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Journal of the Association of Lunar & Planetary Observers

Founded in 1947

The Strolling Astronomer

Volume 46, Number 4, Autumn 2004

Now in Portable Document Format (PDF) for MacIntosh and PC-Compatible Computers

Inside. . .

* A look back at this year's ALPO conference at AstroCon 2004

* FINALLY! Apparition reports on (take your pick) Mars, Venus and the remote planets

* A look a lunar dome near the Valentine Dome

* A book review of the Photographic Atlas of the Moon

This Issue's Cover: Elizabeth Westfall receives the ALPO Peggy Haas Service Award from ALPO Executive Director Richard Schmude at the 2004 AstroCon 2004 banquet.

. . . plus LOTS of reports about your ALPO section activities and much, much more.

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

Volume 46, No. 4, Autumn 2004
This issue published in October 2004 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.

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http://www.lpl.arizona.edu/alpo

For Online Readers

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Inside the ALPO

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Association of Lunar and Planetary Observers (ALPO)

Point of View

Professional-Amateur Collaboration

By Richard Schmude, Jr., ALPO executive director

During the past year, ALPO members carried out several activities, which were of interest to professional astronomers; these included: 1) imaging the dark side of Venus, 2) monitoring the major dust storm on Mars in Dec. 2003, 3) imaging white spots on Saturn and 4) imaging all longitudes of Jupiter on the night of Feb. 28-29. Some of the results of these activities are (or will be) published in the pages of this Journal.

Christophe Pellier imaged the dark side of Venus last spring and this is a truly remarkable achievement. Pellier's results along with those of others will help us unravel the mystery of the Ashen Light.

The combined effort of amateurs in Europe, American, Asia and Australia yielded a 360-degree coverage of Jupiter on the evening of Feb. 28-29, 2004. These images will be used by a professional astronomer to construct a map of that planet. Please stay tuned to more Jupiter opportunities in 2005.

I am hoping that everyone will get the chance to read the 2003 Mars apparition report in this issue. This report contains lots of quantitative data; this is data that professional astronomers want to see. It is my hope that the 2003 Mars report will serve as a reference point for future studies of Mars and will also serve as a catalyst for future ALPO Mars studies.

Inside the ALPO

Member, section and activity news (continued)

ALPO Founder Walter Haas Recovering Well After Fall

Walter Haas, age 86 and founder of this organization, is recovering nicely from a broken hip suffered from a fall while in London in June. The announcement was made to ALPO officers by his daughter, Mary Haas Alba (dmvalba@zianet.com)

Walter can be contacted via David Oosterman (e-mail: Davidoosterman@hotmail.com, telephone 011 44 207-701-1408).

Address Change: Jeff Beish

Effective August 1, 2004, the street name of Jeff's home address has been changed to the following:

842 Hallmark Avenue
Lake Placid, Florida 33852

Reminder: Address changes

Unlike regular mail, electronic mail is not forwarded when you change e-mail addresses unless you make special arrangements.

More and more, e-mail notifications to members are bounced back because we are not notified of address changes. Efforts to locate errant members via online search tools have not been successful.

So once again, if you move or change Internet Service Providers and are assigned a new e-mail address, please notify Matt Will at will008@attglobal.net as soon as possible.

In Memoriam: Scotty Murrell

By Walter H. Haas

We regret to report the death of A. S.("Scotty" Murrell) in September, 2004. He had been an ALPO member for half a century and was in addition a valued personal friend.

Scotty was a native of Clovis, New Mexico. He served his country in the U.S. Navy during World War II and spent most of his working life on the staff of the New Mexico State University Observatory. There he was a major observer in the search for possible small natural satellites of the Earth in the 1950's. In the later decades of the 20th century he was a major contributor to the amassing of a very large collection of (traditional) planetary photographs. It was jokingly said that he specialized in securing good photos on nights almost complete cloudy.

He was very helpful with the three ALPO Conventions which have been held in Las Cruces, including taking care of the familiar exhibit. He was a very active member of the Astronomical Society of Las Cruces and was the treasurer for many years. His patience and diligence with forgetful members in this tiresome chore were truly legendary. He was always most willing to help others in innumerable ways, e.g., finding meeting rooms for the ASLC and collimating this writer's Newtonians.

Scotty will be very greatly missed.

The Journal Of The Association Of Lunar And Planetary Observers

The Strolling Astronomer

Volume 20, Numbers 1 - 2

January - February, 1966
Published January, 1967

Photograph of extraordinary Leonid meteor shower on November 17, 1966. The bright star to which the arrows point is Beta Ursae Minoris. The camera was a Miranda 50-mm., F: 1.9 lens, mounted on a 12-inch telescope tracking at the sidereal rate. The stars are hence points; the meteors are roughly parallel streaks. 10-minute exposure on Tri-X film at about 11 hrs. 30 mins., Universal Time on November 17. Photograph by Mr. Scott Murrell at New Mexico State University Observatory. Text on pages 29 - 33.

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Association of Lunar & Planetary Observers — ALPO

Founded In 1947

Inside the ALPO
Member, section and activity news (continued)

Report from the ALPO Membership Secretary/Treasurer

By Matthew L. Will

Please see the listing of our newest members at the end of this section.

Interest Section Reports

Computing Section

By Kim Hay, coordinator

August 21– It's hard to believe that summer is almost over. I trust that everyone was able to get out and do some observing either in his or her backyards or a Star party.

The ALPO Computing Section is dedicated to providing comprehensive computational support to the Association of Lunar & Planetary Observers.

The Computing section has been lonely without your imput. We have had a program update from Jeff Beish (thank you Jeff!). The file is in the New uploaded Files, called TDLmisc1.zip. This is a file that measures Celestial Objects, and includes Measure Mars' Polar Cap with a Micrometer and Measuring Solar System Objects with Micrometer or Camera.

The ALPOCS listserv, which is located at http://groups.yahoo.com/group/alpocs/ is available to all ALPO members. It was established in 1999 and currently has 152 members on the list. There are more files located on the group page as well.

If you wish to subscribe, please send a message to alpocs-subscribe@yahoogroups.com.

So on those cloudy nights when there might not be anything left to do, why not come on in and look around – you might be intrigued to put finger to keyboard and ideas to screen, and come up with a program to share with others.

If you have ideas on what you would like to see this section do or have included, please let us know. You can contact me at kimhay@kingston.net privately, or post to the ALPOCS list.

Visit the ALPO Computing Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/computer.html

Instruments Section

By R.B. Minton, coordinator

August 26 – Enthralled by the very recent news that the surface of Venus can be imaged at long infrared wavelengths, I am exploring the feasibility of building a camera to image Venus at 2-3 microns. At 2.5 microns, the surface brightness (not the cloud layer) is 20,000 times brighter than at 1.1 microns - the long wavelength cutoff of almost all silicon-based webcam and CCD chips. I intend to test some IR phototransistors (using a hot iron) to see if any have a sufficiently long IR response. If not, then building such a camera will be more difficult - but not impossible - for the advanced amateur. I'm still brainstorming the scanning and display aspects, but I've built many photometer amplifiers and I don't see any problems in the sensor/amplifier area. Beware, this is not a project for the newbie/novice.

I'm much closer to finishing construction of a cosmic ray counter that will run 24 hours a day, 7 days a week. It will tally cosmic ray hits every 10 seconds and should show the diurnal rise and fall of cosmic rays, any rare cosmic bursts (they do happen!), and much more common solar proton storms. The hardware is in hand and being assembled. The detector uses a 5-lb. cylinder of scintillator plastic and a 5-inch diameter photomultiplier (PM) tube recently purchased at a Los Alamos, New Mexico surplus sales store (The Black Hole). Mr. Ed Grothus kindly sold me the tube and plastic for only $100! The software will be very similar to what I've used for the last 5 years to count radiometeors. I built a prototype using a 2-in. PM tube with a 2-in. plastic disk, and it counted about 1.5 cosmic rays per second over a long interval.

My radiometeor counts (and other meteor observations) have been published in WGN - Journal of the International Meteor Organization. (Mr. Robert Lunsford has written me that he does not want me to send him my radiometeor observations, and that they should be sent directly to Ken or WGN - so I send them to WGN!). The Feb. 2003 issue had 3 radiometeor papers by me. The most innovative was "Diversity radio observations of the 2002 Leonids on November 19". I observed at two wavelengths (albeit FM frequencies) and found the durations and peaks to be equal - but the individual counts were uncorrelated. This means the 2 radios were not counting the same meteors. More importantly it means that a system comprised of N radios could detect more sparse

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meteor showers - by a factor of the square root of N (since their signals can be co-added).

Over the last six months, I have been writing a GW-Basic computer program to solve some of the numerical tasks that a physicist might encounter. I am using for my reference a well-written (with solved problems!) entry-level college physics textbook (College Physics by Serway & Faughn, 1992). I started this program to teach myself atomic physics by solving the problems in the book, and it has grown in scope to cover more borderline topics such as light. It presently has about 900 lines of source code and dozens of solved problem types. Each problem is summarized with a screen of text, and the user is then prompted to enter the sample values used in the textbook (and shown on the screen), or his own. It has been a huge educational aid to me since one actually has to do the math and get it right. I am willing to send a free copy to anyone who sends me a 3-1/2 in. floppy disk. (I'll send a copy to the new Computing Section coordinator and see if she wants to distribute it.) Perhaps one day, all authors will do this and include copies for their students - except that it will make doing the homework extremely easy !!!

Since I received my Oct. 2004 *Sky & Telescope*, I've been trying to purchase a Meade Deep Sky Imager using the Sony HAD color CCD priced at $299. It is similar to other Sony HAD CCD's except the pixels are about twice as big, so they collect 3 - 4 times more light. My old b&w CCD is now 10 years old and I've been ready to purchase a color Sony HAD for some time. Meade has beaten SAC's price, but has not shipped them to any of the dealers I've called - they found out about it when they got their S&T's!!!. I look forward to using this camera and writing a product review. (Note to Don Parker: I know you are the ALPO CCD Mentor and are probably much more well-liked at Meade than me, so if you get one first and want to write a review - go ahead. I just want to find one and start using it!!!

No one in the last year has written me with questions about astronomical instruments. This is nothing new - it has happened a few times before in earlier years. My goal is to try to remain in touch with current trends and popular subjects - and then find something to build, do or review in those areas. I am not the least surprised that amateurs are unresponsive - the professionals are too! Not one astronomer has contacted me in five years regarding any of my meteor observations, techniques, or instrumentation even though my work is being published in one of the more prestigious meteor journals!

Wanted: Anyone who is using an observatory and would like to submit at least 2 pages of text and 4 photographs of their observatory for publication in the JALPO Instruments Section. Please send this material to me, R. B. Minton, and I will help with any editing and other details. Note that timely publication is not guarantied because we are all waiting our turn in line.

Visit the ALPO Instruments Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/inst.html

ALPO Lunar & Planetary Training Program

By Tim Robertson, coordinator

For information on the ALPO Lunar & Planet-ary Training Program on the World Wide Web, go to http://www.cometman.net/alpo/, regular mail to Tim Robertson at 2010 Hillgate Way #L, Simi Valley CA, 93065; e-mail to cometman@cometman.net

Observing Section Reports

Eclipse Section

By Mike Reynolds, coordinator

Please note that my e-mail address has changed; drmike@astrospace.net

Visit the ALPO Eclipse Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/eclipse.html

Meteors Section

By Robert Lunsford, coordinator

Sept. 12 - Meteor season continues in high gear this autumnm with the arrival of several strong annual meteor showers. The best of these are the Orionids, the Leonids, the Geminids and the Ursids.

The Orionids are expected to peak on October 21 with highest rates near 20 per hour. The Moon will just be past first quarter and will not interfere when the radiant climbs high into the sky. The Leonids will peak near November 17 with expected rates near 15 per hour. The Moon will be just before its first quarter phase and will set as the radiant begins to rise in the east. The Geminids peak on December 13 with rates exceeding 60 meteors per hour. The Moon is just past new and will not be in the night sky at all. The only

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shower affected by the moon this year will be the Ursids. Yet some activity may be seen on the morning of December 22 when the Moon sets in the west. This will allow an hour or two of dark skies before the start of morning twilight.

The Meteors Section conduct an expedition in California to view the Orionids in October, when nights are still comfortable and camping tolerable. We hope some members will join Robin Gray and myself to pick up some tips on meteor watching and to enjoy the show. The dates for this expedition will be October 20-22 and it will be held at the Trona Pinnacles National Monument, near Ridgecrest. If interested, e-mail Robert Lunsford at lunro.imo.usa@cox.net or send regular mail to 161 Vance St., Chula Vista, CA 91910.

Visit the ALPO Meteors Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/meteor.html

Solar Section

By Rick Gossett, acting coordinator

August 21 – The June 2004 transit of Venus turned into a deluge created a deluge of observations in both white light and h-alpha wavelengths. Observers are still submitting observations. Many of them are available for viewing at http://www.lpl.arizona.edu/~rhill/alpo/solstuff/prev_rotn_old.html

Observations for the current rotation are available at http://www.lpl.arizona.edu/~rhill/alpo/solstuff/recobs.html

For the calendar year 2004, we are averaging 175 image submissions per month.

The revised observers handbook is coming along nicely, thanks to Jamey Jenkins. This project is a joint effort, and many of the ALPO's best solar observers are participating. Once finished, this will be a "must have" guidebook for anyone interested in solar observing.

I would also like to congratulate Ralf Vandebergh. His excellent image of the Venus Transit is on page 144 of the October issue of *Sky & Telescope*. The rest of his transit images are posted at http://www.lpl.arizona.edu/~rhill/alpo/solstuff/prev_rotn_old.html

Submit all observations to at rick2d2@sbcglobal.net

Visit the ALPO Solar Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/solar.html

Mercury Section

By Frank J. Melillo, coordinator

Visit the ALPO Mercury Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/merc.html

Venus Section

By Julius Benton, coordinator

August 21 – Analysis of the observations and images from the immediately-preceding 2003-2004 Eastern (Evening) Apparition is underway and will appear in this Journal at a later date. As of this writing, the 2004-2005 Western (Morning) apparition of Venus is underway, with Venus well-placed for viewing before sunrise. Venus passed greatest brilliancy on 2004 July 15 (visual magnitude -4.5) and reached Greatest Elongation West on 2004 August 17 (46°).

Note that Venus is proceeding through waxing phases during this apparition, yet diminishing in angular diameter (a progression from crescent through gibbous phases). We are seeing Venus' trailing hemisphere during western apparitions and observing the dawn side of the planet at the time of terrestrial dawn.

Observations and images have been pouring in from observers worldwide, and a sample image accompanies this report. Venus will reach Superior Conjunction with the Sun on 2005 March 31, so there is ample opportunity for observers to follow the planet prior to that time. At times of western (morning) apparitions, it is possible to wait until the planet gains altitude and the background sky brightens considerably, and Venus can readily be followed into daylight. It is perfectly desirable to observe Venus during daylight hours when most of the prevailing glare associated with the planet is gone or reduced, but observing Venus too far into the daylight hours can become a problem as solar heating produces turbulent air and resulting poor seeing.

While it may seem difficult to look for Venus in daylight, it should be recalled that the planet is comparatively bright, and in practice, the observer can usually find Venus if knowledge of exactly where to look is obtained before the observing session. It is worth mentioning that observers find that the presence of a slight haze or high cloud often stabilizes and reduces glare conditions while improving definition.

Observers are encouraged to submit regular CCD and webcam images, as well as carefully executed

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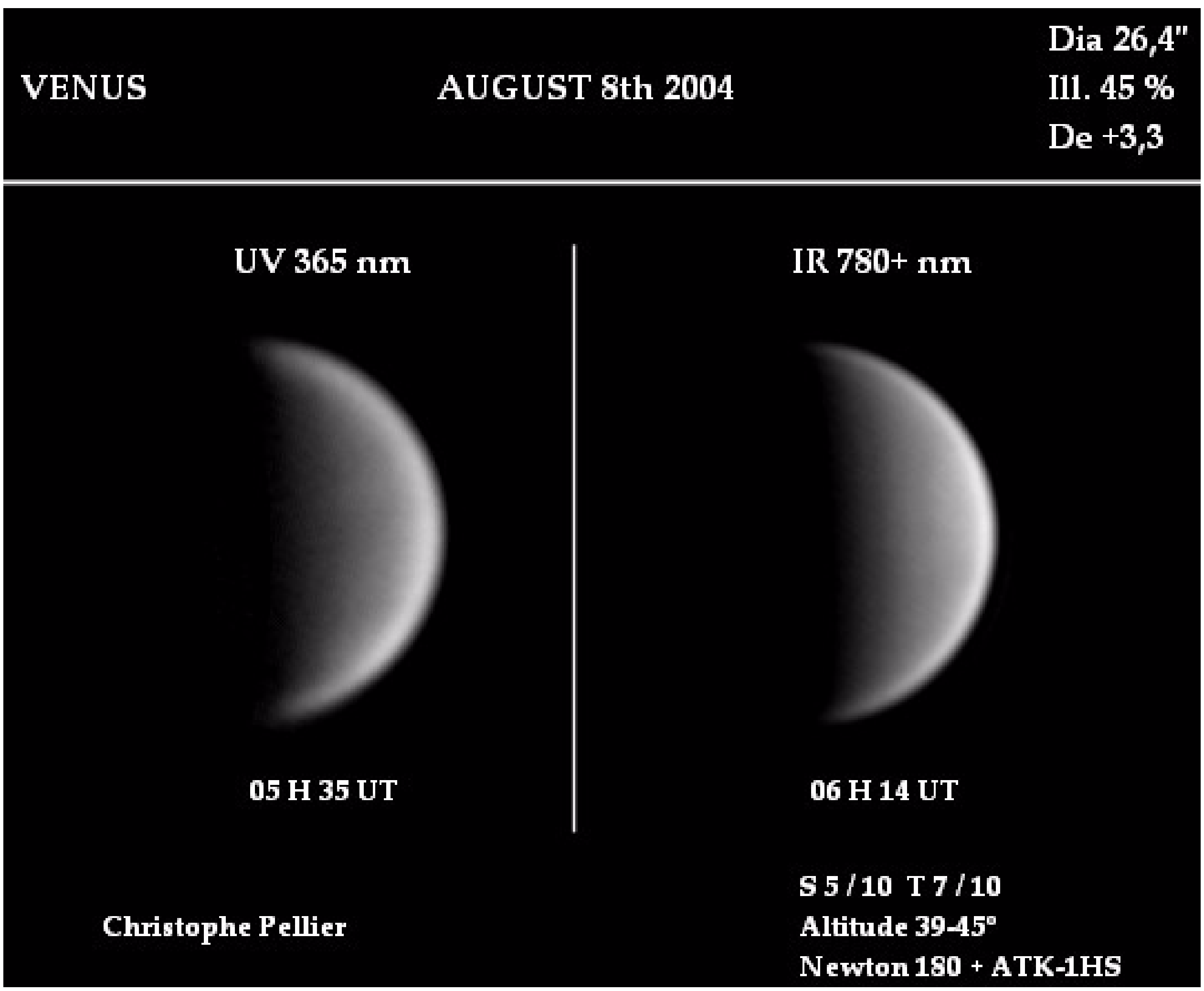
drawings, made at roughly the same time and on the same date (simultaneous observations). A greater level of confidence in our results improves as observers make an effort to do simultaneous observations, and the ALPO Venus Section is stressing combined visual observations and CCD imaging for comparative analysis of resultant data. There is also a definite need for continued ultraviolet imaging of Venus simultaneously with visual observations; for example, some observers apparently have a slight visual sensitivity in the near UV range, whereby they report radial dusky features that are so readily apparent on UV photographs and images.

ALPO studies of the Ashen Light, which peaked during the Pioneer Venus Orbiter Project, are still continuing every apparition. Constant monitoring of the planet for the presence of this phenomenon by a large number of observers (ideally participating in a simultaneous observing program) remains important as a means of improving our chances of capturing confirmed dark hemisphere events. Imaging with CCDs and webcams to attempt to capture the faint glow on the dark hemisphere at crescentic phases is an important endeavor that must continue.

It is the ultimate goal of the ALPO Venus Section to attempt to assemble a completely homogeneous mass of accurate, reliable observational data collected over many apparitions, permitting an exhaustive statistical analysis. It is hoped that we might derive enough from painstaking observations and analysis to help provide some answers to questions that continue to perplex us about Venus.

Observations of the atmosphere of Venus are organized into the following routine programs:



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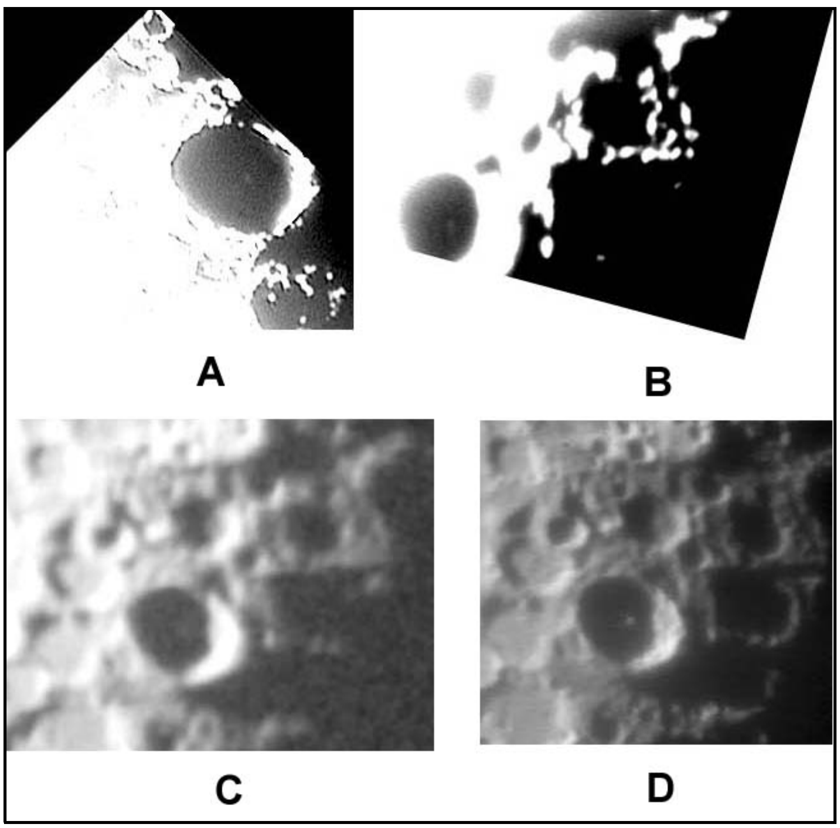
- Visual observation and categorization of atmospheric details in dark, twilight, and daylight skies.
- Drawings of atmospheric phenomena.
- Observation of cusps, cusp-caps, and cusp-bands, including defining the morphology and degree of extension of cusps.
- Observation of dark hemisphere phenomena, including monitoring visibility of the Ashen Light.
- Observation of terminator geometry (monitoring any irregularities).
- Studies of Schröter's phase phenomenon.
- Visual photometry and colorimetry of atmospheric features and phenomena.
- Routine photography (including UV photography), CCD imaging, photoelectric photometry, and videography of Venus.

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

Complete details can be found about all of our observing programs in the ALPO Venus Handbook. Individuals interested in participating in the programs of the ALPO Venus Section are cordially invited to visit the ALPO Venus Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/venus.html



Tycho images — A: May 9, 2003 21:04 UTC, central peak just visible, Sun's altitude +1.2°, CCD image stacked and contrast stretched. B: May 9, 2003 00:05 UTC, central peak just visible, Sun's altitude +2.3°, CCD image stacked and contrast stretched. C: May 10, 2003 01:23 UTC, central peak visible, but image grainy, Sun's altitude +2.8°, Sony Digital Camera, some contrast enhancement. D: May 10, 2003 03:00 UTC, central peak plainly visible, but very little contrast enhancement needed, Sun's altitude +3.4°, PC23C CCD video camera, single, 1/30 second TV frame. Images A and B by Brendan Shaw, United Kingdom; image C by David Darling of Wisconsin, USA; image D by Robert Spellman of California, USA.

Lunar Section:
Lunar Meteoritic Impact Search
By Brian Cudnik, coordinator

Visit the ALPO Lunar Meteoritic Impact Search site on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/lunarstuff/lunimpacts.html

Lunar Topographical Studies
William M. Dembowski, FRAS acting assistant coordinator

July 31 – Participants in the Lunar Topographical Studies Section continue to observe the many intricacies of the Moon's surface and record them with both sketches and imaging systems. As an indication of the universal appeal of the Moon, in the four months leading up to this writing, submissions were received from 16 observers in 9 different countries.

Recent studies included vertical displacements of various points in the Ptolemaeus/Alphonsus/Arzachel

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crater chain and a study of the ejecta blankets and bright rays on the floor of Clavius under a half-dozen different lighting and libration conditions.

Selected contributions to the Section are featured in the Lunar Section's monthly newsletter, *The Lunar Observer*, which can be found at http://www.zone-vx.com/tlo.pdf In addition, discussions of the Moon are always welcomed at the Lunar Section e-mail discussion group at http://groups.yahoo.com/group/Moon-ALPO/

For information on how you can participate in the study of the topography of Earth's only natural satellite, contact William Dembowski at Dembowski@adelphia.net

Visit the ALPO Lunar Topographical Studies Section on the World Wide Web at http://www.zone-vx.com/alpo_topo.htm

Persons interested in the revived survey are invited to join the Yahoo discussion group on Lunar Domes located at http://groups.yahoo.com/group/lunar-dome/

Visit the ALPO Lunar Dome Survey Section on the World Wide Web at http://www.lunar-dome.com

Lunar Selected Areas
Julius Benton, coordinator

Visit the ALPO Lunar Selected Areas Program on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/lunarstuff/selarea.html

Lunar Transient Phenomena
Anthony Cook, coordinator

Sept. 22 – During 2003 observations were received from many observers in the UK, Italy, USA, Puerto Rico and New Zealand. These are summarized in a monthly LTP newsletter and in TLO. Our aim is to try to disprove some of the past LTP reports contained within the 1978 NASA LTP catalog, and make the statistical analysisof remaining LTP reports easier.

We do this by asking observers to take CCD images, make sketches, or even give a simple written description of what they see for a lunar crater at a specific date and time. Predictions listed on the LTP web site are to encourage observations at the same illumination (+/- 0.5 deg sub-solar longitude and latitude), or same illumination and topocentric libration (+/- 1 degree for both) to the original LTP reports. In this way we make a control set of observations of the normal appearance of these craters from which a proper analysis of the original report can be made.

We have found that several past LTP reports can now be explained as normal appearances of these craters e.g., a slight highland protrusion starting to appear from a shadow filled crater floor.

However some past LTP reports remain enigmatic, in particular, color events or shadows that should be black but which appear as temporarily gray. We have also received some intriguing new observations which are under analysis, for example on 2003 May 10 Robert Spellman noticed that the central peak of Tycho was illuminated and had a couple of faint spurs. Whilst the coordinator thinks that these faint spur like features are atmospheric image flare (but would be happy to be proved wrong!), what was interesting was that the central peak was being illuminated when the local solar altitude was +3.4 deg.

David Darling had been imaging earlier when the local solar altitude at Tycho was even lower at +2.8 deg and here, too, the central peak was faintly visible. Incredibly, observations received from Brendan Shaw in the UK (on May 9} also showed a very weak central peak, and these were obtained when the solar altitude was a mere +1.2 deg. Now the Times Atlas of the Moon has the rim to floor depth of Tycho at 4.5km and the central peak height of approximately 1.9km above the floor, so should the central peak be illuminated by sunlight at a local solar altitude of +1.2 deg? A Digital Elevation Model of the crater has been obtained by the coordinator from a radar astronomer (Dr Jean-Luc Margot) and will be used to investigate whether the central peak is being illuminated by direct sunlight or perhaps was being weakly illuminated by secondary reflection from the brightly sunlit west inner wall.

