RS	R	6.126	6.808
Aug. 16.312	JF	B	6.404	-6.539	Nov. 8.149	JF	V	5.828	7.112
Sept. 16.210	JF	V	5.811	7.104	Nov. 8.149	JF	B	6.295	6.645
Sept. 16.210	JF	B	6.292	-6.623	Nov. 12.139	JF	V	5.824	7.121
Sept. 20.185	JF	V	5.819	-7.095	Nov. 12.140	JF	B	6.304	6.641
Sept. 20.186	JF	B	6.299	-6.615	Nov. 20.131	JF	V	5.834	7.123
Oct. 5.156	JF	V	5.814	-7.100	Nov. 20.132	JF	B	6.313	6.644
Oct. 5.157	JF	B	6.311	-6.603	Dec. 7.186	JF	V	5.833	7.152
Oct. 8.190	JF	V	5.804	-7.110	Dec. 7.186	JF	B	6.294	6.691
Oct. 8.190	JF	B	6.274	-6.640	Dec. 8.115	JF	V	5.858	7.129
Oct. 9.191	JF	V	5.817	-7.098	Dec. 8.116	JF	B	6.327	6.660
Oct. 9.192	JF	B	6.283	-6.632	Dec. 13.110	JF	V	5.864	7.132
Oct. 14.116	RS	R	6.125	6.792	Dec. 13.111	JF	B	6.324	6.672
Oct. 14.135	RS	R	6.169	6.748	Dec. 14.062	RS	R	6.152	6.846
Oct. 14.162	RS	I	7.47[b]	5.45[b]	Dec. 14.076	RS	R	6.201	6.797
Oct. 14.166	JF	V	5.810	-7.107	Dec. 14.092	RS	I	7.394	5.604
Oct. 14.167	JF	B	6.286	-6.631	Dec. 14.106	RS	I	7.386	5.612
Oct. 16.109	RS	V	5.786	7.132	Dec. 18.077	JF	V	5.888	7.117
Oct. 16.130	RS	V	5.774	7.144	Dec. 18.078	JF	B	6.347	6.658
Oct. 19.163	JF	V	5.829	7.091	Dec. 24.101	JF	V	5.888	7.129
Oct. 19.163	JF	B	6.294	-6.626	Dec. 24.101	JF	B	6.351	6.666
Oct. 20.178	JF	V	5.806	7.115	Dec. 29.083	JF	V	5.896	7.130
Oct. 20.178	JF	B	6.275	6.646	Dec. 29.083	JF	B	6.355	6.671
Oct. 23.143	JF	V	5.818	7.105	Jan. 28.092	JF	V	5.923	7.155
Oct. 23.144	JF	B	6.288	6.635	Jan. 28.093	JF	B	6.361	6.717
Nov. 3.045	RS	I	7.279	5.655	Jan 31.090	JF	V	5.930	7.152
Nov. 3.057	RS	I	7.287	5.647	Jan. 31.090	JF	B	6.361	6.721

[a]Initials: JF = Jim Fox; RS = Richard Schmude, Jr.

[b]This is probably a bad data point because of clouds.

