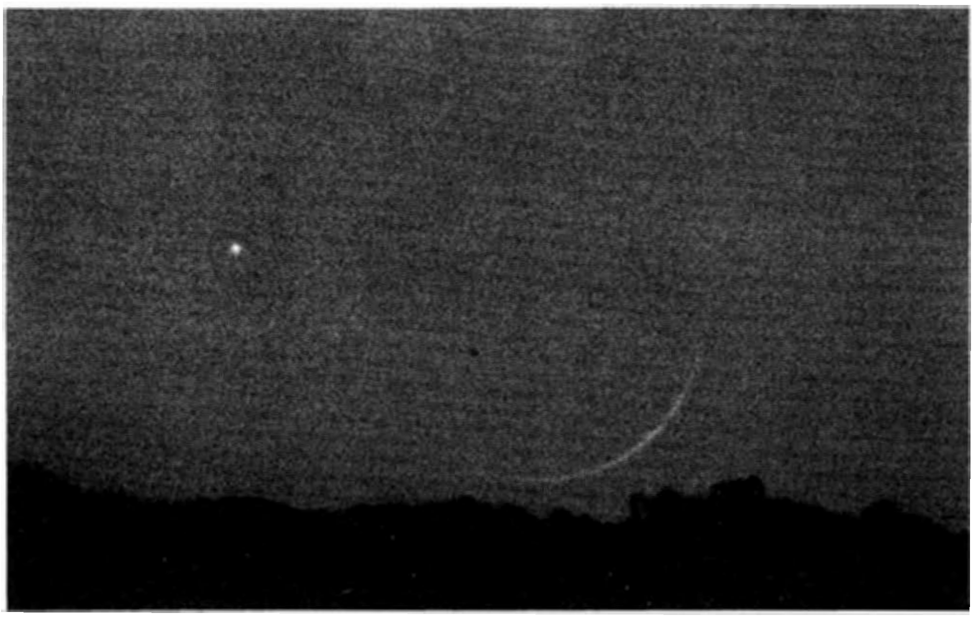
ISSN 0039-2502

The Journal Of The Association Of Lunar And Planetary Observers

The Strolling Astronomer

Volume 42, Number 4 October, 2000 (Published January, 2001)



The planet Venus hangs above a cloud layer just 0.44 degrees to the left of the 24.3-hour old Moon as photographed by Cecil Post on 2000 August 01, 02h44m48s UT. One-second exposure on Ektachrome 200 slide film, 800-mm FL lens with camera on sidereal mount. Photographed from Las Cruces, New Mexico; Venus was occulted by the Moon as seen from the northwest United States, Western Canada, and Alaska.

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Memphis, TN 38187-1302

Association of Lunar & Planetary Observers — Founded in 1947

In This Issue

The Strolling Astronomer, Journal of the A.L.P.O.
VOLUME 42 NUMBER 4. OCTOBER, 2000

A.L.P.O. OBSERVATIONS OF VENUS DURING THE 1997-98 EASTERN (EVENING) APPARITION

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ABSTRACT

This report is a synopsis of visual, photographic and CCD observations contributed to the A.L.P.O. Venus Section by observers in the United States, Italy and Germany during the 1997-98 Eastern (Evening) Apparition, including instrumentation and data resources utilized in making those observations. Comparative studies deal with observers, instruments, and photovisual data. The report includes illustrations and a statistical analysis of the categories of features reported 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, as well as in a few ultraviolet photographs and images. 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 Ashen Light.

INTRODUCTION

A total of 99 drawings, photographs and CCD images of Venus were received by the A.L.P.O. Venus Section during the 1997-98 Eastern (Evening) Apparition. Geocentric phenomena in Universal Time (UT) for the 1997-98 Apparition are presented in *Table 1* (to right), while *Figure 1* (p. 150) illustrates the distribution of observations by month during the observing season.

Observational monitoring of Venus was generally good throughout the 1997-98 Eastern (Evening) Apparition. In what continues to be a desirable trend in recent apparitions, individuals started their observing programs soon after Venus emerged from Superior Conjunction (which occurred on 1997 APR 02), and they continued to follow the planet up to less than one day before Superior Conjunction on 1998 JAN 16. The "observing season," or observation period, ranged from 1997 APR 06 to 1998 JAN 15, with over five-sixths of the observations (85 percent) submitted for the period from 1997 June through December.

Eight individuals contributed a total of 99 visual and photographic observations of Venus during the 1997-98 Apparition, and *Table 2* (p. 150) gives their observing sites, number of observations, and instruments used.

Figure 2 (p. 151) depicts the distribution of observers and contributed observations by nation of origin for the 1997-98 Eastern (Evening) Apparition. Three-quarters of the individuals contributing to the A.L.P.O. Venus Section (75 percent) were located in the United States but accounted for slightly less than half (45 percent) of the total observations received. As in several recent previous apparitions, international participation in our programs continued in an apparent favorable response to our efforts to foster increased cooperation among lunar and planetary observers worldwide.

Table 1. Geocentric Phenomena in Universal Time (UT) for the 1997-98 Eastern (Evening) Apparition of Venus

		1997
Superior Conjunction		APR 02^d 14^h
Initial Observation		APR 06 09
Dichotomy (predicted)		NOV 05 05
Greatest Elongation East (47°)		NOV 06 07
Greatest Brilliancy (m_V = -4.7)		DEC 11 23
		1998
Final Observation		JAN 15 21
Inferior Conjunction		JAN 16 11
Observed Range:		
Apparent Diameter, d:	9".67-	(1997 APR 06)
	62".51	(1998 JAN 15)
Phase Coefficient, k):	1.000-	(1997 APR 06)
	0.005	(1998 JAN 15)

The types of telescopes employed to perform observations of Venus in 1997-98 are shown graphically in *Figure 3* (p. 151). The overwhelming majority (98 percent) of observations in 1997-98 were made with astronomical instru-

Table 2. A.L.P.O. Venus Observers During the 1997-98 Eastern (Evening) Apparition.

Observer and Observing Site	No. Observations	Telescope(s) Used*
Benton, Julius L, Jr.; Wilmington Island, GA	30	15.2-cm (6.0-in) REF
Boisclair, Norman J.; South Glens Falls, NY	1	50.8-cm (20.0-in) NEW
Frassati, Mario; Crescentino, Italy	4	20.3-cm (8.0-in) SCT
	1	31.8-cm (12.5-in) NEW
Haas, Walter H.; Las Cruces, NM	1	20.3-cm (8.0-in) NEW
	1	31.8-cm (12.5-in) NEW
Melillo, Frank J.; Holtsville, NY	3	20.3-cm (8.0-in) SC
Niechoy, Detlev; Göttingen, Germany	2	10.2-cm (4.0-in) REF
	47	20.3-cm (8.0-in) SC
Post, Cecil; Las Cruces, NM	5	20.3-cm (8.0-in) NEW
Schmude, Richard W., Jr.; Barnesville, GA	4	50.8-cm (20.0-in) NEW
Total Number of Observers	8	
Total Number of Observations	99	

*REF = Refractor, SC = Schmidt-Cassegrain, NEW = Newtonian

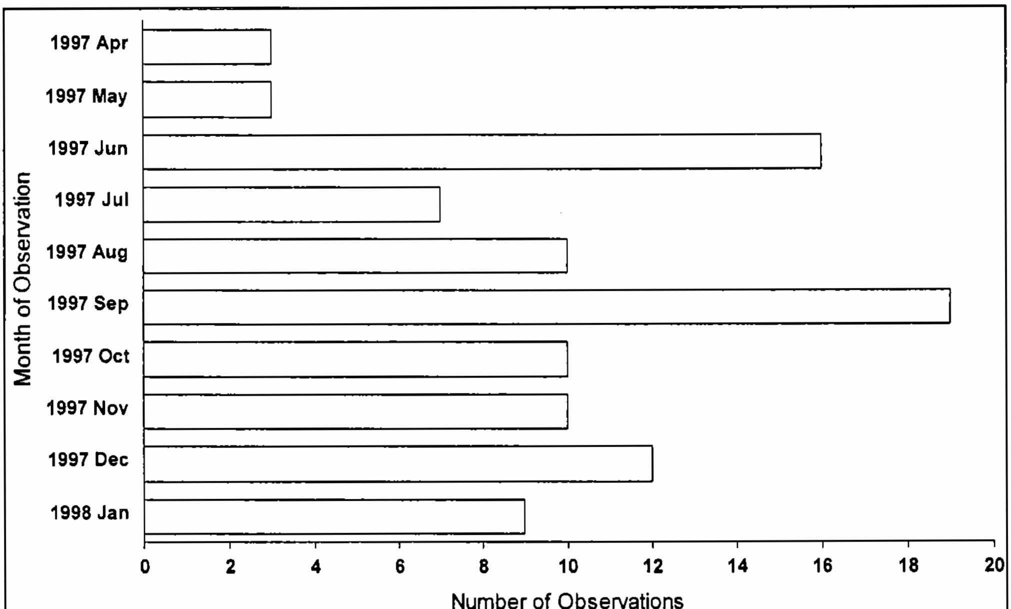

Figure 1. Distribution of observations by month during the 1997-98 Eastern (Evening) Apparition of Venus.

ments 15.2 cm (6.0 in) in aperture or larger, and classical designs (e.g., refractors and Newtonians) were used to make a little less than half (45 percent) of the observations; the remainder (55 percent) were made with Schmidt-Cassegrains.

During 1997-98, most observations (83 percent) were conducted under dark-sky conditions, although a few observers attempted their observations in twilight to avoid spurious atmospheric effects near the horizon.

The A.L.P.O. Venus Section Coordinator expresses his sincere gratitude to the eight individuals mentioned in this report who carefully followed Venus and submitted photovisual observations during 1997-98. Readers desiring to learn more about the planet Venus are encouraged to join the A.L.P.O. and become regular participants to our observational programs in forthcoming apparitions.

Observations of Venusian Atmospheric Details

Standard procedures and techniques for conducting visual studies of the vague and elusive "markings" in the atmosphere of Venus are discussed in detail in *The Venus Handbook* (Benton, 1987). Readers who have access to earli-

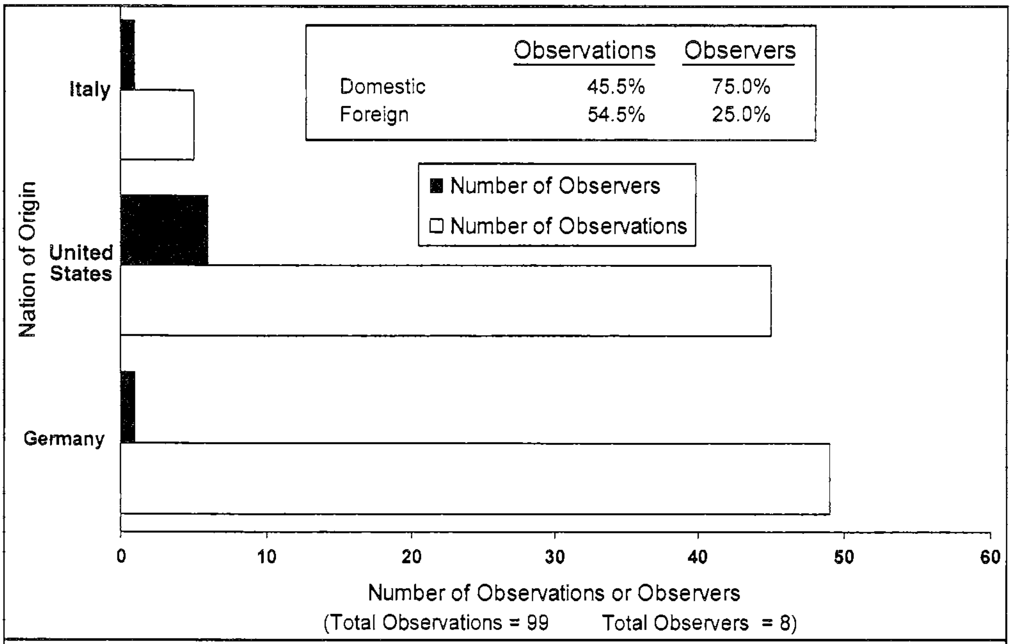

Figure 2. Distribution of observers and observations by nation of origin during the 1997-98 Eastern (Evening) Apparition of Venus.

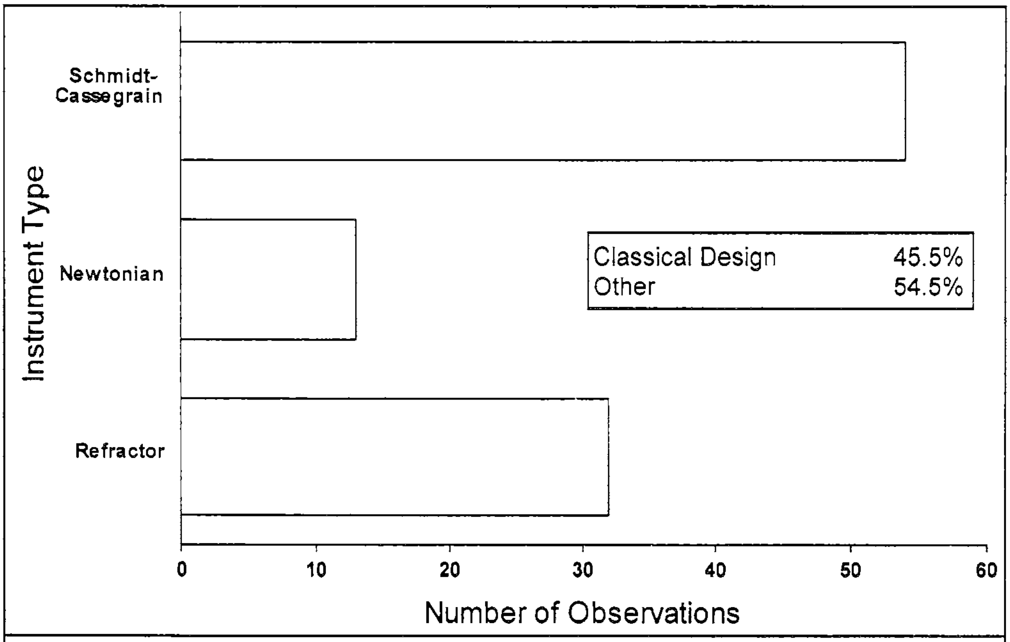

Figure 3. Types of telescopes used during the 1997-98 Eastern (Evening) Apparition of Venus. "Classical Design" consists of refractors and Newtonian reflectors.

er issues of this Journal may find it beneficial to consult previous apparition reports for a historical perspective on photo-visual studies of the planet Venus by A.L.P.O. observers.

The great majority of observations utilized in this analysis were made at visual wavelengths, and several examples of these observations in the form of drawings and a CCD image appear in this report to aid the reader in interpreting the phenomena reported in the atmosphere of Venus in 1997-98. As was the case in the last two apparitions, Frank Melillo continued his painstaking efforts to obtain images of Venus in ultraviolet wavelengths, and one of his CCD images accompanies this report (*Figure 10*, p. 157).

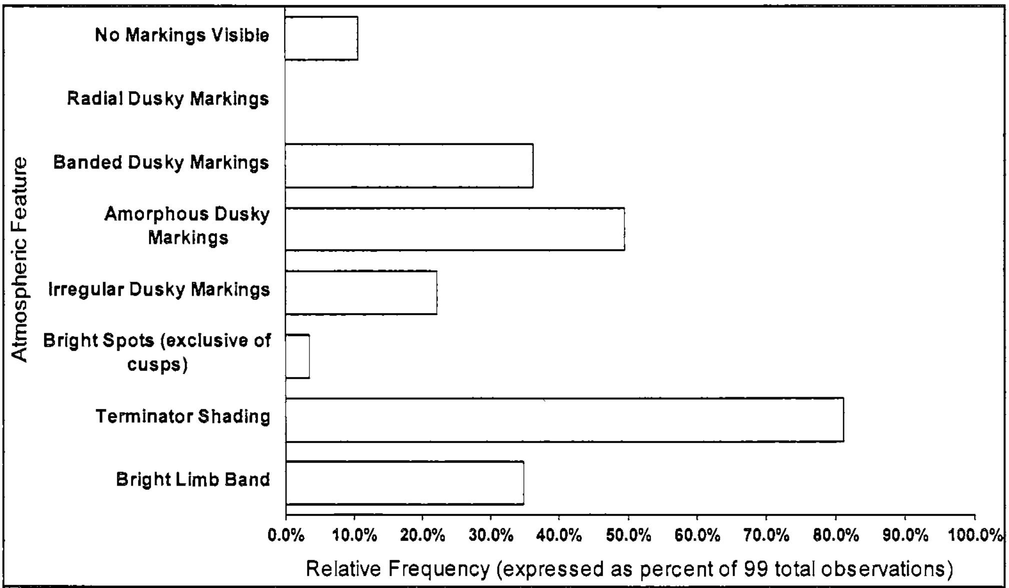

Figure 4. Relative frequency of specific forms of atmospheric markings on Venus during the 1997-98 Eastern (Evening) Apparition.

With the exception of radial dusky markings, the visual and photographic data for the 1997-98 Apparition represented all of the traditional categories of dusky and bright markings in Venus' atmosphere as described in the literature referenced at the end of this report. *Figure 4* (above) illustrates the frequency that the specific forms of markings were seen or suspected. Most observations referred to more than a single category of marking or feature, and thus totals exceeding 100 percent are possible. Readers should realize, too, that a rather high incidence of subjectivity is inherent in visual attempts to describe the extremely elusive atmospheric markings of Venus. This undoubtedly affected the data in Figure 4, but it is believed that conclusions deduced from these data are at least reasonable.

Any dusky markings in the atmosphere of Venus are notoriously troublesome to detect visually, which is a characteristic of the planet that is largely independent of the experience of the observer. Using color filters and variable-density polarizers helps reveal subtle cloud phenomena on Venus at visual wavelengths, but the A.L.P.O. Venus Section continues to encourage observers to try UV photography or CCD images. The morphology of features revealed at UV wavelengths is usually quite different from what is seen in visual regions of the spectrum, particularly radial dusky patterns.

Figure 4 shows that a small portion (11 percent) of the observations of Venus in 1997-98 referred to a brilliant completely featureless disc, similar to the situation in the 1996-97 Western (Morning) Apparition, but contrasting with several earlier apparitions of the planet. When dusky features were seen or suspected, most were classed as "Banded Dusky Markings" (36 percent), "Amorphous Dusky Markings" (50 percent), and "Irregular Dusky Markings" (22 percent). No sightings of "Radial Dusky Markings" were reported during the 1997-98 Eastern (Evening) Apparition. In a few of Melillo's images taken in near ultraviolet wavelengths, a few vague dusky atmospheric features are apparent.

Terminator shading was apparent during much of the 1997-98 observing season, reported in 81 percent of the observations, as shown in Figure 4. The terminator shading usually extended from one cusp region to the other, and the shading appeared to lighten (i.e., take on a higher intensity) as one progressed from the region of the terminator toward the bright limb of the planet. This gradual variance in brightness ended in the Bright Limb Band in most accounts. In a few of Melillo's photographs in 1997-98, terminator shading appears to be represented.

The mean relative intensity for all of the dusky features on Venus in 1997-98 ranged from 8.0 to 8.5. [This scale runs from 0.0 for completely black to

10.0 for the brightest possible condition. Ed.] The A.L.P.O. Scale of Conspicuousness (which runs sequentially from 0.0 for "definitely not seen" up to 10.0 for "certainly seen") was also used regularly during 1997-98. On this scale, the dusky markings in Figure 4 had a mean conspicuousness of 3.5 during the apparition, which suggests that these features fell within the range from very indistinct impressions to fairly good indications of their actual presence on Venus.

Figure 4 also shows that "Bright Spots or Regions," exclusive of the cusp areas, were seen or suspected in only 3.5 percent of the total submitted observations, and these areas had a derived mean relative intensity of 9.2 to 9.8. In drawings made at visual wavelengths, observers called attention to such bright areas by sketching in dotted lines around such features, and although these features were completely absent on photographs in integrated light, perhaps one of Melillo's near-ultraviolet photographs shows barely perceptible bright regions.

Observers routinely used color filters during the 1997-98 Apparition, and when results were compared with studies in integrated light, it was obvious that variable-density polarizers and color filters improved the visibility of vague atmospheric phenomena on Venus.

The Bright Limb Band

Figure 4 shows that a "Bright Limb Band" on the sunlit hemisphere of Venus was apparent in 35 percent of the submitted observations in 1997-98. When the Bright Limb Band was reported, it appeared as a continuous, brilliant arc extending from cusp to cusp 78 percent of the time, and was interrupted or only partially visible along the limb of Venus in 22 percent of the positive reports. The mean numerical intensity of the Bright Limb Band was 9.9 and this feature was definitely more conspicuous when color filters or variable-density polarizers were used. Although visual observers referred to the dazzling brightness of this feature in 1997-98, it was not apparent on any photographs of Venus that were submitted.

Terminator Irregularities

The terminator is the geometric curve that divides the sunlit and dark hemispheres of Venus. Observers described an irregular or asymmetric terminator in slightly more than one third (38 percent) of the observations in 1997-98. Amorphous, banded, and irregular dusky atmospheric markings appeared to blend with the dusky shading along the terminator, perhaps contributing to reported deformities. Filter techniques enhanced the visibility of terminator irregularities and dusky atmospheric features closely associated with them during the 1997-98 Apparition. Because of irradiation, bright features adjacent to the terminator may occasionally look like bulges, and dark features may appear as dusky hollows.

Cusps, Cusp-Caps, and Cusp-Bands

In general, when the phase coefficient, **k** (the fraction of the disc that is illuminated), lies between 0.1 and 0.8, features on Venus having the most contrast and prominence are repeatedly sighted at or near the planet's cusps. These cusp-caps are sometimes bordered by what are described as dark, usually diffuse, cusp-bands. *Figure 5* (p. 154) shows the visibility statistics for Venusian cusp features in 1997-98.

Figure 5 illustrates that, when the northern and southern cusp-caps of Venus were observed in 1997-98, these features were almost always equal in size and brightness. There were a very few instances when either the northern or southern cusp-cap was the larger, the brighter, or both, and in slightly more than a quarter of the observations submitted (29 percent), neither cusp-cap was visible. The mean relative intensity of the cusp-caps was about 9.8 during the 1997-98 Apparition. Dusky cusp-bands bordering the bright cusp-caps were not reported in 36 percent of the observations when cusp-caps were visible (see Figure 5), and the cusp-bands displayed a mean relative intensity of about 6.8.

Cusp Extensions

As can be seen in Figure 5, there were no cusp extensions reported beyond the 180° expected from simple geometry in 87 percent of the observations (in integrated light and with color filters). Later in the apparition, as Venus progressed through increasingly crescentic phases

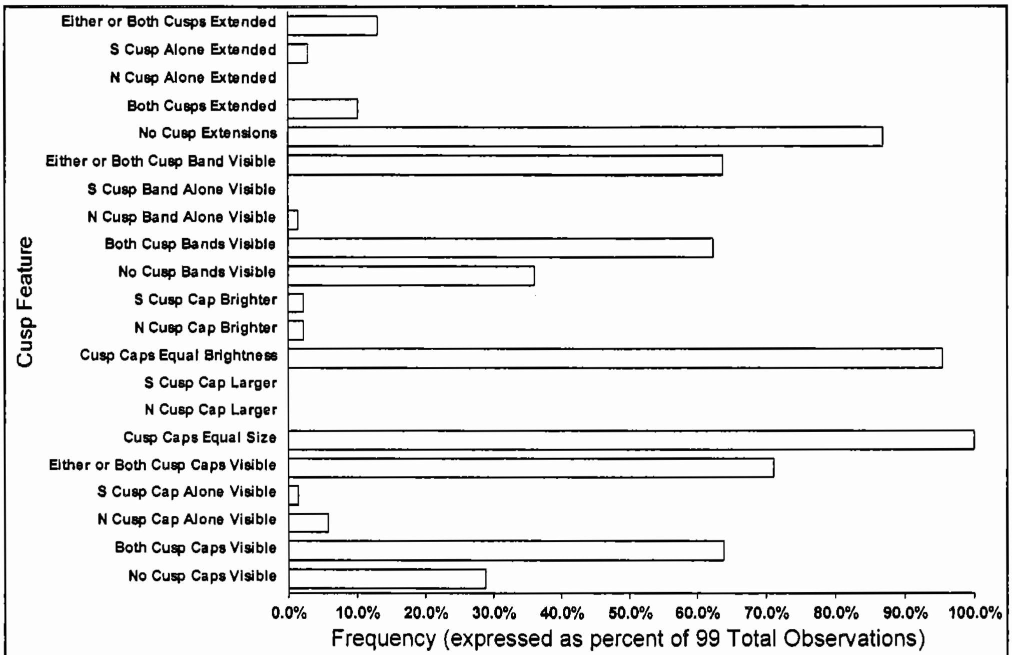

Figure 5. Visibility statistics of cusp features of Venus during the 1997-98 Eastern (Evening) Apparition.

approaching inferior conjunction in 1997-98, several observers recorded cusp extensions that ranged from 2° to 10°. Just before inferior conjunction, a few observers reported (especially in a W47 dark-blue filter) the cusps joining along the planet's unilluminated limb, forming a complete halo encircling the dark hemisphere of Venus. Reported cusp extensions were shown on drawings, with their appearance enhanced by color filters and polarizers, but none were photographed successfully. Experience has shown that cusp extensions are very difficult to document on film due to the fact that the sunlit regions of Venus are so much brighter than the faint extensions. Observers are encouraged to try their hand at recording cusp extensions using CCD or video cameras 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 reported by observers during the 1997-98 Eastern (Evening) Apparition. The predicted half-phase occurs when k = 0.500, and the phase angle, **i**, between the Sun and the Earth as seen from Venus, equals 90°. The observed-minus-predicted discrepancies for 1997-98 are given in *Table 3* (right).