The assistant coordinator, David Darling, has been in contact with various upcoming lunar missions in order to attempt an observing program of simultaneous observations with spacecraft imaging on the near side. This way, if any LTP are observed by telescopic observers, then there should be images from a spacecraft readily available to check these out. Similar observing programs were conducted during the Apollo era, and more recently with the Clementine and Prospector missions.

Finally, it should be stated that observations submitted to the LTP section are not just restricted to LTP

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studies, but in the case of high resolution images and sketches, can be of immense use to other coordinators of ALPOs lunar sub-sections. So we consider our LTP observing program to be multi-purpose.

Visit the ALPO Lunar Transient Phenomena program on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/lunarstuff/ltp.html

Mars Section

By Dan Troiani, coordinator
Daniel P. Joyce, assistant coordinator

Sept. 13 – Mars observers, filled with memories of a fantastic apparition in 2003, are already at the edges of their seats waiting for autumn, 2005's Martian encore even as conjunction currently obscures the planet for several weeks to come. The visions of a uniquely close look at Mars, the excitement obvious in the public reaction and such momentous discoveries made by the small armada of probes are plenty enough for the moment to placate those who wish Mars would never hide behind the Sun. The Section is quite aware that there may be an appearance of an opportunity to think of the next apparition as anticlimatic, but we are very much guarding against that. Yet we will surely never forget the enchantment of an apparition of such epic proportions. Many thanks to all participants.

Visit the ALPO Mars Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/mars.html

Minor Planets Section

By Frederick Pilcher, coordinator

Sept. 16 – I am please to announce my second discovery of small minor planet under the Spacewatch public discovery program, the FMO project. Discovery of 2004 SA came on September 16, at about 7:00 a.m., my 1,210th review image for Spacewatch.

With this designation, I became the first observer to have two confirmed objects, or MPEC's, see http://www.hohmanntransfer.com/mn/0409/19.htm#tco for more details.

This very small minor planet was rated H 26.12, or just 20 meters is size. Based on its one day arc, this may not return to Earth and its estimated discovery magnitude until perhaps the 22nd century. I plan to stay with the FMO project, and will announce any additional finds late next year to avoid too many posts here.

Visit the ALPO Minor Planets Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/minplan.html

Jupiter Section

By Richard W. Schmude, Jr., coordinator

August 19 – Jupiter will reach conjunction in September and it will not be visible until October in the predawn sky. During mid-August, the North Equatorial Belt was thinner than the South Equatorial Belt and the North Temperate Belt was not visible. Let's see if this trend continues into October and November. The Great Red Spot should be near a system II longitude of 100 degrees by November 2004.

I am currently analyzing the 2004 Jupiter data and am hoping to have the 2003-04 Jupiter apparition report completed by October. Please keep up the good work that you did in 2003-04.

Visit the ALPO Jupiter Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/jup.html

Saturn Section

By Julius Benton, coordinator

August 21 – Saturn's southern hemisphere and south ring face remain open to our telescopes during 2004-2005 at about _23° to our line of sight. Saturn has only recently emerged from the glare of the Sun, having passed conjunction on 2004 July 08, and appears in the East as a +0.2 magnitude object in Gemini just before sunrise. Saturn will reach opposition on 2005 January 13. The rings are gradually "closing up" with Saturn diminishing gradually in brightness as the next edgewise orientation in 2009 approaches.

With respect to recent apparitions of Saturn, all reports for the 2003-20043 apparition have been received, logged into the ALPO Saturn Section database and are now undergoing detailed analysis. Observer response during 2003-2004 was excellent, with a considerable number of superb CCD, videographic and webcam images of Saturn received along with routine drawings and descriptive reports. The apparition report for the 2003-2004 will appear at a later date in this Journal.

Saturn's atmosphere showed some interesting white spot activity during the 2003 – 2004 apparition, so it will be interesting to see if such activity carries over into 2004 – 2005.

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Member, section and activity news (continued)

All ALPO Saturn observers will not want to forget that there is a great opportunity this apparition for participation in the Amateur-Professional Cassini Observing Patrol because Cassini's arrival at Saturn (orbit insertion) occurred on 2004 July 1 and will be followed by the Titan Probe Entry and Orbiter flyby on 2004 November 27. What will be most useful to the professional community will be digital images of Saturn at wavelengths ranging from 400 nm - 1 micron in good seeing using webcams, CCD's, digital cameras and videocams. This effort began in April 2004 to coincide when Cassini starts observing Saturn at close range. Use of classical broadband filters (e.g., Johnson system: B, V, R and I) have been recommended, and for telescopes with large apertures (e.g., 30.0 cm and greater), imaging through a 890-nm narrow band methane filter will also be extremely worthwhile.

The Cassini Team is hoping that ALPO Saturn observers will carefully and systematically patrol the planet every clear night to search for individual features, their motions and morphology, to serve as input to Cassini's imaging system, thereby indicating to Cassini scientists where interesting (large-scale) targets exit. Suspected changes in belt and zone reflectivity (i.e., intensity) and color will be also useful, so visual observers can also play a very useful role by making careful visual numerical relative intensity estimates. The Cassini team also would like to combine ALPO Saturn Section images with data from Hubble Space Telescope and from other professional ground-based observatories (a number of proposals have been submitted).

The ALPO Saturn Section is always eager to enlist new observers, and anyone interested in our programs should contact the ALPO Saturn Section cordinator on how to get started.

Further information on ALPO Saturn programs, including observing forms and instructions, can be found on the Saturn page on the official ALPO Website at http://www.lpl.arizona.edu/~rhill/alpo/sat.html

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

Remote Planets Section

By Richard W. Schmude, Jr., coordinator

August 19 – Both Uranus and Neptune will be in the evening sky in October and November. Several observers have drawn or imaged albedo features on Uranus. Please continue to observe Uranus and report any albedo features to the coordinator at Schmude@gdn.edu.

The brightness of Uranus continues to drop at a rate of about 0.005 magnitudes per year. Brightness measurements of Uranus and Neptune are valuable and can give us information about the seasons on these planets.

Pluto will be getting closer to the Sun in November, but newly-discovered outer "planet" Sedna will reach opposition in November. Please be sure to send me any observations of the planets Uranus, Neptune and Pluto. I can also send you a finder chart for Uranus and Neptune.

Visit the ALPO Remote Planets Section on the World Wide Web at http://www.lpl.arizona.edu/~rhill/alpo/remplan.html

ALPO Membership Online

The ALPO now accepts membership payment by credit card via a special arrangement with the Astronomical League. However, in order to renew by this method you MUST have Internet access. See the inside back cover of this Journal for details.

ALPO Interest Codes

The following codes are used to indicate member interests in the table of newest members later in this section.

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

Inside the ALPO
Member, section and activity news (continued)

Newest Members

By Matthew L. Will, ALPO Secretary/Treasurer

The ALPO would like to wish a warm welcome to those who recently became members. Below are persons that have become new members from June 13, 2004, through August 29, 2004: where they are from and their interest in lunar and planetary astronomy. The legend for the interest codes are located at the bottom of the page. The legend for the interest codes are located at the bottom page 10.

MEMBER	CITY	STATE	COUNTRY	INTERESTS
MICHEL BEAUCHEMIN	ILE-DES-CHENES	MB	CANADA	
LLOYD E BEAUMONT	BEVERLY	KY		3456M
ROBERT K BOHM	FORT VALLEY	VA		
REID BOND	GRIFFIN	GA		
DENIS FELL	EDMONTON	AB	CANADA	
ERNESTO GUIDO	CASTELLAMMARE DI STABIA		ITALY	
ROBERT HEFFNER	NAGOY	NA	JAPAN	78
WAYNE HENSLEY	GROSSE POINTE WOODS	MI		
RALPH KREUTZER	MADISON	WI		
ENRIQUE MADRONA	MENTOR	OH		
FRANCISCO MIRA MIRO	MALAGA		SPAIN	
ROGELIO F PFIRTER	NEW YORK	NY		
DAVID W POWELL	BRENTWOOD	NY		356
FREDERICK RUDOLPH	MARIETTA	GA		
WILLIAM F RYAN	WEXFORD	PA		
ALTON SMITH	BELVIDERE	TN		M
TOM BECK	COLUMBUS	OH		03569ACDMPR

Book Review:
Photographic Atlas of the Moon

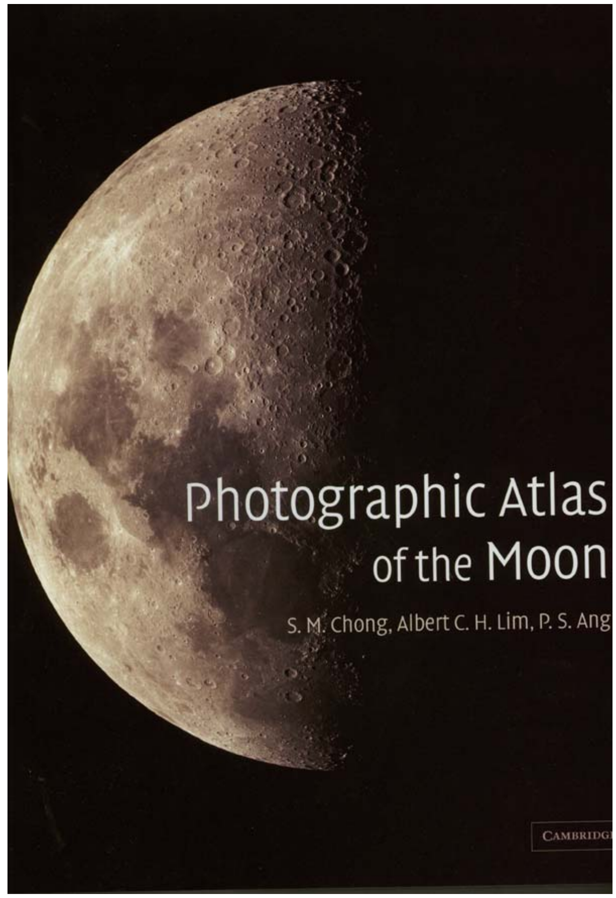
By S. M. Chong, Albert Lim, and P. S. Ang; published by Cambridge University Press, 40 West 20th Street, New York, 10011-4211. 2002. 146 pages. Price: $50, clothbound, ISBN 0-512-81392-1

Review by Robert A. Garfinkle, F. R. A. S.
E-mail to ragarf@earthlink.net

Whether you are a longtime observer of the Moon or a novice, you will discover many new things about the Moon as you work your way through the *Photographic Atlas of the Moon*. The three authors claim that they examined more than 10,000 slides "to secure the best possible daily full-phase Moon sequence. I tend to believe them because this book contains many very fine lunar images.

The authors take their readers on a day-by-day journey through a lunation from New Moon to the following New Moon. Each day opens with a page of text detailing what you can expect to be able to observe that day. The facing page has a full-scale image of the Moon for that day with new features identified along the lunar terminator on the picture. The full-scale image is followed by the same shot, but without the names cluttering up the lunar image. Enlarged sections of the full image displaying featured sites to observe that lunation day are included. A few of these sectional images (such as on page 34) are marred by numerous strange horizontal lines (printing error?). Overall, the images are sharp and detailed. Each photograph is accompanied by data about when the image was taken, Moon age, film type, telescope and camera, seeing conditions, etc.

I realize that the authors were more inclined to get the pictures right than on making sure that their nomenclature was accurate. Their list of lunar nomenclature contains the same mistakes found in the USGS on-line nomenclature, as of the time that they put the book together. The USGS list has been updated lately to correct some of the mistakes. For some strange reason the authors end their "Chronology of lunar selenography" (Appendix 2) with 1964, thereby totally ignoring all of the space-age mapping and publications. The Index of Lunar Named Featurers (Appendix 3) is more than a simple "on what page do I find something" kind of index. Instead, it contains that basic information along with data such as the feature's coordinates, diameter, date the IAU approved the feature name, and the origin of the name. They also give the Rükl *Atlas of the Moon* map number.



I highly recommend this book to any student of the Moon — or even to a casual observer who just wants to have some idea of what he or she is looking at on the Moon. The text is clear and so are the images of the Moon.

Feature Story:

ALPO Observations of Venus During the 2000-2001 Eastern (Evening) Apparition

For Online Readers

Items in blue text are links to e-mail addresses, tables, figures and websites for more information. Left-click your mouse on:

- •Items labeled "Table" to jump to that particular table.
- •Items labeled "Figure" to jump to that particular figure.
- •Bracketed numbers in blue text to jump to that particular item in the References section.
- •In the References section, items in blue text to jump to source material or information about that source material (Internet connection must be ON).

By: Julius L. Benton, Jr., coordinator
ALPO Venus Section
E-mail to: *jlbaina@msn.com*
Peer review by: *John Westall, Richard Ulrich*

Abstract

Observers from Germany, Italy, Spain, Puerto Rico, the United Kingdom, and the United States contributed photo-visual observations to the ALPO Venus Section during the 2000-2001 Eastern (Evening) Apparition. This report summarizes the results of those investigations. Data resources and types of telescopes and accessories used in making the observations are discussed. Comparative studies deal with observers, instruments, visual and photographic data. The report includes illustrations and a statistical analysis of the traditional categories of features in the atmosphere of Venus, including cusps, cusp-caps, and cusp-bands, seen or suspected at visual wavelengths, both in integrated light and with color filters. Terminator irregularities and the apparent phase are discussed, as well as coverage based on results from continued monitoring of the dark hemisphere of Venus for the enigmatic Ashen Lightlight.

Introduction

The ALPO Venus Section received 257 drawings, photographs, and CCD images of Venus during the 2000-2001 Eastern (Evening) Apparition from seventeen (17) contributors in Germany, Italy, Spain, Puerto Rico, the United Kingdom, and the United States. Geocentric phenomena in Universal Time (UT) for the 2000-2001 observing season are given in *Table 1*, while *Figure 1* shows the distribution of observations by month during the apparition, and *Table 2* lists the observers, the locale where the observations occurred, the number of observations

Table 1: Geocentric Phenomena in Universal Time (UT) for the 2000-2001 Eastern (Evening) Apparition of Venus

Superior Conjunction	2000	Jun	11^d	11^h UT	
Initial Observation	2000	Jul	12	14	
Greatest Elongation East	2001	Jan	17	06	(47°.1)
Dichotomy (predicted)	2001	Jan	19	11.6^h	
Greatest Brilliancy	2001	Feb	22	01	m_v = -4.6
Final Observation	2001	Mar	30	00	
Inferior Conjunction	2001	Mar	30	04	
Apparent Diameter (observed range)			9″.780 (2000 Jul 12) - 59″.080 (2001 Mar 30)		
Phase Coefficient, ***k*** (observed range)			0.989 (2000 Jul 12) - 0.011 (2001 Mar 30)		

Table 2: Participants in the ALPO Venus Observing Program During the 2000-2001 Eastern (Evening) Apparition		
Observer and Site	**No. of Observations**	**Telescope(s) Used***
Benton, Julius L. Wilmington Island, GA	81	15.2-cm (6.0-in) REF
Berg, Ray. Crown Point, IN	2	10.2-cm (4.0-in) SCT
	18	20.3-cm (8.0-in) SCT
Boisclair, Norman J. South Glens Falls, NY	2	8.9-cm (3.5-in) MAK
	1	50.8-cm (20.0-in) NEW
Boyar, Dan. Boynton Beach, FL	1	6.0-cm (2.4-in) REF
	4	7.5-cm (3.0-in) REF
	1	10.4-cm (4.1-in) NEW
Bradbury, Mark . Indianapolis, IN	1	8.0-cm (3.1-in) REF
Carlino, Lawrence. Lockport, NY	1	15.2-cm (6.0-in) REF
	1	15.2-cm (6.0-in) MAK
	1	17.8-cm (7.0"-in) MAK
Crandall, Ed. Winston-Salem, NC	11	7.5-cm (3.0-in) REF
	18	25.4-cm (10.0-in) NEW
Cudnik, Brian. Weimar, TX	1	35.6-cm (14.0-in) SCT
del Valle, Daniel. Aquadillo, Puerto Rico	2	9.0-cm (3.5-in) MAK
	2	12.7-cm (5.0-in) REF
	32	20.3-cm (8.0-in) SCT
Frassati, Mario. Crescentino, Italy	7	20.3-cm (8.0-in) SCT
Haas, Walter H. Las Cruces, NM	7	20.3-cm (8.0-in) NEW
	7	31.8-cm (12.5-in) NEW
Melillo, Frank J. Holtsville, NY	19	20.3-cm (8.0-in) SCT
Meredith, Cliff. Manchester, UK	1	20.3-cm (8.0-in) SCT
Niechoy, Detlev. Göttingen, Germany	1	6.0-cm (2.4-in) REF
	11	20.3-cm (8.0-in) SCT
Peach, Damian. Norfolk, UK	4	30.5-cm (12.0-in) SCT
Schmude, Richard W. Barnesville, GA	19	10.2-cm (4.0-in) REF
Tobal, Tòfol. Garraf, Spain	1	10.2-cm (4.0-in) REF
Total Number of Observers	17	
Total Number of Observations	257	
* REF = Refractor, SCT = Schmidt-Cassegrain, NEW = Newtonian, MAK = Maksutov		

submitted, and the instruments used used during 2000-2001.

Observational coverage of Venus throughout the 2000-2001 Eastern (Eevening) Apparition apparition was considerably better than averageusual. Several individuals started observing the planet about a month after Superior Conjunction (which occurred on 2000 June 11), and they continued their studies of the planet through Superior Conjunction on 2001 March 30. Consistent, systematic observation of Venus from conjunction to conjunction is extremely important, a practice that has now become customary by Venus observers in recent apparitions. The "observing season," or apparition, ranged from 2000 July 12 to 2001 March 30, with almost five-sixths of the observations (83.3%) submitted for the period 2000 December through 2001 March. During this time span, Venus progressed through maximum elongation from the Sun (47°), dichotomy, and greatest brilliancy ($-4.6m_v$).

Figure 2 graphically depicts the distribution of observers and submitted observations by country of

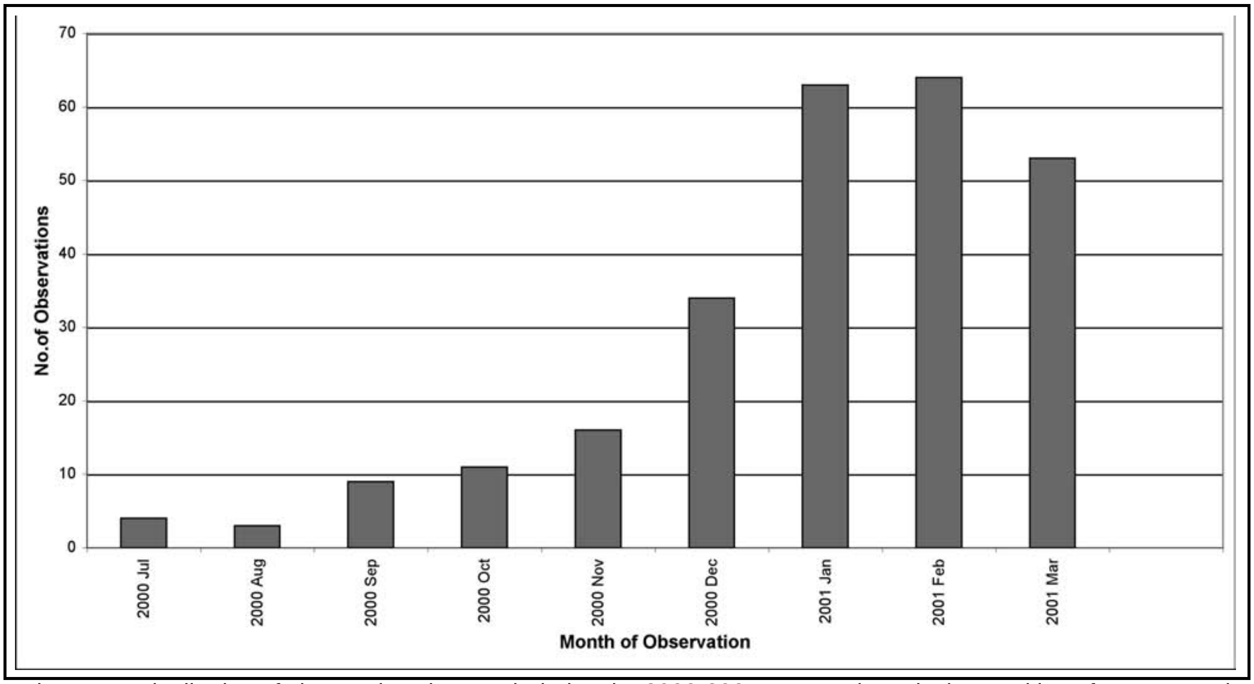


Figure 1 – Distribution of observations by month during the 2000-2001 Eastern (Evening) Apparition of Venus. Total of 257 observations subkitted by 17 observers in 2000 - 2001.

origin for the 2000-2001 Eastern (Evening) Apparition of Venus. Nearly two-thirds (64.7%) of the participants in the ALPO Venus observing programs were located in the United States, who accounted for roughly three-fourths (76.3%) of the total observations. During 2000-2001, as in many recent observing seasons, the international flavor of ALPO Venus programs was evident as the focus on improving global cooperation among lunar and planetary observers continues.

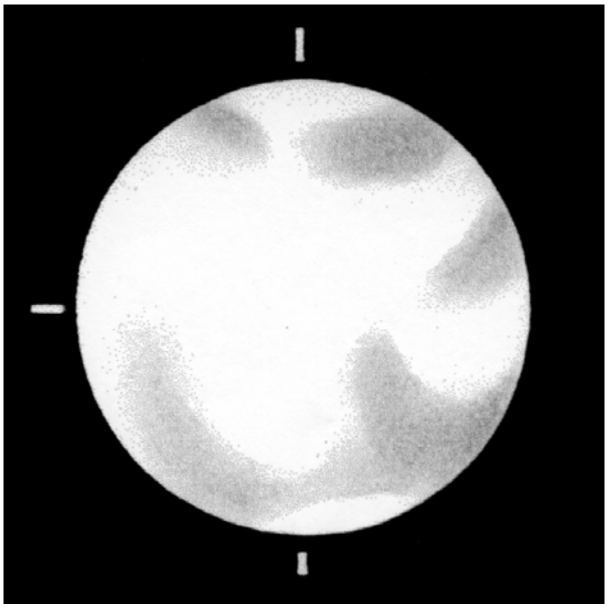


Plate 1. 2000 Jul 16 11:30 UT. Mario Frassati. Drawing. 20.3-cm (8.0-in) SCT, 250X, W80A (blue) Filter. Seeing 5.0 (interpolated). Phase (k) = 0.986, Diam. = 9".8.

The types of telescopes used to observe Venus during 2000-2001 are presented graphically in *Figure 3*. Slightly more than four-fifths (81.3%) of all observations were made with telescopes ≥15.2 cm (6.0 in.) in aperture. Classical designs (e.g., refractors and Newtonian reflectors) were employed for nearly two-thirds (61.92%) of the observations, while the remaining percentage (38.1%) of Venus reports were accomplished with Schmidt-Cassegrains and Maksutovs. During 2000-2001, essentially all of the observations (98.99%) were performed under twilight or daylight conditions, since regular observers have learned through experience that viewing Venus in twilight or broad daylight minimizes the overwhelming glare associated with the planet, plus looking at the planet when it is higher in the sky dramatically reduces detrimental effects of atmospheric dispersion and image distortion common near the horizon.

The author expresses his sincere gratitude to the 17 individuals mentioned in this report for their continued support of our programs by sending in an excellent collection of drawings, CCD images, photographs, and descriptive reports of Venus in 2000-2001. Interested parties who wish to follow Venus in coming apparitions are urged to join the ALPO and become regular contributors to our observational efforts. Venus is, of course, always a bright object that is easy to find, and near the times of greatest elongation from the Sun, the planet is about 15 times brighter than Sirius and can cast shadows when

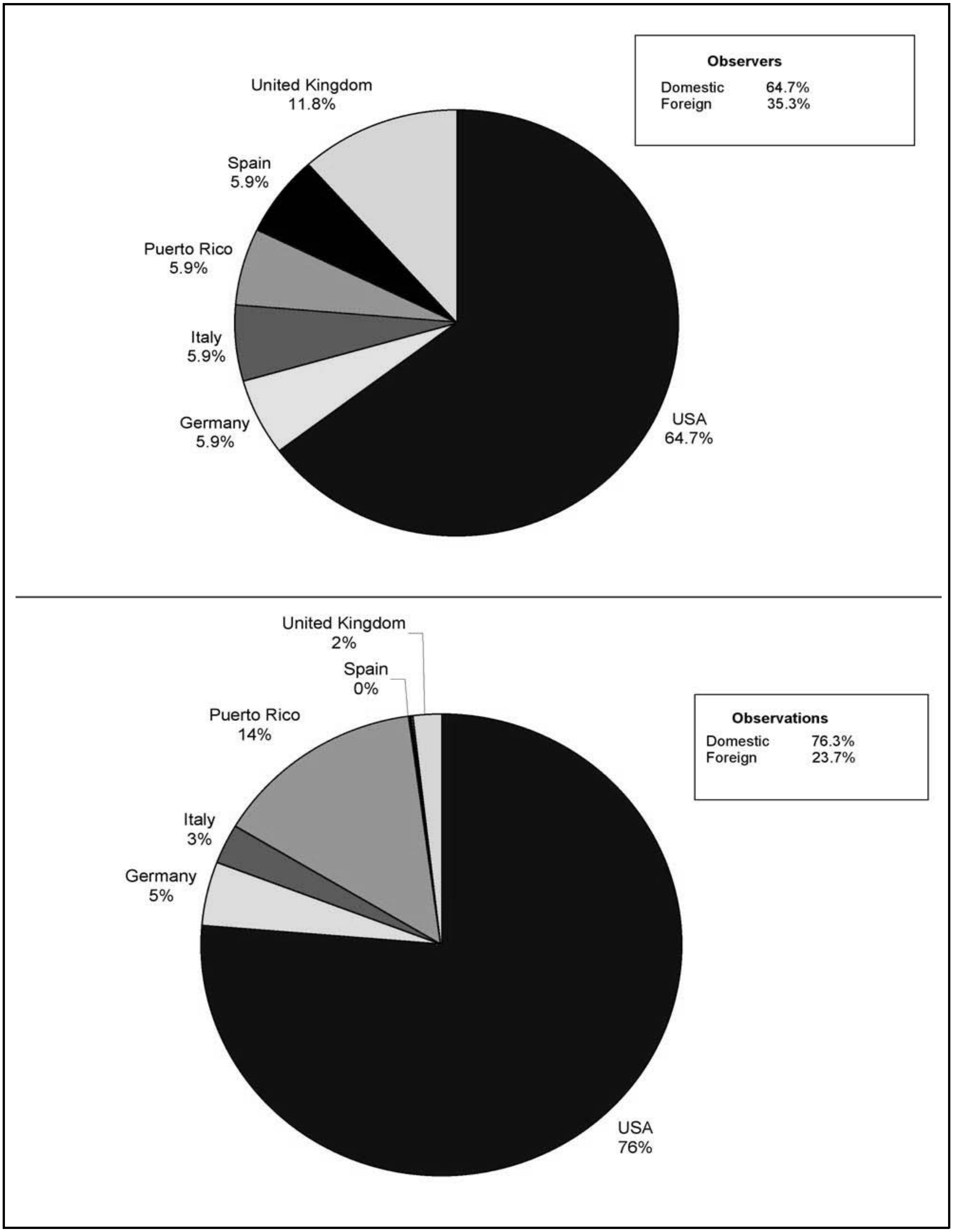


Figure 2 – Distribution of observers and observations by nation of origin during the 2000 - 2001 Eastern (Evening) Apparition.

