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The April 14, 1987, penumbral lunar eclipse as seen from the Moon. Painted by Edwin Faughn, copyright 1987. Near the Moon's North Pole, the Earth covered about three-quarters of the Sun's disk. See pages 32-35 of this issue about the upcoming total lunar eclipse on February 20, 1989.

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IN THIS ISSUE

THE 1984-85 EASTERN (EVENING) APPARITION OF THE PLANET VENUS: VISUAL AND PHOTOGRAPHIC OBSERVATIONS

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ABSTRACT

Visual and photographic observations of the planet Venus for the 1984-85 Eastern (evening) Apparition are summarized, based on an extensive analysis of data submitted by A.L.P.O. Venus Section observers in the United States and several other countries. The report emphasizes the sources of data and the instrumentation used in acquiring information about Venus. For the 1984-85 observing season, there is a statistical analysis of the categories of features seen or suspected at visual wavelengths (integrated light and color filters) in the atmosphere of Venus. A similar treatment is given to the cusps, cusp-caps, and cusp-bands, together with a brief discussion of the Ashen Light and other curious dark-hemisphere phenomena. Comparative studies deal with observers, instrumentation, visual and photographic data, simultaneous observations, and so forth. Illustrations accompany the text of the report in order to enhance the reader's overall appreciation of the variable phenomena observed in the atmosphere of Venus in 1984-85

INTRODUCTION

Observers submitted an excellent variety of visual and photographic observations of the planet Venus during the 1984-85 Apparition, and this report is based upon an extensive analysis and evaluation of these data. The appropriate geocentric phenomena during this apparition are given in *Table 1* below in Universal Time (UT).

Table 1. Geocentric Phenomena for the 1984-85 Apparition of the Planet Venus.

Superior Conjunction................	1984 JUN	15, 23^h UT
Greatest Elongation East..........	1985 JAN	22, 02 (47°)
Greatest Brilliancy.....................	FEB	26, 18 (Mag. -4.6)
Stationary..................................	MAR	12, 08
Inferior Conjunction.................	APR	03, 22

A total of 137 observations, including visual drawings and photographs (chiefly at visual wavelengths), was collected for the 1984-85 Apparition. A histogram is presented in *Figure 1* (p. 2) that illustrates the distribution of observations by month.

Observational coverage of Venus was fairly good during this apparition, with individuals starting their observing program early in the period and following through until conjunction with the Sun. The observational period extended from 1984 JUL 21 through 1985 MAR 31, with maximum effort during the months of 1984 December through 1985 March, which included 89.8 percent of the observations. As in previous apparitions, the time of greatest emphasis took place around the time of greatest elongation from the Sun and greatest brilliancy.

Fifteen persons submitted visual and photographic observations of Venus during the 1984-85 Eastern (evening) Apparition, and a list of these colleagues, along with the number of observations they contributed, and the instruments they used, is summarized in *Table 2* (p. 2). Our warmest thanks are extended to all of the dedicated observers in the United States and abroad for their continued participation in our efforts to monitor variable phenomena in the atmosphere of the planet Venus.

OBSERVATIONS OF VENUSIAN ATMOSPHERIC DETAILS

As noted in earlier reports that have appeared in this Journal, conventional methods and techniques of making visual studies of somewhat vague, elusive "markings" in the atmosphere of Venus have been outlined in appropriate Venus Section pamphlets and booklets. [*1,2,3*] Careful study of these sources is strongly suggested, as well as of previous apparition reports, for those unfamiliar with the nomenclature used or with the basic observational methods.

This report is based upon descriptive notes, accompanying drawings, and numerous photographs, the latter chiefly taken at visual wavelengths. A sample of these drawings and photographs accompanies this report in order to aid the reader in interpreting the phenomena reported or suspected on Venus in 1984-85.

The visual and photographic data for 1984-85 represented nearly all the categories of dusky and bright markings on Venus, as covered in depth in the literature cited earlier. A quantitative treatment of this material similar to that done in earlier Venus apparition reports, appears in *Table 3* (p. 3), which shows the percentages of observations which fit specific categories. *[Text continued on p. 3.]*

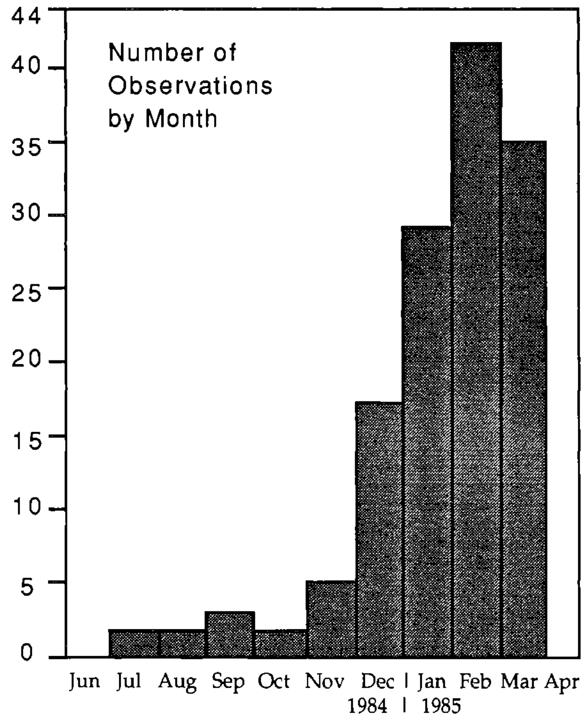


Figure 1. Frequency of Venus observations by month during the 1984-85 Eastern (evening) Apparition.

Table 2. Participants in the A.L.P.O. Venus Observing Program During the 1984-85 Eastern (Evening) Apparition

Observer and Location	No. of Observations	Instrument(s) Used
Domenec Barbany. Barcelona, Spain	4	8.0cm (3.1in) Refractor
Julius L. Benton, Jr. New Hope, PA	20	15.2cm (6.0in) Refractor
Edwin W. Faughn. Paragould, AR	1	20.3cm (8.0in) Newtonian
Marc A. Gelinas. St-Hubert, Quebec, Canada	17	20.3cm (8.0in) Schm.-Cass.
D.L. Graham. Brompton-on-Swale, England	13	10.2cm (4.0in) Refractor
Walter H. Haas. Las Cruces, NM	7	31.8cm (12.5in) Newtonian
Alan W. Heath. Nottingham, England	28	30.5cm (12.0in) Newtonian
Daniel Louderback. South Bend, WA	1	20.3cm (8.0in) Schm.-Cass.
M. Maksymowicz. Moisson, France	9	11.2cm (4.4in) Refractor 15.0cm (5.9in) Refractor 20.3cm (8.0in) Schm.-Cass.
Paul Maxson. Phoenix, AZ	15	27.9cm (11.0in) Schm.-Cass.
Gary T. Nowak. Williston, VT	2	20.3cm (8.0in) Schm.-Cass.
Peter Scott. Indiana, PA	1	20.3cm (8.0in) Schm.-Cass.
Don Spain. Fairdale, KY	13	9.0cm (3.5in) Maksutov
Richard Tanger, Jr. Pleasantdale, NJ	4	6.0cm (2.4in) Refractor 7.6cm (3.0in) Refractor
Roger Venne. Quebec, Canada	2	20.3cm (8.0in) Newtonian

Total Number of Observers.,....... 15
Total Number of Observations.... 137

Note: "Schm.-Cass." means Schmidt-Cassegrain.

Table 3. Frequency of Occurrence of Types of Markings in the Atmosphere of Venus During the 1984-85 Eastern (evening) Apparition.

Apparent Surface (Atmospheric) Feature Categories	Percentage of 137 Reports
Banded Dusky Markings	7.3 %
Radial Dusky Markings	0.7
Irregular Dusky Markings	6.6
Amorphous Dusky Markings	31.4
Terminator Shading	27.7
No Markings Seen or Suspected	65.7
Bright Spots or Regions (exclusive of the cusp regions)	5.1

Notes:

1. The geometric phase k ranged from 0.986 (1984 JUL 21) to 0.014 (1985 MAR 31).
2. Assuming that the bright illuminated hemisphere of Venus (all areas devoid of any shadings or obvious markings) was typically assigned a relative numerical intensity of 8.5 to 8.7 in 1984-85, it was noted that the average assigned intensity for the dusky shadings (the first five items in *Table* 3) in integrated light (no filter) was about 7.5 to 7.8 in 1984-85; the last category in *Table 3* had an assigned intensity value of 9.0 during this period. (Intensities are on the standard A.L.P.O. scale, where 0.0 is totally black shadow and 10.0 is the most brilliant features ever seen.)
3. The scale of conspicuousness, ranging from 0 for definitely not seen to 10 for certainly seen, was utilized somewhat effectively in the 1984-85 Apparition, when the conspicuousness rating was about 5.0 for the first five items in *Table 3*, as well as for the bright spots, indicating that all features' presences lay somewhere between vague suspicions and strong indications.
4. Seeing conditions, on the standard A.L.P.O. scale (ranging from 0 for the worst possible to 10 for perfect), averaged about 3.0 to 3.5; generally poor to fair at best.
5. Transparency conditions, normally expressed as the faintest star detectable by the naked eye on a clear, dark night in the region of the planet (reference objects usually noted), were quite difficult to evaluate owing to the fact that nearly all observations were carried out against a twilight or daytime sky. When Venus was seen in a fairly dark sky, and thus at a relatively low altitude, the evaluated transparency averaged about +4.5.

[Text continued from p. 1.]

Despite diligent efforts to reduce subjectivity, this factor must affect the quantitative data for this apparition, but some reasonable if tentative conclusions may be derived from the percentages in *Table 3*,.

For example, more than half of the drawings and other visual observations of Venus, and nearly all of the photographs submitted, showed the planet as completely devoid of any shadings or markings of any kind. It is well established that the markings of Venus' atmosphere are highly elusive, both to the novice and to the experienced observer, and it would be helpful to have photographs of the planet taken at ultraviolet wavelengths in order to bring out any dusky markings. It is also true that markings revealed in the ultraviolet differ characteristically from those occasionally seen or suspected at visual wavelengths, particularly with respect to radial dusky patterns.

Terminator shading was reasonably apparent in 1984-85, when there was a usual tendency for the terminator shading to lighten (i.e., assume a higher intensity value) as one proceeded from the terminator toward the illuminated limb. In some cases, this gradation terminated in the bright limb band. Normally, this shading extended from one cusp region to the other, and this shading was most common from around the time of dichotomy (1984 JAN 24) and later, when the phase was a crescent. In terms of photographs, only a few submitted during this apparition suggested terminator shading.

In 1984-85, the majority of the dusky markings reported were in the category, "Amorphous Dusky Markings" (in 31.4 percent of all observations in *Table 3*). Other dusky atmospheric features were divided almost equally between "Dusky Banded Markings" (7.3 percent) and "Irregular Dusky Markings (6.6 percent), with only one observation of "Radial Dusky Markings" (0.7 percent).

Excluding the cusp regions, bright regions or mottling were rarely observed during the 1984-85 Apparition. A few drawings and perhaps one or two photographs depicted these bright spots or regions on Venus.

Color filter observations with Wratten 47 (violet), W25 (red), W15 (yellow), and other filters showed variable enhancement of atmospheric features on Venus. A systematic use of color filters of known transmission, together with studies in integrated light (no filter), can be immensely useful. Observations using these colorimetric techniques are highly encouraged for future apparitions.

CUSPS, CUSP-CAPS, AND CUSP-BANDS

The most contrasting and conspicuous features in the atmosphere of Venus are found at or near the cusps of the planet, usually when its phase lies between 0.8 and 0.1 (measured by **k**, the proportion of the disk that is illuminated). These cusp-caps occasionally appear on Venus, sometimes bounded by darkish, often diffuse, peripheral cusp-bands.

Table 4, below, presents selected cusp-cap and cusp-band statistics for the 1984-85 Apparition, from which several conclusions can be drawn.