Dark Hemisphere Phenomena and Ashen Light Observations

The Ashen Light, 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 resembles Earthshine on the dark portion of the Moon. Most observers agree that

Table 3. Observed versus Predicted Dichotomy of Venus: 1997-98 Eastern (Evening) Apparition.

Observers:	J. Benton	D. Niechoy
a. UT Dates (1997).		
Observed (O)	Nov 01.10	Oct 29.70
Predicted (P)	Nov 05.22	Nov 05.22
Difference (O-P)	-4.12^{d}	-6.52^{d}
b. Phase (k).		
Observed (O)	0.500	0.500
Predicted (P)	0.520	0.532
Difference (O-P)	-0.020	-0.032
c. Phase Angle (i, degrees).		
Observed (O)	90.0	90.0
Predicted (P)	87.7	86.4
Difference (O-P)	+2.3	+3.6

Venus must be viewed against a completely dark sky for the Ashen Light to be seen, but this condition occurs only when the planet is very low in the sky where adverse terrestrial atmospheric conditions contribute to poor seeing. Also, substantial glare in contrast with the surrounding dark sky influences such observations. Even so, the A.L.P.O. Venus Section continues to hear from observers who say they have seen the Ashen Light when Venus was in a twilight sky.

During 1997-98, there were only three instances (3 percent of the observations) when the Ashen Light was suspected in integrated light, color filters, or variable-density polarizers. On rare occasions a few observers vaguely suspected the presence of the Ashen Light, but confirmation was lacking. There a few times during the 1997-98 Eastern (Evening) Apparition (in 4 percent of the observations) when observers said they thought they could see the dark hemisphere of Venus appearing darker than the surrounding sky. This phenomenon, in reality, is almost certainly a contrast effect.

Conclusions

The results of our analysis of visual and photographic observations contributed to the A.L.P.O. Venus Section during the 1997-98 Eastern (Evening) Apparition of Venus suggested limited activity in the atmosphere of the Venus. It has already been mentioned that it very difficult to differentiate between what may be genuine atmospheric phenomena and what is merely illusory on Venus at visual wavelengths. A greater level of confidence in our results will improve as the number of observers and incidence of simultaneous observations increases. The A.L.P.O. Venus Section is continuing the effort to organize and implement a simultaneous observation schedule during 2000 and subsequent years so that observers in relative proximity to one another can establish times to follow Venus when others (using similar methods and equipment) are viewing the planet. A simultaneous observing schedule is expected to appear on the A.L.P.O. website (www.lpl.arizona.edu/alpo) in the very near future. In addition to routine observations, the A.L.P.O. Venus Section needs many more ultraviolet photographs of the planet, as well as CCD images of Venus in different wavelengths. We are attempting to standardize and improve observational techniques and methodology for more effective comparison of results among apparitions.

A.L.P.O. studies of the Ashen Light, which peaked in 1988 during the Pioneer Venus Orbiter Project, are 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.

Active international cooperation by individuals making regular systematic, simultaneous observations of Venus continues to be our prime objective, and the A.L.P.O. Venus Section invites interested readers to join us in our projects and challenges ahead.

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The drawings and photographs that follow (Figures 6-15) have had their contrast enhanced and are oriented with the South Pole of Venus at top. Any that were originally drawn reversed have been rectified, as noted in their captions. Unless otherwise stated, Seeing *(S)* is in the Standard A.L.P.O. Scale (0 = worst to 10 = perfect) and Transparency *(Tr)* is the limiting visual stellar magnitude in the vicinity of Venus. *k* is the phase coefficient and *d* is the angular diameter. Ephemeris data are from *The Astronomical Almanac*,1997 and 1998 editions.

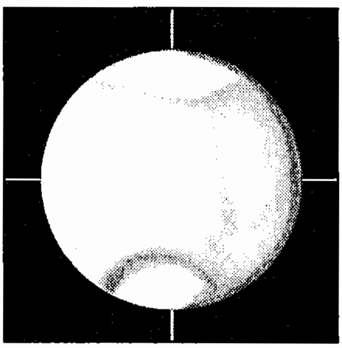

Figure 6. Drawing of Venus by D. Niechoy. 1997 JUN 01, 08h09m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 112X, integrated light. S = 2.0, Tr = 2.0 (daylight). k = 0.962, d = 10".2. Original reversed.

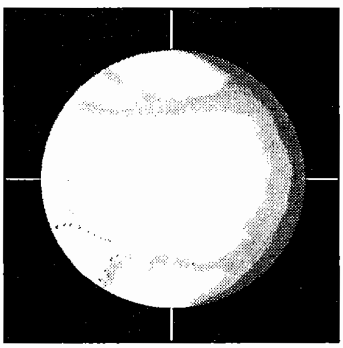

Figure 7. Drawing of Venus by D. Niechoy. 1997 JUL 01, 10h35m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 112X, integrated light. S = 2.0, Tr = 2.0 (daylight). k = 0.888, d = 11".4. Original reversed.

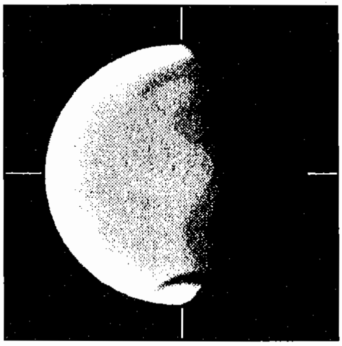

Figure 8. Drawing of Venus by Mario Frassati. 1997 SEP 09, 17h35m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 300X, integrated light. S = 6.0 (interpolated), daylight. k = 0.725 (estimated as 0.70), d = 15".2.

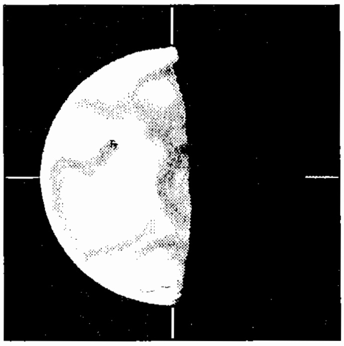

Figure 9. Drawing of Venus by D. Niechoy. 1997 SEP 20, 15h14m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 112X, integrated light. S = 2.0, Tr = 2.0 (daylight). k = 0.687, d = 16".4. Original reversed.

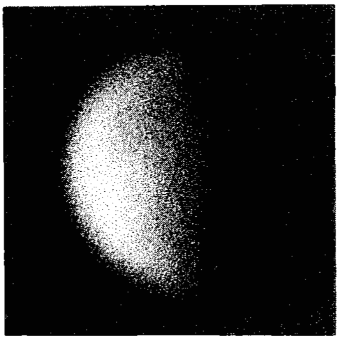

Figure 10. CCD image of Venus by Frank Melillo. 1997 Oct 12, 22^h30^m-22^h31^m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 6-second exposure at f/20. Schott UG-1 Ultraviolet Filter with Starlight Xpress MX-5 CCD camera. S = 8.0, Tr = +4.5 (daylight). k = 0.605 (estimated as 0.60), d = 19".6.

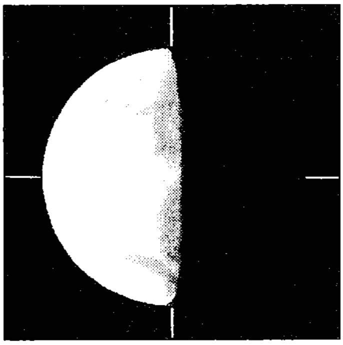

Figure 11. Drawing of Venus by D. Niechoy. 1997 Oct 31, 16^h41^m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 225X, integrated light. S = 3.0, Tr = +3.0. k = 0.523, d = 23".5.

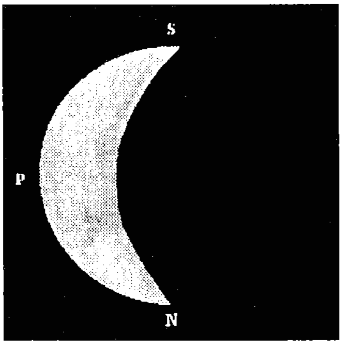

Figure 12. Drawing of Venus by Richard Schmude. 1997 Nov 27, 18^h18^m-18^h27^m UT. 50.8-cm (20.0-in) Newtonian, 95X, integrated light and W80A (blue) Filter. S = 4.0, Tr = 5.5 (daylight). k = 0.368 (estimated as 0.38), d = 33".0.

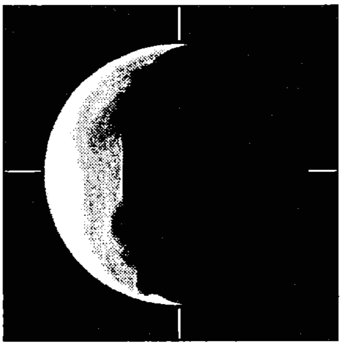

Figure 13. Drawing of Venus by Mario Frassati. 1997 Dec 12, 14^h23^m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 222X, integrated light. S = 6.0 (interpolated), Tr = medium (daylight). k = 0.253 (estimated as 0.28), d = 41".5.

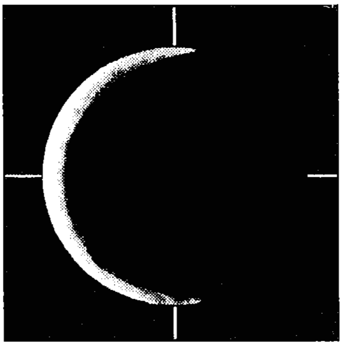

Figure 14. Drawing of Venus by D. Niechoy. 1997 Dec 30, 16^h27^m UT. 20.3-cm (8.0-in) Schmidt-Cassegrain, 225X, W25 (red) Filter. S = 3.0, Tr = +3.0. k = 0.089, d = 55".2. Original reversed.

Figure 15. Drawing of Venus by Cecil Post. 1998 Jan 09, 20^h36^m-21^h17^m UT. 20.3-cm (8.0-in) Newtonian, 156X, integrated light and W21 (orange), W23A (light red), W11 (yellowish-green), W25 (red) and W80A (blue) Filters. S = 2.0-4.0, Tr = "mild haze, scattered cirrus clouds." k = 0.019, d = 61".3. Mr. Post noted "Cusp extension flashed into view. Very thin and pale. Strong suggestion I could see dark side."

Observations of the Remote Planets in 1999

By: Richard W. Schmude, Jr., A.L.P.O. Remote Planets Coordinator

Abstract

A total of 138 photoelectric magnitude measurements were made of Uranus and Neptune in 1999 and the selected normalized magnitudes of Uranus are: B(1,0) = -6.65±0.02, V(1,0) = -7.16±0.02, R(1,0) = -6.89±0.04 and I(1,0) = -5.60±0.04 while the corresponding values for Neptune are: B(1,0) = -6.62±0.02, V(1,0) = -6.99±0.02, R(1,0) = -6.61±0.04 and I(1,0) = -5.61±0.04. A bright spot was strongly suspected on Uranus by three individuals in September, 1999. Spectra of Uranus and Neptune, at a resolution of 30 Å, show several methane absorption bands. The spectra also show that the light intensity at wavelengths greater than 6500 Å drops off more slowly for Uranus than for Neptune.

Introduction

In the last three years, six new moons have been discovered orbiting Uranus [*Sky & Telescope*, 1998, 19; 1999a, 22; 1999b, 24] and amateur Paul Boltwood has imaged one of these new moons [*Sky & Telescope*, 1999b, 128]. In a second major development, Neptune has been imaged to a resolution of 0.05 arc-seconds with the Keck II telescope combined with adaptive optics; this is a better resolution than the Hubble Space Telescope achieves [*Sky & Telescope*, 2000, 21]. Finally, one other significant event has taken place in the A.L.P.O. Remote Planets Section — Frank Melillo has succeeded in imaging the spectra of Uranus and Neptune. This report will summarize observations made of the Remote Planets in 1999.

Table 1 (lower left) lists the characteristics of the 1999 apparitions of Uranus, Neptune and Pluto. Nine individuals submitted observations of Uranus and Neptune in 1999; their names, locations and types of observations are summarized in *Table 2* (bottom left).

Table 1. Characteristics of the 1999 Apparitions of Uranus, Neptune and Pluto.

[Data were taken from the 1998, 1999 and 2000 *Astronomical Almanac*.]

Parameter	Uranus	Neptune	Pluto
First conjunction date	1999 Feb 02	1999 Jan 22	1998 Nov 30
Opposition date	1999 Aug 07	1999 Jul 26	1999 May 31
Angular diameter (opposition)	3".7	2".3	0". 1
Right ascension (opposition)	$21^h 10^m$	$20^h 21^m$	$16^h 37^m$
Declination (opposition)	-17°03'	-19°13'	-10°05'
Second conjunction date	2000 Feb 06	2000 Jan 24	1999 Dec 03

Table 2. Contributors to the A.L.P.O. Remote Planets Section in 1999.

Observer and Location	Type of Observation*
Normal Boisclair; South Glenn Falls, NY	C, V
Brian Cudnik; Weimar, TX	C, V, VP
Bob English; Franklin, TN	V
Robin Gray; Winnemucca, NV	C, V, VP
Walter Haas; Las Cruces, NM	H
Brian Loader; New Zealand	PP
Frank Melillo; Holtsville, NY	CCD, PP, S
Donald Parker; Coral Gables, FL	CCD
Richard Schmude, Jr.; Barnesville and Villa Rica, GA	PP, V, VP

* C = Color, CCD = CCD image, H = Historical, PP = photoelectric photometry, S = Spectra, V = visible description/drawing, VP = visual photometry.

Photoelectric Photometry

Three people (Brian Loader, Frank Melillo and the author) submitted photoelectric magnitudes of Uranus and Neptune in 1999. In all cases, an SSP-3 solid state photoelectric photometer was used, this instrument is described elsewhere [Optec, 1997; Schmude, 1992, 20]. Loader carried out his measurements from New Zealand, and he used a 0.20-m Schmidt-Cassegrain telescope. Melillo also used a 0.20-m Schmidt-Cassegrain telescope, making his measurements from Long Island, New York. The author used a 0.51-m Newtonian telescope near Villa Rica, Georgia. *Table 3* (p. 159) lists the comparison stars used in the photoelectric measurements.

The measurements made by Loader and the author were all corrected for both atmospheric extinction and transformation. Loader carried out mea-

Table 3. Comparison stars used for Photoelectric Magnitude Measurements in 1999.

Star	R.A. (Position (2000.0)[a])	Dec.	B (Magnitude[b])	V	R	I
HD192773	20^h 17.3^m	-19° 58'	8.96	7.86	---	---
HD194213	20^h 25.1^m	-19° 26'	7.84	6.83	---	---
HD194473	20^h 26.4^m	-19° 09'	8.05	7.55	---	---
ρ Cap	20^h 28.9^m	-17° 49'	5.18	4.80	4.46	4.26
HD196078	20^h 35.5^m	-16° 32'	6.39	6.19	---	---
HD199947	21^h 00.9^m	-17° 32'	7.34	6.07	---	---
HD202261	21^h 15.1^m	-17° 21'	7.03	6.05	---	---

[a]All positions are from Hirshfeld *et al.* (1991).
[b]Magnitudes are from the program GUIDE except for ρ Cap which is from Iriarte *et al.* (1965) and HD 196078 which is from Hirshfeld *et al.* (1991).

surements of the two stars: SAO 205871 and SAO 205899 and from these, transformation coefficients of ε_B = +0.235 and ε_V = +0.013 were computed. The author used χ Peg and γ Peg as the red and blue star combination and computed transformation coefficients of ε_B = +0.091, ε_V = -0.019, ε_R = -0.072 and ε_I = -0.107 for his system. Loader's data had smaller extinction corrections than those for the author because of the high altitudes of Uranus and Neptune from New Zealand.

All photoelectric measurements of Uranus are summarized in *Table 4* (pp. 161-162) while those of Neptune are summarized in *Table 5* (p. 162). Selected normalized magnitude of Uranus and Neptune are listed in *Table 6* (below). The normalized magnitudes, $X_{(1,0)}$ are computed from:

$$X_{(1,0)} = X - 5.00 \log [r\, \Delta] \qquad (1)$$

where X is the measured magnitude, r is the planet-Earth distance and Δ is the planet-Sun distance; both r and Δ are in astronomical units [one astronomical unit, or AU, is the mean distance from the Earth to the Sun, or 149,597,870 km].

The normalized V-filter magnitude for Uranus is $V_{(1,0)}$ = -7.16±0.02, which is the same as in 1998 [Schmude, 2000] but is a little dimmer than the 1991 value of -7.20±0.02 [Schmude, 1992, 20]. The 1991 and 1999 values are consistent with the notion that Uranus has decreased in V-filter brightness by about 0.005 magnitudes per year in the 1990s.

The normalized V-filter magnitude of Neptune in 1999 was $V_{(1,0)}$ = -6.99±0.02 which is similar to the 1998 value but is brighter than the 1991 value of -6.91±0.02. The 1991 and 1999 values suggest that Neptune increased in V-filter brightness by about 0.010 magnitude per year in the1990s.

Melillo reports that Uranus was a little fainter in the infrared in 1999 than in 1998 and 1997. He also believes that Uranus was less active in 1999 than in the previous two years.

Visual Magnitude Estimates

Three individuals submitted 52 and 35 visual magnitudes of Uranus and Neptune respectively. The mean normalized magnitudes are -7.1±0.02 and -6.9±:0.02 for Uranus and Neptune respectively. As in the 1998 report, [Schmude, 2000] only the random errors are included in the uncertainty.

Uranus and Neptune Disc Appearance

Six people submitted visual observations of Uranus and Neptune in 1999. *Figure 1* (p. 160) shows a CCD image of Uranus made by Parker, taken in 1995, which is a composite of 9 images made close together in time. Cudnik, Gray and Schmude all suspected a bright spot on Uranus in 1999. English observed a bright area on Uranus on 1999 Oct 17.04; however, this was not confirmed by Cudnik 75 minutes later. Under average and better seeing conditions, no detail was seen on Uranus on the following 1999 dates: Aug 30.22, Sep 06.33, Oct 11.19, Oct 17.09 and Nov 07.06; no detail was seen on Neptune on: Oct 17.11 and Nov 07.05.

Boisclair used a 0.51-m (20-in) Newtonian telescope and reported

Table 6. Selected Normalized Magnitudes for Uranus and Neptune in 1999.
(The number of measurements is given in brackets.)

Planet	B(1,0) (Normalized Magnitude)	V(1,0)	R(1,0)	I(1,0)
Uranus	-6.65±0.02 [20]	-7.16±0.02 [30]	-6.89±0.04 [1]	-5.60±0.04 [1]
Neptune	-6.62±0.02 [19]	-7.00±0.02 [39]	-6.61±0.03 [2]	-5.61±0.03 [2]

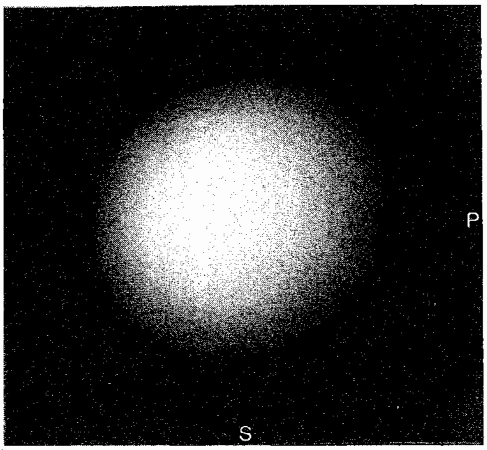

Figure 1: A CCD image of Uranus made on 1995 Jul 09, 07h30m UT, by Donald Parker. This view is a composite of 9 individual images.

a moderate yellow color for Uranus and a faint gray color for Neptune. Cudnik and Gray both reported various bluish-green hues for Uranus and Neptune.

Spectra of Uranus and Neptune

Melillo submitted spectra of both Uranus and Neptune in 1999. A spectrum is a graph of light intensity versus the color of light. Each color of visible light has its own unique wavelength range. *Figure 2* (below) shows the spectra of Uranus and Neptune recorded by Melillo; the vertical axis is the light intensity and the horizontal axis is the light wavelength in angstroms. One angstrom is 1.0×10^{-10} m (the symbol for angstrom is Å). The colors for the wavelengths plotted along the bottom axis are approximately shown on the top axis of each spectrum.

Absorption bands (intensity minima) are in the Uranus spectrum at wavelengths of 5430, 5740, 6190, 6640, 6920, 7260, 7910, 8370 and 8680 Å. The bands at 5430, 6190, 7260 and 8680 Å are due to methane [Fegley *et al.*, 1991, 152-154]. The 6920- and 7910-Å bands may

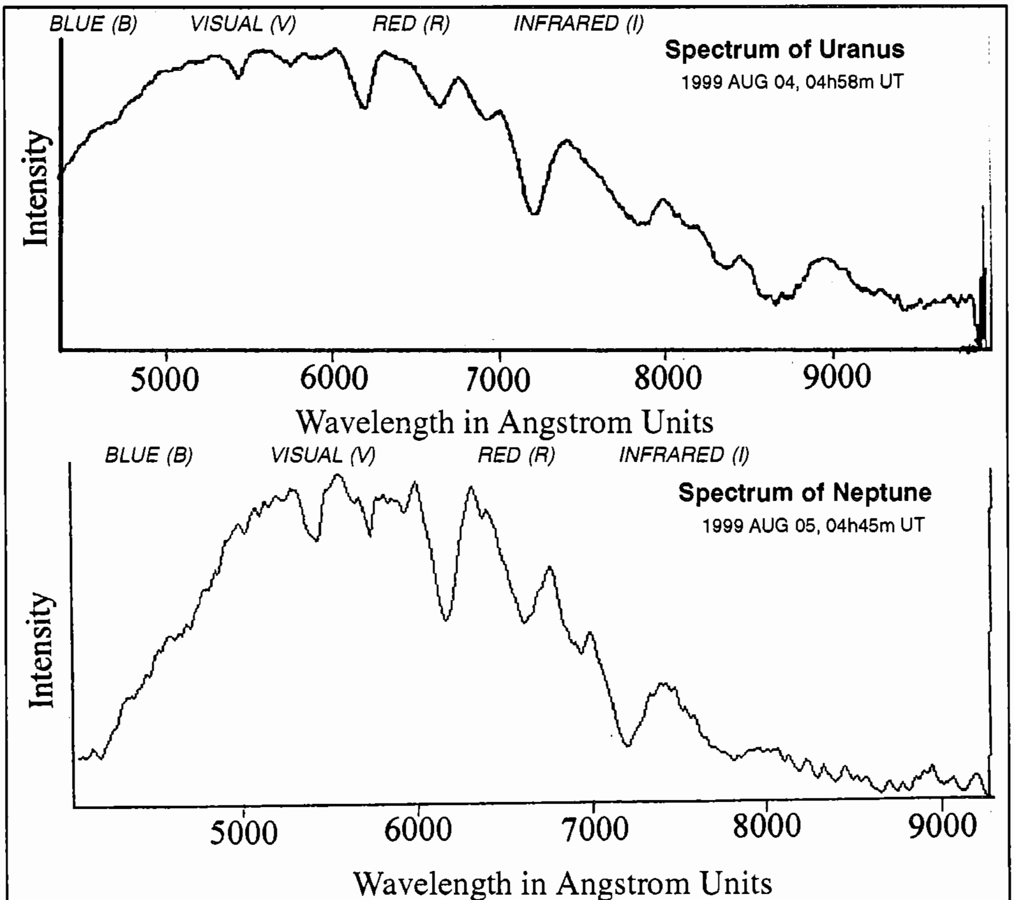

Figure 2: Spectra of Uranus (top) and Neptune (bottom) made by Melillo with a CCD camera. A 0.20-m Schmidt-Cassegrain telescope was used along with a spectroscope manufactured by Rainbow Optics.

be the 6818.9-Å and 7800-Å methane bands described in Fegley *et al.* [1991, 152-154]. The spectrum of Neptune shows absorption features similar to that of Uranus; however, there is one difference: the light intensity at wavelengths greater than 6500 Å drops off more slowly for Uranus than for Neptune.