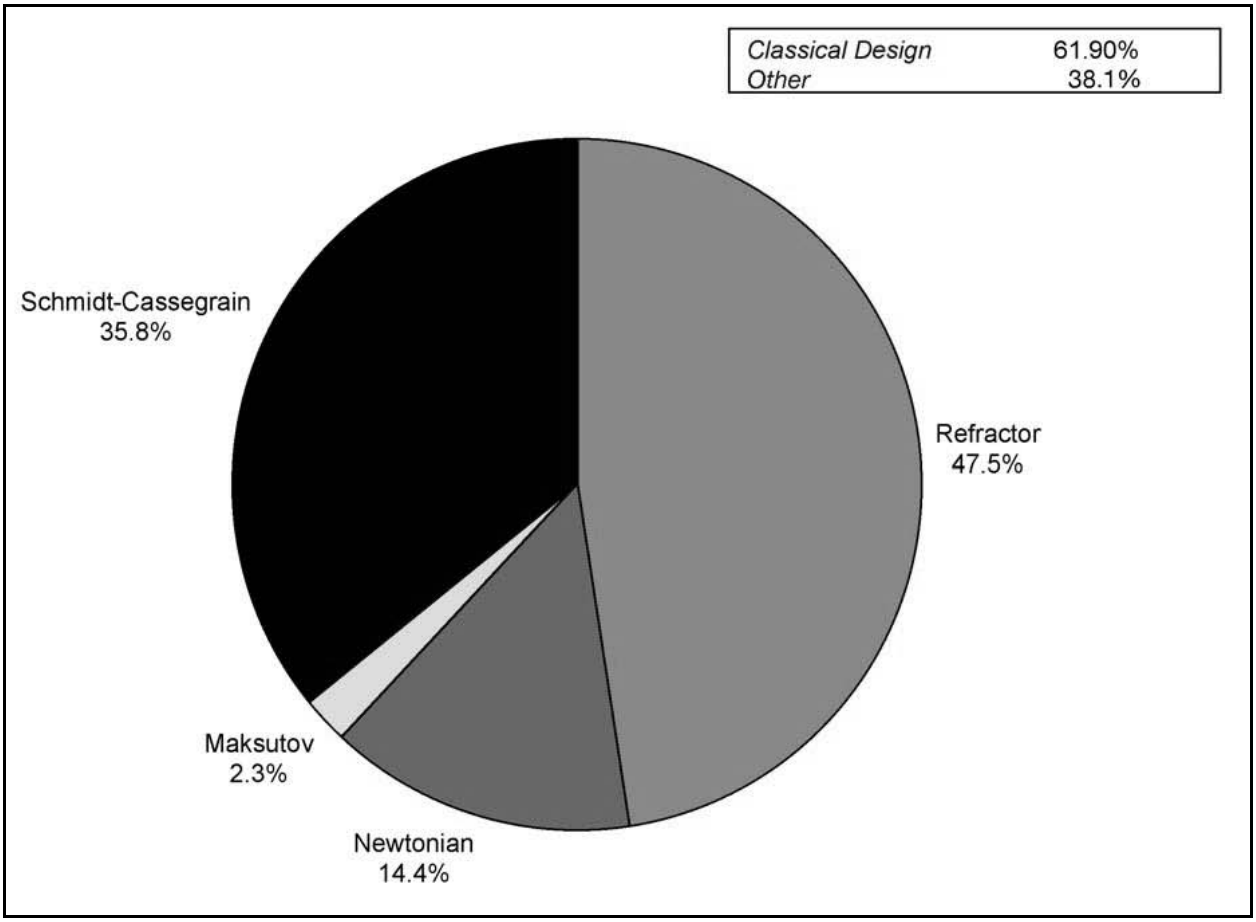


Figure 3 – Types of telescopes used during the 2000 - 2001 Eastern (Evening) Apparition of Venus.

viewed from a dark, moonless observing site. Getting started in the work we do requires only minimal aperture in the range of 7.5 cm (3.0 in.) for refractors to 15.2 cm (6.0 in.) for reflectors. Observers who wish to make good use of small, portable instruments take heed!

Observations of Venusian Atmospheric Details

The routine methodology for attempting visual studies of the vague and elusive "markings" in the atmosphere of Venus are discussed in detail in *The Venus Handbook*, available from the ALPO Venus Section in printed or digital format. Readers who have copies of earlier issues of this Journal, *The Strolling Astronomer*, may also find it worthwhile to consult previous apparition reports for a good historical account of ALPO studies of Venus.

Most of the observations comprising this analysis were made at visual wavelengths, although Melillo continues to submit his superb images of Venus taken in ultraviolet (UV) light using Schott UG-1 UV and infrared rejection filters. Several examples of submitted observations in the form of drawings, photo-

Plate 2. 2000 Oct 29 22:00-22:14 UT. Daniel del Valle. Drawing. 20.3-cm (8.0-in) NEW 250X, W23A (light red) Filter. Seeing 4.0. Phase (k) = 0.797, Diam. = 13".5.

Plate 3. 2000 Nov 24 20:27-20:50 UT. Frank J. Melillo. CCD image. 20.3-cm (8.0-in) SCT, Schott UG-1 UV Filter w/ IR blocker, Starlight Xpress MX-5 CCD 2 sec f/20. Seeing 5.0. Phase (k) = 0.723, Diam. = 15".6.

graphs, and images accompany this report to assist the reader in interpreting the phenomena reported in the atmosphere of Venus in 2000-2001.

Represented in the photo-visual data for the 2000-2001 apparition were all of the traditional categories of dusky and bright markings in the atmosphere of Venus, including a small fraction of radial dusky features, as described in the literature cited earlier in this report. *Figure 4* illustrates the frequency specific forms of markings were seen or suspected. Most observations observers called attention to more than one category of marking or feature, so totals exceeding 100% are not uncommon. Readers should understand that a certain level of subjectivity is unavoidable as attempts are made by visual observers to properly describe, or accurately represent on drawings, the very elusive atmospheric phenomena on Venus. This inherent bias probably affected some of the data in *Figure 4*, but it is believed that our conclusions discussed in this report are at least reasonable.

The dusky markings in the atmosphere of Venus are notoriously hard to detect visually. This is a characteristic of the planet that is largely independent of the experience of the observer, but using color filters and variable-density polarizers often improves views of cloud phenomena on Venus at visual wavelengths. In conjunction with visual work, the ALPO Venus Section strongly encourages observers to try UV photography and imaging. The morphology of features exposed at UV wavelengths is usually quite different from what is apparent at visual regions of the spectrum, particularly atmospheric radial dusky patterns.

Figure 4 shows that in about 44.3% of the observations contributed in 2000-2001, the brilliant disc of Venus was considered to be completely devoid of markings of any kind. When dusky atmospheric features were seen or suspected, the largest percentage

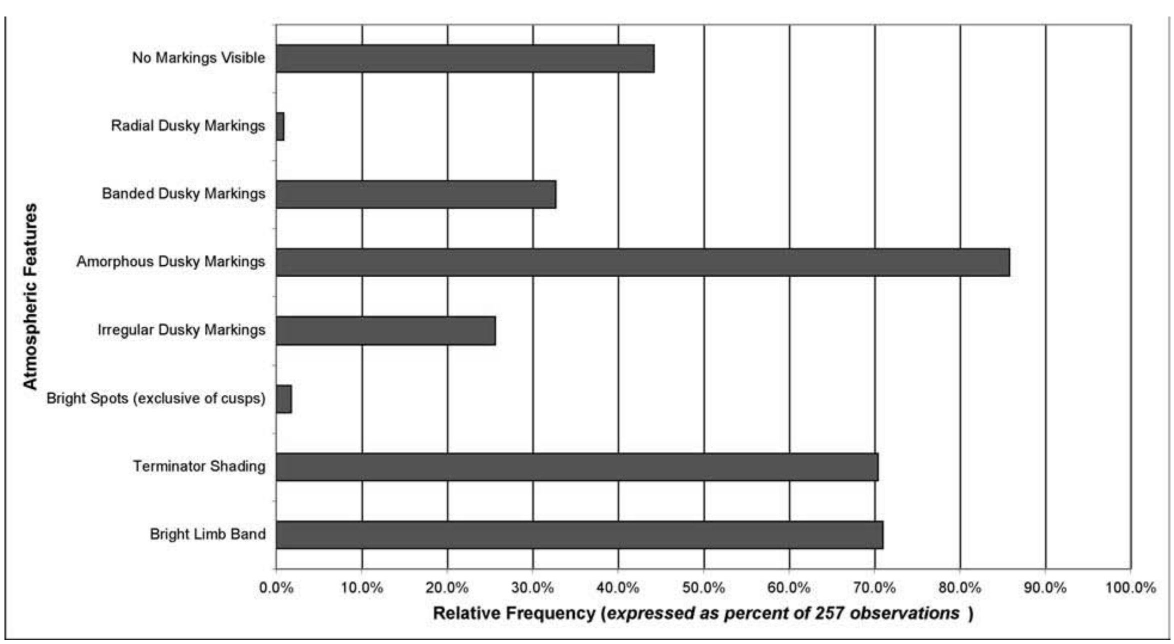


Figure 4 – Relative frequency of specific forms of atmospheric markings on Venus during the 2000 - 2001 Eastern (Evening) Apparition.

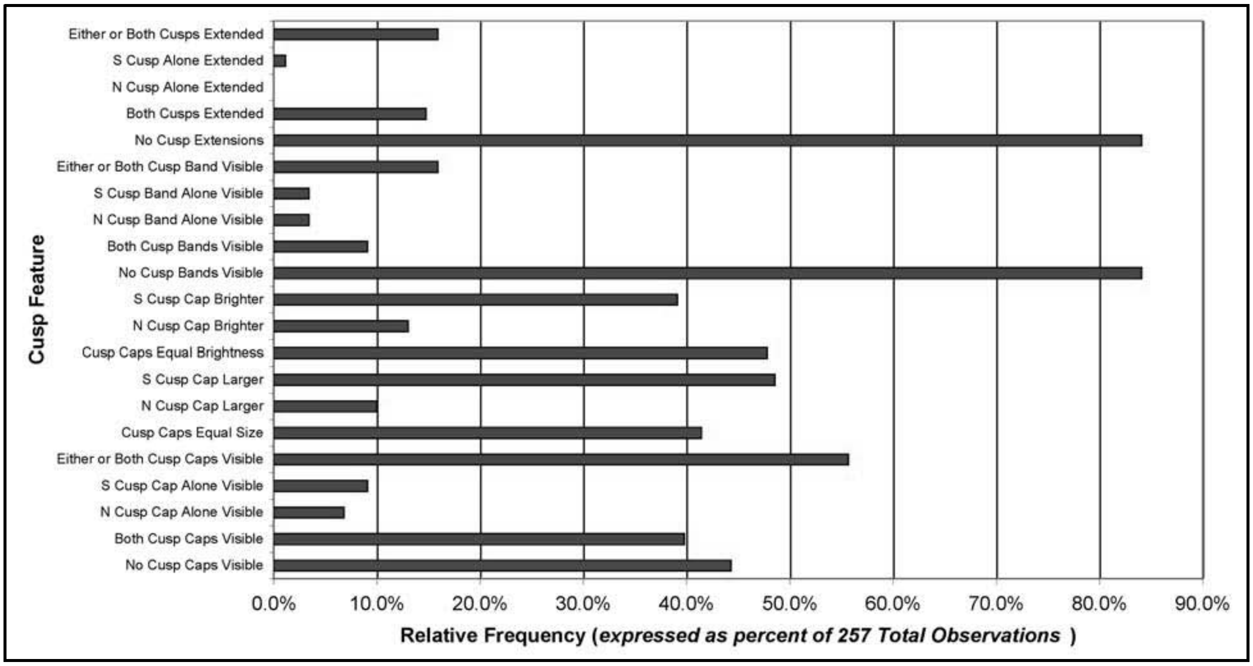


Figure 5 – Visibility statistics of cusp features of Venus during the 2000 - 2001 Eastern (Evening) Apparition.

occupied the category of "Amorphous Dusky Markings" (85.86%), followed by “Banded Dusky Markings” (32.73%), and “Irregular Dusky Markings” (25.76%), with only a negligible fraction (0.889%) occupying the classification of “Radial Dusky Markings” during the 2000-2001 Eastern (Evening) Apparition.

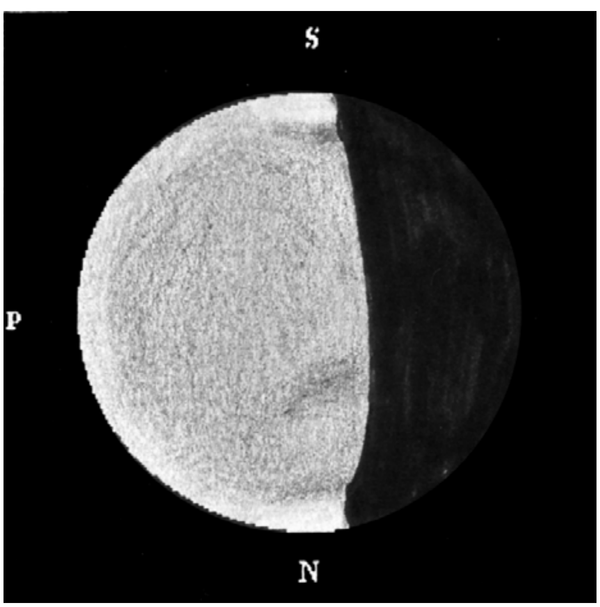


Plate 4. 2000 Dec 12 23:50 UT - Dec 13 00:01 UT. Richard W. Schmude. Drawing. 10.2-cm (4.0-in) REF, 230X, IL (Integrated Light). Seeing 6.0 . Phase (k) = 0.663, Diam. = 17".7.

Terminator shading was reported in 70.51% of the observational database during 2000-2001, as shown in *Figure 4*. Terminator shading normally extended from one cusp of Venus to the other, and the dusky shading was progressively lighter in tone (higher intensity) from the region of the terminator toward the bright planetary limb. This gradation in brightness ended in the Bright Limb Band according to most reports. A few photographs at visual wavelengths during 2000-2001 marginally showed the terminator shading, but it was particularly evident in many of Melillo’s fine UV CCD images.

The mean numerical relative intensity for all of the dusky features on Venus in 2000-2001 ranged from 8.5 to 8.7. The ALPO Scale of Conspicuousness (a numerical sequence from 0.0 for “definitely not seen” up to 10.0 for “definitely seen”) was routinely employed during 2000-2001. On this scale, the dusky markings in *Figure 4* had a mean conspicuousness of ~3.0 during the apparition, suggesting the atmospheric features on Venus were within the range from highly indistinct impressions to moderately good indications of their actual presence.

Figure 4 also shows that “Bright Spots or Regions,” exclusive of the cusps, were seen or suspected in only 1.8% of the submitted observations. It is standard practice for observers to call particular attention to such bright areas on drawings by using dotted lines to surround such features.

Observers regularly used color filter techniques during the 2000-2001 Eastern (Evening) Apparition, and

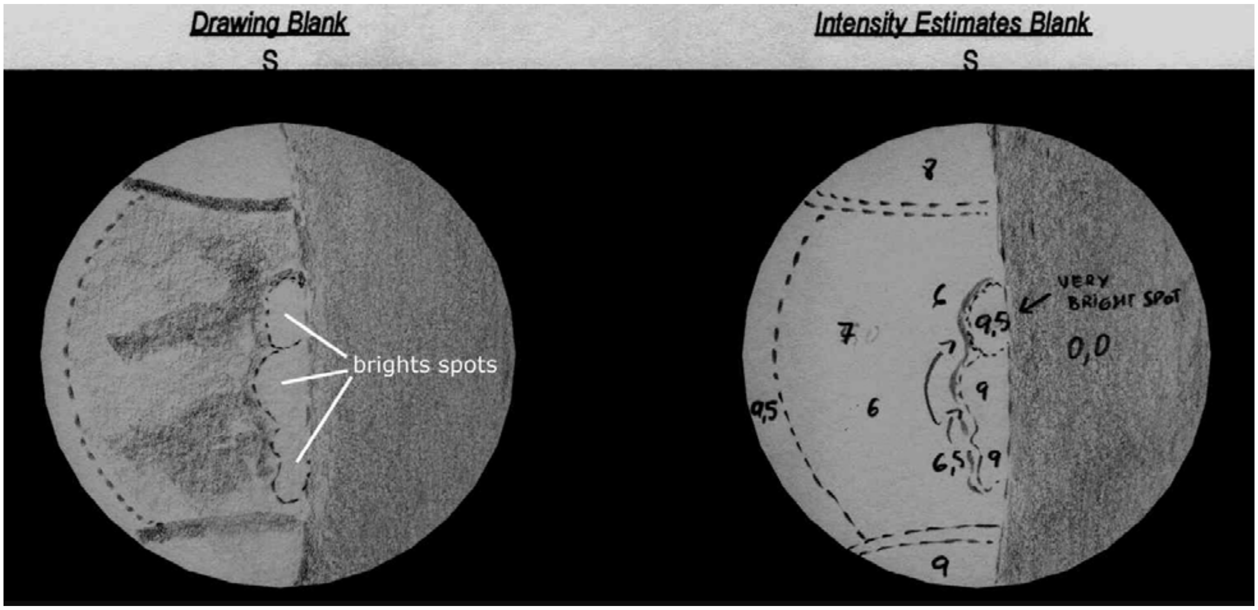


Plate 5. 2000 Dec 18 17:25 UT. Tòbol Tobal. Drawing. 10.2-cm (4.0-in) REF 154X, Yellow Filter. Seeing 5.0 . Phase (k) = 0.642, Diam. = 18".5.

when results were compared with studies in integrated light, it was clearly evident that color filters and variable-density polarizers enhanced the visibility of otherwise indistinct atmospheric features on Venus.

The Bright Limb Band

Figure 4 shows that 71% of the submitted observations in 2000-2001 called attention to a conspicuous "Bright Limb Band" on the illuminated hemisphere of Venus. When the Bright Limb Band was reported, it appeared as a continuous, brilliant arc running from cusp to cusp 67.58% of the time, and interrupted or only marginally visible along the limb of Venus in 32.53% of the positive reports. The mean numerical intensity of the Bright Limb Band was 9.8, becoming more pronounced when color filters or variable-density polarizers were utilized. This dazzling, bright feature that more-often-than-not was apparent to visual observers was captured on some of the CCD images of Venus submitted in 2000-2001.

Terminator Irregularities

The terminator refers to the geometric curve that separates the bright sunlit and dark hemispheres of Venus. A deformed or asymmetric terminator was reported in only 22.2% of the observations in 2000-2001. Amorphous, banded, and irregular dusky atmospheric markings often seemed to merge with the terminator shading, possibly contributing to the incidence of suspected irregularities. Filter techniques generally improved the visibility of terminator asymmetries and closely associated dusky atmospheric features during 2000-2001. Due to irradiation, bright features adjacent to the terminator can sometimes appear as bulges, while particularly dark features may look like dusky hollows.

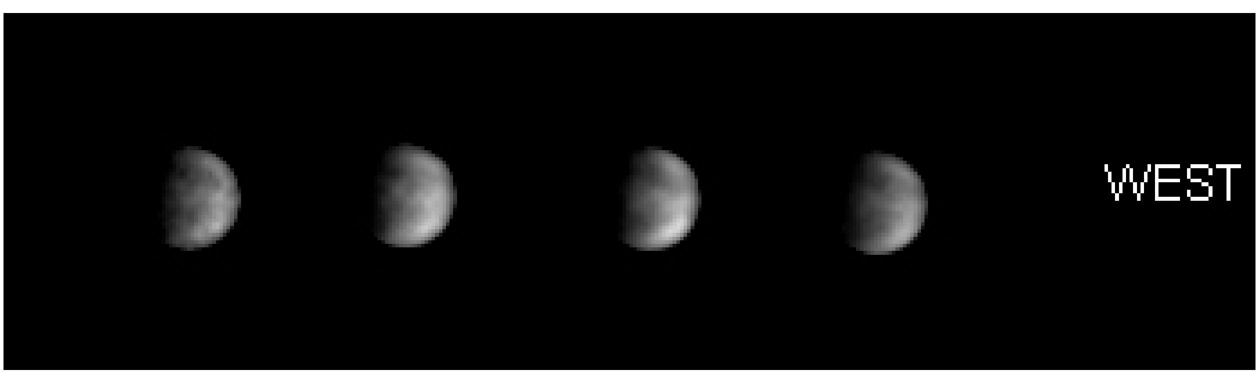


Plate 6. 2000 Dec 24 21:12-21:30 UT. Frank J. Melillo. CCD image. 20.3-cm (8.0-in) SCT, Schott UG-1 UV Filter w/ IR blocker, Starlight Xpress MX-5 CCD 3 sec f/20. Seeing 5.5. Phase (k) = 0.617, Diam. = 19".5.

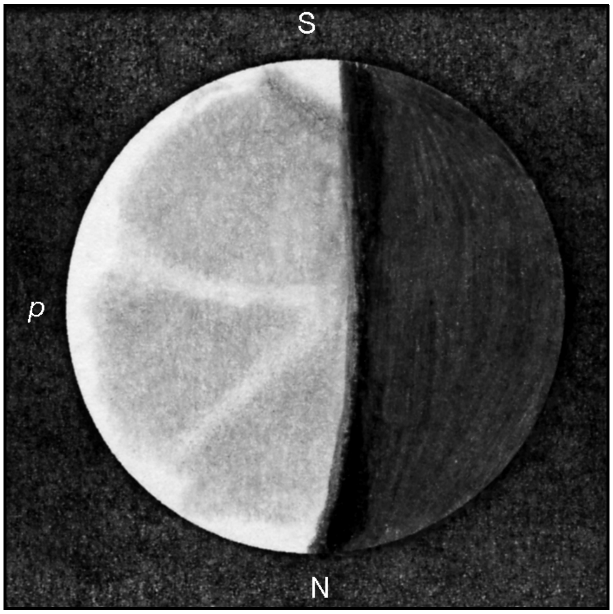


Plate 7. 2000 Dec 29 22:32-23:00 UT. Daniel del Valle. Drawing. 20.3-cm (8.0-in) SCT 225X, W47 (dark blue), W12 (yellow), W80A (blue) Filters. Seeing 7.0. Phase (k) = 0.597, Diam. = 20".3

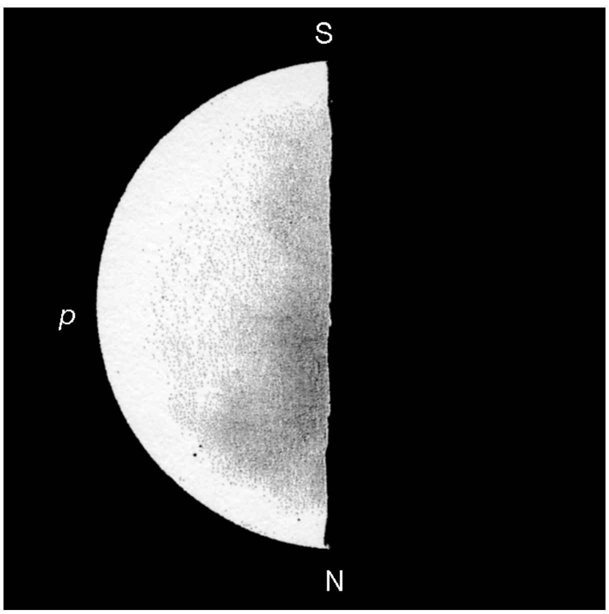


Plate 8. 2001 Jan 13 17:28-17:52 UT. Ed Crandall. Drawing. 25.4-cm (10.0-in) NEW 225X, W15 (yellow), W47 (dark blue), W25 (red), W58 (green) Filters. Seeing 8.0. Phase (k) = 0.529, Diam. = 23".4.

Cusps, Cusp-Caps, and Cusp-Bands

When the *phase coefficient* (the fraction of the disc that is illuminated), $\boldsymbol{k}$, is between 0.1 and 0.8 , atmospheric features on Venus with the greatest contrast and overall prominence are consistently sighted at or near the planet's cusps, bordered sometimes by dusky cusp-bands. *Figure 5* shows the visibility statistics for Venusian cusp features in the 2000-2001 Eastern (Evening) Apparition.

When the northern and southern cusp-caps of Venus were reported in 2000-2001, *Figure 5* shows that these features were equal in size 41.4% of the time and equal in brightness in 47.88% of the observations. The southern cusp-cap was considered larger 48.69% of the time and brighter in 39.1% of the observations, while the northern cusp-cap was larger in only 10.0% of the observations and brighter 13.0% of the time. Neither cusp-cap was visible in 44.3% of the observational reports. The mean relative intensity of the cusp-caps was about 9.8 during the 2000-2001 observing season. No dusky cusp-bands were detected flanking the bright cusp-caps in 84.1% of the observations when cusp-caps were visible. When seen, the cusp-bands displayed a mean relative intensity of about 6.9 (see *Figure 5*).

Cusp Extensions

Figure 5 also illustrates that there were no cusp extensions detected in integrated light or with color filters beyond the 180° expected from simple geometry in 84.1% of the observations. Later during the apparition, as Venus progressed into crescentic phases approaching superior conjunction (2001 March 30), observers sporadically recorded cusp extensions ranging from 2° to 45°. Just before this date, a handful of observers suspected that the cusp extensions connected with one another along the planet's unilluminated limb, producing a strikingly beautiful halo encircling the dark hemisphere of Venus. Suspected cusp extensions were apparent on several drawings that were submitted, with observers noting that variable-density polarizers improved their visibility. With the exception of Melillo's images on 2001 March 25, where slight cusp extensions are apparent, cusp extensions were not clearly indicated on any photographs or CCD images received. Experience has shown that cusp extensions are very difficult to document on film because sunlit regions of Venus are so much brighter than the faint extensions. Nevertheless, observers are encouraged to continue to try to record cusp extensions using CCD imagers in future apparitions.

Estimates of Dichotomy

A discrepancy between the predicted and the observed dates of dichotomy (half-phase), known as the "Schröter Effect" on Venus, was not reported by any observers during the 2000-2001 Eastern (Evening) Apparition (i.e., no observers submitted estimates during the apparition). The predicted half-phase occurs when $\boldsymbol{k}$ = 0.500, and the phase angle,

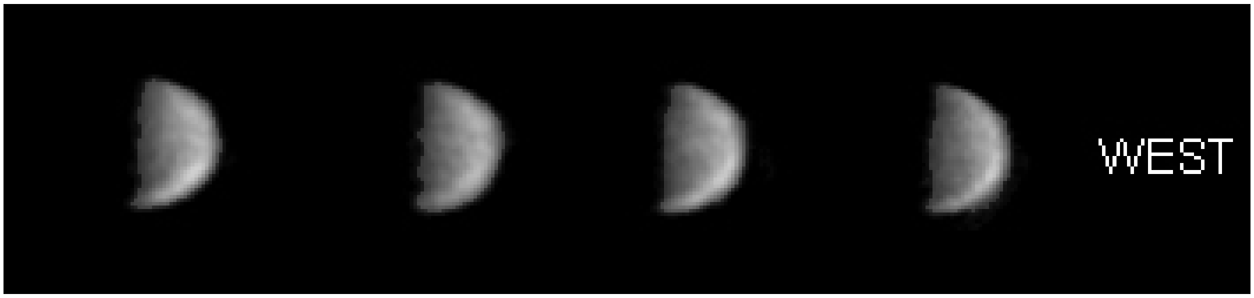


Plate 9. 2001 Jan 13 21:05-21:30 UT. Frank J. Melillo. CCD image. 20.3-cm (8.0-in) SCT, Schott UG-1 UV Filter w/ IR blocker, Starlight Xpress MX-5 CCD 1.5 sec f/20. Seeing 4.5. Phase (k) = 0.529, Diam. = 23".5.

