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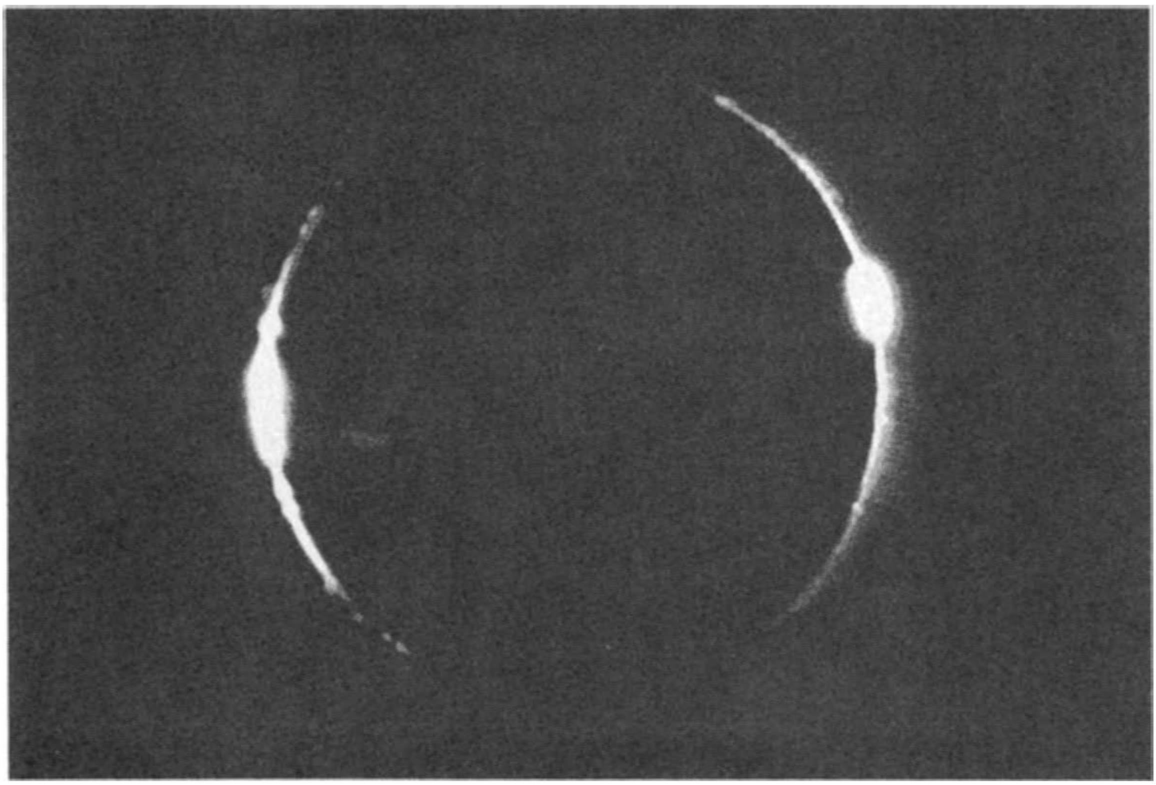

A two-photograph composite of the total solar eclipse of 1998 February 26, showing the "Diamond Ring" and chromosphere at the beginning (left) and end (right) of totality. North is at the top. Taken from Puerto Escondido, Venezuela, with a 127-mm f/10 Schmidt-Cassegrain telescope (C-5), Kodak Elite 100 film, and 1/1000-second exposures by J. Westfall.

THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

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In This Issue

The Strolling Astronomer, Journal of the A.L.P.O.
Volume 40 Number 2, April, 1998

Report on Mercury Observations (Winter, 1996 - Spring, 1997)

By: Oscar L. Cole-Arnal, A.L.P.O. Mercury Coordinator

Abstract

This report of activities by the A.L.P.O. Mercury Section, covering the Winter, 1996 Evening (Eastern) Apparition through the Spring, 1997 Evening (Eastern) Apparition, is divided into three parts: (1) a brief summary of organizational and recruiting efforts this past year; (2) a description and analysis of the observations received during this period, including efforts to correlate observed surface features with the A.L.P.O. Mercury map and a comparison of drawings and video images; and (3) a concluding section outlining hopes and plans for the immediate future.

Introduction

The author was appointed Acting Coordinator of the A.L.P.O. Mercury Section in July 1996, and spent much of the intervening time bringing together a coordinated team of both experienced and novice observers. To assist with this task, help was sought from a number of veteran A.L.P.O. observers. Much assistance was provided by John and Elizabeth Westfall, Harry Jamieson and Rik Hill, a professional observer and a member of the Mercury Section. The author was also able to consult Don Parker on planetary observing techniques and owes an immense debt of gratitude to Richard Baum, the previous Recorder of the A.L.P.O. Mercury Section, for years of guidance and support.

In an effort to rekindle interest in observing Mercury, an appeal was sent out to all previous contributors listed in the A.L.P.O. address roster. A new Mercury observing form, designed by the Coordinator and modeled on other A.L.P.O. observing forms, was also included. Additional appeals were sent out on computer reader networks and as a brief letter to *Sky News*, the Canadian astronomy magazine edited by Terence Dickinson. In fact, a short piece on observing Mercury will appear in that publication early in 1998. Finally, two speaking engagements by the Coordinator at local astronomy clubs also netted some interest in observing Mercury.

These efforts have produced the results that follow. To date, 19 inquiries about observing Mercury have been received, including 15 who have expressed an interest in joining the team. The Mercury Section is also grateful to Julius L. Benton, Jr., the A.L.P.O. Venus Coordinator, who has encouraged his observers to devote some time to Mercury as well. Mercury observers are of course encouraged to reciprocate.

Observations of Mercury

A total of 88 observations of Mercury, including 38 drawings, 2 photographs, 2 video images and 22 light-intensity estimates, were received for the period encompassing the Winter, 1996 Apparition through to the Spring, 1997 Apparition. The remaining observations provided numerical data only. *Table 1* (below) summarizes the participants, their locations and the optical equipment used.

Results

The various data submitted were analyzed in the following ways: (1) by comparing, where applicable, simultaneous or near-simultaneous drawings; (2) by comparing any recorded mark-

Table 1. Participant Mercury Observers (Winter, 1996-Spring, 1997).

Observer	Observing Site	Number of Observations	Instrument(s) and Season(s)
Archer, Daryl	Kitchener, Ontario, Canada	2	25.4-cm (10.0-in) RFL; Spr., '97
Braga, Raffaello	Corsica, France	2	10.2-cm (4.0-in) RFR; Spr., '97
Cole-Arnal, Oscar	Bellwood, Ontario, Canada	39	12.7-cm (5.0-in) RFR; Spr., Sum., Aut., '96; Win., Spr., '97
Frassati, Mario	Crescentino, Italy	4	20.3-cm (8.0-in) SCT; Win. & Spr., '97
Giuntoli, Massimo	Pistoia, Italy	5	8.1-cm (3.2-in) RFR; Spr., '96 & Spr., '97
Hargreaves, Gary	Mission, B.C., Canada	2	15.2-cm (6.0-in) RFL. Aut., '96
Howell, John	Salt Spring Island, B.C., Can.	1	Camera Photo., Spr., '97
Melillo, Frank	Holtsville, N.Y.	1	20.3-cm (8.0-in) SCT (photo.); Spr., '95
Milanese, Piero	Alessandria, Italy	2	10.2-cm (4.0-in) RFR; Win. & Spr., '96)
Niechoy, Detlev	Göttingen, Germany	24	20.3-cm (8.0-in) SCT.
		6	10.2-cm (4.0-in) RFR; Spr., Sum., Aut., '96; Spr., '97

Abbreviations: RFR (refractor), RFL (reflector), SCT (Schmidt-Cassegrain); Win. = Winter, Spr. = Spring, Sum. = Summer, Aut. = Autumn.

ings with a standard map of Mercury; (3) by evaluating intensity estimates of the observed features; and (4) by comparing, where possible, drawings, photographs and video images. A selection of representative images, arranged in chronological sequence, follows. In their captions, k = phase coefficient (proportion of apparent disk sunlit), d = angular diameter, and Seeing is expressed in the Standard A.L.P.O. Scale, ranging from 0 = worst to 10 = perfect. South is at the top in all the illustrations.

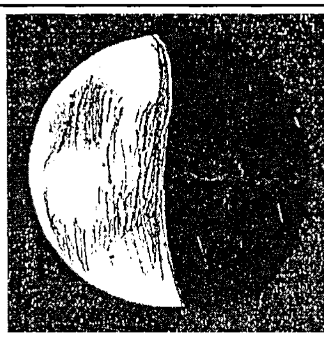


Figure 1. Spring (Evening, Eastern) Apparition, 1996 Apr 18, 18h20m-18h40m UT. P. Milanese. 10.2-cm refractor, 450X, no filter. k = 0.535, d = 6".92.

Giuntoli describes his drawing in *Figure 2* (upper right) as his "best ever observation of Mercury." With an observed phase effect near 50 percent and a central meridian longitude of 102°, he identifies the markings as Solitudo Martis (south) and Solitudo Admetei (north). A comparison of this image with the drawing by Milanese in *Figure 1* (above) provides a tentative confirmation of the features recorded. The correspondence of major albedo features between these two drawings and the map of Mercury (*Figure 3*, below) is also convincing.

Unfortunately, correspondence is not very good between Cole Arnal's drawing (*Figure 4*, to right) on the same date as Giuntoli's sketch (*Figure 2*), nor with the earlier Milanese observation (*Figure 1*) .

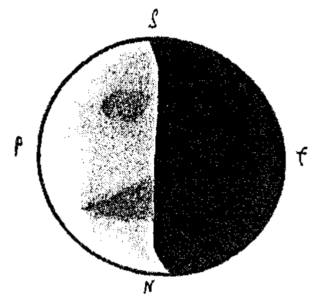


Figure 2. Spring (Evening, Eastern) Apparition, 1996 Apr 21, 18h37m-18h50m UT. M. Giuntoli. 8.1-cm refractor, 200X, no filter. Seeing = 5. k = 0.432, d = 7".50.

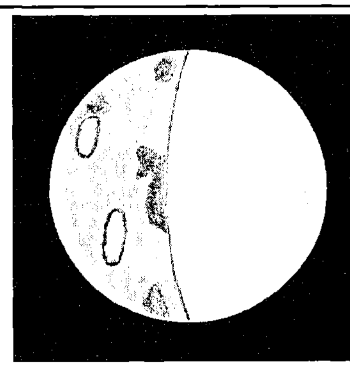


Figure 4. Spring (Evening, Eastern) Apparition, 1996 Apr 21, 00h43m 00h49m UT. O. Cole-Arnal. 12.7-cm refractor, 243X, W21 (orange) Filter. Seeing = 5. k = 0.457, d = 7".35.

Due to Mercury's relatively slow rotation, direct comparison of these drawings made only three days apart appears valid. While most features on the Cole-Arnal sketch do not closely parallel the map nor the Giuntoli and Milanese drawings, the terminator shading in the equatorial area (*Figure 4*) may correspond to Solitudo Jovis. This lack of clear cut correspondence even among near-simultaneous drawings, underscores the importance of verifying what is recorded, as well as the urgent need for more amateurs to observe and image this challenging planet.

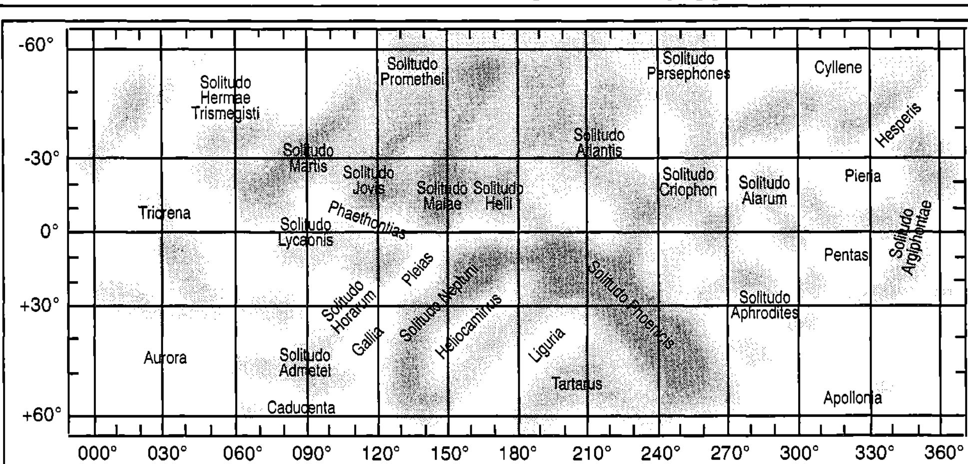
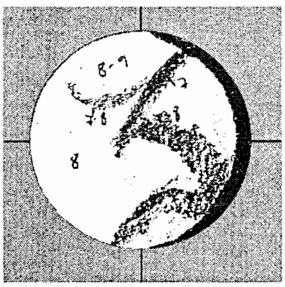


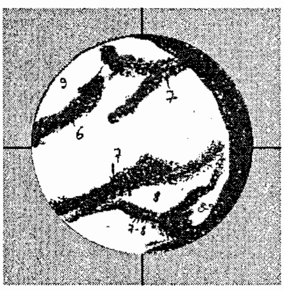
Figure 3. A.L.P.O. map of Mercury. Mercator Projection with south at top.

The following two drawings (*Figure 5a, 5b,* below) by Niechoy are interesting on several accounts. The first is Mercury's proximity to the Sun at the time of observation, which usually results in very bad seeing due to atmospheric heating. Second, the views were obtained under daylight conditions, greatly reducing the relative contrast of the planet's albedo features. In spite of these limitations, these drawings show a remarkable amount of detail, including areas which clearly correspond to Solitudo Phoenicis, Solitudo Admetei and Solitudo Neptuni.

Figure 5. Summer Apparition, 1996 (one week after Superior Conjunction; Evening, Western).



[5a]. 1996 JUL 17, 13h04m-13h09m UT. D. Niechoy. 20.3-cm refractor, 225X, W25 (red) Filter. Seeing = 2- 3. k = 0.963, d = 5".07.



[5b]. 1996 JUL 20, 13h38m-13h43m UT. D. Niechoy. 20.3-cm refractor, 225X, W25 (red) Filter. Seeing = 2. k = 0.930, d = 5".13.

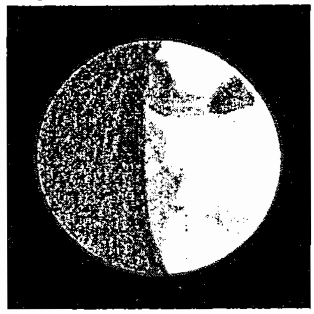
Three observers provided drawings from the favorable Northern-Hemisphere apparition of Mercury in Autumn, 1996 (Morning, Western). This permitted direct comparison both among the observers and with the map of Mercury. The following drawings by Niechoy and Cole-Arnal, respectively, were chronologically closest (see *Figure 6a, 6b,* upper right).

In both drawings, the terminator shading near the Mercurian equator is roughly similar and likely corresponds to Solitudo Alarum and Solitudo Aphrodites. The other prominent area in both drawings parallels the series of dark markings on the map that begins with Solitudo Helii and ends with Solitudo Jovis. Although these drawings are not identical they do show some significant parallels.

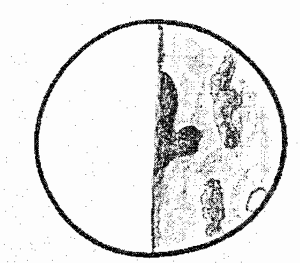
Hargreave's drawing (*Figure 7,* to right) was made four days later than *Figure 6b.* Although this interval precludes direct comparison with *Figure 6,* the planet's slow rotation allows both to show a terminator projection possibly representing Solitudo Aphrodites.

Figure 8 (p. 52) consists of two drawings from the morning Winter (Western) Apparition (1997), one by Mario Frassati and the other by Oscar Cole-Arnal, presented together for comparison. Though made six days apart, the two drawings in *Figure 8* show similar terminator shadings adjacent to the bright areas. The darker, more southerly terminator marking in both sketches likely corresponds to Solitudo Admetei and Solitudo Horarum.

Figure 6. Autumn (Morning, Western) Apparition.



[6a]. 1996 OCT 03, 06h01m-06h12m UT. D. Niechoy. 20.3-cm refractor, 225X, no filter. Seeing = 4. k = 0.514, d = 6".95.



[6b]. 1996 OCT 04, 11h05m-11h17m UT. O. Cole-Arnal. 12.7-cm refractor, 243X, no filter. Seeing = 5-1/2. k = 0.569, d = 6".76.

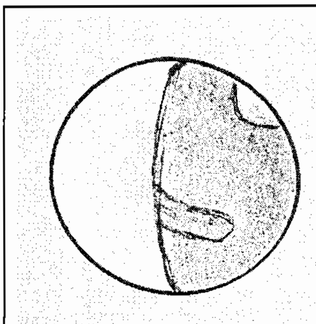
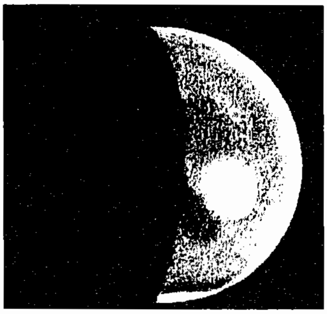


Figure 7. Autumn (Morning, Western) Apparition, 1996 OCT 08, 14h 39m-15h00m UT. G. Hargreaves, 15.2-cm reflector, 197X, W29 (deep red) Filter. Seeing = 5. k = 0.732, d = 6".07.

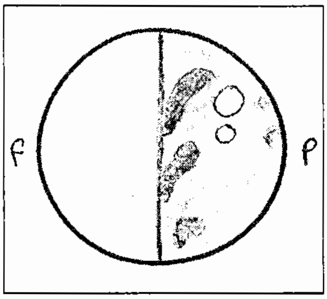
The remaining views, from from the favorable Evening (Eastern) Elongation of Spring 1997, provide some interesting comparisons and possibilities for the future (see *Figure 9* , p. 52, and *Figure 10,* p. 53). Four drawings are included, as well as two images taken with a CCD video camera. Although there is only minimal correspondence in detail between the video image and the drawings, some patterns are noteworthy. For example, the planet's phase is similar in both figures, and there is some general similarity in features between the video image and the Braga drawing. There is also some correspondence between the lighter areas in the Archer image and the bright spots in the Cole-Arnal drawings, particularly the one on 1997 APR 04 (*Figure 6b*).

In *Figure 10* are two near-simultaneous representations of Mercury, one a drawing by Cole-Arnal, the other a video image by Archer taken with the same computer-driven telescope. The drawing was executed first and was followed immediately by video imaging.

Figure 8. Winter (Morning, Western) Apparition.

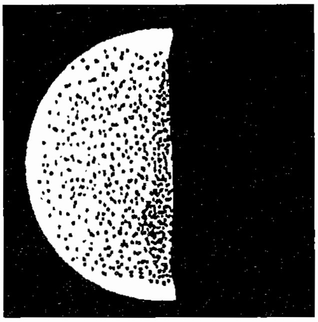


[8a]. 1997 JAN 15, 06h 30m-07h20m UT. M. Frassati. 20.3-cm Schmidt-Cassegrain, 300X, W80A (blue) Filter. Seeing = 2-3. k = 0.398, d = 8".05.

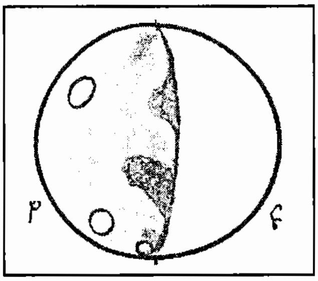


[8b]. 1997 JAN 21, 11h 52m-12h03m UT. O. Cole-Arnal. 12.7-cm refractor, 243X, W21 (orange) Filter. Seeing = 4.5. k = 0.572, d = 7".04.

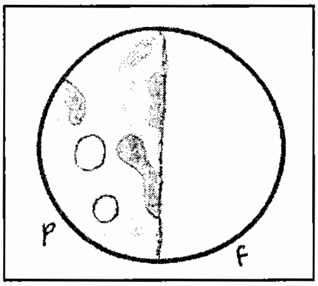
Figure 9. Spring (Evening, Eastern) Apparition.



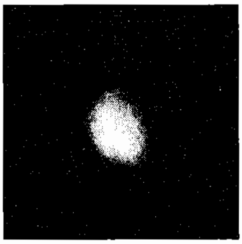
[9a]. 1997 APR 02, 18h15m-18h44m UT. R. Braga. 10.2-cm refractor, 240X, W21 (orange) Filter. Seeing = 4. k = 0.532, d = 6".96.



[9b] 1997 APR 02, 00h12m-00h19m UT. O. Cole-Arnal. 12.7-cm refractor, 243X, W21 (orange) Filter. Seeing = 4. k = 0.561, d = 6".82.



[9c] 1997 APR 04, 00h20m-00h28m UT. O. Cole-Arnal. 12.7-cm refractor, 243X, W21 (orange) Filter. Seeing = 4. k = 0.483, d = 7".20.



[9d] 1997 APR 01, no time given (dusk). D. Archer. 10-in reflector with CCD video camera, 256-level gray scale, 5-mmX3.6-mm array size, frame rate 60 per second.

Although the planet's phase differs slightly in these figures, there is some consistency in the albedo markings, with Solitudo Martis, Lycaonis and Admetei hinted at in both images. This kind of comparison (drawings and electronic imaging) offers some promising possibilities for future Mercury observing, although clearly more experimentation along these lines is required.

While lying outside this observational period, the photograph of Mercury by Frank Melillo (*Figure 11*, p. 53) is of interest because it clearly shows the planet's gibbous phase at the time, although no identifiable surface details. [Note: Mercury is very difficult to photograph due in part to its proximity to the sun and because of the low contrast of its albedo features. Ed.] This was clearly demonstrated as well by the light-intensity estimates contributed for this report. Despite the clear element of subjectivity in such estimates, the values recorded by different observers compared very well and also reconfirmed that contrast differences among Mercury's albedo features are very subtle indeed.

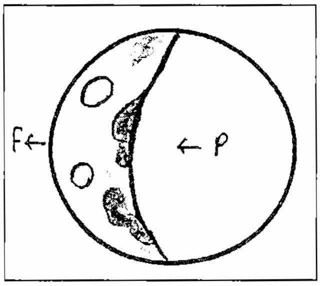
TOWARD THE FUTURE

We hope to receive many more observations of Mercury from the Summer, 1997 - Spring, 1998 cycle than were available for this report. Consequently, we urge A.L.P.O. members and others to observe Mercury and to forward their data to the Coordinator.

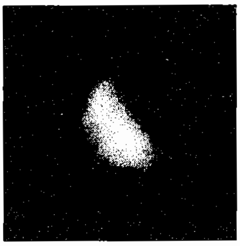
Plans are also underway to foster more cooperation between the Mercury Section and other amateur organizations. The A.L.P.O. Venus Section has already been mentioned. The participation of Massimo Giuntoli and the observers of the Mercury Section of the Unione Astrofili Italiani is also gratefully acknowledged. Correspondence will be maintained with Richard Baum of the British Astronomical Association in the hope that their members also will share Mercury observations. Finally, comparison between visual drawings and electronic images will be continued. Three members of the Royal Astronomical Society of Canada, Daryl Archer, Clark McDonald and Oscar Cole-Arnal, plan to carry out work along these lines. The year 1997-1998 promises a rich and useful harvest of amateur work on this challenging object.

Figures 10 and 11 for this report appear on p. 53.

Figure 10. Spring (Evening, Eastern) Apparition of Mercury.



[10a] 1997 APR 10, 00h32m-00h47m UT. O.Cole-Arnal. 12.7-cm refractor, 243X, W25 (red) Filter. Seeing = 4. k = 0.267, d = 8".57.



[10b] 1997 APR 10, 00h50m-01h07m UT. D. Archer, same optics with video imaging as described in *Figure 9.*

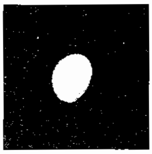


Figure 11. Spring (Evening, Eastern) Apparition of Mercury, 1995 MAY 07, no time given. F. Melillo. 20.3-cm Schmidt-Cassegrain, 20-mm eyepiece with 2X Barlow, 7 seconds exposure on Kodak TP 2415 Film.

BERYL E. (PEGGY) HAAS (1912-1997)

By: Walter H. Haas, A.L.P.O. Director Emeritus

Many of you readers graciously sent cards of sympathy and condolence after my wife, Peggy, died in October, 1997; and a few even attended the funeral services from some distance. Your thoughtfulness is much appreciated.

She was born on March 29, 1912 in Mandeville, Jamaica, (then) British West Indies to George E. Godfrey, a jeweler and Sun Life Insurance salesman, and Kathleen Mullings Godfrey, a homemaker. Educated in the British schools of the period, she worked at various times in a hotel and law offices in Mandeville, for the Jamaica Tourist Board in Kingston, as a domestic helper for a wealthy family in Canada, and for the Forestry Commission in London, England. Many of these jobs required typing, accounting, or bookkeeping. We first met in Jamaica in the summer of 1935, when I studied under the tutelage of Professor William H. Pickering, a retired Harvard University lunar and planetary astronomer. Peggy was his close neighbor and occasional secretary. We resumed correspondence as a result of considerable international publicity given to Tsuneo Saheki's observation of a gray cloud-bulge on the south limb of Mars on January 15, 1950 (*The Strolling Astronomer,* Vol. 4, no. 2, pg. 11 and Vol. 4, no. 3, pg. 1 and 11). We enjoyed London together at the time of the coronation of Queen Elizabeth II, married in Jamaica later in 1953 and subsequently lived in Las Cruces. We have one daughter, Mary, born in 1957.

Peggy was never an enthusiastic amateur astronomer, nor did I become an avid gardener in her preferred hobby. However, she was time and again extremely helpful in typing the A.L.P.O.'s journal, in finding new typists as the need frequently arose, in designing a banner for the A.L.P.O. conventions, in ideas for tarpaulin covers for my outdoor telescopes, and in many other ways. For 20 years, 1966-1985, she served as A.L.P.O. Librarian, conducting a postal astronomy book-lending service for our members. She made many friends at the meetings of the A.L.P.O., the Western Amateur Astronomers, and the Astronomical League. It must also be remarked that the hours kept by observing astronomers put severe strains on household routines, and on wifely patience.

Peggy contracted arthritis in 1971, and other health problems followed as the years passed. These could only grow slowly worse with increasing age. It is typical of her concern for others that she insisted, only six weeks before she died, that I resume studies with the backyard telescopes. The end came peacefully on October 31.

A.L.P.O. OBSERVATIONS OF VENUS: THE 1994 EASTERN (EVENING) APPARITION

By: Julius L. Benton, Jr., A.L.P.O. Venus Coordinator

ABSTRACT

This report uses data contributed by A.L.P.O. Venus Section observers in the United States, Canada, Germany, and Belgium, giving a synopsis of visual and photographic observations of Venus for the 1994 Eastern (Evening) Apparition. It includes the sources of data and instruments used in making observations; comparative studies based on observers, instruments, and visual and photographic data; illustrations; a statistical analysis of the categories of features in Venus' atmosphere, including cusps, cusp-caps, and cusp-bands, seen or suspected at visual wavelengths, both in integrated light and with color filters; terminator deformities; the apparent phase; as well as results from the continuing monitoring of the dark hemisphere of Venus for the Ashen Light.

INTRODUCTION

A.L.P.O. observers submitted a creditable series of visual and photographic observations of Venus during the 1994 Eastern (Evening) Apparition. The circumstances of the apparition are presented in *Table 1* (right).