Table 4. Cusp-Cap and Cusp-Band Statistics: 1984-85 Eastern (evening) Apparition of Venus.

Condition of Feature(s)	Percentage of 137 Reports
South Cap Alone Visible	1.5 %
Both Caps Visible	27.7
North Cap Alone Visible	2.2
Either or Both Caps Visible	31.4
Neither Cap Visible	68.6
South Cap the Larger in Size	5.1 %
Both Caps Equal in Size	22.6
North Cap the Larger in Size	3.7
South Cap the Brighter	5.1 %
Caps of Equal Brightness	24.1
North Cap the Brighter	2.2
S. Cusp-Band Alone Visible	0.0 %
Both Cusp-Bands Visible	5.1
N. Cusp-Band Alone Visible	0.7
Either or Both Cusp-Bands Vis.	5.8
Neither Cusp-Band Visible	94.2

Notes:

1. Assuming that the relative numerical intensity of the bright illuminated hemisphere of Venus was typically 8.5 to 8.7 in 1984-85, the mean intensity of the cusp-caps averaged about 9.5 to 9.7. The average value for the cusp-bands was 7.8 for this apparition.
2. The seeing and transparency notes in *Table 3* (p. 3) apply here as well.
3. The sum of the percentages in the above table does not always equal 100, particularly for the size and brightness of the cusp-caps. Clearly, when only one cusp-cap was visible, it was not possible to make comparisons of size and brightness.

During the 1984-85 Eastern (evening) Apparition, when the southern and northern cusp-caps of Venus were recorded, they were most frequently seen at the same time. There were times, however, when only one was detected; the northern cusp-cap marginally more frequently than the southern in this case. Neither cusp-cap was reported in over two-thirds of the observations.

In terms of size, the cusp-caps were usually equal when both were seen, but there were times when one was larger than the other. Also, when both cusp-caps could be seen, they were usually reported as equal in brightness. However, in 1984-85, as with cusp-cap size, one cusp-cap was sometimes reported as brighter than the other.

The cusp-bands are dusky features occasionally seen bordering either or both of the cusp-caps. As *Table 4* shows, they were only rarely reported in 1984-85. When they were seen, both were reported, although there were one or two observations when a single northern cusp-band was suspected.

EXTENSION OF THE CUSPS

Most observers reported only very slight cusp extensions for Venus during the 1984-85 Apparition. However, these extensions were seldom shown on drawings and no photographs showed them when they were suspected visually. [Haas and Maxson sometimes reported considerable extensions. They are, of course, difficult to photograph, being considerably fainter than the fully sunlit portions of the disk. Ed.]

THE BRIGHT LIMB BAND

In 1984-85, 37.2 percent of the 137 observations submitted noted a bright limb band on the sunlit limb of Venus. This feature extended from cusp to cusp, was narrow in width, and uniform in intensity throughout its extent. The average numerical intensity assigned to this feature was 9.5 to 9.7.

TERMINATOR IRREGULARITIES

The terminator of Venus is the geometric curve that separates the sunlit and dark hemispheres of the planet. During the 1984-85 Apparition, 10.2 percent of the 137 observations submitted reported terminator irregularities. Amorphous and irregular dusky markings and, to a lesser extent, banded and radial dusky shadings merged with the terminator shading and possible reported deformities along the otherwise geometrically regular terminator in 1984-85.

THE ASHEN LIGHT AND OTHER DARK-HEMISPHERE PHENOMENA

Throughout the 1984-85 Eastern (evening) Apparition, there were no instances of confirmed visual or photographically detected darkside phenomena on Venus.

ESTIMATES OF PHASE AND DICHOTOMY

The "Schröter Effect" on Venus, a discrepancy between the predicted and the observed dates of dichotomy (half phase), was reported in 1984-85. The predicted date occurs when **k** = 0.500 and **i** = 90°, where **i** is the phase angle (the angle between the Sun and the Earth as seen from Venus). The observed-predicted discrepancies in these values for the 1984-85 Apparition are given in *Table 5* below.

Table 5. Observed and Predicted Dichotomy of Venus: 1984-85 Eastern (evening) Apparition.

Predicted Dichotomy.... 1985 JAN 24.4

(Observed - Predicted) Discrepancy:

	Gelinas *et al.*	Heath
Observed Date, JAN:	22.3^d	22.7^d
Discrepancy: Date	-2.1^d	-1.7^d
Phase (**k**)	-.011	-.009
Phase Angle (**i**)	+1°.2	+1°.0

CONCLUSIONS

Limited activity was reported in the atmosphere of Venus during the 1984-85 Eastern (evening) Apparition. It should be interesting to compare the 1984-85 Apparition of Venus with previous evening apparitions, or even with morning observing seasons. It will undoubtedly be discovered that the features of Venus' atmosphere remain as elusive as ever, and there definitely exists an opportunity for further work on the planet, particularly in terms of simultaneous observations and ultraviolet photographs. Although Venus frequently appears devoid of any details at all, there are times when the patterns of the ephemeral dusky or bright markings become visible to the persistent observer. Continued monitoring of the planet by diligent participants over many years remains our major emphasis, and interested readers are encouraged to join us in our efforts to gather information about the planet Venus.

REFERENCES

1. Benton, Julius L., Jr. (1973). *An Introduction to Observing Venus.* Savannah, Review Publishing Co.
2. ________ (1987). "The 1983-84 and 1985-86 Western (Morning) Apparitions of Venus: Visual and Photographic Observations." *J.A.L.P.O., 32,* Nos. 5-6 (Oct.), 93-101.
3. ________ (1988). *Visual Observations of Venus: Theory and Methods (the ALPO Venus Handbook).* Pub. by author.
4. U.S. Naval Observatory (1983). *The Astronomical Almanac, 1984.* Washington: U.S. Government Printing Office.
5. ________ (1984). *The Astronomical Almanac, 1985.* Washington: U.S. Government Printing Office.

SELECTED DRAWINGS AND PHOTOGRAPHS OF VENUS, 1984-85 EASTERN (EVENING) APPARITION

The drawings and photographs here and on the following pages are oriented in the normal simply inverted view with south at the top and preceding (celestial east) to the right. Unless otherwise stated, seeing is on the A.L.P.O. scale (0 = worst, 10 = best), while transparency is the limiting naked-eye stellar magnitude.

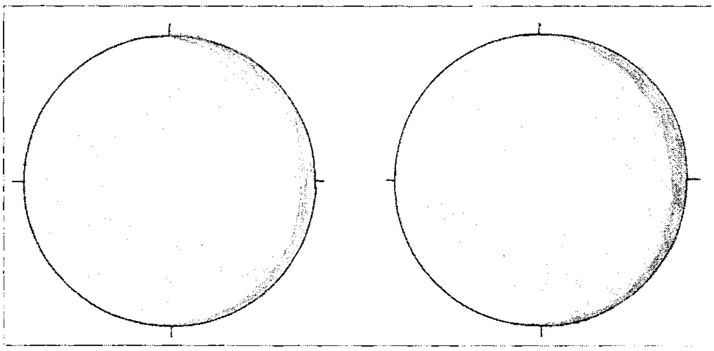


Figure 2. Drawings by M. Maksymowicz on 1984 JUL 29. 15-cm. refractor. Seeing 2-3, transparency 7 (scale of 10). *Left:* 13h 00m UT, 150X-225X with W58 (green) Filter. *Right:* 13h 30m UT, 150X with W26 (red) Filter. Diameter = 9".9, **k** = 0.977.

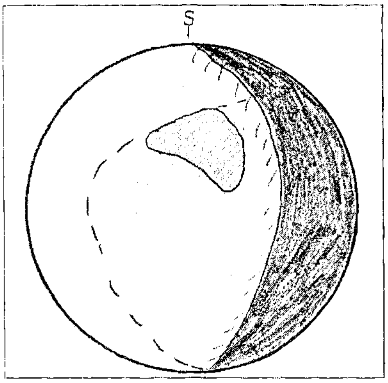


Figure 3. Drawing by Marc Gelinas on 1984 NOV 30, 21h 27m-21h 40m UT. Seeing = 5, Transparency = +3.7. 20-cm. Schmidt-Cassegrain, 406X, W47 (violet) Filter. Diameter = 15".7, **k** = 0.721.

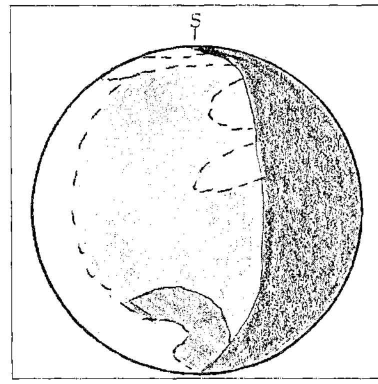


Figure 4. Drawing by Marc Gelinas on 1984 DEC 04, 21h 00m-21h 32m UT. Seeing = 7, Transparency = +4.2. 20-cm, Schmidt-Cassegrain, 406X, yellow and W47 (violet) Filters. Diameter = 16".2, **k** = 0.708.

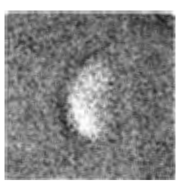


Figure 5. Photograph by Paul Maxson on 1984 DEC 24, 01h 46m UT. Seeing = 5, Transparency = 3 (scale of 0-5). 28-cm. Schmidt-Cassegrain. Tri-X Film, 1 sec. at f/60 with Optica Ultraviolet Filter. Diameter = 18".6, **k** = 0.641.

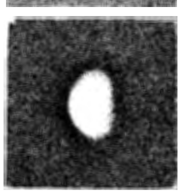


Figure 6. Photograph by Roger Venne on 1984 DEC 26, 23h 15m UT. 20-cm. Newtonian at f/8 on Tri-X Film. Diameter = 19".0, **k** = 0.629.

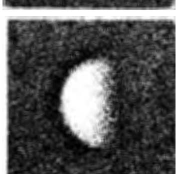


Figure 7. Photograph by Paul Maxson on 1985 JAN 01, 01h 37m UT. Seeing = 4-5, Transparency = 3 (scale of 0-5). 28-cm. Schmidt-Cassegrain. Tri-X Film, 1/8 sec. at f/60 with No. 80 (blue) Filter. Diameter = 19".8, **k** = 0.609.

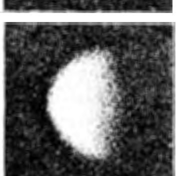
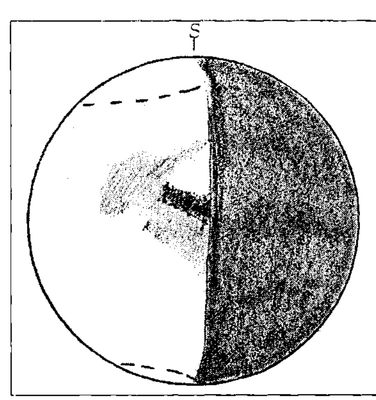


Figure 8 (to left). Photograph by Alan W. Heath on 1985 JAN 02, 16h 00m UT. Diameter = 20".1, **k** = 0.602.

Figure 9 (to right). Drawing by Marc Gelinas on 1985 JAN 03, 21h 54m-22h 11m UT. Seeing = 6, Transparency = +4. 20-cm. Schmidt-Cassegrain, 169X with W47 (violet) Filter. Diameter = 20".3, **k** = 0.597.



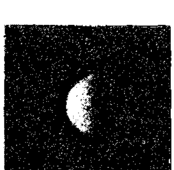


Figure 10 (to left). Photograph by M. Maksymowicz on 1985 JAN 05, 16h 10m UT. Seeing = 2, Transparency = 9 (0-10 scale). 15-cm. Refractor, f/63 on Panatomic-X Film with RG630 (red) Filter. Diameter = 20".6, **k** = 0.590.