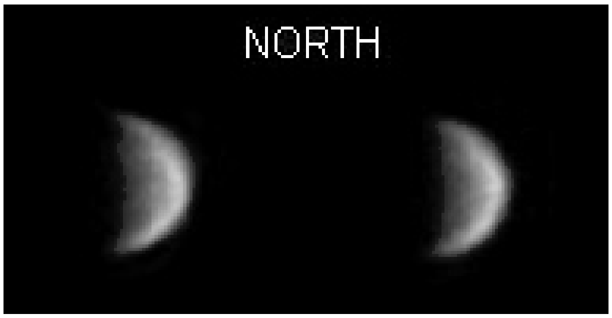


Plate 10. 2001 Jan 28 22:00-22:15 UT. Frank J. Melillo. CCD image. 20.3-cm (8.0-in) SCT, Schott UG-1 UV Filter w/ IR blocker, Starlight Xpress MX-5 CCD 2 sec f/20. Seeing 6.5. Phase (k) = 0.446, Diam. = 27".8.

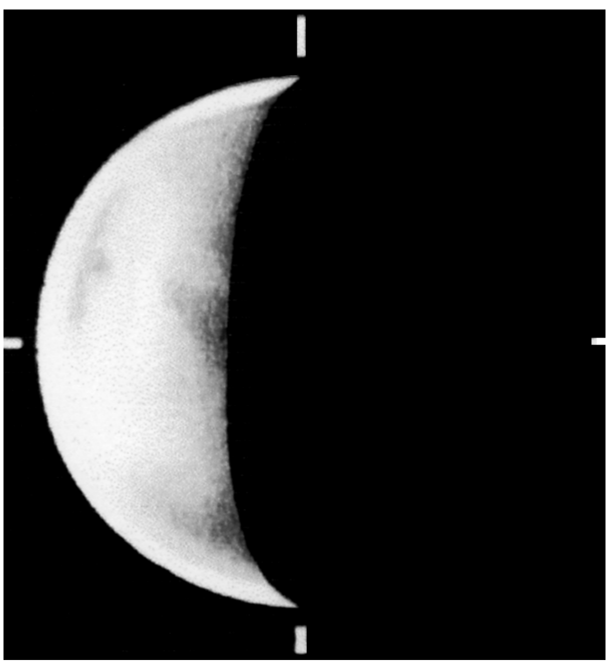


Plate 11. 2001 Feb 12 16:47 UT. Mario Frassati. Drawing. 20.3-cm (8.0-in) SCT 250X, W56 (light green) Filter. Seeing 5.0 (interpolated). Phase (k) = 0.348, Diam. = 33".8.

i, between the Sun and the Earth as seen from Venus equals 90°.

Dark Hemisphere Phenomena and Ashen Light Observations

The Ashen Light phenomenon, first reported by G. Riccioli in 1643, refers to an extremely elusive, faint illumination of Venus' dark hemisphere. Although it does not have the same origin, the Ashen Light is said to resemble somewhat Earthshine on the dark portion of the Moon. Many observers are in agreement that Venus must be viewed against a totally dark sky for the Ashen Light to be seen, but these "ideal" circumstances occur only when the planet is extremely low in the sky where bad seeing adversely affects viewing.

Also, substantial glare from Venus in contrast with the surrounding dark sky influences such these types of observations.

Despite all of this, the ALPO Venus Section continues to receive reports from seasoned observers, looking at the planet in twilight, who are completely convinced they have seen the Ashen Light, and so the controversy continues. Based on encouragement by the author, Melillo started imaging Venus during crescentic phases in 2000-2001 to try to capture any dark side illumination, although there have been no positive results so far. Hopefully, more observers will begin likewise imaging Venus, and ideally in a real simultaneous observing effort with visual observers, it will be possible to objectively assess any visual suspicions of the Ashen Light.

During the 2000-2001 eastern (evening) apparition, there were virtually no occasions (99.4% of the observations) when the Ashen Light was suspected in integrated light, color filters, or variable-density polarizers (i.e., only one observer vaguely suspected dark-side illumination in extremely bad seeing). There were also essentially no instances in 2000-2001 when observers thought the dark hemisphere of Venus actually looked darker than the background sky, a phenomenon that is almost certainly a contrast effect.

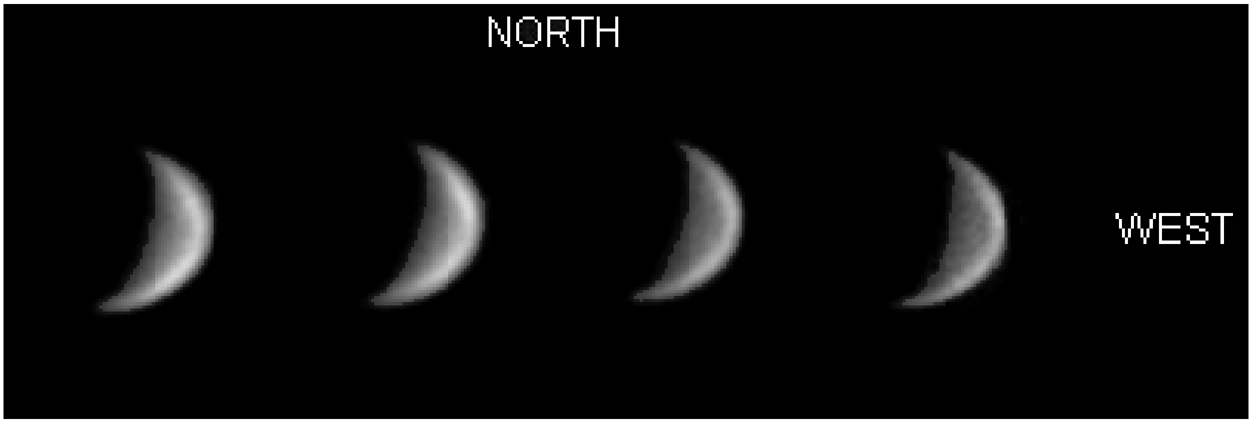


Plate 12. 2001 Feb 12 22:00-22:20 UT. Frank J. Melillo. CCD image. 20.3-cm (8.0-in) SCT, Schott UG-1 UV Filter w/ IR blocker, Starlight Xpress MX-5 CCD 1.5 sec f/20. Seeing 6.0. Phase (k) = 0.346, Diam. = 34".0.

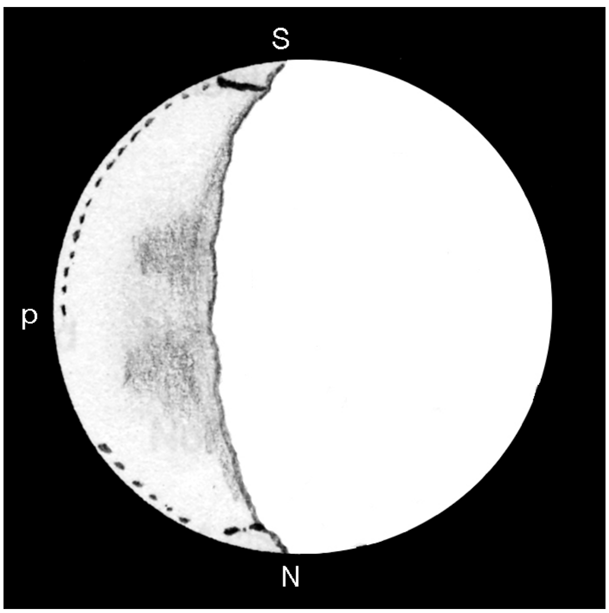


Plate 13. 2001 Feb 17 23:39-23:59 UT. Ray Berg. Drawing. 20.3-cm (8.0-in) SCT 266-322X, W80A, W47, W25, W58 (green), W21 (orange) Filters. Seeing 7.0, Transparency 5.0. Phase (k) = 0.307, Diam. = 36".6.

Conclusions

The outcome of our analysis of ALPO visual and photographic observations of Venus during the 2000-2001 eastern (evening) apparition suggests only marginal activity in the atmosphere of the planet. It must be reiterated, however, that it is very difficult to differentiate between what may constitute real atmospheric phenomena on Venus and what is merely illusory at visual wavelengths. Greater confidence in observer's results will improve as the number of program participants and the incidence of simultaneous observations increases.

It is important to emphasize that drawings of Venus are a vital part of our overall program and will remain so, but there is a need to increase simultaneous observations by individuals in close relative proximity to one another. The intent is to improve the opportunity for confirmation of highly elusive atmospheric phenomena, to introduce more objectivity, and to standardize observational techniques and methodology. More and more of our observers are now using CCD imaging of the planet at different wavelengths, a very encouraging and worthwhile trend.

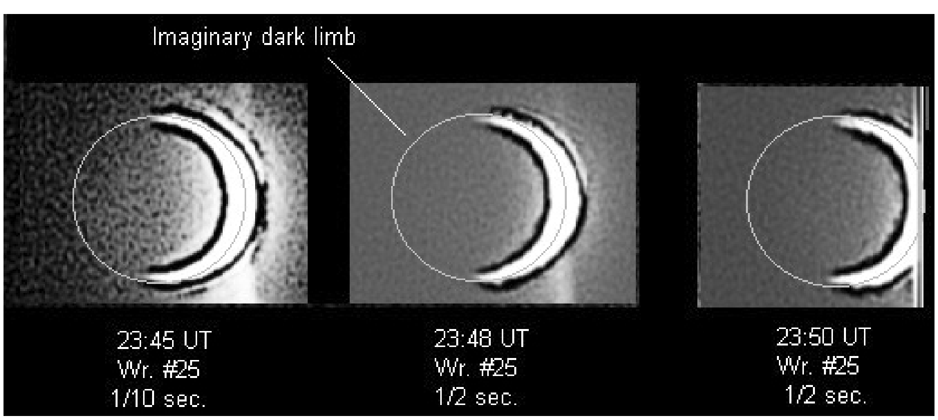


Plate 14. 2001 Mar 10 23:45-23:50 UT. Frank J. Melillo. CCD image. 20.3-cm (8.0-in) SCT, W25 (red) Filter, Starlight Xpress MX-5 CCD 0.1-0.5 sec . Seeing 8.0. Phase (k) = 0.120, Diam. = 50".5

In addition to routine visual and photographic work, the ALPO Venus Section is actively seeking observers who will embark on a systematic program of ultraviolet photography of the planet as exemplified by the ambitious, excellent work of Melillo.

ALPO studies of the Ashen Light, which peaked during the Pioneer Venus Orbiter Project, are continuing every apparition. Constant monitoring of the

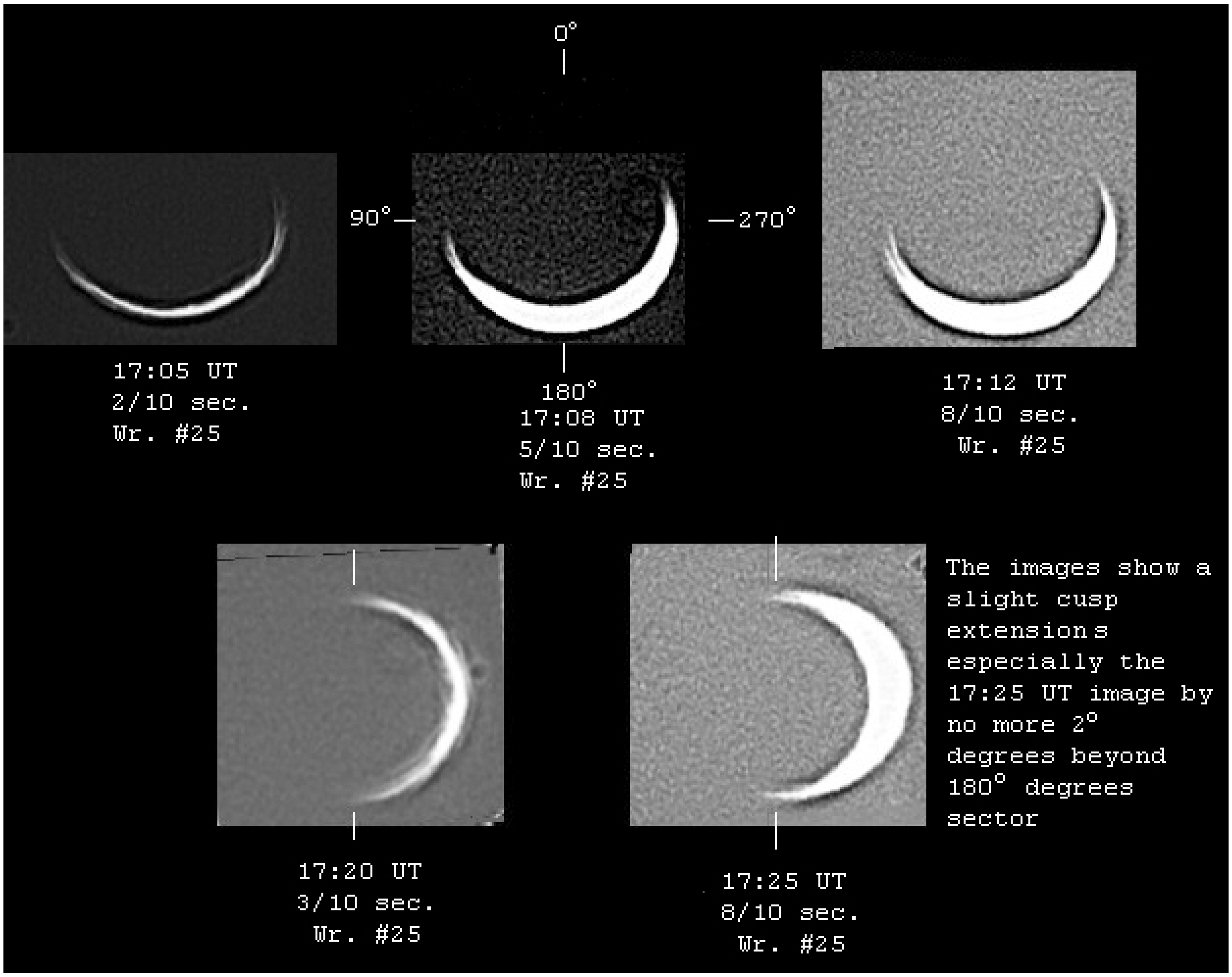


Plate 15. 2001 Mar 25 17:05-17:25 UT. Frank J. Melillo. CCD image. 20.3-cm (8.0-in) SCT, W25 (red) Filter, Starlight Xpress MX-5 CCD 0.2-0.8 sec . Seeing 5.0. Phase (k) = 0.019, Diam. = 58".5.

planet for the presence of this phenomenon by a large number of observers (ideally participating in a simultaneous observing program) remains important as a means of improving our chances of capturing confirmed dark hemisphere events.

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

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Feature Story:

A Study About an Unlisted Dome Near the "Valentine Dome"

For Online Readers

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By K.C. Pau and *Raffaello Lena* and the Geologic Lunar Research Group

Abstract

We describe a dome located at ξ +.151 and η +.528 (longitude +10.26°, E latitude 31.89° N) that is not in the ALPO Lunar Dome Survey database. It requires a very low angle of illumination to be visible.

Introduction

Lunar domes are gentle swells between 3 and 60 km across, and at most a few hundred meters in height. Domes probably formed by either of two modes:

- As surface lava flows analogous to Hawaiian shield volcanos. These formed at the end of a lunar volcanic era, when the rate of extrusion was lower and the temperature of eruption was lower; or
- As subsurface intrusions similar to laccoliths on Earth. [Wilhelms, 1987]

The name "Valentine Dome" was coined by Alika Herring for the well-known feature at ξ +.152 and η+.510 (long +10.18°, lat +30.66°) [*Hill, 1991*]. Two recent papers focus on its subtle surface features and particularly its rille [*Lena, Pau, and Fattinnanzi, 2003; Douglas, 2004]*. Recently, we detected near the Valentine Dome the presence of another smaller dome that is the subject of this paper. The use of CCD imaging enabled us to extract additional information about this dome. As a result of this study, this new dome has been added to the ALPO Lunar Dome Catalog.

Observations

The Geologic Lunar Research Group observed the Valentine Dome in a coordinated program from 1998 to 2003. On October 16, 2003, at 19:02 UT, Pau obtained a CCD image of a flat dome located to the north of the Valentine Dome (co-longitude 165.13°, solar altitude 4.26°). This observation was carried out

Figure 1. The larger, low, central oval is the well-known Valentine Dome. Arrowed below (north) of it is the newly detected dome. Illumination is from the right. In this image and the other images in this article, south is at the top and east is to the left. See text for imaging circumstances of this and the other images.

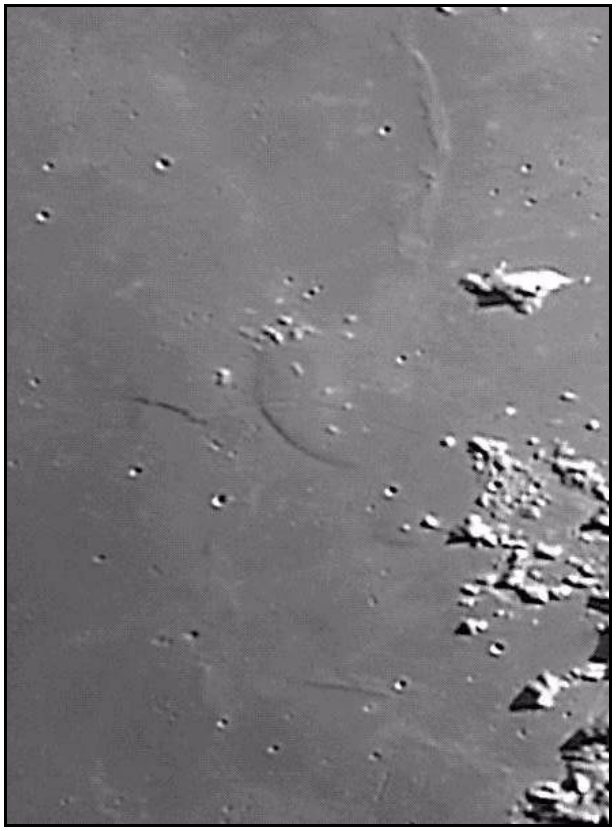

Figure 2. The same area as Figure 1, but at a higher solar angle.

under good seeing conditions using a 250mm f/6 Newtonian telescope (*Figure 1*). The image reveals much fine detail in the dome, including two small prominences. (Incidentally, the same image clearly shows the very elusive rille that crosses the Valentine dome). In another CCD image by Pau taken on September 16, 2003, at 21:11 UT (co-longitude 160.43°, solar altitude 8.69°), the dome is barely evident (*Figure 2*). Thus, one can detect this dome only at very low solar altitudes.

Lena made an observation of this region at even lower solar altitude at 17:35 UT on November 30, 2003, using a 100mm refractor at f/15 (co-longitude = 352.49°, solar altitude 2.061°). The seeing was 7-8 on the ALPO scale. *Figure 3* is the drawing by Lena showing the dome. A further image was obtained by Pau on November 30, 2003 at 13:12 UT (*Figure 4*), at co-longitude 350.275°and solar altitude 0.20°. It shows three low mare domes emerging from shadow. The new one is labelled "1", the Valentine Dome is labelled "2", and a broad, very low third dome is labelled "3". Numbers "2" and "3" are already in the ALPO lunar dome list. Another fine image revealing the unlisted dome was sent to GLR by Jim Phillips (*Figure 5*). The image was obtained by Phillips using a TMB 8-inch f/9 apochromatic refractor; however, the date and time of exposure are unknown.

In communications with other observers about this dome, we received a drawing by Massimo Cicognani that shows the dome. John Westfall, Harry Jamieson and Eric Douglas reviewed our images and agreed that the unlisted structure is a real dome.

Analysis of the Dome Images

We measured the dome by enlarging the images, counting the number of pixels in the object of interest, and then converting this into kilometers per pixel. The results for the unlisted dome are as follows:

- Position: ξ +.151, η +.528
- Dimensions: 14 km x 11 km
- Westfall classification: DW/2b/5g/8p [*Westfall, 1964*].

It appears to have a flat top, which is unlike Earth's shield volcanos. This supports the possibility that it was formed by a subsurface intrusion of magma. In our observations, the shading on its antisolar slopes are not black, indicating that the slopes are of very low inclination. The images show two protrusions on the dome. Their nature has not been determined, but two possible mechanisms of their origin are: (a) they were pre-existing peaks of the adjacent Montes Caucasus that were embayed by the dome, or (b) they

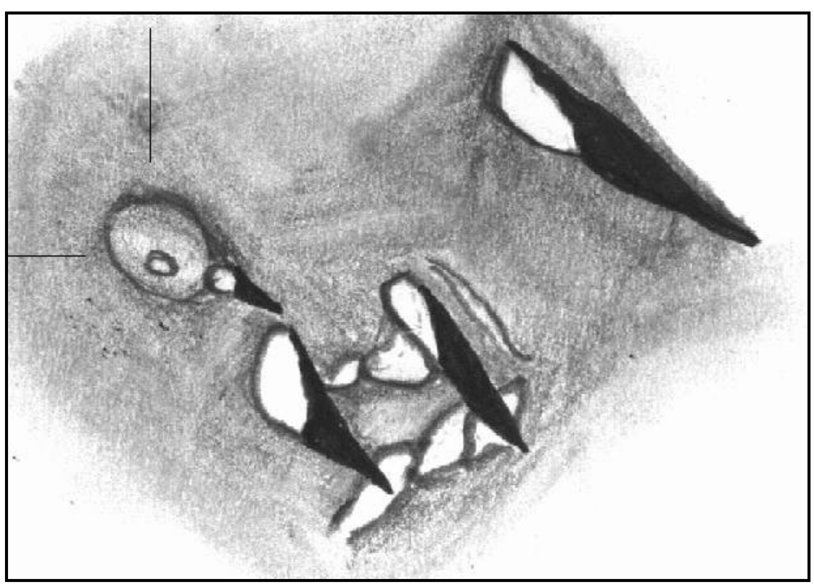

Figure 3. Lena's drawing of the dome and nearby mountains, illuminated from the left.

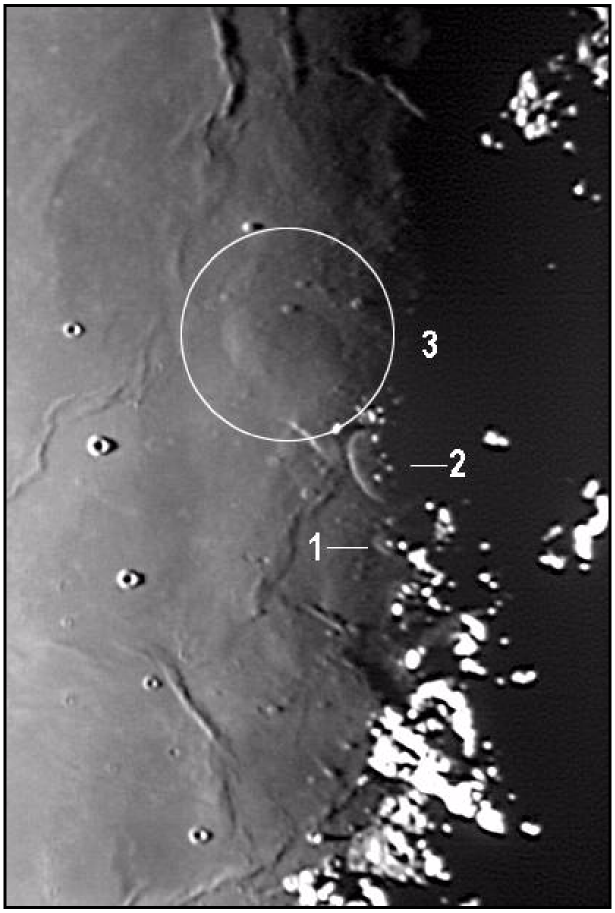

Figure 4. A broader view of the same region at even lower solar angle. The new dome is labelled 1, the Valentine Dome is labelled 2, and another previously listed dome is labelled 3.

are cinder cones that formed after the dome. [*Wilhelms, 1987*]

It resembles a miniature of the famous Valentine Dome. Given the geologic setting of that structure [*Douglass, 2004*], we think that the unlisted dome is a bona fide lava dome.

Comments

Our study of this dome illustrates both the elusive nature of these volcanic structures and the utility of CCD imaging and digital image analysis in the elucidation of their character.

It also illustrates the fruitfulness of the revitalized ALPO Lunar Dome Survey. We hope that this report will stimulate increased cooperation among lunar observers worldwide. The GLR has an ongoing project to discover such domes, and we are now studying further the slope, height and geological setting of the dome described here. Clearly, more work is needed in this challenging area.

This dome was added to the unpublished revised Lunar Dome Catalogue by Robert A. Garfinkle, and to the unpublished revised list by Charlie Kapral (personal communications).

Acknowledgements

Many thanks to J. Westfall, E. Douglass, H.D. Jamieson, R. A. Garfinkle and B. Dembowsky for their stimulating discussions.

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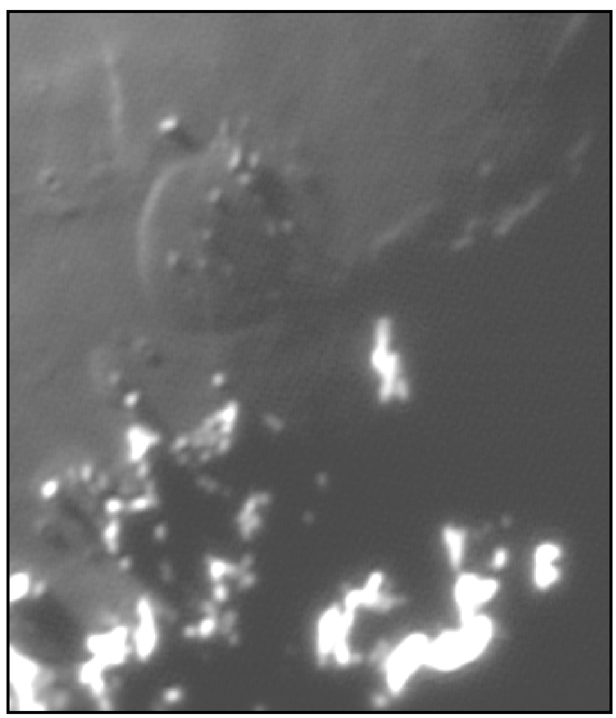

Figure 5. Image by Jim Phillips showing the unlisted dome.