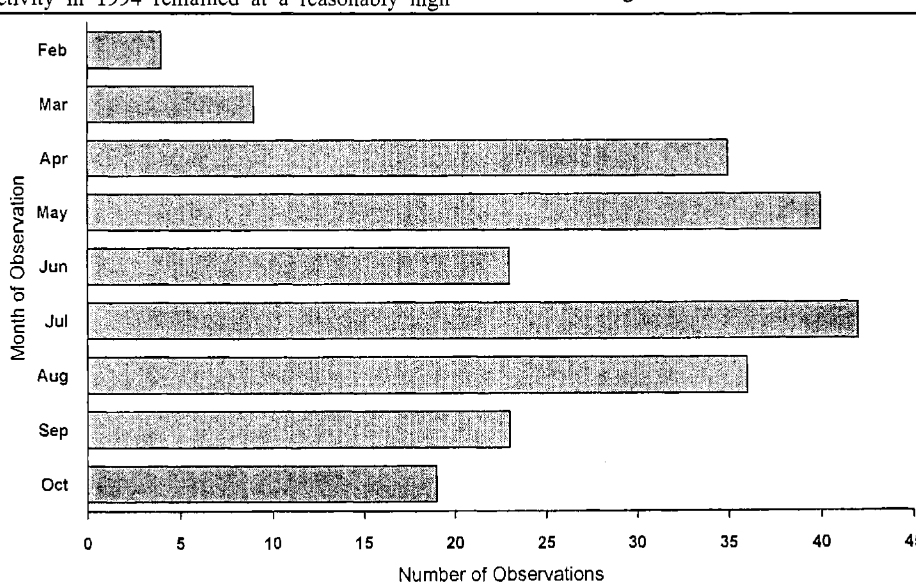
A total of 231 observations comprised of visual drawings and photographs were received for the 1994 Eastern (Evening) Apparition, and *Figure 1* (below) shows the distribution of these observations for each month during the observing season.

Most individuals began their programs quite early in the apparition, and then followed Venus until the planet neared Superior Conjunction. This "observing season" covered 1994 FEB 13-OCT 31, with the greatest emphasis during April-September (86.2 percent of the total observations). As in many previous apparitions, the observational activity in 1994 remained at a reasonably high level throughout the period when Venus was near dichotomy (half phase), greatest brilliancy, and maximum elongation from the Sun.

Table 1. Geocentric Data in Universal Time (UT) for the 1994 Eastern (Evening) Apparition of Venus. [Association of Lunar and Planetary Observers, 1993]

		d	h
Superior Conjunction.................	1994	JAN 17	02
First Observation (Elong. 7°E)..		FEB 13	- -
Dichotomy (predicted)..............		AUG 22	10
Greatest Elongation East (46°).		AUG 24	23
Greatest Brilliancy (-4.6)...........		OCT 25	- -
Last Observation (Elong. 8°E)..		OCT 31	- -
Inferior Conjunction...................		NOV 02	23

Apparent Diameter (observed range):
9".82 (1994 FEB 13) - 61".28 (1994 OCT 31)
Phase Coefficient (k; observed range):
0.994 (1994 FEB 13) - 0.008 (1994 OCT 31)



Total Observations = 231 (86.2% received from Apr thru Sep)

Figure 1. Distribution of observations by month during the 1994 Eastern (Evening) Apparition of Venus.

Ten individuals submitted visual and photographic observations of Venus during the 1994 Apparition. These observers are listed in *Table 2* (below) with their observing sites, number of observations, and instruments used.

Figure 2 (below) shows the distribution of observers and contributed observations by nation of origin for this apparition. Almost two-thirds of the observers were located in the United States, but those individuals only accounted for about

Table 2. Participants in the A.L.P.O. Venus Observing Program During the 1992-93 Eastern (Evening) Apparition.

Observer	Observing Site	Number of Observations	Telescope(s) Used
Benton, Julius L.	Wilmington Island, GA	25	15.2-cm (6.0-in) Refractor
Bosselaers, Marc	Berchem, Belgium	1	11.0-cm (4.3-in) Schiefspiegler
		5	25.4-cm (10.0-in) Newtonian
Gélinas, Marc A.	Ile-Perrot, Que., Canada	7	15.2-cm (6.0-in) Refractor
Graham, Francis G. & Graham, Theresa	East Pittsburgh, PA	1	6.4-cm (2.5-in) Refractor
		5	10.2-cm (4.0-in) Refractor
		1	15.2-cm (6.0-in) Refractor
		46	16.0-cm (6.3-in) Refractor
		2	25.4-cm (10.0-in) Newtonian
		2	40.6-cm (16.0-in) Newtonian
		1	86.0-cm (33.8-in) Cassegrain
Lehman, David	Fresno, CA	3	25.4-cm (10.0-in) Newtonian
Niechoy, Detlev	Göttingen, Germany	27	10.2-cm (4.0-in) Refractor
		89	20.3-cm (8.0-in) Schmidt-Cass.
		4	30.5-cm (12.0-in) Newtonian
Nowak, Gary T.	Essex Jct., VT	4	25.4-cm (10.0-in) Schiefspiegler
Schmude, Richard W.	Barnesville, GA	4	35.6-cm (14.0-in) Schmidt Cass.
Stryk, Ted	Bristol, VA	2	25.4-cm (10.0-in) Newtonian
Viens, Jean-Francois	Charlesbourg, Que., Canada	2	11.5-cm (4.5-in) Newtonian

Total Number of Observers.................... 10

Total Number of Observations... 231

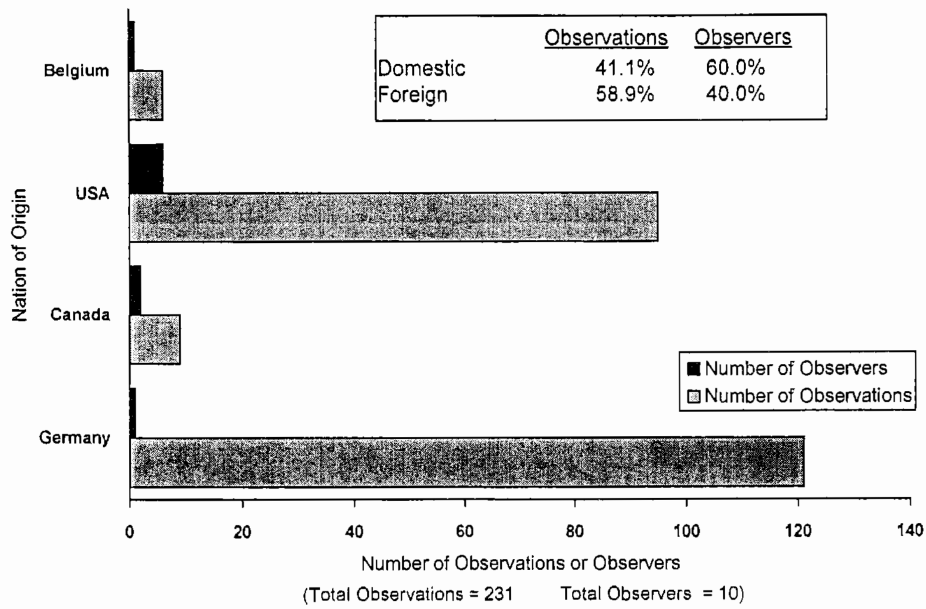


Figure 2. Distribution of observations and observers by nation of origin, 1994 Eastern (Evening) Apparition of Venus.

two-fifths of the total observations received. As in past observing seasons, our programs continue to be highly international in scope.

The types of telescopes employed to make observations are graphically depicted in *Figure 3* (below). In addition, it should be noted that the majority (84.8 percent) of the-observations were made with telescopes of 15.2-cm (6.0-in) aperture or greater.

In terms of atmospheric conditions, the mean Seeing was 3.5, or "fair," on the standard A.L.P.O. Seeing Scale that ranges from 0.0 (poorest seeing conditions) to 10.0 (perfect). The mean Transparency, expressed as the limiting stellar magnitude, was +4.1. During 1994, observations were made against a light (twilight) sky about as frequently as those made under relatively dark skies.

This Coordinator expresses his sincere gratitude to all individuals cited in this report who contributed observations to the A.L.P.O. Venus Section in support of our ongoing effort to assemble a database of long-term, detailed investigations of the planet Venus. Cooperation continued in 1994 from such groups as the British Astronomical Association and the Vereinigung der Sternfreunde in Germany.

Observations of Venusian Atmospheric Details

The methods and techniques for carrying out visual studies of the typically vague, elusive "markings" in the atmosphere of Venus have been outlined in A.L.P.O. Venus Section literature. Novice observers should thoroughly study these source materials as well as previous apparition reports that have appeared in this Journal.

All of the observations used in preparing this report were made at visual wavelengths, and several samples of these observations in the form of drawings and photographs appear in this report to assist the reader in interpreting the phenomena reported or suspected on Venus in the 1994 Eastern (Evening) Apparition.

The visual and photographic data for the 1994 Apparition represented virtually all of the categories of bright and dusky atmospheric features on Venus that are described in the literature cited above. *Figure 4* (p. 57) summarizes the relative frequency by which the specific forms of markings were reported. More than one type of marking or feature were shown in many of the observations, so that totals of over 100 percent are possible in the analysis. There is no doubt that some subjectivity is inherent in the reporting of the vague and elusive markings of Venus, which must affect the values shown in *Figure 4*. Our tentative conclusions based on these data, however, appear reasonable.

Detecting the faint, dusky markings of the atmosphere of Venus is frequently an arduous task both for the novice and experienced visual observer. It is now widely accepted that good ultraviolet (UV) photographs of Venus will tend to reveal more of these subtle atmospheric shadings, and the A.L.P.O. Venus Section strongly urges individuals to pursue UV photography. It has been demonstrated that many features look different at these short UV wavelengths as opposed to markings reported in the visual region of the electromagnetic spectrum, particularly the Venusian radial dusky patterns. It is interesting from *Figure 4*, however, that only 11.7 percent of the drawings and other visual observations of Venus during the 1994 observing season showed the planet as devoid of shadings or markings of any kind. This resembles the situation in other recent apparitions, but not for many of the observing seasons before 1988-89. In the photographs taken at visual wavelengths there were no indications at all of markings on Venus, even though visual observers reported seeing radial, banded, radial, irregular, and amorphous dusky markings. A contributing factor may be the frequent use by our visual observers of standard, sys-

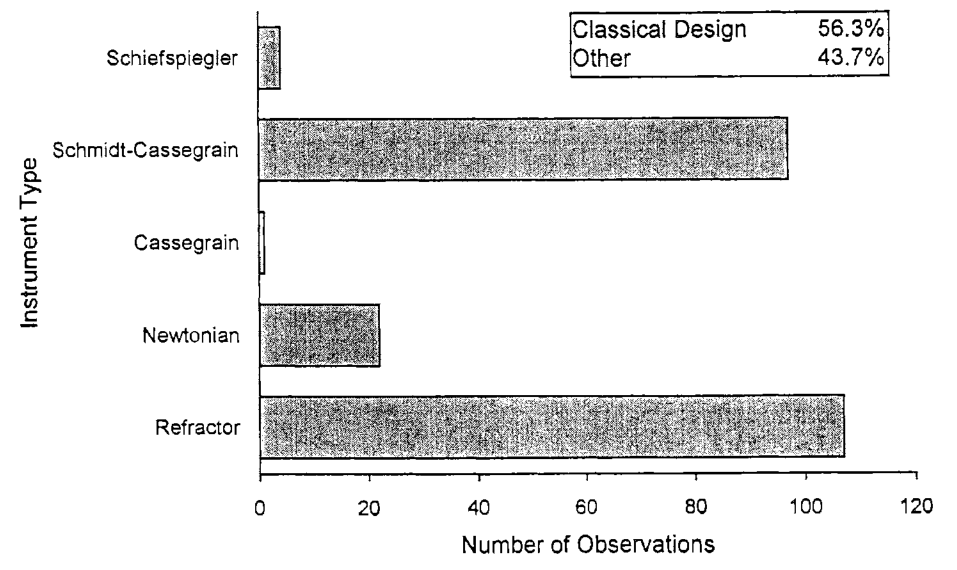


Figure 3. Types of telescopes used during the 1994 Eastern (Evening) Apparition of Venus.

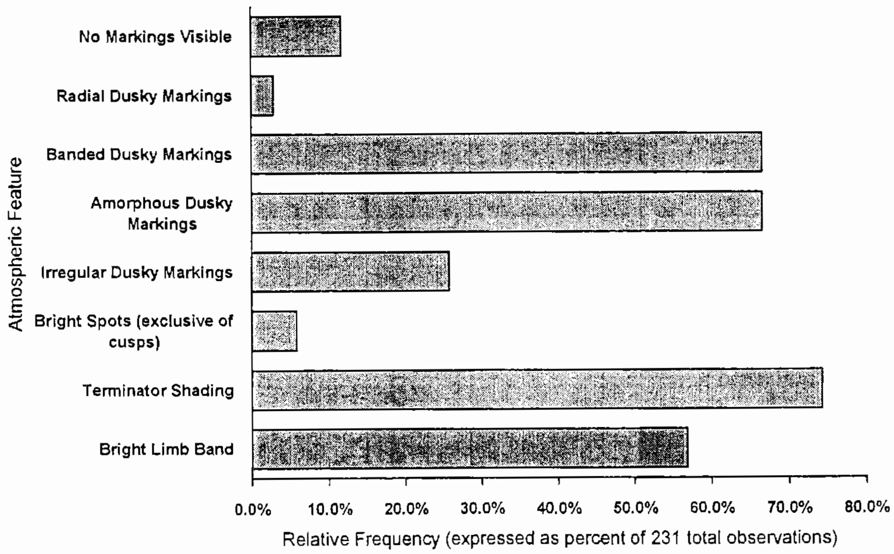


Figure 4. Relative frequency of specific forms of atmospheric marking on Venus during the 1994 Eastern (Evening) Apparition.

tematic techniques with variable-density polarizers and color filters.

Figure 4 shows that two-thirds of the reported dusky features fell in the categories of "Amorphous Dusky Markings" (66.5 percent) and "Banded Dusky Markings" (66.5 percent) while other dusky shadings were distributed among the categories of "Irregular Dusky Markings" (25.7 percent) and "Radial Dusky Markings" (2.9 percent) in 1994.

Terminator shading was usually fairly prominent during the 1994 apparition, visible in 74.3 percent of the observations, as shown in *Figure 4*. There was the usual tendency for the terminator shading to lighten (i.e., assume a higher intensity value) as one progressed from the terminator region toward the illuminated limb of the planet. This subtle gradation in brightness often ended at the Bright Limb Band, and frequently this terminator shading extended from one cusp region to the other. Unlike the many drawings received during 1994, photographs rarely suggested that terminator shading was present.

The mean relative intensity for all of the dusky features on Venus in 1994 ranged from 8.4 to 8.6, where 0.0 represent pure black and 10.0 is the brightest possible condition.

Ranging from 0.0 for "definitely not seen" up to 10.0 for "certainly seen," the A.L.P.O. Scale of Conspicuousness was also used rather effectively during the 1994 observing season. The dusky markings referred to in *Figure 4* were assigned a mean conspicuousness of 5.0 during the apparition, meaning that all of these features lay somewhere between vague suspicions and strong indications of actual presence on Venus.

It is also shown in *Figure 4* that "Bright Spots or Regions," exclusive of the cusp areas, were infrequently perceived (averaging about 9.6 in mean relative intensity). A very small number of drawings showed these bright spots or mottlings, and photographs were completely devoid of these features.

Color filter techniques were employed systematically during the 1994 Eastern (Evening) Apparition. These methods produced good results when compared with views in Integrated Light. The overall visibility of most of the atmospheric phenomena on Venus was improved by the use of Wratten and Schott color filters as well as variable-density polarizers.

The Bright Limb Band

In the 1994 Eastern (Evening) Apparition, *Figure 4* shows that 56.8 percent of the observations contributed referred to a "Bright Limb Band" on the sunlit hemisphere of Venus. When this brilliant band was reported, the feature showed continuity from cusp to cusp 80.7 percent of the time, and was broken or only partially visible in 19.3 percent of the positive reports. The mean numerical intensity of the Bright Cusp Band was 9.7, and its visibility was enhanced through the use of color filters and variable-density polarizers.

Terminator Irregularities

The terminator of Venus refers to the geometrically curved boundary separating the illuminated and dark hemispheres of the planet. During the 1994 Apparition, 26.7 percent of the observations called attention to an asymmetric or irregular terminator. When the terminator was not seen as a regular geometric feature, amorphous and irregular dusky markings, and to a lesser extent banded and radial dusky shadings, appeared to merge with the terminator shading and with several reported deformities. As with other filter observations during this apparition, systematic filter techniques seemingly improved the visibility of any terminator irregularities and associated dusky atmospheric features. Note that irradiation may cause brilliant features adjacent to the terminator to appear as apparent bulges, and dark features sometimes take the form of dusky hollows.

Cusps, Cusp-Caps, and Cusp-Bands

The most contrasting and conspicuous features occasionally seen in the atmosphere of Venus are located at or near the planet's cusps, usually when the phase coefficient, k, lies between 0.1 and 0.8 (the phase coefficient is the fraction of the disc that is illuminated). These cusp caps are occasionally bounded by dark, often diffuse, peripheral cusp bands. *Figure 5* (below) graphically depicts the visibility statistics for Venus' cusp features throughout 1994.

From *Figure 5*, it can be seen that when the northern and southern cusp-caps were detected, they were of usually equal in size and brightness. There were some instances, however, when the either the northern or southern cusp-cap was the larger, brighter, or both. In somewhat less than half of the observations received, neither cusp-cap could be detected. The mean relative intensity of the cusp-caps was about 9.8 during the 1994 Apparition.

The cusp-caps were bordered by dusky cusp-bands in about half of the observations received, with a mean relative intensity of about 6.0,. However, nearly as frequently neither cusp-band was reported, as *Figure 5* shows.

Cusp Extensions

As illustrated in *Figure 5*, in 94.2 percent of the observations, there were no reported cusp extensions beyond the 180° expected from simple geometry, as seen in integrated light and with color and polarizing filters.

During the latter part of the apparition (when Venus had a crescent phase) reports were received of both cusps ranging from 2° to 45° beyond the anticipated 180°. There were many times when the reported extensions of both cusps joined, forming a truly spectacular halo fully encircling the dark hemisphere of Venus. These cusp extensions were depicted on drawings, enhanced by color filters and polarizers, but were not visible on photographs that were submitted. As expected, cusp extensions were virtually impossible to capture on film, since they are typically much fainter than the dazzling sunlit regions of Venus.

Estimates of Dichotomy

The "Schröter Effect" on Venus, a discrepancy between the predicted and the observed dates of dichotomy (half-phase), was reported in 1994. 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 1994 are given in *Table 3* (p. 59).

The Ashen Light and Other Dark-Hemisphere Phenomena

The Ashen Light, first reported by G. Riccioli in 1643, is an extremely elusive, faint illumination of the dark hemisphere of Venus. It resembles Earthshine on the dark portion of the Moon, although the origin is not the same. It is also usually believed that Venus must be viewed against a dark sky in order to perceive the Ashen Light, but the planet is very low in the sky at those times and suffers greatly from the effects of poor seeing and

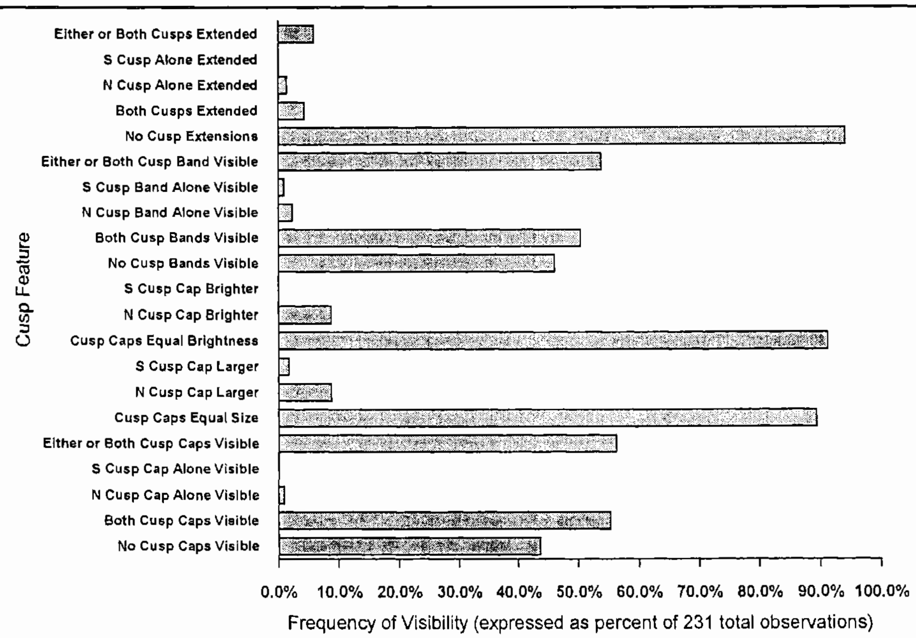


Figure 5. Visibility statistics of cusp features of Venus during the 1994 Eastern (Evening) Apparition.

Table 3. Observed versus predicted dichotomy of Venus, 1994 Eastern (Evening) Apparition.

Dichotomy (k = 0.500)	Observer: J. Benton	Observer: F. Graham
Observed (0)	Aug 20.02	Aug 19.01
Predicted (P)	Aug 22.47	Aug 22.47
Difference (O-P, days)	-2.45	-3.46

glare in contrast with the dark sky background.

Table 4 (below) summarizes the few dates during 1994 when there were positive and negative observations of the Ashen Light. Although positive and negative reports of the Ashen Light sometimes occurred on the same date, the times of observation were usually considerably different. Because of the characteristically elusive nature of the phenomenon, this came as no surprise. On the occasions when positive reports were submitted, there were only vague suspicions of the Ashen Light with color filters and in Integrated Light. At no time were contributing observers certain of the presence of the phenomenon during the 1994 Apparition.

There were sporadic cases when observers believed that the dark hemisphere of Venus was actually darker than the background sky, but in reality, this phenomenon is almost certainly caused by differential contrast.

Table 4. Ashen light observations, 1994 Eastern (Evening) Apparition of Venus.

1994 UT		Observer	Instrument	Filter	Ashen Light
Jul 08	02:45 -02:50	Stryk	25.4-cm NEW, 135X	IL	S (vague)
				W47	S (vague)
	20:06-20:29	Niechoy	10.2-cm REF, 217X	IL	NS
				W25	NS
				W16	NS
				W47	NS
Aug 01	00:15-00:30	Nowak	25.4-cm SCHF, 150X	IL	NS
	01:00-01:20	Graham	25.4-cm NEW, 120X	IL	NS
				W47	NS
	13:41-14:18	Niechoy	20.3-cm SC, 225X	IL	S (vague)
				W25	S (vague)
				W15	S (vague)
				W47	S (vague)
Aug 02	01:00-01:10	Graham	25.4-cm NEW, 133X	IL	NS
	13:42-14:13	Niechoy	20.3-cm SC, 225X	IL	S (vague)
				W25	S (vague)
				W15	S (vague)
				W47	S (vague)
Oct 12	14:51-15:24	Niechoy	20.3-cm SC, 225X	IL	S (vague)
				W25	S (vague)
				W15	S (vague)
				W47	S (vague)
Oct 16	21:35-21:40	Graham	16.0-cm REF, 133X	IL	S (vague)

Notes

Filters are: W15 or W16 = yellow, W25 = red, W47 = dark blue; IL = Integrated Light. Instrument types are: NEW = Newtonian, REF = Refractor, SC = Schmidt-Cassegrain, SCHF = Schiefspiegler. Under "Ashen Light," the visibility codes are: NS = nothing seen or suspected, S = suspected, StS = strongly suspected, VStS = very strongly suspected, and DS = definitely seen by the observer.

Conclusions

The level of atmospheric activity on Venus was moderate during the 1994 Eastern (Evening) Apparition. As a standard practice, it is worthwhile to compare these results with those of previous evening apparitions of the planet, as well as with morning apparitions. In particular, we have maintained our routine investigation of the curious Ashen Light, observations of which reached a peak during the days of the Pioneer Venus Orbiter (PVO). Very rewarding has been the international cooperation between individuals and organizations in our studies of Venus, and this worldwide effort is now on firm ground. A systematic, simultaneous monitoring of Venus by visual, photographic, video, and CCD methods over the span of many years by a solid nucleus of skilled observers remains as our prime objective. Thus, we invite interested readers to contribute reliable scientific information about the planet in coming apparitions.

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Hunten, D.M., *et al.*, eds. (1983). *Venus.* Tucson: University of Arizona Press.

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Figures 6-19 are shown on pp. 60-61 and are oriented with south at the top. Those drawings that were reversed due to the use of eyepiece diagonals have been un-reversed. When given, and unless otherwise indicated, Seeing is in the standard 0-10 A.L.P.O. Scale and Transparency is the limiting naked-eye magnitude in the vicinity of Venus; k = phase coefficient and d = diameter in arc-seconds.

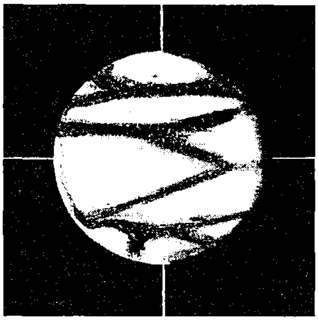
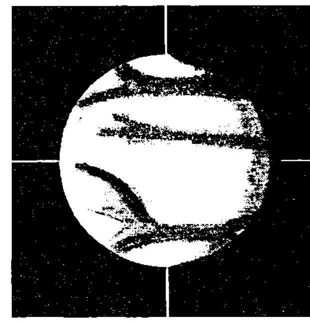


Figure 6. D. Niechoy. 1994 Feb 19, 12h40m UT. 20-cm Schmidt-Cassegrain, 225X, U63 Filter. k = 0.991, d = 9".86.

Figure 7. D. Niechoy. 1994 Apr 07, 14h21m UT. 20-cm Schmidt-Cassegrain, 225X, W15 (yellow) Filter. k = 0.943, d = 10".55.



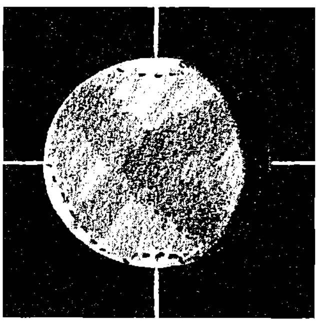
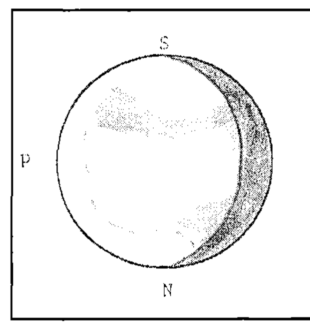


Figure 8. M. Bosselaers. 1994 May 01, 19h40m UT. 25-cm Newtonian, 150X, violet filter. Seeing = fair. k = 0.898, d = 11".27.

Figure 9. M. Gélinas. 1994 May 22, 21h30m-21h48m UT. 15-cm refractor, 305X, W15 (yellow) and W38 (green) Filters. Seeing = 6, Transparency = +4. k = 0.847, d = 12".18.



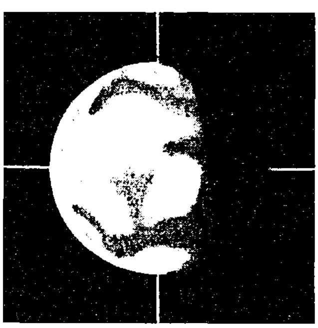
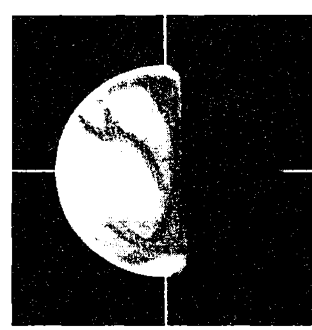


Figure 10. D. Niechoy. 1994 Jun 07, 19h28m UT. 10-cm refractor, 145X, no filter. k = 0.802, d = 13".12.

Figure 11. D. Niechoy. 1994 Jul 16, 12h15m UT. 20-cm Schmidt-Cassegrain, 225X, W15 (yellow) Filter. k = 0.666, d = 16".79.



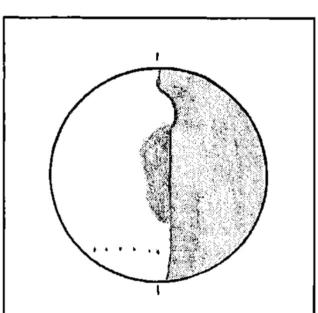


Figure 12. G. Nowak. 1994 Aug 01, 12h15m UT. 25-cm Tri-Schiefspiegler, 150X, no filter. Seeing = 4.0, Transparency = +5.0. k = 0.602, d = 19".12.

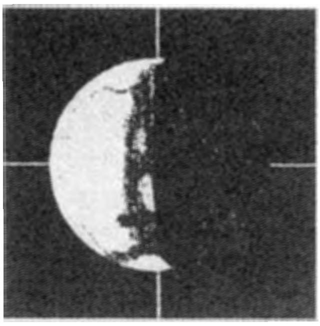


Figure 13. D. Niechoy. 1994 Aug 26, 12h31m UT. 20-cm Schmidt-Cassegrain, 112X, no filter. k = 0.478, d = 24".92.