Melillo also photographed Uranus and Neptune with and without a methane-band filter, using a 200-mm telephoto lens. The methane-band filter's transmission was centered on 8900 Å. Uranus and Neptune were not visible in the methane-band filter photograph, although the faintest objects in the photograph had a magnitude of +11.

Meillo made an unfiltered CCD image of Uranus, Titania and Oberon on 1999 AUG 10 at 06^h00^m UT. At that time, both Titania and Oberon were at greatest elongation. Melillo reports that Titania was 0.33 magnitudes brighter than Oberon.

Conclusion

The photoelectric V-filter measurements of Uranus and Neptune are similar to the 1998 values but are different from those in 1991. On average, Uranus has dimmed by 0.005 magnitudes/year in the 1990s whereas Neptune has brightened by 0.010 magnitudes/year during that same period. A bright spot on Uranus was suspected by three people in September of 1999. Melillo imaged spectra of Uranus and Neptune in August, 1999, showing methane absorption features.

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Table 4. Photoelectric Measured and Normalized Magnitudes of Uranus in 1999.

1999 UT Date	Filter	Magnitude Meas. +	Magnitude Norm. -	Comparison Star	Δ Air Mass: Planet-Star
MAY					
18.754	V	5.80	7.17	HD202261	+0.008
18.755	V	5.81	7.16	"	+0.008
18.760	V	5.80	7.17	"	+0.008
18.763	V	5.79	7.18	"	+0.008
18.765	V	5.80	7.17	"	+0.008
JUN					
19.752*	V	5.77	7.14	HD202261	+0.007
19.753*	V	5.79	7.13	"	+0.012
20.264	B	6.25	6.66	HD196078	+0.37
20.267	V	5.73	7.18	"	+0.35
JUN					
20.276	B	6.28	6.63	HD196078	+0.28
20.278	V	5.75	7.17	"	+0.28
20.287	B	6.36	6.56	"	+0.25
20.290	V	5.77	7.14	"	+0.23
20.309	B	6.23	6.68	"	+0.16
20.311	V	5.73	7.18	"	+0.14
20.330	B	6.25	6.66	"	+0.08
20.332	V	5.75	7.16	"	+0.07
20.347	B	6.19	6.72	"	+0.04

(Continued on p. 162)

Table 4. Photoelectric Measured and Normalized Magnitudes of Uranus in 1999—*Continued.*

1999 UT Date	Filter	Magnitude Meas. +	Magnitude Norm. -	Comparison Star	Δ Air Mass: Planet-Star
Jun					
20.349	V	5.75	7.16	HD196078	+0.03
20.365	B	6.20	6.71	"	0.00
20.367	V	5.72	7.19	"	-0.02
20.387	B	6.19	6.73	"	-0.05
20.389	V	5.77	7.14	"	-0.05
Jul					
14.448	V	5.69	7.19	HD202261	0.00
14.450	V	5.69	7.19	"	+0.01
14.453	V	5.76	7.13	"	+0.01
14.457	V	5.74	7.15	"	+0.01
14.459	V	5.76	7.13	"	0.00
14.464	B	6.23	6.66	"	+0.01
14.466	B	6.30	6.59	"	0.00
Sep					
05.166	B	6.33	6.57	ρ Cap	-0.07
05.168	V	5.79	7.10	"	-0.08
05.171	R	6.00	6.89	"	-0.08
05.173	I	7.29	5.60	"	-0.08
Oct					
01.403	V	5.76	7.16	HD199947	0.00
01.406	V	5.78	7.14	"	0.00
01.409	V	5.77	7.16	HD199947	0.00
01.410	V	5.77	7.15	"	0.00
01.415	B	6.28	6.65	"	0.00
01.418	B	6.28	6.65	"	0.00
01.420	B	6.26	6.66	"	0.00
01.422	B	6.28	6.65	"	0.00
Nov					
07.421	V	5.82	7.17	HD199947	-0.01
07.424	V	5.83	7.16	"	-0.01
07.426	V	5.84	7.15	"	-0.03
07.428	V	5.83	7.16	"	-0.02
07.430	V	5.85	7.14	"	-0.01
07.435	B	6.34	6.65	"	-0.02
07.437	B	6.37	6.62	"	-0.02
07.440	B	6.35	6.64	"	-0.02
07.442	B	6.35	6.64	"	-0.01
07.444	B	6.39	6.61	"	-0.02

*The sky conditions were poor and so these data were not included when computing the selected values in Table 6.

Table 5. Photoelectric Measured and Normalized Magnitudes of Neptune in 1999.

1999 UT Date	Filter	Magnitude Meas. +	Magnitude Norm. -	Comparison Star	Δ Air Mass: Planet-Star
May					
18.731	V	7.77	7.00	HD194473	0.00
18.734	V	7.76	7.00	"	0.00
18.737	V	7.77	6.99	"	0.00
18.739	V	7.75	7.02	"	0.00
18.742	V	7.80	6.96	"	0.00
18.744	V	7.77	6.99	"	0.00
Jun					
19.723*	V	7.73	7.00	HD194473	+0.01
19.726*	V	7.73	7.00	"	+0.01
19.729*	V	7.69	7.04	"	+0.01
19.732*	V	7.76	6.97	"	+0.01
19.735*	V	7.71	7.02	"	+0.01
19.738*	V	7.76	6.97	"	+0.01
19.740*	V	7.73	7.00	"	+0.01
20.318	B	8.09	6.64	HD196078	+0.10
20.321	V	7.74	6.99	"	+0.09
20.336	B	8.15	6.58	"	+0.09
20.339	V	7.74	6.99	"	+0.08
20.353	B	8.06	6.67	"	+0.09
20.356	V	7.79	6.94	"	+0.09
20.371	B	8.06	6.67	"	+0.11
20.373	V	7.74	6.99	"	+0.10
20.381	B	8.03	6.70	"	+0.10
20.383	V	7.78	6.95	"	+0.10
Jul					
14.395	V	7.74	6.98	HD194213	-0.01
14.398	V	7.69	7.03	"	-0.02
14.401	V	7.74	6.98	"	-0.01
14.410	V	7.68	7.03	"	-0.01
14.413	V	7.73	6.99	"	-0.01
14.417	V	7.70	7.02	"	-0.01
14.420	V	7.71	7.00	"	-0.01
14.423	V	7.72	7.00	"	-0.01
14.430	B	8.18	6.54	"	-0.01
14.433	B	8.13	6.58	"	-0.01
14.435	B	8.02	6.70	"	-0.01
Aug					
03.163	V	7.74	6.97	HD196078	0.00
03.172	V	7.76	6.96	"	+0.03
Sep					
05.118	B	8.22	6.51	ρ Cap	+0. 04
05.123	V	7.80	6.93	"	+0.04
05.125	R	8.10	6.63	"	+0.05
05.128	I	9.15	5.59	"	+0.05
05.151	B	8.18	6.55	"	+0.06
05.154	V	7.84	6.89	"	+0.07
05.157	R	8.14	6.59	"	+0.07
05.159	I	9.11	5.63	"	+0.08
Oct					
01.385	V	7.74	7.02	HD192773	+0.01
01.388	V	7.78	6.98	"	+0.01
01.390	V	7.77	6.99	"	+0.01
01.392	V	7.71	7.05	"	+0.01
01.432	B	8.07	6.69	"	+0.01
01.435	B	8.05	6.71	"	+0.01
01.437	B	8.15	6.61	"	+0.01
01.439	B	8.13	6.63	"	+0.01
Nov					
07.387	V	7.79	7.02	HD192773	+0.02
07.390	V	7.75	7.06	"	+0.02
07.392	V	7.76	7.05	"	+0.02
07.395	V	7.78	7.03	"	+0.02
07.397	V	7.77	7.04	"	+0.02
07.403	B	8.23	6.57	"	+0.02
07.405	B	8.17	6.63	"	+0.02
07.408	B	8.14	6.66	"	+0.03
07.410	B	8.24	6.56	"	+0.03
07.412	B	8.15	6.65	"	+0.03

*The sky conditions were poor and so these data were not included when computing the selected values in Table 6.

A.L.P.O. Minor Planets Section Report and Review for 1999: PART III— General Report of Position Observations by the A.L.P.O. Minor Planets Section for the Year 1999

By: Frederick Pilcher, A.L.P.O. Minor Planets Coordinator

Abstract

Observations of positions of minor planets by members of the Minor Planets Section in calendar year 1999 are summarized.

During the year 1999 a total of 4908 positions of 934 different minor planets were reported by members of the Minor Planets Section. Of these 52 are photographic measures (denoted P) and 3088 are CCD images (denoted C). All the remainder are approximate visual positions. All of the numbered minor planets were observed at positions agreeing within errors of measurement with those predicted from their published ephemerides.

Positional observations were contributed by the observers listed in *Table 1* (below).

The summary given in *Table 2* (pp. 164-171) lists minor planets in numerical order, the observer and telescope aperture (in cm), UT dates of the observations, and the total number of observations in that period. The year is 1999 except as otherwise indicated, when a series of observations begun in calendar 1999 continued into 2000.

Table 1. Observers Submitting Positions to the A.L.P.O. Minor Planets Section, 1999.

Observer	Location	Instrument(s)	Number of Planets	Number of Positions
Arlia, Saverio	Buenos Aires, Argentina	15-cm f/6 New	3	52P
Camaiti, Plinio	Torino, Italy	13-cm f/6 refr+CCD 20-cm S-C + CCD	15	16C
Faure, Gerard	Col d'Arlezier France	20-cm S-C	112	277
Foglia, Sergio	Milan, Italy	10X50 & 20X80 binoculars	7	14
Garrett, Lawrence	Fairfax, VT USA	32-cm f/6 refl	146	303
Giambersio, Antonio	Potenza, Italy	20-cm f/6.3 refl+ CCD	10	38C
Goretti, Vittorio	Pianoro, Italy IAU Observatory	25-cm f/4 Schm + CCD	943 610	2915C
Harvey, G. Roger	Concord, NC, USA	74-cm New	221	732
Harvey, G. Roger and Farney, Mike	Dakota Wesleyan Univ., Mitchell, SD, USA	20-cm S-C	2	11
Hudgens, Ben	Memphis, TN, USA & vic.	25-cm f/4.5 Dob	79	166
Lucas, Michael	Ft. Myers, FL, USA	20-cm f/6 New & 35-cm f/11 S-C	19	59(1C)
Pilcher, Frederick	Jacksonville, IL, USA	35-cm S-C	30	187
Pryal, Jim	Ravensdale WA, USA	20-cm S-C	10	20
Puccini, Silvano	AIRALI Observatory, Rosignano, Italy	25-cm f/5.1 New + CCD	8	42C
Serafino Zani Observatory Observers: C. Cremaschini, L. Cocca, S. Foglia, W. Marinello, M. Marinello, G. Pizzetti	Lumezzane, Italy	40-cm R-C + CCD	16	76C

Telescope Types: Dob = Dobsonian, New = Newtonian, refr = refractor, refl = reflector, R-C = Ritchey-Chretien, Schm = Schmidt, S-C = Schmidt-Cassegrain

Table 2. Observations of Minor Planet Positions Submitted to the A.L.P.O. Minor Planets Section in 1999.

Data are given in the following order:
(First line) Minor planet number (and name if applicable);
(Succeeding lines) Observer, telescope aperture (cm), dates of observation(s), number of observations (C = CCD, P = Photographic; [no letter] = visual).

1 Ceres		
Camaiti, 13	Apr 4	1C
Foglia, 5	Jan 4-5	2
Pilcher, 35	Jan 19-Feb 10	6
4 Vesta		
Foglia, 5	Jan 5-22	2
Hudgens, 25	Feb 14-15	2
Pilcher, 35	Jan 19-Feb 10	7
6 Hebe		
Foglia, 8	Dec 5-6	2
Giambersio, 20	Dec 3-6	4C
Pilcher, 35	Oct 11-18	6
7 Iris		
Pilcher, 35	Nov 30-Jan 1'00	7
8 Flora		
Pilcher, 35	Mar 12-18	5
9 Metis		
Lucas, 20, 35	Apr 19-May 16	3
Pilcher, 35	Apr 7-13	3
10 Hygiea		
Lucas, 20, 35	Mar 7-23	4
11 Parthenope		
Giambersio, 20	May 8	2C
Lucas, 20	Mar 9-23	3
12 Victoria		
Lucas, 20	Apr 19	2
14 Irene		
Foglia, 8	Dec 5-6	2
Pilcher, 35	Dec 30-Jan 1'00	6
16 Psyche		
Arlia, 15	Jul 31-Sep 15	23P
Giambersio, 20	Sep 3-6	4C
17 Thetis		
Goretti, 25	Feb 11	5C
Lucas, 20, 35	Feb 7-24	3(1C)
19 Fortuna		
Lucas, 20	Mar 9-12	2
26 Proserpina		
Lucas, 20	Jan 18-23	3
29 Amphitrite		
Foglia, 8	Dec 5-6	2
37 Fides		
Pilcher, 35	Mar 12-22	7
39 Laetitia		
Camaiti, 20	May 5	1C
Goretti, 25	Mar 19-23	55C
40 Harmonia		
Lucas, 20, 35	Mar 19-23	2
41 Daphne		
Arlia, 15	Jul 17-26	14P
Giambersio, 20	Jun 14-28	7C
Goretti, 25	May 29-Jun 5	10C
45 Eugenia		
Lucas, 20	Jan 8-23	6
47 Aglaja		
Goretti, 2	Nov 8	5C
52 Europa		
Lucas, 20	Jan 8-23	6
57 Mnemosyne		
Pryal, 20	Oct 4	2
58 Concordia		
Garrett, 32	Sep 12	2
60 Echo		
Goretti, 25	Apr 1	5C
68 Leto		
Goretti, 25	Feb 8	5C
Pilcher, 35	Jan 19-Feb 10	5
77 Frigga		
Harvey, 74	Jan 17	3
Lucas, 20	Feb 7-9	2
80 Sappho		
Goretti, 25	Apr 4	5C
82 Alkmene		
Pilcher, 35	Apr 7-13	3
85 Io		
Harvey & Farney, 20	Oct 29	3
Pryal, 20	Oct 4	2
89 Julia		
Lucas, 20	Mar 23-Apr 19	2
91 Aegina		
Garrett, 32	Sep 4	2
97 Klotho		
Camaiti, 20	May 14	1C
Pilcher, 35	Mar 12-22	8
99 Hekate		
Pryal, 20	Sep 4	2
101 Helena		
Goretti, 25	Feb 8-13	10C
105 Artemis		
Camaiti, 20	Jun 11	1C
112 Iphigenia		
Goretti, 2	Sep 3	8C
Pilcher, 35	Sep 6-10	6
Pryal, 20	Sep 12	2
121 Hermione		
Camaiti, 20	May 14	1C
Garrett, 32	Jun 12	2
124 Alkeste		
Pilcher, 35	Apr 7-13	3
131 Vala		
Pilcher, 35	Sep 30-Oct 6	5
141 Lumen		
Goretti, 25	Sep 7	5C
143 Adria		
Garrett, 32	Apr 6	2
Goretti, 25	Mar 19	5C
149 Medusa		
Garrett, 32	May 15	2
152 Atala		
Garrett, 32	Jan 12	2
153 Hilda		
Garrett, 32	Jun 13	2
158 Koronis		
Faure, 20	Jun 11	2
Garrett, 32	Jun 13-19	4
164 Eva		
Goretti, 25	Apr 1	5C
169 Zelia		
Garrett, 32	Sep 4	2
Pryal, 20	Sep 4	2
171 Ophelia		
Goretti, 25	Jan 20	5C
177 Irma		
Goretti, 25	Mar 19	5C
181 Eucharis		
Lucas, 20	Jan 18-22	2
183 Istria		
Lucas, 20	Jan 12-23	3
186 Celuta		
W. Marinello, 40	Dec 7	4C
190 Ismene		
Goretti, 25	Mar 20-Apr 4	10C
193 Ambrosia		
Goretti, 25	Oct 27	5C
Pryal, 20	Oct 4	2
196 Philomela		
Goretti, 2	Jan 21	5C
198 Ampella		
Harvey & Farney, 20	Oct 27-29	8
Pryal, 20	Sep 4	2
201 Penelope		
Lucas, 20	Jan 8-23	6
205 Martha		
Goretti, 25	Sep 7-Oct 16	15C
208 Lacrimosa		
Garrett, 32	Feb 6	2
213 Lilaea		
Camaiti, 20	May 14	1C
216 Kleopatra		
Foglia, 8	Dec 5-6	2
219 Thusnelda		
Pryal, 20	Sep 4	2
222 Lucia		
Garrett, 32	Apr 11	2
Goretti, 25	Apr 30	5C
240 Vanadis		
Goretti, 25	Feb 6	5C
Lucas, 20	Feb 7-9	2
245 Vera		
Lucas, 20	Jan 22-23	2
251 Sophia		
Garrett, 32	Sep 3	2
260 Huberta		
Goretti, 25	Apr 30	5C
261 Prymno		
Goretti, 25	Jun 6	5C
263 Dresda		
Hudgens, 25	Nov 28-29	2
273 Atropos		
Hudgens, 25	Feb 15	2
274 Philagoria		
Faure, 20	Jan 20	2
Goretti, 25	Feb 18	5C
Hudgens, 25	Feb 15	2
280 Philia		
Faure, 20	Nov 8-28	3
289 Nenetta		
Goretti, 25	Jul 23	5C
300 Geraldina		
Garrett, 32	Sep 3	2
304 Olga		
Goretti, 25	Feb 23	5C
310 Margarita		
Faure, 20	Dec 7	2
311 Claudia		
Garrett, 32	Jun 6	2
313 Chaldaea		
Arlia, 15	Jan 5-10	15P
316 Goberta		
Hudgens, 25	Nov 13-29	3
331 Etheridgea		
Hudgens, 25	Oct 7	2
332 Siri		
Garrett, 32	Jun 19	2
334 Chicago		
Garrett, 32	Sep 1	2
336 Lacadiera		
Garrett, 32	Apr 6	2
338 Budrosa		
Garrett, 32	Apr 6	2
340 Eduarda		
Goretti, 25	Apr 6	5C
341 California		
Goretti, 25	Apr 25	5C
349 Dembowska		
Giambersio, 20	Jun 1-2	3C
Lucas, 20	Mar 19-23	2
350 Ornamenta		
Camaiti, 20	May 14	1C
Garrett, 32	Jun 13	2
Goretti, 25	Apr 30	5C
351 Yrsa		
Garrett, 32	Feb 6	2
361 Bononia		
Hudgens, 25	Sep 7	2
387 Aquitania		
Camaiti, 20	May 14	1C
389 Industria		
Camaiti, 13	Apr 4	2C
Goretti, 25	Jan 20	5C
391 Ingeborg		
Garrett, 32	May 15	2
401 Ottilia		
Garrett, 32	May 15	2
417 Suevia		
Garrett, 32	Jun 6	2
422 Berolina		
Garrett, 32	Sep 12	2
Pryal, 20	Sep 12	2
430 Hybris		
Hudgens, 25	Jan 19	2
447 Valentine		
Garrett, 32	Feb 6	2
448 Natalie		
Faure, 20	Aug 22	2
Hudgens, 25	Oct 3	2
449 Hamburga		
Garrett, 32	May 15	2
450 Brigitta		
Faure, 20	Dec 6	2
455 Bruchsalia		
Goretti, 25	Apr 30	5C
459 Signe		
Hudgens, 25	Jan 17-19	2

461 Saskia	Faure, 20	Dec 1	2
463 Lola	Goretti, 25	May 2	5C
468 Lina	Garrett, 32	Oct 31	2
	Hudgens, 25	Oct 7	2
483 Seppina	Garrett, 32	Jun 19	2
486 Cremona	Faure, 20	Mar 20	2
	Hudgens, 25	Mar 18-Apr 7	2
502 Sigune	Garrett, 32	Mar 8	2
	Hudgens, 25	Mar 18-Apr 7	2
	Pilcher, 35	Feb 9-14	6
511 Davida	Goretti, 25	May 24-Jun 5	10C
512 Taurinensis	Garrett, 32	Mar 9	2
516 Amherstia	Pryal, 20	Sep 4	2
518 Halawe	Faure, 20	May 15	2
519 Sylvania	Camaiti, 20	May 14	1C
525 Adelaide	Faure, 20	Dec 1	2
529 Preziosa	Goretti, 25	May 24	5C
532 Herculina	Foglia, 8	Dec 5-6	2
547 Praxedis	Goretti, 25	May 2	5C
557 Violetta	Faure, 20	Nov 28	2
559 Nanon	Garrett, 32	May 12	2
	Goretti, 25	Apr 30	5C
567 Eleutheria	Garrett, 32	Jun 6	2
570 Kythera	Garrett, 32	Jun 13	2
573 Recha	Garrett, 32	Sep 3	2
575 Renate	Faure, 20	Aug 22	2
583 Klotilde	Garrett, 32	Jun 19	2
590 Tomyris	Garrett, 32	Feb 6	2
	Goretti, 25	Jan 30-Feb 17	20C
597 Bandusia	Goretti, 2	Oct 27	5C
598 Octavia	Garrett, 32	Jun 13	2
604 Tekmessa	Garrett, 32	Oct 31	2
605 Juvisia	Hudgens, 25	Oct 3	2
609 Fulvia	Faure, 20	Dec 1	2
614 Pia	Faure, 20	Nov 27	2
	Garrett, 32	Dec 2	2
622 Esther	Goretti, 25	Jul 23	5C
624 Hektor	Garrett, 32	Jan 14	2
625 Xenia	Garrett, 32	Sep 1	2
628 Christine	Goretti, 25	May 2	5C
629 Bernardina	Hudgens, 25	Nov 6-7	3
632 Pyrrha	Giambersio, 20	Sep 30-Oct 2	4C
640 Brambilla	Goretti, 25	Jan 21	5C
644 Cosima	Faure, 20	Aug 22	3
646 Kastalia	Garrett, 3	Sep 1-12	4
	Hudgens, 25	Aug 4-13	4
653 Berenike	Garrett, 32	Jun 13	2
	Goretti, 25	Jun 22	5C
661 Cloelia	Garrett, 32	Sep 2	2
683 Lanzia	Pilcher, 35	Nov 30-Dec 8	8
687 Tinette	Faure, 20	Oct 16	2
	Garrett, 32	Oct 30	2
	Hudgens, 25	Oct 7	2
691 Lehigh	Garrett, 32	Feb 6	2
	Goretti, 25	Jan 20	5C
695 Bella	Goretti, 25	Jan 21	5C
696 Leonora	Goretti, 25	Jul 17	5C
699 Hela	Faure, 20	Jun 13	4
	Garrett, 32	Sep 3	2
	Goretti, 25	Jul 4-Dec 31	124C
	Hudgens, 25	Aug 13	2
	W. Marinello, Pizzetti, 40	Sep 11	4C
708 Raphaela	Faure, 20	May 6	2
711 Marmulla	Hudgens, 25	Oct 15	2
716 Berkeley	Hudgens, 2	Feb 15	2
720 Bohlinia	Garrett, 32	Sep 12	2
733 Mocia	Garrett, 32	Sep 3	2
737 Arequipa	Harvey, 74	Aug 4	3
738 Alagasta	Goretti, 25	Apr 25-May 9	10C
739 Mandeville	Garrett, 32	Mar 8	2
740 Cantabia	Garrett, 32	May 15	2
754 Malabar	Garrett, 32	Sep 12	2
761 Brendelia	Faure, 20	May 15	2
766 Moguntia	Faure, 20	Jan 20	2
770 Bali	Goretti, 25	Oct 27	5C
771 Libera	Hudgens, 25	Oct 15	2
773 Irmintraud	Giambersio, 20	Oct 10-11	4C
778 Theobalda	Garrett, 32	Jan 14	2
784 Pickeringia	Harvey, 74	Dec 8	3
786 Bredichina	Garrett, 32	Jun 12	2
787 Moskva	Garrett, 32	May 12	2
	Goretti, 25	Apr 30	5C
795 Fini	Hudgens, 25	Apr 7-17	3
807 Ceraskia	Goretti, 25	May 2	5C
808 Merxia	Goretti, 25	Apr 6	5C
815 Coppelia	Faure, 20	Mar 21	2
	Goretti, 25	May 2	5C
816 Juliana	Hudgens, 25	Jan 19	2
825 Tanina	Faure, 20	Mar 21	2
	Garrett, 32	May 15	2
829 Academia	Faure, 20	Sep 7	2
	Goretti, 25	Oct 10	5C
830 Petropolitana	Garrett, 32	Feb 6	2
	Goretti, 25	Jan 21	5C
832 Karin	Faure, 20	Nov 28	2
834 Burnhamia	Goretti, 25	Apr 13	5C
838 Seraphina	Hudgens, 25	Jul 4	2
840 Zenobia	Hudgens, 25	Oct 3	2
846 Lipperta	Faure, 20	Nov 27	2
	Hudgens, 25	Nov 28-29	2
847 Agnia	Faure, 20	Nov 8-28	3
	Goretti, 25	Oct 27	5C
	Hudgens, 25	Oct 15	2
860 Ursina	Garrett, 32	Oct 30	2
	Goretti, 25	Nov 12	5C
877 Walküre	Hudgens, 25	Jan 17-19	2
885 Ulrike	Faure, 20	Dec 1	2
890 Waltraut	Goretti, 25	Oct 6	5C
891 Gunhild	Garrett, 32	Feb 6	2
893 Leopoldina	Garrett, 32	Sep 1	2
	Goretti, 25	Jul 23	3C
898 Hildegard	Faure, 20	Jun 11	2
	Garrett, 32	Jun 13	2
905 Universitas	Goretti, 25	Mar 20	5C
	Harvey, 74	Mar 17	3
915 Cosette	Hudgens, 25	Jan 19	2
918 Itha	Goretti, 25	Feb 13	5C
928 Hildrun	Goretti, 25	May 29-Jun 5	10C
938 Chlosinde	Hudgens, 25	Oct 3	2
941 Murray	Faure, 20	Dec 6	2
942 Romilda	Faure, 20	Nov 5-27	5
	Garrett, 32	Dec 1	2
	Hudgens, 25	Nov 28-29	2
943 Begonia	Hudgens, 25	Jan 17-19	2
949 Hel	Garrett, 32	Apr 6	2
950 Ahrensa	Goretti, 25	Oct 7	5C
954 Li	Garrett, 32	Sep 3	2
981 Martina	Garrett, 32	Oct 31	2
	Hudgens, 25	Oct 7	2
989 Schwassmannia	Goretti, 25	Jun 22	5C
996 Hilaritas	Faure, 20	Mar 20	2
	Hudgens, 25	Feb 15	2
999 Zachia	Goretti, 25	Sep 13	5C
1005 Arago	Goretti, 25	Mar 19	5C
1007 Pawlowia	Garrett, 32	Dec 2	2
1012 Sarema	Goretti, 25	Apr 25	5C
1017 Jacqueline	Garrett, 32	Jan 12	2
1018 Arnolda	Faure, 20	Nov 28	2
1022 Olympiada	Faure, 20	Jun 12	2
	Garrett, 32	Jun 12	2
	Hudgens, 25	Jun 6	2
1029 La Plata	Garrett, 32	Sep 6	2
1034 Mozartia	Goretti, 25	Feb 8	5C
1036 Ganymed	Goretti, 25	Jan 20	5C
	Lucas, 20	Jan 8-18	4
1041 Asta	Garrett, 32	Jan 12	2
1057 Wanda	Faure, 20	Sep 10	2
	Garrett, 32	Oct 13	2
1060 Magnolia	Goretti, 25	Dec 2	5C
1063 Aquilegia	Faure, 20	Nov 28-Dec 1	2
1067 Lunaria	Faure, 20	Oct 16	2
	Garrett, 32	Oct 30	2
	Hudgens, 25	Oct 3	2
	Pilcher, 35	Oct 5-12	8
1069 Planckia	Hudgens, 25	Jan 17-19	2
1075 Helina	Faure, 20	Sep 17	2
1078 Mentha	Faure, 20	Jan 17	3
	Garrett, 32	Feb 6	2
	Hudgens, 25	Jan 19	2
1082 Pirola	Faure, 20	Dec 1	3
1083 Salvia	Garrett, 32	Feb 6	2
	Hudgens, 25	Jan 19	