Table 5: Brightness Measurements of Neptune Made in 2012

Date	Obs.[a]	Filter	Brightness (magnitudes)[b]		Date	Obs.[a]	Filter	Brightness (magnitudes)	
			Meas. (+)	Normalized (–)				Meas. (+)	Normalized (–)
July 16.309	JF	V	7.706	7.006	Oct. 9.161	JF	B	8.099	6.619
July 16.309	JF	B	8.104	6.608	Oct. 14.141	JF	V	7.709	7.014
July 30.261	JF	V	7.691	7.011	Oct. 14.141	JF	B	8.134	6.589
July 30.261	JF	B	8.051	6.652	Oct. 19.136	JF	V	7.722	7.006
Aug. 7.270	JF	V	7.688	7.011	Oct. 19.136	JF	B	8.100	6.628
Aug. 7.270	JF	B	8.055	6.644	Oct. 20.152	JF	V	7.719	7.010
Aug. 9.257	JF	V	7.699	6.999	Oct. 20.152	JF	B	8.130	6.599
Aug. 9.257	JF	B	8.088	6.610	Oct. 23.117	JF	V	7.720	7.013
Aug. 12.246	JF	V	7.682	7.016	Oct. 23.117	JF	B	8.098	6.635
Aug. 12.246	JF	B	8.018	6.680	Nov. 8.081	JF	V	7.755	6.996
Aug. 16.258	JF	V	7.672[b]	7.024[b]	Nov. 8.081	JF	B	8.133	6.618
Aug. 16.258	JF	B	7.826[c]	6.87[c]	Nov. 12.112	JF	V	7.760	6.997
Sept. 16.181	JF	V	7.691	7.011	Nov. 12.112	JF	B	8.142	6.615
Sept. 16.181	JF	B	8.061	6.641	Nov. 23.069	JF	V	7.757	7.013
Sept. 20.159	JF	V	7.729	6.975	Nov. 23.069	JF	B	8.148	6.622
Sept. 20.159	JF	B	8.092	6.612	Dec. 7.094	JF	V	7.824	6.963
Oct. 5.130	JF	V	7.690	7.025	Dec. 7.094	JF	B	8.179	6.608
Oct. 5.130	JF	B	8.083	6.632	Dec. 8.061	JF	V	7.788	7.000
Oct. 8.162	JF	V	7.711	7.001	Dec. 8.061	JF	B	8.210	6.578
Oct. 8.162	JF	B	8.089	6.629	Dec. 13.082	JF	V	7.798	6.996
Oct. 9.161	JF	V	7.706	7.012	Dec. 13.082	JF	B	8.191	6.603

[a]Initials: JF = Jim Fox; RS = Richard Schmude, Jr.

[b]The B-V value is assumed to be 0.40 for the purposes of the color correction since the B values is considered to be unreliable (see the next footnote).

[c]This is a bad data point because it is more than four standard deviations from the mean. This point was not included in the mean value of the normalized magnitude.

Table 6: Selected Normalized Magnitudes for Uranus and Neptune

Filter	Planet	Normalized magnitude (stellar magnitudes)	Number of measurements
B	Uranus	-6.645 ± 0.009	22
V	Uranus	-7.117 ± 0.007	24
R	Uranus	-6.81 ± 0.02[a]	6
I	Uranus	-5.63 ± 0.05[a]	5
B	Neptune	-6.621 ± 0.009	20[b]
V	Neptune	-7.005 ± 0.009	21

[a] Includes measurements made before and after the discovery of a bright spot on Uranus.

[b]The measurement made on August 16 is not included in the average or the number of measurements.

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- **Monograph No. 3**. *H.P. Wilkins 300-inch Moon Map.* 3rd Edition (1951). Available as one comprehensive file (approx. 48 megabytes) or five section files (Part 1, 11.6 megabytes; Part 2, 11.7 megabytes; Part 3, 10.2 megabytes; Part 4, 7.8 megabytes; Part 5, 6.5 mb)

- **Monograph No. 4.** *Proceedings of the 45th Convention of the Association of Lunar and Planetary Observers. Wichita, Kansas, August 1-5, 1995.127* pages. Hard copy $17 for the United States, Canada, and Mexico; $26 elsewhere. File size approx. 2.6 mb.

- **Monograph No. *5.*** *Astronomical and Physical Observations of the Axis of Rotation and the Topography of the Planet Mars. First Memoir; 1877-1878.* By Giovanni Virginio Schiaparelli, translated by William Sheehan. 59 pages. Hard copy $10 for the United States, Canada, and Mexico; $15 elsewhere. File size approx. 2.6 mb.

- **Monograph No. *6.*** *Proceedings of the 47th Convention of the Association of Lunar and Planetary Observers, Tucson, Arizona, October 19-21, 1996.20* pages. Hard copy $3 for the United States, Canada, and Mexico; $4 elsewhere.File size approx. 2.6 mb.

- **Monograph No. 7.** *Proceedings of the 48th Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, June 25-29, 1997.76* pages. Hard copy $12 for the United States, Canada, and Mexico; $16

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elsewhere.File size approx. 2.6 mb.

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

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

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

- **Monograph No. 11**. *The Charte des Gebirge des Mondes* (Chart of the Mountains of the Moon) by J. F. Julius Schmidt, this monograph edited by John Westfall. Nine files including an accompanying guidebook in German. Note files sizes:
Schmidt0001.pdf, approx. 20.1 mb;
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Order the following directly from the appropriate ALPO section recorders; use the address in the listings pages which appeared earlier in this booklet unless another address is given.