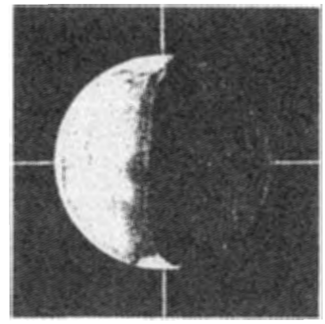


Figure 14. D. Niechoy. 1994 Aug 28, 11h42m UT 20-cm Schmidt-Cassegrain, 225X, no filter. k = 0.467, d = 25".51.

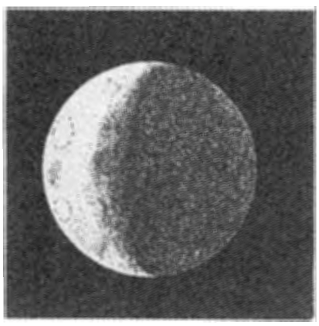


Figure 15. D. Lehman. 1994 Sep 10, 23h50m UT. 25-cm Newtonian, 124X, W47 (dark blue) Filter. Seeing = 5, Transparency = +5. k = 0.387, d = 30".38.

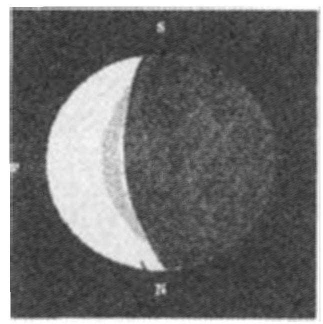


Figure 16. F. Graham. 1994 Sep 18. 23h37m-23h40m UT. 16-cm Refractor, 133X, no filter. Seeing ≈ 3 arc-seconds, Transparency = +3.0. k = 0.331, d = 34".13.

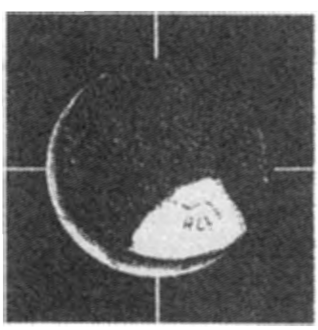


Figure 17. D. Niechoy. 1994 Oct 12, 14h51m UT. 20-cm Schmidt-Cassegrain, 51X, no filter. k = 0.134, d = 49".82. Note suspected ashen light.

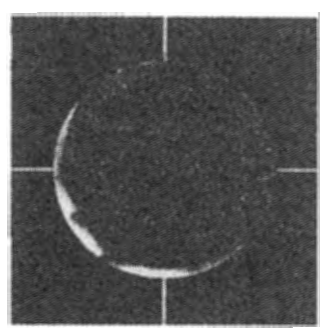


Figure 18. D. Niechoy. 1994 Oct 15, 15h17m UT. 20-cm Schmidt-Cassegrain, 225X, W25 (red) Filter. k = 0.107, d = 52".18.

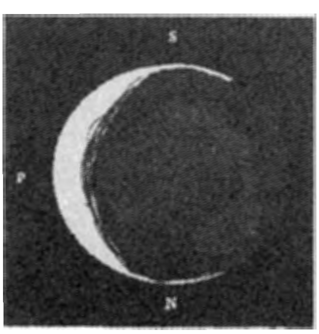


Figure 19. F. & T. Graham. 1994 Oct 16, 21h35m-21h40m UT. 16-cm Refractor, no filter. Seeing = 7-8 arc-seconds. k = 0.096, d = 53".16. Note cusp extension and suspected ashen light near terminator.

Meteors Section News

By: Robert D. Lunsford, A.L.P.O. Meteors Coordinator

Table 1. Recent A.L.P.O. Meteor Observations; July-December, 1996.

1996 UT Date	Observer and Location	Universal Time	Number and Type* of Meteors Seen	Comments (+N = Limiting Magnitude)
Jul 06	Wayne Hally, NJ	03:00-05:00	1 CAP, 3 SAG, 5 SPO	+5.3
	George Zay, CA	04:45-11:23	5 SAG, 16 SPO	+5.6
07	Pierre Martin, Ontario	03:06-04:55	2 CAP, 7 SPO	+5.6
	Wayne Hally, NJ	03:21-04:10	1 CAP, 1 SAG, 2 SPO	+5.3
	George Zay, CA	04:45-10:22	3 SAG, 15 SPO	+5.9
09	Robert Lunsford, CA	08:30-11:30	2 JPE, 18 SPO	+6.2
10	Pierre Martin, Ontario	06:55-08:00	1 CAP, 3 JPE, 5 SPO	+5.8
11	Pierre Martin, Ontario	03:03-08:02	2 CAP, 5 JPE, 4 PER, 27 SPO	+5.8
	Doug Kniffen, MO	03:20-04:53	3 JPE, 14 SPO	+5.6
	George Zay, CA	04:43-11:22	1 JPE, 4 SAG, 20 SPO	+6.0
	Wayne Hally, NJ	05:00-08:15	1 JPE, 18 SPO	+5.5
	Robert Lunsford, CA	07:30-11:30	4 JPE, 1 SAG, 22 SPO	+6.3
12	Doug Kniffen, MO	02:45-04:07	9 SPO	+5.4
	Pierre Martin, Ontario	03:07-07:25	1 CAP, 3 JPE, 12 SPO	+5.8
	Wayne Hally, NJ	06:30-08:15	11 SPO	+5.5
	Robert Lunsford, CA	07:30-11:30	2 JPE, 19 SPO	+5.7
14	George Zay, CA	05:07-11:32	1 CAP, 1 JPE, 9 PER, 4 SAG, 38 SPO	+6.0
15	Robert Lunsford, CA	07:30-11:30	10 PER, 19 SPO	+6.3
16	Doug Kniffen, MO	02:45-03:47	7 SPO	+5.3
	Tim Cooper, South Africa	02:55-03:55	1 SDA, 9 SPO	+5.5
	Pierre Martin, Ontario	06:23-08:04	3 CAP, 1 PER, 7 SPO	+5.7
	Robert Lunsford, CA	07:30-11:30	1 CAP, 12 PER, 22 SPO	+6.5
	Tim Cooper, South Africa	17:20-20:16	2 CAP, 2 SAG, 1 SDA, 14 SPO	+5.6
17	Pierre Martin, Ontario	03:22-08:17	1 ACY, 4 CAP, 8 PER, 3 SDA, 23 SPO	+5.9
	George Zay, CA	04:43-11:36	4 CAP, 7 NDA, 14 PER, 3 SDA, 45 SPO	+6.0
	Robert Lunsford, CA	07:45-11:45	5 ACY, 5 CAP, 11 PER, 1 SDA, 51 SPO	+6.4
18	Pierre Martin, Ontario	03:27-08:16	6 CAP, 6 PER, 5 SDA, 24 SPO	+5.7
	Mark Davis, SC	04:24-08:30	3 CAP, 6 PER, 2 SDA, 29 SPO	+5.7
	George Zay, CA	04:48-11:35	5 CAP, 1 NDA, 7 PER, 4 SDA, 21 SPO	+6.1
	Robert Lunsford, CA	07:45-11:45	1 ACY, 1 CAP, 8 PER, 2 SDA, 36 SPO	+6.3
19	Mark Davis, SC	04:40-08:40	3 CAP, 3 PER, 2 SDA, 34 SPO	+5.9
20	Mark Davis, SC	04:32-07:41	3 CAP, 2 PER, 1 SDA, 19 SPO	+5.6
	Pierre Martin, Ontario	04:33-08:00	3 CAP, 2 ACY, 8 PER, 8 SDA, 19 SPO	+5.9
	Wayne Hally, NJ	05:43-08:15	3 PER, 1 SDA, 10 SPO	+5.8
	Peter Gural, MD	05:52-08:30	4 PER, 19 SPO	+5.5
21	Peter Gural, MD	02:25-04:38	1 PER, 10 SPO	+6.0
	Pierre Martin, Ontario	04:10-07:46	6 CAP, 1 ACY, 8 PER, 6 SDA, 17 SPO	+6.0
	Wayne Hally, NJ	05:35-08:30	1 CAP, 2 PER, 1 SDA, 11 SPO	+5.4
	Richard Taibi, MD	05:36-07:36	5 SPO	+6.0
	Lew Gramer, MA	06:30-08:40	3 ACY, 1 NDA, 2 ODR, 5 PER, 20 SPO	+6.7
22	Pierre Martin, Ontario	03:08-07:26	6 CAP, 10 PER, 4 SDA, 16 SPO	+6.0
23	Pierre Martin, Ontario	03:41-06:49	2 CAP, 3 PER, 3 SDA, 13 SPO	+5.9
24	Pierre Martin, Ontario	04:35-08:10	4 CAP, 7 PER, 9 SDA, 23 SPO	+5.7
27	Richard Taibi, MD	07:03-08:34	4 PER, 3 SDA, 12 SPO	+6.0
28	John Penner, CA	07:52-10:37	6 SDA, 2 SPO	+4.8
Aug 03	Graham Wolf, New Zeal.	14:00-18:00	3 CAP, 1 PAU, 7 SDA, 12 SPO	+4.5
04	Neil Bone, England	21:35-22:45	4 PER, 5 SPO	+5.3
	Graham Wolf, New Zeal.	09:00-12:00	2 CAP, 1 PAU, 5 SDA, 8 SPO	+4.5
06	Doug Kniffen, MO	03:15-04:35	1 CAP, 1 PER, 10 SPO	+5.3
	George Gliba, MD	06:41-07:42	1 NDA, 2 PER, 5 SPO	+5.0
	Peter Detterline, UT	10:00-11:00	9 PER, 2 UPG, 2 SPO	+5.5
07	Doug Kniffen, MO	02:48-04:00	15 SPO	+6.0
	Graham Wolf, New Zeal.	09:00-15:00	4 CAP, 2 PAU, 7 SDA, 25 SPO	+4.5
	Neil Bone, England	21:40-23:40	19 PER, 4 SPO	+5.2
08	Robert Lunsford, CA	06:00-12:00	2 CAP, 3 KCG, 4 NDA, 39 PER, 7SDA, 1 UPG, 45 SPO	+6.0
	Peter Detterline, AZ	09:00-10:00	7 PER, 5 UPG, 2 SPO	+5.3; 30% cloudy

Table 1 continued on pp. 63-69 with notes on p. 69.

Table 1—Continued.

1996 UT Date	Observer and Location	Universal Time	Number and Type*of Meteors Seen	Comments (+N = Limiting Magnitude)
Aug 08	Graham Wolf, New Zeal.	09:00-12:00	1 CAP, 3 SDA, 14 SPO	+4.6
09	Mark Davis, SC	02:00-06:24	3 CAP, 3 NDA, 1 KCG, 9 PER, 4 SDA, 35 SPO	+5.6
	Brian Simmons, FL	05:00-05:30	2 PER, 8 SPO	+5.5
	Karl Simmons, FL	05:00-05:30	2 PER, 4 SPO	+5.7
	Robert Hays, IL	06:00-08:00	1 KCG, 31 PER, 13 SPO	+6.5
	Robert Lunsford, CA	06:00-12:00	2 CAP, 6 KCG, 8 NDA, 63 PER, 9 SDA, 38 SPO	+6.2
	Graham Wolf, New Zeal.	15:00-18:00	1 CAP, 2 SDA, 16 SPO	+4.6
10	Mark Davis, SC	02:00-09:00	2 CAP, 1 KCG, 2 NDA, 23 PER, 9 SDA, 48 SPO	+5.7
	George Zay, CA	04:26-11:42	3 CAP, 8 KCG, 3 NDA, 49 PER, 9 SDA, 3 SIA, 26 SPO	+6.0
	Robert Hays, IL	06:00-08:00	2 KCG, 1 NDA, 41 PER, 15 SPO	+6.7
	Robert Lunsford, CA	06:00-12:00	5 NDA, 57 PER, 4 SDA, 30 SPO	+6.3
	V. Giovannone, NY	07:38-08:38	4 PER, 1 SPO	+5.0
	Peter Detterline, AZ	08:00-10:00	36 PER, 8 UPG, 12 SPO	+5.9
	Jim Bedient, HI	10:20-12:20	5 NIA, 11 PER, 21 SPO	+6.0
	Graham Wolf, New Zeal.	16:00-18:00	1 SDA, 8 SPO	+4.4
11	Mark Davis, SC	02:00-09:00	4 CAP, 2 KCG, 4 NDA, 60 PER, 8 SDA, 61 SPO	+5.7
	Peter Gural, VT	02:03-03:53	3 PER, 11 SPO	+5.3
	Wayne Hally, NJ	02:30-09:30	3 KCG, 46 PER, 47 SPO	+5.2
	Kevin Kilkenny, NJ	03:20-09:00	1 KCG, 39 PER, 36 SPO	+5.1
	Lew Gramer, FL	04:17-05:40	2 CAP, 2 KCG, 2 NDA, 1 PAU, 9 PER, 2 SDA, 1 SIA, 7 SPO	+6.8
	George Gliba, WV	04:24-08:15	9 NDA, 66 PER, 1 PAU, 2 SDA, 1 UPG, 8 XPR, 24 SPO	+6.3
	Peter Gural, VT	04:34-05:15	8 PER, 6 SPO	+5.8
	George Zay, CA	04:35-11:54	2 CAP, 1 KCG, 2 NDA, 95 PER, 15 SDA, 1 SIA, 59 SPO	+6.0
	Richard Taibi, MD	04:42-08:08	1 CAP, 36 PER, 1 SDA, 12 SPO	+5.8
	Thom Morgan, NC	05:16-09:27	5 KCG, 21 PER, 1 SPO	+5.5
	Robert Lunsford, CA	06:00-12:00	3 CAP, 1 KCG, 2 NDA, 145 PER, 5 SDA, 77 SPO	+6.3
	V. Giovannone, NY	06:24-07:06	2 PER, 2 SPO	+5.0; 35% cloudy
	Roger Venable, GA	06:48-07:48	22 PER, 10 SPO	+6.0; 5% cloudy
	Michael Morrow, HI	07:15-09:15	1 PAU, 5 PER, 1 SDA, 9 SPO	+6.0
	Jim Bedient, HI	07:15-10:00	8 PER, 22 SPO	+6.5
	Wes Stone, OR	07:53-10:36	89 PER, 35 SPO	+6.5
	Tom Giguere, HI	08:13-10:00	2 NDA, 5 PER, 17 SPO	+6.0
11/12	Tim Cooper, South Africa	22:30-02:23	4 BCE, 3 NDA, 5 NIA, 5 PER, 2 PAU, 7 SDA, 2 SIA, 25 SPO	+5.6
12	Tom McEwan, Scotland	00:00-02:00	61 PER, 11 SPO	+5.6
	Detlef Koschny, Germany	00:21-02:14	2 KCG, 2 NDA, 104 PER, 12 SPO	+5.5
	Tom McEwan, Scotland	02:15-03:00	15 PER, 3 SPO	+5.0
	George Zay, CA	04:00-12:04	12 CAP, 2 KCG, 4 NIA, 1 NDA, 206 PER, 16 SDA, 8 SIA, 25 SPO	+6.0
	Lew Grammar, MA	04:07-10:10	4 CAP, 13 NDA, 6 NIA, 1 PAU, 172 PER, 2 KCG, 9 SDA, 1 SIA, 80 SPO	+7.3
	Kevin Kilkenny, NJ	04:15-07:50	5 KCG, 41 PER, 26 SPO	+5.3
	Neil Kirsten, CA	04:37-06:00	11 PER	*n.a.*
	David Holman, CA	04:40-10:12	48 PER, 24 SPO	+6.2
	Wes Stone, OR	04:46-06:07	46 PER, 10 SPO	+6.3
	Elisabeth Shepard, CA	04:50-07:10	42 PER, 18 SPO	+6.0
	Robert Hays, IL	05:00-06:00	1 KCG, 40 PER, 8 SPO	+6.7
	Tim Printy, FL	05:00-08:47	4 KCG, 4 NDA, 73 PER, 10 SPO	+6.3
	Ray Cash, CA	05:30-06:50	21 PER, 7 SPO	+5.7
	Ray Berg, NE	05:49-06:52	40 PER, 12 SPO	+6.2
	Peter Detterline, TX	06:00-10:00	152 PER, 8 UPG, 20 SPO	+6.0
	Robert Lunsford, CA	06:00-12:00	4 CAP, 4 KCG, 4 NDA, 208 PER, 5 SDA, 67 SPO	+6.4
	Wes Stone, OR	06:23-07:35	57 PER, 17 SPO	+6.4
	Robert Togni, UT	06:25-11:10	4 NDA, 91 PER, 5 SPO	+6.0

Table 1 continued on pp. 64-69 with notes on p. 69.

Table 1—Continued.

1996 UT Date	Observer and Location	Universal Time	Number and Type* of Meteors Seen	Comments (+N = Limiting Magnitude)
Aug 12	Robert Hays, IL	07:00-09:00	88 PER, 18 SPO	+6.7
	Norman McLeod, FL	07:26-09:51	1 CAP, 1 KCG, 69 PER, 11 SPO	+6.8; 10% cloudy
	Diana Rosenblum, CA	07:30-07:57	19 PER, 1 SPO	+5.0
	Tien Huynh-Dinh, CA	07:30-07:57	19 PER, 1 SPO	+5.0
	Doug Slauson, IA	07:40-09:40	57 PER, 9 SPO	+5.5
	Ray Berg, NE	07:55-08:55	30 PER, 14 SPO	+6.1
	Ron Rosenwald, TX	08:00-10:05	55 PER, 9 SPO	+5.2; 30% cloudy
	Wes Stone, OR	08:02-09:28	105 PER, 18 SPO	+6.5
	Mark Gingrich, CA	08:30-10:00	53 PER, 17 SPO	+6.6; 25% cloudy
	Michael Morrow, HI	08:30-13:00	4 NIA, 43 PER, 41 SPO	+6.5
	John Penner, CA	08:41-10:36	39 PER, 1 SPO	+5.8
	Tom Giguere, HI	09:09-13:00	4 NIA, 86 PER, 1 UPG, 53 SPO	+5.5; 10% cloudy
	Wes Stone, OR	09:28-11:00	128 PER, 21 SPO	+6.5
	Jim Bedient, HI	09:30-14:30	3 NIA, 127 PER, 51 SPO	+6.5
	Graham Wolf, New Zeal.	10:00-18:00	4 NDA, 2 NIA, 29 SPO	+4.6
	J. Kenneth Eakins, CA	10:50-11:50	19 PER, 3 SPO	+5.1
	Tom McEwan, Scotland	23:00-24:00	23 PER, 4 SPO	+5.6
13	Tom McEwan, Scotland	00:00-01:00	19 PER, 4 SPO	+5.8; 10% cloudy
	Neil Bone, England	00:35-03:15	51 PER, 15 SPO	+5.4
	Doug Kniffen, MO	02:30-03:34	13 PER, 7 SPO	+6.0
	Lloyd Overcash, TX	02:57-10:33	94 PER, 64 SPO	+6.5
	Louis Binder, TX	02:57-10:33	136 PER, 22 SPO	+6.5
	David Swann, OK	04:00-09:00	2 NDA, 47 PER, 3 UPG, 33 SPO	+6.0
	Doug Kniffen, MO	04:20-05:30	30 PER, 11 SPO	+6.0
	Kristopher Court, UT	04:30-06:30	27 PER, 4 SPO	+6.0
	Daniel Simmons, FL	04:31-05:31	7 PER, 3 SPO	+5.5
	Brian Simmons, FL	04:35-05:40	13 PER, 10 SPO	+5.5
	Karl Simmons, FL	04:38-05:40	12 PER	+5.8
	John Glover, IL	05:00-06:00	17 PER, 5 SPO	+5.2
	Ray Berg, NE	05:11-06:11	15 PER, 4 SPO	+4.4; 30% cloudy
	Richard Schmude, GA	05:24-06:24	2 NDA, 10 PER, 1 SPO	+4.5
	Robert Hays, IL	06:00-08:00	62 PER, 20 SPO	+6.6; 5% cloudy
	Elsa Granados, CA	07:30-08:30	24 PER, 4 SPO	+5.2
	D. Louderback, WA	07:30-08:33	6 PER	*n.a.*
	Jung Suk Pak, CA	07:31-08:31	22 PER, 14 SPO	+5.2
	Ray Cash, CA	07:42-08:44	24 PER, 6 SPO	+6.0
	Carl Miller, CA	07:55-09:05	25 PER, 4 SPO	+5.3; 20% cloudy
	Robert Lunsford, CA	08:00-12:00	1 CAP, 2 NDA, 107 PER, 7 SDA, 40 SPO	+6.3
	Graham Wolf, New Zeal.	10:00-17:00	2 NDA, 1 NIA, 24 SPO	+4.4
	Neil Bone, England	22:00-24:00	16 PER, 4 SPO	+5.4
14	Robert Hays, IL	05:00-06:00	1 KCG, 19 PER, 7 SPO	+6.2
	Wayne Hally, NJ	05:24-06:50	1 KCG, 8 PER, 11 SPO	+5.6
	Kristopher Court, UT	05:45-07:40	29 PER, 10 SPO	+6.0
	Norman McLeod, FL	06:26-09:50	1 CAP, 1 KCG, 5 NDA, 72 PER, 21 SPO	+7.3
	Wayne Hally, NJ	07:10-08:51	2 KCG, 8 PER, 1 UPG, 11 SPO,	+5.5
	Lloyd Overcash, TX	07:19-08:25	26 PER, 1 SPO	+6.5
	Louis Binder, TX	07:19-08:25	26 PER, 1 SPO	+6.5
	Robert Lunsford, CA	08:00-12:00	1 CAP, 1 KCG, 5 NDA, 69 PER, 3 SDA, 3 SIA, 42 SPO	+6.2
	Richard Schmude, GA	09:10-09:25	3 NDA, 4 PER	+4.5
15	Kristopher Court, UT	05:30-06:55	25 PER, 12 SPO	+6.0
	Neil Bone, England	22:00-23:30	5 PER, 2 SPO	+5.2
17	Ray Berg, NE	08:12-09:15	16 PER, 9 SPO	+5.9
	Graham Wolf, New Zeal.	10:00-17:00	2 NDA, 3 NIA, 30 SPO	+4.5
18	Graham Wolf, New Zeal.	10:00-14:00	1 NDA, 3 NIA, 13 SPO	+4.4
	Koen Miskotte, Netherl.	20:55-22:30	3 KCG, 3 NIA, 3 PER, 9 SPO	+5.9
	Neil Bone, England	21:30-23:30	3 PER, 13 SPO	+5.6
18/19	Marco Langbroek, Netherl.	21:08-02:50	6 KCG, 10 PER, 69 SPO	+6.4
19	Graham Wolf, New Zeal.	10:00-14:00	1 NDA, 4 NIA, 17 SPO	+4.6
19/20	Marco Langbroek, Netherl.	20:45-02:45	5 KCG, 17 PER, 105 SPO	+6.6
20	Graham Wolf, New Zeal.	10:00-17:00	1 NDA, 6 NIA, 33 SPO	+4.5
	Neil Bone, England	21:35-23:05	2 PER, 8 SPO	+5.5
21	Robert Lunsford, CA	08:00-12:00	1 KCG, 7 NDA, 2 NIA, 13 PER, 6 SDA, 40 SPO	+6.6

Table 1 continued on pp. 65-69 with notes on p. 69.

Table 1—Continued.

1996 UT Date	Observer and Location	Universal Time	Number and Type*of Meteors Seen	Comments (+N = Limiting Magnitude)
Aug 21	Graham Wolf, New Zeal.	10:00-15:00	6 NIA, 20 SPO	+4.5
25	Lew Gramer, MA	07:00-08:55	3 NDA, 2 NIA, 5 PER, 4 SPO	+5.2; 10% cloudy
Sep 07	Thom Morgan, NC	07:56-11:15	7 DAU, 9 SPO	+5.6
	Graham Wolf, New Zeal.	11:00-17:30	1 SPI, 14 SPO	+4.5
08	George Gliba, WV	05:30-06:30	3 DAU, 2 KCG, 2 SPI, 2 ATR, 11 SPO	+6.2
09	Graham Wolf, New Zeal.	11:00-17:00	1 SPI, 33 SPO	+4.7
10	Robert Lunsford, CA	07:30-12:30	9 DAU, 3 SPI, 39 SPO	+6.4
	Graham Wolf, New Zeal.	11:00-17:00	1 SPI, 31 SPO	+4.5
11	Doug Kniffen, MO	03:40-04:50	9 ATR, 11 SPO	+6.0
	Robert Lunsford, CA	08:30-12:30	7 DAU, 47 SPO	+6.3
	Robert Togni, AR	09:25-09:55	*(none seen)*	+5; 30% cloudy
	Graham Wolf, New Zeal.	11:00-17:00	2 SPI, 34 SPO	+4.5
12	George Gliba, WV	04:34-05:35	1 DAU, 3 SPI, 2 ATR, 4 SPO	+5.4
	George Gliba, WV	06:28-08:31	2 DAU, 3 SPI, 2 ATR, 16 SPO	+5.8
	Robert Togni, AR	07:21-08:21	1 ATR, 3 SPO	+5.1; 30% cloudy
	Robert Lunsford, CA	08:30-12:30	8 DAU, 1 SPI, 57 SPO	+6.4
13	Robert Lunsford, CA	08:00-12:00	4 DAU, 3 SPI, 35 SPO	+6.4
	Joseph Assmus, CA	08:00-10:30	3 ATR, 3 DAU, 5 SPI, 18 SPO	+6.0
14	Mark Davis, SC	05:30-09:00	3 ATR, 20 SPO	+5.9
	Richard Taibi, SC	06:10-08:40	2 ATR, 1 SPI, 14 SPO	+6.0
	Peter Gural, VA	06:55-08:30	1 DAU, 12 SPO	+5.7
15	Peter Detterline, AZ	03:00-05:00	9 ATR, 4 DAU, 9 SPO	+6.1
	Kevin Kilkenny, NJ	04:00-06:30	3 ATR, 1 DAU, 8 SPO	+6.0
16	Mark Davis, SC	06:24-07:12	1 DAU, 7 SPO	+5.6
	Graham Wolf, New Zeal.	11:00-17:00	3 SPI, 34 SPO	+4.7
17	Graham Wolf, New Zeal.	11:00-17:00	3 SPI, 34 SPO	+4.6
19	Pierre Martin, Ontario	07:03-08:05	1 DAU, 1 KAQ, 3 SPI, 3 SPO	+5.8
	Robert Lunsford, CA	07:30-12:30	7 DAU, 2 SPI, 26 SPO	+6.5
	Robert Togni, AR	08:15-09:17	1 SPI, 3 ATR, 1 SPO	+5.0
	Graham Wolf, New Zeal.	11:00-17:00	5 SPI, 32 SPO	+4.7
20	Mark Davis, SC	07:30-09:00	1 DAU, 1 SPI, 7 SPO	+5.7
	Graham Wolf, New Zeal.	11:00-17:00	10 SPI, 28 SPO	+4.5
21	Mark Davis, SC	04:00-08:00	4 DAU, 4 SPI, 30 SPO	+5.3
	Richard Taibi, MD	04:29-07:00	2 DAU, 1 KAQ, 1 SPI, 13 SPO	+5.8
	Wayne Hally, NJ	05:55-09:47	3 DAU, 2 SPI, 31 SPO	+5.5
	Pierre Martin, Ontario	06:24-07:50	7 DAU, 2 SOR, 1 SPI, 7 SPO	+5.7
	Kristopher Court, UT	08:47-10:00	19 SPO	+5.0
	Graham Wolf, New Zeal.	11:00-17:00	3 SPI, 31 SPO	+4.7
22	Graham Wolf, New Zeal.	11:00-17:00	2 SPI, 33 SPO	+4.5
Oct 04	Wayne Hally, NJ	01:55-03:43	7 SPO	+5.4
	Kevin Kilkenny, NJ	05:45-07:45	9 SPO	+5.6
05	Graham Wolf, New Zeal.	14:00-17:00	2 NTA, 6 ORI, 1 STA, 11 SPO	+5.8
06	Pierre Martin, Ontario	03:56-04:56	3 SPO	+5.9
	Graham Wolf, New Zeal.	14:00-17:00	3 NTA, 6 ORI, 2 STA, 13 SPO	+5.9
07	Robert Lunsford, CA	09:00-12:00	1 NTA, 2 SOR, 1 STA, 24 SPO	+6.6
08	Robert Lunsford, CA	07:30-12:30	3 DAU, 6 NTA, 6 ORI, 4 SOR, 8 STA, 38 SPO	+6.5
09	Robert Lunsford, CA	08:30-12:30	2 NTA, 6 ORI, 1 SOR, 2 STA, 44 SPO	+6.6
10	Mark Davis, SC	05:49-06:49	3 ORI, 3 STA, 30 SPO	+5.7
	Graham Wolf, New Zeal.	14:00-17:00	2 NTA, 9 ORI, 1 STA, 14 SPO	+5.8
11	Mark Davis, SC	06:30-08:30	1 NTA, 2 ORI, 1 STA, 23 SPO	+5.8
	Pierre Martin, Ontario	07:29-08:29	3 DAU, 2 OAR, 2 ORI, 5 SPO	+6.0
	Kristopher Court, UT	08:18-10:02	28 SPO	+6.0
12	Mark Davis, SC	06:33-08:33	1 NTA, 5 ORI, 2 STA, 17 SPO	+5.7
	Wayne Hally, NJ	06:55-09:30	1 EGE, 1 NTA, 2 ORI, 2 STA, 11 SPO	+5.6
	Norman McLeod, FL	07:01-08:03	4 ORI	+7.2
13	George Gliba, WV	05:26-06:26	1 EGE, 1 NTA, 1 OAR, 2 ORI, 1 STA, 8 SPO	+6.2
	Michael Morrow, HI	07:45-09:00	1 ORI, 3 SPO	+6.0
14	Graham Wolf, New Zeal.	14:00-17:00	3 NTA, 14 ORI, 1 STA, 14 SPO	+5.9
15	George Zay, CA	05:00-12:34	8 EGE, 8 NTA, 10 ORI, 11 STA, 33 SPO	+6.0
	Wayne Hally, NJ	05:08-08:35	1 NTA, 6 ORI, 2 STA, 23 SPO	+5.7
	Pierre Martin, Ontario	05:38-07:30	4 OAR, 4 ORI, 1 SOR, 4 SPO	+6.1

Table 1 continued on pp. 66-69 with notes on p. 69.