1088 Mitka
Hudgens, 25 Dec 30-
Jan 7'00 3

1089 Tama
Garrett, 32 Sep 2 2

1095 Tulipa
Goretti, 25 Mar 19 5C

1098 Hakone
Hudgens, 25 Nov 28-29 2

1118 Hanskya
Goretti, 25 Mar 20 5C

1123 Shapleya
Faure, 20 Jan 20 2

1128 Astrid
Goretti, 25 Apr 13 5C

1130 Skuld
Faure, 20 Nov 27-28 2
Hudgens, 25 Oct 15 2

1131 Porzia
Faure, 20 Nov 5 2

1135 Colchis
Garrett, 32 Dec 10 2
Hudgens, 25 Nov 28-29 2

1142 Aetolia
Faure, 20 Jun 11 2
Garrett, 32 Jun 13 2

1144 Oda
Garrett, 32 Sep 2 2

1146 Biarmia
Goretti, 25 Nov 8 5C

1158 Luda
Faure, 20 Sep 17 2

1166 Sakuntala
Hudgens, 25 Aug 4 2

1169 Alwine
Goretti, 25 Mar 20 5C

1170 Siva
Goretti, 25 Mar 20 5C

1173 Anchises
Goretti, 25 Jul 17 5C

1197 Rhodesia
Garrett, 32 Apr 11 2
Hudgens, 25 Apr 7-17 3

1200 Imperatrix
Faure, 20 Apr 16 2
Garrett, 32 May 15 2
Hudgens, 25 Apr 16-17 2

1204 Renzia
Garrett, 32 Sep 2 2
Hudgens, 25 Aug 8-11 2

1214 Richilde
Goretti, 25 Feb 5 5C

1236 Thaïs
Faure, 20 Nov 8 2
Hudgens, 25 Oct 7 2

1240 Centenaria
Goretti, 25 Jan 20 5C

1243 Pamela
Garrett, 32 Oct 12 2

1253 Frisia
Hudgens, 25 Nov 28-29 2

1271 Isergina
Garrett, 32 Jan 12 2

1276 Ucclia
Cremaschini, W. Marinello,
Pizzetti, 40 Dec 30 3C

1279 Uganda
Garrett, 32 Sep 3 2

1325 Inanda
Faure, 20 Sep 17 2
Garrett, 32 Oct 31 2

1330 Spiridonia
Faure, 20 Mar 20-
Apr 16 5
Garrett, 32 Apr 6 2

1331 Solvejg
Faure, 20 Sep 17 2

1333 Cevenola
Goretti, 25 Jun 22 5C

1355 Magoeba
Faure, 20 Dec 6 2

1362 Griqua
Goretti, 25 Jul 4-19 30C

1365 Henyey
W. Marinello, Pizzetti, 40
Oct 10 3C

1367 Nongoma
Puccini, 25 Oct 27 5C

1368 Numidia
Faure, 20 May 6 2

1373 Cincinnati
Goretti, 25 Jan 20-24 15C

1374 Isora
Faure, 20 Aug 21 2
Hudgens, 25 Sep 7 2

1383 Limburgia
Goretti, 25 Oct 7 5C

1390 Abastumani
Hudgens, 25 Nov 7 2

1403 Idelsonia
Faure, 20 Nov 27 2
Hudgens, 25 Nov 7 2

1423 Jose
Faure, 20 Nov 27-28 2
Hudgens, 25 Oct 15 2
Pilcher, 35 Oct 12-18 4

1424 Sundmania
Garrett, 32 Jan 14 2

1426 Riviera
Faure, 20 Apr 16 2
Garrett, 32 May 15 2

1430 Somalia
Harvey, 74 Nov 4 3

1437 Diomedes
Garrett, 32 Jan 14 2

1442 Corvina
Garrett, 32 Sep 3 2

1446 Sillanpää
Garrett, 32 Apr 11 2

1448 Lindbladia
Pilcher, 35 Dec 30-
Jan 1'00 6

1457 Ankara
Garrett, 32 Sep 3 2

1459 Magnya
Faure, 20 Dec 7 2

1469 Linzia
Garrett, 32 Sep 12 2
Goretti, 25 Oct 7-18 15C

1485 Isa
Goretti, 25 Mar 19 5C

1493 Sigrid
Garrett, 32 Dec 2 2

1499 Pori
Garrett, 32 Oct 12 2
Goretti, 25 Oct 27 5C

1503 Kuopio
Faure, 20 Apr 16 2

1514 Ricouxa
Goretti, 25 Apr 6 5

1527 Malmquista
Garrett, 32 Dec 2 2

531 Hartmut
Goretti, 25 Jan 21 5C

1541 Estonia
Goretti, 25 Feb 23-
Apr 4 10C

1560 Strattonia
Hudgens, 25 Oct 7 2

1569 Evita
Harvey, 74 Oct 15 3

1572 Posnania
Faure, 20 Nov 28 2

1581 Abanderada
Goretti, 25 Jan 20-22 10C

1585 Union
Hudgens, 25 Feb 15 2
Pilcher, 35 Feb 9-14 6

1591 Baize
Faure, 20 Jun 19 2
Garrett, 32 Jun 12 2
Goretti, 25 May 29 5C

1596 Itzigsohn
Goretti, 25 Jan 21 5C

1600 Vyssotsky
Camaiti, 20 Apr 16 1C
Goretti, 25 Apr 30 5C

1603 Neva
Hudgens, 25 Oct 7 2

1607 Mavis
Hudgens, 25 Nov 28-29 2

1614 Goldschmidt
Camaiti, 20 May 21 1C

1615 Bardwell
Goretti, 25 Jan 20 5C

1621 Druzhba
Faure, 20 Aug 21 2
Garrett, 32 Sep 2 2

1622 Chacornac
Faure, 20 May 6 2

1627 Ivar
Goretti, 25 Jan 24 5C

1628 Strobel
Faure, 20 Apr 16 2

1632 Sieböhme
Faure, 20 Sep 10 2

1638 Ruanda
Faure, 20 Jun 23 2

1642 Hill
Hudgens, 25 Feb 15 2

1648 Shajna
Goretti, 25 Nov 5-6 5C

1656 Suomi
Camaiti, 20 Jun 12 1C
Goretti, 25 Jul 2 5C

1668 Hanna
Garrett, 32 Sep 12 2

1687 Glarona
Faure, 20 Nov 27 2
Garrett, 32 Dec 2 2
Hudgens, 25 Nov 28-29 2

1689 Floris-Jan
Hudgens, 25 Sep 7 2

1698 Christophe
Goretti, 25 Nov 5 5C

1701 Okavango
Faure, 20 Nov 8 2

1723 Klemola
Faure, 20 Mar 20 2

1725 CrAO
Garrett, 3 Sep 3 2

1726 Hoffmeister
Goretti, 25 Dec 2 5C

1728 Goethe Link
Goretti, 25 Feb 13 5C

1731 Smuts
Faure, 20 Sep 7 2
Garrett, 32 Sep 2-12 4

1736 Floirac
Goretti, 25 Apr 10 5C

1770 Schlesinger
Goretti, 25 Oct 27 5C

1774 Kulikov
Goretti, 25 Feb 6-8 10C

1789 Dobrovolsky
Faure, 20 Sep 17 2

1792 Reni
Faure, 20 Nov 27 2
Goretti, 25 Nov 28 5C
Hudgens, 25 Nov 29 2

1811 Bruwer
Goretti, 25 Oct 6 5C

1812 Gilgamesh
Harvey, 74 Feb 11 3

1833 Shmakova
Garrett, 32 Sep 6 2

1836 Komarov
Faure, 20 Sep 10 2

1853 McElroy
Goretti, 25 Oct 27 5C

1863 Antinous
Faure, 20 Mar 16 7
Goretti, 25 Sep 7-13 10C
Harvey, 74 Feb 22 6

1867 Deiphobus
Goretti, 25 Sep 13 5C

1886 Lowell
Goretti, 25 Mar 24 5C

1889 Pakhmutova
Faure, 20 Nov 28 2
Goretti, 25 Nov 6 5C

1907 Rudneva
Goretti, 25 May 2 5C

1908 Pobeda
Goretti, 2 Feb 18 5C

1925 Franklin-Adams
Garrett, 32 Sep 3 2

1943 Anteros
Goretti, 25 Nov 5-
Dec 31 10C

1946 Walraven
Goretti, 25 Feb 8 5C

2006 Polonskaya
Goretti, 25 Jan 21 5C

2008 Konstitutsiya
Goretti, 25 Mar 20 5C

2014 Vasilevskis
Faure, 20 Apr 17 2
Garrett, 32 May 15 2

2016 Heinemann
Garrett, 32 Sep 2 2

2021 Poincare
Goretti, 25 Jun 1 5C

2031 BAM
Hudgens, 25 Oct 7 2

2044 Wirt
Goretti, 25 Apr 1 5C

2046 Leningrad
Goretti, 25 Mar 20 5C

2057 Rosemary
Harvey, 74 Oct 15 3

2065 Spicer
Garrett, 32 Sep 12 2

2067 Aksnes
Goretti, 25 Feb 23 5C

2094 Magnitka
Goretti, 25 Jan 20 5C

2118 Flagstaff
Garrett, 32 Dec 10 2
Hudgens, 25 Nov 28-29 2

2120 Tyumenia
Faure, 20 Sep 10 2

2144 Marietta
Goretti, 25 Jan 20-Feb 5 10C

2151 Hadwiger
Garrett, 3 Jan 14 2

2167 Erin
Garrett, 32 Apr 11 2

2190 Coubertin
Harvey, 74 Mar 12 3

2217 Eltigen
Garrett, 32 Sep 6 2

2222 Lermontov
Faure, 20 Dec 1 2
Goretti, 25 Nov 5 5C

2229 Mezzarco
Harvey, 74 Aug 4 3

2233 Kuznetsov
Goretti, 25 Nov 8-12 10C

2238 Steshenko
Goretti, 25 Oct 7-8 10C
Harvey, 74 Oct 15 3

2251 Tikhov
Hudgens, 25 Sep 7 2

2259 Sofievka
Goretti, 25 Sep 12 5C

2262 Mitidika
Faure, 20 Oct 16 2
Garrett, 32 Oct 12 2
Pilcher, 35 Oct 12-18 8

2266 Tchaikovsky
Faure, 20 Dec 1 2

2267 Agassiz
Goretti, 25 Feb 6 5C

2281 Biela
Goretti, 25 Mar 24 5C

2320 Blarney
Goretti, 25 Apr 10 5C

2331 Parvulesco
Hudgens, 25 Dec 30-Jan 7'00 3

2333 Porthan
Goretti, 25 Apr 4 5C

2337 Boubin
Goretti, 25 Apr 1 5C

2355 Nei Monggol
Goretti, 25 Dec 2 5C

2375 Radek
Garrett, 32 Jun 13 2

2378 Pannekoek
Goretti, 25 Apr 1 5C

2385 Mustel
Garrett, 32 Sep 12 2

2390 Nezarka
Goretti, 25 Feb 11 5C

2400 Derevskaya
Goretti, 25 Oct 9 5C

2402 Satpaev
Goretti, 25 Sep 9 5C

2413 van de Hulst
Goretti, 25 Feb 8 5C

2446 Lunacharsky
Harvey, 74 Apr 3 4

2448 Sholokhov
Faure, 20 Apr 17 2
Goretti, 25 May 2-29 10C

2463 Sterpin
Garrett, 32 Sep 12 2

2550 Houssay
Harvey, 74 Nov 10 3

2557 Putnam
Hudgens, 25 Oct 7 2
Pilcher, 35 Oct 6-12 6

2563 Boyarchuk
Goretti, 25 Jan 20 5C

2584 Turkmenia
Goretti, 25 Mar 20 5C

2586 Matson
Goretti, 25 Oct 7 5C
Harvey, 74 Sep 12 3

2598 Merlin
Harvey, 74 Nov 5 3

2606 Odessa
Faure, 20 Apr 16 2
Garrett, 32 May 12 2
Hudgens, 25 Apr 16-17 2

2607 Yakutia
Garrett, 32 Sep 2 2

2610 Tuva
Goretti, 25 Feb 6 5C

2612 Kathryn
Faure, 20 Apr 17 2
Goretti, 25 Apr 30 5C

2637 Bobrovnikoff
Goretti, 25 Feb 18 5C

2642 Vesalé
Harvey, 74 Oct 15 3

2655 Guangxi
Goretti, 25 May 2 5C

2685 Masursky
Goretti, 25 Oct 9 5C

2696 Magion
Harvey, 74 Feb 15 3

2707 Ueferji
Harvey, 74 Dec 8 3

2711 Aleksandrov
Harvey, 74 Sep 12 3

2717 Tellervo
Faure, 20 Sep 7 2
Garrett, 32 Sep 3 2
Hudgens, 25 Sep 7 2

2725 David Bender
Faure, 20 Nov 27 2
Hudgens, 25 Nov 28-29 2

2733 Hamina
Harvey, 74 Feb 9 3

2751 Campbell
Goretti, 25 Jul 17 5C

2768 Gorky
Pilcher, 35 Dec 7-11 6

2786 Grinevia
Hudgens, 25 Oct 3 2

2787 Tovarishch
Goretti, 25 Dec 2 5C

2804 Yrjö
Harvey, 74 May 18 3

2815 Soma
Harvey, 74 Sep 30 3

2816 Pien
Goretti, 25 Apr 25 5C

2832 Lada
Goretti, 25 Jun 4 5C

2853 Harvill
Goretti, 25 Sep 9 5C

2862 Vavilov
Goretti, 25 Jan 21 5C

2865 Laurel
Goretti, 2 Feb 5 5C

2878 Panacea
Goretti, 25 Feb 23 5C

2880 Nihondaira
Goretti, 25 Feb 11 5C

2898 Neuvo
Harvey, 74 Jan 25 3

2928 Epstein
Goretti, 25 Oct 7 5C

2972 Niil
Harvey, 74 Nov 4 3

2987 Sarabhai
Goretti, 25 Sep 9 5C

3015 Candy
Harvey, 74 Nov 10 3

3019 Kulin
Goretti, 25 Apr 10 5C

3053 Dresden
Garrett, 32 Sep 2 2

3067 Akhmatova
Harvey, 74 Dec 12 3

3089 Oujianquan
Faure, 20 Jun 23 2
Garrett, 32 Jun 13 2

3103 Eger
Goretti, 25 Apr 13 5C

3105 Stumpff
Harvey, 74 Sep 2 3

3109 Machin
W. Marinello, Pizzetti, 40 Dec 7 3C

3112 Velimir
Garrett, 32 Sep 3 2

3114 Ercilla
Harvey, 74 May 17 3

3133 Sendai
Goretti, 25 Apr 6 5C

3143 Genecampbel
Goretti, 25 Oct 6-9 14C

3146 Dato
Goretti, 25 Oct 9 5C

3164 Prast
Goretti, 25 Oct 6 5C

3169 Ostro
Faure, 20 Jun 19 3

3188 Jekabsons
Harvey, 74 Sep 12 3

3199 Nefertiti
Goretti, 25 Feb 6 5C

3200 Phaethon
Goretti, 25 Nov 5 5C
Puccini, 25 Nov 10-12 7C

3224 Irkutsk
Faure, 20 May 16-Jun 11 3

3246 Bidstrup
Goretti, 25 Jun 5 5C

3268 De Sanctis
Goretti, 25 Feb 8 5C

3279 Solon
Goretti, 25 Jul 17 5C

3281 Maupertuis
Goretti, 25 Feb 13 5C

3285 Ruth Wolfe
Faure, 20 Dec 6 2
Hudgens, 25 Nov 7 2
Pilcher, 35 Nov 4-9 6

3352 McAuliffe
Goretti, 25 Jan 20-Apr 6 10C

3389 Sinzot
Goretti, 25 Jun 1 5C

3408 Shalamov
Garrett, 32 Sep 6 2

3409 Abramov
Goretti, 25 Mar 24 5C

3429 Chuvaev
Harvey, 74 Sep 12 3

3440 Stampfer
Goretti, 25 Oct 10 5C
Harvey, 74 Sep 11 3

3485 Barucci
Goretti, 25 Dec 7 5C

3501 Olegiya
Goretti, 25 Feb 8 5C

3507 Vilas
Goretti, 25 Nov 8 5C

3527 McCord
Harvey, 74 May 17 3

3533 Toyota
Goretti, 25 Oct 10 5C

3538 Nelsonia
Harvey, 74 Dec 12 3

3557 Sokolsky
Goretti, 25 Apr 25 5C

3573 Holmberg
Goretti, 25 Nov 8-12 10C

3581 Alvarez
Faure, 20 Jun 12 4
Goretti, 25 May 29-Jul 16 25C

3607 Naniwa
Puccini, 25 Nov 14 5C

3622 Ilinsky
Goretti, 25 Oct 10-16 10C

3641 Williams Bay
Harvey, 74 Sep 12 3

3645 Fabini
W. Marinello, Pizzetti, 40 Oct 10 3C

3646 Aduatiques
Puccini, 25 Nov 24-25 8C

3652 Soros
Harvey, 74 Sep 2 3

3657 Ermolova
Goretti, 25 Oct 9-16 10C

3659 Bellingshausen
Goretti, 25 Mar 19 5C

3660 Lazarev
Harvey, 74 Mar 17 3

3661 Dolmatovskij
Goretti, 25 Nov 8-12 10C

3678 Mongmanwai
Goretti, 25 Apr 1 5C

3703 Volkonskaya
Goretti, 25 Jun 8 5C

3704 1981 YX1
Harvey, 74 Sep 12 3

3715 Stohl
Goretti, 25 Jul 17 5C

3754 Kathleen
Faure, 20 Mar 21 2
Hudgens, 25 Apr 16-17 2

3777 McCauley
Harvey, 74 Oct 15 3

3790 Raywilson
Goretti, 25 Dec 7 5C

3803 Tuchkova
Harvey, 74 Feb 9 3

3811 Karma
Garrett, 32 Dec 1 2

3812 Lidaksum
Harvey, 74 Jan 19 3

3813 Fortov
Garrett, 32 Sep 1 2

3838 Epona
Goretti, 25 Nov 6-Dec 17 24C
Harvey, 74 Nov 4 6

3857 Cellino
Harvey, 74 Apr 13 3

3858 Dorchester
Harvey, 74 Oct 1 3

3863 Gilyarovskij
Harvey, 74 Jul 10 3

3873 Roddy
W. Marinello, Pizzetti, 40
Jul 24-25 4C

3888 Hoyt
Goretti, 25 Jun 26 5C

3912 Troja
Goretti, 25 Oct 10 5C

3924 Birch
Goretti, 25 Jan 21 5C

3931 1987 DU6
Goretti, 25 Mar 20 5C

3944 Halliday
Harvey, 74 Nov 5 3

3951 Zichichi
Cremaschini, W. Marinello,
Pizzetti, 40 Dec 30 3C

3952 Russellmark
Goretti, 25 Nov 5 5C

3973 1981 UC1
Harvey, 74 Oct 1 3

3986 Rozhkovskij
Harvey, 74 Dec 30 3

4003 Schumann
Harvey, 74 Sep 12 3

4008 Corbin
Harvey, 74 Mar 12 3

4016 Sambre
Harvey, 74 Feb 15 3

4046 Swain
Harvey, 74 May 6 3

4052 Crovisier
Goretti, 25 Nov 8 5C

4054 Turnov
Goretti, 25 Nov 5 5C

4061 Martelli
Goretti, 25 Apr 25 5C

4088 1986 GG
Harvey, 74 Nov 8 3

4105 Tsia
Goretti, 25 Oct 7-17 15C
Harvey, 74 Sep 18 3

4109 Anokhin
Goretti, 25 Mar 20 5C

4113 Rascana
Harvey, 74 Jan 19 3

4135 Svetlanov
Harvey, 74 Nov 4 3

4150 Starr
Goretti, 25 Jan 20 5C

4163 Saaremaa
Goretti, 25 Jun 5 5C

4164 Shilov
Goretti, 25 Nov 9 5C
Harvey, 74 Nov 10 3

4207 Chernova
Harvey, 74 Jan 11 3

4224 Susa
Faure, 20 Sep 7 2
Pilcher, 35 Sep 6-10 8

4226 Damiaan
Faure, 20 Dec 6 2
Hudgens, 25 Oct 15 2

4229 Plevitskaya
Harvey, 74 Dec 29 3

4246 Telemann
Goretti, 25 Dec 7 5C

4263 Abashiri
Goretti, 25 Oct 6-10 10C

4278 Harvey
Harvey, 74 Sep 2-4 9

4283 Stöffler
Goretti, 25 Feb 8 5C
Harvey, 74 Jan 16 3

4286 Rubtsov
Harvey, 74 Dec 28-29 3

4287 Trisov
Harvey, 74 Oct 15 3

4297 Eichhorn
Harvey, 74 May 16 3

4350 Shibecha
Harvey, 74 Jan 16 3

4369 Seifert
Faure, 20 Aug 21 2
Garrett, 32 Sep 12 2

4388 Jurgenstock
Goretti, 25 Jun 8 5C

4391 Balodis
Harvey, 74 Aug 4 3

4422 Jarre
Giambersio, 20 Nov 13-16 4C
Harvey, 74 Oct 1 3
Hudgens, 25 Nov 7 2

4454 Kumiko
Goretti, 25 Oct 8 5C

4483 Petöfi
Camaiti, 20 Jun 12 1C
Faure, 20 Jun 12 3
Goretti, 25 Jun 26 5C

4493 1988 TG1
Harvey, 74 Nov 30 3

4497 Taguchi
Faure, 20 Nov 27 2
Garrett, 32 Oct 30 2
Harvey, 74 Oct 15 3
Hudgens, 25 Oct 15 2
Pilcher, 35 Oct 5-
Nov 4 9

4503 Cleobulus
Goretti, 25 Mar 20 5C

4512 Sinuhe
Garrett, 32 Mar 9 2
Hudgens, 25 Feb 15 2
Pilcher, 35 Feb 9-14 6

4526 Konko
Harvey, 74 May 9 3

4528 Berg
Goretti, 25 Jul 17 5C

4535 1986 QV2
Harvey, 74 Apr 12 3

4557 Mika
Harvey, 74 Jan 17 3

4566 Chaokuangpiu
Goretti, 25 Jun 17 5C

4570 Runcorn
Harvey, 74 Dec 30 3

4573 Piestany
Goretti, 25 Mar 24 5C

4584 Akan
Harvey, 74 Jan 16 3

4585 Ainonai
Harvey, 74 May 18 3

4594 Dashkova
Goretti, 25 Feb 23 5C

4602 Heudier
Garrett, 32 Oct 30 2
Harvey, 74 Nov 4 3

4611 Vulkaneifel
Harvey, 74 Nov 4 3

4613 Mamoru
Faure, 20 Nov 27 2
Goretti, 25 Dec 13 5C
Harvey, 74 Nov 4 3
Hudgens, 25 Nov 28-29 2
Pilcher, 35 Nov 9-15 6

4629 Walford
Goretti, 25 Nov 8 5C

4645 Tentaikojo
Goretti, 25 Oct 27 5C

4648 Tirion
Harvey, 74 Jan 16 3

4656 1978 VZ3
Goretti, 25 Feb 8 5C

4709 Ennomos
Goretti, 25 Nov 8 5C

4710 Wade
Harvey, 74 Jan 16 4

4721 Atahualpa
Goretti, 25 Mar 20 5C

4727 Ravel
Goretti, 25 Nov 8-9 5C

4730 1980 XZ
Harvey, 74 Mar 12 3

4733 ORO
Goretti, 25 Oct 6 5C

4766 Malin
Harvey, 74 Jan 11 3

4808 1925 BA
Harvey, 74 Jan 11 3

4826 Wilhelms
Harvey, 74 May 17 3

4879 Zykina
Goretti, 2 Mar 20 5C

4898 Nishiizumi
Harvey, 74 Apr 2 3

4918 Rostropovich
Goretti, 25 Nov 5 5C

4951 Iwamoto
Harvey, 74 Nov 30 3

4958 1991 NT1
Harvey, 74 Jan 16 3

4970 Druyan
Harvey, 74 Nov 5 3

5010 Amenemhet
Harvey, 74 Apr 12 3

5019 1979 MS6
Goretti, 25 Nov 6 5C

5032 1990 OO
Goretti, 25 Apr 6-7 5C

5033 Mistral