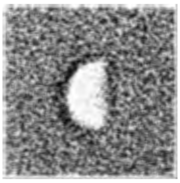


Figure 11. Photograph by Paul Maxson on 1985 JAN 11, 01h 35m UT. Seeing = 6-7, Transparency = 4 (0-5 scale). 20-cm. Newtonian at f/37, Tri-X Film with No. 80A (blue) Filter. Diameter = 21".7, **k** = 0.566.

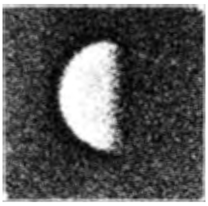


Figure 12. Photograph by Paul Maxson on 1985 JAN 20, 02h 10m UT. Seeing = 6, Transparency = 4 (0-5 scale). 28-cm. Schmidt-Cassegrain at f/60 with W61 (green) Filter on Tri-X Film. Diameter = 23".7, **k** = 0.522.

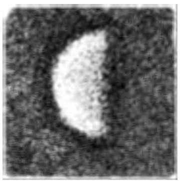


Figure 13. Photograph by Roger Venne on 1985 JAN 24. 20-cm. Newtonian at f/8. Diameter = 24".8, **k** = 0.502.

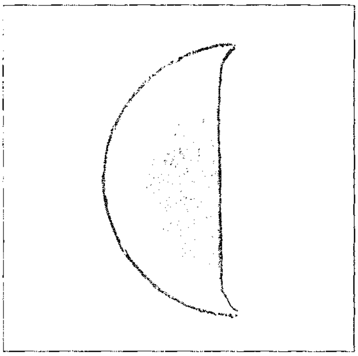


Figure 14. Drawing by D.L. Graham on 1985 JAN 26, 13h 40m-14h 25m UT. Seeing 2 (Antoniadi Scale; slight undulations with calm moments). 10.2-cm. Refractor, 108X. Diameter = 25".5, **k** = 0.488.

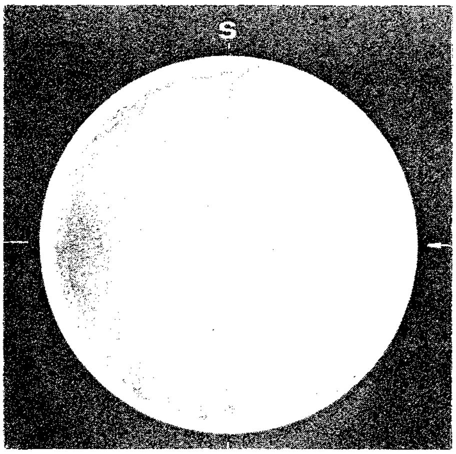


Figure 15. Drawing by Domenec Barbany on 1985 JAN 30, 17h 45m-18h 15m UT. Seeing = 3 (Antoniadi Scale; moderate), Transparency = Good. 8-cm.. Refractor, 100X-130X. Red and blue filters. Diameter = 26".8, **k** = 0.464.

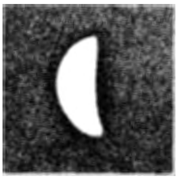
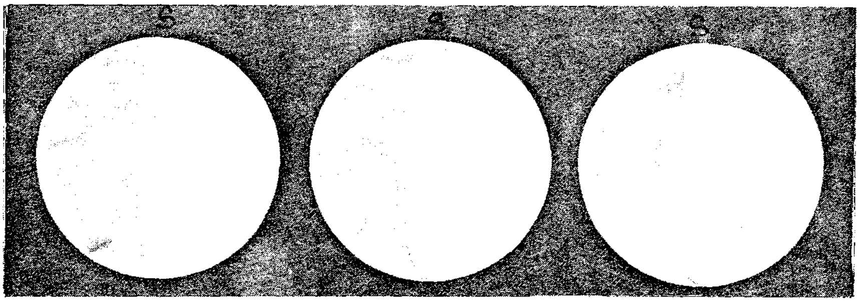


Figure 16 (left). Photograph by Paul Maxson on 1985 FEB 02, 01h 15m UT. Seeing = 3-4, Transparency = 5 (0-5 scale). 28-cm. Schmidt-Cassegrain, Kodak Technical Pan 2415 at f/60 with W47 (violet) Filter. Diameter = 27".5, **k** = 0.451.

Figure 17 (below). Drawings by M. Maksymowicz on 1985 FEB 05, 17h 50m-18h 10m UT. Seeing 2-3 (Antoniadi Scale; Fair-Good), Transparency = 9 (0-10 scale). 11.8-cm. Refractor, 100X. From left to right: Neutral-density Filter, Yellow-Green Filter, Red Filter. Diameter = 28".8, **k** = 0.428.



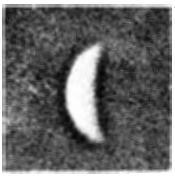


Figure 18. Photograph by Paul Maxson on 1985 FEB 10, 00h 58m UT. Seeing = 3-4, Transparency = 4-5 (0-5 scale).28-cm. Schmidt-Cassegrain, f/60 with Kodak TP2415 Film and W47 (violet) Filter. Diameter = 30".5, **k** = 0.400.

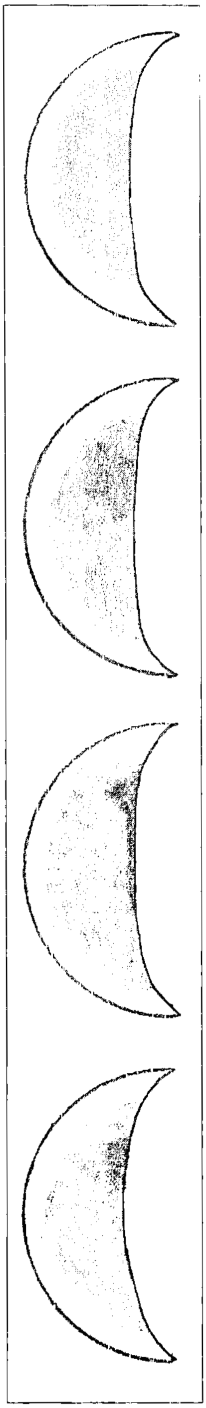


Figure 19. Drawings by D.L. Graham on 1985 FEB 15. Seeing = 2 (Antoniadi Scale). 10.2-cm. Refractor, 108X. From top to bottom: 15h06m-15h10m UT, integrated light; 15h15m-15h20m UT, yellow (W15) Filter; 15h27m-15h 45m, red (W25) Filter; 15h 40m-15h45m, blue (W44A) Filter. Diameter = 32".9, **k** = 0.362.

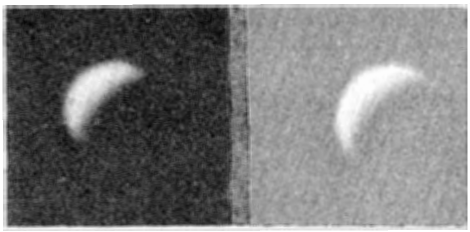


Figure 20. Photographs by M. Maksymowicz on 1985 FEB 16, 16h 30m UT. Seeing = 2 (Antoniadi Scale), Transparency = 9-10 (0-10 scale). 15-cm. Refractor, f/63. Left: Tri-X Film, 1/60 sec., RG595 (yellow) Filter. Right: FP4 Film, 1 sec., W35 (purple) Filter. Diameter = 33".4, **k** = 0.354.

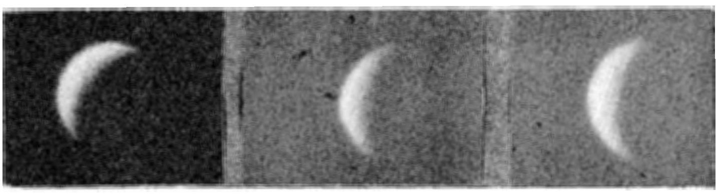


Figure 21. Photographs by M. Maksymowicz on 1985 FEB 23. Seeing = 2 (Antoniadi Scale), Transparency = 10 (0-10 scale). 15-cm. Refractor, f/63, Pan F Film. Left to right: 16h 10m UT, W35 (purple) Filter;17h 10m UT, RG515 (yellow) Filter;17h 00m UT, no filter. Diameter = 37".0, **k** = 0.299.

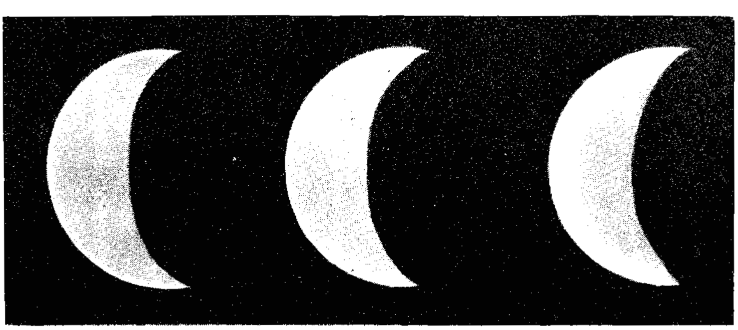


Figure 22. Drawings by Alan W. Heath on 1985 FEB 24, 17h 10m UT. Seeing = 2-3 (Antoniadi Scale). 30-cm. Newtonian, 190X-318X. Left to right: No filter, red (W25) filter, blue (W47) filter. Diameter = 37".6, **k** = 0.291.

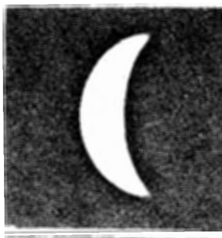


Figure 23. Photograph by Paul Maxson on 1985 FEB 26, 02h 00m UT. Seeing = "Fair+", Transparency = 4 (0-5 scale). 28-cm. Schmidt-Cassegrain, Kodak TP2415 Film at f/60 with a W47 (violet) Filter. Diameter = 38".4, **k** = 0.280.

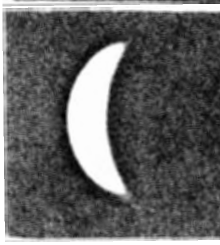


Figure 24. Photograph by Paul Maxson on 1985 MAR 01, 01h 55m UT. Seeing = Fair, Transparency = 3-4 (0-5 scale). 28-cm. Schmidt-Cassegrain, Kodak TP2415 Film at f/60 with a W47 (violet) Filter. Diameter = 40".2, **k** = 0.255.

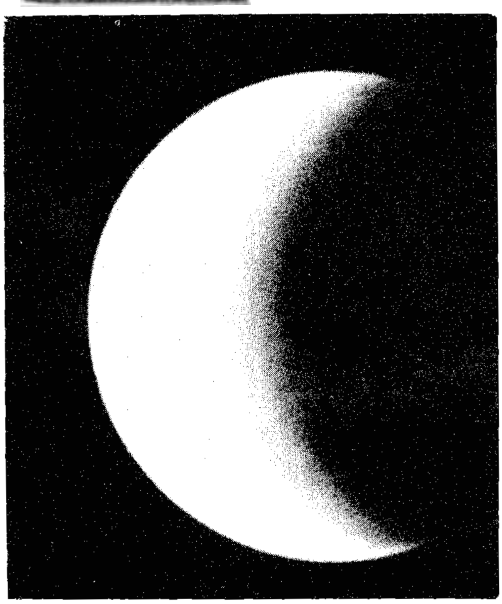


Figure 25. Drawing by Edwin W. Faughn on 1985 MAR 07, 01h 09m-01h 42m UT. 20-cm. Newtonian, 128X-256X. Diameter = 44".1, **k** = 0.201.

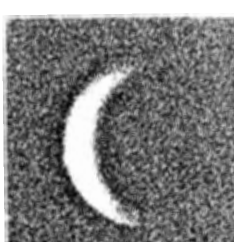


Figure 26. Photograph by Alan W. Heath on 1985 MAR 14, 17h 45m UT. 30-cm. Newtonian with 190X eyepiece. Diameter = 49".6, **k** = 0.130.