Table 1—Continued.

1996 UT Date	Observer and Location	Universal Time	Number and Type*of Meteors Seen	Comments (+N = Limiting Magnitude)
Oct 15	Kevin Kilkenny, NJ	06:15-08:35	2 EGE, 5 ORI, 23 SPO	+5.6
	Robert Lunsford, CA	09:15-12:15	5 EGE, 2 NTA, 8 ORI, 3 STA, 4 SPO	+6.5
	Michael Morrow, HI	13:00-14:30	1 ORI, 24 SPO	+6.0
	Graham Wolf, New Zeal.	14:00-17:00	3 NTA, 15 ORI, 2 STA, 13 SPO	+6.1
16	Robert Togni, AR	04:48-05:48	3 ORI, 2 SPO	+5.4
	George Zay, CA	05:00-12:44	5 EGE, 6 NTA, 18 ORI, 10 STA, 31 SPO	+6.0
	Norman McLeod, FL	06:26-08:02	6 ORI, 6 STA	+7.3
	Robert Lunsford, CA	09:45-12:45	4 EGE, 2 NTA, 10 ORI, 2 STA, 30 SPO	+6.6
	Graham Wolf, New Zeal.	11:00-17:00	6 NTA, 25 ORI, 3 STA, 28 SPO	+5.7
17	Pierre Martin, Ontario	06:17-08:18	1 EGE, 4 OAR, 6 ORI, 4 SPO	+6.0
	Robert Togni, AR	10:48-11:48	3 ORI, 2 SPO	+5.4
18	George Zay, CA	05:51-12:45	6 EGE, 7 NTA, 20 ORI, 16 STA, 32 SPO	+6.0
	Pierre Martin, Ontario	08:16-09:38	1 EGE, 2 OAR, 5 ORI, 1 SOR, 6 SPO	+5.7
19	George Zay, CA	07:02-11:41	5 EGE, 6 NTA, 33 ORI, 5 STA, 20 SPO	+6.0
	David Swann, TX	08:35-10:35	1 EGE, 9 ORI, 2 STA, 17 SPO	+5.9
	Robert Togni, AR	10:04-10:50	5 ORI, 2 SPO	+5.1; 20% cloudy
20	Norman McLeod, FL	06:26-10:26	1 DAU, 1 EGE, 5 NTA, 78 ORI, 7 STA, 19 SPO	+7.4
	Robert Hays, IN	08:50-09:50	1 NTA, 21 ORI, 1 STA, 6 SPO	+6.2
	David Swann, TX	08:35-10:35	17 ORI, 3 EGE, 17 SPO	+6.1
	Graham Wolf, New Zeal.	14:00-17:00	3 NTA, 17 ORI, 2 STA, 16 SPO	+5.1
21	Norman McLeod, FL	06:26-10:00	2 EGE, 2 NTA, 69 ORI, 5 STA, 20 SPO	+7.4
	Robert Lunsford, CA	07:45-12:45	5 EGE, 1 NTA, 98 ORI, 6 STA, 29 SPO	+6.3
	Joseph Assmus, CA	08:40-12:40	8 EGE, 65 ORI, 2 STA, 36 SPO	+6.1
22	Norman McLeod, FL	07:26-10:26	3 EGE, 1 NTA, 55 ORI, 4 STA, 14 SPO	+7.3
	Robert Lunsford, CA	08:45-12:45	4 EGE, 2 NTA, 96 ORI, 6 STA, 33 SPO	+6.3
	Joseph Assmus, CA	08:50-12:50	4 EGE, 52 ORI, 6 STA, 41 SPO	+5.9
	Richard Schmude, GA	10:18-10:48	3 ORI, 1 SPO	+5.0
23	Norman McLeod, FL	08:26-10:45	3 EGE, 1 NTA, 46 ORI, 2 STA, 25 SPO	+7.4
	Robert Lunsford, CA	09:45-12:45	2 EGE, 2 NTA, 48 ORI, 3 STA, 23 SPO	+6.3
	Joseph Assmus, CA	10:02-11:02	2 EGE, 16 ORI, 1 STA, 5 SPO	+5.9
24	Norman McLeod, FL	09:02-10:02	17 ORI, 3 STA, 2 SPO	+7.0
28	Graham Wolf, New Zeal.	14:00-17:00	3 NTA, 8 ORI, 1 STA, 18 SPO	+5.2
29	Graham Wolf, New Zeal.	14:00-17:00	4 NTA, 4 ORI, 3 STA, 16 SPO	+5.2
31	Graham Wolf, New Zeal.	14:00-17:00	3 NTA, 5 ORI, 4 STA, 14 SPO	+5.1
Nov 03	Pierre Martin, Ontario	00:05-00:35	1 SPO	+5.7
04	Norman McLeod, FL	01:38-06:01	15 STA, 7 NTA, 13 SPO	+7.0
05	Norman McLeod, FL	04:22-07:02	1 LEO, 8 NTA, 12 STA, 19 SPO	+7.3
06	Norman McLeod, FL	04:21-08:00	6 LEO, 6 NTA, 6 STA, 23 SPO	+7.3
07	Norman McLeod, FL	04:22-07:42	1 LEO, 8 NTA, 1 PEG, 14 STA, 19 SPO	+7.4
	Robert Lunsford, CA	09:00-13:00	2 NTA, 2 STA, 16 SPO	+5.7
08	Norman McLeod, FL	04:26-08:29	4 LEO, 12 NTA, 11 STA, 27 SPO	+7.3
	Robert Lunsford, CA	10:00-13:00	6 NTA, 2 STA, 11 SPO	+5.7
09	George Zay, CA	06:00-13:12	3 LEO, 22 NTA, 9 STA, 31 SPO	+5.9
	Mark Davis, SC	06:01-08:15	5 LEO, 2 NTA, 3 STA, 23 SPO	+6.1
	Kristopher Court, UT	06:30-10:00	57 UNCLASSIFIED	+6.5
10	Norman McLeod, FL	05:26-09:38	5 LEO, 21 NTA, 7 STA, 30 SPO	+7.3
	Kristopher Court, UT	08:00-11:20	80 UNCLASSIFIED	+6.5
	Mark Davis, SC	08:04-10:00	4 LEO, 1 NTA, 1 STA, 11 SPO	+6.1
	Richard Taibi, MD	09:10-10:25	1 LEO, 2 NTA, 2 STA, 4 SPO	+5.3
11	Norman McLeod, FL	05:17-09:27	4 LEO, 8 NTA, 12 STA, 28 SPO	+7.3
	Wayne Hally, NJ	05:50-08:31	3 NTA, 2 STA, 17 SPO	+5.3
	Kevin Kilkenny, NJ	05:50-08:30	2 NTA, 13 SPO	+5.7
	George Zay, CA	*(not given)*	2 LEO, 12 NTA, 10 STA, 39 SPO	+5.9
	Mark Davis, SC	07:40-10:00	5 LEO, 6 NTA, 2 STA, 24 SPO	+6.1
	Michael Morrow, HI	09:45-11:15	17 SPO	+5.5
12	Jonathan Wojack, DE	02:00-02:20	*(none seen)*	+3.8; 30% cloudy
	George Zay, CA	*(not given)*	4 LEO, 23 NTA, 12 STA, 52 SPO	+6.0
	Michael Morrow, HI	08:30-09:30	1 SPO	+5.0
13	Mark Davis, SC	06:00-09:24	5 LEO, 10 NTA, 2 STA, 30 SPO	+6.3
	Norman McLeod, FL	05:26-10:36	3 LEO, 9 NTA, 2 STA, 15 SPO	+7.3
	Robert Lunsford, CA	09:45-12:45	7 LEO, 3 NTA, 2 STA, 26 SPO	+6.1

Table 1 continued on pp. 67-69 with notes on p. 69.

Table 1—Continued.

1996 UT Date	Observer and Location	Universal Time	Number and Type*of Meteors Seen	Comments (+N = Limiting Magnitude)
Nov 13	Jonathan Wojack, DE	11:00-11:45	4 SPO	+4.1; 20% cloudy
	Graham Wolf, New Zeal.	12:00-14:00	5 NTA, 8 SPO	+5.6
14	Marco Langbroek, Netherl.	02:20-05:17	9 LEO, 3 NTA, 39 SPO	+6.4
	Robert Hays, IL	06:50-08:50	4 LEO, 3 NTA, 1 STA, 17 SPO	+6.2
	Pierre Martin, Ontario	08:00-09:00	1 DER, 2 LEO, 3 SPO	+6.1
15	Jonathan Wojack, DE	01:15-02:33	2 NTA, 3 PEG, 5 SPO	+4.5
	Wayne Hally, NJ	08:15-10:33	1 AMO, 6 LEO, 2 NTA, 2 STA, 9 SPO	+5.1
	Richard Taibi, MD	08:43-10:19	1 LEO, 9 SPO	+5.4
	Graham Wolf, New Zeal.	12:00-16:00	4 LEO, 4 NTA, 21 SPO	+5.7
15/16	Marco Langbroek, Netherl.	23:58-02:24	16 LEO, 4 NTA, 2 STA, 85 SPO	+6.6
16	Jonathan Wojack, DE	00:00-01:00	5 SPO	+4.2
	Jonathan Wojack, DE	02:00-02:30	4 SPO	+4.2
	Mark Davis, SC	05:00-10:00	2 LEO, 2 NTA, 19 SPO	+5.9; 50% cloudy
	Peter Brown, Ontario	05:47-10:50	21 LEO, 2 NTA, 1 STA, 28 SPO	+6.0
	Lew Gramer, NH	07:40-09:15	15 LEO, 3 NTA, 1 STA, 25 SPO	+7.2
	Richard Taibi, MD	08:02-10:02	5 LEO, 3 NTA, 2 STA, 15 SPO	+6.0
	Norman McLeod, FL	08:25-08:35	*(none seen)*	+5.5
	Wayne Hally, NJ	09:09-10:39	15 LEO, 13 SPO	+5.2
	Norman McLeod, FL	09:30-10:05	*(none seen)*	+5.5
	Graham Wolf, New Zeal.	10:00-16:00	7 LEO, 5 NTA, 29 SPO	+5.6
16/17	Marco Langbroek, Netherl.	23:46-05:25	12 LEO, 7 NTA, 25 SPO	+6.7
17	Marc de Lignie, France	01:43-03:30	17 LEO, 1 NTA, 8 SPO	+6.1; 75% cloudy
	Mark Davis, SC	03:00-06:00	2 NTA, 3 STA, 28 SPO	+6; 25% cloudy
	Marco Langbroek, Netherl.	03:28-04:57	107 LEO, 2 NTA, 4 STA, 69 SPO	+6.4
	Orlando B. Sanchez, Canary Is.	03:50-06:10	18 AMO, 67 LEO, 3 NTA, 2 STA, 1 VEL, 93 SPO	+6.5
	Tom McEwan, Scotland	04:15-06:15	52 LEO, 1 NTA, 9 SPO	+5.7; 5% cloudy
	Peter Brown, Ontario	04:22-11:12	120 LEO, 9 NTA, 4 STA, 39 SPO	+6.3; 45% cloudy
	Nick Martin, Scotland	04:30-06:12	45 LEO, 2 NTA, 1 STA, 2 SPO	+6.0
	Cathy Hall, Ontario	04:50-11:00	139 LEO, 1 NTA, 51 SPO	+5.9
	Paola Gilardoni, Argentina	05:00-08:05	17 LEO, 25 SPO	*n.a.*
	Celina R. Cudiciotti, Argen.	05:00-08:05	19 LEO, 25 SPO	*n.a.*
	Adrian P. Arquiola, Argen.	05:00-08:05	17 LEO, 25 SPO	*n.a.*
	Natalia Risiglione, Argen.	05:00-08:05	16 LEO, 25 SPO	*n.a.*
	Damien Wacker, Argentina	05:00-08:05	20 LEO, 25 SPO	*n.a.*
	Peter Detterline, PA	05:00-10:00	84 LEO, 12 NTA, 6 SPO	+6.0
	Doug Love, MD	05:00-11:00	16 LEO, 5 SPO	+4.0
	Pierre Martin, Ontario	05:26-10:25	1 AMO, 83 LEO, 7 NTA, 2 STA, 13 SPO	+6.0
	Norman McLeod, FL	05:26-10:26	1 AMO, 125 LEO, 11 NTA, 3 STA, 30 SPO	+7.3
	John Sabia, PA	05:28-07:45	44 LEO, 14 SPO	+5.3
	Wayne Hally, NJ	05:30-10:40	3 AMO, 88 LEO, 6 NTA, 1 STA, 34 SPO	+5.3
	Peter Gural, VA	05:30-10:40	97 LEO, 5 NTA, 2 STA, 45 SPO	+6.0
	Brian Shulist, Ontario	05:40-09:50	5 AMO, 93 LEO, 11 NTA, 13 SPO	+6.4
	Marco Langbroek, Netherl.	05:42-05:52	10 LEO, 5 SPO	+6.2
	George Zay, CA	06:06-13:14	1 AMO, 89 LEO, 8 NTA, 8 STA, 24 SPO	+6.0
	Thom Morgan, NC	06:08-08:45	27 LEO, 10 SPO	+5.2
	Tim Printy, FL	06:13-10:40	94 LEO, 9 NTA, 5 STA, 13 SPO	+6.4
	Hedy M. Teidons, Argen.	06:25-08:00	13 LEO, 6 SPO	*n.a.*
	Carlos S. Sosa, Argentina	06:25-08:00	13 LEO, 4 SPO	*n.a.*
	Richard Taibi, MD	06:25-10:16	49 LEO, 1 NTA, 31 SPO	+6.1
	Frank Melillo, NY	06:30-08:00	40 LEO	+4.5
	Robert Lunsford, CA	06:30-13:30	3 AMO, 126 LEO, 14 NTA, 5 STA, 47 SPO	+6.3
	Lew Gramer, NH	06:45-09:05	57 LEO, 7 NTA, 3 STA, 18 SPO	+7.4
	Joseph Assmus, CA	06:45-10:00	29 LEO, 6 NTA, 2 STA, 17 SPO	+6.2
	George Gliba, WV	06:55-10:55	156 LEO, 6 STA, 62 SPO	+6.3
	Louis Binder, TX	08:54-11:10	11 LEO	+4.8
	Michael Morrow, HI	09:45-10:45	7 SPO	+6; 20% cloudy
	Phyllis Eide, HI	09:45-12:45	14 LEO, 15 SPO	+6; 10% cloudy
	Graham Wolf, New Zeal.	10:00-16:00	14 LEO, 4 NTA, 31 SPO	+5.7
	Michael Morrow, HI	11:15-12:45	15 LEO, 13 SPO	+6; 10% cloudy
	Joseph Assmus, CA	11:45-13:30	31 LEO, 5 NTA, 7 SPO	+6.0
17/18	Vladimir Lukic, Yugoslavia	23:33-02:33	8 LEO, 36 SPO	+5.3

Table 1 continued on pp. 68-69 with notes on p. 69.

Table 1—Continued.

1996 UT Date	Observer and Location	Universal Time	Number and Type*of Meteors Seen	Comments (+N = Limiting Magnitude)
Nov 18	Graham Beedie, Scotland	00:00-01:00	3 LEO, 8 SPO	+5.5
	Dragana Okolic, Yugo.	00:05-01:16	5 LEO, 1 NTA, 19 SPO	+5.4
	Sasa Nedeljkovic, Yugo.	00:10-02:11	5 LEO, 32 SPO	+5.7
	Dubravko Potkrajac, Yugo.	00:10-02:11	2 LEO, 31 SPO	+5.7
	Vesna Slavkovic, Yugo.	00:10-02:36	11 LEO, 21 SPO	+5.3
	Mila Popovic, Yugoslavia	00:10-02:36	8 LEO, 15 SPO	+5.0
	Jonathan Wojack, DE	00:35-01:30	2 NTA, 2 SPO	+4.0
	Marija Vucelja, Yugoslavia	00:50-02:25	13 LEO, 29 SPO	+6.0
	Iris Miljacki, Yugoslavia	00:50-02:30	14 LEO, 34 SPO	+5.4
	Irena Zivkovic, Yugoslavia	00:52-01:56	4 LEO, 12 SPO	+5.3
	George Zay, CA	07:19-13:11	25 LEO, 8 NTA, 5 STA, 31 SPO	+6.0
	Norman McLeod, FL	08:25-10:31	3 AMO, 19 LEO, 2 NTA, 15 SPO	+7.3
	Robert Lunsford, CA	10:15-13:15	1 AMO, 14 LEO, 18 SPO	+5.8
19	Vladimir Lukic, Yugoslavia	02:00-03:01	5 LEO, 20 SPO	+5.2
22	Marco Langbroek, Netherl.	03:53-05:20	7 AMO, 12 LEO, 1 STA, 26 SPO	+6.3
28	Jonathan Wojack, DE	00:29-01:07	3 SPO	+4.3
	Jonathan Wojack, DE	02:55-03:15	2 SPO	+4.2
29	Jonathan Wojack, DE	02:41-03:17	*(none seen)*	+4.2
30	Jonathan Wojack, DE	01:10-03:00	4 SPO	+4.5
Dec 04	Robert Lunsford, CA	08:35-13:35	11 HYD, 4 MON, 5 XOR, 45 SPO	+5.9
	Richard Schmude, GA	09:20-09:50	1 GEM, 1 SPO	+4.9
	Michael Morrow, HI	09:55-11:25	2 GEM, 17 SPO	+6.5
05	Michael Morrow, HI	07:00-08:30	1 GEM, 8 SPO	+7.0
08	Thom Morgan, NC	06:00-09:00	15 GEM, 9 SPO	+5.3
09	Norman McLeod, FL	06:09-10:56	7 COM, 1 DAR, 31 GEM, 8 HYD, 6 MON, 2 PUP, 46 SPO	+7.3
	Robert Togni, AR	06:20-07:05	1 COM, 5 GEM, 4 MON, 1 SPO	+5.7
10	Michael Boschat, N.Scotia	03:30-04:00	5 GEM	+5.0
	Richard Schmude, GA	04:53-05:23	3 GEM, 1 SPO	+5.5
	Robert Togni, AR	05:36-06:36	13 GEM, 2 SPO	+5.6
	Norman McLeod, FL	06:38-10:29	4 COM, 19 GEM, 2 HYD, 2 MON, 1 PUP, 1 XOR, 16 SPO	+7.3
11	Michael Boschat, N.Scotia	02:00-03:00	5 GEM	*n.a.*
	Robert Togni, AR	05:00-05:42	3 GEM, 1 XOR	+5.6
	Norman McLeod, FL	05:26-08:48	3 COM, 51 GEM, 11 HYD, 3 MON, 2 PUP, 1 XOR, 14 SPO	+7.3
	Mark Davis, SC	06:00-10:00	19 GEM, 7 HYD, 3 MON, 1 PUP, 53 SPO	+6.3
12	Norman McLeod, FL	04:26-08:08	2 COM, 122 GEM, 7 HYD, 4 MON, 3 XOR, 13 SPO	+7.3
	Peter Gural, AZ	06:35-08:30	43 GEM, 7 HYD, 13 SPO	+6.1
	Robert Togni, AR	06:43-07:35	16 GEM, 2 XOR, 2 SPO	+5.6
12/13	Vesna Slavkovic, Yugo.	22:11-00:40	33 GEM	+5.3
	Dragana Okolic, Yugo.	22:12-01:40	50 GEM	+5.8
	Marija Vucelja, Yugoslavia	22:13-01:39	62 GEM	+5.9
13	Sasa Nedeljkovic, Yugo.	00:20-02:20	34 GEM	+5.7
	D. Potkrajac, Yugoslavia	00:20-02:20	33 GEM	+5.7
	Tom McEwan, Scotland	00:55-02:55	73 GEM, 8 SPO	+5.8
	Mark Davis, SC	00:56-02:41	23 GEM, 1 XOR, 19 SPO	+6.1
	Javier Portero, Canary Is.	01:25-02:53	30 GEM, 2 SPO	*n.a.*
	Joseph Assmus, CA	03:00-08:00	126 GEM, 6 XOR, 52 SPO	+6.1
	Tom McEwan, Scotland	03:24-04:24	36 GEM, 7 SPO	+5.8
	Norman McLeod, FL	03:31-10:45	427 GEM	+7.3
	Peter Gural, AZ	04:00-05:40	52 GEM, 1 HYD, 18 SPO	+6.3
	Carl Miller, CA	04:40-06:50	69 GEM, 10 SPO	+5.7
	George Zay, CA	04:45-13:31	9 COM, 397 GEM, 8 HYD, 14 MON, 1 PUP, 42 SPO	+6.0
	Robert Lunsford, CA	05:00-14:00	8 COM, 551 GEM, 10 HYD, 5 MON, 5 XOR, 71 SPO	+6.3
	Michael Hann, TX	05:40-07:35	40 GEM, 1 SPO	+5.2
	Phyllis Eide, HI	07:00-12:15	46 GEM, 96 SPO	+6.0
	Jim Bedient, HI	07:30-09:30	41 GEM, 15 SPO	+6.5
	Michael Morrow, HI	07:30-09:30	26 GEM, 28 SPO	+6.5
	David Swann, TX	09:40-11:40	1 COM, 30 GEM, 6 SPO	+4.8

Table 1 continued on p. 69 with notes.

Table 1—Continued.

1996 UT Date	Observer and Location	Universal Time	Number and Type*of Meteors Seen	Comments (+N = Limiting Magnitude)
Dec 13	Peter Gural, AZ	09:50-11:30	150 GEM, 11 HYD, 28 SPO	+6.3
	John Penner, CA	10:10-12:02	112 GEM, 4 SPO	+5.7
	Michael Morrow, HI	10:15-12:15	73 GEM, 73 SPO	+6.5
	Jim Bedient, HI	10:30-12:15	89 GEM, 28 SPO	+6.5
	Joseph Assmus, CA	12:00-13:00	50 GEM, 1 XOR, 8 SPO	+6.1
13/14	Marco Langbroek, Netherl.	20:00-06:00	934 GEM, 25 HYD, 40 MON, 5 XOR, 253 SPO	+6.6
	Tim Cooper, South Africa	22:00-00:53	45 GEM, 1 HYD, 2 MON, 2 PUP, 3 XOR, 71 SPO	+5.2; 5% cloudy
	Felix Bettonvil, Netherl.	22:02-05:00	230 GEM, 1 MON, 36 SPO	+6.0
	Manuel Ruiz, Canary Is.	22:15-00:45	78 GEM, 27 SPO	+5.4
	Cis Verbeeck, Belgium	22:16-01:54	140 GEM, 57 SPO	+6.1
14	Mark Davis, SC	01:00-05:00	78 GEM, 5 MON, 1 PUP, 6 XOR, 52 SPO	+6.2
	Joseph Assmus, CA	02:00-05:00	56 GEM, 9 SPO	+6.3
	Robert Lunsford, CA	02:00-11:00	2 COM, 263 GEM, 4 HYD, 3 MON, 5 XOR, 38 SPO	+6.4
	Natalia Risiglione, Argen.	02:20-06:40	41 GEM, 12 SPO	+5.0
	Celina Cudiciotti, Argen.	02:20-06:40	52 GEM, 16 SPO	+5.0
	Damien Wacker, Argentina	02:20-06:40	30 GEM, 2 SPO	+5.0
	Dante Militano, Argentina	02:20-06:40	24 GEM, 3 SPO	+5.0
	Adrian Arquiola, Argentina	02:20-06:40	34 GEM, 7 SPO	+5.0
	Carlos Sosa, Argentina	02:20-06:40	28 GEM	+5.0
	Paola Gilardoni, Argentina	02:20-06:40	12 GEM, 10 SPO	+5.0
	Norman McLeod, FL	02:43-04:26	1 COM, 241 GEM, 6 HYD, 4 MON, 35 SPO	+7.3
	Tim Printy, FL	03:00-08:30	228 GEM, 12 SPO	+6.5
	Thom Morgan, NC	05:00-09:00	48 GEM, 59 SPO	+5.3
	George Zay, CA	05:00-13:30	7 COM, 266 GEM, 10 HYD, 13 MON, 1 PUP, 57 SPO	+6.0
	Mark Davis, SC	05:15-07:15	2 COM, 53 GEM, 4 HYD, 6 MON, 4 PUP, 2 XOR, 31 SPO	+6.1
	Martin Barrile, Argentina	06:00-07:20	25 GEM	*n.a.*
	Gregory Robinson, AL	06:30-07:30	49 GEM, 4 SPO	+5.0
	Phyllis Eide, HI	07:00-08:15	15 GEM, 10 SPO	+6.2; 20% cloudy
	Michael Morrow, HI	07:00-08:15	13 GEM, 11 SPO	+6.5
	Mark Davis, SC	07:20-10:00	5 COM, 44 GEM, 8 HYD, 6 MON, 5 PUP, 3 XOR, 37 SPO	+6.1
	Robert Hays, IL	07:51-08:51	27 GEM, 5 SPO	+5.3
	Wes Stone, OR	08:06-11:10	36 GEM, 4 HYD, 2 XOR, 22 SPO	+5.8
	Joseph Assmus, CA	09:00-13:00	142 GEM, 36 SPO	+6.2
15	Gregg Pasterick, OH	03:40-05:44	16 GEM, 8 SPO	+6.0
	Robert Lunsford, CA	06:00-11:00	4 COM, 26 GEM, 29 SPO	+6.2
	Norman McLeod, FL	07:26-11:04	10 COM, 1 DAR, 20 GEM, 6 HYD, 4 MON, 1 PUP, 2 XOR, 26 SPO	+7.0
16	Norman McLeod, FL	07:26-10:56	4 COM, 9 GEM, 5 HYD, 2 MON, 1 PUP, 27 SPO	+7.0
21	Marco Langbroek, Netherl.	04:00-05:54	3 COM, 1 URS, 37 SPO	+6.3
22	Marco Langbroek, Netherl.	04:30-06:15	2 COM, 13 URS, 2 XOR, 28 SPO	+6.3
	Norman McLeod, FL	09:51-11:12	1 COM, 1 HYD, 2 PUP, 5 URS, 11 SPO	+7.0

***Meteor Shower Abbreviations**

ACY	Alpha Cygnids
AMO	Alpha Monocerotids
ATR	Aries-Triangulids
BCE	Beta Cetids
CAP	Alpha Capricornids
DAR	Delta Arietids
DAU	Delta Aurigids
DER	Delta Eridanids
EGE	Epsilon Geminids
GEM	Geminids
HYD	Sigma Hydrids
JPE	July Pegasids
KAQ	Kappa Aquarids
KCG	Kappa Cygnids
LEO	Leonids
MON	Monocerotids
NDA	North Delta Aquarids
NIA	North Iota Aquarids
NTA	Northern Taurids
OAR	October Arietids
ODR	Omicron Draconids
ORI	Orionids
PAU	Piscis Austrinids
PEG	November Pegasids
PER	Perseids
PUP	Puppid-Velids
SAG	Sagittarids
SDA	South Delta Aquarids
SIA	South Iota Aquarids
SOR	Sigma Orionids
SPI	Piscids
SPO	Sporadics
STA	Southern Taurids
UPG	Upsilon Pegasids
URS	Ursids
VEL	Velids
XOR	Chi Orionids
XPR	Chi Perseids

Observations of Possible Inhomogeneities in the Perseid Stream in 1997

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Introduction

In the early morning hours of August 12, 1997 (local time) I observed the Perseid Meteor Shower from the southern Laramie Range near Laramie, Wyoming, latitude 41°23' N, longitude 105°26' W, at an elevation of 8075 feet above sea level, under near-perfect conditions. The observing site was a pull-off on a little-used mountain road. From 06h38m to 10h45m on 1997 Aug 12 UT, 270 Perseid meteors were recorded. Time, magnitude, and direction were recorded for each meteor in an attempt to resolve possible small-scale inhomogeneities in the meteor stream.