Feature Story:

ALPO Observations of the 2003 Apparition of Mars

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By: *Richard Schmude, Jr.*, *Dan Troiani, Jeff Beish*, *Deborah Hines*, *Rich Jakiel*, *Daniel Joyce*, *Don Parker*, **Doug West and Jim Wood**

Abstract

The South Polar Cap (SPC) of Mars was larger during the early Martian spring of 2003 than in 1924, 1939, 1956 and 1988. Maps of the SPC were made at 4º increments of L_S and these reveal how the cap shrunk during spring. Three regional dust storms developed in July (2), and Dec., and four local storms probably developed in Aug. and Sep. near the SPC. Polarization measurements show that the Dec. storm had not settled until Jan. 23. The selected normalized magnitudes of Mars are: B(1,0) = 0.01, V(1,0) = -1.45, R(1,0) = -2.60 and I(1,0) = -3.06.

Introduction

Two big discoveries were made by professional astronomers during the 2003 apparition: Mars had liquid water on its surface in the past (Cowen, 2004a, 195) and Mars currently has methane in its atmosphere (Cowen, 2004b). The second discovery is significant because methane quickly escapes from Mars and so methane is currently being replenished.

Amateurs recorded thousands of images of Mars during 2002-2004; for example, 2,451 Mars images were on the Association of Lunar and Planetary Observers (ALPO) website; 5,076 images were on the International MarsWatch website and 9876 images were on the ALPO-Japan website. In many cases, these images had resolutions near 0.1 arc-second per pixel. Furthermore, 830 additional drawings and other measurements were made that were not posted on websites. This report summarizes work done by amateurs.

Astronomers of the International Mars Patrol (IMP), an ALPO Mars Section observing program, are credited with an above average number of quality visual and photographic observations during the 2003 Mars apparition. This effort resulted form the close cooperation between observers of the IMP, organized in the 1960's by ALPO's senior Mars recorder Charles F. (Chick) Capen. Between 1962 and 2004 the IMP has collected over 38,000 observations of Mars by over 800 individual amateur and professional observers. During the 2003 apparition, 245 people from 32 different countries and regions submitted observations.

Thanks to the improved instrumentation available to amateurs, quality observations could be performed when Mars's apparent diameter is as small as 4 arc-seconds. This resulted in observational coverage from late Martian southern hemisphere autumn in 2002 (L_s = 94.1°) to early autumn in 2004 (L_s = 38.1°) – nearly one Martian year! Such complete coverage has never been previously achieved.

Table 1 lists the characteristics of the 2003 apparition and *Table 8* lists the people who submitted observations during the 2003 apparition. *Figure 1* shows images of Mars made in 2003-04 and *Figure 2* shows drawings of Mars made in 2003.

Table 1: Characteristics of the 2003 Apparition of Mars; Data from The Astronomical Almanac for the Years 2002-2004

First Conjunction	10 Aug 2002
Opposition	28 Aug. 2003
Second Conjunction	15 Sep. 2004
At Opposition	
Equatorial Diameter	25.1 arc-seconds
Magnitude	-2.9
Geocentric declination of Mars	-15.8º
Declination of the Sun	-23.8º
Declination of Earth	-19.0º

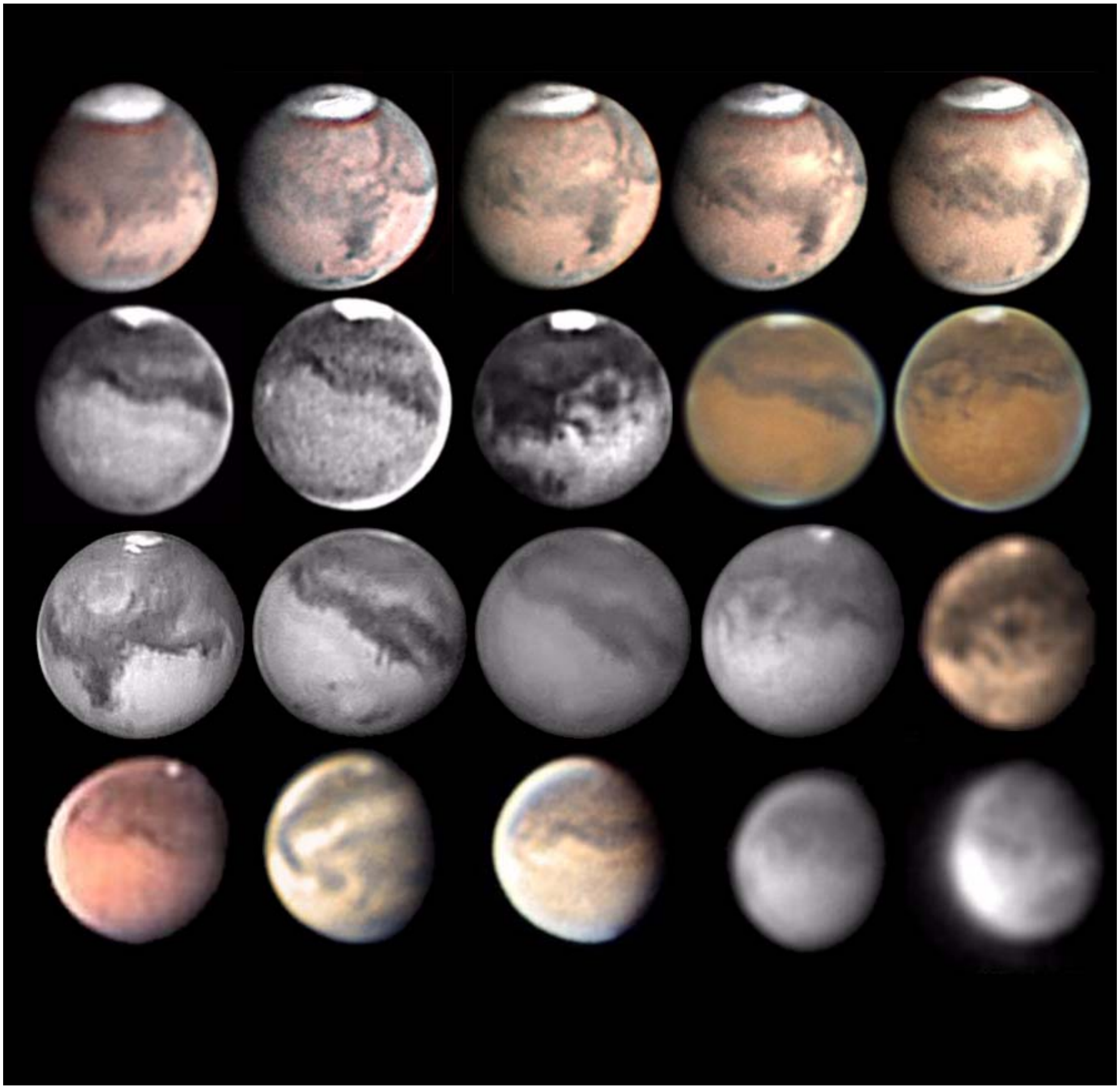

Figure 1: Images of Mars made in 2003-04 arranged in chronological order; CM = longitude of the central meridian; R = red, G = green, I = infrared and RGB = color image made from red, green and blue images. South is to the top and the preceding limb is to the left in all images. TOP ROW-left: June 19, 2003, CM = 19ºW, Parker, RGB; 2nd left: July 1 CM = 273ºW, Parker, RGB; 3rd left: July 2 CM = 262ºW, Parker, RGB; 4th left: July 3 CM = 256ºW, Parker, RGB; 5th left: July 4 CM = 244ºW, Parker, RGB; SECOND ROW-left: Aug. 15 CM = 164ºW, Sherrod, R; 2nd left: Aug. 17 CM = 176ºW, Sherrod, G; 3rd left: Aug. 27 CM = 67ºW, Sherrod, R; 4th left: Aug. 27 CM = 193ºW, Velden, RGB; 5th left: Sep. 4 CM = 123ºW, Velden, RGB; THIRD ROW-left: Sep. 5 CM = 317ºW, Schmidt, R; 2nd left: Sep. 6 CM = 210ºW, Lazzarotti, R; 3rd left: Sep. 6 CM = 210ºW, Lazzarotti, G; 4th left: Oct. 6 CM = 123ºW, Valimberti, R; 5th left: Sep. 6 CM = 210ºW, Lazzarotti, R; FOURTH ROW-left: Dec. 4 CM = 156ºW, Maxson, RGB; 2nd left: Dec. 15 CM = 19ºW, Parker, RGB; 3rd left: Jan. 7, 2004, CM = 159ºW, Parker, RGB; 4th left: Feb. 8, 2004, CM = 110ºW, Pellier, I; 5th left: Apr. 6, 2004, CM = 12ºW, Parker, R.

South Polar Cap (SPC)

Schmude constructed a series of maps of the SPC from hundreds of images; see *Figure 3*. Images made by: Adelving, Akutsu, Bates, Canapine, Chaikin, Chavez, Chuen, Clark, Colville, Croman, Fattinnanzi, Faworski, Fiobo, Grafton, Guidoni, Hatton, Hauwermeiren, Jacobson, Kumamori, Kusakai, Lau, Lazzarotti, Leong, Melillo, Mills, Moore, Ng, Owens, D. Parker, T. Parker, Pau, Peach, Pellier, Schmidt, Shank, Sheng, Sherrod, So, Tasselli, Williamson, Yan, Yu, Zannelli and Zanotti were used in constructing maps of the SPC. In almost all cases, red light images were used because Parker and Beish

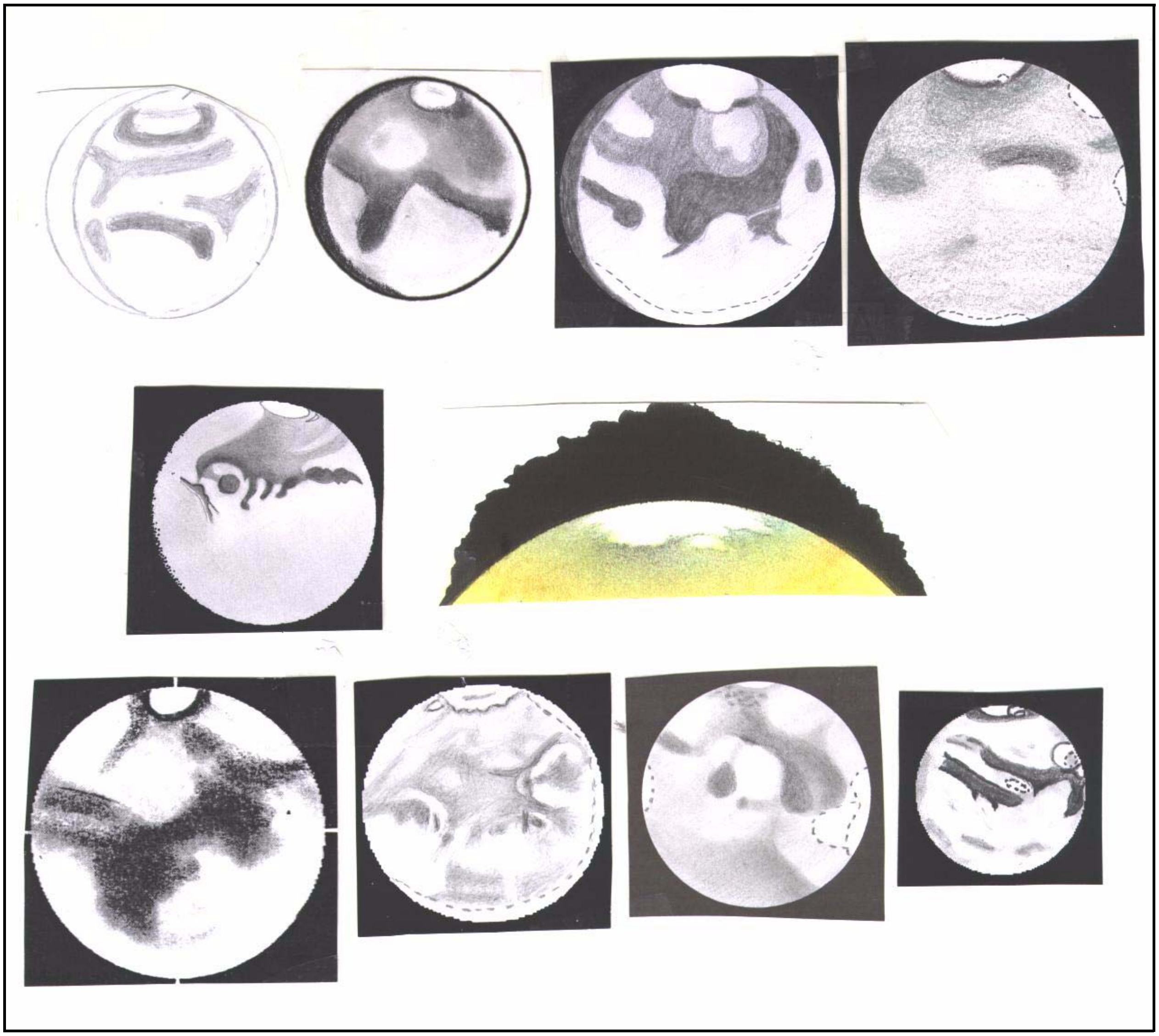

Figure 2: Drawings of Mars made in 2003 arranged in chronological order; CM = longitude of the central meridian. South is at the top in all drawings and in all drawings (except on Aug. 25) the preceding limb is to the left. On Aug. 25, the preceding limb is to the right. TOP ROW-left: June 26, 2003, CM = 340ºW, Haas, seeing = 2-3; 2nd left: June 27, CM = 294ºW, Albert, seeing = 7-8; 3rd left: July 15, CM = 28ºW, Siegel, Seeing = 7 (Ant. = II); 4th left: Aug. 15, CM = 140ºW, Schmude, Seeing = 8; SECOND ROW-left: Aug. 23, CM = 104ºW, Kenyon, seeing = 10; 2nd left: Aug. 24, CM = 330ºW, Baum, seeing = 7 (Ant. = II); THIRD ROW-left: Aug. 25, CM = 298ºW, Niechoy, seeing = 5; 2nd left: Aug. 26, CM = 38ºW, Boyar, seeing = 4-7; 3rd left: Aug. 31, CM = 75ºW, Sweetman, seeing = 5-6; 4th left: Sep. 11, CM = 242ºW, Budine, seeing = 7-8.

found that red light penetrates polar hazes better than other wavelengths. Maps of the SPC were made every 4° of areocentric longitude (L_s). The areocentric longitude is the angle between Mars and the vernal equinox of that planet measured from the Sun. Spring and summer for Mars' southern hemisphere begin at $L_s = 180°$ and $L_s = 270°$. The SPC had three large projections: Novus Mons, Thyles Mons and Mons Argenteus.

Grafton imaged a small bright spot within the SPC on June 18 ($L_s = 205°$); this spot was at 26°W, 65°S, which is the location of Mons Argenteus. One day later, Mons Argenteus appeared as a bright spot within the SPC; there was a projection at 27°W and a small rift at 34°W. Mons Argenteus was a double bright projection in Ng's July 3 image ($L_s = 214°$). The average positions of this feature during July 27–31 ($L_s = 229°$-$232°$) were: first projection: 23°±2°W, small rift 33°±2°W and second projection: 44°±2°W. The development of Mons Argenteus followed three steps:

1. Bright spot with a small rift near 33°W: ($206° < L_s < 214°$)

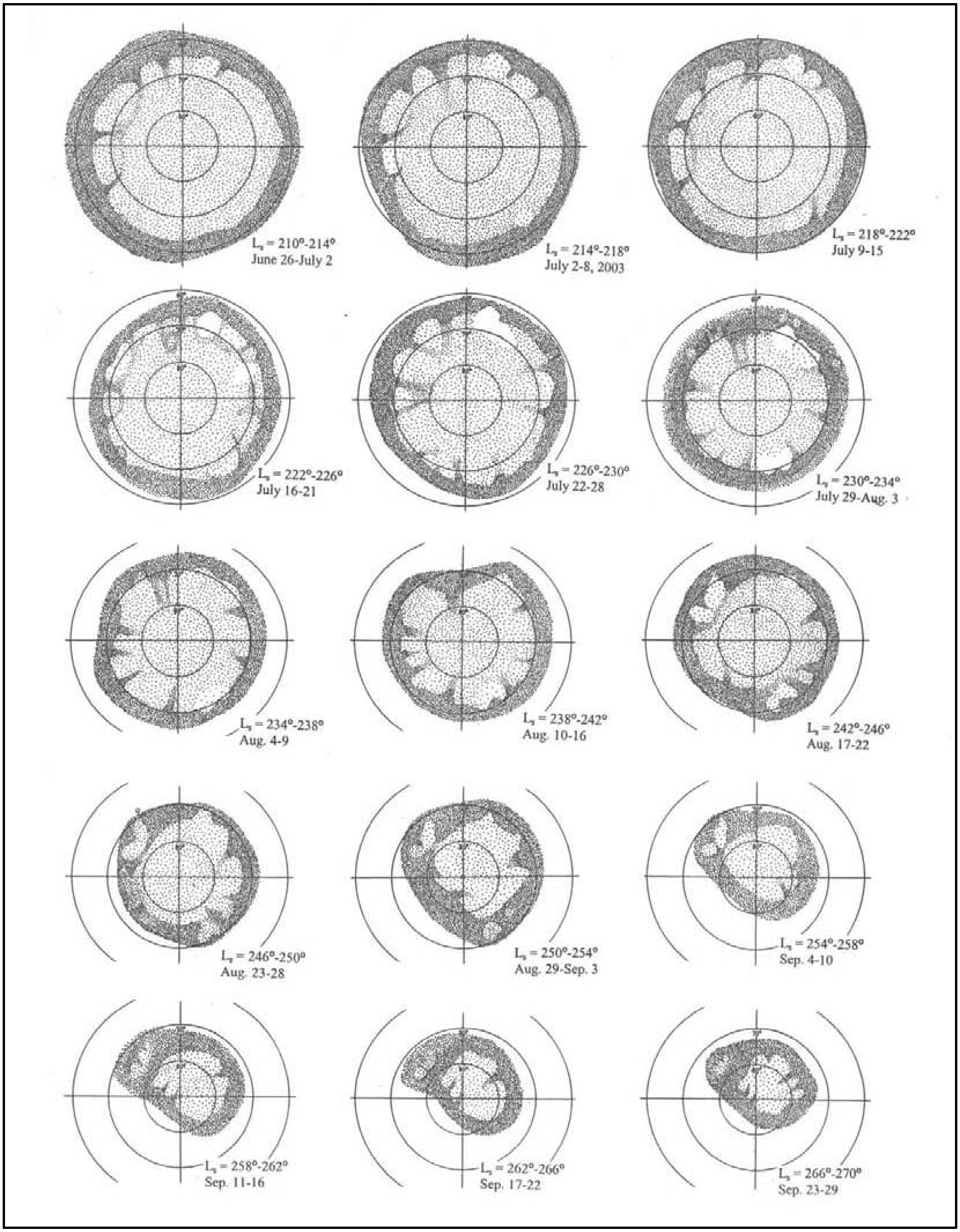

Figure 3: A series of 15 drawings of the Martian South Polar Cap (SPC). The dark ring around the SPC is the Martian Surface and the dark polar collar. Longitudes are: top = 0ºW, right: 90ºW, bottom: 180°W and left: 270°W. Each circle represents 10° of latitude.

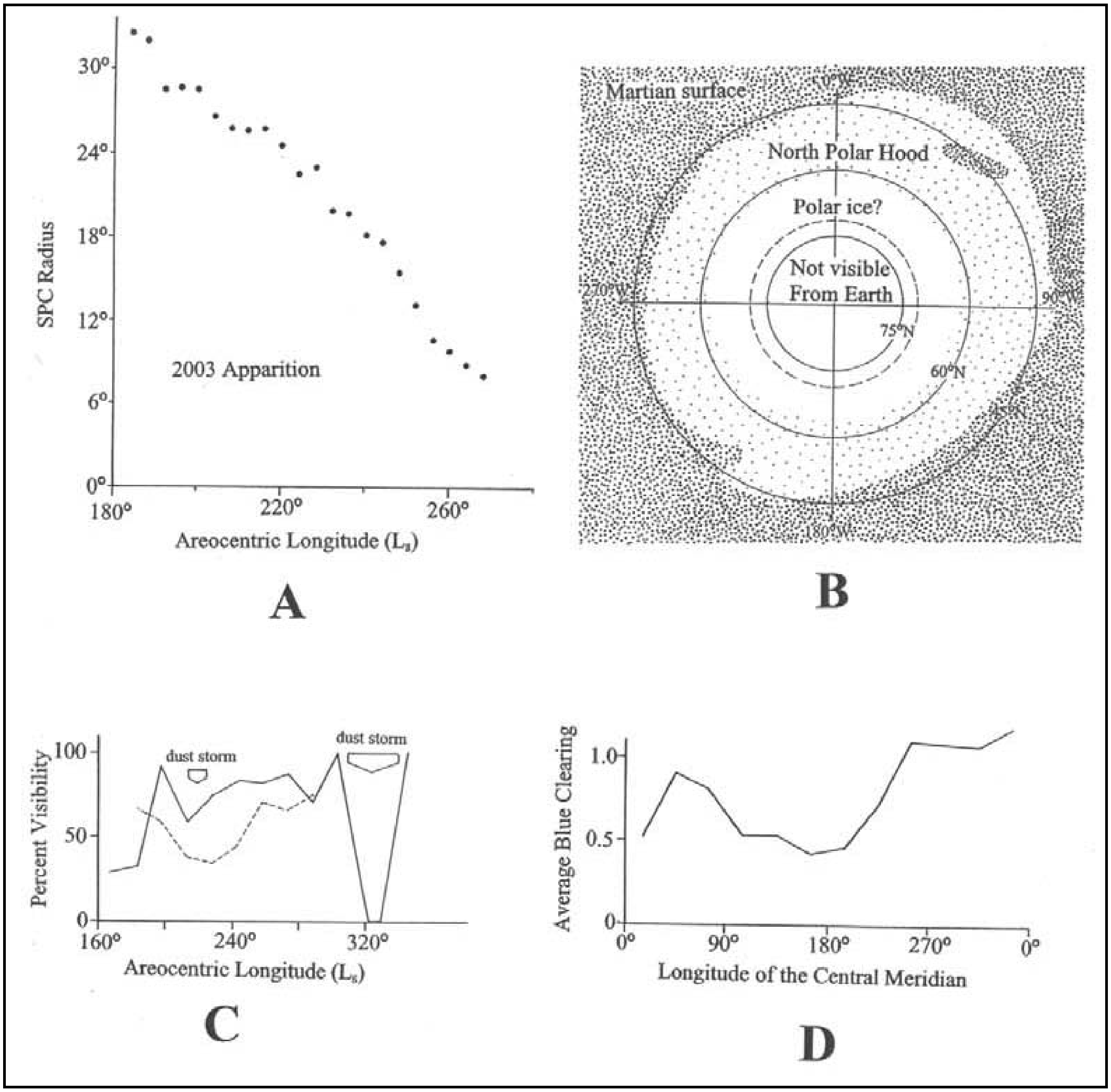

Figure 4-A: The radius of the South Polar Cap (SPC) plotted against the areocentric longitude of Mars. The approximate dates are: May 6 for L_s = 180°, July 12 for L_s = 220° and Sep. 13 for L_s = 260°. Figure 2-B: A map of the Martian North Polar Cap and Hood. This map was constructed from images made on August 26 and 27, 2003; two of the images used were made by the Hubble Space Telescope. The dashed circle at 71°N represents the area that could not be imaged from the Earth due to Mars' tilt. Figure 2-C shows the percent visibility of the north polar hood (solid line) and discrete clouds (dashed line). Figure 2-D shows the average blue clearing plotted as a function of the longitude of the central meridian.

2. Double projection: (214° < L_s < 253°)
3. Single broad projection: (253° < L_s < 261°)

Mons Argenteus is shown in *Figure 1*, second row, third image from the left and in *Figure 2*, first row, third image from the left.

Lazzarotti and Crudeli imaged Thyles Mons on June 30 (L_s = 213°) at 160°W; it was a small, northward projection on the SPC. This projection was not present on Dierick's June 29 image. The average longitude of Thyles Mons during July 9-14 (L_s = 218°-221°) was: 159°±2°W. The development of Thyles Mons followed three steps: projection: (213° < L_s < 253°); bright spot separated from the SPC: (253° < L_s < 261°) and disappearance after L_s = 261°. Thyles Mons is shown in *Figure 1*, second row, first and second images from the left and in *Figure 2*, first row, fourth image from the left.

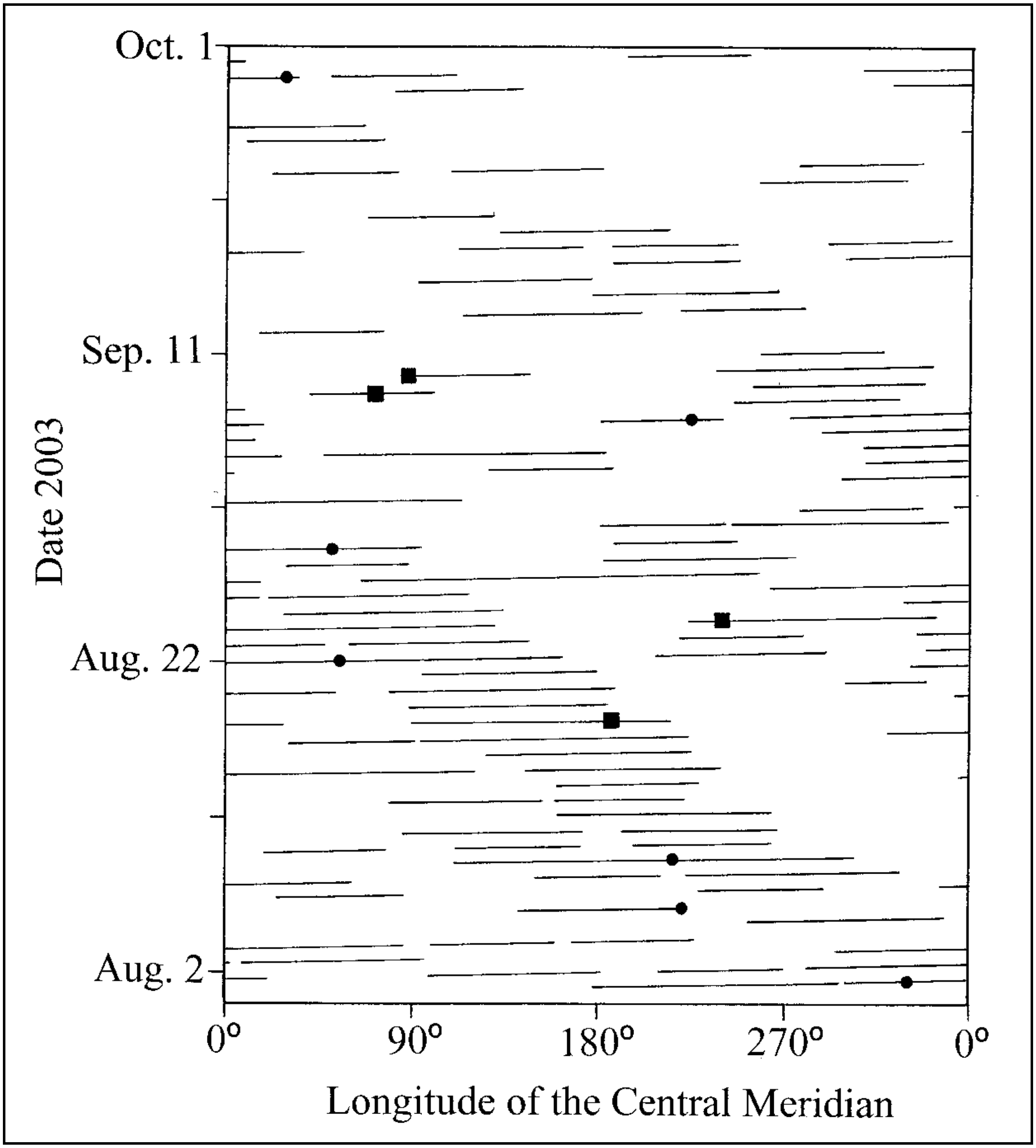

Figure 5: A graph of date versus longitude coverage of images in the ALPO data bank. The images were examined for dust storms that were near the edge of the SPC. A solid square is a probable dust storm and a solid circle is a possible dust storm.