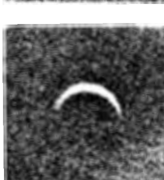


Figure 27. Photograph by Paul Maxson on 1985 MAR 31, 17h 45m UT. Seeing = Good. 20-cm. Newtonian at f/18 on Kodak TP2415 Film with W25 (red) Filter. Venus was approximately 9° from the Sun at the time of this view. Diameter = 58".7, **k** = 0.014.

A THREE-DIMENSIONAL SUNSPOT CLASSIFICATION SYSTEM

By: Richard E. Hill, A.L.P.O. Solar Recorder

ABSTRACT

The traditional Zurich Sunspot Classification System has had only limited success in predicting the onset of solar flares. This paper describes the McIntosh Sunspot Classification System, which uses three parameters--the "Modified Zurich Class," the "Type of Largest Spot," and "Sunspot Distribution." This newer system, described and diagramed here, has proven very successful in making 24-hour predictions of flare occurrences. A.L.P.O. Solar Section observers are urged to learn and apply the McIntosh System.

In 1938, M. Waldmeier devised what is now known as the Zurich Sunspot Classification of sunspot groups. [Waldmeier 1961] This system consists of nine steps or classes, lettered A through J, but omitting I. It delineates the characteristic evolutionary stages of sunspot groups, although not all groups go through all classes. Most groups go only partly through the sequence and then either reverse their trend or skip ahead to one of the later classes. In general, the greater the area of a group, the more asymmetrical will be its growth curve. [The last is the graph of the group's area over time. Group areas tend to increase from class A to J. An idea of the typical appearance of groups of different Zurich classes can be got from *Figure 28* (p. 12) Ed.] A large group will tend to have an asymmetrical growth curve, rising rapidly from class A to E and then decaying more slowly as it goes from E to J, spending the majority of its decay time in classes G to J. [Bray and Loughhead 1979]

One reason why sunspot classes are significant is their use for predicting solar flares. It has been known for some time that groups of classes D, E, and F are the flare-producing classes. However, not all such groups produce flares, which is a problem for those whose job it is to predict flares. Even with the most active class, F, a forecaster has had but little chance of success in predicting the flare probability for any 24-hour period based on Zurich Class alone. A new system has been needed that takes additional parameters into account.

Flares are the most energetic events in our Solar System. They are eruptions that take place in and around sunspot groups, and flares release large amounts of energy across most of the electromagnetic spectrum. Often they are accompanied by the ejection of subatomic particles at various speeds, which may impact the Earth's upper atmosphere. The electromagnetic emissions and subatomic particles can cause aurorae and disrupt radio communications. Typically, flares last from a few minutes to as long as four hours, although the majority are from ten to twenty minutes in duration. The more energetic flares tend to be of longer duration, especially when observed in x-rays. In the white-light and H-α ("Hydrogen Light") wavelengths used by most amateurs, the relationship between duration and energy output is not quite so clearcut. Flares are best seen in monochromatic light such as H-α or in the H and K lines of calcium light. Some flares are bright enough to be seen even in the combined light of the entire spectrum ("white light").

However, in order for flares to be observed and studied by the professional, and particularly for white-light flares to be predicted and looked for by the amateur, a reliable system for classifying sunspot groups is needed. Otherwise, an observer would have to spend an inordinate amount of time at the telescope observing nearly every well-developed sunspot group all the time in hopes of seeing these elusive events. It would be highly advantageous to be able, on the basis of a few parameters, to weed out many of the groups less productive of flares.

In 1966, Patrick McIntosh of the Space Environment Services Center (SESC) of the National Oceanic and Atmospheric Administration (NOAA) introduced a system of sunspot classification that was an improvement over the older Zurich Classification. The new classifications consist of three letters. The first is the modified Zurich Class. This basically retains the old Zurich Class, omitting classes G and J, which now are redundant. The Modified Zurich Class is used, rather than an entirely new classification, so as to be an inducement for observers reluctant to convert to the new system. The second letter describes the Largest Spot in the group; not necessarily the leading spot, but the **largest** spot. The third letter assesses the Sunspot Distribution within the group.

In order to understand the McIntosh Classification system further, two terms have to be defined [McIntosh 1984]:

Unipolar Group--A single spot, or compact cluster of spots, with the greatest separation between spots being less than 3 heliographic degrees. With a Class H group the separation is taken to be the distance between the outer border of the main spot penumbra and the most distant attendant umbra.

Bipolar Group--Two or more spots forming an elongated cluster with a length of 3 or more heliographic degrees. If there is a large principal spot, then the cluster must be greater than 5 degrees in extent in order to be bipolar.

Figure 28 (p. 12) illustrates the Modified Zurich Classes, while *Figure 29* (p. 13) shows the Largest Spot and the Sunspot Distribution categories. The definitions of these categories are as follows, where all degree measures and directions are heliographic. [McIntosh 1984] Note that extents are as corrected for foreshortening:

MODIFIED ZURICH CLASS--

A--A unipolar group with no penumbra. This can be either the early or the final stage in the evolution of the group.

B--A bipolar group with no penumbrae on any spots.

C--A bipolar group with penumbra on one end of the group, usually surrounding the largest leader umbrae.

D--A bipolar group with penumbrae on spots at both ends of the group and a length of less than 10 degrees.

E--A bipolar group with penumbrae on spots at both ends of the group and a length of 10 to 15 degrees.

F--A bipolar group with penumbrae on spots at both ends of the group and a length greater than 15 degrees.

H--A unipolar group with a penumbra, usually the remains from a bipolar group.

TYPE OF LARGEST SPOT--

x--No penumbra (for groups of class **A** or **B**).

r--Rudimentary penumbra that usually only partially surrounds the largest spot. Such a penumbra will be granular rather than filamentary, making it appear brighter than a mature penumbra. The width of the penumbra will be only a couple to a few granules, and the penumbra may be either forming or dissolving.

s--Small, symmetric spot (similar to the old Zurich Class J) with a mature, dark, filamentary penumbra of circular or elliptical shape with a clean sharp border. If there are several umbrae in the penumbra, they will form a tight cluster mimicking the symmetry of the penumbra. The north-south diameter is 2°.5 or less.

a--Small, asymmetric spot with irregular surrounding penumbra and with the umbrae within separated. The north-south diameter is 2°.5 or less.

h--A large symmetric spot; like type **s**, but the north-south diameter is greater than 2°.5.

k--A large asymmetric spot; like type **a**, but the north-south diameter is greater than 2°.5.

SUNSPOT DISTRIBUTION--

x--Unipolar group of Modified Zurich Classes **A** or **H** (i.e., a solitary spot).

o--Open distribution with a leader and a follower spot and few or no spots between them. Any spots between will be very small umbral spots.

i--Intermediate distribution where numerous umbral spots lie between the leader and follower spots.

c--Compact distribution where the area between the leader and the follower spots contains many spots with at least one having a penumbra. In extreme cases the entire group may be enveloped by one complex penumbra.

Over the last 20 years, the McIntosh Classification System has proven to be a more accurate predictor of solar flares than the previous Zurich Classification. Indeed, the new system has helped solar astronomers better to understand the relationship between solar flares and sunspots. Sunspot groups of the type that produce solar flares are rare. Because of this, it has taken two solar cycles of observations to demonstrate the effectiveness of the new system.

Using the old Zurich Classification, it was found that groups of Class F were the most likely to produce flares. However, it was further found that only a 40-percent flare probability for a 24-hour period could be predicted on the basis of this parameter alone. With the new system, using just the Modified Zurich Class **F**, the probability was improved to 60 percent. Using just the Largest Spot class of **k**, the 24-hour probability was 40 to 50 percent. Were just the Spot Distribution category of **c** used, the flare probability would be up to 70 percent in a given 24-hour period! However, when all three dimensions of this system were used, the classes of **Fsi**, **Fki**, and **Fkc** all showed a 24-hour probability of up to 100 percent for production of M Flares, while the McIntosh Class **Fkc** had a further probability of up to 50 percent in producing X Flares! [M and X Flares produce intermediate and high soft X-ray fluxes respectively. Ed.] This resultsurpasses any former method of flare prediction, including sunspot areas. [McIntosh 1984]

Observers within the A.L.P.O. Solar Section are urged to begin using the McIntosh Classification System, especially those observers involved in the detection of white-light flares. Persons doing whole-disk drawings are most strongly encouraged to use the new system. Other standard procedures need to be followed, as laid out in the Handbook for the Section. [Hill 1984] These procedures are designed to make the observations of the Solar Section more closely match those done at NOAA/SESC. Our data may be used by NOAA if we can demonstrate competent use of this system on a daily basis. There are many days when NOAA/SESC has no white-light drawings, and some interest has been expressed in using our data to fill this void in the future. It is also of critical importance that observers send in either original drawings or very clean electrostatic copies. Many of the drawings received are covered with spurious spots ("Xerox sunspots"), smears, or large, dark, charcoal-like smudges. Such drawings cannot be used in this condition.

The McIntosh Sunspot Classification System has demonstrated its effectiveness as a tool in the search for solar flares and in understanding the buildup, storage, and dissipation of energy in a flare. Amateur solar astronomers who want to make their observations of the most use to professional researchers should adopt this system as soon as possible. Observations should then be submitted to the Solar Section because we are now making all observations available to these researchers. In this way, the amateur astronomer can enjoy the esthetic endeavor of observing the ever-changing solar features while still making a lasting and valuable contribution to science.

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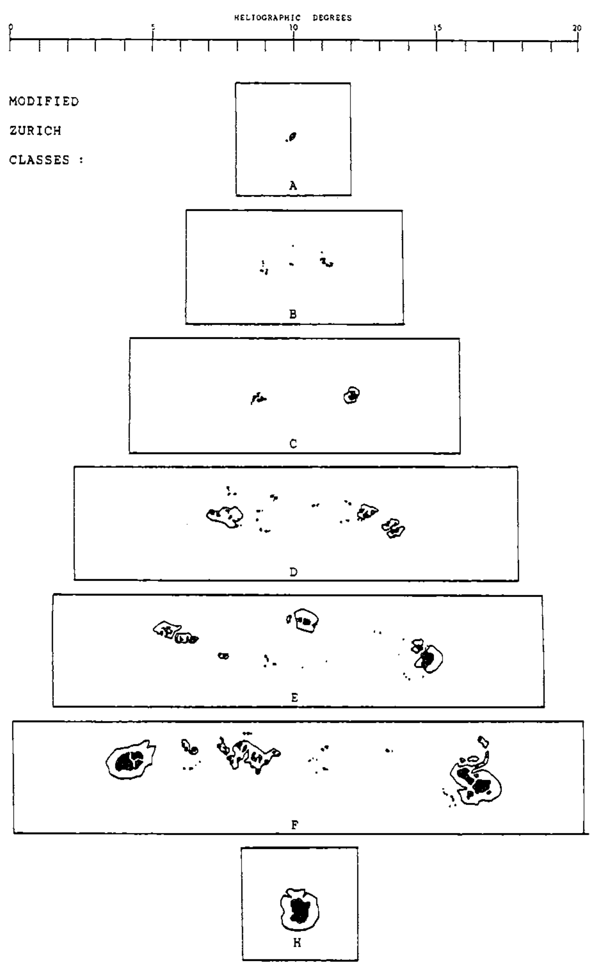

Figure 28. Typical examples of Modified Zurich Sunspot Classes. See text, p.11.