Goretti, 25 May 9 5C

5036 Tuttle
Harvey, 74 Apr 12 3

5042 1974 ME
Harvey, 74 Mar 12 3

5044 Shestaka
Goretti, 25 Feb 6 5C

5066 Garradd
Goretti, 25 Dec 17-30 10C

5075 Goryachev
Goretti, 25 Nov 8 5C

5084 Gnedin
Harvey, 74 Mar 12 3

5092 Manara
Harvey, 74 Mar 12 3

5131 1990 BG
Goretti, 25 Jan 24 5C

5133 Phillipadams
Harvey, 74 Nov 4 3

5139 Rumoi
Garrett, 32 Sep 12 2

5144 Achates
Faure, 20 Aug 13-22 5
Garrett, 32 Sep 1 2
Giambersio, 20
Sep 23-24 3C

5145 Pholus
Goretti, 25 May 9 3C

5150 Fellini
Goretti, 25 Oct 6-9 14C

5155 Denisyuk
Goretti, 25 Apr 15 5C

5160 Camoes
Goretti, 25 Feb 8 5C

5164 Mullo
Goretti, 25 Jan 24 5C
W. Marinello, Pizzetti, 40
Feb 6 4C

5166 Olson
Harvey, 74 Jan 19 3

5167 Joeharms
Harvey, 74 Sep 18 3

5247 Krylov
Goretti, 25 Jun 26 5C
Harvey, 74 Jun 13 3

5236 Yoko
Goretti, 25 Apr 4 5C

5275 Zdislava
Garrett, 32 Oct 12 2
Harvey, 74 Oct 1 3

5291 Yuuko
Harvey, 74 Mar 23 3

5292 1991 AJ1
Harvey, 74 Jan 11 3

5315 Bal'mont
Goretti, 25 Oct 6 5C
Harvey, 74 Sep 18 3

5325 Silver
Harvey, 74 Jul 10 3

5350 Epetersen
Harvey, 74 Apr 13 3

5351 Diderot
Harvey, 74 Apr 13 3

5356 1991 FF1
Harvey, 74 Feb 11 3

5382 McKay
Harvey, 74 Mar 8 3

5384 1957 VA
Goretti, 25 May 2 5C
Harvey, 74 Apr 12 3

5404 Uemura
Harvey, 74 Oct 15 3

5430 Luu
Harvey, 74 Jun 13 3

5431 Maxinehelin
Goretti, 25 Oct 28 5C

5447 Lallement
Goretti, 25 Feb 18 5C

5468 Hamatonbetsu
Goretti, 25 Jul 17 5C

5473 Yamanashi
Harvey, 74 Oct 16 3

5483 1990 UQ11
Harvey, 74 May 16 3

5523 Luminet
Goretti, 25 Mar 24 5C

5535 Annefrank
Goretti, 25 Sep 7 5C

5539 1965 UA1
Garrett, 32 Sep 3 2

5550 1981 UB1
Goretti, 25 Feb 6-11 10C

5564 1991 VH2
Goretti, 25 Nov 6-12 19C

5585 Parks
M. & W. Marinello, 40 Aug 5 3C

5589 1990 SD14
Goretti, 25 Sep 13 5C

5599 1991 SG1
Harvey, 74 Dec 30 3

5607 1993 EN
Harvey, 74 Sep 11 3

5622 1990 TL4
Garrett, 32 Sep 2 2
Harvey, 74 Aug 4 3
Hudgens, 25 Aug 13 2

5647 1990 TZ
Faure, 20 Mar 20 3
Hudgens, 25 Jan 19 2

5665 1982 BD13
Goretti, 25 Apr 4 5C

5673 McAllister
Goretti, 25 Feb 23 5C

5680 1989 YZ1
Goretti, 25 Oct 8 5C

5693 1993 EA
Goretti, 25 May 23 5C

5697 Arrhenius
Goretti, 25 Oct 6 5C

5702 Morando
Harvey, 74 Mar 8 3

5726 Rubin
Goretti, 25 Feb 23 5C

5733 1989 AQ
Harvey, 74 Nov 14 3

5754 1992 FR2
Goretti, 25 Jun 1 5C

5764 1985 CS1
Harvey, 74 Apr 12 3

5781 Barkhatova
Goretti, 25 Jul 23 3C

5785 Fulton
Harvey, 74 Jan 16 3

5876 1990 DM2
Goretti, 25 Feb 5 5C

5883 1993 VM5
Harvey, 74 Nov 5 3

5887 Yauza
Goretti, 25 Oct 10 5C

5955 Khromchenko
Goretti, 25 Apr 4 5C

5959 Shaklan
Goretti, 25 Feb 18 5C

5968 Trauger
Goretti, 25 Apr 15 5C
Harvey, 74 Apr 12 3

5979 1992 XF
Goretti, 25 Feb 13 5C

5981 Kresilas
Goretti, 25 Feb 23 5C

6027 1993 SS2
Faure, 20 Jun 19 2
Garrett, 32 Jun 13 2
Goretti, 25 Jun 4 5C
Harvey, 74 May 17 3

6047 1991 TB1
Goretti, 25 Apr 1 5C
Harvey, 74 Mar 19 6

6084 Bascom
Harvey, 74 Feb 9 3

6115 Martinduncan
Goretti, 25 Feb 8 5C

6161 Vojno-Yasenetsky
Harvey, 74 Nov 30 6

6170 Levasseur
Harvey, 74 Mar 8 3

6171 1981 UT
Goretti, 25 Jan 21-22 10C

6174 Polybius
Harvey, 74 Sep 18 3

6177 1986 CE2
Harvey, 74 Feb 11 3

6178 1986 DA
Goretti, 25 Dec 30 5C

6181 1986 RW
Goretti, 25 Feb 13 5C

6185 1987 YD
Harvey, 74 Feb 15 3

6194 1990 TN
Harvey, 74 Feb 11 3

6199 Yoshiokayayoi
Harvey, 74 Dec 15 3

6206 Carradolamberti
Goretti, 25 Sep 12 5C

6207 1988 BV
Goretti, 25 Apr 6 5C

6209 Schwaben
Harvey, 74 Jan 19 3

6217 1975 XH
Harvey, 74 Feb 15 3

6220 Stepanmakarov
Goretti, 25 Oct 9 5C

6251 Setsuko
Goretti, 25 Mar 20 5C

6297 1988 VZ1
Goretti, 25 Nov 5 5C

6306 1989 UL3
Harvey, 74 Jan 11 3

6324 1991 DN1
Harvey, 74 Jan 17 3

6349 1995 CN1
Harvey, 74 Jan 16 3

6354 Vangelis
Faure, 20 Apr 16 2

6360 1978 UA7
Harvey, 74 Apr 13 3

6362 1979 KO
Harvey, 74 Jan 11 3

6372 Walke
Goretti, 25 Nov 6 5C

6373 Stern
Harvey, 74 Mar 17 3

6384 Kervin
Harvey, 74 Dec 29 3

6389 Ogawa
Goretti, 25 Feb 6 5C

6401 Roentgen
Goretti, 25 Feb 13 5C

6411 Tamaga
Goretti, 25 Apr 4 5C
Harvey, 74 Feb 11 3

6414 Mizunuma
Goretti, 25 Nov 8-12 10C

6422 1994 CD1
Harvey, 74 May 17 3

6423 1994 CP2
Goretti, 25 Feb 23 5C

6444 1989 WW
Faure, 20 Dec 1 2
Harvey, 74 Nov 30 3

6450 1991 GV1
Goretti, 25 Apr 4 5C

6453 1991 NY
Harvey, 74 Jun 13 3

6465 Zvezdotchet
Harvey, 74 Feb 9 3

6480 Scarlatti
Harvey, 74 Sep 11 3

6489 Golevka
Goretti, 25 May 9-Jun 8 25C

6505 1976 AH
Harvey, 74 Feb 9 3

6521 Pina
Goretti, 25 Oct 6 5C

6532 Scarfe
Goretti, 25 Nov 6-12 19C

6562 1991 UR3
Harvey, 74 Jan 16 3

6571 Sigmund
Goretti, 25 Oct 7-8 10C

6573 1974 SK1
Goretti, 25 Sep 9 5C

6587 Brassens
Goretti, 25 Oct 8-11 15C

6608 1991 VC4
Harvey, 74 Dec 17 3

6632 Scoon
Goretti, 25 Nov 12 5C

6633 1986 TR4
Harvey, 74 Oct 1 3

6638 1989 CA
Harvey, 74 Nov 14 3

6646 1991 CA3
Goretti, 25 Mar 24 5C

6648 1991 PM11
Garrett, 32 Sep 2 2
Harvey, 74 Sep 12 3

6649 1991 RN
Harvey, 74 Sep 2 3

6661 1993 BO
Harvey, 74 Dec 2 3

6670 Wallach
Garrett, 32 Jun 19 2
Harvey, 74 Jun 13 3

6699 Igaueno
Harvey, 74 Nov 14 3

6703 1988 CH
Harvey, 74 Jun 13 3

6731 Hiei
Goretti, 25 Nov 8 5C

6821 Ranevskaya
Harvey, 74 Nov 5 3

6839 1995 WB2
Garrett, 32 Sep 3 2

6859 Datemasamune
Goretti, 25 Jun 26 5C

6896 1987 RE1
Goretti, 25 Jan 21 5C

6934 1994 YN2
Goretti, 25 Jan 21 5C

6969 1991 VF5
Goretti, 25 Feb 18 5C

6976 Kanatsu
Goretti, 25 Jan 21 5C

7003 Zoyamironova
Goretti, 25 Nov 8 5C

7016 1991 YG
Harvey, 74 Feb 11 3

7018 1992 DF
Goretti, 25 Feb 23 5C

7019 1992 EM1
Harvey, 74 Feb 11 3

7064 Montesquieu
Goretti, 25 Dec 2 5C

7086 Bopp
Harvey, 74 Oct 15 3

7089 1992 FX1
Harvey, 74 Mar 12 3

7133 Kasahara
Goretti, 25 Mar 20 5C

7233 1986 EQ5
Garrett, 32 Apr 11 2
Harvey, 74 Apr 12 3

7238 1989 OA
Goretti, 25 May 2 5C

7262 1995 BX1
Harvey, 74 May 16 3

7358 1995 YA3
Goretti, 25 Jan 21 5C

7360 Moberg
Harvey, 74 Jan 17 3

7366 1996 UY
Goretti, 25 Apr 6 5C

7444 1992 UU2
Harvey, 74 Nov 30 3

7447 Marcusaurelius
Goretti, 25 Oct 10 5C
Harvey, 74 Sep 18 3

7476 1993 GE
Harvey, 74 May 9 3

7480 Norwan
Goretti, 25 Jan 24 5

7485 Changchun
Garrett, 32 Dec 31 2
Harvey, 74 Dec 28-29 3

7536 Fahrenheit
Harvey, 74 Sep 18 3
W. Marinello, Pizzetti, 40 Sep 11 4C

7575 Kimuraseiji
Harvey, 74 Nov 5 3

7609 1995 WX3
Goretti, 25 Oct 7-8 10C

7628 1977 QY
Harvey, 74 Sep 18 3
W. Marinello, Pizzetti, 40 Sep 11-Nov 27 7C

7629 Foros
Harvey, 74 Nov 8 3

7634 Shizutanikou
Goretti, 25 Nov 8 5C

7636 Comba
Goretti, 25 Oct 27 5C

7694 1983 SF
Harvey, 74 Sep 18 3

7708 1994 GF9
Goretti, 25 Oct 8 5C

7746 1987 RC1
Goretti, 25 Oct 7-8 10C

7772 1992 EQ15
Goretti, 25 Sep 9 5C

7797 1996 BK2
Harvey, 74 Sep 12 3

7895 Kaseda
Harvey, 74 Dec 30 6

7936 1990 OW2
Goretti, 25 Feb 8 5C

7955 1993 WE
Goretti, 25 Jan 20 5C

8036 Maehara
Goretti, 25 Jan 20 5C

8045 1995 AW
Harvey, 74 Jan 11 3

8062 1977 EZ
Harvey, 74 Feb 9 3

8077 1986 AW2
Harvey, 74 Feb 15 3

8094 1992 UG3
Goretti, 25 Feb 8 5C

8119 1997 TP25
Goretti, 25 Feb 23 5C

8128 Nicomachus
Goretti, 25 Feb 8 5C

8132 1976 YA6
Harvey, 74 Mar 12 3

8144 1982 VY2
Goretti, 25 Feb 8 5C

8176 1991 WA
Goretti, 25 Nov 30 5C

8197 1993 VX
Goretti, 25 Jan 21 5C

8231 Tetsujiyamada
Goretti, 25 Jan 21 5C

8238 Courbet
Goretti, 25 Mar 20 5C

8270 Winslow
Garrett, 32 Sep 2 2

8278 1991 JJ
Harvey, 74 Feb 15 3

8360 1990 FD1
Goretti, 25 May 29 5C
Harvey, 74 May 17 3

8466 1981 EV34
Goretti, 25 Oct 8 5C

8470 1982 SA4
Harvey, 74 Sep 12 3

8616 Fogelquist
Goretti, 25 Oct 8 5C

8617 1980 PW
Harvey, 74 Sep 18 3

8644 Betulapendula
Harvey, 74 Sep 11 3

8692 1992 WH
Goretti, 2 Nov 8 5C

8736 1997 AD7
Garrett, 32 Sep 12 2
Goretti, 25 Sep 9-Oct 7 10C
Harvey, 74 Sep 2 3
Pilcher, 35 Sep 7-10 6

8748 1998 FV113
Goretti, 25 Oct 6-10 11C

8761 Crane
Goretti, 25 Oct 27-Nov 8 10C

8794 1981 EA7
Goretti, 25 Jul 17 5C

8805 1981 UM11
Goretti, 25 Nov 28 5C

8830 1988 VZ
Harvey, 74 Sep 12 3

8862 1991 UZ
Harvey, 74 Sep 11 3

8864 1991 VU
Goretti, 25 Oct 9 5C

8875 1992 UP10
Goretti, 25 Nov 8-9 5C

8900 1995 UD2
Harvey, 74 Sep 18 3

8904 1995 VY
Harvey, 74 Oct 15 3

8925 Boattini
Goretti, 25 Nov 8 5C

9035 1990 SH1
Harvey, 74 Sep 18 3

9078 1994 PB2
Goretti, 25 Oct 6-8 15C

9117 Aude
Faure, 20 Dec 1-6 4

9257 Kunisuke
Goretti, 25 Oct 10 5C

9661 1996 FU13
Goretti, 25 Nov 6 5C

9671 1997 TU9
Goretti, 25 Jan 24 5C

9765 1991 XZ
Harvey, 74 Jan 17 3

9780 1994 SB
Harvey, 74 Jan 16 3

9845 1990 FM1
Harvey, 74 Feb 15 3

10115 1992 SK
Faure, 20 Mar 15 3
Garrett, 32 Mar 21 3
Harvey, 74 Feb 22 6

10479 1982 HJ
Harvey, 74 May 10 3

10778 Marcks
Goretti, 25 Nov 5-6 5C

10999 1978 VC6
Harvey, 74 Sep 2 6

11405 1999 CV3
Faure, 20 Mar 15 3
Garrett, 32 Mar 9 3
Goretti, 25 Feb 23-27 10C
Harvey, 74 Feb 13 6

11650 1997 CN
Harvey, 74 Nov 4 3

11780 1942 TB
Harvey, 74 Nov 5 3

11787 1977 QF1
Harvey, 74 Nov 5 3

11852 1988 RD
Harvey, 74 Nov 8 4

11861 1998 VY2
Harvey, 74 Nov 8 6

11922 1992 UT3
Harvey, 74 Nov 14 3

11939 1993 FH36
Harvey, 74 Nov 8-10 3

11949 1993 SD2
Harvey, 74 Nov 14 3

12181 1964 VL1
Harvey, 74 Dec 28-29 3

12255 1988 XR1
Harvey, 74 Dec 2 3

12336 1992 WO3
Harvey, 74 Dec 2 3

1958 TL1
Goretti, 25 Jan 20-22 10C

1971 SB
Goretti, 25 Oct 6 5C

1972 HL
Goretti, 25 May 2 5C

1973 SF6
Goretti, 25 Jun 4 5C

1977 SX15
Harvey, 74 Mar 8 3

1978 RR8
Goretti, 25 Feb 6 5C

1978 TR2
Goretti, 25 Jan 20-22 10C

1979 KD
Goretti, 25 Feb 8 5C

1979 OA
Goretti, 25 Sep 12 5C

1981 EA19
Goretti, 25 Nov 8 5C

1981 EK27
Goretti, 25 Oct 8-11 15C

1981 EE47
Goretti, 25 Sep 13 5C

1982 VD5
Goretti, 25 Oct 6-7 10C

1983 RL
Goretti, 25 Nov 12 5C

1984 UD
Goretti, 25 Jan 21 5C

1985 BS1
Goretti, 25 Feb 6 5C

1985 CU1
Goretti, 25 Jan 20-21 10C

1985 TS
Goretti, 25 Nov 8 5C

1986 QT1
Goretti, 25 Jan 21-22 10C

1988 DE
Goretti, 25 Dec 17 5C

1988 RD
Goretti, 25 Oct 6-27 10C

1988 RZ5
Goretti, 25 Sep 13 5C

1988 RQ12
Goretti, 25 Feb 18 5C

1988 TW2
Goretti, 25 Sep 12 5C

1988 VR3
Goretti, 25 Sep 14 5C

1989 RL
Goretti, 25 Sep 13 5C

1989 SR
Goretti, 25 Sep 13 5C

1989 UG3
Goretti, 25 Feb 5 5C

1989 UU3
Goretti, 25 Sep 13 5C

1990 FM1
Goretti, 25 Apr 1 5C

1990 KE
Goretti, 25 Jul 15 5C

1990 SY3
Cremaschini, W. Marinello, Pizzetti, 40 Dec 13-30 8C

1990 SC4
Goretti, 25 Mar 24 5C

1990 SU15
Goretti, 25 Sep 13-14 5C

1990 TG13
Goretti, 25 Jan 21 5C

1991 BB
Goretti, 25 Dec 31 5C

1991 NB1
Goretti, 25 Oct 7 5C

1991 UE2
Goretti, 25 Oct 7-11 23C

1991 GT2
Goretti, 25 Jul 23 5C

1991 LZ
Goretti, 25 Sep 12 5C

1991 PH12
Goretti, 25 Feb 8 5C

1991 UL3
Goretti, 25 Sep 13 5C

1991 XD
Goretti, 25 Nov 28 5C
Harvey, 74 Nov 14 3

1992 DG1
Goretti, 25 Feb 13 5C

1992 EE
Goretti, 25 Feb 8-13 10C

1992 EB16
Goretti, 25 Oct 6 5C

1992 FS1
Goretti, 25 Jun 4 5C

1992 GH
Goretti, 25 Jan 21 5C

1992 ME
Goretti, 25 May 29 5C

1993 EA
Goretti, 25 May 9 5C

1993 FL4
Goretti, 25 Oct 7-11 24C

1993 FG23
Goretti, 25 Feb 18 5C

1993 FR23
Goretti, 25 Jan 21 5C

1993 FO36
Goretti, 25 Sep 14 5C

1993 HS
Goretti, 25 Feb 18 5C

1993 SK3
Goretti, 25 Oct 27 5C

1993 TJ2
Goretti, 25 Dec 6-17 15C

1994 BY
Goretti, 25 Oct 7-10 20C

1994 BN4
Goretti, 25 Oct 10 5C

1994 CL
Goretti, 25 Oct 6-8 15C

1994 GT
Goretti, 25 Mar 24 5C

1994 PF22
Goretti, 25 Jan 21 5C

1994 WG
Goretti, 25 Sep 12 5C

1995 DZ1
Giambersio, 20 May 23-30 3C

1995 MB
Goretti, 25 Sep 12 5C

1995 SX2
Goretti, 25 Nov 12 5C

1995 UQ4
Goretti, 25 Dec 31 5C

1995 UQ44
Goretti, 25 Oct 9 5C

1995 WB9
Goretti, 25 Nov 8 5C

1996 GN19
Goretti, 25 Mar 24 5C

1996 JV6
Goretti, 25 May 19 5C

1996 RD1
Goretti, 25 Jul 2-12 15C

1996 XQ5
Goretti, 25 Dec 2 5C

1996 XQ13
Goretti, 25 Jun 22 5C

1996 XF19
Goretti, 25 Oct 10-16 10C

1996 XQ32
Goretti, 25 Oct 6-7 10C

1997 AB13
Goretti, 25 Dec 7 5C

1997 BP1
Goretti, 25 Dec 2 4C

1997 NJ6
Goretti, 25 Nov 30 6C

1997 PS3
Goretti, 25 Jan 21 5C

1997 VD4
Goretti, 25 Feb 6-8 10C

1997 WK
Goretti, 25 Mar 24 5C

1997 WU22
Goretti, 25 Dec 30 5C

1998 FS68
Goretti, 25 Oct 27-Nov 8 10C

1998 FC118
Goretti, 25 Oct 7-8 10C

1998 HH93
Goretti, 25 Oct 8 5C

1998 JB2
Goretti, 25 Nov 5 5C

1998 KZ46
Goretti, 25 Nov 12 5C

1998 MW5
Goretti, 25 May 13-23 10C

1998 MC45
Goretti, 25 Nov 12 5C

1998 QT60
Faure, 20 Jan 16 2
Goretti, 25 Feb 6 5C

1998 SU10
Goretti, 25 Dec 30-31 5C

1998 WS
Faure, 20 Jan 20 3
Harvey, 74 Mar 8 6

1998 YP11
Goretti, 25 Jun 18-Jul 23 30C

1999 BE8
Goretti, 25 Feb 23 5C

1999 BJ8
Harvey, 74 Feb 14 6

1999 BS15
Goretti, 25 Jan 21-22 7C

1999 CZ8
Goretti, 25 Feb 6-18 11C

1999 FN19
Goretti, 25 Apr 4-13 15C
Harvey, 74 Apr 12 6

1999 GU3
Harvey, 74 Apr 14 6

1999 GK4
Goretti, 25 May 9-13 10C

1999 HF1
Cocca, W. Marinello, Pizzetti, 40 Apr 24 4C
Faure, 20 May 6 7
Goretti, 25 May 9-23 10C

1999 HX2
Faure, 20 Jun 23 3
Garrett, 32 Jul 3 3
Goretti, 25 Jul 17-23 15C
Harvey, 74 Jul 10 6

1999 JV3
Goretti, 25 May 13-Jun 8 20C

1999 JD6
Goretti, 2 Jun 4-23 15C

1999 JV6
Goretti, 25 May 23 5C

1999 JD8
Goretti, 25 May 23-24 10C

1999 JM8
Faure, 20 Aug 22 5
Goretti, 25 Nov 5 5C
Harvey, 74 Aug 4 6

1999 JO8
Camaiti, 20 May 21 1C
Faure, 20 Jun 11 5
Garrett, 32 Jun 11 3
Goretti, 25 May 23-Jun 17 32C
Harvey, 74 Jun 13 6

1999 KQ4
Goretti, 25 Nov 8 5C

1999 KU4
Goretti, 25 Jun 4 5C

1999 KW4
Goretti, 25 May 24-Jun 22 27C

1999 LF6
Harvey, 74 Oct 15 6

1999 LN2
Goretti, 25 Jun 22-Jul 15 35C

1999 LO28
Goretti, 25 Jun 22-Jul 19 40C

1999 ML
Goretti, 25 Sep 9-29 10C

1999 NT1
Goretti, 25 Nov 8 5C

1999 NW2
Goretti, 25 Jul 16-17 20C

1999 ND43
Goretti, 25 Sep 7-Dec 30 36C

1999 OW2
Goretti, 25 Nov 12 5C

1999 QJ
Goretti, 2 Sep 7-12 20C

1999 RH27
Faure, 20 Nov 28 3
Garrett, 32 Dec 1 2
Goretti, 25 Nov 5-Dec 30 35C
Harvey, 74 Nov 14 6

1999 RQ36
Faure, 20 Sep 17 8
Garrett, 32 Sep 18 3
Harvey, 74 Sep 19 6

1999 RJ42
Goretti, 25 Nov 8 5C

1999 SM5
Goretti, 25 Oct 6 5C

1999 TD5
Goretti, 25 Nov 30 5C

1999 US3
Faure, 20 Dec 6 4
Foglia, Pizzetti, 40 Nov 28 5C
Garrett, 32 Dec 1 2
Goretti, 25 Nov 28-Dec 21 52C
Harvey, 74 Nov 14 6
Pilcher, 35 Nov 30-Dec 11 10