According to Antoniadi (1975), Novus Mons is a snow patch on top of the bright albedo feature Novissima Thyle. When Novus Mons becomes separated from the SPC, it is often called the Mountains of Mitchel. There were several projections near 320°W between 210°< L_s < 230°; however, these projections were south of Novus Mons. By Ls = 230°, Rima Brevis and Rima Australis had expanded to the point where Novus Mons was obvious.

Mountains of Mitchel

Schmidt imaged the Mountains of Mitchel on Sep. 5 as a bright feature that was connected to the SPC by a strip of ice; see *Figure 1*, third row, left. Parker imaged Mars on Sep. 7 and it is not clear if the Mountains of Mitchel had separated. On Sep. 7 at 4:00 UT, Roussell states "Novissima Thyle (Mountains of Mitchel) nearly separate". Wilson used the Lowell

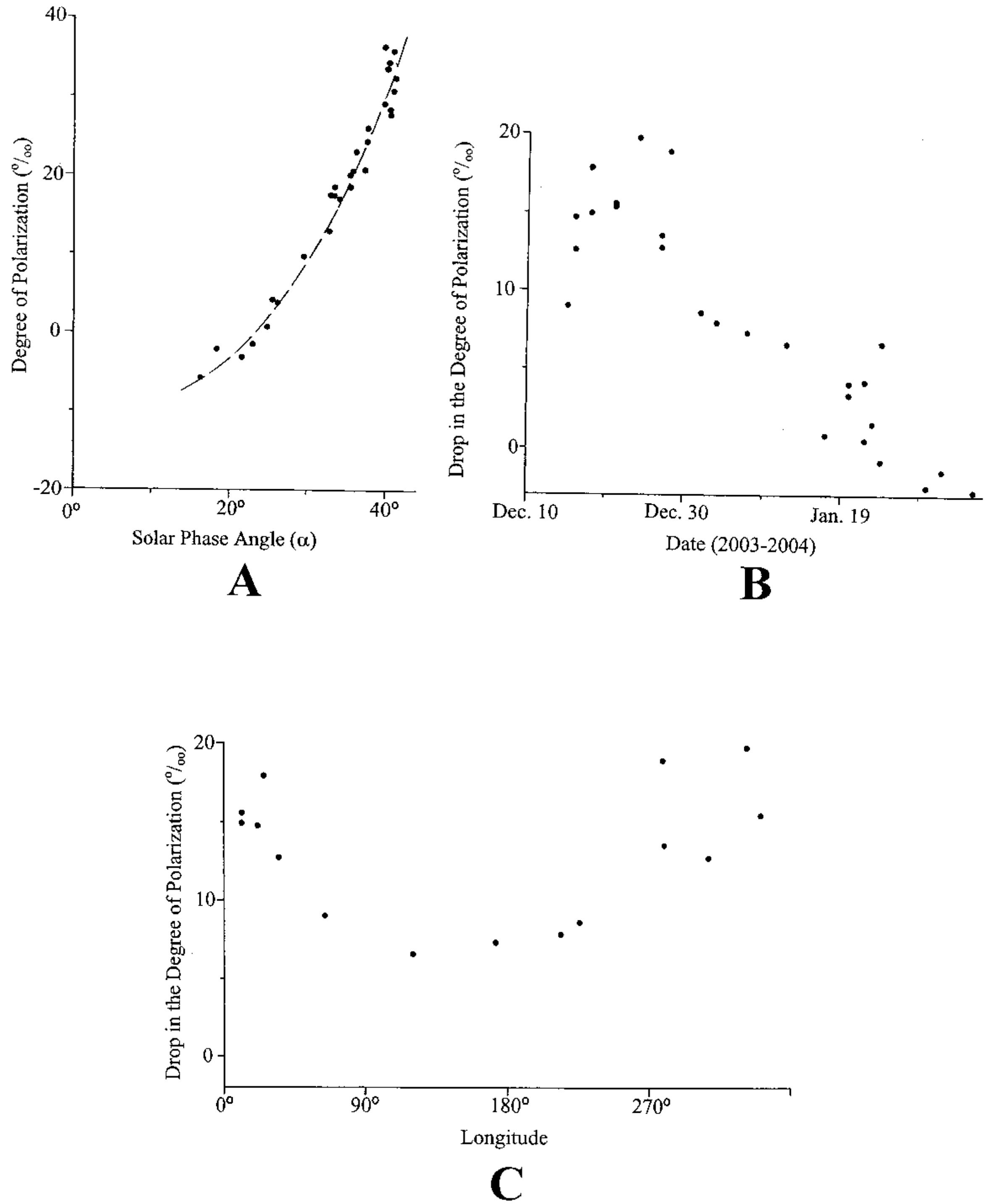

Figure 6-A: The degree of polarization measured from Sep. 16 to Nov. 23, 2003 under nearly dust-free conditions on Mars. The dashed curve is defined by the equation: $-5.3 - 0.675\alpha + 0.039212\alpha^2$ where α is the solar phase angle of Mars in degrees. Figure 3-B shows the drop in the degree of polarization as a result of the dust storm that broke out in December on Mars. Figure 3-C shows the drop in the degree of polarization as a function of the longitude of the central meridian on Mars.

refractor to observe the Mountains of Mitchell a few hours after Roussell made his observation; and she found them detached from the SPC. Haas observed the Mountains of Mitchel to be separate from the SPC on Sep. 8. It thus appears that the Mountains of

Table 2: Dimensions, positions and intensities of the Mountains of Mitchel based on images made between Sep. 8 and Sep. 23, 2003; the intensity is measured on a scale of 10 = bright SPC to 2 = bright areas east and west of Syrtis Major.

Date (2003)	L_S	east-west dimension (km)	north-south dimension (km)	Area (10^6 km^2)	Latitude	Longitude	Light intensity
Sep. 8-11	258º	490	280	0.11	77ºS	316ºW	7
Sep. 17	263º	440	260	0.09	75ºS	322ºW	6
Sep. 22-23	266º	460	220	0.08	72ºS	321ºW	4

Mitchel became separated from the SPC on Sep. 7 or 8, 2003 (L_s = 256º).

The Mountains of Mitchel were observed until at least Sep. 26 (L_s = 268º); the resulting positions and other characteristics are summarized in *Table 2*. The data are consistent with the Mountains of Mitchel fading to invisibility rather than shrinking to invisibility. This feature was centered at 75ºS, 319ºW between 256º < L_s < 267º, which is similar to the average position between 1892 and 1924 of 72ºS, 319ºW (I computed this position from the 11 positions listed in Antoniadi, 1975, 297).

South Polar Cap Regression

Due to the irregular shape of the SPC, its area (in km2) was computed from a grid along with a formula in (CRC Standard Math Tables, 1955). One must remember that the SPC covers a three dimensional planet and so it was necessary to use equations that yield areas for a 3-dimensional cap. Once the area was measured, it was divided by pi (3.1416) and then the square root was taken, yielding the radius in km; finally this radius was divided by 59.3 to yield the radius in degrees of latitude. The resulting radii are displayed in *Figure 4-A*. The radii in *Figure 4-A* are consistent with the radii measured by Beish except for near L_s = 200° where Beish measured a radius of 32° compared to 28° in *Figure 4-A*.

Table 3: Cloud Areas at Different Local Times

Date Range	L_S Range	Areas in 10^6 km^2				Location
		1-3 PM	3-4 PM	4-5 PM	5-6 PM	
Tharsis Clouds						
May 2-31	178º-194º	----	2.1	1.6	1.6	109ºW,7ºS
June 5-27	197º-211º	1.1	1.7	1.4	0.8	116ºW, 4ºS
July 3-27	219º-229º	----	0.24	0.23	0.31	123ºW, 12ºS
Aug. 9-23	237º-246º	0.07	0.19	0.28	0.32	118ºW, 14ºS
Elysium Cloud						
Apr. 24-May 5	173º-180º	0.49	0.65	1.3	----	220ºW, 22ºN
Edom Cloud						
May 15-June 25	185º-209º	Not Visible	NV	0.64	0.70	342ºW, 1ºS
Libya Cloud						
May 20-June 24	188º-209º	Not Visible	NV	0.88	1.1	285ºW, 1ºS

Table 4: Polarization Measurement of Mars Made in 2003-04 (All measurements by Schmude)

Date	α (degrees)	λ (deg.)	Degree of Polarization V-filter	Date	α (degrees)	λ (deg.)	Degree of Polarization V-filter
Mar. 31.426 2003	41.0	93	29.6	Nov. 20.057	41.1	293	35.9
Apr. 1.406	41.1	76	30.2	Nov. 20.147	41.1	324	30.9
Apr. 14.402	42.1	309	26.6	Nov. 22.012	41.3	257	32.3
June 2.393	42.2	192	22.1	Dec. 15.059	42.3	65	27.3
June 9.363	41.5	114	29.9	Dec. 16.002	42.3	21	21.6
June 22.309	39.2	331	24.2	Dec. 16.043	42.3	35	23.6
July 9.297	34.3	166	6.6	Dec. 18.030	42.3	11	21.4
July 10.347	33.9	174	10.7	Dec. 18.069	42.3	25	18.4
July 21.258	29.1	41	8.0	Dec. 21.028	42.2	341	20.7
July 28.241	25.3	331	2.0	Dec. 21.114	42.2	11	20.5
Sep. 16.220	16.3	238	-5.9	Dec. 24.088	42.1	332	18.1
Sep. 19.147	18.4	185	-2.2	Dec. 27.022	42.0	280	22.0
Sep. 24.200	21.8	159	-3.2	Dec. 27.103	42.0	308	22.8
Sep. 26.217	23.1	146	-1.6	Dec. 28.043	42.0	278	16.6
Sep. 29.097	24.9	77	0.8	Jan. 1.004, 2004	41.8	225	26.4
Sep. 30.141	25.5	83	4.1	Jan. 3.027	41.7	213	26.8
Oct. 1.154	26.1	79	3.7	Jan. 7.020	41.5	172	26.9
Oct. 15.131	32.8	301	13.0	Jan. 12.013	41.1	120	26.6
Oct. 16.092	33.1	278	17.6	Jan. 17.063	40.7	88	31.3
Oct. 17.085	33.5	266	17.6	Jan. 20.019	40.5	44	28.3
Oct. 17.145	33.5	288	18.4	Jan. 20.067	40.5	60	27.6
Oct. 19.022	34.2	225	17.0	Jan. 22.050	40.3	35	27.0
Oct. 23.066	35.6	203	20.0	Jan. 22.094	40.3	50	30.7
Oct. 23.147	35.6	232	18.4	Jan. 23.026	40.2	17	29.3
Oct. 24.062	35.9	192	20.3	Jan. 24.024	40.1	6	24.0
Oct. 25.013	36.2	166	23.1	Jan. 24.067	40.1	21	31.5
Oct. 25.085	36.2	191	23.1	Jan. 30.067	39.5	323	31.7
Oct. 30.063	37.5	136	20.8	Jan. 31.041	39.4	304	32.8
Oct. 31.073	37.8	130	24.2	Feb. 1.038	39.3	293	30.1
Oct. 31.185	37.8	169	26.0	Feb. 5.071	38.9	265	30.6
Nov. 11.994	40.0	348	29.2	Feb. 19.058	37.2	124	29.3
Nov. 12.174	40.0	51	36.3	Feb. 22.051	36.8	92	26.6
Nov. 13.123	40.2	23	33.8	Mar. 10.088	34.5	299	24.8
Nov. 14.071	40.4	356	34.2	Mar. 11.053	34.3	278	20.6
Nov. 14.171	40.4	30	28.3	Mar. 18.074	33.3	217	24.5
Nov. 16.076	40.7	338	31.7	Mar. 20.051	33.0	189	21.3
Nov. 16.131	40.7	357	27.9				

* Polarization measurements made in other filters: dates (values): B-filter: Nov. 14.071 (46.3), Nov. 16.076 (45.9), Nov. 22.012 (57.3); R-filter: Nov. 16.076 (16.0), Nov. 22.055 (16.2) and I-filter: Nov. 16.076 (2.6). α is the solar phase angle and λ is the longitude of the central meridian.

Table 5: Photometric Measurements of Mars Through B, V, R and I filters in 2003 and 2004 (All measurements by Schmude)

Date	Magnitude in the B, V, R and I filters				Date	Magnitude in the B, V, R and I filters			
	B	V	R	I		B	V	R	I
Dec. 15.454, 2002	3.00	1.62	---	---	Sep. 14.110, 2003	-1.10	-2.62	-3.76	-4.21
Dec. 16.476	---	---	0.38	-0.07	Sep. 14.147	-1.13	-2.63	---	---
Jan. 4.462, 2003	3.01	1.56	0.35	-0.17	Sep. 16.240	---	-2.55	---	---
Jan. 7.453	2.95	1.48	0.28	-0.29	Sept. 17.105	-0.99	-2.50	-3.74	-4.18
Jan. 14.452	2.86	1.31	0.05	-0.47	Sep. 20.088	-0.99	-2.42	-3.61	-4.06
Jan. 18.461	2.76	1.29	0.10	-0.40	Sep. 24.188	-0.83	-2.38	-3.50	-4.03
Jan. 28.432	2.76	1.34	---	---	Sep. 26.066	---	---	---	-3.96
Feb. 11.435	2.64	1.15	-0.06	-0.60	Sep. 27.106	-0.81	-2.22	-3.42	---
Feb. 13.441	2.57	1.12	-0.14	-0.65	Sep. 24.054	-0.66	-2.22	-3.27	-3.74
Mar. 11.434	2.31	0.84	-0.36	-0.84	Oct. 2.064	-0.56	-1.96	-3.12	-3.56
Mar. 24.419	2.08	0.57	-0.66	-1.19	Oct. 3.083	---	-2.02	---	---
Apr. 12.390	1.73	0.29	-0.89	-1.33	Oct. 5.053	-0.48	-1.94	-3.00	-3.47
Apr. 22.411	1.50	0.10	-1.03	-1.52	Oct. 9.069	-0.25	-1.76	-2.82	-3.42
Apr. 27.387	1.50	-0.04	-1.22	-1.71	Oct. 15.068	-0.18	-1.66	-2.79	-3.27
May 4.386	1.37	-0.17	-1.37	-1.89	Oct. 16.133	-0.04	-1.67	-2.70	-3.22
May 12.356	1.17	-0.35	-1.45	-1.91	Oct. 19.063	-0.15	-1.56	-2.67	-3.16
June 10.390	---	-0.99	---	---	Oct. 23.025	-0.03	-1.45	-2.66	---
June 21.342	0.22	-1.14	-2.33	-2.80	Oct. 23.048	---	---	---	-3.15
July 10.370	---	-1.84	---	---	Oct. 23.105	-0.01	-1.52	-2.62	-3.14
July 21.225	---	-2.07	---	---	Oct. 30.043	0.33	-1.20	---	---
July 25.300	-0.86	-2.25	-3.28	-3.69	Oct. 30.103	0.24	-1.23	-2.53	-2.95
July 28.309	---	-2.24	---	---	Oct. 30.139	---	---	---	-2.93
Aug. 1.308	-0.98	-2.32	-3.39	-3.89	Nov. 2.012	---	-1.15	-2.26	---
Aug. 4.256	---	-2.46	-3.59	-4.03	Nov. 2.067	---	---	-2.33	-2.82
Aug. 4.301	-0.94	-2.42	-3.56	---	Nov. 10.158	0.45	---	-1.98	-2.55
Aug. 22.187	---	-2.85	---	---	Nov. 10.195	0.57	---	---	-2.55
Aug. 22.242	-1.44	-2.82	-3.92	-4.38	Nov. 12.138	0.49	-0.93	---	---
Aug. 23.186	-1.37	-2.80	-4.01	---	Nov. 13.082	0.49	-0.89	-1.93	-2.41
Aug. 27.142	-1.49	-2.90	-3.99	-4.39	Nov. 13.150	---	---	-1.92	-2.37
Aug. 27.195	-1.52	-2.87	-4.01	-4.42	Nov. 14.023	0.62	-0.84	-1.90	---
Sep. 1.258	---	-2.87	---	---	Nov. 16.020	---	---	---	-2.36
Sep. 4.256	-1.39	-2.84	-3.89	-4.37	Nov. 20.098	0.72	-0.72	-1.73	-2.20
Sep. 8.122	-1.22	-2.65	-3.74	-4.25	Nov. 21.027	0.69	-0.70	-1.75	-2.23
Sep. 12.135	-1.22	-2.71	-3.86	-4.31	Nov. 23.016	0.72	-0.67	-1.67	-2.18

Between $184° < L_s < 256°$, the 2003 SPC was 2.4°±0.4° larger than the 1988 cap and 1.4°±0.2° larger than the 1924 cap. (The 1924 cap data was taken in integrated light whereas the 1988 data was taken in red light.) The SPC was measured from red light images made in 1939 and 1956 (Slipher, 1962) and I found that the 2003 cap was 2.2°±0.9° and 3.3°±0.7° larger than the 1956 and 1939 caps respectively. The 2003 SPC was larger than normal;

Table 6: Photometric Measurements in the V-filter (Late 2003 and 2004)

Date	Mag.	Date	Mag.	Date	Mag.	Date	Mag.
Dec. 15.123	-0.26	Jan. 7.044	0.24	Jan. 30.043	0.65	April 2.066	1.43
Dec. 16.023	-0.20	Jan. 12.037	0.34	Feb. 1.057	0.68	April 9.066	1.54
Dec. 18.051	-0.19	Jan. 17.092	0.45	Feb. 5.090	0.74	April 15.068	1.48
Dec. 21.049	-0.11	Jan. 20.042	0.54	Feb. 10.064	0.79	April 17.072	1.57
Dec. 21.135	-0.14	Jan. 22.069	0.55	Feb. 19.077	0.94	April 28.074	1.56
Dec. 24.066	-0.02	Jan. 23.046	0.58	Feb. 22.074	0.97	May 4.095	1.56
Dec. 27.047	0.08	Jan. 24.047	0.59	Mar. 7.076	1.18	May 5.074	1.59
Dec. 27.124	0.04	Jan. 28.011	0.69	Mar. 11.072	1.22	May 6.076	1.59
Jan. 1.024, 2004	0.13	Jan. 28.136	0.65	Mar. 18.094	1.25	May 8.088	1.57
Jan. 3.051	0.16	Jan. 29.040	0.66	Mar. 20.068	1.27	May 24.082	1.69

perhaps the 2003 cap had less dust in it than in previous years. A low dust level would cause the cap to reflect more light, remain cooler and shrink at a slower rate.

South Polar Hood (SPH)

Maxson made several images between Feb. 2 and Feb. 25, 2004 (central meridians are given in parentheses); the SPH was present on Feb. 10 (216°), and possibly Feb. 9 (228°) but it was not present on Feb. 2 (296°), Feb. 3 (282°), Feb. 5 (265°), Feb. 20 (121°) and Feb. 25 (77°). Parker's Feb. 10 (194°) image also shows the SPH. The average radius of the SPH in Feb. was 20°±2° assuming a circular hood that was centered on the South Pole.

North Polar Hood (NPH)

The NPH was imaged by Van der Velden on Mar. 29, 2003 (L_s = 160°) and was consistently visible after L_s = 173°.

Figure 4-B shows a map of the North Polar Hood (NPH) made from Aug. 26-27 images. The boundaries of the NPH in *Figure 4-B* are from measurements made at the central meridian, which is near local noon. Hubble Space Telescope images show a cloudy section extending from ~45°N to ~62°N, and a bright section north of 62°N. The bright section is probably polar ice. Projections in the cloudy section may be cold fronts. At least one dark spot was visible below the NPH; this is similar to what Parker et al. (1999, 17) noticed in the 1992 NPH.

The NPH had several southward projections and a few of these were imaged over a 1 to 3 day period. One projection was imaged from August 27 to 30, 2003 and it moved from the northwest to the southeast at 18 kilometers per hour or 18 km/hour (11 miles/hour). A second projection was imaged by Owens, Sherrod and Grafton from Aug. 27 through Aug. 29 at 50°W and it moved at 10 km/hour (6 miles/hour). A third projection located at 65°W was imaged by Owens and Bates; its velocity was 24 km/hour (15 miles/hour).

Figure 4-C (solid line) shows the percentage of the time that the NPH was visible between April 2003 and Feb. 2004. The NPH retreated during the July and Dec. 2003 dust storms. Others have also noted that the NPH retreats during dust storms (McKim, 1989, 230).

Table 7: Photometric Constants Measured for Mars Based on Data Collected Between Aug. 1 and Nov. 23, 2003

Filter	X(1,0)	c_X	Geometric Albedo
B	0.01	0.011	0.065
V	-1.45	0.011	0.139
R	-2.60	0.012	0.265
I	-3.06	0.011	0.310

McKim (1989, 230) pointed out that the southern edge of the NPH was sometimes displaced towards the equator near the morning limb. As a result of this remark, Schmude measured the latitude of the southern edge of the NPH at three different longitudes on ten images made between July 19 and Aug. 9. The mean latitudes of the NPH edge were 43°N at 30° west of the central meridian (CM), 48°N at the CM and 50°N at 30° east of the CM. Areas west of the CM experience morning and those east of the CM experience afternoon. Therefore, the NPH was closer to the equator near the morning limb; this is also confirmed in an August 26, 2003 Hubble Space Telescope image of Mars.

Clouds and Limb Hazes

Very early in southern spring (L_s = 180°) water-ice crystal "orographic" clouds were prominent over the Tharsis volcanoes. These were seen to coalesce, forming the famous "W-cloud." By mid-spring, however, only the cloud over Arsia Mons remained, persisting into southern summer. The Tharsis orographic clouds are more common and longer-lived during the northern spring and summer. Likewise, orographics over the Elysium Shield volcanoes, while very conspicuous in northern spring, were all but absent in 2003. These findings, including the behavior of the Arsis cloud, agree well with those derived from the Mars Global Surveyor data (Benson, 2003) and suggest a difference in water vapor transport between northern and southern hemispheres as well as disparities in water ice content between the north and south polar caps.

The clouds that developed over Tharsis, Elysium, Edom and Libya generally appeared when these features were on the preceding (or afternoon) side of Mars; *Table 3* summarizes the areas and positions of these clouds for different local times. The local time is the time at the center of the cloud; for example, if the Sun is 30° west of the meridian as seen from the cloud center then it is 2:00 p.m. local time. The dust storm in early July reduced the size of the clouds in *Table 3*. After July, we were no longer viewing the mid to late afternoon side of Mars and this may have contributed to these clouds being almost invisible as seen from the Earth.

The percentage of images showing at least one discrete cloud on the disc or near one of the limbs is shown in *Figure 4-C* (dashed line). The percentages are a little higher than those reported by (Beish and Parker, 1988), but this is due to the fact that Beish and Parker placed discrete clouds and clouds near the east and west limbs into three separate categories whereas in the present study, clouds in these three categories were placed into the same category.

Equatorial cloud belts were imaged on two dates (Aug. 2 and Nov. 2); this represents about 1% of the dates when high quality Mars images were made during 2003. This percentage is close to the one reported by Beish et al. (1991, 57). Beish observed an equatorial cloud belt in the Chryse-Xanthe region on June 13-16.

Blue Clearings

A blue clearing occurs when albedo features on the Martian surface become visible in blue light; that is through a Wratten #47 or similar filter. Schmude analyzed 171 blue images of Mars made between May 4 and Nov. 16, 2003 and estimated the blue clearing for each image. (The blue clearing is rated on a scale of 0 = no blue clearing to 3 = surface details are as clear in blue light as in white light.) Infrared blocking filters were used in making all blue filter images that Schmude analyzed. There were three slight blue clearings in 2003: (June 24-25, July 2-3 and July 16) and one moderate blue clearing (Aug. 23-Sep. 12). The strongest blue clearing occurred near opposition, which was the case in previous apparitions (McKim, 1991, 277), (Schmude, 1989, 424), (Slipher, 1962, 54). The average blue clearing values for the four ranges of solar phase angle 5-15°, 15-25°, 25-35° and 35-44° were: 1.24, 0.72, 0.62 and 0.47 respectively. The strong dependence of the blue clearing on the solar phase angle is consistent with the statement made by Zurek, (1992, 806) that blue clearings "appear to be due to a phase angle effect of scattering by airborne dust."

The average blue clearing values at different CM longitudes are shown in *Figure 4-D*. Blue clearings were strongest between 240°W and 360°W; a similar trend was reported by Slipher (1962, 52) and (McKim, 1995, 129).

Blue clearing values were estimated on images made with 0.41 m, and 0.25 m Newtonian telescopes in Aug. and Sep.; the average blue clearing values (telescope sizes in parentheses) were: 1.5 (0.41 m), and 0.73 (0.25 m). This suggests that one can image more surface features in blue light with larger apertures.

Several people also estimated the blue clearing visually. Beish reported a moderate blue clearing during most of May. Siegel reported a blue clearing in mid-July.

Dust Storms

Three large dust storms developed in 2003. The first one started as a small bright spot in the northwestern portion of Hellas centered at 283°W, 34°S on July 1 and the over the next few days, spread out and became diffuse. The approximate areas for this storm were: July 1 (100,000 km2), July 2 (300,000 km^2), July 3 (600,000 km^2) and July 4 (3,300,000 km^2); see *Figure 1*, top row, four images on the right. This storm reached “regional status” on July 4 with an east-west dimension of 3200 km. A regional dust storm is one with at least one dimension that exceeds 2,000 km (McKim, 1999, 119). A second dust storm developed at 49°W, 23°N on July 29; having an area of 100,000 km^2. One day later this storm expanded to an area of 500,000 km^2 and was centered at 36°W, 10°N. This storm expanded in an eastward direction at an average speed of 66 km/hour. Parker (2004) reports that this storm reached regional status. A third dust storm broke out in Dec. 2003 at approximately L_s = 308°. This storm developed simultaneously in several areas including Aram (9°S, 12°W), Mare Erythraeum (35°S, 25°W), Chryse (9°S, 42°W), Pandorae Fretum/Deucalionis Regio (20°S, 349°W) and Hellas-Noachis; see *Figure 1*, fourth row, second image from the left. By Dec. 19 (L_s = 319°) it became regional, covering nearly 280 degrees of longitude in the southern hemisphere. By early Jan. 2004 (L_s = 326°), the storm had become diffuse. The decay of this storm is discussed in the photoelectric polarimetry section.

One of us (Schmude) analyzed images in Aug. and Sep. for dust storms near the retreating SPC. Only storms that were bright, had areas of at least 50,000 km^2 and were within 30° of the CM were counted. For each image, a line was drawn 60° in length and centered on the CM on the date of the image; see *Figure 5*. If a storm was suspected then a filled circle was placed at the correct date and latitude; likewise a filled square was placed at the correct date and latitude for probable dust storms. *Figure 5* shows all longitudes that were imaged during Aug. and Sep. As an example, Yan imaged Mars when the CM was 153°W; no dust storms near the SPC edge were imaged and so a line extending from 123°W to 183°W was drawn on Aug. 2 in *Figure 5* without a filled square or circle.