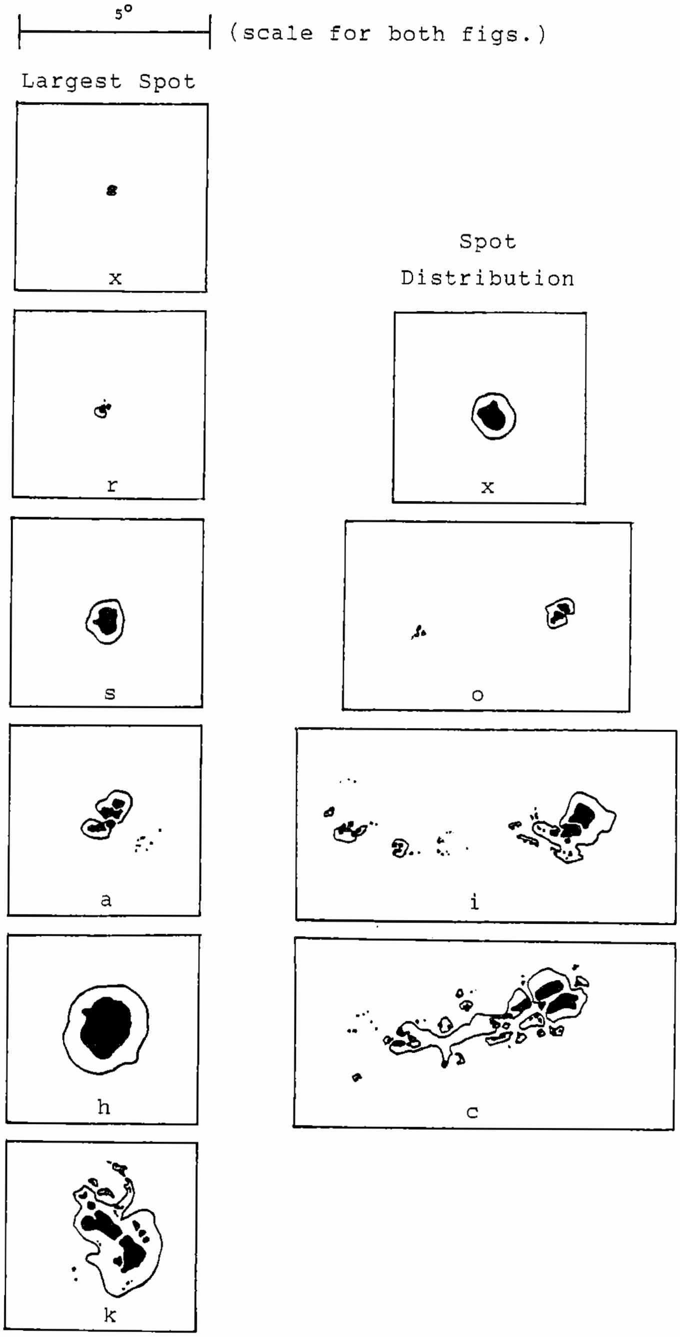

Figure 29. Typical examples of "Largest Spot" and "Spot Distribution" sunspot classifications. See text, p. 11.

PHOTOELECTRIC PHOTOMETRY OF THE MUTUAL EVENTS OF THE GALILEAN SATELLITES IN 1985

By: John E. Westfall, A.L.P.O. Assistant Jupiter Recorder, Eclipse Timings

ABSTRACT

This report analyzes 30 amateur photoelectric observations of 25 separate mutual events, both eclipses and occultations, involving the Galilean Satellites of Jupiter in 1985. Parabolic least-squares regression fits to the observed light curves were used to determine the amount and time of maximum light loss. The maximum light losses were in reasonable agreement with the Aksnes and Franklin predictions. Small but statistically significant differences between the observed times and the times predicted by Aksnes and Franklin and Gregorio were found for most events. As compared with Io, Europa tended to be about 29±2 seconds, and Ganymede about 26±6 seconds, "ahead" in its orbital motion.

INTRODUCTION

Every six years the Sun and the Earth pass through the orbital planes of Jupiter's Galilean Satellites, as occurred in 1985-86. During this period these satellites eclipse each other and, as seen from Earth, also occult each other. Such events produce a light loss, either of the eclipsed satellite for an eclipse, or of the combined light of the two satellites involved for an occultation. Photoelectric measures of these phenomena, conducted frequently throughout each event, give us two items of information about the satellites' orbits. First, the maximum amount of light loss is a function of the orbital latitudes of the satellites. Second, the time of greatest light loss is a function of the orbital longitudes.

Two sets of predictions were supplied to this writer, one by Fred A. Franklin (Harvard-Smithsonian Center for Astrophysics) and Kaare Aksnes (Norwegian Defence Research Establishment) [3], and the other by Professor Paolo Gregorio of the Politecnico di Torino, Italy [4]. Both sets were ultimately based upon the "E-2" model of these satellites' motions, developed by Jay Lieske of the Jet Propulsion Laboratory. Not surprisingly, there was good agreement between the two sets of predictions. Of the 300 events total, most were common to both sets, although Franklin and Aksnes predicted 7 events not in the Gregorio listing and Gregorio listed 17 events that were not predicted by Franklin and Aksnes. There were 143 mutual occultations predicted (47.7 percent) and 157 eclipses (52.3 percent). [8] The chronology of this mutual event observing season was:

Conjunction....................	**1985 JAN 15**
First Mutual Event........	**FEB 04**
Opposition (δ = -18°.0)..	**AUG 04**
Jovicentric latitude of Sun = 0°.0	**OCT 01**
Jovicentric latitude of Earth = 0°.0	**DEC 23**
Conjunction....................	**1986 FEB 18**
Last Mutual Event.........	**APR 20**
Opposition (δ = -6°.2).....	**SEP 11**

The timing of Jupiter's conjunction with the Sun in early 1986 meant that events after November, 1985, were difficult to observe and the events reported here fell between May and November, 1985. The declination of Jupiter was negative during this period, favoring observers in the Earth's Southern Hemisphere.

METHOD OF OBSERVATION

This report analyzes 12 photoelectric observations by Thomas Langhans [5], 7 by B. Adcock *et al.* [1], 7 by John E. Westfall, and 4 by Henk J. J. Bulder [2]. The 30 observations were equally divided between occultations and eclipses. Of the above sets, those of Langhans and Westfall are the most completely documented and are thus reported in the most detail here. At least one other amateur observer, F.J. Melillo, made photoelectric timings which are not analyzed here. [7]

Langhans employed a 36-cm. Schmidt-Cassegrain telescope, using an Optec SSP-3 photometer with a V filter and a 40 arc-second photometer aperture. Westfall used a 25-cm. Cassegrain and an Optec SSP photometer with a V filter and a 25 arc-second aperture. Both observers input their photometer readings, and their times, continuously into computers; Langhans used a Commodore-64 with a 2-second integration time, while Westfall used an Apple IIe and averaged 16 "fast" readings for a 0.912-second interval. Thus they both accumulated lengthy series of readings in each observing session, the number ranging from 264 to 1921.

Bulder, using a 30-cm. Newtonian, apparently made individual readings, ranging from 15 to 36 for each event; his mean spacing of readings varied from 27 to 72 seconds. Adcock *et al.* used a Gencom Starlight 1 photometer and both a 20-cm. Schmidt Cassegrain and a 31.5-cm. Schiefspiegler. They employed a guide telescope, and used a 26 arc-second aperture throughout. Judging by a diagram of theirs, they made individual readings at intervals of about 30 seconds.

One serious problem was keeping a satellite in the photometer aperture for an entire event, a period ranging from 9 to 29 minutes. Another difficulty was in measuring and correcting for the scattered light from Jupiter. Indeed, no one attempted to measure an event closer to Jupiter than about 2.8 of its radii. Because the background light varied with distance from the planet, it was necessary, not only to keep the satellite within the aperture, but also to keep the aperture a constant distance from the planet. Langhans guided throughout using a guide telescope. Westfall began by frequently inspecting the field (and thus interrupting the series of readings) but later began guiding as well.

Naturally, both satellites had to be kept consistently in the photometer aperture in the case of an occultation. Near opposition, when the two satellites appeared close together, this was also necessary in the case of eclipses.

For occultations, it was also desirable to measure the ratio of brightness between the two satellites involved. However, this was not possible if the relative motion of the two bodies was so slow as to keep them within the same photometer aperture for several hours.

METHOD OF ANALYSIS

One method of analysis was simply to graph photometer readings versus time. This method was used by Adcock *et al.* and Bulder and is quite reasonable, given no more than a few dozen readings. Although somewhat subjective, the time of maximum light loss can be estimated to within perhaps 10 seconds at best. However, given even an approximate mid-event time, the amount of light loss can be estimated accurately because the light curve is changing very slowly at that time.

Given their large numbers of readings, Langhans and Westfall stored their data on computer diskettes and subsequently analyzed them statistically. In some cases, readings were automatically plotted so that intervals of faulty data caused by aperture drift could be identified and eliminated. Two sample light curves are plotted as *Figure 30* and *Figure 31* on p. 17.

The analysis program performed a second-order (parabolic) least-squares regression analysis in two stages (maximum light loss, followed by time of maximum light loss; the last omitting excessively small readings) on a subset of the readings, selected so as to be approximately centered on the time of minimum light. The output included the residual from each reading, the time of minimum light, the minimum-light reading, and the 1-σ standard error of the last two values. When the minimum-light reading was subtracted from the mean of readings before and/or after the event, the amount of light loss could be found.

The conditions and results of each of the 30 sets of observations are given in *Table 3* (pp. 18-22). In that table, the top line, "Event Type," gives, first, the number of the eclipsing or occulting satellite. Next is "Ec" for an eclipse, or "Oc" for an occultation. The third item is the number of the eclipsed or occulted satellite: where 1 indicates Io; 2, Europa; 3, Ganymede; and 4, Callisto. Fourth, "A" stands for an annular event, "P" for partial, and "T" for total. Distances from Jupiter are in units of its equatorial radius. "n.a." means "not available." It is hoped that the other items in *Table 3* are self-explanatory. All "±" values are 1-σ standard errors; if the uncertainty range is asymmetric, both tails are given in brackets. Residuals are given in the sense of *observed minus predicted.* All times are given in U.T.; the Gregorio ephemerides were in E.T. and were converted using a value of Δt of +55 seconds. Note also that complete data are available only for the 19 Langhans and Westfall observations.

One indication of the accuracy of the observations is the formal standard errors of the estimated times of minimum light. For Langhans these ranged from ±0.5 to ±29.1 seconds, with a median of ±6.8 seconds. The same values for Westfall were ±2.5 to ±24.6 seconds, with a median of ±5.8 seconds. Naturally, the formal statistical error is only a lower limit on the possible error. Fortunately, Langhans and Westfall simultaneously observed five events, and comparing their independent results gives a better idea of the actual uncertainties. This is shown in *Table 1* below, where "Difference" is the Langhans time minus the Westfall time and the light loss is that predicted by Aksnes and Franklin.

Table 1. Time Differences between Langhans and Westfall Observations.

Obs. Nos.	Event Type & Date	Light Loss %	Time Difference seconds
1,2	2 Oc 4 P, 5/30/85	14	+19.2±32.3
3,4	3 Oc 2 T, 6/10/85	36	-0.8± 4.7
5,6	4 Oc 1 P, 7/10/85	67	-3.6±3.6
8,9	1 Oc 3 P, 8/03/85	11	-33.4±7.2
16,17	1 Ec 2 P, 10/16/85	69	-10.4±4.2

The time differences tend to be larger for the estimates with the larger uncertainties, which in turn are larger for the shallower events with relatively small amounts of light loss. Only the last two differences are statistically significant.

The differences in measured maximum light loss are also available for the five events listed in *Table 1.* In chronological order, the (Langhans minus Westfall) maximum light-loss differences, in percent, were: +1.3±4.2, +0.4±0.8, -8.8±3.7, +4.8±1.8, and -15.5±3.8. The mean difference was -3.6 percent, and the mean absolute difference was ±6.2 percent.

CONCLUSIONS

To a limited extent, the observations allow one to estimate the errors of the predictions, in terms of the relative positions of pairs of satellites. This discussion deals only with the Franklin-Aksnes ephemeris, as their predictions received greater circulation than did Gregorio's. For most events, the time differences between the two ephemerides were small, with a median (Aksnes-Franklin minus Gregorio) difference of -0.27 minutes for event beginnings and +0.02 minutes for event endings. The first step in estimating the errors of the predictions is to select events that involve particular satellite pairs. Assuming that one satellite is consistently either "ahead" or "behind" the other in terms of its ephemeris residual, the residual is multiplied by +1 if the lower-numbered satellite is the occulter or the eclipser, and by -1 if the lower-numbered satellite is the occulted or the eclipsed. Then the residuals involving particular pairs of satellites are averaged, excluding any residuals that appear to deviate excessively from the others.