Observing Conditions

After moonset (about 06h30m UT) the sky was clear and virtually cloudless throughout the entire observing session; scattered high clouds near the southeast horizon close to dawn were not considered a factor. The treeless skyline was less than 20° above horizontal in all directions. The limiting magnitude was determined to be about +6.5 using the stars of the Little Dipper, a condition that held at least until the onset of dawn at 10h25m, after which a steady drop in limiting magnitude was recorded (see comments, *Figure 3d,* p. 71). The Zodiacal Light was first noted on the eastern horizon at 09h15m UT (see *Figure 3c,* p. 71) and it gradually spread up along the ecliptic to a length of 50° at dawn: the effect of this light was felt to be minimal. Two cars went by; one at 07h16m and a more inquisitive one at 09h55m, which stopped with its headlights on near me for about a minute (noted in *Figure 3d*). I shielded my eyes both times and the effect of the second car may have been minimal to moderate for a minute or two.

Observing and Recording Technique

For the observing sessions I used a reclining lawn chair and a cassette tape recorder. The chair faced east and the center of the field of view was located between the zenith and the radiant point, which moved southeastward during the evening (see *Figure 1,* upper right). There were four observing sessions between 06h38m and 10h45m UT, each lasting 55 to 60 minutes with 5- to 10-minute breaks in between. During each session my eyes were continuously on the sky, and mostly aimed at the center of the field (*Figure 1*). I was the only person present.

With the tape running the starting time was recorded, using a digital watch set to the USNO master clock, and then each meteor was noted with respect to category (Perseid or non-Perseid), magnitude, and direction from radiant. The latter was recorded using a 360° coordinate system centered on the radiant and subdivided into 30° increments, with the direction toward Polaris (north) as 0° and

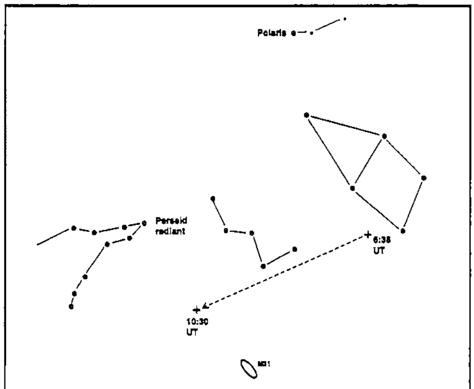


Figure 1. Location and movement of center of field of view during the night of observation.

proceeding clockwise around the radiant (see *Figure 2,* below). At the end of each session the ending time was recorded.

Later the recording for each session was played back concurrently with a timer. For each meteor the time elapsed since the start of recording was noted, and the resulting UT calculated. The position of each meteor on a horizontal time scale was then plotted as a vertical line, with the length of the line corresponding to magnitude (see *Figure 3*). The direction for each meteor was entered into a plotting program designed for geologic data (*Stereonet,* by Richard Allmendinger, Cornell University), and "rose diagrams" of meteor direction were generated for each observing session (see *Figure 4,* p. 72).

Results

In 224 minutes of observing, 270 Perseid meteors were recorded (shown in *Figure 3*), along with 43 non-Perseids (not shown in *Figure 3*). The main peak of activity appeared to occur between 08h30m and 09h30m UT (see *Figure 3b* and *3c*),

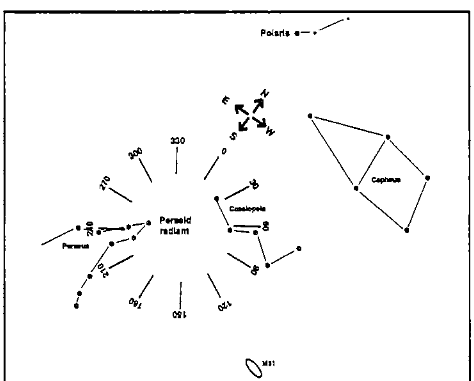


Figure 2. Radiant coordinate system (shown by numbered lines) used for Perseid meteor directions.

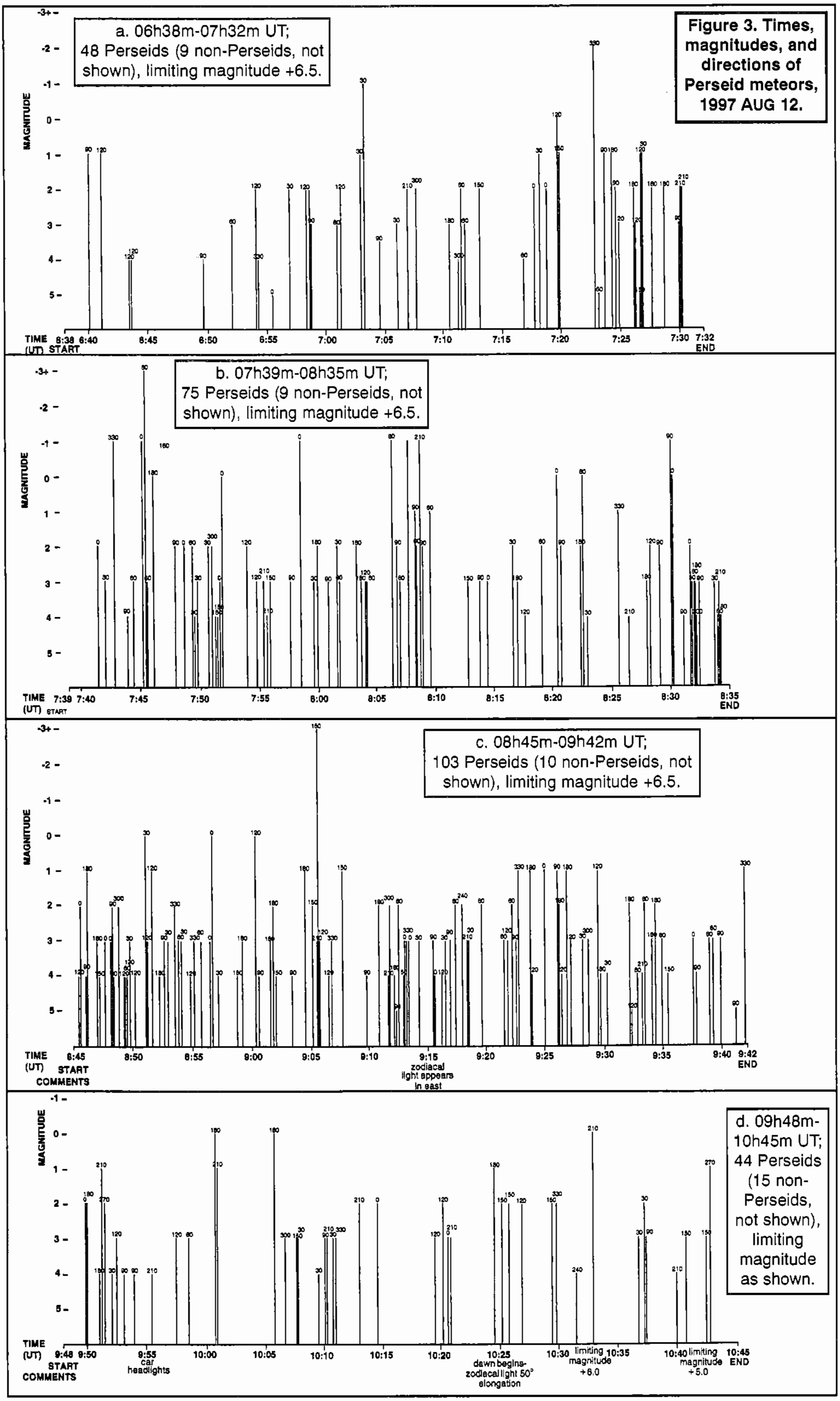
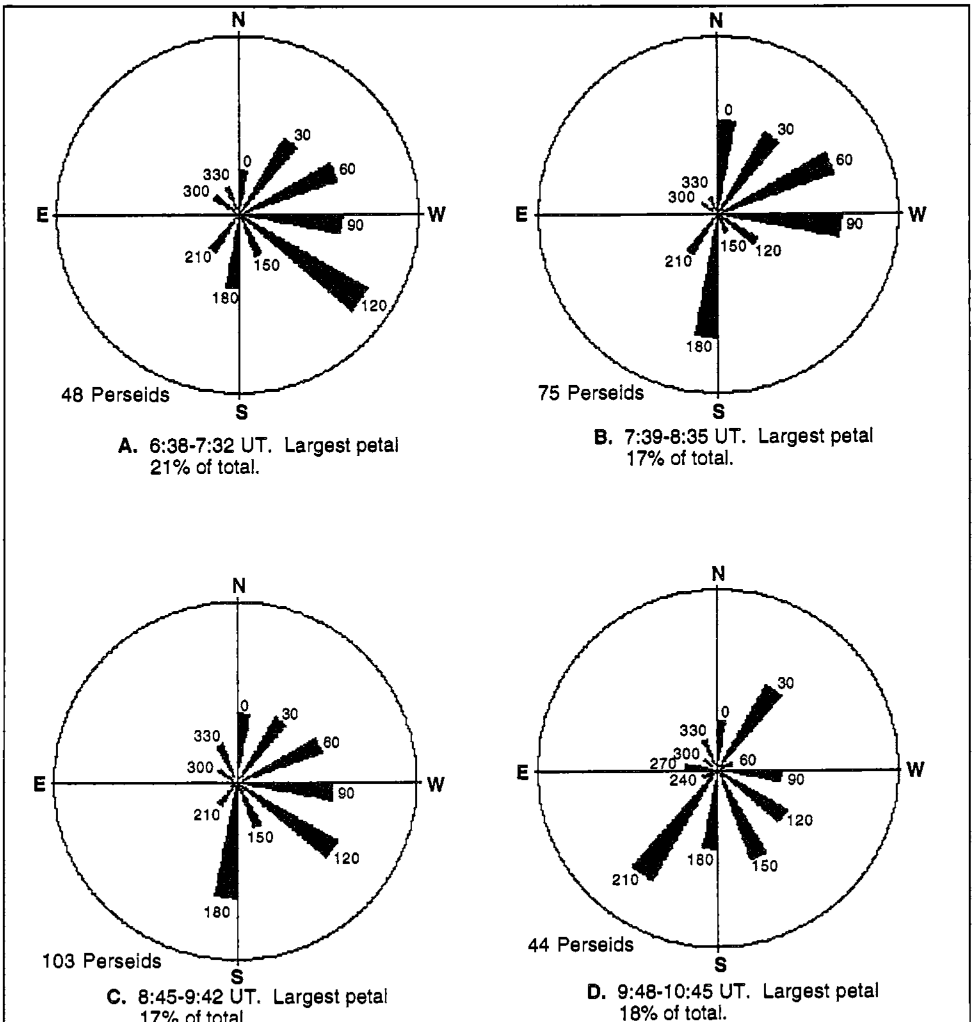


Figure 3. Times, magnitudes, and directions of Perseid meteors, 1997 AUG 12.
a. 06h38m-07h32m UT; 48 Perseids (9 non-Perseids, not shown), limiting magnitude +6.5.
b. 07h39m-08h35m UT; 75 Perseids (9 non-Perseids, not shown), limiting magnitude +6.5.
c. 08h45m-09h42m UT; 103 Perseids (10 non-Perseids, not shown), limiting magnitude +6.5.
d. 09h48m-10h45m UT; 44 Perseids (15 non-Perseids, not shown), limiting magnitude as shown.
MAGNITUDE
TIME (UT)
START
END
COMMENTS
zodiacal light appears in east
car headlights
dawn begins-zodiacal light 50° elongation
limiting magnitude +6.0
limiting magnitude +5.0



A. 6:38-7:32 UT. Largest petal 21% of total.

B. 7:39-8:35 UT. Largest petal 17% of total.

C. 8:45-9:42 UT. Largest petal 17% of total.

D. 9:48-10:45 UT. Largest petal 18% of total.

Figure 4. Rose diagrams of Perseid meteor directions, 1997 Aug 12.

when 100 Perseids were recorded in 50 minutes of observing. Within the main peak period, bursts of higher-rate activity were observed: between 08h31m-08h33m UT 6 Perseids were seen in 1 minute (*Figure 3b*); between 09h00h and 09h15m UT 4 Perseids were seen in one minute and 9 in about 2 minutes (*Figure 3c*); and between 08h48m and 08h50m, 8 Perseids were seen in less than 2 minutes (*Figure 3c*). At 8:40, during a break between the second and third observing sessions (*Figure 3b* and *3c*), 10 Perseids were seen in 1 minute. A lesser peak may have occurred before the main one, between 07h45m and 08h10m UT, with 40 Perseids recorded in 25 minutes (*Figure 3b*). Overall rates during the first observing session (06h38m-07h32m UT; *Figure 3a*) and the last observing session (09h48-10h45m UT; *Figure 3d*) were clearly lower than the middle two sessions (*Figure 3b* and *3c*), probably even after allowing for lower radiant position (first session) and the onset of dawn (last session). Zenithal hourly rates (ZHRs) were not computed for these data.

The brightness data (*Figure 3*) show a sharp increase in numbers of meteors from the brightest meteors (negative magnitudes) to fainter ones (magnitudes +2 to +4), as would be expected. There is a sharp drop off in number, however, from magnitude +4 to +5. This pattern may be a result of fewer sightings due to dimness, inaccurate magnitude estimates (see below), or a true drop off in numbers of faint meteors, similar to that noted for recent Leonid showers.

The directional data (*Figure 4*) show that that the first three observing sessions (06h38m-09h42m UT; *Figure 3a-c*) had very similar directional trends, with activity broadly distributed in the NW to WSW directions (0-120°) but with the direction of greatest activity (longest "petal") apparently rotating from a SW (120°) to a S (180°)direction. In contrast, in the last session (09h48m-10h45m UT) the bulk of the activity had swung to a SW to SSE direction, with the direction of greatest activity having rotated to the SSE (210°). In all four sessions activity was notably very quiet in the NE to ESE directions (240-330°).

Accuracy of the Data and Recording Techniques

Undoubtedly the greatest uncertainty in the data is in the meteor magnitude estimates (*Figure 3*). Their brief duration and the observer's lack of extensive experience in magnitude estimation results in estimates that may be off by a magnitude or two in some cases Note the scarcity of magnitude +5 meteors; this may be due to inaccurate brightness estimates for the fainter meteors rather than a true decline due to dimness. In the future a more accurate calibration of the observer's magnitude estimates is needed before observing.

Another source of inaccuracy is the time recorded for each meteor during playback of the tapes, due to slight discrepancies in recording and playback speeds. This has caused an overall uncertainty of as much as one minute for the true time for each meteor; however, the rates of meteor activity, particularly during the more active periods, are accurate. The general direction recorded for each meteor (*Figures 3* and *4*) is also thought to be reasonably accurate.

Conclusions

The data show that a distinct peak in activity for the 1997 Perseid Meteor Shower occurred between 08h30m-09h30m UT, with a possible lesser peak between 07h45m-08h10m UT. During this period rates were as high as several per minute. This is the sharp "90s peak", brought on by the recent passage of Comet Swift-Tuttle, that precedes the broader "traditional peak." The estimated time for the new peak this year by the International Meteor Organization (IMO) was about 08h15m UT (*Sky & Telescope*, August, 1997, p. 91), which happens to fall between the main and lesser peaks recorded here. I also recorded two peaks in 1994 (data sent to Martin Beech, IMO, and *Sky & Telescope*).

The directional data clearly show few meteors moving in northeast and southeast directions from the radiant. This result can be partially, but not totally, accounted for by the fact that my center of view was slightly west of the radiant and that the radiant was mostly to the east of the zenith during the observing period. An additional possible explanation for the overall trend is that meteors more readily burn up in a direction opposite the Earth's rotation, which perhaps also corresponds to the overall direction of the meteor stream. A peak in direction is finally seen in the southeast quadrant in the last observing session, when the radiant is highest and closest to the center of view. This, however, does not explain why the east and northeast directions are uniformly quiet throughout the entire observing period. Does the meteor stream have a south-directed component as well?

The major question concerning the nonuniformity of these data is: How much is mere observer bias or stochastic variation ("noise"), and how much reflects true small-scale inhomogeneities in the meteor stream? This question can probably only be answered by comparing detailed observations from more people over a larger geographic area and over more years.

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50 Years Ago: A Selection from The Strolling Astronomer, April 1, 1948 (Vol. 2, No. 4), "The February Occultation of Mars," pp. 3-4.

"...White's report deserves discussion in some detail. [Note, E.K. White observed from Kimberley, British Columbia, with a 7-inch reflector.]

He observed just at sunset, with the bodies only five degrees high. Mars exhibited a north cap but no other markings. A definite dark band adjacent to the bright limb of the moon was seen against Mars. This band was darkest at the moon's limb and grew fainter towards its outer edge, which was very diffuse. The width was about two seconds of arc. The color of the band was blue-black to gray; perhaps the blue was due to the bright sky. The band was presumably darker than all maria on Mars. It was seen as soon as the emerging Mars was noted, and it probably vanished at the moment of fourth contact. The band remained stationary relative to the limb of the moon throughout its period of visibility. These various appearances accord fairly well with past observations of the band.

If White's band is to be a lunar atmospheric effect, it is necessary to suppose that [the other observers] Morgan, Garneau, and Mentrum failed to observe the feature. That is perhaps admissible; for White is a veteran planetary observer, and in recent months his telescope has exhibited such delicate Saturnian features as Encke's Division and Cassini's in front of the ball. We must also here suppose that the lunar atmospheric effect was lacking (at least, unnoted) very near the south cusp and on the dark limb. It has been regularly invisible at the dark limb in the past. Is it due to absorbing lunar vapors or dust raised a few miles above the surface only when that surface is hot enough?

Was the band due to contrast? Computations based on the distances of Mars and the moon from the sun on February 23 and on their average albedoes make the moon about 4/3 as bright as the planet. Could this small amount of contrast produce a spurious band? Perhaps not, though some enterprising reader might approach this fundamental problem experimentally. Rosebrugh reports that Mars was dimmer than the moon; even the north cap was dimmer and pinker than the moon to him. He compares the two objects to a stack of fresh yellow hay standing in snow, though Mars was pinker than hay. White remarks on a pronounced difference in colors: Mars red-orange and the moon pale yellow. He and Johnson failed to notice which disc was brighter; the two presumably differed little. There is good observational evidence above that the difference in brightness near the south cusp of the moon did not cause a contrast-band. To blame White's band upon contrast, we must suppose the effect somehow lacking for all other observers."

THE BICOLORED ASPECT OF SATURN'S RINGS AND THE STILES-CRAWFORD EFFECT

By Roger J. Venable

ABSTRACT

The bicolored aspect of Saturn's Rings was observed systematically in the Fall of 1993. It was found to be quite different from the effects of vignetting and of atmospheric refraction. It is produced by drift of the eye away from the optical axis of the telescope under conditions of small exit pupil, high magnification, and the use of certain filters. The entoptic phenomenon known as the Stiles-Crawford Effect explains the bicolored aspect very well. Observers are asked to verify the detection of the Stiles-Crawford effect in observing Saturn. Photographic or CCD-imaging studies of the bicolored aspect may still prove to be interesting.

INTRODUCTION

The curious bicolored aspect of Saturn's Rings was first noticed in 1949 by Walter Haas. This effect consists of a subjective difference between the brightnesses of the two ansae when viewed with a colored filter. It has been seen most often in violet or blue light, and occasionally in red light, while a difference in brightness has seldom been evident in integrated light. Although one might suppose that such an effect is simply due to refraction of the planet's light by the Earth's atmosphere, experienced observers who are very familiar with the effects of atmospheric refraction on planet images have repeatedly noted the effect without ascribing it to such refraction. Mr. Haas has made note of the effect hundreds of times, while each year a few reports from other observers are received by the A.L.P.O. Saturn Coordinator. For example, in the 1991-1992 Apparition of Saturn, seventeen positive reports of the phenomenon were made by a total of three observers, and thirteen of these reports were by Mr. Haas himself [Benton, 1993]. Until the present study, no simultaneous observations of the phenomenon by more than one observer have occurred. C. F. Capen recorded the phenomenon photographically with a 41-cm reflector at the Table Mountain Observatory in 1963, and one of these photographs is reproduced in a popular book on planetary observing [Dobbins, Parker, and Capen, 1988]. It has been proposed that a bicolored effect could be caused by temporary segregation of particles according to size in different parts of the Rings [Cragg and Goodman, 1964]. Vignetting in the telescope has also been proposed [Haas, personal communication, 1993].

In September, 1993, the author initiated a program of observations of the phenomenon. During this effort, the author came upon an explanation of the effect, and this explanation is the purpose of the present article. [Throughout the present report, the terms "east" and "west" denote celestial directions rather than planetary directions.]

INITIAL RESULTS

Using a 40-cm f/4.5 Newtonian reflector and an 4.8-mm eyepiece, giving 375X, it became evident in September, 1993, that the effect was visible at almost every observation in dark-blue light (Wratten 47 Filter), occasionally and only weakly in red light (Wratten 25), and very seldom in integrated light. Then, at a "star party" of the Astronomy Club of Augusta (Georgia) on 1993 Oct 15, near 03h UT, five of six inexperienced observers agreed with the author that the east ansa was dimmer in dark-blue light using this telescope and eyepiece, and also with an 12.5-mm eyepiece (144X). However, the sixth observer reported that the west ansa was definitely dimmer. This sixth observer is several inches taller than the rest of us. On 1993 Nov 05 at about 01h30m UT, while the author showed the effect to another friend, such a discrepancy occurred again, the two observers each having no difficulty seeing the effect in violet light at 375X, but perceiving it on opposite ansae. It was then that the author noticed that the effect was reliably produced by positioning the small exit pupil on the periphery of his larger iris pupil, and the dimming would switch from one ansa to the other as the eye was moved from right to left, corresponding to the directions of the ansae.

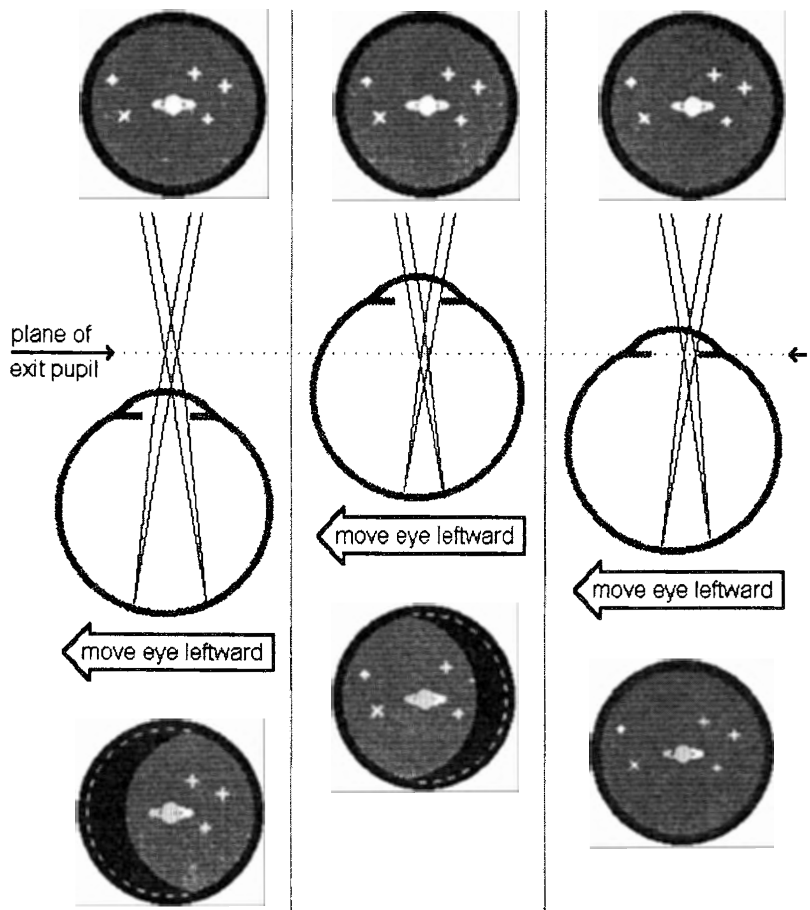
The dimming of one ansa occurred on the same side as the effect of vignetting. That is, the ansa to be vignetted first by motion of the eye away from the central position was the ansa that, before it was dimmed by vignetting, first dimmed in this curious effect. The effect was frequently perceived as brightening of the opposite ansa, but careful observation has confirmed that to be illusory—it was a dimming of one ansa, not a brightening of the other. The dimming was often not immediately visible but required one or two seconds of observation before it appeared.

VIGNETTING AND THE BICOLORED ASPECT

The bicolored aspect is produced by positioning the eye so as to place a small exit pupil at the periphery of the eye's iris pupil. Vignetting, of course, can also be produced by positioning the eye away from the telescope's optical axis. It is natural to wonder whether the two effects might be related. To investigate this, the author made a series of observations of the bicolored aspect with the eye positioned first nearer to the eyepiece, and then farther from the eyepiece, than the plane of the exit pupil is located. To understand the significance of this observation, one must understand an important characteristic of vignetting.

When the eye's pupil is larger than the exit pupil, which is the usual situation with planetary observing, the effect that vignetting has on the telescopic image varies, depending on where the eye's pupil is with regard to the plane of the exit pupil. This is portrayed in *Figure 1* (below). When the iris is positioned farther from the eyepiece than the plane of the exit pupil, vignetting occurs as in *Figure 1(a)*: the side of the field of view toward which the eye is moving is the first area of the field of view to be obscured by the vignetting, and a crescent of darkness encroaches on that side of the field of view. However, when the iris is positioned nearer to the eyepiece than the plane of the exit pupil, vignetting occurs as in *Figure 1(b)*: the side of the field of view away from which the eye is moving is the first area of the field of view to be obscured by the vignetting, and an arc of darkness encroaches on that opposite side. (Vignetting as in *Figure 1(b)* can be difficult or impossible to demonstrate when using an eyepiece that has unusually short eye relief.) In practice, it is sometimes difficult to position the iris exactly at the plane of the exit pupil, but when this is done, vignetting occurs as in *Figure 1(c)*: the entire field of view darkens simultaneously, with no encroaching arc of darkness. An understanding of these effects is essential to understanding the relevant observations made by the author. The effects can best be understood by considering the rays drawn in *Figure 1*, and which of them are interrupted first by the vignetting iris as the eye moves laterally away from the optical axis.

In observing, first on 1993 Nov 13 at about 01h30m UT and on several dates since then, the bicolored aspect was unaffected by the distance of the eye from the eyepiece, whether nearer to or farther from the eyepiece than the plane of the exit pupil. While the crescent of darkness of vignetting could easily be made to switch sides of the field of view by moving the eye closer to and then farther from the eyepiece, the dimmer ansa was never brightened by such motion, and the bicolored



(a) Eye farther from the eyepiece than the exit pupil. Vignetting on the left and the right ansa is the brighter.