Four smaller (local) dust storms probably developed near the edge of the SPC. These storms had a different color than the SPC and they covered portions of the dark South Polar Collar. The longitudes of these storms are shown in *Figure 5*. There was an additional seven suspected dust storms. During August, 44% of the longitudes were imaged and during September 26% of the longitudes were imaged.

Photoelectric Polarimetry

The same equipment used in Schmude (2002) was used in making 2003-04 polarization measurements. The method for reducing these measurements is described in Dollfus (1961).

During 2003-04, Schmude made 79 polarization measurements of Mars. Most of the measurements were made in the V-filter which has a peak wavelength near 540 nanometers. All polarization measurements are summarized in *Table 4*. Measurements made between Sep. 16 and Nov. 22 are plotted in *Figure 6-A*, and were made when there was little or no dust in the Martian atmosphere. The data in *Figure 6-A* were entered into a calculator and a least squares routine was done; the best equation for the data is:

Degree of Polarization (in ‰) is:

$$-5.3 - 0.675\alpha + 0.039212\alpha^2 \qquad (1)$$

where α is the solar phase angle in degrees. The solar phase angle of Mars is the angle between Mars and the observer measured from the Sun. Equation (1) predicts the degree of polarization for Mars under nearly dust free conditions.

Lyot discovered that dust in the Martian atmosphere causes the degree of polarization to drop by up to 20 units or 2% (Dollfus, 1961, 387). Therefore, if the degree of polarization is below what is predicted in equation (1) then it indicates the presence of dust in the Martian atmosphere. Using this criteria, Schmude, carried out additional polarization measurements starting in mid Dec., 2003. The drop in the degree of polarization is plotted in *Figure 6-B*. If the drop is greater than zero then it indicates the presence of dust.

During mid Dec., the degree of polarization dropped 10 to 20 units. The drop steadily declined in late Dec. and Jan., 2004. The drop reached zero on Jan. 23, 2004 and so the dust storm lasted from Dec. 1, 2003 (Parker, 2004) to about Jan. 23, 2004 or 7 – 8 weeks (308°-338° of L_s).

The drop in the degree of polarization is also plotted as a function of the longitude of Mars’ central meridian; see *Figure 6-C*. Data collected in Dec. and Jan. were used. *Figure 6-C* shows that the drop never reached zero, which indicates that dust was at all Martian longitudes.

Photoelectric Photometry

Schmude used a 0.09 m Maksutov telescope along with an SSP-3 solid state photometer and filters that were transformed to the Johnson B, V, R and I system to make magnitude measurements. The resulting magnitude measurements are summarized in *Table 5* and *Table 6*; all of these measurements have been corrected for color and atmospheric extinction in the same way as in (Schmude, 2002).

All magnitude measurements made before August 1, 2003 are believed to be unusually bright as a result of the SPC. These measurements were not used in evaluating the solar phase angle coefficients and normalized magnitudes. Measurements made between Aug. 1 and Nov. 23 were used in evaluating the data in *Table 7*; the Aug. 1 to Nov. 23 data were broken up into 12 longitude regions starting with 10°W - 40°W. The normalized magnitudes at solar phase angle α were then computed in the same way as is described in Schmude (2000). The average normalized magnitudes X(1,0), solar phase angle coefficients cx and geometric albedos are summarized in Table 8. Geometric albedos were computed in the same way as in (Schmude, 1994, 81). In previous years, the average V-filter normalized magnitudes were: -1.58 (1997), -1.60 (1999) and -1.45 (2001). The dim V(1,0) value in 2003 is probably due to the large dark areas in Mars' southern hemisphere being tilted towards the Earth.

Doug West and Jim Wood both used the new SSP-4 photometer which measures infrared light. These two made measurements of Mars with the J and H filters; these filters transmit light at wavelengths of 1,250 and 1,650 nanometers. The resulting color indexes at a solar phase angle of 40° were: I - J = 0.20±0.05 and J - H = 0.35±0.05. The I-filter measurements used in computing the I - J values were taken from *Table 4*. Approximate solar phase angle coefficients of c_J = 0.0065 and c_H = 0.0111 were determined from the data reported by West and Wood.

South Polar Cap (SPC) Albedo

The albedo is the fraction of light that an object reflects. If the albedo is 1.0, then the object reflects all of the light that falls on it. The albedo affects the temperature; for example, a black asphalt road having an albedo of 0.1 will get hotter than a concrete road having an albedo of 0.3. This is because the asphalt road reflects less light and hence it absorbs more sunlight than the concrete road. This same principle applies to a polar cap. Dust has a lower albedo than polar ice deposits and so a cap having lots of dust will get warmer (and shrink faster) than a cap having no dust in it. Because of the importance of cap albedo, Schmude has used his photoelectric magnitude measurements to compute the albedo of the SPC.

The SPC albedos were computed from equation (2):

$$R = 1 + (B/f) \qquad (2)$$

where R is the albedo ratio, which is the SPC albedo divided by the average albedo of Mars; B is the increase in brightness of Mars as a result of the presence of the SPC and f is the fraction of Mars' disc (as seen from Earth) that is covered with the SPC. The value of B was computed from the difference between the measured normalized magnitude and the predicted magnitude computed from the solar phase angle coefficient for the specific longitude of interest. As an example, on May 12, 2003, the V-filter magnitude of Mars was measured to be -0.354 and the measured normalized magnitude was -1.103 (the normalized magnitude was computed in the same was as in Schmude, 2000); the longitude of the central meridian at the time of measurement was 22°W, and the solar phase angle on this date was 43.1°. The solar phase angle coefficient and normalized magnitude for the 10°-40°W longitude range was 0.0130 mag./deg. and -1.496 respectively. The computed normalized magnitude from the solar phase angle coefficient and normalized magnitude is: -1.496 + (0.0130 mag./deg. x 43.1°) = -0.936 and so the May 12 magnitude is -0.936 - - 1.103 = 0.167 magnitudes brighter than expected. Finally, the SPC covered 0.08677 of the Martian disc and so R = 1 + (0.167/0.08677) = 2.92.

The average value of R for the time period May 4 - July 28 was 2.98±0.92, 2.73±0.54, 3.09±0.53 and 2.86±0.69 for the B, V, R and I filters respectively. The SPC albedos are then the product of R and the geometric albedos in Table 7, which are: B-filter: 0.19±0.07; V-filter; 0.38±0.11; R-filter: 0.82±0.22 and I-filter: 0.89±0.28. The uncertainties in the albedos include random error and estimated errors due to other factors.

Albedo Features

Parker (2004, 93) describes changes in Mars' albedo features that occurred in 2003. Of special interest is a large dark feature that appeared on July 10, 2003 (L_s = 219°). It extended from Deucalionis Regio (340°W, 15°S) to eastern Noachis (330°W, 45°S) and persisted through the remainder of the apparition. This region should be closely monitored in 2005.

Conclusions

Our conclusions for the 2003 Mars apparition are:

1. The SPC was larger in 2003 than in 1924, 1939, 1956 and 1988 at L_s = 184° to 256°.
2. The Mountains of Mitchel separated from the SPC at L_s = 256° and disappeared at L_s = 268°.
3. The SPH started to become visible at L_s = 347°.
4. The NPH started to become visible at L_s = 160° and it was consistently visible after L_s = 173°.
5. Condensate clouds developed in Tharsis, Elysium, Edom and Libya during May and June when these features were on the afternoon side;

this is evidence that some water vapor is released from the shrinking SPC.

6. Regional dust storms developed in early and late July and in December of 2003.
7. Cloud activity dropped after the early July dust storm broke out.
8. The 2003 data indicates that one can image more surface features in blue light with larger apertures; that is, one is more likely to have a "blue clearing" with a large aperture than with a small one.
9. Photoelectric polarimetry measurements show that the December 2003 dust storm did not completely settle until about January 23, 2004.
10. The selected normalized magnitudes of Mars are: B(1,0) = 0.01, V(1,0) = -1.45, R(1,0) = -2.60 and I(1,0) = -3.06; the selected solar phase angle coefficients in magnitudes/degree are: $c_B = 0.011$, $c_V = 0.011$, $c_R = 0.012$, $c_I = 0.011$.
11. Mars reached a magnitude of -2.90 on Aug. 27.
12. The albedos of the SPC during mid 2003 were: I-filter: 0.19 ± 0.07, V-filter: 0.38 ± 0.11, R-filter: 0.82 ± 0.22, B-filter: 0.89 ± 0.28.

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Table 8: Contributors to This Report

Name; location	Type of obs.	Telescope	Name; location	Type of obs.	Telescope
Acquarone, Fabio; Italy	I	0.30 m T	Colville, Brian; Ontario, Canada	I	0.30 m SC
Adelving, Francis; France	I	0.25 m RL	Comolli, Lorenzo; Italy	I	Several
Aerts, Leo, Belgium	D, I	----	Cooke, Antony; CA USA	D	0.46 m RL
Akutsu, Tomio; Japan	I	0.32 m RL	Cooper, Jamie	I	----
Albert, Jay; FL USA	D	0.28 m SC 0.18 m MC	Coretti, Becky; FL USA	I	0.38 m RL
Ameye, Tom; Belgium	I	0.20 m SC	Crandall, Ed; NC USA	D	0.25 m RL
Anderson, David; SC USA	DN	0.33 m RL 0.25 m RL	Croman, Russell; TX USA	I	0.36 m SC
Arai, Masura; Japan	I	0.28 m SC	Crudeli, Daniele; several in Italy	I	0.20 m RL 0.28 m SC
Armstrong, Jerry; GA USA	I	0.36 m SC	Cudnik, Brian; TX USA	D	0.25 m RL 0.32 m RL
Atanackov, Jure; Slovenia	D	----	Curcic, Bratislav; Melbourne Australia	I	0.25 m DK 0.40 m DK
Baldoni, Paolo; Italy	I	0.23 m SC 0.18 m	D' Auria, Tippy; FL USA	I	0.30 m SC
Banich, Howard; OR USA	DN	----	Dethloff, Chuck; OR USA	D	0.32 m RL
Basso, Stefano; Italy	D, I	0.20 m SC	Di Sciullo, Maurizio; FL USA	I	0.25 m RL
Batchelor, Mike; CA USA	I	0.23 m MC	Dierick, Dominique	I	0.23 m SC
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Bhanukitsiri, Ron; CA USA	D	0.20 m RL 0.10 m RR	Eckstein, Marco; Germany	I	0.20 m SC
Biver, Nicolas; France	D	Several	Escobar, Mauricio; Chile	I	----
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Bordonan, Francisco; Spain	I	0.20 m SC	Falsarella, Nelson; Brazil	I	----
Borman, Michael; IN USA	I	0.30 m SC	Fattinnanzi, Cristian; Italy	I	0.24 m SC 0.25 m RL
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Buchanan, Tom; GA USA	S	Spectro- scope	Fioba, P. Della; Italy	I	0.18 m MC
Buda, Stefan; Melbourne, Australia	I	0.25 m DK 0.40 m DK	Frassati, Mario; Italy	I	0.20 m SC
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Bunge, Bob; MD USA	D	Several	Giovannone, Vincent; NY USA	D	0.15 m RL
Camaiti, Plinio; Italy	I	0.28 m SC	Gomez, Angel; FL USA	I	M
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Canapine, F.; Italy	I	0.25 m RL	Gordon, Roger; USA	P	----
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Carter, Barry; MI USA	I	0.13 m MC	Grassmann, Guilherme; Americana, Brazil	I	Several
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Chakraborty, Sagnik; India	D	0.20 m SC	Guidoni, N; Italy	I	0.18 m MC
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Coelho, P.	I	0.20 m SC	Hansson, Anders; Sweden	I	----
			Hase, Frank; Germany	D	0.13 m RR

Table 8: Contributors to This Report (continued)

Name; location	Type of Obs	Telescope	Name; location	Type of Obs	Telescope
Hatch, Laurie; CA USA	D	0.91 m RR	Maxson, Paul; AZ USA	I	0.20 m SC
Hatton, Jason; CA USA	I	0.23 m SC 0.25 m SC	Maxson, Steve; Australia	I	----
Hausfeld, Garry; Australia	I	0.25 m SC	McGaha, James; USA	I	0.64 m RL
Hauwermeiren, Gino; Japan	I	0.08 m RR	McKim, Richard; United Kingdom	DN	----
Haworth, David; WA USA	I	0.15 m MC	Melillo, Frank; NY USA	I	0.20 m SC
Hayashi, Toshio; Japan	I	0.36 m SC	Melka, Jim; MO USA	DN, I	0.32 m RL
Hergenrother, Carl; AZ USA	I	1.55 m RL	Meyer, Jorg; Germany	I	0.35 m SC
Hernandez, Carlos; FL USA	D	Several	Mills, J.	I	----
Hernandez, Ramiro; Saltillo, Mex-ico	I	0.20 m SC	Milone, Antonio	D	0.44 m RL
Hill, Richard; AZ USA	I	0.36 m SC	Milton, Russell; OR USA	D	----
Hines, Deborah; IL USA	I	0.30 m SC	Misch, Tony; CA USA	D	0.91 m RR
Hoehne, Brad; OH USA	I	----	Miyazaki, Isao; Japan	DN	0.40 m RL
Hubal, Ken; OH USA	D	0.15 m RL 0.15 m RR	Modinger, Victor; Chile	I	0.11 m RL
Ikemura, Toshihiko; Japan	I	0.31 m RL	Moore, David; AZ USA	I	0.25 m RL
Ishadoh, Hiroshi; Japan	DN	0.25 m RL 0.31 m RL	Morita, Yukio; Japan	I	----
Jacobson, Jake; CA USA	I	0.20 m RL	Mosher, Jim	I	----
Jakiel, Rich; GA USA	D, DN	Several	Mourron, Jean-Francois; France	I	----
Janssen, Eike; Germany	I	0.38 m RL	Mutti; Martin; Switzerland	I	0.20 m SC
Jones, Jane; CA USA	D	0.18 m RR	Naha, Ameku; Japan	DN	0.25 m RL 0.31 m RL
Joyce, Daniel; IL USA	V	0.46 m RL	Naha, Shuri; Japan	DN	0.25 m RL 0.31 m RL
Keene, Steve; OH USA	I	0.33 m RL	Nakai, Kenji; Japan	I	0.25 m SC
Kenyon, Tim; TX USA	D	0.25 m RL	Narang, Vikrant; India	D	0.20 m SC
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Kuberek, Robert; CA USA	I	----	Niikawa, Masahito; Japan	I	0.28 m SC
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Kung, Dennis; Ontario, Canada	I	0.20 m SC	Owens, Larry; FL & GA USA	I	0.36 m SC
Kusakai, H.; Japan	I	0.20 m RL	Pace, Ben; Darwin Australia	I	0.15 m M
Lai, S. K.; Hong Kong, China	I	----	Palmieri, Vic; Italy	I	0.08 m RR 0.20 m RL
Lau, Canon; Honk Kong, China	I	0.36 m SC	Parker, Donald; FL USA	D, I	Several
Lazzarotti, Paolo; Italy	I	Several	Parker, Tim; CA USA	I	0.15 m RR 0.32 m C
Leighton, Andrew; United Kingdon	D	0.20 m RL	Pau, K. C.; Hong Kong, China	I	0.21 m C 0.32 m RL
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Lindner, Frank; Germany	I	0.20 m RL	Pellier, Christophe; France	I	0.18 m RL 0.36 m SC
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Marquette, Mark; TN USA	DN	0.20 m RL	Richards, Thomas; Australia	I	0.18 m RR
Marsh, Celinda; AZ USA	I	1.55 m RL	Roel, Eric; Mexico	I	----
Massey, Paul; USA	I	0.24 m SC	Rose, David; United Kingdom	I	----
Massey, Steve; Sydney Australia	I	Several	Rosenbaum, Gary	DN	----

Table 8: Contributors to This Report (continued)

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Sanchez, Jesus; Spain	I	0.28 m SC	Troiani, Daniel; IL USA	D, DN, I	0.30 m SC 0.32 m
Santacana, Guido; PR USA	D	Several	Tyson, Rich	DN	0.25 m RL
Schedler, Johannes, Australia	I	0.10 m RR 0.28 m SC	Valimberti, Maurice; Australia	I	0.35 m SC
Schmidling, Jack; IL USA	I	----	Van der Velden, Erwin; Australia	I	0.20 m SC
Schmidt, Mark; WI USA	I	0.36 m SC	Van der Velden, Myron; VA USA	I	----
Schmude, Richard; GA USA	D, P, PM, Po	Several	Vandebergh, Ralf; The Nether-lands	I	0.15 m RR
Schulz, E.; Vicuna, Chile	I	0.25 m MC	Varsec, Alen; Sydney, Australia	I	0.09 m C
Seip, Stefan; Germany & Chile	I	0.25 m MC	Villette, Antonie; France	I	0.12 m RL
Shank, K; TX USA	I	0.35 m SC	Vollberg, Richard; FL USA	I	----
Sheehan, William; CA USA	D	0.91 m RR	Voltmer, Sebastion, Namibia	I	----
Sheng, Tsai; Taiwan	I	0.23 m SC	Warren, Joel; TX USA	I	0.20 m SC
Sherrod, Clay; AR USA	I	0.41 m SC	Wasiuta, Sylvain; France	I	----
Siegel, Elisabeth; Denmark	D	0.20 m SC	Weiller, Richard	I	----
Smith, Dean; ND USA	I	0.46 m RL	West, Doug; KS USA	PM	0.25 m SC
Smith, Horace; MI USA	I	0.60 m RL	Whitby, Samuel; VA USA	I	0.15 m RL
Snowden, Michael; Argentina	I	0.60 m	White, Brooke; AZ USA	I	1.55 m RL
So, Oldfield; Hong Kong, China	I	0.20 m SC	Wilhelm, Thomas; NM USA	I	0.20 m RL
Sorensen, Jesper; Denmark	I	0.30 m SC	Williams, Bill; FL USA	I	0.38 m RL
Stekelenburg, Robert; The Netherlands	I	0.14 m MC	Williamson, Greg; CA USA	I	----
Stelmack, Gerald, MB, Canada	I	0.23 m SC	Williamson, Thomas; NM USA	I	0.20 m RL
Stryk, Ted; TN USA	D, I	0.11 m RL	Wilson, Barbara; TX & AZ USA	DN	0.20 m RL 0.61 m RR
Sussenbach, J. S.; The Nether-lands	I	0.28 m SC	Woehler, Alexander; Germany	I	0.20 m RL
Sussmann, Friedrich, Austria	I	----	Woehler, Christian; Germany	DN, I	0.20 m RL
Sweetman, Mike; AZ USA	D, DN	0.13 m RR	Wolff, M.; low Earth orbit	I	HST
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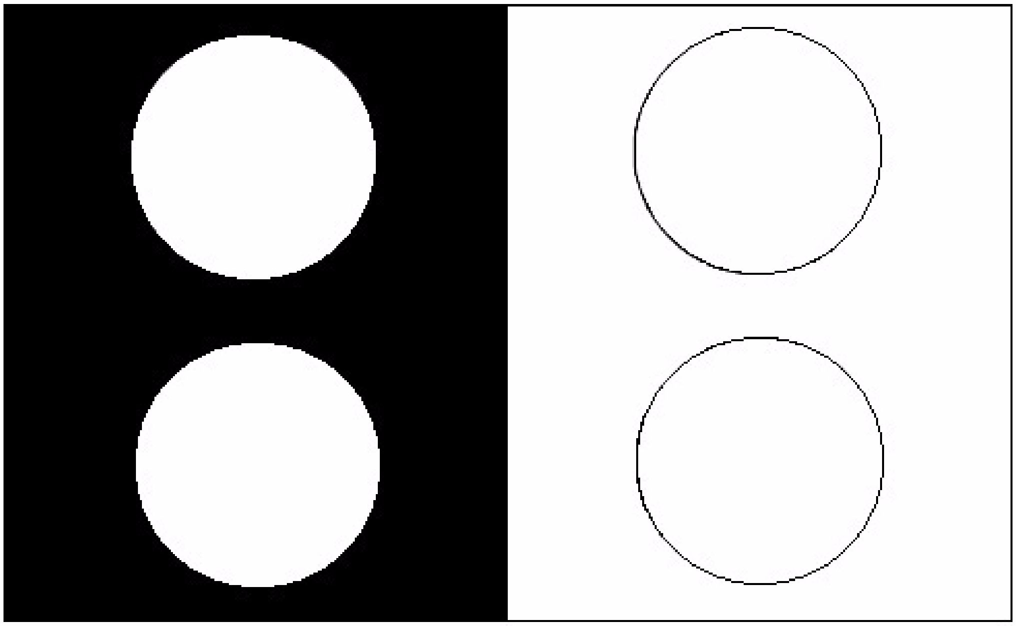
Talwar, Neelam; India	D	0.20 m SC	Woodridge, Tom; Australia	I	0.18 m RR
Tasselli, Andrea; several in Italy and the United Kingdom	I	0.20 m MN 0.15 m MC	Yan, C. K.; Hong Kong, China	I	0.12 m RR
Taylor, Martin; United Kingdom	I	0.36 m SC	Yoneyama, Seiichi; Japan	I	0.20 m RL
Tegerdine, Jim; WA USA	I	----	Yu Gu; WV USA	I	0.23 m SC 0.32 m RL
Teichert, Gerard; France	D	0.28 m SC	Yunoki, Kenkichi; Japan	I	0.20 m RL
Tejfel, Victor; Kazakhstan	I	0.60 m	Zachary, Ron; MI USA	I	0.35 m SC
Teng, Jefferson; WA USA	I	0.13 m RR	Zanazzo, Alfredo; Italy	I	0.30 m T
Thienpont E.	I	0.24 m MN	Zannelli, Carmelo; Italy	I	0.13 m RL
Tilley, Lorne “Scott”; BC Canada	I	0.10 m SC	Zanotti, Ferruccio; Italy	I	Several
Tobias, Chris; WI USA	I	0.35 m SC 0.23 m SC	Zwiefel, Mike; WI USA	I	----

Observation abbreviations: D = drawings, DN = descriptive notes, I = video/CCD images, P = photographs, PM = photoelectric magnitude measurements, Po = Polarization measurements, S = spectra

Telescope abbreviations: C = Cassegrain, DK = Dall Kirkham, HST = Hubble Space Telescope, MC = Maksutov-Cassegrain, MN = Maksutov-Newtonian, N = Newtonian, RL = reflector, RR = refractor, S = Schiefspiegler, SC = Schmidt-Cassegrain, T = Tri-Schiefspiegler

A.L.P.O. Mars Section Observation



Top: Time (UT):______________________ Bottom: Time (UT):______________________
CM:________________° W CM:________________° W
Filter:____________________(W / S) Filter:____________________(W / S)

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

Notes

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The Uranus, Neptune and Pluto Apparitions in 2002

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By: Richard W. Schmude, Jr., coordinator
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Abstract

The selected 2002 normalized magnitudes for Uranus are: B(1,0) = -6.63 ± 0.02, V(1,0) = -7.13 ± 0.01, R(1,0) = -6.75 ± 0.04 and I(1,0) = -5.55 ± 0.04 while the corresponding values for Neptune are: B(1,0) = -6.57 ± 0.02 and V(1,0) = -7.00 ± 0.01. Uranus has become dimmer in blue, red and near infrared light since 1993. Evidence is presented that suggests the south limb of Uranus was brighter than the north limb in visible light during late 2002.

Introduction

Several important discoveries made by professional astronomers were published in 2002-03 and a few of these are summarized here. In all cases, the International Astronomical Union (IAU) standard for north and south is used.

Four important Uranus studies are briefly noted. Bauer and co-workers (2002) carried out a spectroscopic study of Uranus' moon Miranda and, from this study, they concluded that Miranda's surface contains a considerable amount of water ice. Imke de Pater and co-workers (2002) used near Infrared light to image eight small clouds in the upper troposphere of Uranus, with sizes from 1,000 to 2,000 km (600 - 1,200 miles). Veiga et al. (2003) reported that the positions of Uranus and its five largest moons were very close to their predicted positions between 1982 and 1998. These results argue against the presence of a large "Planet X" near Uranus. Rages et al. (2002b) report that there is evidence for changes in Uranus' south polar region on a time scale of months.

Several important Neptune studies were also carried out in 2002. A group of astronomers headed by Holman and Kavelaars discovered three small moons orbiting Neptune with diameters near 35 kilometers (22 miles) (Beatty 2003b). This brings the number of known moons for Neptune as of May 2003 to 11. Rages and co-workers (2002a) reported detecting a bright feature in Neptune's south polar region in red light. This feature moved at a speed of 130 ± 80 meters/second (290 miles/hour). Lockwood and Thompson (2002, 40) listed photoelectric magnitudes of Neptune made between 1972 and 2000. They reported that Neptune had a fairly uniform brightness from 1972-1985 but, from 1985 to 2000, it became approximately 8% brighter. There is also evidence that clouds imaged in visible light are growing in the southern hemisphere of Neptune (Cowen, 2003, 325).

In addition to Uranus and Neptune, professional astronomers have carried out important studies of Pluto and Trans-Neptune Objects (TNOs). Grundy et al. (2002) used the NASA Infrared Telescope Facility at Mauna Kea to collect infrared spectra of Triton and the Pluto-Charon system, which suggests that Pluto has less surface ice than Triton. During July and August 2002, Pluto moved in front of two stars, enabling astronomers to measure how quickly the starlight dimmed. This showed that Pluto's atmospheric pressure and temperature have increased since the late 1980s (Beatty, 2003a, 30). Michael Brown and Chadwick Trujillo discovered Quaror. This new object has a diameter of 1,300 km (800 miles) and it completes one orbit around the Sun in 288 years (Cowen, 2002). Lellouch et al. (2002) studied a second Trans-Neptune Object, (20,000) Varuna, and found that this object reflects very little light and has a diameter of 1,060 km (660 miles).

Although professional astronomers carried out important work in 2002, members of the Association of Lunar & Planetary Observers (ALPO) have also carried out important remote planets work and this is discussed in this article. The names, locations and types of observations of the 23 people who submitted remote planets observations are listed in Table 1.

Table 1: Contributors to the ALPO Remote Planets Section in 2002

Name	Location	Type of Observation*
Patrick Abbott	AB, Canada	VP
Michael Amato	CT, USA	C, VP
Norman Boisclair	NY, USA	C, DN
Tom Buchanan	GA, USA	S
Brian Cudnik	TX, USA	C, DN
Barrett Duff	---	CCD
Lorenzo Frassati	Crescentino, Italy	D, CCD
Mario Frassati	Crescentino, Italy	CCD
Ed Grafton	TX, USA	CCD, PP
Robin Gray	NV, USA	C, D, DN, VP
Walter Haas	NM, USA	D, DN, VP
David Hufnagel	Mt. Evans, CO USA	C, DN
Gabor Kiss	Hungry	CCD
Brian Loader	Darfield, New Zealand	PP
Frank Melillo	NY, USA	CCD, PP, S, M
Kevin Murdock	GA, USA	PP
Toby Murdock	GA, USA	PP
Don Parker	FL, USA	CCD
Phil Plante	OH, USA	C, DN, VP
Richard Schmude, Jr.	GA, USA Mt. Evans, CO USA	C, DN, PP, VP
Roger Venable	GA, USA	DN
Doug West	KS, USA	PP, S
John Westfall	CA, USA	PP
*C = color, CCD = CCD images, D = drawing, DN = descriptive notes, M = methane band data, PP = photoelectric photometry, S = spectra, VP = visual photometry		

The characteristics of the 2002 apparitions of Uranus, Neptune and Pluto are listed in Table 2.