For events involving Io and Europa, six observations were averaged (Nos. 12, 16, 17, 21, 23, and 29; No. 11 was excluded). For events involving Io and Ganymede, six observations were used (Nos. 7, 8, 9, 10, 15, and 30; Nos. 13 and 27 were excluded). For events involving Europa and Ganymede, four observations were used (Nos. 3, 4, 25, and 26; No. 20 was excluded). Then, taking Io as a standard, the mean time residuals are shown in *Table 2* below.

Table 2. Mean Time Residuals for Europa and Ganymede Relative to Io.

Io................	**0.0 sec.**
Europa........	**-29.2±2.4 sec. (based on Io)**
	-14.0±3.8 sec. (based on Ganymede)
Ganymede..	**-26.2±5.6 sec. (based on Io)**
	-11.0±6.3 sec. (based on Europa)

The results for the inner three Galilean satellites are inconsistent by about 15 seconds, which this writer thinks is a result of systematic errors in the observations. Callisto's inconsistencies are fairly large. Two observations (Nos. 5 and 6) gave the mean Io-Callisto residual as -44 seconds. Four observations (Nos. 1, 2, 22, and 24; Nos. 14, 19, and 28 were excluded) gave the mean Europa-Callisto residual as -47 seconds. One observation (No. 18) gave the Ganymede-Callisto residual as +107 seconds. These results for Callisto are clearly not compatible with those for Io, Europa, and Ganymede.

Only the Aksnes-Franklin predictions give predicted maximum light losses. These were compared with the 26 observations that reported maximum light losses, giving a mean (Observed minus Computed) residual as +3.2 percent, and a mean absolute residual of ±7.5 percent. In 16 cases, the observed light loss was greater than that predicted; in 9 cases it was less, and there was no difference in one case.

Overall, our observations appear comparable to the photoelectric results of Marcialis, who reported that his observations agreed with the Aksnes-Franklin predictions within 5 percent of maximum light loss and 30 seconds of time. [6]

To conclude, our photometric results appear to be consistent and to give useful information about the orbital positions of the Galilean Satellites. They show that amateurs with modest equipment can make scientific contributions. We wish to thank those observers who submitted the data used in this report. Mutual Galilean Satellite phenomena will recur in 1990-91, under conditions favorable for Northern-Hemisphere observers, and predictions of them will be given in the *A.L.P.O. Solar System Ephemeris*. We hope that more observers will be interested in, and suitably equipped for, such observations when this next opportunity occurs.

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Figure 30. Photoelectric measures by Westfall of the partial occultation of Callisto by Europa on 1985 MAY 30. The vertical scale is in relative units. The horizontal scale represents time in seconds after 11h 07m 51.9s U.T. A typical "shallow"event with a 12.7-percent light loss. Note that the satellites drifted out of the photometer aperture at about 2320 seconds.

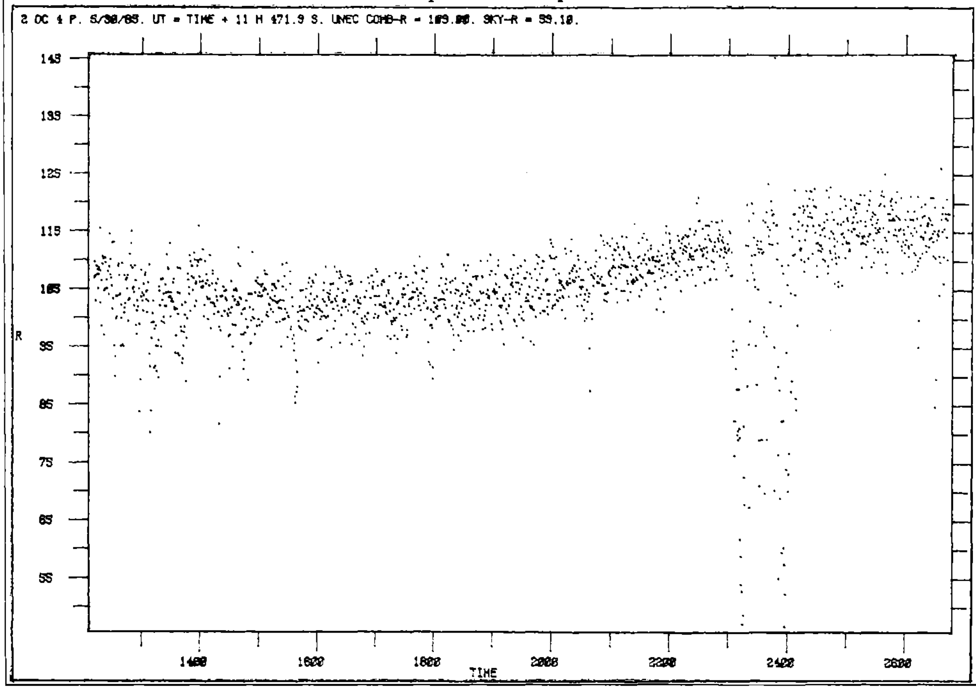


Figure 31. Photoelectric measures by Westfall of the total occultation of Europa by Ganymede on 1985 JUN 10. The vertical scale is in relative units. The horizontal scale represents time in seconds after 09h 08m 00.9s U.T. A fairly "deep"event with a 38.6-percent light loss.

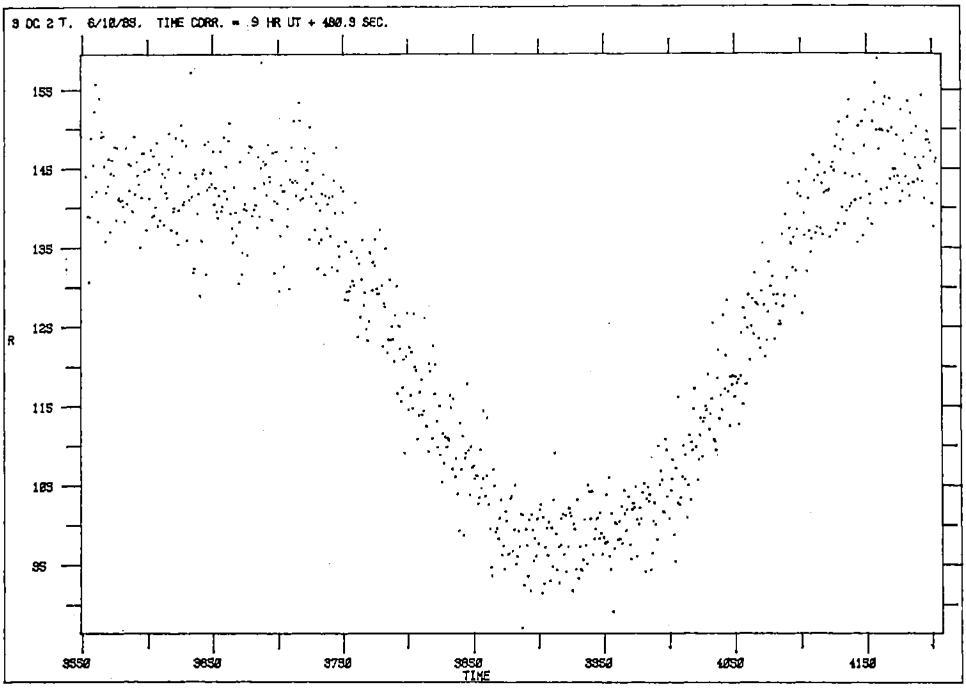


Table 3. Summary of Photoelectric Observations of the Mutual Phenomena of the Galilean Satellites in 1985.

Event Number and Type	(1) 2 Oc 4 P	(2) 2 Oc 4 P	(3) 3 Oc 2 T
U.T. Date	**1985 MAY 30**	**1985 MAY 30**	**1985 JUN 10**
Distance from Jupiter	3.6 radii	3.6 radii	7.8 radii
Observer	Langhans	Westfall	Langhans
Telescope Aperture	35.6 cm.	25.4 cm.	35.6 cm.
Photometer Aperture	40".	25".	40".
Photometer Filter	V	V	V
Observing Period (U.T.)	10:28:03-10:56:30	10:28:10-10:52:25	10:06:21-10:20:03
Number of Readings	822	1596	397
Brightness Ratio			
Satellites	n.a.	2:4	3:2
Ratio	n.a.	1.610±.124	1.507±.048
Magnitude Difference	n.a.	0.52±.09	0.45±.03
Regression Results			
U.T. Range Used	10:34:00-10:44:00	10:31:12-10:42:28	10:11:18-10:15:17
Light Loss	**14.0±3.4 %**	**12.7±2.4%**	**39.0±0.4**
Readings Used	288	748	116
U.T. of Minimum Light	**10:38:37.0±29.1**	**10:38:17.8±14.0**	**10:13:30.4±3.1**
Readings Used	154	460	99
Predicted Values			
Aksnes/Franklin U.T.	10:39.0	10:39.0	10:13.3
Aksnes/Franklin Light Loss	14 %	14 %	36 %
Gregorio U.T.	10:39:33	10:39:33	10:12:23
Residuals (Obs. - Predicted)			
Aksnes/Franklin Time	-23 sec.	-42 sec.	+12 sec.
Aksnes/Franklin Light Loss	0.0 %	-1.3 %	+3.0 %
Gregorio Time	-56 sec.	-75 sec.	+67 sec.

Event Number and Type	(4) 3 Oc 2 T	(5) 4 Oc 1 P	(6) 4 Oc 1 P
U.T. Date	**1985 JUN 10**	**1985 JUL 10**	**1985 JUL 10**
Distance from Jupiter	7.8 radii	2.8 radii	2.8 radii
Observer	Westfall	Langhans	Westfall
Telescope Aperture	25.4 cm.	35.6 cm.	25.4 cm.
Photometer Aperture	25".	40".	25".
Photometer Filter	V	V	V
Observing Period (U.T.)	10:07:14-10:18:05	09:31:40-09:42:51	09:31:46-09:41:26
Number of Readings	717	324	638
Brightness Ratio			
Satellites	3:2	1:4	1:4
Ratio	1.611±.015	2.426±1.186	2.193±.152
Magnitude Difference	0.52±.01	0.96[+.43/-.73]	0.85±.08
Regression Results			
U.T. Range Used	10:11:26-10:15:30	09:36:00-09:38:30	09:36:15-09:38:30
Light Loss	**38.6±0.7 %**	**57.6±2.3 %**	**66.4±2.9 %**
Readings Used	269	73	139
U.T. of Minimum Light	**10:13:31.2±3.5**	**09:37:17.5±2.6**	**09:37:21.1±2.5**
Readings Used	226	60	117
Predicted Values			
Aksnes/Franklin U.T.	10:13.3	09:36.6	09:36.6
Aksnes/Franklin Light Loss	36 %	67 %	67 %
Gregorio U.T.	10:12:23	09:36:42	09:36:42
Residuals (Obs. - Predicted)			
Aksnes/Franklin Time	+13 sec.	+42 sec.	+45 sec.
Aksnes/Franklin Light Loss	+2.6 %	-9.4 %	-0.6 %
Gregorio Time	+68 sec.	+36 sec.	+39 sec.