(b) Eye nearer to the eyepiece than the exit pupil. Vignetting on the right and the right ansa is the brighter.

(c) Eye at the exit pupil. Vignetting is diffuse and the right ansa is the brighter.

Figure 1. Vignetting and the bicolored aspect.

aspect did not switch sides. This is represented by the images of Saturn in *Figure 1*. This experiment effectively eliminates vignetting as a possible cause of the bicolored aspect.

In addition, the bicolored aspect was noted to be different from vignetting in that it usually can be seen before the obscuring crescent of vignetting appears, as the eye moves laterally.

In making these observations, the author discovered that he consistently observes with his iris positioned farther from the eyepiece than the plane of the exit pupil. Consequently, he usually experiences vignetting on the side of the field of view toward which his eye moves. Accordingly, in his first observations of the bicolored aspect (see "Initial Results" above) he found that the ansa that dimmed was the one on the side that was the first to be vignetted by motion away from the optic axis. For another observer—one who consistently observes with his iris positioned nearer to the eyepiece than the plane of the exit pupil—the ansa that dims will be the one on the side opposite that which is the first to be vignetted by eye motion away from the optic axis. But in every case, the bicolored aspect renders that ansa dimmer in the direction which the eye moves as it leaves the optical axis. This is true for all detections of the bicolored aspect, whether in blue, red, or integrated light.

ATMOSPHERIC REFRACTION

An observing schedule was chosen to allow multiple observations of Saturn at a variety of tilts of its ring plane with respect to the observer's horizon. Saturn was observed near 03h UT (11 PM the previous evening EDT) every clear Saturday and Sunday from 1993 SEP 04 through OCT 31, and beginning on 1993 NOV 06 the time of observation was moved up to 01h30m UT on Saturdays and Sundays (8:30 PM the previous evening EST) because Saturn then was getting low in the southwest.

The last 1993 observation of Saturn was on DEC 19. In early September, Saturn was in the southeastern sky after dusk and the line of its equator and ring system was tipped about 27° from the horizontal, the east ansa being at a lower altitude than the west ansa. In early October, the line of the ansae was parallel to the horizon. By DEC 19, the planet was in the southwestern sky after dusk and the line of the ansa was tipped the opposite way, the west ansa being lower than the east, at an angle of about 40° from the horizontal. As the author observes from 33°.5 north latitude and Saturn was at about 15° south declination all autumn, it never rose above 42° altitude. The effect of differential refraction by the Earth's atmosphere was clearly seen during each observing session, with the spectrum of Saturn's light slightly dispersed in a direction perpendicular to the horizon. The observability of the bicolored aspect remained good at all orientations of the planet's rings, and at all orientations it was seen as a difference in brightness along the line of the ansae, and never in the direction of the differential atmospheric refraction. This difference in the directions of the two effects was especially obvious when the line of the ansae was parallel to the horizon, as one might expect. Moreover, the two effects appeared quite different from one another in character. Differential refraction blurs the image, while the bicolored aspect does not; in integrated light, the former effect appears as color dispersion, while the latter does not. The differential-refraction effect does not cause a difference between the apparent brightnesses of the two ansae, which is the *sine qua non* of the bicolored aspect; and the former is not affected by the position of the eye in the plane of the exit pupil, while the latter is *(Table 1,* below). These differences are so pronounced that this writer believes that no one who has seen both the bicolored aspect and differential atmospheric refraction could confuse the two.

Table 1. Differences between atmospheric refraction and the bicolored aspect

Characteristic	Atmospheric Refraction	Bicolored Aspect
Blurs image	yes	no
Visible color dispersion	yes	no
Ansae of different brightnesses	no	yes
Eye-position effects	no	yes
Direction	hor	ans

hor = perpendicular to horizon.
ans = along the line of the ansae.

FACTORS AFFECTING THE VISIBILITY OF THE BICOLORED ASPECT

Because of the suspicion that exit pupil size and the use of colored filters have something to do with the visibility of the phenomenon, a series of observations was carried out by the author on 1993 Nov 16, Nov 21, and Nov 26. The time of observation was 01h UT to 02h UT on each date (8:00 to 9:00 PM in the evenings of November 15, 20, and 25, 1993, EST). The telescope used was the same 40-cm Newtonian, and observations were carried out using 32-mm (57X), 12.5-mm (144X), and 4.8-mm (375X) focal-length eyepieces; in integrated, red (W25), and dark-blue light (W47). In each observing session, observations were done with the full aperture and then repeated with an aperture stop of 15.9 cm. Such a stop reduces brightness and exit pupil size without affecting magnification. The observation consisted of moving the eye from side to side at the eyepiece while making note of the equality of brightness of the ansae.

The bicolored aspect was rated on a four-level scale as 0 = absent, 1 = very subtle, 2 = readily evident, or 3 = very prominent. *Table 2* (p. 77) presents the results. Correlation coefficients, calculated by Quattro Pro for Windows spreadsheet by Borland International, Inc., are included in *Table 2* at the bottom of the column of each independent variable. The correlation coefficient for filters was calculated by assigning a value of 1 for integrated light, 2 for a red filter, or 3 for a dark-blue filter. It is apparent that the visibility of the bicolored aspect is related to each of the factors listed (aperture, magnification, exit pupil, and filter).

Table 2. The prominence of the bicolored aspect with different telescope arrangements (0 = absent, 1 = very subtle, 2 = readily evident, 3 = very prominent).

Telescope Arrangement				Bicolored Aspect with 1993 Date			
Aperture	Magnif.	Exit Pupil	Filter	Nov 16	Nov 21	Nov 25	Mean
400 mm	57X	7.0 mm	none	0	0	0	0.0
"	"	"	red	0	0	0	0.0
"	"	"	dark blue	0	0	0	0.0
"	144X	2.8 mm	none	0	0	0	0.0
"	"	"	red	0	0	1	0.3
"	"	"	dark blue	0	2	1	1.0
"	375X	1.1 mm	none	0	0	0	0.0
"	"	"	red	1	0	1	0.7
"	"	"	dark blue	2	2	2	2.0
159 mm	57X	2.8 mm	none	0	0	0	0.0
"	"	"	red	1	1	0	0.7
"	"	"	dark blue	1	0	0	0.3
"	144X	1.1 mm	none	0	0	0	0.0
"	"	"	red	1	1	1	1.0
"	"	"	dark blue	2	2	2	2.0
"	375X	0.42 mm	none	1	1	1	1.0
"	"	"	red	1	1	2	1.3
"	"	"	dark blue	3	3	3	3.0
-0.346	+0.546*	-0.562*	+0.584*	Correlation coefficient of this variable versus bicolored aspect; * = significant at a 5-percent level.			

Table 3. Simple and multiple linear regression analysis of factors influencing visibility of bicolored aspect.

Independent Variables	r^2
(1) Aperture	0.12
(2) Magnification	0.30*
(3) Filter	0.34*
(4) Exit-pupil diameter	0.32*
(1) + (2) + (3)	0.76**
(1) + (2) + (3) + (4)	0.76**

Significance Levels:
* = 5 percent, ** = 1 percent.

Single and multiple linear regression analysis results are detailed in *Table 3* (upper right), as calculated by the spreadsheet. The r^2 values are the squares of the correlation coefficients, and are known as the *coefficients of determination.* They represent the fraction of the variance of the dependent variable (bicolored aspect) that is attributable to the respective independent variable or variables. For completely unrelated independent variables, r^2 is purely additive, while for related independent variabies r^2 is less than additive. These data reveal that aperture, magnification, and filter are simply additive in their effects, thus truly independent determinants of visibility of the bicolored aspect, and together account for 76 percent of the variance in its visibility. Addition of exit pupil size to the analysis accounts for none of the remaining variance, which can be expected inasmuch as exit pupil is the quotient of aperture and magnification and its effects are therefore included in the analysis of those variables. The remaining 24 percent of the variance is due to unmeasured factors, of which the most important may be the subjective nature of the ratings of the intensity of the bicolored aspect, the imprecision in standardizing the observing technique, and possibly, nonlinearity in the influences of the independent variables.

Because the bicolored aspect was most easily seen at high magnification, the question arises whether the effect is dependent on such high magnification. This was investigated on 1993 Dec 04 and 07, at about 01h UT. On each evening, Saturn was observed with the same 180-cm focal length telescope with the aperture stopped to 6 cm and then to 4 cm. At 6 cm, the bicolored aspect was very subtle at 57X in dark-blue and in red, but was not detectable in integrated light, while at 4 cm at the same magnification it was readily evident in dark-blue and red, while being very subtle in integrated light. These arrangements give exit pupils of about 1.1 and 0.7 mm, respectively. Thus, the bicolored aspect was more visible when using these small apertures than it was at the same magnification using the larger apertures, as reported in *Table 2*. So the bicolored aspect is not simply an effect of high magnification, but rather is inversely related to aperture as well, and, by inference, to exit pupil size.

Stopping down the aperture of a telescope renders the image fainter, and increasing the magnification also decreases the image intensity (although preserving the total light flux). Might the bicolored aspect be related to image dimness? To investigate this, stacks of filters were used to make the image very dim when observed with the full 40-cm aperture. A Wratten 25 plus a Wratten 58 (green) combination worked well, and combinations of "light pollution" filters with color filters can also be used. These combinations block virtually all of the violet and blue light. Under these conditions, on 1993 Dec 04 and 07, the bicolored aspect could not be detected at 57X or at 144X, and was not seen any more readily than it had been without the filters. The bicolored effect is thus not due to dimness of the image.

The Stiles-Crawford Effect

In 1933, W.S. Stiles and B.H. Crawford discovered that a narrow pencil of light that is directed at the fovea through the center of a dilated pupil appears brighter than the same light does when directed at the fovea through the periphery of the pupil (*Figure 2*, p. 78). They therefore concluded that light that strikes the retina at or near a 90° angle is more efficient at stimulating retinal photoreceptors than light that is incident at a lesser angle. Typically, a pencil of light entering 2 to 3 mm from the center of the pupil will have only about 50 percent of the perceived intensity it has when entering centrally [Stiles and Crawford, 1933]. The phenomenon occurs in retinal cones but not in rods [Flamant and Stiles, 1948]. It has been characterized for light of all visible wavelengths and is found, with some differences in its detail, in all areas of the retina. In addition to this difference in brightness, there is a difference in perceived hue: light entering through the periphery of the retina is seen as redder [Stiles, 1939].

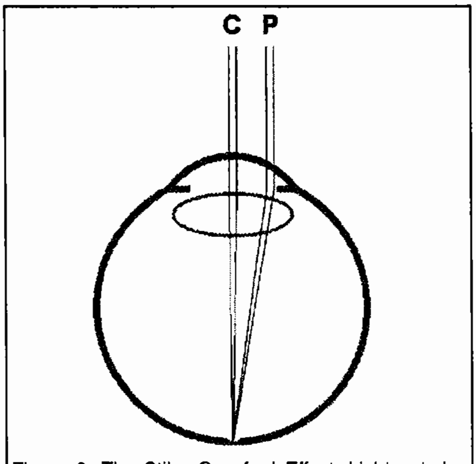


Figure 2. The Stiles-Crawford Effect. Light entering the pupil centrally (C) is perceived as more intense and bluer than the same light entering at the periphery (P).

Figure 3 (below) graphs the Stiles-Crawford Effect for various wavelengths in one subject's dark-adapted fovea as determined by Stiles. Although the abscissa of *Figure 3* is measured in millimeters of displacement of the pencil from the center of the pupil, this scale can be translated to angle of incidence on the fovea by means of simple trigonometry. The peak sensitivity is usually not exactly in the visual axis of the eye, and this is presumed to be due to the fact that the optical axis of the eye is usually somewhat displaced from the visual axis [Stiles, 1939]. The peak sensitivity is in the nasal side of the pupil 80 percent of the time [Duke-Eider, 1968], which is opposite to the direction Stiles found it in the subject from whom this graphed data was obtained. In the graph, the sensitivity curves for the various wavelengths have been moved vertically so as to make their peaks coincident, for the purpose of clarity; therefore, the graph does not allow comparison of absolute sensitivities at different wavelengths. Instead, it compares for various wavelengths the strength of the directional effect. It shows that the drop in sensitivity is steepest for blue light (430 nm) as the pencil of light moves away from the center of the pupil, while the drop in sensitivity is least in the middle of the spectrum (500 and 570 nm). The drop for red light (640 and 700 nm) is intermediate in steepness between the declines for blue and yellow. (Stiles' graph for the dark-adapted parafovea is considerably different from this in the blue end of the spectrum, with very little directional effect demonstrable, while the graphs for the light-adapted fovea and the light-adapted parafovea resemble *Figure 3* closely.)

As applied to Saturn, the difference between the angles of incidence on the retina of light from the west and east ansae is depicted in *Figure 4* (below). The size of Saturn and of its projected image on the retina is exaggerated in the drawing. The east ansa will appear dimmer than the west, because the light of the east strikes the retina relatively obliquely while that of the west strikes nearly perpendicularly. The effect will be most pronounced in blue light, because the decline in perceived intensity with increasing obliquity is most dramatic in blue light. It will be next most evident in red light. The eye is most sensitive to light in the middle of the spectrum, where the Stiles-Crawford effect is weakest, so that viewing Saturn in integrated light will allow the middle of the spectrum to dominate, rendering the Stiles-Crawford effect less readily evident.

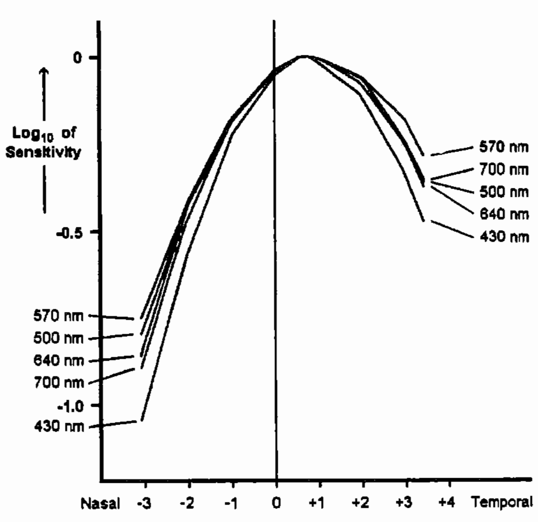


Figure 3. Directional sensitivity of dark-adapted fovea. (Adapted from Stiles, 1939).

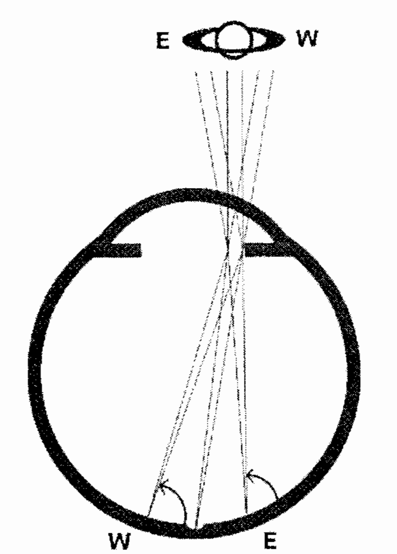


Figure 4. A 7-mm iris pupil and a 1-mm exit pupil; the light from the east ansa strikes the retina obliquely while the light from the west ansa strikes perpendicularly. The size of Saturn's image is exaggerated for clarity; note that the image of Saturn on the retina is reversed.

Discussion

It has been asserted elsewhere that the iris pupil normally adjusts to match the size of the exit pupil [Texereau, 1963]. One can study this with regard to one's own pupil by observing the types of vignetting that one experiences with different exit pupil sizes. When the exit pupil is the same size as the iris opening, the entire periphery of the image is vignetted by a dark ring if the iris is held either further away from or closer to the eyepiece than the exit pupil is located. In order to avoid such vignetting, one naturally tends to keep the iris at the plane of the exit pupil. Consequently, any lateralward movement of the eye results in the diffuse type of vignetting depicted in *Figure 1(c)*. So, any motion of the eye causes significant vignetting when the exit pupil diameter equals the iris pupil diameter. In contrast, when the exit pupil is considerably smaller than the iris pupil, the eye is "free" to move, letting the exit pupil roam about the iris opening, without producing vignetting. But sufficient lateralward movement will produce vignetting as depicted in *Figure 1(a)* and *1(b)*. An observer can thus ascertain whether his iris pupil is the same size as the exit pupil by taking notice of vignetting phenomena. The present author has not formally measured the tendency of the iris pupil size to match exit pupil size. But years of professionally looking at and through iris pupils has shown him that most pupils will seldom constrict below 2 mm and very rarely below 1 mm. Moreover, the darkness of the night is a powerful stimulus to pupillary dilation, and it seems incongruous that a small exit pupil size could completely overcome this. It can be expected that, when the exit pupil diameter is small, the iris pupil fails to match it in size. By observing vignetting, the author finds that, with an exit pupil larger than 3.1 mm, his own iris usually matches the exit pupil; at 2.8 mm it usually does not; and at an exit pupil smaller than 2.8 mm, it will not. So the tendency of the iris pupil to match the size of the exit pupil is limited.

An often-repeated recommendation is that an amateur's high-magnification eyepiece yield about 20X per centimeter, or 50X per inch, of aperture [Norton, 1973]. Such an eyepiece will produce an exit pupil of 0.5 mm, which is smaller than most observers' irises can constrict. It is thus likely that amateurs frequently observe Saturn with an exit pupil small enough to allow the Stiles-Crawford effect to be manifested.

When the exit pupil is large, the occurrence of vignetting as the iris pupil moves away from the central position prompts the observer to move his iris back to the exit pupil. This is a natural reaction, requiring little or no conscious control. But when the exit pupil is small, slight drifting of the eye does not cause vignetting to so prompt the observer, so that it can be difficult to keep one's eye centered in the telescope's optical axis. At such times, an observer probably judges where his eye is in relation to the telescope's optical axis by his perception of the background sky and of its limits at the edge of the field of view, comparing it grossly to his impression of where the eye lens is. But in observing the bicolored aspect, due to the combination of high magnification and a filter, the background sky is likely to be so black as to be indistinguishable from the blackness outside the field of view. In this case, the eye may drift away from the optical axis unintentionally, and without the observer's notice. If there are physical discomforts in one's observing posture, such as can occur when using a large amateur telescope that requires stretching and leaning to position oneself at the eyepiece, there may be a tendency for the eye to drift in a direction that will lessen the difficulty of maintaining one's posture. This seems to have occurred at the star party of the Augusta Astronomy Club on October 15, 1993. The author's telescope did require the observers to stretch and lean, and the only one of the seven observers who saw the dimming on the west ansa was the tallest of the seven, presumably affected somewhat differently than the others by the position of the eyepiece. One suspects that some of the past observations of the bicolored aspect were made under similar observing conditions. For example, Haas typically observes with a 31.8-cm Newtonian telescope at 366X [Benton, 1993], which should result in a black sky background when used with certain filters, and which may be a large enough telescope to require unnatural postures. The difficulty in detecting where the eye is in relation to a telescope's optical axis may elucidate why the bicolored aspect has not been previously explained—observers have been unable to detect the wandering of the eye in relation to their perception of the bicolored aspect.

It is remarkable that a full 76 percent of the variance of the visibility of the bicolored aspect was accounted for by the known variables of aperture, magnification, and filter, and it thus seems highly likely that these variables are the true determinants of its visibility. The effect of small aperture is to decrease the size of the exit pupil so as to enable all of Saturn's light to enter through the periphery of the iris pupil. The effect of high magnification is not only to decrease the size of the exit pupil but also to enlarge the planet's image on the retina so as to increase the difference between the two ansae's angles of incident light on the retina. The effect of a blue filter is to limit the wavelengths to those that are the most strongly dimmed by obliquity of incidence on the retina in the foveal area. These three variables fit the Stiles-Crawford effect so well that it seems that a satisfactory explanation has now been provided for the visual perception of the bicolored aspect of Saturn's Rings.

The existence of the Stiles-Crawford effect actually requires that effects like the bicolored aspect should be visible, and Stiles and Crawford might have predicted the Saturn phenomenon had they thought of it.

At a magnification of 375X, as was used in many of the observations in the present study, Saturn's Ring System subtends a maximum dimension of about 1.6 mm on the retina. The fovea is a shallow pit about 1.5 mm across. The parafovea is the area around the fovea, extending to a total radius of 2.8 mm from central gaze [Duke-Eider, 1961]. Thus, the outer edge of the Rings at that magnification are projected onto the parafovea. As previously mentioned, Stiles found that the decrease in retinal sensitivity with decreasing angle of incidence was not present in blue light in the dark-adapted parafovea; it was still present in other colors in the parafovea. But Stiles did not acquire data to establish an exact line of transition between the areas of the retina where the directional effect in blue light is visible and where it is not. The present observations of Saturn suggest that the directional effect in blue light is present in the innermost area of the dark-adapted parafovea. However, with magnification substantially above 375×, observers may find that the bicolored effect is not visible in blue or violet light, but that it is still visible in red light, since the larger retinal image of Saturn would project its ansae well into the parafovea.

Stiles and Crawford first detected their namesake phenomenon in a laboratory devoted to the elucidation of the physiology of vision [Stiles and Crawford, 1933]. It has subsequently been detected in the out-of-focus star images seen by a myopic researcher, who, upon studying it, suggested that under certain circumstances it may have value in the diagnosis of myopia and hyperopia [Westheimer, 1967]. The present author has found no other descriptions in the literature of natural detections of the effect. Thus, the present description of the bicolored aspect of Saturn's Rings may be the second identification of the effect outside the physiology laboratory.

The effect is not fully characterized or fully understood [Duke-Eider, 1968]. Most laboratory studies of the Stiles-Crawford effect were done using brief flashes of light, a condition quite different from the prolonged observation of a planet. It is possible that a study of the details of the effect as seen on Saturn could contribute to an understanding of it. For example, the delay of one to four seconds before the effect appears (when seen with a dark-blue filter and high magnification) has not previously been described.

Photography of the Bicolored Aspect

Capen's blue-light photograph shows very well the inequality in brightness of the ansae, rendering it obvious. This appearance, in the opinion of the present author, is indistinguishable from the effect as seen visually. Thus, the bicolored aspect can be very obvious and unmistakable. Consequently, the effect should be easy to photograph if it represents a phenomenon on the planet. Indeed, it has been noticed in a sufficiently high percentage of visual observations that it could be expected to be evident in a significant percentage of photographs. But the difficulty in obtaining photographic documentation of the effect was itself part of the mystery of the bicolored aspect until Capen's 1963 photographs. The lack of other photographs of this phenomenon remains very peculiar. [However, see the video image reproduced as *Figure 9* in Benton, 1998. Ed.]

One possible explanation for the dearth of photographic documentation is that the phenomenon is caused by the Stiles-Crawford effect. Photography will not display the Stiles-Crawford effect. If this is the correct explanation, then the problem is reformulated as, "What is the explanation of Capen's unique photographs?" Examination of the published reproduction reveals that the inequality of brightness affects not only the Rings, but also the Globe. This is not subtle, and it appears more pronounced than can be accounted for by limb darkening or by the direction of solar illumination. The involvement of the Globe and Rings together presents a large problem for theorists who would try to provide a planetological explanation of the phenomenon. For example, it rules out the possibility that the phenomenon is due to temporary segregation of ring particles according to size, since that explanation has nothing to do with the effect on the Globe. When coupled with the dearth of other photographic documentation, it suggests that the phenomenon as Capen recorded it is not planetological but rather is an artifact of photographic processes. Inspection of the original negatives, if still extant, would be helpful in verifying the nature of his photographic observation.

Photographic documentation of a planetologic bicolored aspect should be sought.

The Bicolored Effect on Deep-Sky Objects

One might expect the Stiles-Crawford effect to be discernable on certain deep-sky objects. The author has looked for the Stiles-Crawford effect on bright planetary nebulae including NGC 7662 in Andromeda and NGC 2392 (the Eskimo) in Gemini, without success, using the same telescope described previously. These planetaries are about 7.5 magnitudes fainter than Saturn. Even though the author can see some green coloration in NGC 7662, it is likely that most of his perception of these objects is with rods, not with cones, and rods do not manifest the Stiles-Crawford effect. The author can see green color in M42 (the Great Nebula in Orion) as well, but no trace of the Stiles-Crawford effect. This object also does not have a surface brightness comparable to that of Saturn.

While Westheimer noted the effect in the out-of-focus star images he saw with his unaided, myopic eyes, the author has succeeded in observing the effect telescopically in the defocused images of Procyon (α Canis Minoris) and Capella (α Aurigae). At magnitudes +0.4 and +0.1 respectively, these stars are comparable in brightness to Saturn. The detection of the effect on these objects was much more difficult than on Saturn.

It was noted that the eye tends to gaze at the edge of the out-of-focus image rather than at the middle, and this results in an "averted vision effect" rendering the opposite edge of the image, away from the direction of gaze, to be always brighter. Only with considerable concentration was the author able to keep his gaze on the center of the out-of-focus image long enough to allow the Stiles-Crawford effect to become evident. In contrast, Saturn during the 1993-94 Apparition was brightest in the Globe, not in the Rings, so that the eye naturally tended to rest on the Globe.

How to See the Bicolored Effect

Given the success the author had in sharing the bicolored aspect with members of the Astronomy Club of Augusta, it is likely that most amateur astronomers will be able to see it. On the Rings of Saturn it is seen considerably more readily than on a blurry star image, so the telescope should be pointed at the planet. It is best seen with an exit pupil diameter of less than 1 mm (exit pupil diameter in millimeters is equal to telescope aperture in millimeters divided by the magnification). The best way to achieve this is to use as high a magnification as possible, and if that alone does not achieve it then the aperture should be stopped down as far as is needed to yield the small exit pupil. Adding a violet filter adds greatly to its visibility, but a blue or a red filter could be used instead. Having prepared in this way, one then looks at the Globe of Saturn while moving one's eye slowly away from the central eyepiece position, moving in the direction in which one of the ring ansae extends from the planet. Before any vignetting encroaches on the Rings, stop the eye motion and wait. It may take as long as four seconds for the opposite ansa to brighten, but a delay of one or two seconds is more usual. This delay in the appearance of the bicolored aspect caused the author to miss the phenomenon a few times early in the course of his study of it.

To do this, one must be able to position one's eye accurately and stably with a tolerance of less than a millimeter. The author has found that if he observes while standing he continuously makes fine balancing motions of his body, rendering it difficult to position the eye stably within this tolerance. To avoid this problem he uses a seat of the correct height to support him at the eyepiece. Another problem arises due to wandering of the eye due to the darkness of the background sky caused by the high magnification plus the use of a filter (see "Discussion," p. 79). In this regard, the author has found that placing his hand so as to span the distance between his brow and the eyepiece, gently touching both, provides useful sensory input for guiding the motion of the eye.

Observers who succeed or fail in detecting the bicolored aspect in this way are urged to report their findings to the A.L.P.O. Saturn Coordinator, Julius L. Benton, Jr., (address in the staff listing in this journal) or to the author at 3405 Woodstone Place, Augusta, GA, 30909, United States.

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Note by A.L.P.O. Saturn Coordinator

Dr. Venable has contributed the preceding paper that describes experiments he has carried out to try to understand the curious bicolored aspect of Saturn's ring ansae, and his results offer at least one possible explanation for the phenomenon. Whether the *Stiles-Crawford Effect* accounts for *all* visual observations of the bicolored aspect over many years remains open to question. It would certainly be worthwhile for observers to try some experiments of their own. The A.L.P.O. Saturn Coordinator encourages appropriately equipped observers to make every attempt to photograph Saturn in integrated light (no filter) and alternately using red and blue filters. Use of photographic, video, or CCD imaging techniques becomes especially meaningful when the bicolored aspect of the rings is detected visually. Without question, simultaneous observations of the phenomenon are of vital importance. Sightings of the bicolored aspect of the rings, with accompanying photographic, video, CCD, or visual data, should be promptly dispatched to our Saturn Coordinator. Observers interested in details on how to establish a systematic program of observing Saturn should contact the A.L.P.O. Saturn Coordinator.

Notes by A.L.P.O. Editor

(1) CCD images of the bicolored effect, as opposed to film photographs, have the advantage that any effect can not only be seen but also be quantified.

(2) As the apparent equatorial diameter of the planet Jupiter is comparable to that of Saturn's Ring System, bicolored-effect experiments might also be conducted with the disk of Jupiter (preferably near opposition date to avoid any terminator coloration).