1999 VL5
Puccini, 25 Nov 25 5C

1999 VN6
Goretti, 25 Nov 30-Dec 6 10C

1999 VO11
Goretti, 25 Nov 30 5C

1999 VC12
Goretti, 25 Nov 30-Dec 6 10C

1999 VZ20
Goretti, 25 Nov 19-Dec 6 20C

1999 VM40
Goretti, 25 Dec 18 5C

1999 VU57
Puccini, 25 Nov 27-28 7C

1999 WY
Goretti, 25 Dec 31 5C

1999 WS1
Goretti, 25 Dec 11-13 11C

1999 XO35
Goretti, 25 Dec 7-30 15C

1999 XS35
Goretti, 25 Dec 6-30 20C

1999 XU97
Puccini, 25 Dec 30-Jan 2'00 7C

1999 XD127
Cocca, W. Marinello, Pizzetti, 40 Dec 7-13 14C

4193 T-1
Goretti, 25 Nov 12 5C

Project "Delta Luna": A Proposal to Search for Impact Features on the Moon of Recent Origin

By: Thomas Dobbins, Acting Coordinator, and William Sheehan, Acting Assistant Coordinator, A.L.P.O. History Section

(This paper was delivered at the A.L.P.O. Conference in Ventura, California, July 20, 2000.)

The recent video recordings of impacts on the portion of the Moon illuminated by earthshine during the November, 1999 Leonid meteor storm by David Dunham and his colleagues of the International Occultation Timing Association have vindicated reports of impacts on the Moon by generations of visual observers. Here is a representative sampling of a half-dozen reports culled from references cited in Barbara Middlehurst's comprehensive *Chronological Catalog of Reported Lunar Events*:

> *October 19, 1945:* Using a 9-inch Newtonian reflector at a magnification of 220×, the British selenographer F.H. Thornton detected a brilliant orange-yellow point of light on the floor of Plato near the ramparts of the crater's eastern (IAU) wall. With impressions of the Second World War fresh, Thornton compared the phenomenon to "the flash of an AA [anti-aircraft] shell exploding in the air at a distance of about ten miles." He noted that "the date is in the middle of the Orionid meteor stream."
>
> *April 15, 1948:* A.W. Vince was examining the Earthlit portion of the crescent Moon with a 16-cm refractor when he was startled by a momentary flash, similar in brightness to a third-magnitude star, located near the darkened limb some 30 degrees north of the crater Grimaldi, which could be distinguished as a dark patch.
>
> *August 8, 1948*: While examining the entire lunar disc at a magnification of 50×, A.J. Woodward saw a flash "like a bright sparkle of frost on the ground ... bluish-white then yellow, on the dull part of the Moon, somewhat above and to the left of the Moon's center." Duration about three seconds. To Woodward "it had the appearance of an object striking the Moon's surface."
>
> *May 17, 1951:* The renowned British selenographer H.P. Wilkins observed a bright speck within the crater Gassendi that lasted for only a second, followed by an afterglow which persisted for two to three seconds.
>
> *May 10, 1954:* The lunar authority and prolific author V.A. Firsoff saw "a white flash, which, with a magnification of 30 diameters and an aperture of 1.75-inches had the naked-eye brilliance of a star of the fourth magnitude, may have lasted for about a second and left behind it a bluish afterglow..." The site was near the crater Lyot [now named Ammonius. *Ed.*], which lies on the floor of the large walled plain Ptolemaeus.
>
> *April 24, 1955:* "F.C. Wykes was observing the Moon when he saw a white flash of short duration on the unilluminated portion of the disc ... in the northern part of Mare Serenitatis, not far and somewhat east of Posidonius."

In 1960 the Atomic Energy Commission and the military intelligence services of the United States established a global network of sensors, many installed on the rooftops of embassies, to detect the low-frequency acoustic waves generated by nuclear explosions. Over the years a number of powerful anomalous airbursts were recorded by these devices that have been interpreted as meteoritic in origin.

The largest event, which corresponded to a yield of 500 kilotons, presumably resulted from the arrival at a velocity of 15 to 20 kilometers per second of a piece of cosmic shrapnel some 20 meters across and weighing upwards of 8,000 tons that fell harmlessly between South Africa and Antarctica in August of 1963.

Since 1975 the U.S. Air Force Space Command has operated a network of surveillance satellites in geosynchronous orbits that are equipped with arrays of detectors to monitor the upper atmosphere for the infrared signatures of the exhaust of ballistic missiles as well as nuclear explosions. The 17-year record of atmospheric explosions detected by these early-warning sentinels was declassified by the Department of Defense in 1993. The frequency of the meteoritic bombardment that was revealed came as a rather rude shock to all but a handful of specialists.

Based on the military data, Edward Tagliaferri estimates that kiloton-yield meteoroids strike the Earth 80 times in an average year. Fortunately, non-metallic objects of this size are annihilated at high altitudes and pose little threat to life and limb. Apparently far more energy is released in the infrared than in the visible region of the spectrum, accounting for the comparative dearth of reports of extremely bright bolides by visual meteor observers.

With only 1/4 the diameter and 1/81 the mass of the Earth, the Moon will be subject to a dramatically reduced rate of bombardment. But even when these factors are taken into account, a cursory extrapolation from the terrestrial data suggests that a kiloton-yield impact should occur on the visible hemisphere of the Moon every two years.

Unimpeded by the presence of an appreciable atmosphere, even those fragile bodies that fail to penetrate the Earth's protective blanket of gases would strike the lunar surface, producing craterlets surrounded by considerably larger haloes of bright ejecta. The underlying assumption of our proposal is that a few of these ejecta blankets should subtend an apparent angular diameter of one arc second or more (at the distance of the Moon, 1.9 km subtends about one arc-second) and be discernible in even modest telescopes under high angles of illumination as diffuse bright spots with a virtually stellar appearance. This may well explain why they have gone unnoticed—lunar observers almost invariably scrutinize or make high-resolution photographs of features when they are near the terminator, but under these conditions shadows accentuate topographic relief rather than differences in albedo.

A careful comparison of old photographs of the Full and gibbous Moon with modern images should reveal the presence of these features. Redundant gibbous phase plates should prevent any spurious "discoveries" from "Kodak star" emulsion defects. Actually, the exercise should prove similar to looking for novae or asteroids.

The recent Clementine Mission images are ideal for making these comparisons since they were almost invariably obtained under high sun angles and their resolution leaves nothing to be desired. Fortunately, the complete set of Clementine images at various image scales is available on CD-ROM at a modest price.

Suitable 19th-century photographs include the series taken with the 36-inch refractor at Lick Observatory by E.S. Holden and E.E. Barnard *circa* 1889-92. The authors have communicated extensively with the Lick Observatory staff in an effort to gain access to these plates. Unfortunately, their attempts to locate these plates have been unsuccessful, despite a concerted effort. However, they have managed to locate excellent plates of the Full Moon and the gibbous phases taken through a yellow filter at the prime focus of the Lick refractor by J.H. Moore and J.F. Chappell *circa* 1937-1947. The focal length of that instrument is 17.6 meters, giving a generous image scale of 160mm to the Moon's diameter. These images should provide an excellent 50-year time span comparison with the Clementine images.

The plates taken by Moritz Loewy and Paul Puiseaux at the Paris Observatory through a 23.6-inch f/30 Coude refractor *circa* the 1890s may be the best images from that era, with a plate scale very similar to the Lick plates. These would provide a 100-year time span versus the Clementine images. The renowned French astrophotographer Jean Dragesco has remarked that the Loewy and Puiseaux plates consistently managed to achieve the theoretical resolution of a 13-cm aperture (limited principally by the astigmatism of defective plane mirrors, the optician Jean Texereaux later claimed), which should be quite adequate for the intended purpose. We recently enlisted the assistance of Audouin Dollfus, currently retired from the Meudon Observatory in Paris. He has kindly offered to assist me in contacting the archivist at the Paris Observatory in order to obtain scanned, digitized versions of the Loewy and Puiseaux plates taken at Full Moon and at the gibbous phases.

In addition, John Westfall has kindly supplied digitized images scanned from 8×10-inch glass plates of the gibbous Moon taken through the U.S. Naval Observatory's 61-inch astrometric reflector during 1966-67. Scanning at a resolution of 600 pixels per inch has yielded a pixel size of about one kilometer, which corresponds closely to the limitations of the original photographs. These images promise to provide an excellent 30-year time-span comparison with the Clementine images.

No doubt comparing the Clementine images to any digitized versions of old Earthbased photographs on a desktop computer will prove to be a painstaking, time-consuming exercise, but perhaps a number of project participants could be redundantly assigned sections of the lunar disk. When making these comparisons, even if an identical image scale is achieved, the effects of the spaceprobe's vantage point from lunar orbit and the effects of libration on the Earth-based photographs will almost certainly render any attempt to simply mimic a blink comparator impractical. However, a more primitive technique that was employed to discover one of Saturn's satellites shortly before the invention of the blink comparator may serve us well.

On long-exposure photographs taken at the Arequipa Station of Harvard College Observatory on three successive nights in August of 1898 with the Bruce astrograph, W.H. Pickering discovered the ninth, outermost satellite of Saturn, which he named Phoebe. A faint fifteenth-magnitude wisp of light, Phoebe was found on crowded plates that contained the images of over 100,000 stars. Pickering examined pairs of plates by laying one atop the other with a slight offset in registration so that every stationary object appeared to have a close, identical companion. Armed with a hand-held magnifying glass, he painstakingly scanned the backlit plates, looking for any object that appeared single, signifying motion. Percival Lowell and his staff employed the same technique in their early search for a trans-Neptunian planet *circa* 1905.

The authors propose that any search begin by slightly offsetting the registration of superimposed, digitized images of the lunar maria, where the contrast between the bright ejecta and background of dark basalts will be greatest. We do not think that it would be prudent to extend the search for recent impact features into the brighter lunar highland terrain (at least initially), because this promises to be a far more daunting task. However, since the maria comprise about 40 percent of the visible hemisphere of the Moon, the sample size that they represent should prove sufficient.

If results of the exercise that we have described are positive, they promise to provide the first definitive evidence of a topographic change (however modest) on the Moon occurring within human memory and to verify recent estimates of the terrestrial meteoric bombardment rate. If the results are negative, they will be curiously at odds with the recent body of terrestrial bombardment data and hence still be very noteworthy. Hardly as significant as refining the value of the Hubble Parameter, we must admit, but well worth doing nonetheless, we hope you'll agree.

If this project is deemed worthy of pursuing, we suggest that it be christened "Project Delta Luna," after the Greek letter that is used to denote change in mathematical formulae.

CCD Methane Band Observations of Titan in 1999

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Abstract

Titan, one of the largest satellites in our Solar System, was monitored in the wavelength of 890 nm±10 nm where methane absorbs heavily in the near infrared band. The observations were made to determine any possible variations in brightness as Titan revolves around Saturn.

Introduction

Titan is an interesting satellite that possesses an atmosphere. Taking about 16 days to go around Saturn, and with an angular diameter of 0.8 arc-seconds as seen from Earth, only the larger amateur telescopes can resolve its disk. In smaller instruments it is just a point of light.

Titan's atmosphere contains mostly nitrogen and a mixture of other gases which includes methane (CH_4). In 1944, Gerald P. Kuiper discovered methane absorption lines when he obtained Titan's spectrum. In 1980-81, Voyagers 1 and 2 imaged Titan. The surface was completely obscured by many layers of a dense, cloudy, 'smog-like' atmosphere. No bands and no details were seen in the atmosphere. Therefore, Titan disappointed many Voyager scientists.

Unlike Venus, which has a cloudy thick atmosphere with many low-contrast details, Titan's appearance is like smog. However, it is known that certain wavelengths in the near-infrared band can penetrate Titan's smog and be used to seek otherwise-hidden details on its surface.

Thus, in the mid-1990s, large telescopes with adaptive optics and the Hubble Space Telescope were used to obtain high-resolution images, obtaining their first true views ever of the surface of Titan.

Observations

The writer's observations were done with a Starlight Xpress MX-516 CCD camera on a Celestron 20-cm (8-in) telescope. In addition, a methane absorption filter with its bandpass at 890 nm±10 nm was used to capture images of Titan. The exposures were fairly long, at least 3-30 seconds with a total of 90 seconds even at the prime focus of f/10. When all three images were combined, Saturn itself was completely overexposed in order to capture Titan and perhaps a few other satellites. In 1999, five such images were taken, four of which are shown in *Figure 1* (below).

Titan was seen at a wide range of orbital longitudes. Titan was imaged at both eastern and westerly elongations, with the purpose of detecting possible infrared variations when comparing both elongations.

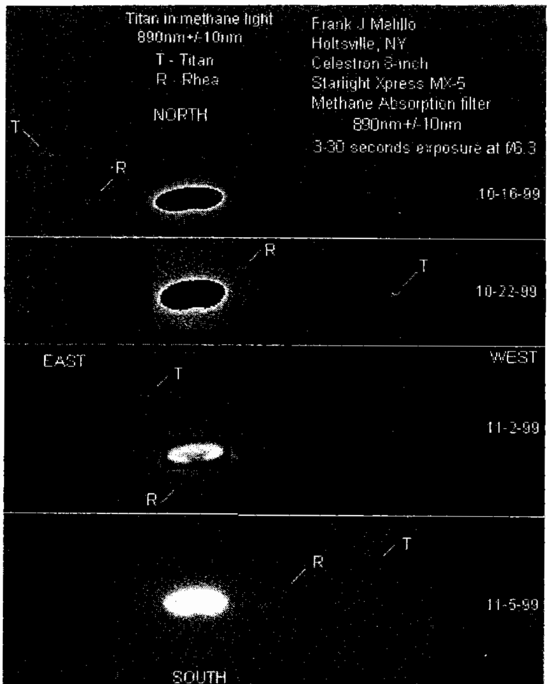

Figure 1. CCD images of Saturn, Titan and Rhea by Frank J. Melillo. Supporting data are given on the images.

Results

Back in the mid-1990s, part of Titan's surface was imaged for the very first time. The surface thus revealed was more toward Titan's equator as the polar regions were obscured by the smog. One hemisphere of the satellite always faces Saturn just as the Moon does with the Earth. As Titan revolves around Saturn, the earthbased observer sees all longitudes on the surface. Titan is suspected of having light and dark surface regions, so that views in infrared wavelengths might show Titan's brightness varying in its course around Saturn. The leading hemisphere, turned toward us near eastern elongation, appears to be the brightest. At a western elongation, Titan is at its dimmest. At the time of observation in 1999, Saturn's south pole was tilted approximately 18° toward us. Since Titan orbits near Saturn's equatorial plane, and assuming that its rotational axis is approximately perpendicular to its orbital place, we should have viewed Titan's south polar area as well as its equatorial region.

In the writer's CCD images, Titan was visible despite the methane in the atmosphere. Rhea, although fainter than Titan in visible light, was also visible as it has no atmosphere. Titan appeared slightly fainter than Rhea, indicating that Titan has some absorption in the near-infrared, but considerably less than Uranus or Neptune. Also, the wavelengths used may have penetrated through much of the atmosphere but not below, say, 100 km above the surface. In other words, the images do not penetrate deeply enough to see a rotational lightcurve. As a result, the images may show Titan's variations just marginally, but not conclusively. In addition to that, there is a possibility that short-term variations in Titan's brightness, on the order of a terrestrial day, at 890 nm may still occur. This would be very interesting. In the higher layers of Titan's atmosphere, above 100 km, the haze may change its brightness due to longitudinal winds.

Conclusion

Titan was imaged through a methane absorption filter at 890 nm±10 nm. It is hard to say at this moment whether any real light variations were detected; but if the satellite is continually monitored for a longer period of time, a more definite light variation might be seen. Other wavelengths, say at 940 nm or even longer, at 3 μm, would have been a better choice to get a definite lightcurve caused by differences on the surface; but at least this observation shows that the 0.89-μm wavelength can penetrate a significant amount of the atmosphere in order to look for possible changes in the haze layer.

This turns out to be a very good project for both amateur and professional astronomers. Due to the Cassini space probe that will enter Saturn's system in 2004, there is a great interest in Titan observations. One astronomer, Ralph D Lorenz of the Lunar and Planetary Laboratory in Tucson, Arizona, invites amateur photometricists to participate in his project. There is evidence that Titan is changing. Therefore, amateur astronomers are ready to step in and take an important role in monitoring this truly dynamic object that we call Titan.

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A Brief History of the A.L.P.O. Lunar Meteors Project

By: Thomas R. Williams

Introduction

As many members of the Association of Lunar and Planetary Observers (A.L.P.O.) are aware, in the closing months of 1999 a significant breakthrough occurred in a field that was of interest to the A.L.P.O. for several decades after the A.L.P.O. was founded. On November 17, 1999, A.L.P.O. member Brian Cudnik and other observers from the International Occultation Timing Association (IOTA) as well as independent observers in Mexico were successful in observing the impact of six Leonid meteoroids on the surface of the Moon. Although that breakthrough did not occur under the auspices of the A.L.P.O., it did make evident the difficult technical problems attendant with this field of observational astronomy. The results of the IOTA effort also illustrate, as clearly as one could hope under such circumstances, how insightful Walter Haas has been in his leadership of this association.[1]

The Pre-History of the Lunar Meteor Project

As with all topics of interest to the members of A.L.P.O., the lunar meteors problem has a pre-history. It is necessary to consider that history, both from the observational and the theoretical perspectives, to comprehend what was understood about the matter when the A.L.P.O. initiated its formal Lunar Meteors Search project in 1955. That history includes the theoretical prospect of observing lunar meteors when Walter Haas first took on this problem as an observational project in 1939.

As Richard Baum has demonstrated, many leading observational astronomers in the eighteenth and nineteenth centuries reported seeing occasional flashes on the dark part of the moon. The history of these observations is freighted with questions about the veracity or skills of the observers involved. In Baum's view, however, one simply cannot dismiss the observational reports of such well-known observers as William Herschel, Johann Hieronymus Schröter, and Johann Mädler. Herschel's sightings of what he took to be volcanoes on the Moon, Schröter's observations of lunar crescent cusp extensions or Mädler's report of observing a bright flash, demand of us that we accord similar, if not equal, attention to the many reports of lesser professional and amateur astronomers who, over the past three centuries, have reported a number of such sightings. Interpretations placed on these observations by the observers involved should be considered separately from the reported observation.[2]

If it is important to understand that, from an historical perspective, observers have reported flashes and other transient phenomena on the moon for several centuries, it is equally important to develop some notion of the theoretical understanding of meteors and the Moon as a function of time. Meteors did not begin to receive much attention from astronomers until nearly the middle of the nineteenth century. Leading texts in the first half of the nineteenth century don't mention meteors as astronomical topics.[3] It was not until after the multiple stone fall at de Aigle, France in 1803, and then the spectacular Leonid shower in the United States in 1833, that meteors began to attract attention from a few astronomers like Dennison Olmsted at Yale. By 1850 meteors were understood to be objects that originated outside the Earth's atmosphere. Nonetheless, John Herschel's 1859 edition of *Outlines of Astronomy* still relegated meteors to a brief but perfunctory statement near the end of his book.[4]

With the 1866 return of the Leonids on a 33-year cycle, meteors began to attract theoretical attention. By late 1866 Herbert Anson Newton, Giovanni Schiaparelli and other astronomers had computed orbits for several meteor streams. Those orbits had, in turn, been compared with the orbits of periodic comets. The comparisons led to the discovery that Comet Temple was the likely source of the material causing the Leonid meteor shower. That discovery was a triumph for theoretical astronomy, but still, meteors had trouble competing with the more glamorous aspects of astronomy like stellar evolution. When Russell, Dugan and Stewart updated the standard astronomical textbook of their mentor, Charles A. Young, in 1926 they added little to Young's original text, even though a year earlier Charles Pollard Olivier had produced a substantial monograph on meteors, one that stood as a standard reference for decades to follow. Professional astronomers were, quite simply, not very interested in meteor astronomy.[5]

The Moon didn't fare much better, though a great deal more effort was invested in observing our celestial neighbor. The volcanic origin of the craters on the Moon, strongly defended by nineteenth-century amateur astronomers James Nasmyth and James Carpenter, was accepted as fact until well into the twentieth century. Richard Proctor advanced the alternative theory of meteoroid impact cratering in 1873. Proctor's idea was substantially advanced by the geologist G. K. Gilbert in 1878, and promoted by T. J. J. See in 1910. However, the dominant theory of crater formation remained volcanic until Ralph B. Baldwin's mid-1940s book, *The Face of the Moon*.[6]

So by 1940, we see that neither meteors, nor the origin of the craters on the Moon, were well understood as astronomical problems. There was yet a third aspect of the problem, and that was the question of an atmosphere on the Moon. The basic evidence cited to justify believing the Moon had no atmosphere was the absence of any refraction effect during the occultation of a star by the Moon. However, for several decades in the nineteenth century there was a troublesome problem that the diameter of the Moon, as determined by occultation experiments, was consistently 2 arcseconds lower than the diameter as determined by other methods. A small amount of refraction, not determinable by ordinary means, might account for the difference. The problem became an embarrassment for Astronomer Royal Airy until he finally acknowledged that 2 arcseconds was likely within the errors of the respective measurements, and in any event refraction of that order would represent an atmosphere with only 1/2000th the density of that of the Earth.[7]

Opinions about the extent of the atmosphere that could theoretically be present on the Moon varied over time, but nearly everyone was satisfied that, were there an atmosphere, it was at least three orders of magnitude less dense than that of the Earth. The lack of an atmosphere on the Moon was taken as fact until well into the twentieth century, when some doubts began to be expressed about the reality of the statement. Baldwin, in fact, made this doubt explicit in 1965 when he stated "It has been known for a long time that the Moon does not have a dense atmosphere...[but if] the Moon has little in the way of an atmosphere...it is not reasonable to claim it has no atmosphere."[8]

Haas Defines the Issues for Amateur Observers

Thus, when Walter Haas first began his astronomical career, what was thought to be known would not have led one to invest much energy in the idea of observing meteoritic impacts on the Moon. However, Haas spent one summer at W. H. Pickering's Woodlawn Observatory near Mandeville, Jamaica. During that summer, one of the problems that Pickering introduced Haas to was that of observing the impact of meteoroids on the moon. Pickering's suggestion was to observe intensely during a lunar eclipse, so Haas took up this challenge. His first attempts to observe meteoroids impacting the darkened moon were in 1939 while he was a graduate student at Ohio State University.[9]

Through the mid-1930s, Haas participated in the Planetary and Lunar Section of the American Amateur Astronomers Association (AAAA). Headquartered in Milwaukee but with members from New York to California, the AAAA provided a meeting ground in which amateur astronomers could engage in the science of astronomy and discuss their results with like-minded individuals. Haas became acquainted with Latimer J. Wilson, Edwin P. Martz Jr., Hugh Johnson, Frank Vaughn, and other accomplished planetary observers in this period. The members of this planetary observing group maintained an active correspondence after the AAAA failed in 1938. Thus deeply involved with other knowledgeable amateur astronomers, Haas expected to have little difficulty attracting others to occasional searches for possible lunar meteors.[10]

In his 1942 manifesto for lunar observers, "Does anything ever happen on the Moon?", Haas used his own lunar observations as well as those of many of his correspondents in building his case for studying the Moon. One of the studies he proposed was that of lunar meteoritic impacts. First Haas presented evidence that the project was viable by discussing the availability of meteoroids to impact the Moon and the odds of seeing one impact on the dark side of the Moon facing the Earth. Following an earlier analysis by Pickering, Haas theorized that because of the differences between surface gravity of the Earth and the Moon, a tenuous atmosphere might exist above the Moon at nearly the same altitudes and densities that existed on Earth. Such an atmosphere would create conditions in which meteoroids approaching the Moon might be ablated and form meteor trails like those displayed in the Earth's upper atmosphere. [The accepted terminology is that a small natural object in interplanetary orbit is a *meteoroid*, while the light phenomenon caused by its ablation in an atmosphere is a *meteor*. Ed.] If the density of the atmosphere was insufficient to ablate meteoroids, then they should impact the surface of the moon. The larger meteoroids might produce a flash visible in Earth-based telescopes.