Table 3--*Continued.*

Event Number and Type	(7) 1 Oc 3 P	(8) 1 Oc 3 P	(9) 1 Oc 3 P
U.T. Date	**1985 JUL 27**	**1985 AUG 03**	**1985 AUG 03**
Distance from Jupiter	3.2 radii	3.7 radii	3.7 radii
Observer	Langhans	Langhans	Westfall
Telescope Aperture	35.6 cm.	35.6 cm.	25.4 cm.
Photometer Aperture	40".	40".	25".
Photometer Filter	V	V	V
Observing Period (U.T.)	05:12:59-05:21:57	07:36:08-07:45:50	07:36:21-07:45:37
Number of Readings	264	286	608
Brightness Ratio			
Satellites	3:1	3:1	3:1
Ratio	1.032±.074	1.313±.214	1.479±.017
Magnitude Difference	0.03±.08	0.30[+.16/-.20]	0.42±.01
Regression Results			
U.T. Range Used	05:16:20-05:18:59	07:39:30-07:42:50	07:39:46-07:42:15
Light Loss	**12.9±1.4 %**	**17.6±1.8 %**	**12.8±0.4 %**
Readings Used	73	98	153
U.T. of Minimum Light	**05:18:01.3±8.8**	**07:41:11.0±4.2**	**07:41:44.4±5.8**
Readings Used	52	81	104
Predicted Values			
Aksnes/Franklin U.T.	05:17.5	07:41.0	07:41.0
Aksnes/Franklin Light Loss	12 %	11 %	11 %
Gregorio U.T.	05:18:06	07:41:39	07:41:39
Residuals (Obs. - Predicted)			
Aksnes/Franklin Time	+31 sec.	+11 sec.	+44 sec.
Aksnes/Franklin Light Loss	+0.9 %	+6.6 %	+1.8 %
Gregorio Time	-5 sec.	-28 sec.	+5 sec.

Event Number and Type	(10) 1 Oc 3 P	(11) 1 Ec 2 P	(12) 1 Ec 2 P
U.T. Date	**1985 AUG 10**	**1985 AUG 27**	**1985 SEP 21**
Distance from Jupiter	4.2 radii	5.0 radii	7.0 radii
Observer	Langhans	Westfall	Langhans
Telescope Aperture	35.6 cm.	25.4 cm.	35.6 cm.
Photometer Aperture	40".	25".	40".
Photometer Filter	V	V	V
Observing Period (U.T.)	10:02:01-10:13:04	05:45:53-06:14:59	05:57:10-06:10:42
Number of Readings	324	1921	399
Brightness Ratio			
Satellites	3:1	1:2	n.a.
Ratio	1.453±.222	1.972±.166	n.a.
Magnitude Difference	0.41[+.15/-.18]	0.74[+.09/-.10]	n.a.
Regression Results			
U.T. Range Used	10:05:01-10:07:59	05:53:15-06:07:34	06:02:00-06:04:59
Light Loss	**19.8±2.9 %**	**9.9±6.8 %**	**94.8±4.8 %**
Readings Used	88	775	89
U.T. of Minimum Light	**10:06:40.6±5.5**	**06:07:42.6±24.6**	**06:03:22.3±0.7**
Readings Used	72	425	79
Predicted Values			
Aksnes/Franklin U.T.	10:06.1	06:00.5	06:02.9
Aksnes/Franklin Light Loss	10 %	4 %	85 %
Gregorio U.T.	10:06:52	n.a.	06:02:51
Residuals (Obs. - Predicted)			
Aksnes/Franklin Time	+35 sec.	+433 sec.	+28 sec.
Aksnes/Franklin Light Loss	+9.8 %	+5.9 %	+9.8 %
Gregorio Time	-11 sec.	n.a.	+31 sec.

Table 3--*Continued.*

Event Number and Type	(13) 1 Oc 3 P	(14) 2 Ec 4 P	(15) 1 Ec 3 P
U.T. Date	**1985 SEP 22**	**1985 SEP 23**	**1985 SEP 23**
Distance from Jupiter	5.8 radii	3.3 radii	7.2 radii
Observer	Langhans	Langhans	Langhans
Telescope Aperture	35.6 cm.	35.6 cm.	35.6 cm.
Photometer Aperture	40".	40".	40".
Photometer Filter	V	V	V
Observing Period (U.T.)	03:11:23-03:28:28	03:10:31-03:23:45	03:52:47-04:02:24
Number of Readings	506	392	285
<u>Brightness Ratio</u>			
Satellites	3:1	n.a.	n.a.
Ratio	1.593±.049	n.a.	n.a.
Magnitude Difference	0.51±.04	n.a.	n.a.
<u>Regression Results</u>			
U.T. Range Used	03:17:51-03:23:00	03:16:51-03:19:50	03:56:00-03:58:59
Light Loss	**6.4±1.0 %**	**23.7±7.7 %**	**4.3±0.4 %**
Readings Used	153	89	89
U.T. of Minimum Light	**03:21:47.3±15.2**	**03:18:20.7±5.9**	**03:57:57.1±7.8**
Readings Used	84	67	67
<u>Predicted Values</u>			
Aksnes/Franklin U.T.	03:19.2	03:17.35	03:57.5
Aksnes/Franklin Light Loss	7 %	24 %	6 %
Gregorio U.T.	03:20:35	03:19:50	03:57:17
<u>Residuals (Obs. - Predicted)</u>			
Aksnes/Franklin Time	+155 sec.	+60 sec.	+27 sec.
Aksnes/Franklin Light Loss	-0.6 %	-0.3 %	-1.7 %
Gregorio Time	+72 sec.	-89 sec.	+40 sec.

Event Number and Type	(16) 1 Ec 2 P	(17) 1 Ec 2 P	(18) 3 Ec 4 P
U.T. Date	**1985 OCT 16**	**1985 OCT 16**	**1985 OCT 26**
Distance from Jupiter	7.0 radii	7.0 radii	7.5 radii
Observer	Langhans	Westfall	Westfall
Telescope Aperture	35.6 cm.	25.4 cm.	25.4 cm.
Photometer Aperture	40".	25".	25".
Photometer Filter	V	V	V
Observing Period (U.T.)	02:38:56-02:51:56	02:39:04-02:51:10	02:41:04-03:04:01
Number of Readings	395	797	1511
<u>Brightness Ratio</u>			
Satellites	n.a.	n.a.	n.a.
Ratio	n.a.	n.a.	n.a.
Magnitude Difference	n.a.	n.a.	n.a.
<u>Regression Results</u>			
U.T. Range Used	02:44:14-02:46:30	02:44:34-02:46:09	02:49:07-02:53:06
Light Loss	**81.0±0.3 %**	**96.5±3.8 %**	**39.5±3.2 %**
Readings Used	69	106	181
U.T. of Minimum Light	**02:45:16.7±0.5**	**02:45:27.1±4.2**	**02:52:07.8±7.9**
Readings Used	69	73	126
<u>Predicted Values</u>			
Aksnes/Franklin U.T.	02:44.9	02:44.9	02:50.35
Aksnes/Franklin Light Loss	69 %	69 %	25 %
Gregorio U.T.	02:44:58	02:44:58	02:54:21
<u>Residuals (Obs. - Predicted)</u>			
Aksnes/Franklin Time	+23 sec.	+33 sec.	+107 sec.
Aksnes/Franklin Light Loss	+12.0 %	+27.5 %	+14.5 %
Gregorio Time	+19 sec.	+29 sec.	-133 sec.

Table 3--*Continued.*

Event Number and Type	(19) 2 Ec 4 P	(20) 3 Oc 2 P	(21) 1 Ec 2 P
U.T. Date	**1985 NOV 14**	**1985 AUG 27**	**1985 SEP 07**
Distance from Jupiter	13.8 radii	9.4 radii	6.6 radii
Observer	Langhans	Bulder	Bulder
Telescope Aperture	35.6 cm.	30 cm.	30 cm.
Photometer Aperture	40"	n.a.	n.a.
Photometer Filter	V	n.a.	n.a.
Observing Period (U.T.)	02:31:00-02:58:20	19:28-19:48	00:22-00:40
Number of Readings	814	25	15
Brightness Ratio			
Satellites	n.a.	n.a.	n.a.
Ratio	n.a.	n.a.	n.a.
Magnitude Difference	n.a.	n.a.	n.a.
Regression Results *(Note: Regression not used for Observations 20-30)*			
U.T. Range Used	02:43:00-02:47:00	n.a.	n.a.
Light Loss	**8.8±0.3 %**	n.a.	n.a.
Readings Used	121	n.a.	n.a.
U.T. of Minimum Light	**02:45:35.8±11.6**	**19:38:16±10**	**00:29:32±15**
Readings Used	78	n.a.	n.a.
Predicted Values			
Aksnes/Franklin U.T.	02:44.4	19:37.15	00:29.15
Aksnes/Franklin Light Loss	37 %	18 %	59 %
Gregorio U.T.	02:42:33	19:35:28	00:29:00
Residuals (Obs. - Predicted)			
Aksnes/Franklin Time	+72 sec.	+67 sec.	+23 sec.
Aksnes/Franklin Light Loss	-28.2 %	n.a.	n.a.
Gregorio Time	+183 sec.	+168 sec.	+32 sec.

Event Number and Type	(22) 4 Ec 2 A	(23) 1 Ec 2 P	(24) 4 Oc 2 T
U.T. Date	**1985 OCT 01**	**1985 OCT 26**	**1985 JUL 26**
Distance from Jupiter	5.6 radii	6.8 radii	7.4 radii
Observer	Bulder	Bulder	Adcock *et al.*
Telescope Aperture	30 cm.	30 cm.	31.5 cm.
Photometer Aperture	n.a.	n.a.	26".
Photometer Filter	n.a.	n.a.	n.a.
Observing Period (U.T.)	18:54-19:13	18:14-18:26	n.a.
Number of Readings	36	27	n.a.
Brightness Ratio			
Satellites	n.a.	n.a.	n.a.
Ratio	n.a.	n.a.	n.a.
Magnitude Difference	n.a.	n.a.	n.a.
Results			
U.T. Range Used	n.a.	n.a.	n.a.
Light Loss	n.a.	n.a.	**75 %**
Readings Used	n.a.	n.a.	n.a.
U.T. of Minimum Light	**19:06:45±10**	**18:20:00±20**	**12:34:10**
Readings Used	n.a.	n.a.	n.a.
Predicted Values			
Aksnes/Franklin U.T.	19:05.65	18:19.5	12:33.2
Aksnes/Franklin Light Loss	68 %	46 %	63 %
Gregorio U.T.	19:05:37	18:19:36	12:31:58
Residuals (Obs. - Predicted)			
Aksnes/Franklin Time	+66 sec.	+30 sec.	+58 sec.
Aksnes/Franklin Light Loss	n.a.	n.a.	+12 %
Gregorio Time	+68 sec.	+24 sec.	+132 sec.

Table 3--*Continued.*

Event Number and Type	(25) 3 Oc 2 P	(26) 3 Oc 2 P	(27) 3 Ec 1 A
U.T. Date	1985 AUG 13	1985 AUG 20	1985 OCT 10
Distance from Jupiter	9.3 radii	9.4 radii	4.2 radii
Observer	Adcock *et al.*	Adcock *et al.*	Adcock *et al.*
Telescope Aperture	31.5 cm.	20.0 cm.	20.0 cm.
Photometer Aperture	26".	26".	26".
Photometer Filter	n.a.	n.a.	n.a.
Observing Period (U.T.)	n.a.	n.a.	n.a.
Number of Readings	n.a.	n.a.	n.a.
Brightness Ratio			
Satellites	n.a.	n.a.	n.a.
Ratio	n.a.	n.a.	n.a.
Magnitude Difference	n.a.	n.a.	n.a.
Results			
U.T. Range Used	n.a.	n.a.	n.a.
Light Loss	**28 %**	**27 %**	**88 %**
Readings Used	n.a.	n.a.	n.a.
U.T. of Minimum Light	**13:13:30**	**16:22:--**	**10:33:30**
Readings Used	n.a.	n.a.	n.a.
Predicted Values			
Aksnes/Franklin U.T.	13:13.3	16:21.6	10:33.25
Aksnes/Franklin Light Loss	21 %	20 %	96 %
Gregorio U.T.	12:11:50	16:20:01	10:33:14
Residuals (Obs. - Predicted)			
Aksnes/Franklin Time	+12 sec.	+24 sec.	+15 sec.
Aksnes/Franklin Light Loss	+7 %	+7 %	-8 %
Gregorio Time	+160 sec.	+119 sec.	+16 sec.