(3) The Editor has confirmed Dr. Venable's calculations in *Table 2* and*3,* and added the levels of significance; the effect of magnification, exit pupil, and filter is significant as regards the bicolored effect, but aperture alone is not. The two multiple-regression coefficients in *Table 3* are both significant. Dr. Venable's assignment of 1 = no filter, 2 = red filter, and 3 = dark-blue filter appears somewhat arbitrary; changing these values to 0 = no filter, -1 = red filter, and +1 = dark-blue filter reduced the filter:bicolored correlation to +0.35, which was no longer statistically significant.

ARTISTIC PHILOSOPHIES IN LUNAR DRAWING

By: Matthew L. Will, A.L.P.O. Training Program Coordinator

ABSTRACT

Visual observation through drawing is still a highly valued method of recording lunar and planetary observations. When used for comparison, drawings of today can help better our understanding of past visual observations. Also, the act of drawing trains the eye to see detail normally missed through other means of data collecting such as photography and electronic imaging. For two academic semesters the author enrolled in art courses that taught drawing theory. The goal was to correct for his own shortcomings in lunar drawing by applying the artistic concepts that had been learned in drawing class and to instruct students in the A.L.P.O. Training Program about these concepts. This paper examines these artistic techniques and how they relate to what we are seeing and attempting to record while observing the Moon; it is not necessarily meant to be a beginners' how-to article for those just starting to draw lunar features but assumes that the reader already knows the basics of recording and documenting such observations. The author discovered that learning these artistic skills not only improved his drawing style but also enhanced his enjoyment of lunar geology by combining the best attributes of both art and science.

INTRODUCTION

The desire to record observations and to extract every detail of what is seen is always uppermost in the amateur astronomer's mind. Despite the quality of the telescope or the sophistication of data-collection gadgetry such as CCD cameras, it is the observer that must recognize, appreciate, and appraise what he or she is seeing. And even today the most basic method of collecting data, recording an observation through drawings, is still practiced by many serious amateurs..

For research purposes, drawings of today give us an important baseline for comparison with drawing done in the past. Contemporary drawings are excellent for comparing what was seen in the past "visually" with what is seen now. If you have already purchased a telescope there will be no need to acquire and learn additional, costly instrumentation. Art supplies are inexpensive and as a "creative" activity you can practice drawing limited only by your own expectations.

In addition, the act of drawing helps train the eye to see detail that is normally overlooked in casual observation or even after electronic images are glanced at and stored to disk.

Everyone can draw. But one can have difficulties expressing what one sees. There is an analogy to public speaking; everyone can speak, but how many of us are completely satisfied with ourselves when we do it in front of a group?

As one of the two Coordinators for the A.L.P.O. Lunar and Planetary Training Program, I can say that we receive many requests for instruction in performing observations using visual and drawing skills. Some ask for guidance with planetary observations. Many more ask for help in drawing lunar features. Probably, the most demanding type of observing is lunar drawing.

Recently, for a period of two academic semesters I enrolled in art courses that taught drawing theory. I attended an introductory Drawing I course and the second-semester Drawing II course. My motivation was to see if drawing theory could enhance or perfect one's drawing style. Rendering lunar features on paper had never been an easy task for me. In 1994 the A.L.P.O. Lunar and Planetary Training Program was reactivated after a year's hiatus of reorganization and restructuring. My partner, Tim Robertson, and I noticed that we were receiving quite a few requests for guidance in lunar drawing. To share the load with Tim and to correct for my own shortcomings, I enrolled in the art courses. Specifically, I wanted to apply skills I would learn in class toward my interest in lunar observing and be able to instruct others in drawing technique.

Through the two-semester course I drew still-life, human figures, abstract shapes, and so on, and used various drawing skills and media to portray them. I can say what I learned in these courses has helped in not just replicating the lunar surface on paper, but also has helped me to see lunar features more distinctly.

This paper will discuss the artistic philosophy or viewpoint involved in making good drawings. There will be some discussion of drawing techniques as they apply to explaining some philosophical concepts. The reader should refer to the Andrew Johnson article about lunar drawing for a fuller discussion about actual application of these techniques [5].

THE ART COURSES

Enrolling in and taking the art courses required a special determination that demanded that I overcome any inhibitions that anyone has when entering a new realm. Having been trained in the analytical sciences where raw data resolves the universe through mathematical equations, the arts offered a new approach to describing our world and others through visual perception.

In the first few class sessions, the art instructor challenged our sensibilities about perception. We drew geometric shapes, particularly boxes seen at different angles. The purpose of this was to change our own preconceived view of these objects using the concepts of three-dimensional perspective. The instructor was trying to make us see with our own two eyes instead of our mind's eye; seeing things as they actually are instead of what we thought they were supposed to be. We did this using a few artistic techniques of measuring objects and space as they physically appeared.

Early on, after a few weeks of practice, the instructor gave us our first composition or project to work on. Our assignment was to replicate on paper a photograph we had been given. We were all given the same picture, a black-and-white photograph of a pile of empty, shinny coffee cans laying in every conceivable orientation and consequently reflecting and blocking light in every manner. Drawing this was a test of what we had learned up to that point. We had already had some practice in drawing circles, ellipses, and cylinders. We had also gotten a good feel for using the H- and B-series drawing pencils to portray subtleties in shading. This project demanded our skill at mind-eye coordination in seeing proportions correctly. I thought to myself at the time, "what better way to practice lunar drawing than through this exercise!", since lunar pencil drawings require the above aspects of dimensionality, shading values, and estimating size.

We had been asked to complete this project over the course of a few weeks and in some ways this was similar to the other five or six major projects assigned over the remaining 1-1/2 semesters. This initial assignment brought in some of the artistic concepts and philosophies that we would encounter again and again. I have applied these same principles when I sketch a lunar feature and I will attempt to share them with you in this paper. Other projects in both art courses included using different techniques in developing representational drawings and the uses of different media which I will touch upon briefly later in this paper (p. 86).

The Act of Lunar Drawing

The purpose of making a good lunar drawing is to make a reliable record of what was seen at a given time for a particular lunar feature. However, in portraying these features one must go beyond simply recording them passively, without reasoning about what one is seeing. In other words, certain rationales must be used to incorporate true visualization of what is really seen. This can be the difference between a drawing that has true dimensionality and one that just appears as an unrelated series of lines and shadings. Also, the artistic concepts I am about to discuss are not considered to be under the purview of science; however, they are as old as astronomy itself and have every foundation in reality as does science. This paper is not necessarily a "beginners' how-to" article for those who are just beginning to draw lunar features. It assumes that the observer already knows how to record and document a lunar observation. There are good articles in the *J.A.L.P.O.* and other popular astronomy magazines and books that help the novice to record lunar observations accurately [2,3,7,10]. Instead, this paper is primarily designed to assist those amateurs who have had problems in drawing the Moon in the past or are actively involved in that pursuit now.

The first step one takes in drawing a lunar feature, such as a crater, is to line-out the drawing. Doing this requires considerable hand-eye coordination, getting shapes to appear close to what they look like in the telescope. In the art classes I attended, I observed that sizes and distances were difficult to estimate for persons that had not drawn much in the past. In the classroom, though, the art instructor would demonstrate techniques, such as holding a pencil at arms length and using it as a caliper to estimate relative size and spatial relationships. There were other techniques that were introduced to us to measure space. However, all these approaches do not translate very well to lunar drawing. Perhaps one could use a reticle eyepiece to correlate the size of lunar features relative to each other. However, these features often are too small for such an application to be useful. So the amateur is basically left to his or her own in practicing size estimation and distance relationship, using the eye alone. Nonetheless, one can build a fairly accurate drawing just by getting the overall shape of a crater or feature down on paper and building on that frame by using it to reference other features' locations. Again, it just takes practice. It helps to perceive shapes as having some rough geometric form, whether it might be the base of a mountain or dome, the areal coverage of certain lunar terrain or the shape of a crater itself. In studying the curves of a crater rim closely, one can break down the structure into a polygonal shape, noticing where the rim turns sharply at various spots around the crater's perimeter [9]. These geometric relationships help in perceiving and reproducing exact size and shapes on paper.

It is also a good idea to look at a finished outline of a drawing in terms of complete unity. Anywhere you look on the Moon except for the disk center, there will be some foreshortening, where a crater that is really circular will look elliptical and the outlines of other features will also appear distorted. In faithfully reproducing the lunar landscape, line by line, this situation should take care of itself. Sometimes though, it is easy to get fooled into thinking you have misinterpreted the nature of a feature. For example, you may have drawn a crater inside another only to realize that the outer one is elliptical while the inner one is basically circular. Such a mismatch may indicate that what was perceived as a inner crater may have been a central peak or curved rille inside the larger crater rather than just a result of sloppy sketch work. Let foreshortening provide clues for your better perception of the lunar landscape.

In addition to viewing the size and proportions of shapes on the Moon, skills in perceiving values of the variation of illumination are important. Value is a measure of the variation between light and dark (see *Figure 1*, p. 84). The lightest tones seen on the Moon occur in areas such as the white central peak features inside some craters, while cast shadows produced by crater walls appear pitch black. On a standard 0-to-10 scale white would then be rated a value of "10" and black a value of "0." Between 0 and 10 are varying tones of gray, the darkest gray near 1, progressively getting lighter and advancing away from 1 toward the

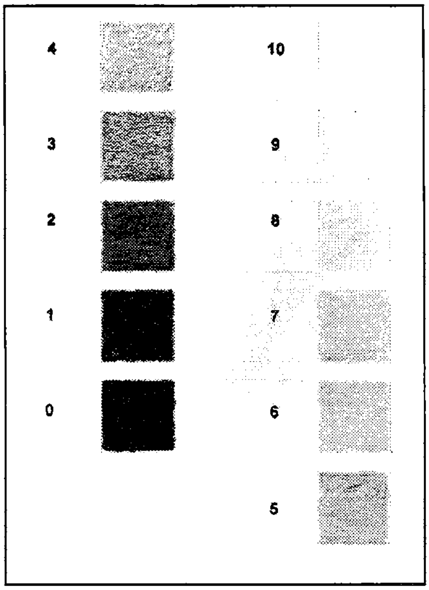

Figure 1.Standard grey-value scale.

lightest gray value of 9. Most lunar surface material exhibits these intermediate gray values.

The first medium that I will focus on is the use of drawing pencils and paper. The amateur astronomer, like the artist, is not limited to pencil sketching, but can use a variety of media including ink, charcoal, and crayon, to name just a few. I will stick to the use of drawing pencils since it is the easiest medium to control and I will describe other media later.

A chief concern for the lunar observer is the direction and quality of sunlight on the surface of the lunar features. One should be able to perceive where and in what direction the Sun is shining and if the Sun is high or low over the lunar horizon. Knowing this will insure a sense of the continuity of the overall shape of the lunar features, and heighten your awareness of unusually cast shadows or other odd forms. It will also dispel any confusion about how the main shadows lie if Sun direction and Sun angle is understood at the beginning of the observation.

The orientation of landforms on the Moon with respect to the direction of sunlight can be defined by the values of light and shadow. A ridge perpendicular to sunlight will usually offer the most contrast, with the sunward side of the ridge being light and the backside being dark. Conversely, a ridge parallel to the rays of the Sun offers little or no contrast except in areas where the ridge curves or terminates. In other words, there will be little or no change in value on either slope of the latter ridge so that the area in question appears as basically a monotone except for secondary lighting effects that we will discuss shortly. The full circumference of a crater rim will exhibit all the above lighting characteristics.

However, where ridges, hills, and rims have portions parallel, or nearly parallel to the Sun's

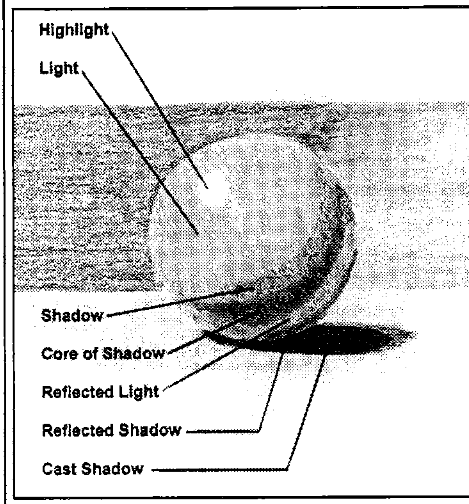

Figure 2. Pencil drawing of ball showing variations in light and shadow.

rays, this condition does not necessarily make them invisible to the eye. While the Sun is, of course, the only direct source of light on the Moon, the lunar landforms themselves conspire to reflect sunlight at various angles that can subtly light features that would normally not stand out on their own. This is particularly true with craters that are reflecting light at every conceivable angle. Naturally, most of the direct sunlight is absorbed by the lunar rock. But enough can be reflected to lighten some shadow areas. The artists of the Renaissance had a name for the study of light and shadow. They called it "chiaroscuro," which comes from the Italian word "chiaro," meaning light, and "oscuro," meaning dark. The technique being used here is simply understanding the change in values seen over a landform and using them to create the illusion of shape and solidity on paper.

Some instructional books on art use the example of a ball resting on a table to demonstrate the dynamics of light and shadow (see *Figure 2*, above). The ball in those examples is lit by a single light source. The ball is casting a shadow on the table and is shadowing itself so that there is a light and a dark side on its spherical surface. It is the dark side of the ball that, upon close inspection, is not all one dark shade but of several darker tones and is not as dark as the cast shadow that the ball presents on the table. These variations can include a gradation from light to shadow at the light/shadow boundary, the deeper darker core shadow, reflected light from nearby surfaces, and reflected shadow from the cast shadow darkening the ball still further. At the opposite side of the ball, we have an area in the lighted portion where the light is most intense and stands out. It is called the "highlight." Constructing an image by replication of these tones on paper gives the ball its definition and the appearance of shape [6].

On the Moon we see these same lighting effects at work. Not all shadows are pitch black.

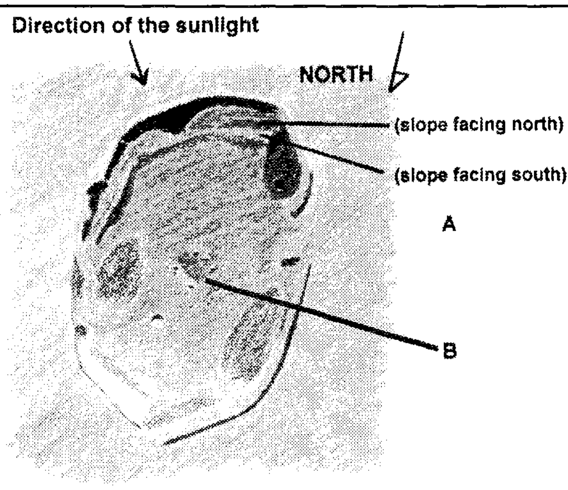

FIGURE 3

The Crater Atlas

Date: November 29, 1995, Time: 1:45 - 2:20 UT,
Colongitude: 350.93° - 351.23°
Sun Angle: Altitude = 24°; Azimuth = 117°,
Seeing: 7 - 8, Transparency: 5,
Instrument: 6 inch f/8 Newtonian reflector, Power: 230

A. Shadow area partially lit up by the opposite ridge
B. Peaks that form a rough circle that could be misconstrued as a rim of a crater

Figure 3. Sample lunar pencil drawing by Matthew Will.

Depending on the Sun angle and lunar terrain, some shadow areas can reveal themselves quite differently from the rest of the terrain in direct sunlight. For example, some bright crater rims can reflect light to soften shadow areas on the opposite and adjacent sided rims (see *Figure 3*, above). Internal reflections of indirect sunlight can expose delicate relief features in shaded areas along the crater rim and floor. These relief features could be ridges, terraced walls, inner craters, ejecta from impact, and so forth. These delicate relief features can cast minor shadows of their own. If the observer is not really looking for them, he or she may only record, say, a bright area without seeing the shadows it projects and thus miss the structure both visually and artistically. Highlighted areas can be just as easily be overlooked. Some gradual rises on the lunar surface "peak out" at a maximum brightness near their light/shadow boundary. Reproducing this visualization on paper gives the effect of dimension and solidity to the feature drawn.

In summary, one has to consider the direction and quality of light to yield a true representation of what is being seen.

FURTHER CONSIDERATIONS FOR DRAWING LUNAR FEATURES

Up to this point, I have written about portraying forms realistically. I would now like to discuss the opposite aspect of form: space. In lunar drawings it can simply be the overall value of the soil or landscape that predominates the drawing. Space is an important quality, because it provides for a foundation that allows our lunar forms to stand out. Of course, not all lunar features project over the lunar landscape very dramatically with great contrast against the background of level land. Nevertheless, even the subtlest contrast can be brought out provided one works properly with the "negative space" (as opposed to positive form that is standing out) as some artists call it. I have a couple of suggestions for working within closely related gray tones.

In sketching the general monotone of the surface, it is a good idea to let your pencil strokes form a consistent pattern. If you choose to draw with diagonal pencil stokes, in accomplishing an overall surface, be sure to follow through over the complete sketch with this same uniform pattern. Haphazard strokes portraying the general surface will make the drawing difficult to view, for it will cause the forms to stand out less and can disorient the viewer's sense perspective. In the past, artist stumps have been recommended for smoothing out pencil shadings to eliminate pencil strokes. Personally, I have found that the artist stumps work best with the H-series pencils that produces the lighter tones. The stumps do not work well with the B-pencils, used for darker shading, and appear to alter both the tone and texture of the drawing when used. It suffices to say that it is a good idea to think about the character of the drawing ahead of time so that you can avoid reworking any major aspects. Of course, the spaces or flat surfaces inside and outside of a crater may display a variety in changing tones across the area it occupies and these variations should be correctly recorded. However, whenever possible, every effort should be made to accentuate positive protruding forms through emphasizing this negative space. Again, I stress the need for portraying the overall landscape accurately but using the space to your best advantage.

In a suggestion related to the above, don't be afraid to be bold with your pencils or other media. Some very accurately made drawings do not stand out well because the tones were drawn too lightly. Working with pencils or other media takes practice, and if one is working from other intensity-estimate diagrams or notational sketches, then one can practice away from the telescope in perfecting a feel for shading.

As much as I have talked about the artistry of lunar drawing, our drawings are still basically scientific records and should be approached as such. The term "composition" in art infers arranging the subject to yield its best visual presence. As an example with a still-life drawing, objects might be arranged to show some uniformity or balance that would be visually stimulating. Since our endeavors are scientific in nature, we cannot treat our drawings as literal artistic compositions. We must report accurately what we are seeing through the telescope. Very fine accuracy in estimating distances may be impossible due to the human error involved in the placement of lunar features. However, an objective, visual recording of features seen as they are is what is needed. Given this requirement, utilizing the tools of artistry that are described above can improve on the presentation of the facts and visualization of what we see.

We can use a couple of techniques in regards to compositional theory without destroying the integrity of our scientific observations. In talking about form and space, I was actually alluding to a broader concept: the organization of technique. A drawing that shows consistency of technique is much easier to view and analyze than one that is variable in style. This is especially true in the use of media other then pencil. One such is ink, where line-drawing techniques like crosshatching, stippling, and so on, are used in place of shading techniques with pencils. Consistency is something that an observer has to be aware of from the initial moments of lining out an observation to the last finishing touches of the drawing.

In my experience with the art courses, I became more and more adept at critiquing my art work. Initially, in the course of completing a project, the art instructor would take each student aside individually and we would view the drawing together privately. During these sessions the instructor would appraise our progress and advise on certain aspects. The idea here was to catch any aberrations in technique before they became too difficult to remedy easily. Also, these critiquing sessions were designed to focus the students' self-examination of their own drawings using what they learned in class. The interaction in these one-on-one meetings allowed the student to acquire the mental perspective to critique his or her work. I believe disciplining yourself to evaluate your own work is the most difficult, and at the same time the most valuable, asset one can apply to his or her work due to its subjective nature. It is from the results of this self-analysis that one should experiment with other methodologies in drawing, to create broader experiences that one can use in future attempts in drawing the Moon and planets.

One need not be confined to the medium of the pencil and the technique of using gray values to represent tonal qualities. Black ink can be a suitable medium for representing tones through the technique of contour line drawing. It will not be in the scope of this paper to discuss contour line drawing in much depth. Andrew Johnson covers the aspects of this approach well in explaining the use of stippling and hatching [5]. There are also other related techniques, such as cross-contouring and the modeled line approach, which are yet other means of portraying dimension in a lunar drawing. The second-semester art class I attended covered this particular aspect of drawing. One of the major projects involved depicting a landscape using ink and line-drawing methods. In a class of only seven or eight students, I was impressed with the differing styles of presentation even though we were all using the same general techniques. My drawing tended to appear much like a draftsman's or architectural sketch. Some students worked toward promoting contrast more. Others seemed to emphasize a sense of motion or mood. Although each one of us had used a different type of landscape to draw, our renderings appeared very different from one another more because we seemed to project our own personalities into these drawings. Sometimes we would over-project a style that could be detrimental to the sketch. For example, in doing pencil shading drawings, I would tend to "under emphasize" darker values, which would lead to rather bland drawings without enough contrast or dimension. So, I had to watch myself to be sure I underscored darker tones with the right amount of contrast so that the shapes in the sketch had solidity. Again, one's personality and propensities can easily be projected into the drawing. However, there is nothing wrong with personal style as long as it doesn't interfere with your intent to render a reasonable likeness of a lunar feature. We are striving for an awareness of one's abilities and shortcomings to express what we wish to characterize as our impressions of the lunar landscape and features. While accuracy and fidelity are important, these goals should not be confused with perfection, which is not humanly possible. We don't wish to kid ourselves into thinking that we can make a photographically accurate reproduction of the lunar surface. That is clearly impossible! Instead we want to draw to the best of our abilities and perceptions.

Evaluating the Usefulness of Art Courses

The art courses I took certainly helped me in improving my artistic style in lunar drawings. These courses made me more knowledgeable and more experienced about artistic techniques than I could have been from only studying the subject on my own. A former director of the A.L.P.O. Training Program, Jose Olivarez, said once that artistic style is something that may take years for an observer to develop. This is certainly true. Regardless of the level of skill one starts out with, personal experience will teach you if you apply yourself on a regular basis. However, like some other amateur astronomers, I felt I was running into a wall and not progressing when it came to lunar observing. Thus I sought formal training in drawing theory. The personal attention and assistance I received from my instructor was invaluable. I could not have obtained this kind of instruction through books or through self-taught experience. Through this interaction I was able to learn not only artistic methodologies but to properly critique my own work as well.

Earlier, I stated that through drawing we become more observant. I think once we draw, we become more involved with the subject matter and question and judge the identification of the features we are seeing. It is then that we can more properly evaluate what it is we are viewing. This is a crucial step in understanding lunar landforms. Along with the aid of a good lunar map or atlas, one can educate himself or herself about lunar geology or selenology [1,8]. As a result, through drawing, we can open up the world of planetary geology which elevates this endeavor from merely an artistic execution to one that combines the skills of both art and science.

Of course, at the core of this discussion is the intent of enhancing our interest in lunar observing through understanding artistic techniques. It is not necessarily true or important that one will or should make Earth-shaking (Moon-shaking?) discoveries while depicting lunar features. I prefer to use the comet-hunting analogy. Most amateurs that hunt for comets don't partake in this search only for the glory of discovery. For them it is a quiet pastime, to learn the night sky degree by degree, minute by minute, in a way they never could looking at an sky atlas alone. It is this act of observing that makes these amateurs become more involved with the night sky. And it is this objective that makes comet-seeking an enjoyable pursuit. Likewise, lunar drawing can be an interest in and of itself, including the primary objects of an observing program. So, as with comet observing the dividends of accomplishment are also evident.

Well, all of this begs the big question. Is a course in drawing theory really necessary to draw the Moon?

The answer to that question lies with the individual. Naturally, any academic course takes commitment and time. Training in the arts is very different from scientific training. The two world views demand different attitudes toward what is being taught. Also, it is a bit of a challenge to learn a skill that is, for the most part, normally absent in our day-to-day lives. My decision to enroll in an art class was not an easy one since I had no previous experience or apparent aptitude in the arts. It was my interest in what I could learn from these courses and how I could apply it to my other activities that spurred me on. Also, this was a brand new experience for me and it opened a world that I had not been exposed to previously. I can say that I certainly benefitted from the art courses. This paper is proof of that. This training has helped me with my observations and allowed me better to help others in the Training Program. I must say that, in the final analysis, taking an art course to improve upon one's artistic style for lunar and planetary drawing is solely an individual decision. The choice depends on whether or not your skill level needs boosting and if you feel comfortable enough to receive instruction in the environment of an art class.

I believe that there remains a great relevance to using drawing in lunar observing today. This tool provides us with a gateway to understanding what it is we are seeing. Using the skills of drawing we can better express our impressions of, and scrutinize more closely, the lunar surface. This specialized focus enhances our knowledge and enjoyment of lunar observation. It also allows us the opportunity to offer our own *personalized* touches to the science of selenology.

Acknowledgments

I wish thank my brother Chris and his wife Patricia for not only critically reviewing this paper but also for their support in providing me invaluable observing time, using the six-inch reflector that Chris maintains. Without their support, this paper would have never have been possible.

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Book Reviews

Edited by Jose Olivarez

Unusual Telescopes.

By Peter L. Manly

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. 221 pages, illustrations, index. Price $49.95 cloth, 1992 (ISBN 0-521-38200-9); and $20.95 paper, 1995 (ISBN 0-521-48393-X).

Reviewed by David H. Levy

Most readers of this Journal are familiar with the long and exciting story of telescopes that began when Galileo first pointed his small spyglass toward the heavens and discovered Jupiter's four moons in 1610. Again in the minds of most readers, this story reached a climax in 1990 and 1993 with the launch and repair of the Hubble Space Telescope. What most readers might not be aware of, however, is that this long journey has taken many strange turns, dead ends, and just plain humorous sidings. In *Unusual Telescopes*, amateur astronomer Peter Manly takes us on an unforgettable tour through these twists and turns.

When Manly set out to write about the unusual and the unique in telescope design, he risked a project that could have been of little value—a listing of telescopes that fell off the train of telescope evolution, made by people with more of an interest in whimsy than science or technology. But this book takes its task seriously, resulting in a good read for people interested in learning about how telescope designs evolved; how some oddball shapes of one time turned into the accepted design of another. Organized around the major headings of optics, mounts, drives, record holders, and whimsy, the book shows us how some of the strange designs of yesterday led to the accepted telescopes of today. In the 1920s, for example, Russell Porter fashioned a decorative garden telescope that used a horseshoe-shaped mounting. That design eventually found its way into Palomar's 5-meter reflector, and variations on it are in use in many large telescopes today.

Manly's book is organized so that off-the-wall designs that succeed, and become part of the tradition of telescope design, come out clearly. Calling these telescopes "mystical machines," he includes telescopes as different as the MMT on Mount Hopkins, one having a liquid mirror formed by rotating a pool of mercury, Michelson's turn-of-the-century 50-foot interferometer at Mount Wilson Observatory, Clyde Tombaugh's 9-inch Newtonian with a mount that used parts from a cream separator and a 1910 Buick, and a host of others—mystical machines these telescopes might be, but they are obviously made from the love and commitment that accompanies a serious love of astronomy.

Sometimes an event, like an occultation or the passage of a satellite over a remote location, requires a telescope that is mobile. While small telescopes have long been carried about, whole observatories have not. Thus, the trailer-mounted 0.4-meter telescope on page 131 comes complete with a dome that rolls into itself like a clamshell, so that dome, telescope, and detector are capable of being moved around and setting up quickly. Other telescopes are specifically meant for limited observing, most particularly the Sun. Manly has a good description of how the long Snow Telescope atop Mount Wilson, with its stationary tube and moveable optics, evolved a half century later into Kitt Peak's much longer solar telescope. The long optical path of the Snow is horizontal, but sunlight entering the famous Kitt Peak telescope goes right along the polar axis, making for one of the most efficiently designed solar telescopes in the world.

For those interested in the far side of telescope evolution, the book's closing chapter on whimsy contains a few notes on telescope ideas like a beer can, and a fork-mounted telescope actually mounted on a dinner fork. Once completed, the reader leaves this book with an increased sense of awareness of how varied and beautiful the history of telescopes has been.

New Books Received

Notes by Jose Olivarez, A.L.P.O. Book Review Editor

Hartung's Astronomical Objects for Southern Telescopes.