Thus, observing whether meteor trails or impact flashes were visible on the Moon might test the scientific question of whether or not such a lunar atmosphere did exist. By calculating the odds and showing how increasing the number of observer hours at the eyepiece would improve chances of actually observing lunar meteor events, Haas hoped to encourage more observers to take up this potentially rewarding task. While his article was in preparation at the *Journal of the Royal Astronomical Society of Canada*, Haas observed what he took to be a Perseid meteor streaking through the lunar atmosphere. His note added in press describing this observation, though carefully worded, could not conceal Haas' elation at having an observation to report along with his appeal.[11]

THE A.L.P.O. AS A NEW ORGANIZATIONAL FORMAT FOR OBSERVERS

After serving as a training instructor for Naval officers during World War II, in 1946 Haas settled in New Mexico, working as a mathematician at New Mexico State University. In the previous decade, he had emerged as a thought leader among amateur lunar and planetary observers in the United States, having assembled, analyzed and published their observations of several planets and the Moon in articles in astronomical journals. It was clear that the informal network of observers was stable and growing, and Haas decided the time had come to organize formally. The March 1947 publication of the first issue of *The Strolling Astronomer* and founding of the Association of Lunar and Planetary Observers announced therein is now a well-known story.[12]

PRELIMINARY A.L.P.O. EFFORTS ON LUNAR METEORS

Although a myriad of other issues with the fledgling organization now commanded Haas' attention, the lunar meteors problem was not forgotten. Haas used the pages of the *Journal, Association of Lunar and Planetary Observers* (*J.A.L.P.O.*, subtitled *The Strolling Astronomer*) to encourage other observers to take up his interest in this topic. For example, in an early issue of *J.A.L.P.O.*, Haas summarized the results of previous observations and pointed out the scientific value of attempting to observe lunar meteors, referring to his article published earlier that year in *Popular Astronomy* and emphasizing the opportunity presented by the forthcoming Perseid shower.[13]

In the following issue, Haas reported on his own observational effort during that meteor shower. In five hours of concentrated observing spread over four nights, Haas reported seeing one moving 6th-magnitude speck projected against the dark part of the Moon. He provided details based on the assumption that the object was actually at the distance of the Moon. In the next issue, Haas again discussed the observation of lunar meteors, this time in his article summarizing results reported for the lunar eclipse of 7 October 1949. Previous appeals had apparently had some effect, as twenty-four observers reported having spent a total of 15 hours of observing time in the search for lunar meteors during the eclipse, using telescopes ranging in aperture from three to twelve inches. A total of fourteen suspected events was reported, including twelve suspected stationary flashes or flares, and two moving flashes or streaks, as they were later known. One event was reported simultaneously by R. Venor and B. Lane, observing with 12-inch and 3-inch reflectors respectively, and separated by over 2000 miles. However, Venor reported the event as a streak, while Lane reported only a stationary flash. There was a large number of other observers with their eyes to telescopes and observing the Moon at exactly that same time, and no one else reported seeing either type of event. While Haas was unwilling to reject this one pair of sightings, he concluded the other thirteen observed events were spurious, noting that both he and others reported seeing terrestrial meteors while attempting to observe lunar meteors during the eclipse.[14]

For the next eight years, the pattern was similar, with Haas occasionally exhorting members to spend time searching for lunar meteors, especially during total lunar eclipses. The result of his low-key appeals was not encouraging. Haas received only sporadic reports. For example, San Diego observer Rudolph Lippert observed a peculiar bright flash on the Moon on 16 September 1953. In 1955, Patrick Moore, who had discussed the possibility of observing lunar meteors in his 1953 book, *A Survey of the Moon*, reported that one of the younger but nonetheless reliable BAA observers had reported seeing a flash while observing the Moon. Moore's report did not comment on the all-important question of whether the flash was stationary or moving.[15]

New Leadership and a Formal Program

By 1955, Haas had decided that the A.L.P.O. needed a more formal program to address the accumulated record of "possible" lunar meteor observations. But, although he had come to that realization, Haas had his hands full administering a growing organization and publishing its journal. He could not possibly provide formal leadership to a new project himself.

Fortunately, Robert M. Adams of Neosho, Missouri volunteered to lead an A.L.P.O. lunar meteor project. Adams had, for several years, been reporting telescopic meteors that he observed while making variable star estimates to Charles Pollard Olivier of the American Meteor Society. Adams had also submitted observations to Haas; he was characterized by Haas as "our most active member in searching for lunar meteors and possible lunar meteoritic impact-flares." In Adams' most recent effort, thirty half-hour periods of observation had yielded only two possible events, which he described as "...so brief that I consider it possible that they might be labeled subjective phenomena." The experience caused Adams to consider how to structure a more scientific approach to the lunar meteor problem and he had a plan.[16]

Adams' idea was that the random observing approach was unlikely to succeed, but that the odds of success were greatly enhanced if many observers watched the moon during scheduled favorable periods. He asked volunteers to participate in such a program. If sufficient observers volunteered, Adams would provide the schedule, receive and evaluate the observing records, and prepare reports to be published in *The Strolling Astronomer*. With such a schedule, two or three observers looking at the moon simultaneously from distant locations would be sufficient to reduce the number of false positives involving terrestrial atmospheric phenomena. To preserve the objectivity of his evaluations, Adams declared that he would not continue his own effort to observe lunar meteors and would instead devote his full effort to the matter of coordinating and reporting on the project.[17]

Adams' enthusiasm apparently stimulated interest in the project. New observers, scattered from Canada to Galveston, Texas, and from the Northeast to the West Coast, volunteered to participate in the program. Adams published a schedule of favorable observing periods to increase the possibility that simultaneous observations would be made from isolated stations.

Interest was no doubt enhanced by an event that was reported in *The Strolling Astronomer* later that year. On September 27, 1955, Eugene C. Larr, observing the Moon with an 8-inch solar coelostat, was startled by a bright speck moving across the face of the Moon in the vicinity of Sinus Iridum. Larr commented immediately to his observing companions, Roy K. Ensign and Dr. M. L. Stehsel, who recorded his comments describing the event for the two seconds or so it was visible. Haas congratulated Larr on the quality of his report, but characterized this only as an "exciting possibility that we are here dealing with a lunar meteor in a very rare lunar atmosphere..."[17]

A late report of a similar event was doubtless also stimulated by growing interest in the project. On November 15, 1953, Dr. Leon H. Stuart of Tulsa, Oklahoma, had observed visually though his camera finder, and photographed simultaneously, a brilliant spot near the terminator on the moon. He developed his photographic plate immediately to insure that the event had been recorded. By the time he returned to the telescope the spot had disappeared. Haas noted that the film used was especially sensitive to infrared radiation, which would include the heat released by a meteoritic impact. He opined that the brilliance of the spot shown on the picture reproduced in *The Strolling Astronomer* was therefore likely overstated in comparison to its visual appearance, in agreement with Stuart's comments to that effect.[19]

Adams began periodic progress reporting in the September-October 1955 issue of *The Strolling Astronomer.* When it became apparent that scheduled times for observation were not providing sufficient overlapping coverage, Adams shifted emphasis to more rigorously scheduled participation with observations conducted at sites that were isolated from each other by several miles. Only by such isolation was it possible to ensure that any terrestrial atmospheric events would be eliminated by the parallaxes among the stations.

Enthusiasm for the project grew in response to this more organized approach. For his report for the period from November 1955 to July 1956, Adams discussed results received from twenty-eight observers. In his report for the period from August 1957 to July 1958 that number had grown to forty-one observers. Adams was well known as a member of AAVSO. His appeal to that organization drew in experienced variable star observers in the next few years, for example Clinton B. Ford of Connecticut and Curtis Anderson of Minneapolis. Enthusiasm was also spur-red by a renewed theoretical justification for the possibility of observing lunar meteors, this time by Steadman Thompson.[20]

Adams' appeal for more systematic effort on the local level was successful. Small groups of Connecticut and Massachusetts observers banded together to form coordinated multi-station observing programs. The Amateur Astronomers Association of Pittsburgh formed a similar network in the Tri-State area.[21]

Montreal's Program

Members of the Montreal Centre of the Royal Astronomical Society of Canada (RASC) mounted the most substantial program designed to produce duplicate observations. The Montreal observers, under the leadership of Geoffrey Gaherty, accomplished substantial periods of overlapping observations from at least two and as many as five sites. One reason for that success may well have been that sixteen good observing sites were identified within a convenient distance from clusters of homes of Centre members. This arrangement allowed the RASC observers to accumulate an impressive record of simultaneous observations. There were a few reports of possible lunar events during the Montreal sessions, but the lack of a corroborative report by a simultaneous observer from another isolated station always negated such observations.[22]

In each of his seven progress reports, Adams recited the names of observers who participated, the approximate number of hours each spent at the eyepiece, and information about their telescopes in addition to the number of "events" observed, together with brief descriptions of the events as flashes or streaks. Most reports were negative, but even many of those that appeared positive were couched in terms that made it apparent that, although an event was being reported, either the observer or Adams or both believed it was likely a terrestrial and not a lunar event.

In 1962, after seven years as the leader of the A.L.P.O. Lunar Meteor Search Project, Adams elected to step down and return to observing himself. Kenneth Chalk, one of the leaders of the Montreal effort, replaced Adams as project recorder. Chalk indicated his dedication to the project by undertaking a new theoretical analysis of the odds of observing a lunar meteor. Considering the matter in greater technical depth than either Haas or Thompson, Chalk included possible differences in the composition of a tenuous lunar atmosphere compared to that of the earth. He computed a graphical comparison of the variation of atmospheric density as a function of altitude above the surface of the earth or moon, showing that for lunar surface atmospheric pressures that ranged from 10^{-4} to 10^{-6} that at the surface of the earth, it was reasonable to speculate that larger meteoroids entering the tenuous lunar atmosphere 100 to 120 km above the lunar surface would produce a visible ablation trail. Chalk also noted that recent studies by Dollfus placed an upper limit on the density of any atmosphere at the lunar surface at 10^{-9} that of the earth's atmosphere. At that low a density visible meteor trails were unlikely.[23]

TERMINATION OF THE A.L.P.O. PROJECT AND CONCLUSION

Chalk's tenure as the A.L.P.O. Lunar Meteor Search Project Recorder was limited by his own inability to continue the work. However, it is also true that interest in the project faded. In his 1965 announcement of the termination of the project, Haas cited the largely negative results over the life of the project as well as the fact that participation by observers outside of Montreal had greatly diminished. He also noted that observers had failed to detect any evidence of the impact of Ranger vehicles on the surface of the Moon. It also appears likely to a casual reader of *The Strolling Astronomer* that the lunar meteors program was, in reality, subsumed within the burgeoning joint A.L.P.O./NASA effort to observe transient lunar phenomena.[24]

It is difficult to tabulate in any comprehensive manner the total results of the nearly ten years of observer effort devoted to the A.L.P.O. Lunar Meteor Search Project. Reports to Adams and Chalk were often incomplete, or summarized the efforts of multiple observers in a non-quantitative manner. *Table 1* (p. 183) is an attempt to pull together these reports and give some dimension to the effort. As noted in Table 1, there was a number of events observed during the A.L.P.O. project, but none were ever conclusively supported by simultaneous observations from another observer at an isolated site. Thus, Haas, Adams and Chalk were forced to conclude that the events observed, however interesting they might have appeared otherwise, could only be assumed to have occurred in the terrestrial atmosphere.

The November 1999 observations during the Leonid meteor shower may thus be seen in a more appreciative light. Those videotaped confirmations of visual observations of meteoritic impacts on the Moon showed not only that such visual observations could actually be made with earth-based telescopes, but also just how very difficult it is to do so. It is obvious from these latest data that the A.L.P.O. program was likely doomed to failure by a variety of circumstances, even with simultaneous observations from isolated stations. From the IOTA data, it is apparent that unless observers deployed larger instruments than the 3- to 6-inch telescopes most frequently utilized by observers in the A.L.P.O. project it was unlikely that a confirmed observation could be made. As shown in *Figure 1* (p. 183), about three-fourths of the reported telescope usage was with instruments of six inches aperture or less.

Additionally, it is apparent from the videotaped observations that even the slightest inattention, in fact the mere blink of an eye, could cause an event to be missed. As shown in the examination of the videotapes, the brightest presence of the meteoritic impact was visible on only one frame. Even when a presence of the flash was visible in a second video frame, it was always at greatly reduced brightness. Thus the flash had faded substantially in less than 1/60th second.

The November 1999 observations of lunar meteoritic impacts are important from another perspective, however, and that is in reinforcing our appreciation of the imaginative leadership that the A.L.P.O. received from its founder over many years. In effect, one might in fact

Table 1. Results of the A.L.P.O. Lunar Meteor Search Project.

Recorder	*J.A.L.P.O.* Vol., No.	Number of Observers	Events Observed: Flashes	Events Observed: Streaks	Confirmations: Positive	Confirmations: Negative
Adams	9, 9-10	12+	14	?	0	2
Adams	10, 5-6	28	13	4	0	0
Haas/Adams	11, 1-6	19+	8	3	0	2
	Illinois*	11+	26	9	15†	Many?
	Ohio*	5	25	?	25†	Many?
	Wyoming*	2	6	1	0	Many?
Adams	12, 7-9	41	6	4	0	6
		1‡	15	8	0	0
Adams	15, 3-4	32	6	2	0	6
Chalk	18, 1-2	37	5	4	0	2

* These groups were organized locally and reported their observations to the Lunar Meteor Search Recorder after a total lunar eclipse. It is unclear in the information presented whether the organizers of these observing sessions were members of A.L.P.O. but it does appear clear that most of the observers were not.

† These confirmations were from adjacent telescopes at the same site and therefore do not meet the A.L.P.O. criteria for recognition as confirmed events.

‡ These observations were reported by one young and obviously enthusiastic individual observing with a 4-inch reflector, and should likely be ignored.

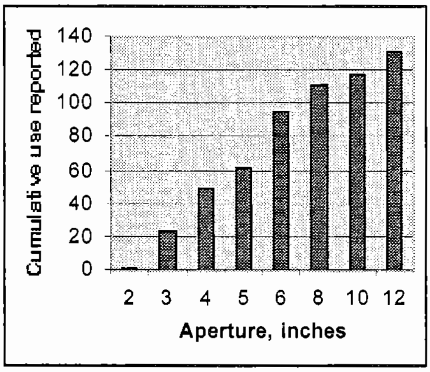

Figure 1. Telescope apertures deployed in the A.L.P.O. Lunar Meteor Search Project, cumulative number by aperture.

see the Lunar Meteor Search Project as a metaphor for Walter H. Haas and the A.L.P.O. in a much broader sense, for it was Haas' vision, persistence in the face of very long odds, and his courageous leadership of the organization that ensured its survival and indeed many successes over its first fifty years. Thus, it is perhaps fitting to consider this paper a tribute to Walter Haas as well as a recognition of the substantial efforts committed by A.L.P.O. and other observers to the possibility of making scientifically valid observations of lunar meteoritic events.

End Notes

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9 Haas, Walter H. 1998. Memorandum of discussion with Thomas R. Williams held at the Haas home, Las Cruces, New Mexico. In files. The best description of the experience of a visit to the Woodlawn Observatory was provided by Edwin P. Martz, Jr., who followed Haas to Mandeville a year later. See Martz, Edwin P. Jr. 1937. "Pilgrimage to a tropical observatory." *Popular Astronomy, 45,* no. 7: 365-374.; and Martz, Edwin P. Jr. 1937. "Pilgrimage to a tropical observatory." *Popular Astronomy, 45,* no. 8: 419-429. Haas carried out an active observing program at various colleges and universities during his undergraduate and graduate studies. His graduate advisor as a mathematics student at Ohio State was Lincoln LaPaz, who was well known for his interest in meteors and meteorites. Haas' Masters degree thesis was on the orbits of meteorites.

10 The journal of the AAAA, titled *Amateur Astronomy,* had limited circulation in the 1930s and is now rare. Copies may be found in a few astronomical libraries. The activity of the AAAA Planetary and Lunar Section is well documented in articles by Martz and Haas in that journal's pages.

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22 Adams, Robert M. 1960. "Progress report of the A.L.P.O. Lunar Meteor Search Project in 1958-59." *J.A.L.P.O., 14,* no. 1-2: 21-26.; and Adams, Robert M. 1961. "Progress report of the A.L.P.O. Lunar Meteor Search Project in 1959-60." *J.A.L.P.O., 15,* no. 3-4: 67-69. The French Canadian observers in Montreal established a parallel but less active program to observe lunar meteors during this same period. In their case, there were three stations, all manned by women observers. See Jean, Jean Pierre. 1963. "Lunar meteor search." *J.A.L.P.O., 17,* no. 1-2: 18-19.

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Book Reviews

Edited by Jose Olivarez

Atlas of the Lunar Terminator

John E. Westfall

Cambridge University Press, 40 West 20th Street, New York, 10011-4211. 2000. 292 pages, illustrations, index. Price: $50, cloth (ISBN 0-512-624336-3)

Reviewed by Robert A. Garfinkle, F.R.A.S.

Longtime A.L.P.O. leader, John Westfall, set out to create a lunar photographic atlas like no other that has ever been published. I feel that he has succeeded completely. The majority of published photographs of the Moon's surface are taken under medium to high solar angles by either earth-based observers or spacecraft cameras. Images taken at such high angles tend to wash out the fantastic details that are usually only visible in low solar-angle images. John attached a CCD camera to his telescope over a period of several years and snapped hundreds of sharp high-resolution images of the Moon's surface. He aimed for the areas where the solar angle was low and the surface details were in high contrast. Hundreds of hours were spent electronically stitching images together to create the mosaics that make up the bulk of the images in this book.

As the Moon orbits the Earth, the sunrise terminator, the line dividing the illuminated from the unilluminated hemisphere as the Sun rises over the surface, slowly proceeds across the lunar disk from the eastern limb just after New Moon to the western limb at Full Moon. After Full Moon, the sunset terminator proceeds again from east to west, progressively plunging the surface into darkness. We measure the position of this line against the surface in a system called the solar selenographic colongitude. This book is divided to show the changing relief of the surface, based on the approximate colongitude at the time the images were taken. The text that accompanies the images is clear, precise, and very informative. John describes the types of surface features and gives general information of how to successfully take CCD images of the Moon. Where appropriate, he gives facts and figures on the Moon's various features.

Practically every page contains a clear mosaic of an area with a smaller-size grayed print of the same image. The feature names overlay the small images. This is a great idea, because it provides an uncluttered image of an area and a labeled image of the same area on the same page.

My only complaint has nothing to do with the efforts of the author, but is a systematic problem with Cambridge University Press (CUP). For my own CUP-published book, *StarHopping; Your Visa to Viewing the Universe*, CUP had a problem printing the small eyepiece-view drawings of deep-sky objects. The images are very dark, which makes it almost impossible to figure out the subjects of drawings. I complained to my editor, but nothing was done. I have seen problems with images and graphics in other CUP books, so I do not fault John for the less than ideal reproduction of some of his images. Some images contain sections that are washed out and appear grossly overexposed, while other images appear grainy (over pixilated) in spots. Although John clearly explains lunar and CCD camera terms in the text, I do object to the fact that this book lacks a glossary. These problems should not dissuade you from adding this wonderful volume to your lunar library.

I think that John has attained his goal—to fill the void in lunar literature for images of the lunar surface taken under low solar angles. He thereby gives us a handy lunar atlas consisting of high-resolution, high-relief images that show the Moon as we rarely can see it in print.

THE LINNÉ CONTROVERSY; OR ON THE SHAPE OF LUNAR CRATERLETS SEEN UNDER DIFFERENT SOLAR ALTITUDES

By: Giancarlo Favero, Osservatorio "Guido Ruggieri", Padova, Italy (faverogian@libero.it)

ABSTRACT

Lunar craterlets with diameters near the resolving power of an atmosphere-instrument-detector system look like hills, if illuminated by a grazing Sun, and reveal their shape only under a higher Sun. The phenomenon is explained in terms of convolution of the subject image with the finite dimension of the single element of a discrete detector: the pixel, in a CCD image; the silver grain, in a photographic emulsion; the retinal cone cell, in a visual observation. The controversy about the different shapes attributed to craterlets like Linné by previous visual observers can thus be resolved. On this basis it appears reasonable to suggest that no physical changes affected Linné during the era of telescopic visual observations.

INTRODUCTION

Among the many lunar sites where different visual observers of the past claimed to have recorded shape or reflectivity variations, Linné is certainly one of the best known. Wilkins and Moore in 1961 [1] and more recently The Lunascan Project organization [2] have traced the history of the different aspects and changes attributed to Linné between 1843 and 1953.

Around 1843 W. Lohrmann, with a 4.25-in (10.8-cm) aperture telescope, and W. Beer and J. H. von Mädler, with 3.75 in (9.5 cm) aperture, described Linné as a deep crater 5 miles (8 km) in diameter, well visible under all lighting conditions. Between 1840 and 1843 J. Schmidt, with a 7-in (17.8-cm) refractor, also recorded Linné as a crater (in eight of eleven drawings), but in 1866 he announced that this description no longer applied and that all that could be seen was a whitish mound. During 1867 many observers could find only a mound. Later in that year, Schmidt announced that he could discern a mountain in the center of the mound. During 1868 Secchi and other observers detected a very shallow depression within the bright area containing a minute pit, half a mile in diameter. Still later Huggins measured its diameter as 2 miles (3 km). Around 1897 H. Corder and W. Goodacre, the latter using a 18-in (45.7-cm) reflector, drew Linné as a cratercone which apparently varied in size as regards its central orifice. In 1951 F. H. Thornton, also with a 18-in (45.7-cm) reflector, found that Linné was a low mound on the summit of which was a deep pit, filled with shadow under low illumination. When the slight shadow cast by the mound had disappeared, owing to increasing solar altitude, the pit on the summit still held shadow, although this eventually disappeared. The white area surrounding Linné looked like some matter thrown out on all sides when the pit was formed. This description was fully and completely confirmed in 1953 by Wilkins and Moore, using the 33-in (83-cm) Meudon refractor.