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

- **Lunar & Planetary Training Section:** *The Novice Observers Handbook* $15. An introductory text to the training program. Includes directions for recording lunar and planetary observations, useful exercises for determining observational parameters, and observing forms. Available as pdf

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file via e-mail or send check or money order payable to Timothy J. Robertson, 195 Tierra Rejada Rd., #148, Simi Valley, CA 93065; e-mail cometman@cometman.net.

- **Lunar (Bailey):** (1) *The ALPO Lunar Selected Areas Program (*$17.50). Includes full set of observing forms for the assigned or chosen lunar area or feature, along with a copy of the *Lunar Selected Areas Program Manual.* (2) observing forms, free at http://moon.scopesandscapes.com/alpo-sap.html, or $10 for a packet of forms by regular mail. Specify *Lunar Forms*. NOTE: Observers who wish to make copies of the observing forms may instead send a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the ALPO lunar SAP section. Observers should make copies using high-quality paper.

- **Lunar**: *The Lunar Observer*, official newsletter of the ALPO Lunar Section, published monthly. Free at http://moon.scopesandscapes.com/tlo.pdf or $1.25 per hard copy: send SASE with payment (check or money order) to: Wayne Bailey, 17 Autumn Lane, Sewell, NJ 08080.

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

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

- **Mars:** *(1) ALPO Mars Observers Handbook,* send check or money order for $15 per book (postage and handling included) to Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114; phone 816-DEEP-SKY (816-333-7759); e-mail leaguesales@astroleague.org. *(2) Observing Forms;* send SASE to obtain one form for you to copy; otherwise send $3.60 to obtain 25 copies (send and make checks payable to "Deborah Hines", see address under "Mars Section").

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

- **Jupiter:** *(1) Jupiter Observer's Handbook*, $15 from the Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114; phone 816-DEEP-SKY (816-333-7759); e-mail leaguesales@astroleague.org. (2) *Jupite*r, the ALPO section newsletter, available online only via the ALPO website at http://mysite.verizon.net/macdouc/alpo/jovenews.htm; (3) *ALPO_Jupiter*, the ALPO Jupiter Section e-mail network; to join, send a blank e-mail to ALPO_Jupiter-subscribe@yahoogroups.com (4) *Timing the Eclipses of Jupiter's Galilean Satellites* free at http://www.alpo-astronomy.org/jupiter/GaliInstr.pdf, report form online at http://www.alpo-astronomy.org/jupiter/GaliForm.pdf; send SASE to John Westfall for observing kit and report form via regular mail. (5) *Jupiter Observer's Startup Ki*t, $3 from Richard Schmude, Jupiter Section Coordinator.

- **Saturn (Benton):** Introductory information for observing Saturn, including observing forms and ephemerides, can be downloaded for free as pdf files at http://www.alpo-astronomy.org/saturn; or if printed material is preferred, the *ALPO Saturn Kit* (introductory brochure and a set of observing forms) is available for $10 U.S. by sending a check or money order made payable to "Julius L. Benton" for delivery in approximately 7 to 10 days for U.S. mailings. The former *ALPO Saturn Handbook* was replaced in 2006 by *Saturn and How to Observe It* (by J. Benton); it can be obtained from book sellers such as Amazon.com. NOTE: Observers who wish to make copies of the observing forms may instead send a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the ALPO Saturn

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Section.

- **Meteors:** (1) *The ALPO Guide to Watching Meteors* (pamphlet). $4 per copy (includes postage & handling); send check or money order to Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114; phone 816-DEEP-SKY (816-333-7759); e-mail *leaguesales@astroleague.org*. (2) *The ALPO Meteors Section Newsletter*, free (except postage), published quarterly (March, June, September, and December). Send check or money order for first class postage to cover desired number of issues to Robert D. Lunsford, 1828 Cobblecreek St., Chula Vista, CA 91913-3917.

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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- Download JALPO43-1 thru the latest current issue as a pdf file from the ALPO website at *http://www.alpo-astronomy.org/djalpo* (free; most recent issues are password-protected, contact ALPO membership secretary Matt Will for password info).

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

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

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

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

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