By David Malin and David J. Frew

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. Second Edition. 1995. 428 pages. Price: $64.95 cloth (ISBN 0-521-55491-8).

Many of the most spectacular and interesting astronomical objects are found in the southern skies. Professor E.J. Hartung first produced a comprehensive and highly respected guide to these objects in 1968. Now his book has been thoroughly revised and expanded. Nearly 200 objects are illustrated and much new material has been included about the constellations as well as a more modern description of the nebulae and galaxies. New tables also include a "Southern Messier" list of objects.

Many of the beautiful photographs in this second edition were taken by renowned astrophotographer David Malin. Recommended as a unique guide to the southern deep sky!

High Resolution Astrophotography

By Jean Dragesco

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. 1995. 158 pages. Price: $39.95 oversize cloth (ISBN 0-521-41588-8).

Telescopic planetary photography is an art. For those interested in photographing the Sun, Moon, and Planets, this volume provides the complete reference. It is packed with practical tips on how to obtain the highest resolution in your astrophotos and provides a wealth of stunning images by the world's best amateurs showing what can be achieved. Part One, which encompasses 59 pages, discusses atmospheric turbulence, the telescope, and astrophotography at the telescope. Part Two concentrates on high-resolution photography of the main Solar System bodies and is packed with examples of great photographs taken by amateurs whose short biographies are given in Part Three.

High Resolution Astrophotography is a practical and inspirational handbook and a must for those considering entering the high-resolution astrophotography field.

Cosmology

By Michael Rowen-Robinson

Oxford University Press, 198 Madison Avenue, New York, NY 10016. Third Edition. 1996. 170 pages. Price: $29.95 paper (ISBN 0-19-851884-6).

Cosmology is a substantially revised and updated new edition of an introductory textbook first published in 1977. It is strong on observational cosmology with introductory chapters on the visible universe, our galaxy, other galaxies, and the empirical basis for cosmological theory. This edition also includes the latest results from the IRAS and COBE missions and a wealth of new material.

The Ever-Changing Sky—A Guide to the Celestial Sphere

By James B. Kaler

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. 1996. 495 pages. Price: $39.95 cloth (ISBN 0-521-38053-7).

The Ever-Changing Sky is a comprehensive and nonmathematical guide to spherical astronomy. It is basically a textbook and focuses on the geometrical aspects of the night sky without the use of complex trigonometry.

Lowell and Mars

By William Graves Hoyt

The University of Arizona Press, Tucson, Arizona 85721. Second Printing, 1996. 376 pages. Price: $19.95 paper (ISBN 0-8165-0514-4).

This is a welcome paperback reprint of the book that was first published in 1976. *Lowell and Mars* is the definitive study of Lowell's colorful and controversial career and is very well written. It was primarily intended for the general reader but the author's extensive research in the Lowell Observatory Archives also makes this book a valuable compendium of historical material. Hoyt's writing style is clear and direct which makes *Lowell and Mars* a joy to read. Indeed, the controversies that marked Lowell's life and the many sides of his personality are skillfully laid out. Highly recommended as absorbing bedside reading !

The New Astronomy

By Nigel Henbest and Michael Marten

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. Second Edition. 1996. 240 pages. Price: $29.95 paper (ISBN 0-521-40871-7).

The New Astronomy is a rich collection of the finest images of planets, stars, galaxies, and the universe. It presents a host of new information, gathered from literally across the spectrum—spanning the cosmos from X-Rays, through the ultraviolet, visible and infrared bands, and out to radio waves. Each object described is displayed in a variety of wavelengths and the nontechnical text explains the science behind the objects.

For this new edition, there are over 200 entirely new images, selected from the Hubble Space Telescope and orbiting X-ray detectors, as well as from the leading groundbased radio and infrared telescopes. Like the first edition, *The New Astronomy* is a colorful photo book.

Prisoners of Light: Black Holes

By Kitty Ferguson

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. 1996. 214 pages. Price: $24.95 cloth (ISBN 0-521-49518-0).

Prisoners of Light: Black Holes is a comprehensive and detailed account of black holes. It answers the questions "What is a black hole?"; "How does it work?" and "What do back holes teach us about the universe?"

Kitty Ferguson's down-to-earth analogies and her desire to bring the excitement of science to a wide audience make this book stimulating and interesting. Recommended.

Volcanoes of the Solar System

By Charles Frankel

Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211. 1996. 232 pages. Price: $ 24.95 paper (ISBN 0-521-47770-0).

Starting with the Earth, *Volcanoes of the Solar System* takes the reader on a guided tour of the terrestrial planets and moons and their volcanic features. Lunar lava flows are seen through the eyes of the Apollo astronauts, and we are taken on an imaginary hike up the martian slopes of Olympus Mons, the highest volcano in the Solar System.

This comprehensive account of volcanoes includes 70 photographs, describes the most recent data on the unique and varied features of Venus, and updates our knowledge of the active volcanoes of Io. This book will interest both astronomers and earth science students.

The Cambridge Illustrated History of Astronomy

Edited by Michael Hoskins

Cambridge University Press, 40 West 20th Street New York, NY 10011-4211. 1997. 392 pages. Price: $39.95 cloth (ISBN 0-521-41158-0).

Astronomy touches every part of our lives. The *Cambridge Illustrated History of Astronomy* traces its history as a science, describing in detail the various discoveries that have led to our current beliefs about space and the universe. It shows how speculations based on skygazing have formed part of the essential mythology of societies from earliest times; reveals astronomy to be an exacting and serious science; and describes the contributions of great thinkers like Pythagoras, Galileo, Descartes, and Newton.

Some of the nine subject areas covered include "Astronomy in Antiquity"; "Islamic Astronomy"; "Newton and Newtonianism"; and "The Message of Starlight: The Rise of Astrophysics." Contributing authors include J.A. Bennett, Christopher Cullen; David Dewhirst; Owen Gingerich, and Clive Ruggles.

The Cambridge Illustrated History of Astronomy is an elegant book profusely illustrated and with many "special information boxes" scattered throughout that tell about unique people, special places, and discoveries in the history of astronomy. A great book for bedside reading !

An Endowment Fund for the A.L.P.O.

In November, 1997, the A.L.P.O. received a very generous gift of $5000 from the Wilbur Smith Foundation, forwarded by James H. Phillips. This donation was unusually large for our group, which suggested that we need an endowment fund, a move approved by our Board of Directors.

We plan that, unless otherwise designated, members' contributions in excess of their dues be added to this fund, including the non-dues balance for Sponsorships and Sustaining Memberships. Members are encouraged to also contribute directly to this fund, or to make provision for it in their estate planning. (For example, one member has designated a charitable remainder trust to be given to the A.L.P.O. upon his death, or the death of his spouse; a fund currently valued at about $350,000).

The A.L.P.O. Endowment Fund is a growth fund. Making a conservative estimate of $3000 contributed per year, with 10-percent annual growth, the fund would reach $295,000 in 25 years; by which time it would likely be augmented by the aforementioned annuity, giving a total of $645,000. Twenty-five years may appear a long interval, but is less than half the present age of the A.L.P.O. Generous donations in excess of our conservative estimate, especially if augmented by provisions made in wills and trusts,would enable this target to be reached considerably sooner. Gifts in kind, particularly of historical observations and astronomical literature are also solicited. Note that that the A.L.P.O. is a 501(c)-designated nonprofit organization, so that gifts to it are normally tax-deductible.

The most important aspect of the A.L.P.O. Endowment Fund is its intended use. The A.L.P.O. Board of Directors believe that our organization is seriously hampered by the lack of a permanent headquarters and of salaried staff who can be counted upon to perform the business operations of the organization in a timely manner. We note that it is usual for the more-mature amateur organizations in the United States and elsewhere to have such headquarters, where the routine business of the groups is conducted; where files, archives, and libraries are housed; and where meetings and workshops may be held. Simply having an address that does not change is itself an asset.

We believe that a permanent headquarters and paid staff is desirable, and indeed necessary, for the long-term success of the A.L.P.O. Such a goal obviously is beyond achieving through our regular dues income, and this is the role we plan for our Endowment Fund, which ultimately depends on the generosity of our membership.

It's Almost Here!

ALPO '98

Atlanta, Georgia

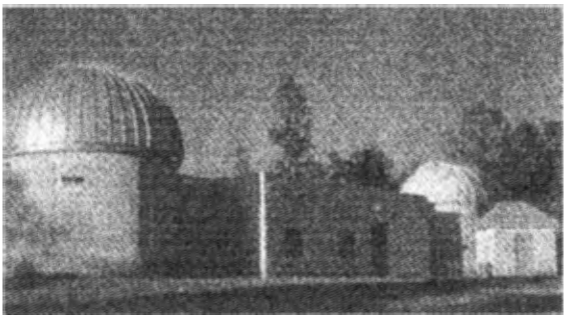
July 9 - 11, 1998

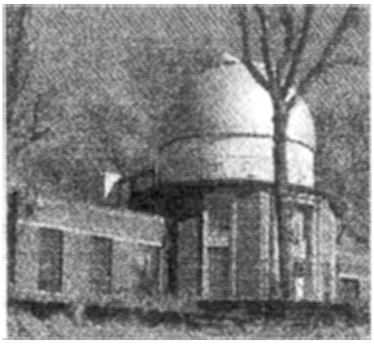
Don't miss out. Register now for the 1998 annual convention of the Association of Lunar and Planetary Observers.

- Paper and business sessions at the prestigious Fernbank Museum of Natural History
- Side trips to Fernbank Science Center Observatory, Agnes Scott College's historic Bradley Observatory, Georgia State University's Hard Labor Creek Observatory, and much more
- Economical, top-rated accommodations nearby

At left, the Fernbank Science Center, home of the Jim Cherry Planetarium and Fernbank Observatory, one of several attractions for after-business visits; at right, the Fernbank Museum of Natural History, site of the daily business sessions.

The Georgia State University Observatory at Hard Labor Creek State Park, featuring a 16-in. Boller & Chivens Classical Cassegrain and a 40-in. Multi-Telescope Telescope (MTT) composed of nine mirrors.





The Bradley Observatory on the campus of Agnes Scott College, houses the 30-inch Lewis H. Beck telescope, an equatorially-mounted Cassegrain. Agnes Scott College and the Bradley Observatory are the site of the founding of the Atlanta Astronomy Club in 1947, today the largest amateur astronomy club in the southeastern United States and your local host while attending this year's ALPO gathering.

For more information, contact:
Ken Poshedly,
1741 Bruckner Ct., Snellville, GA 30078-2784
Phone: (770) 979-9842
E-mail: ken.poshedly@mindspring.com

A.L.P.O.
ANNOUNCEMENTS

Jeffery Sandel Appointed to Solar Section.—Jeffery Sandel has been appointed as an Acting Assistant Solar Coordinator, and will help Coordinator Hill with the production of Solar Section publications; he can be reached at: 937 Michaelmas Avenue, Cayce, SC 29033. Mr. Sandel's ongoing program of solar observation was described in his article, "Observing the Sun by Projection," in the October, 1997, issue of *Sky & Telescope* magazine (pp. 98-100).

Phillip Budine Resigns from Jupiter Section.—Mr. Phillip W. Budine has resigned his position as Assistant Jupiter Coordinator because of personal reasons. The A.L.P.O. owes a debt of gratitude to Phil Budine, who has served the organization in a variety of posts for four decades: Jupiter Recorder 1958-1960 and 1973-1995; Assistant Jupiter Recorder/Coordinator 1967-1971, 1972-1973, and 1996-1998; and Assistant Saturn Recorder, 1960-1961. He served on the A.L.P.O. Board of Directors from 1990-1996 and as Executive Director in 1995. Were all that not enough, Phil Budine has also written and published several books dealing with Solar-System observing.

A.L.P.O. 1998 Convention.—As advertised on page 91, our 49th annual convention will be held in Atlanta, Georgia, on July 9-11, 1998. North American members should have received a registration packet for this conference. For the convenience of overseas members who may be interested, we summarize some of the information here: Business sessions, presentations of papers, and lunches will be held Thursday, Friday and the first half of Saturday (July 9-11) at the Fernbank Museum of Natural History. Our Awards Dinner, with a guest speaker, will be held at the Museum on Friday evening. Lodging will be at the Holiday Inn-Select in Decatur, a short drive from the Fernbank Museum. Registration is $35 per person ($5 late fee after July 1), the Thursday and Friday lunches $11 each, and the Awards Banquet fee is $26 (make checks payable to "ALPO"). If you wish to give a paper, the deadline for the paper abstract, camera-ready paper for the Convention *Proceedings*, and AV requirements is May 31. For lodging, contact: Holiday Inn—Select, Reservations Desk, 130 Clairemont Avenue, Decatur, GA 30030 (404-371-0204 [voice]; 404-377-2726 [FAX]). Rates are $79 plus 12-percent tax per room, whether single, double, or double-double; mention that you are registering for the A.L.P.O. Convention and make payment by June 8, to "Holiday-Inn—Select" if by check; popular credit cards are also accepted).

Copying Consternation.—Our announcement in Vol. 39, No. 4 (p. 192), that photocopier ("xerox") copies of drawings, photographs, or electronic images could not be accepted for publication caused some readers to assume that they now must submit their original drawings to Section Coordinators and to this Editor. This is not the case. (I) The restriction applies to illustrations submitted to this *Journal* only; Coordinators may accept photocopied drawings if they wish, although such observations will not be published in Section reports appearing on these pages. (II) The restriction is for grey-scale figures only; electrostatic copies of black-and-white original ink or stipple drawings remain acceptable. (III) There are several alternatives for creating acceptable grey-scale copies without giving up one's original drawings (photographs or electronic images can of course be readily reproduced): (1) Make a grey-scale copy by hand (e.g., using drawing pencils); (2) Make an electrostatic copy by adding grey scale to it (3) Make a photographic copy; (4) Scan the original and then print out a copy with either a color printer or with a 600 dpi or better laser printer; (5) Scan the original and send the editor a JPEG- or GIF-format computer file; (6) Use a digital camera to image the illustration and then either print out the image (see method 4) or send a file (see method 5); or (7) Use a color copier set to "Black", which will produce grey-scale copies.

Exploring the Solar System With the ALPO.—This is the title of an attractive and informative 33-page booklet, recently edited by Leonard Abbey, that is intended to inform non-members about the activities of our organization. We thank Mr. Abbey for his efforts in producing this information source, which we are sure will help to attract new members. If you are in a situation to help recruit members, contact Harry Jamieson, our Director/Membership Secretary, for copies to distribute.

RELATED ANNOUNCEMENTS OF INTEREST TO OUR READERS

The Astronomical Almanac To Be Revised.—Users worldwide rely on *The Astronomical Almanac* as a key source of essential, fundamental astronomical data. This annual volume is a joint publication of the Astronomical Applications Department of the U.S. Naval Observatory and H.M. Nautical Almanac Office of the Royal Greenwich Observatory. Both offices are now conducting a thorough review of the content and format of the publication, with the goal of making it more relevant to modern users. Some of the proposed changes include: adoption of the International Celestial Reference System (ICRS); introduction of a more modern ephemeris of the solar system to replace DE200/LE200; provision of a companion CD-ROM to the printed book; removal of outdated sub-sections. The entire contents of the book are being reviewed item by item. Some tabular data may be removed entirely. Other data may be moved to the CD-ROM, or may be replaced or complemented by software which can calculate, then display or print those data. The changes are expected to be introduced into the edition for 2002.

In order to assess the needs of the users of *The Astronomical Almanac,* a survey is being conducted by the two offices. The survey is on the World Wide Web at http://www.ast.cam.ac.uk/nao/survey.html. Unless the users of *The Astronomical Almanac* make their needs known in detail, decisions on the changes will be entirely at the discretion of the production staff. Thus all users are strongly encouraged to take the time necessary to complete the survey. The survey will close on 1 August 1998. Early responses will be more effective in influencing the planning. If a user has no access to the World Wide Web, an abbreviated paper version of the survey may be obtained by writing to the U.S. Naval Observatory, Astronomical Applications Department, 3450 Massachusetts Avenue NW, Washington, DC, 20392-5420.

Many A.L.P.O. observers use the Solar-System data in The Astronomical Almanac, but some of these may be removed unless you make your opinions known by participating in this survey. Also there may be data of use to you that do not now appear but which might be added if there is sufficient demand.

MOONLINK.—MOONLINK brings interactive lunar exploration into classrooms around the world by connecting students to the Lunar Prospector spacecraft. If you are interested in sponsoring or otherwise participating in this program, or are a teacher and would like your students to participate, contact: Scott Piotrowski, Director, International Programs, Space Explorers, Inc., 1825 Nimitz Drive, DePere, WI 54115 USA. Telephone: 920-339-4600. E-mail: international@space-explorers.com . Web page: www.space-explorers.com .

Positions at the Astronomical Society of the Pacific.—The nonprofit Astronomical Society of the Pacific is seeking to fill two positions for Project ASTRO: **(1) Bay Area Project ASTRO Coordinator. (2) Project ASTRO Summer 1998 Position**. For further information, contact: Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112.

Forthcoming Amateur and Professional Meetings.—The following meetings are scheduled in the next several months. Information contacts are given in brackets.

May 15-17: International Dark-Sky Association (IDA). 10th anniversary meeting, Park Tucson Hotel, Tucson Arizona. [IDA, 3545 N. Ste3wart Avenue., Tucson, AZ 85716; 520-293-3198 (voice), 520-293-3192 (FAX); saveoursky@aol.co]

May 20-22: International Amateur-Professional Photoelectric Photometry (IAPPP). Mile High Lake Arrowhead Resort, Lake Arrowhead, CA. [Lee Snyder. MacLean Observatory, P.O. Box 3964, Incline Village, NV 89450; 702-831-1931 (voice); 701-831-5535 (FAX); snyder@rigel.physics.unr.edu]

May 22-25: Riverside Telescope Makers Conference (RTMC). At YMCA Camp Oakes near Big Bear, California. This year is the 30th RTMC, with the theme "Rocks in Space." Dr. Eleanor Helin is the keynote speaker with a talk titled, "Detecting Asteroids and Comets with a NEAT System." Other events include paper sessions, the Saturday morning Swap Meet, and commercial vendors.[Fox & Stephens, CPAs, 9045 Haven Avenue., Suite 109, Rancho Cucamonga, CA 91730; 909-948-2205 (voice); robert_stephens@eee.org; Website: http://home.sprynet.com./sprynet/hrmeyer/rtmchome.htm]

June 27-28: UNIVERSE'98. The Astronomical Society of the Pacific (ASP)-Astronomy magazine will sponsor this astronomical exposition at the Hyatt Regency Hotel in Albuquerque, New Mexico. This event will proceed the 110th Annual Meeting of the ASP. [Annual Meeting (General Info.), Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112; 415-337-1100 X-109 (voice); 415-337-5205 (FAX); lkeechler@aspsky.org; Website: www.aspsky.org]

July 6-11: International Astronomical Union Colloquium 172: The Impact of Modern Dynamics in Astronomy. This meeting will be held in Namur, Belgium, and will include the formation and evolution of planetary and satellite systems, planetary rings, and asteroid and comet dynamics. [Website: heetp://www.fundp.ac.be/~iau172/ }

July 18-August 8: International Astronomical Youth Camp (IAYC 1998). 34th International Astronomical Youth Camp, Klingenthal, Germany. [IWA e.v., c/o Gwendolyn Meeus, Parkstraat 91, 3000 Leuven, Belgium; gwendolyn@ster.kuleuven.ac.be; Website: http://www.ster.kuleuven.ac.be/~bart/iayc]

July 21-24: Western Pacific Geophysics Meeting—Special Sessions on Planetology. Sponsored by the American Geophysical Union, meeting in Taipei, Taiwan. [AGU Meetings Department, 1998 Western Pacific Geophysics Meeting, 2000 Florida Ave. NW, Washington, DC 20009. 1-800-966-2481 (voice, toll-free in North America); +1-202-328-0566 (FAX); meetinginfo@kosmos.agu.org; Website: http://www.agu.org/meetings/wp98top.html]

July 21-25: ALCON'98. Astronomical League 51st Annual Convention at French Lick Resort, Indiana. [Mitch Lumans, 2539 Ruby Lane, Wadesville, IN; 812-985-7739; mlumans@aol.com. Registration Information: Charles Miller, P.O. Box 3474 Evansville, IN 47733. E-mail newsletter: alcon98@gs1.revnet.com (type "Join"). Website: http://ourworld.compuserve.com/homepages/scanner]

A.L.P.O. Information

The Association of Lunar and Planetary Observers

Founded by Walter Haas in 1947, the A.L.P.O. now has about 500 members. Our dues include a subscription to our quarterly Journal *(J.A.L.P.O.), The Strolling Astronomer*, and are $23.00 for one year ($40.00 for two years) for the United States, Canada, and Mexico; and $30.00 for one year ($54.00 for two years) for other countries. One-year Sustaining Memberships are $50.00; Sponsorships are $100.00. There is a 20-percent surcharge on all memberships obtained through subscription agencies or which require an invoice.

Our advertising rates are $85.00 for a full-page display advertisement, $50.00 per half-page, and $35.00 per quarter-page. Classified advertisements are $10.00 per column-inch. There is a 10-percent discount for a three-time insertion on all advertising.

All payments should be in U.S. funds, drawn on a U.S. bank with a bank routing number, and payable to "A.L.P.O." All cash or check dues payments should be sent directly to: A.L.P.O. Membership Secretary, P.O. Box 171302, Memphis, TN 38187-1302. VISA or MasterCard may be used by telephoning the Chabot Observatory and Science Center, 510-530-3480 (ask for "Extension 30" and leave a message) between the hours of 10 AM-noon and 1-4 PM Pacific Time, M-F, or by mail to: Chabot Observatory and Science Center, Starry Nights Gift Shop, 4917 Mountain Boulevard, Oakland, CA 94619 U.S.A; you may also FAX to 1-510-879-2194.

When writing to our staff, please provide stamped, self-addressed envelopes. Note that the A.L.P.O. maintains a World-Wide Web homepage at: http://www. lpl.arizona.edu/alpo/

Keeping Your Membership Current.—The top line of your *J.A.L.P.O.* mailing label gives the volume and issue number when your membership will expire (e.g., "40.2" means Vol. 40, No. 2). We also include a First Renewal Notice in that issue, and a Final Notice in the next one. Please let the Membership Secretary know if your address changes. Dues payments should be made directly to the Membership Secretary (unless if by credit card as described above).

A.L.P.O. Monograph Series

A.L.P.O. monographs are publications that we believe will appeal to our members, but which are too lengthy for our Journal. Order them from our Editor (P.O. Box 16131, San Francisco, CA 94116 U.S.A.) for the prices indicated, which include postage; make checks to "A.L.P.O."

Monograph Number 1. ***Proceedings of the 43rd Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, August 4-7, 1993.*** 77 pages. Price: $12.00 for the United States, Canada, and Mexico; $16.00 elsewhere.

Monograph Number 2. ***Proceedings of the 44th Convention of the Association of Lunar and Planetary Observers. Greenville, South Carolina, June 15-18, 1994.*** 52 pages. Price: $7.50 for the United States, Canada, and Mexico; $11.00 elsewhere.

Monograph Number 3. ***H.P. Wilkins 300-inch Moon Map.*** 3rd Edition (1951), reduced to 50 inches diameter; 25 sections, 4 special charts; also 14 selected areas at 219 inches to the lunar diameter. Price: $28.00 for the United States, Canada, and Mexico; $40.00 elsewhere.

Monograph Number 4. ***Proceedings of the 45th Convention of the Association of Lunar and Planetary Observers. Wichita, Kansas, August 1-5, 1995.*** 127 pages. Price: $17.00 for the United States, Canada, and Mexico; $26.00 elsewhere.

Monograph Number 5. ***Astronomical and Physical Observations of the Axis of Rotation and the Topography of the Planet Mars. First Memoir, 1877-1878.*** By Giovanni Virginio Schiaparelii, translated by William Sheehan. 59 pages. Price: $10.00 for the United States, Canada, and Mexico; $15.00 elsewhere.

Monograph Number 6. ***Proceedings of the 47th Convention of the Association of Lunar and Planetary Observers, Tucson, Arizona, October 19-21, 1996.*** 20 pages. Price $3.00 for the United States, Canada, and Mexico; $4.00 elsewhere.

Other Publications of the A.L.P.O.

(Checks must be in U.S. funds, payable to an American bank with bank routing number.)

Order from: A.L.P.O., P.O. Box 16131, San Francisco, CA 94116, U.S.A:

An Introductory Bibliography for Solar System Observers. Free for a stamped, self-addressed envelope. A 4-page list of books and magazines about Solar System bodies and how to observe them. The current edition was updated in June, 1996.

Order from: A.L.P.O. Membership Secretary, P.O. Box 171302 Memphis, TN 38187-1302 U.S.A:

A.L.P.O. Membership Directory. $5.00 in North America; $6.00 elsewhere. Continuously updated list of members on 3.5-in MS-DOS diskette; either DBASE or ASCII format. Make payment to "A.L.P.O." Also available as an e-mail downloaded file, given the requester's e-mail address. Provided at the discretion of the Membership Secretary.

Order from: Walter H. Haas, 2225 Thomas Drive, Las Cruces, NM 88001, U.S.A:

Back issues of *The Strolling Astronomer (J.A.L.P.O.).* The back issues listed below are still in stock but may not long remain so. In this list, volume numbers are in italics, issue numbers are not, and years are given in parentheses. The price is $4.00 for each back issue; the current issue, the last one published, is $5.00. We are always glad to be able to furnish old issues to interested persons and can arrange discounts on orders of more than $25. Make payment to "Waiter H. Haas."

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Current Issue [*40*, 2]; $5.00.

PUBLICATIONS OF THE SECTIONS OF THE A.L.P.O.

Order the following directly from the appropriate Section Coordinator; use the address in the staff listing unless another address is given below.

Lunar and Planetary Training Program (Robertson): *The Novice Observers Handbook,* $10.00. 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."

Solar (Graham): *Solar and Lunar Eclipse Observations 1943-1993;* $25.00 postpaid. (A Handbook for Solar Eclipses is under preparation.)

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 (Graham): (1) *Forms* with explanations (in English or German); send a SASE. (2) *Lunar Photometry Handbook,* $5.00 Ppd. paperbound, $15.00 Ppd. hardbound. (3) Orders are now being accepted for a *Lunar Eclipse Handbook,* $3.00 paperbound plus $1.00 shipping and handling. (4) *Solar and Lunar Eclipse Observations 1943-1993;* $25.00 postpaid.

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.

Venus (Benton): (1) *The ALPO Venus Observing Kit,* $17.50. Includes introductory description of A.L.P.O. Venus observing programs for beginners, a full set of observing forms, and a copy of The Venus Handbook. (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Venus Forms. (To order the above, send a check or money order made out to "Julius L. Benton, Jr." All foreign orders should include $5.00 additional for postage and handling; for domestic orders, these are included in the prices above. Shipment will be made in two to three weeks under normal circumstances. NOTE: Observers who wish to make copies of observing forms have the option of sending a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the A.L.P.O. Venus, Saturn, or Lunar SAP Section. Observers should make copies using high-quality paper.)

Mars (Troiani): 1) *Martian Chronicle;* send 8-10 SASEs; published approximately monthly during each apparition. (2) *Observing Forms;* send SASE to obtain one form which you can copy; otherwise send $3.60 to obtain 25 copies (make checks out to "J.D. Beish").

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

Jupiter (Westfall): *Timing the Eclipses of Jupiter's Galilean Satellites;* send a SASE with 55 cents in stamps. 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 ALPO 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.)

Comets (Machholz): Send SASEs to the Coordinator for monthly installments of *Comet Comments,* a one-page newsletter reviewing recent comet discoveries and recoveries, and providing ephemerides for bright comets.

Meteors (Astronomical League Sales, P.O. Box 572, West Burlington, IA 52655): (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 32¢ in postage per issue to Coordinator Robert D. Lunsford, 161 Vance Street, Chula Vista, CA 91910.

Minor Planets (Derald D. Nye, 10385 East Observatory Dr., Corona de Tucson, AZ 85641-2309): Subscribe to: *The Minor Planet Bulletin;* quarterly, $9.00 per year for the United States, Mexico and Canada; or $13.00 for other countries (air mail only).

Computing Section (McClure): A Computing Section Newsletter, *The Digital Lens,* is available via e-mail. To subscribe or to make contributions, contact the editor, Mike W. McClure, at: MWMCCL1 @ POP.UKY.EDU .

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