To ascertain if the different aspects described could be ascribed to a unique physical reality, even if of complex nature, or if they are so irreconcilable to imply the occurrence of physical changes, in 1999 the author imaged Linné and its surroundings under different lighting conditions using a CCD camera fitted to a 14-in (35.6-cm) reflector.

INSTRUMENTS AND MEASURES

A PXL 211 CCD camera was used, bearing the TC-211 chip with 192×165 rectangular pixels, with pixel size 13.75 μm×16.00 μm. The camera was fitted to a 14-in (35.6-cm) Newtonian reflector, the primary corrected to λ/14, with a secondary mirror of 2-in (5.1-cm) diameter.

The focal length was increased to 6 m with a 3X Barlow lens (TeleVue). Tens of images were taken on 1999 JAN 23 and 24 through an RG9 filter (2 mm thickness) and a manually operated shutter (exposure time about 0.01 s).

The two best images obtained in each session were corrected for the rectangular pixels and two unsharp masking filters were applied (binning of the masks 2X2 and 3X3 pixels). Finally the four images were rotated on the computer monitor so that the shadows were oriented horizontally, along the pixel rows. On these images the diameters of Linné and its whitish patch, of Linné A and Linné B and the lengths of their shadows were measured in units of pixels. From the values for Linné A and B and from their known diameters (4.0 and 5.0 km [3], respectively) the scale of the images was obtained (0.69 km per pixel in both observing sessions) which allowed diameters and lengths of the concerned features to be expressed in kilometers. For each CCD frame considered here, the local altitude of the Sun, H, the local azimuth of the Sun, A, and its colongitude, C, were calculated with the *Lunar Observer's Tool Kit* software. From the shadow lengths and the local solar altitude, the heights of the features casting the shadows were also calculated with the same software. *Tables 1-3* (below) summarize the measurements.

RESULTS

On 1999 JAN 23, with a solar altitude of approximately 1° (*Figure 1*; p. 188, upper left), Linné looked like a hill having a base diameter of 5.5±0.7 km and casting a shadow 8.3±0.7 km in length. The height of the Linné "hill" was estimated as 125±15 m, as compared with the crater wall's true height of 125 m [3]. In Figure 1, other hill-like features, similar to Linné, are indicated by the numbers *1, 2* and *3*. The letters *a* and *b* indicate, respectively, the craters Linné A and Linné B, whose wall heights were estimated as about 285±25 m and 370±30 m, respectively.

Table 1. Dates and times of the four selected images of Linné, coordinates* of the measured features and relevant solar parameters.†

UT Date	Hour (UT)	Feature	ξ	η	H(°)	A(°)	C(°)
1999 JAN 23	$18^h\,01^m$	Linné	+0.181	+0.465	0.94	89.88	348.98
1999 JAN 23	$18^h\,01^m$	Linné A	+0.218	+0.483	3.21	91.96	348.98
1999 JAN 23	$18^h\,01^m$	Linné B	+0.211	+0.508	3.01	91.15	348.98
1999 JAN 23	$18^h\,18^m$	Linné			1.06	89.95	349.12
1999 JAN 23	$18^h\,18^m$	Linné A			3.34	91.23	349.12
1999 JAN 23	$18^h\,18^m$	Linné B			3.13	91.22	349.12
1999 JAN 24	$17^h\,26^m$	Linné			11.42	95.49	000.84
1999 JAN 24	$17^h\,28^m$	Linné			11.43	95.50	000.86

* ξ (Xi) and η (Eta) are lunar rectangular coordinates, in the Orthographic Projection at mean libration, measured in units of the lunar radius, with ξ measured positively to lunar east and η positively to lunar north.

† H is the solar altitude (all values positive), A the solar azimuth, and C the solar colongitude (longitude of sunrise terminator).

Table 2. Dimensions of Linné, seen as hill-shaped, and of the craters Linné A and B.

UT Date	Hour (UT)	Feature	Diameter (pixels, km)		Shadow length (pixels, km)		Height (m)
1999 JAN 23	18h 01m	Linné *hill*	8	5.5	12	8.3	120
1999 JAN 23	18h 01m	Linné A	6	4.1	8	5.5	300
1999 JAN 23	18h 01m	Linné B	7	4.8	10	6.9	350
1999 JAN 23	18h 18m	Linné *hill*	8	5.5	12	8.3	130
1999 JAN 23	18h 18m	Linné A	6	4.1	7	4.8	270
1999 JAN 23	18h 18m	Linné B	7	4.8	10	6.9	390

Table 3. Dimensions of Linné, seen as crater-shaped, and of the Linné light patch.

UT Date	Hour (UT)	Feature	Crater diameter (pixels, km)		Patch diameter (pixels, km)	
1999 JAN 24	17h 26m	Linné *crater*	4	2.8	9	6.2
1999 JAN 24	17h 28m	Linné *crater*	4	2.8	9	6.2

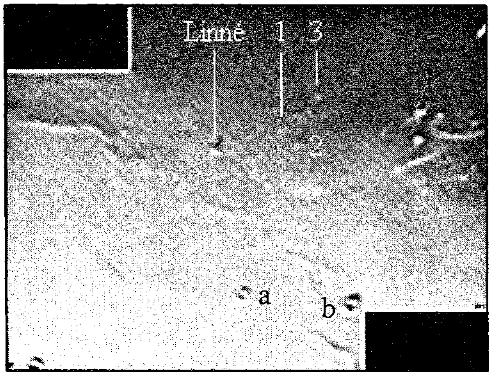

Figure 1. Linné *hill* recorded on 1999 JAN 23, 18ʰ01ᵐ UT, with a local solar altitude of 0°.94; the instrumentation is de-scribed in the text. Other hill-like features are numbered 1, 2, 3; the craters Linné A (a) and Linné B (b) are also identified. Lunar north is to the lower right

On 1999 JAN 24, with a solar altitude of about 11° (*Figure 2*, upper right), Linné appeared as a crater 2.8±0.7 km in diameter, as compared with a true value of 2.45 km [3], filled with shadow and surrounded by a light patch 6.2±0.7 km in diameter. On the same image the formations indicated by the numbers 1, 2 and 3 also revealed their crater nature, with diameters respectively smaller than, nearly equal to or larger than that of Linné, but they showed no trace of light halos.

The 6.2-km diameter of the light patch surrounding the Linné crater in Figure 2 is nearly equal to the diameter of the Linné hill, estimated as about 5.5 km from Figure 1. The conclusion can be drawn that the light patch is detectable under any solar altitude, even if the crater is not discernible, and its diameter is about 6 km.

A photograph taken by the Apollo 15 crew shows Linné as a young crater 2.45 km in diameter, 600 m deep, with a rim height 125 m over the surface of Mare Serenitatis, surrounded by a ring of light ejecta nearly 2 km wide [3]. These data confirm the conclusions presented in this paper.

The different aspects of Linné described in the past, recorded by Apollo 15 in 1971 and by the present author during his January 1999 CCD observations can be summarized as follows:

[a] deep crater 8 km in diameter (1843).

[b] light patch (from 1866 to 1999) with a diameter of about 6 km (1971, 1999).

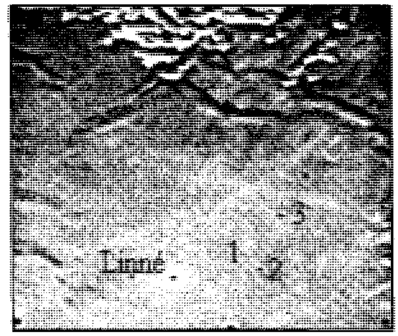

Figure 2. In this image, taken on 1999 JAN 24, 17ʰ28ᵐ UT, with a local solar altitude of 11°.4 , Linné and the features numbered 1, 2, 3 are revealed as craters. (The instrumentation is described in the text.) Lunar north to lower right

[c] craterlet or crater*cone* (from 1867 to 1999) with a diameter of 2.45 km (1971, 1999).

[d] crater*cone* or low hill (from 1897 to 1999) with a base diameter of about 6 km (1999).

DISCUSSION

The diameter of 8 km estimated in 1843 (aspect [a]) appears irreconcilable with the present diameter of Linné crater (2.45 km). However, it must be pointed out that Beer and Mädler observed with a 9.5-cm refractor, and Lohrmann with a 10.8-cm refractor, so that Linné's diameter of 2.45 km would put it near the limit of their resolving power. So, it is hard to accept that the 8 km value is the result of precise micrometric measurements, and thus the figure might be the result of a rough visual estimate. Moreover, given the high contrast between the craterlet filled with shadow and the surrounding light terrain, it can be that Beer and Mädler were misled into making a crude, exaggerated estimate of Linné's diameter.

Passing over the unacceptable value of the diameter reported in 1843, the aspects [a] and [c] are perfectly compatible; both indicate a deep pit, filled with shadow under a low Sun, then appearing as a conspicuous craterlet. This paper has revealed that the [b] aspect, the light patch, is a permanent feature seen at least since 1866, and is presently visible under any lighting condition.

Among the different aspects displayed by Linné during the last 157 years, incompatibility appears to remain only between the form of a deep crater surrounded by a light patch (aspects [a], [b] and [c]) and the form of a hill (aspect [d]). It can be said that this incompatibility is lessened considering that Linné was also seen as a cratercone (aspect [d]); as a hill with a pit on the top, through 45-83 cm instruments. Moreover, comparison between Figures 1 and 2 indicates that, under different lighting conditions, features 1, 2 and 3 also show only one of the two aspects, that of a hill or that of a crater

At this point, it appears that there remain no contradictions among the different portraits of Linné traced by different observers from 1843 to the present, they are only complementary. In fact, an observer recorded an aspect (e.g. the hill), another recorded another aspect (e.g. the crater), representing a unique reality. The same apparent dichotomy was recorded for the craterlets 1, 2 and 3 by an impersonal detector, a CCD camera, under different solar altitudes. Accepting this empirical evidence, it appears unnecessary to assert that Linné underwent important modifications after 1843.

The Hill-Crater Dichotomy Thriller

This paper has documented that Linné displays a hill-like appearance under a low Sun (H near 1°) and reveals its crater nature only under a higher Sun (near 11°). This behavior is not limited to Linné but is well known to lunar observers, for example in the case of Plato's floor craterlets, and is well documented in the present paper for the features indicated by the numbers 1, 2 and 3 in Figures 1 and 2. For this hill-crater dichotomy, the author proposes the following explanation. A craterlet seen under grazing illumination can look like a hill, or like a hill with a pit on the top, if the atmosphere-instrument-detector system is unable to record realistically a *key feature* whose dimensions are near or below its resolving power. The *key feature* is the thin luminous crescent separating the shadow filling the craterlet from the shadow cast by the craterlet rim. This crescent is due to the small portion of the craterlet interior wall illuminated by the grazing Sun.

The key feature under discussion is well visible, for example, in Linné A and B with an 11° solar altitude (Figure 2), thus they immediately reveal their crater nature. In Linné and in the craterlets 1, 2 and 3 under an 1° solar altitude (Figure 1) this luminous sickle should be about 100 m wide at its widest point, and should reduce to nothing at the cusps of a semicircle having a radius slightly larger than 1 km. As already said, one pixel of the author's imaging system covers a rectangle of the lunar surface about 700 m wide. A feature of width 100 m or less cannot be recorded as such, but only contribute with its illumination to the brightness value of the nearby pixels. The result is some lightening of the otherwise dark pixels within the interior or the rim shadow, with the appearance of faintly illuminated pixels which can simulate a hill top.

Increasing the solar altitude widens the luminous crescent, so, when it becomes about 700 m wide or larger, it can be recorded by a significant number of single pixels. To support this explanation the author devised three tests, two direct and one indirect.

The direct tests can be conducted by observing Linné under an 1° solar altitude with a telescope with an aperture at least 100 cm and the same CCD camera as the author's, or with the same telescope and a CCD with pixels about 5 µm. Neither test is feasible for the author.

The indirect proof was obtained by degrading the CCD images of Linné A and B craters in Figure 1 with three Gaussian filters having 1, 2 and 3 pixels width at half height. This convolution simulates observations of Linné A and B carried out in poorer seeing conditions, or with a smaller instruments, or observations concerning a smaller crater (e.g. Linné). The results are given in *Figures 3-5* (p. 190).

The convolution with a Gaussian filter 1 pixel wide (Figure 3) has no significant effect, but slightly reduces the image noise. The convolution with a Gaussian filter 2 pixels wide (Figure 4) transforms craters Linné A and B into apparent hills having a depression on the top. The convolution with a Gaussian filter 3 pixels wide (Figure 5) transforms craters Linné A and B into hills very similar to Linné's appearance and the features indicated as 1, 2 and 3 in Figure 1.

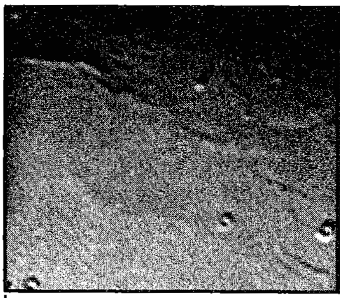

Figure 3. Image of Figure 1 after convolution with a Gaussian filter 1 pixel wide at half height. The only visible effect is a softening of the image.

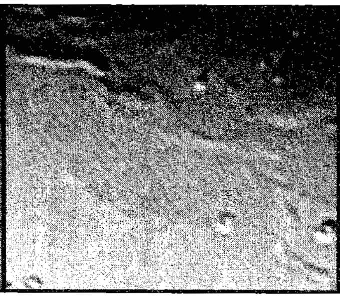

Figure 4. Image of Figure 1 after convolution with a Gaussian filter 2 pixels wide at half height. The craters Linné A and B appear to be hills with depressions on their summits.

Figure 5. Image of Figure 1 after convolution with a Gaussian filter 3 pixels wide at half height. The craters Linné A and B appear hills, just as Linné and features 1, 2, and 3 appear in Figure 1.

These results show what happens to Linné when it is observed under grazing illumination with an atmosphere-instrument-CCD system of insufficient resolving power. A similar convolution results when the eye or the photographic emulsion is used instead of the CCD detector. In the case of the eye, the discrete detector is the retinal cone cell array. In the case of the photographic emulsion, the discrete detector is the disordered array formed by the silver grains.

Conclusions

The convolution between the image of a lunar craterlet grazed by sunlight and a discrete detector can disguise the crater aspect when the crater rim width is near the resolving power of the instrument employed, giving the crater the appearance of a hill. The results presented in this paper thus can account for the different aspects recorded for Linné and other craterlets in the past, and support the author's opinion that Linné might not have undergone any physical modification from 1843 to the present.

Acknowledgments

The author thanks Harry Jamieson for the kind loan of the *Lunar Observer's Tool Kit* software and Raffaello Lena of GLR for stimulating discussions.

References

(1) Wilkins, H. P., and Moore, P. *The Moon,* 2nd Ed., Faber and Faber Ltd., London, 1961, pp. 36 and 96.

(2) The Lunascan Project Home Page is located at:

http://www.evansville.net/~slk/lunascan.html.

Their paper on Linné is located at: http://astrosurf.com/lunascan/Linnecont.htm

(3) Wood, Charles A. "Lunar Notebook: Linné: Here Today, Gone Tomorrow." *Sky & Telescope*, Vol. 98, No. 3 (September 1999), p. 127.

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Note by Editor: Another useful reference about this crater is: Pike, Richard J. "The Crater Linné." *Sky and Telescope*, Vol. 46, No. 6 (December, 1973), pp. 364-366. Also, below is an Apollo photograph of the crater, showing it in greater detail than can be seen from Earth.

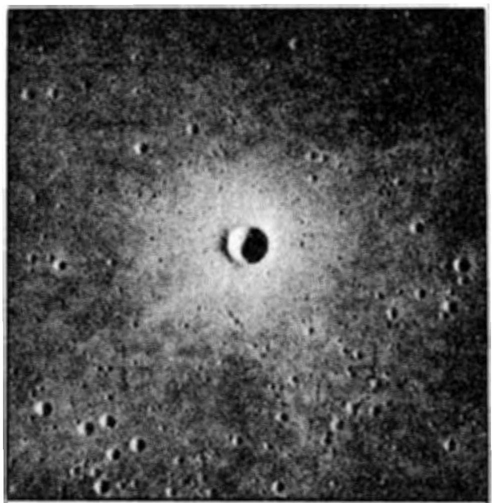

Figure 6. Apollo-15 Mapping Camera photograph of Linné (Frame 408), taken 1971 Jul 31 at about 01h UT; colongitude ~011°.1. North at top.

A.L.P.O. Announcements

Reminder for Authors.—As announced in our last previous issue, this issue of *J.A.L.P.O.* is the final one to be produced by the present Editor. Effectively immediately, all submitted material for our Journal should be sent to the A.L.P.O. Publisher, Harry D. Jamieson, P.O. Box 171302, Memphis, TN 38187-1302.

E-Mail Address Changes.—Effective immediately, the following e-mail addresses have been changed to those given here: (1) Executive Director **Julius L. Benton, Jr.**, jlbaina@msn.com (routine correspondence and A.L.P.O. business), jlbaina@aol.com (all observations and image file attachments); (2) Acting Publications Section Staff Writer **Eric Douglass**, ejdftd@mindspring.com ; (3) Acting Publications Section Science Editor **Richard K. Ulrich**, rulrich@uark.edu ; (4) Acting Publications Section General Editor **Robert A. Garfinkle**, ragarf@earthlink.net .

Observing and Understanding Uranus, Neptune and Pluto.—This is the title of the latest A.L.P.O. Monograph (Number 10). Written by Remote Planets Coordinator Richard W. Schmude, Jr., this 31-page booklet describes how to observe the Remote Planets Uranus, Neptune and Pluto. It may be obtained for $4.00 postpaid ($5.00 for orders outside the United States, Canada and Mexico) from A.L.P.O. Monographs, P.O. Box 2447, Antioch, CA 94531-2447.

Brad Smith Honored.—The name of planetary scientist Bradford A. Smith has been assigned to Minor Planet (8553 = 1995 HG) "Bradsmith." This minor planet was discovered by Japanese amateurs K. Endate and K. Watanabe. In the 1950s and 1960s Dr. Smith was active in the A.L.P.O., his article "Venus in the Ultraviolet" appearing in the *J.A.L.P.O.* July, 1959 issue.

Other Amateur and Professional Announcements

Consolidated Lunar Atlas On Line.—The "CLA", published by the USAF./Lunar and Planetary Laboratory in 1967, is a very rare set of high-resolution observatory photographic prints of the Moon. Thanks largely to the efforts of Eric Douglass, a digital CLA is available online at either: http://www.lpi.usra.edu/research/cla/menu.html *or* http://purl.org/NET/CLA. You may use and reproduce this unique lunar resource, but should credit both the original publication and the website.

Roster of Upcoming Meetings

March 19-24, 2001: International Planetarium and Astronomy Conference. In Sri Lanka. [Sri Lankan Skies & Sir Arthur Conference Secretariat, c/o Sri Lanka Planetarium, Stanley Wijesundera Mawatha, Colombo 07, Sri Lanka. E-Mail: (T.C. Samaranayake) planetsam2001@yahoo.com *or* planetsam2000_1999@yahoo.co.uk; Website: www.slnews.net/slplanet *or* www.slplanet.lgo.uk]

March 26-28, 2001: Fourth Annual Raytheon Science Data Centers Symposium. In Pasadena, California. [Lou Mayo (East Coast Chair), Raytheon ITSS, telephone 301-286-0165, E-mail lmayo@pop600.gsfc.nasa.gov; Emily Greene (West Coast Chair), ITSS, telephone 626-744-5420, E-mail egreene@sdsio.jpl.nasa.gov; Website: http://www.sci-datacenter.org]

April 2-7, 2001: Brown Dwarfs and Planets, 31st Saas-Fee Advanced Course. At Grimentz, Switzerland. [Website: http://obswww.unige.ch/saas-fee/]

June 11-15, 2001: First Eddington Workshop. In Cordoba, Spain. the topic being the Eddington ESA space mission for asteroseismology and extrasolar planet hunting (see also the next conference). [Website: http://astro.esa.int/SA-general/Projects/Eddington/Eddi2001]

June 18-20, 2001: Workshop on the Evolving Sun and Its Influence on Planetary Environments. In Granada, Spain. Sponsored by the Spanish Consejo Superior de Investigaciones Cientificas (CSIC) and the Instituto Nacional de Tecnica Aerospacial (INTA) through the Instituto de Astrofisica de Andalucia (Granada) and the Centro de Astrobiologia (Madrid). [Alvaro Gimenez; Telephone: 34 91 813 11 55; FAX: 34 91 813 11 60; E-mail: ag@laeff.esa.es; Website: http://www.iaa.es/junecongress] Note that transportation from Cordoba to Granada will be provided for those participating in both the Eddington and the Evolving Sun Workshops.

June 25-27, 2001: Deuterium in the Universe. Conference at the Observatoire de Meudon, France; one day will be devoted to the Solar System. [E-Mail: deuterium.2001@obspm.fr; Website: http://wwwusr.obspm.fr/unicom/deuterium/textes/home/htm]

June 25-30, 2001: Conference on Jupiter—Planet, Satellites and Magnetosphere. At the Harvest Regal Hotel, Boulder, Colorado. [Fran Bagenal, Professor of Astrophysical & Planetary Sciences, CB 391, University of Colorado, Boulder. Telephone: 303-492-2598; FAX: 303-492-6946; E-mail: bagenal@colorado.edu; Website: http://lasp.colorado.edu/Jupiter/index.html]

July 24-28, 2001: ALCON 2001. Astronomical League-A.L.P.O. Convention, hosted by the Astronomical League and the Mid-East Region of the Astronomical League. At the Holiday Inn and Francis Scott Key Conference Center, Frederick, Maryland. [Holiday Inn reservations: telephone 301-694-7500 or 800-868-0094. Meeting information, contact Frank Moon, Chair ALCON 2001, 7210 E. Sundown Court, Frederick, MD 21702; E-mail: ALCON 2001Chair@aol.com]

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Lunar and Planetary Training Program (Robertson): *The Novice Observers Handbook,* $15.00. An introductory text to the Training Program. Includes directions for recording lunar and planetary observations, useful exercises for determining observational parameters, and observing forms. To order, send a check or money order made out to "Timothy J. Robertson."

Lunar (Benton): (1) *The ALPO Lunar Section's Selected Areas Program (SAP),* $17.50. Includes a full set of observing forms for the assigned or chosen lunar area or feature, together with a copy of the *Lunar Selected Areas Program Manual.* (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Lunar Forms. (See note for Venus.)

Lunar (Dembowski): *The Lunar Observer*, a monthly newsletter, is available online at the A.L.P.O. Homepage, http://www. lpl.arizona.edu/alpo/ . Hard copies may be obtained by sending a set of self-addressed stamped envelopes to Bill Dembowski at his address in our staff listing.

Lunar (Jamieson): *Lunar Observer's Tool Kit,* consisting of a 3-1/2-in. MS/DOS diskette containing an observation-planning program and a lunar dome data base with built-in instructions. Price $25.00.

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Mars (Troiani): *Martian Chronicle;* available by e-mail. Contact Mars Coordinator Daniel M. Troiani at dantroiani@earthlink.net .

Mars (Astronomical League Sales, P.O. Box 572, West Burlington, IA 52655 U.S.A.): *ALPO's Mars Observer Handbook,* $9.00.

Jupiter: (1) "Jupiter Observer's Start-Up Kit" is available for $3.00 from David J. Lehman. (2) *Jupiter*, the newsletter of the Jupiter Section is available on the Internet at the Jupiter Section Web page or by mail: send SASEs to David J. Lehman. (3) To join the Jupiter Section's E-mail network, "J_Net," send an E-mail message to David J. Lehman at DLehman111@aol.com, write "subscribe J_Net" in the subject field. (4) *Timing the Eclipses of Jupiter's Galilean Satellites;* send a SASE with 55 cents in stamps to John Westfall. This is the project "Observing Kit" and includes a report form.

Saturn (Benton): (1) *The ALPO Saturn Observing Kit,* $20.00. Includes introductory description of A.L.P.O. Saturn observing programs for beginners, a full set of observing forms, and a copy of *The Saturn Handbook.* (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Saturn Forms. (See note for Venus.)

Meteors (Astronomical League Sales, P.O. Box 572, West Burlington, IA 52655 U.S.A.): (1) The pamphlet, *The A.L.P.O. Guide to Watching Meteors* is available for $4.00 (price includes postage). (2) The *Meteors Section Newsletter* is published quarterly (March, June, September, and December) and is available free of charge if you send 33¢ in postage per issue to Coordinator Robert D. Lunsford, 161 Vance Street, Chula Vista, CA 91910 U.S.A..

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