Photometry

Five people (Loader, Melillo, West, Westfall and the writer) submitted photoelectric magnitude measurements of the remote planets in 2002. Four of these people used an SSP-3 solid-state photometer along with filters that were transformed to the Johnson B, V, R and I system. This instrument is described elsewhere (Schmude, 1992, 20), (Optec, 1997). West used a CCD camera along with a V-filter to measure the brightness of Neptune and Pluto.

The comparison stars used in the photoelectric magnitude study are summarized in Table 3. All magnitude measurements in Tables 4 and 5 were corrected for extinction and transformation. The two-star method was used in measuring the transformation coefficients (Hall and Genet, 1988, 199). Westfall used θ-Cap and γ-Cap as check stars and found that the measured magnitudes of these stars were within 0.01 magnitudes of the literature values. The writer used γ-Cap, θ-Cap and ι-Aqr as check stars for Uranus and the measured magnitudes for these stars were: γ-cap (B = 3.98, V = 3.68), θ-Cap (R = 4.07) and ι-Aqr (R = 4.27, I = 4.41); these values compare well with those in Iriarte et al. (1965). For Neptune, the writer used 19-Cap as a check star and the measured magnitudes were B = 6.92 and V = 5.82.

Tables 4 and 5 list the measured magnitudes for Uranus and Neptune respectively; the average normalized magnitudes are listed in Table 6. Normalized magnitudes correspond to the brightness that an object would have if it were 1.0 astronomical unit from both the Earth and Sun and at a solar phase angle of 0°. The solar phase angle is the angle between the Earth and the Sun measured from the target object. Normalized magnitudes are an excellent way of monitoring any brightness change since they are not a function of distance.

The B, R and I normalized magnitudes for both Uranus and Neptune are plotted in Figures 1 and 2. The 1993-1995 values were re-evaluated using transfor-

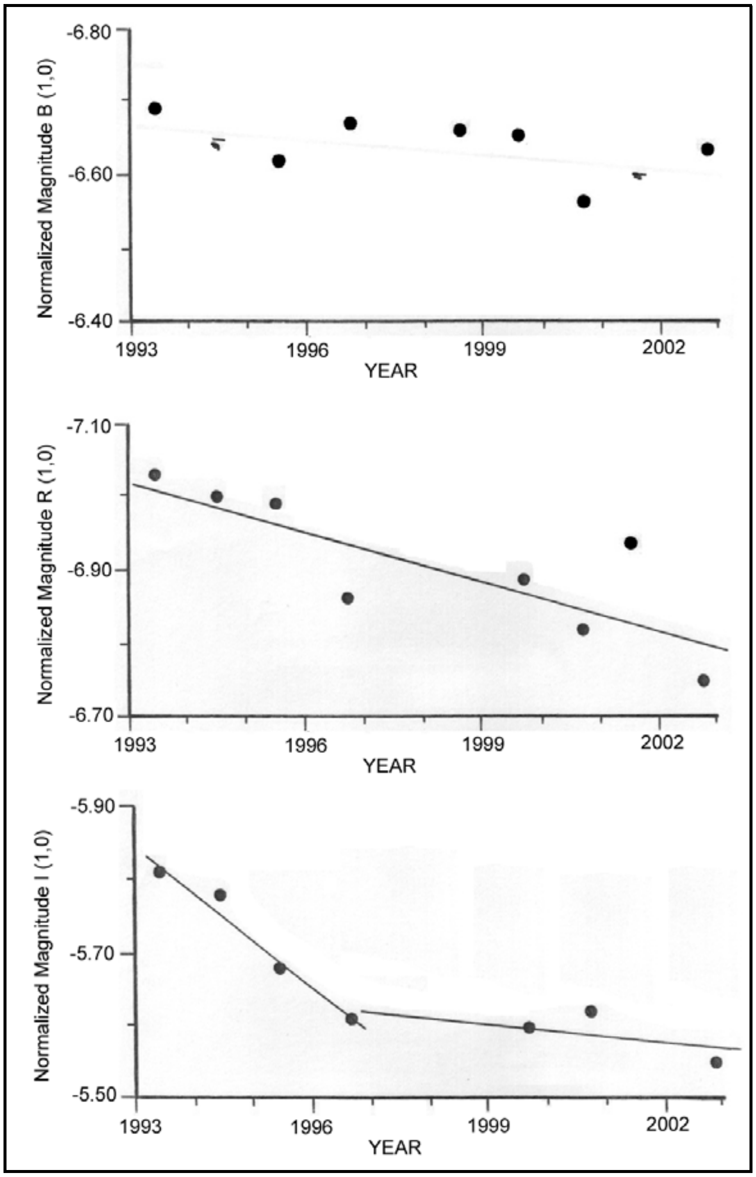

Figure 1: Average annual normalized magnitudes of Uranus plotted against the year for the B, R and I filters.

mation corrections, showing that Uranus has dimmed in the B, R and I filters during the last nine years. The annual dimming rates in the B, and R filters are: 0.0073 and 0.023 magnitudes/year, respectively. Uranus has also become dimmer in the I filter, as was first pointed out by Frank Melillo. According to the data in Figure 2, Neptune has become dimmer in the B-filter at an average rate of 0.0054 magnitude/year; this is in contrast to an average brightening of 0.010 magnitude/year for the V-filter during the same time period.

Westfall plotted his normalized V-filter magnitudes as a function of the solar phase angle and reports solar phase angle coefficients (in magnitude/degree) of -0.0014 ± 0.0013 and 0.0068 ± 0.0042 for Uranus and Neptune respectively. The corresponding values measured by Westfall in 2001 were -0.00007 ± 0.0012 (Uranus) and -0.0039 ± 0.0041 magnitude/degree (Neptune). The writer measured the solar phase angle coefficient for Uranus in the V-filter in 1992 as 0.004 magnitude/degree (Schmude, 1994, 119). It appears that the solar phase angle coefficients for both planets are quite small.

West recorded a single magnitude measurement of Pluto+Charon on April 28, 2002 with an SBIG ST-8 camera and a Johnson V filter. No color corrections were made to this observation; however the color corrections for Doug's equipment are almost always below 0.02 magnitudes and is thus negligible compared to the 0.15 magnitude uncertainty of the measurement. The solar phase angle of Pluto+Charon was 1.2° on April 28 and if a solar phase angle coefficient of 0.041 magnitude/degree (Binzel and Mulholland, 1984) is used then a value of V(1,0) = -0.98 ± 0.15 is computed for Pluto+Charon.

Melillo used an unfiltered starlight Xpress MX-5 camera to measure the magnitude difference between Pluto and two different comparison stars. His data suggests that Pluto reached a brightness maximum on June 10.

Visual Magnitude Estimates

Six people made 183 visual magnitude estimates of Uranus, 36 estimates of Neptune and 1 estimate of Pluto during 2002-03. The average normalized magnitudes are: Uranus (-7.1 ± 0.01), Neptune (-6.9 ± 0.02) and Pluto (-0.8). The uncertainties include only random error.

Methane Band Images of Uranus

Frank Melillo used a CCD camera along with a methane band filter centered at a wavelength of 890 nanometers, a 0.20 meter Schmidt-Cassegrain telescope and one-minute exposures to record methane band images of Uranus. He recorded methane band images on Sep. 13 (3:10 UT to 5:04 UT), and reports that Uranus did not change in brightness.

Table 2: Characteristics of the 2002 Apparitions of Uranus, Neptune and Pluto (Data are from the *Astronomical Almanacs* for the years 2001-2003)

Parameter	Uranus	Neptune	Pluto
First Conjunction Date	2002 Feb. 13	2002 Jan. 28	2001 Dec. 07
Opposition Date	2002 Aug. 20	2002 Aug. 02	2002 Jun. 7
Angular diameter (opposition)	3.7 arc-sec.	2.4 arc-sec.	0.1 arc-sec.
Right Ascension (opposition)	$21^h\ 57^m$	$20^h\ 48^m$	$17^h\ 04^m$
Declination (opposition)	-13.3º	-17.8º	-12.6º
Second Conjunction date	2003 Feb. 17	2003 Jan. 31	2002 Dec. 09

Disc Appearance of Uranus and Neptune

Five different people (Frassati, Grafton, Haas, Parker and Venable) submitted observations that suggested (or showed) that one polar region on Uranus was darker than the other. A few images are shown in Figure 3. Haas reported that on several occasions in October-December that he had the impression that the southern edge of Uranus was brighter than the northern edge. Based on Haas' drawings and visual estimates this bright spot had a radius of 26° ± 10º. The south polar region is also brighter than the northern limb in Grafton's July 6 and 19 images along with Parker's Oct. 12 image and Frassati's Nov. 30 image. No difference in the brightness of Uranus' polar limbs were observed on July 14-16; Aug. 8, 9, 12, 13; Sep. 1-4; Oct. 13, 18, 27 and Nov. 2, 19.

The bright south polar region in Figure 3 may have been seen 90 years ago. Fournier, used a 0.51 meter (20 inch) refractor to observe Uranus in 1913. On Oct. 18 of that year, he reports seeing two dark equatorial belts along with a bright equatorial zone, a bright south polar region and a dusky north polar region (Alexander, 1965, 226). Fournier's 1913 observation was made at a similar Uranus season as in 2002.

The only feature seen on Neptune in 2002 was limb darkening. On Aug. 8, at 6:39 UT, the writer suspected darker limb darkening on the edge away from Triton, which would be the north-east limb. I used a 0.7 meter (28 inch) telescope at 277X at the University of Denver's observatory on top of Mt. Evans (elevation 14,100 feet) to make this observation. Boisclair and Frassati also reported seeing limb darkening on Neptune. Boisclair indicated on several

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

Comparison Star	Right Ascension[a]	Declination[a]	Magnitude			
			B	V	R	I
μ-Cap	$21^h\ 53^m$	-13º 33^m	5.45[a]	5.08[a]	---	---
γ-Cap	$21^h\ 40^m$	-16º 40^m	4.00	3.68	3.45	3.32
ι-Aqr	$22^h\ 06^m$	-13º 52^m	4.21	4.29	---	---
ρ-Cap	$20^h\ 29^m$	-17º 49^m	5.18[b]	4.80[b]	---	---
SAO 163951	---	---	9.59	8.60	---	---
Tyc 5652	---	---	---	10.88	---	---

[a] From Hirshfeld et al. (1991)
[b] From Iriarte et al. (1965)

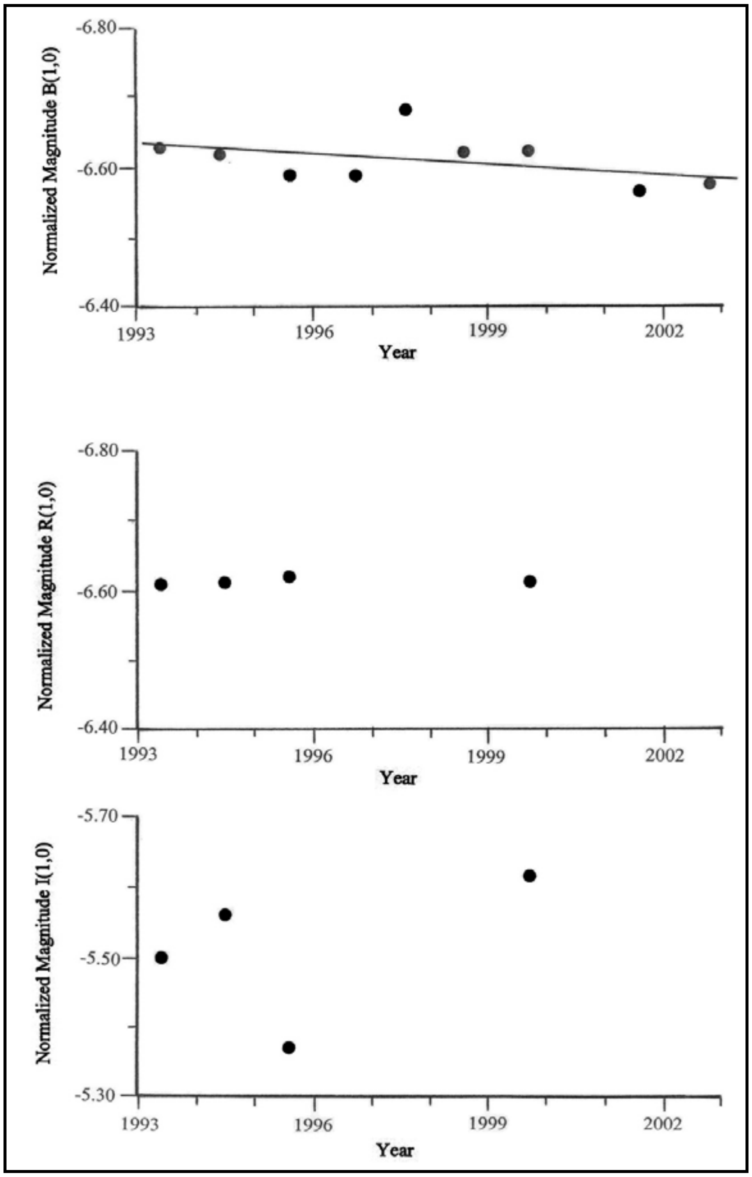

Figure 2: Average annual normalized magnitudes of Neptune plotted against the year for the B, R and I filters.

occasions that the limb darkening on Neptune was more pronounced than on Uranus.

Several people reported on the colors of Uranus and Neptune. Based on all reports, the writer concludes that Uranus had a pale yellow-green color with a hint of blue while Neptune had a gray-blue color with a hint of green.

Spectroscopy

Buchanon, Melillo and West recorded spectra of Uranus and/or Neptune during 2002. *Figure 4* shows that recorded by Melillo and West. There are intensity drops near 540, 620, 730 and 790 nanometers which are due to methane. One difference between the spectra of Uranus and Neptune is the 573 nm absorption feature; this feature is much stronger in the Neptune spectrum. Buchanon photographed the spectrum of Uranus on Dec. 8, 2002; his specrum shows absorption features at 540 and 620 nm.

Satellites

Grafton and Melillo both used unfiltered CCD cameras to record the relative brightness of the satellites of Uranus. Both observers used Titania as the standard. The resulting magnitude differences are listed in Table 7. The average magnitude differences are close to the HST reference data for Oberion, Umbriel and Ariel (Grafton, 2002).

Bob Vanderbei used a 0.09 meter Questar® telescope to image Neptune and its moon Triton. Triton is clearly separated from Neptune in his image and the writer feels that people with small telescopes can do CCD photometry of the brighter moons of Uranus and Neptune.

Conclusions

The average V-filter normalized magnitudes for Uranus and Neptune in 2002 were similar to 2001 values. Uranus has become dimmer in the blue, red and infrared since 1993 — and Neptune became a bit dimmer in blue light since 1993. Several people observed or imaged a bright south polar region on Uranus at visible wavelengths. Ariel, Oberon and Umbriel were measured to be 0.21 ± 0.07, 0.24 ± 0.03 and 0.99 ± 0.07 magnitudes dimmer than Titania respectively.

Acknowledgements

I would like to thank Dr. Bob Stencil for allowing me to use the University of Denver telescope. I am also grateful to everyone who sent in observations of the remote planets in 2002-03.

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Table 4: Photoelectric Magnitude Measurements of Uranus Made During the 2002 Apparition

Date (2002)	Observer Initials	Filter	Raw Magnitude	Normalized Magnitude	Comparison Star
May 15.740	BL	V	5.92	-7.09	ι-Aqr
May 22.387	RS	V	5.86	-7.14	μ-Cap
June 10.339	“	V	5.83	-7.14	“
June 10.355	“	V	5.89	-7.08	“
June 10.371	“	V	5.81	-7.16	“
June 10.388	“	V	5.84	-7.13	“
June 11.319	“	V	5.85	-7.11	“
June 11.334	“	V	5.85	-7.12	“
June 15.343	“	V	5.76	-7.20	“
June 15.359	“	V	5.78	-7.18	“
June 15.374	“	V	5.79	-7.17	“
Aug. 9.318	JW	V	5.77	-7.13	γ-Cap
Aug. 31.308	“	V	5.77	-7.13	“
Sep. 3.290	“	V	5.78	-7.12	“
Sep. 6.302	”	V	5.78	-7.12	“
Sep. 7.280	“	V	5.78	-7.12	“
Sep. 9.297	“	V	5.78	-7.12	“
Sep. 10.273	“	V	5.78	-7.12	“
Sep. 12.243	“	V	5.79	-7.12	“
Sep. 13.265	“	V	5.79	-7.12	“
Sep. 30.209	“	V	5.80	-7.13	“
Oct. 2.214	“	V	5.80	-7.13	“
Oct. 3.216	“	V	5.80	-7.13	“
Oct. 5.181	“	V	5.80	-7.14	“
Oct. 7.168	“	V	5.81	-7.13	“
Oct. 7.435	BL	V	5.82	-7.11	μ-Cap
Oct. 7.460	“	B	6.31	-6.63	“
Oct. 8.173	JW	V	5.81	-7.13	γ-Cap
Oct. 13.185	“	V	5.82	-7.13	“
Oct. 27.167	“	V	5.84	-7.13	“
Oct. 29.140	“	V	5.85	-7.12	“
Oct. 29.434	BL	V	5.85	-7.13	μ-Cap
Oct. 29.453	“	B	6.35	-6.63	“
Oct. 30.151	JW	V	5.86	-7.12	γ-Cap
Oct. 31.058	RS	B	6.34	-6.64	μ-Cap
Oct. 31.089	“	B	6.35	-6.62	“
Oct. 31.097	“	B	6.35	-6.63	“
Oct. 31.113	“	B	6.36	-6.61	“
Oct. 31.126	“	B	6.35	-6.63	“

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Table 4: Photoelectric Magnitude Measurements of Uranus Made During the 2002 Apparition (cont)

Date (2002)	Observer Initials	Filter	Raw Magnitude	Normalized Magnitude	Comparison Star
Oct. 31.137	RS	B	6.34	-6.63	μ–Cap
Nov. 9.054	"	R	6.26	-6.73	γ-Cap
Nov. 14.032	"	R	6.29	-6.72	"
Nov. 14.060	"	R	6.29	-6.72	"
Nov. 15.040	"	R	6.30	-6.70	"
Nov. 19.069	"	R	6.25	-6.76	"
Nov. 19.088	"	I	7.56	-5.45	"
Nov. 19.112	"	R	6.31	-6.71	"
Nov. 22.032	*	V	5.96	-7.06	μ-Cap
Nov. 27.122	JW	V	5.90	-7.13	γ-Cap
Nov. 27.138	"	R	6.14	-6.89	"
Dec. 1.040	RS	I	7.45	-5.59	"
Dec. 1.064	"	I	7.42	-5.62	"

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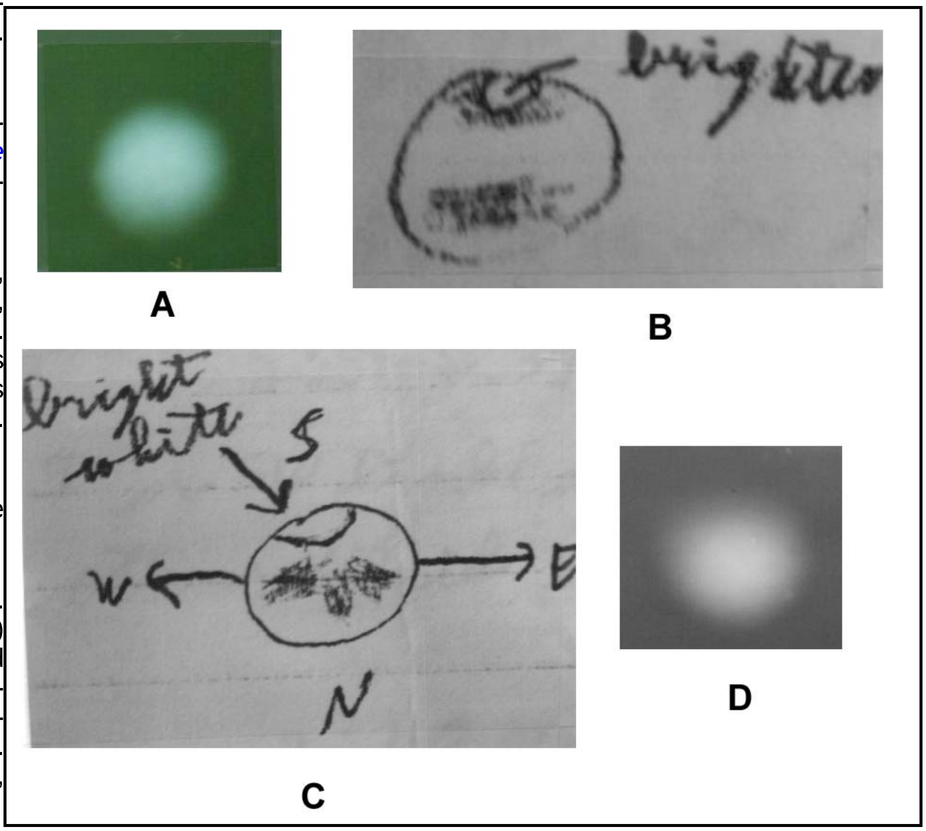

Figure 3: Drawings and images of Uranus in late 2002; south is at the top of all drawings and images. A: By Parker, Oct. 12, 2:32-2:46 UT, 0.41m Newtonian; B: By Haas, Oct. 29 at 2:52-3:10 UT, 0.32m Newtonian; C: By Haas, Dec. 5, 2:08-2:30 UT, 0.32m Newtonian. D: By Mario and Lorenzo Frassati, Nov. 30, 17:50 UT, 0.20m Schmidt-Cassegrain.

Table 5: Photoelectric Magnitude Measurements of Neptune Made During the 2002 Apparition

Date (2002)	Observer Initials	Filter	Raw Magnitude	Normalized Magnitude	Comparison Star
Aug. 9.300	JW	V	7.68	-7.03	θ-Cap
Aug. 31.288	"	V	7.70	-7.02	"
Sep. 3.155	RS	V	7.75	-6.97	ρ-Cap
Sep. 3.175	"	V	7.75	-6.97	"
Sep. 3.194	"	V	7.77	-6.95	"
Sep. 3.210	"	V	7.77	-6.95	"
Sep. 3.226	"	V	7.78	-6.94	"
Sep. 3.267	JW	V	7.69	-7.03	θ-Cap
Sep. 6.283	"	V	7.71	-7.02	"
Sep. 7.261	"	V	7.72	-7.01	"
Sep. 9.278	"	V	7.71	-7.02	"
Sep. 10.253	"	V	7.70	-7.03	"
Sep. 12.224	"	V	7.71	-7.02	"
Sep. 13.245	"	V	7.73	-7.00	"
Sep. 30.190	"	V	7.73	-7.02	"
Oct. 2.198	"	V	7.73	-7.02	"
Oct. 3.051	RS	B	8.21	-6.60	ρ-Cap
Oct. 3.199	JW	V	7.74	-7.01	θ-Cap
Oct. 5.166	"	V	7.79	-6.96	"
Oct. 7.150	"	V	7.74	-7.01	"
Oct. 8.155	"	V	7.73	-7.02	"
Oct. 13.169	"	V	7.75	-7.01	"
Oct. 17.026	RS	B	8.18	-6.58	ρ-Cap
Oct. 17.056	"	V	7.84	-6.93	"
Oct. 17.092	"	B	8.22	-6.54	"
Oct. 27.152	JW	V	7.76	-7.02	θ-Cap
Oct. 29.124	"	V	7.77	-7.01	"
Oct. 30.136	"	V	7.77	-7.01	"
Nov. 27.105	"	V	7.80	-7.01	"

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Table 6: ed Magnitudes for Uranus and Neptune in 2002
(number of measurements is in parentheses)

Planet	B(1,0)	V(1,0)	R(1,0)	I(1,0)
Uranus	-6.63 ± 0.02 (8)	-7.13 ± 0.01 (34)	-6.75 ± 0.04 (7)	-5.55 ± 0.04 (3)
Neptune	-6.57 ± 0.02 (3)	-7.00 ± 0.01 (26)	---	---

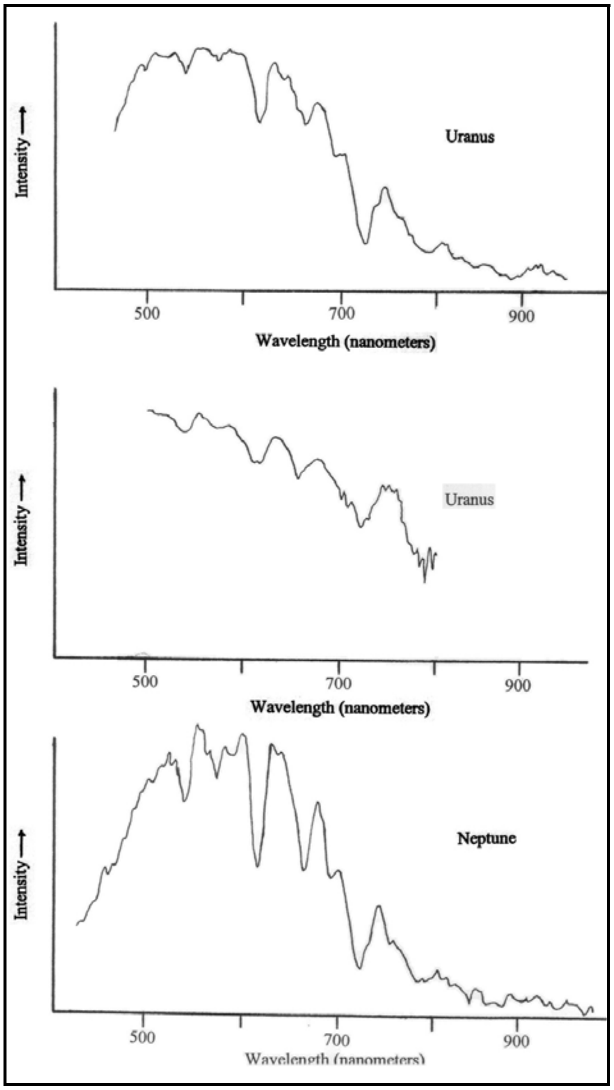

Figure 4: Spectra for Uranus and Neptune in 2002. The top spectrum is of Uranus and it was recorded by Melillo on Sep. 6 at 4:15 UT. The middle spectrum is of Uranus and it was recorded by West on July 18 at 10:26 UT. The bottom spectrum is of Neptune and it was recorded by Melillo on Sep. 5, at 3:30 UT.

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Table 7: Unfiltered Magnitude Differences Between Titania (the Standard Object) and Ariel, Umbriel and Oberon (All Magnitude Differences are: Object – Titania)

Date (2002)	Magnitude Difference			Observer Initials
	Ariel	Umbriel	Oberon	
July 6	0.21 ± 0.20	0.92 ± 0.10	0.20 ± 0.04	EG
July 12	0.22 ± 0.10	---	0.22 ± 0.04	EG
July 18	---	1.07 ± 0.10	0.28 ± 0.04	EG
July 19	0.20 ± 0.10	---	0.26 ± 0.04	EG
July 21	---	---	0.28 ± 0.04	EG
July 22	---	1.04 ± 0.10	0.16 ± 0.04	EG
Aug. 2	---	0.94 ± 0.10	0.16 ± 0.04	EG
Aug. 11	---	---	0.29 ± 0.04	FM
Sep. 6	---	---	0.33 ± 0.04	FM
Average	0.21 ± 0.07	0.99 ± 0.07	0.24 ± 0.03	

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