Event Number and Type	(28) 2 Ec 4 P	(29) 1 Ec 2 P	(30) 1 Ec 3 A
U.T. Date	1985 OCT 10	1985 OCT 12	1985 OCT 14
Distance from Jupiter	3.4 radii	7.0 radii	6.0 radii
Observer	Adcock *et al.*	Adcock *et al.*	Adcock *et al.*
Telescope Aperture	20.0 cm.	20.0 cm.	20.0 cm.
Photometer Aperture	26".	26".	26".
Photometer Filter	n.a.	n.a.	n.a.
Observing Period (U.T)	n.a.	n.a.	n.a..
Number of Readings	n.a.	n.a.	n.a.
Brightness Ratio			
Satellites	n.a.	n.a.	n.a.
Ratio	n.a.	n.a.	n.a.
Magnitude Difference	n.a.	n.a.	n.a.
Results			
U.T. Range Used	n.a.	n.a.	n.a.
Light Loss	**37 %**	**91 %**	**34 %**
Readings Used	n.a.	n.a.	n.a.
U.T. of Minimum Light	**11:54:20**	**13:33:20**	**12:42:15**
Readings Used	n.a.	n.a.	n.a.
Predicted Values			
Aksnes/Franklin U.T.	11:51.75	13:32.7	12:42.1
Aksnes/Franklin Light Loss	32 %	77 %	39 %
Gregorio U.T.	11:52:46	13:32:49	12:42:02
Residuals (Obs. - Predicted)			
Aksnes/Franklin Time	+155 sec.	+38 sec.	+9 sec.
Aksnes/Franklin Light Loss	+5 %	+14 %	-5 %
Gregorio Time	+94 sec.	+31 sec.	+13 sec.

Observing Lunar Domes

By: Harry D. Jamieson

In 1987 the A.L.P.O. Lunar Section revived the "Lunar Dome Survey." This Survey confirms previously suspected domes, identifies uncatalogued domes, and measures and identifies dome characteristics. This is one research area where amateurs can contribute to our knowledge of the lunar surface. This paper describes the source material needed and the types of observations that can be made of these low-lying features. A dome classification system is outlined. Interested observers are invited to write Lunar Recorder Jim Phillips to find out more about, and to participate in, this program.

Domes are low swellings on the lunar surface that are similar to many shield volcanoes found on the Earth and Mars, and a detailed knowledge of their placement and physical characteristics can be of considerable value to selenologists in unraveling the history of the Moon. In 1962, the A.L.P.O. Lunar Section began a study of these features that lasted some 14 years and produced an incomplete listing of about 600 possible domes. The project's aim was to classify and describe these features while continuing to discover additional ones. However, interest in lunar observing waned and the program went into a period of inactivity until 1987. At that time, Dr. Jim Phillips, the present director of the program, John Westfall, A.L.P.O. Director, and myself decided to try to revitalize the program. The response has been very encouraging.

Persons interested in observing domes can make a real contribution to our knowledge of the lunar surface. The observations needed are not difficult to make, and no special equipment is needed. However, observers should be aware of the fact that domes tend to blend into their surroundings when they are more than 8° or 10° from the terminator. Thus, individual domes are usually visible only during a 16- to 18-hour period after lunar sunrise and also before lunar sunset each month.

Participants having access to professional-quality lunar charts with have few problems in locating domes from their coordinates, and such charts can help in efforts to improve dome positions. This writer recommends the *LAC* charts, the *Rectified Lunar Atlas*, or perhaps the *Times Atlas of the Moon*. Those having copies of the old *Orthographic Atlas of the Moon* will find it more than adequate. [Another recommended set of charts is the *Lunar Outline Charts* produced by the Lunar and Planetary Laboratory of the University of Arizona. Ed.] It is also very useful, although not absolutely required, to have a current ephemeris. The *Astronomical Almanac* is available from several sources, and the *A.L.P.O. Solar System Ephemeris* can be obtained from the A.L.P.O. (P.O. Box 16131, San Francisco, CA 94116) for $6.00 in the United States, Canada, and Mexico, or $8.50 for other countries.

The types of observations that are needed are simple to make:

1. Position. You will be given each dome's position, but you should seek to reconfirm it. Many infrequently observed domes have incorrect positions.

2. Diameter. A dome's size is measured in relation to a nearby crater of known diameter. This may be done by an eyepiece reticle or micrometer, or simply estimated by eye.

3. Average Slope Angle and Height. The moment at which a dome appears to be one-quarter covered by black (not gray) shadow is a very important time which should be noted carefully. It is at this time alone that the average slope angle and height can be computed because the Sun's altitude over the dome at that moment can be taken to equal the dome's average slope angle. Given this average slope and the dome's diameter, its height can be found easily. The equations for solar altitude and dome height are:

$$\sin \mathbf{A} = \sin \mathbf{B} \sin \mathbf{SB} + \cos \mathbf{B} \cos \mathbf{SB} \sin(\mathbf{C}+\mathbf{L}),$$

where:

A = elevation of the Sun;
B = Selenographic latitude of dome (from a good chart);
SB = Selenographic latitude of the Sun (from an ephemeris);
C = Sun's colongitude (from an ephemeris);
L = Selenographic longitude of dome (from a good chart; east, in the direction of Mare Crisium, being taken as positive).

To an acceptable degree of accuracy (i.e., ignoring the Moon's curvature), the dome's height is now simply:

$$\mathbf{H} = \mathbf{R} \tan \mathbf{A},$$

where;

H = height of dome (feet or meters);
R = Radius of dome (feet or meters; from observation type **2** above);
A = Sun's altitude from the first equation.

4. Maximum Slope Angle. This value is equal to the Sun's altitude when the last trace of shadow is observed at the foot of the dome in the lunar morning. Note that this determination should also be done in the lunar afternoon and that the two values thus found may be different.

5. Dome Classification. In 1964, John Westfall devised the dome classification system that is still in use. [1] Such classification is necessary both to analyze statistically the characteristics and distribution of domes, and eventually to understand their orogeny. The full text of his paper is sent to new observers who write to Dr. Phillips, but a brief outline of the system here will serve to show how simple it is to use. The system assumes these basic criteria about domes:

a. A dome is a discrete feature; not part of something else.

b. A dome's ratio of major:minor axes (corrected for foreshortening) may not exceed 2:1; this definition eliminates ridges.

c. A dome may not have an **average** slope angle that exceeds 5°; this definition eliminates hills and peaks.

d. No single secondary feature (cleft, crater, etc.) may occupy more than 1/4 of the surface area of a dome.

The classification system itself is designed to describe the physical characteristics of a dome by means of a combination of letters and numbers. A brief outline of this system is:

Broad Category:

D----Dome;
DC--Dome complex (several domes in physical contact; e.g., Rümker).

Surroundings:

U-----Uplands;
W----Maria;
UW--Uncertain if uplands or maria.

Plan; Major Axis is:

1. Less than 5 kilometers;
2. 5 to 20 kilometers;
3. 20 to 35 kilometers;
4. Over 35 kilometers.

(Always try to give a more exact size in your written notes.)

Border:

a. Circular (major:minor axes 1.00-1.25);
b. Elliptical (major:minor axes 1.26-2.00);
c. Polygonal;
d. Irregular;
e. Too ill-defined to classify.

Profile--Average Slope:

5. Gentle (under 2°);
6. Moderate (2°-5°).

Profile--Cross Section:

f. Hemispherical;
g. Flat summit (platykurtic);
h. Sharp summit (leptokurtic);
i. Multiple summit (more than one summit, but of a single type);
f'. Hemispherical--Asymmetric;
g'. Flat summit--Asymmetric;
h'. Sharp summit--Asymmetric;
i'. Complex summit (more than one summit and of different types).

Surface Detail--Type:

7. Depression (pit, craterlet, or saucer);
8. Elevation (hill, ridge, or peak);
9. Cleft or valley;
0. No observable detail.

Surface Detail--Position:

j. Central;
k. Off-center;
m. On margin;
n. Transversal (crosses dome);
p. More than one such feature.

An example of the system in use would be **DW/2b/6f/7j9m8p**. Translated, this describes: A dome on a mare, 5 to 20 kilometers in diameter, elliptical in shape, with an average slope angle between 2° and 5° and a hemispherical cross section. Its surface contains a central depression, a cleft that cuts across its margin, and several elevations.

This classification system describes domes only in the most general terms; and drawings, photographs, and written descriptions are also very valuable and should be included whenever possible. Any reader interested in participating in our Lunar Dome Survey should send a stamped, self-addressed envelope to: Jim Phillips, M.D., 101 Bull St., Charleston, SC 29401.

Reference:

1. Westfall, John E. "A Generic Classification of Lunar Domes." *J.A.L.P.O.*, *18*, Nos. 1-2 (July, 1964), 15-20.

COMET CORNER

By: Don E. Machholz, A.L.P.O. Comets Recorder

Present Comet Activity

As of this writing (November 25, 1988), there are no bright comets available for observation. However, you can find Periodic Comet Tempel 2 as it continues to fade away in the evening sky. The brightest returning comet of 1989, Periodic Comet Brorsen-Metcalf, which may reach the 5th magnitude in September and October, will not be visible in amateur instruments until the middle of 1989. Even a strange comet known for its unpredictable outbursts, Periodic Comet Schwassmann-Wachmann 1, remains in the solar vicinity until May. Positions for these three comets can be found in Assistant Comets Recorder Jim Scotti's Comets chapter in the 1988 (for Tempel 2) and 1989 (Brorsen-Metcalf and Schwassmann-Wachmann 1) editions of the *A.L.P.O. Solar System Ephemeris.*

I am seeking your observations, including photographs and drawings of comets. We presently need more recordings of: Comet Bradfield (1987s), Comet Liller (1988a), and Periodic Comet Tempel 2 (1987g). Please send them to the Comets Recorder (address on inside back cover) by February 15, 1989. For additional recording forms, along with a set of instructions, please write to the Comets Recorder.

Astrophotographers wishing to help in the study of the plasma tail of Periodic Comet Brorsen-Metcalf, due to appear later in 1989, may wish to contact the "International Comet Network." This group is asking for large-scale photographs of that comet. For details, write to: Mr. Andrea Cimatti, Via Volterra 7, 40135 Bologna, Italy.

Comet Names

[The previous Comets Recorder, David H. Levy, wrote briefly on this subject in our March, 1987, issue ("Comet Notes: IX. The Naming of Comets," *J.A.L.P.O.*, *32*, Nos. 1-2, p. 26); here we go into the subject in more detail. Ed.]

Comets are usually designated with three different "names." Perhaps the most popular type of label is the discoverer's proper name following the word "Comet," such as "Comet Smith." First, however, we'll discuss the other two types of labels; the year of discovery followed by a letter, and the year of perihelion passage followed by a Roman numeral.

Immediately following confirmation of discovery, every new or returning comet is given the year of discovery followed by a letter. The first comet of 1988, for example, was "1988a." The second was "1988b," and so forth. All the letters are lower case, although the twelfth comet of a year sometimes uses a capital letter ("L"), or is written in cursive ("$\mathcal{L}$"), so as not to confuse the letter "l" with the number "1."

Prior to 1987, the record number of comets in any one year was set in 1983, reaching the letter "w" with 23 comets. What do we do when there are more than 26 comets? The Interna- tional Astronomical Union, which oversees comet designations, has approved the use of numbers following the letters, all following the year. These numbers would be subscripts, in the sequence a_1, b_1, ... z_1, a_2, ...) but large numbers (a1, b1, etc.) may be acceptable. This system was needed in 1987, when 33 comets were designated, the last one being Comet Jensen-Shoemaker, 1987g_1.

Because comets are not given the previous form of designation until after confirmation, there is little wastage with this system. Only once in the past dozen years has such a label been placed on a nonexistent "comet," which turned out to be a series of photographic defects.

On the other hand, some comets never receive this preliminary designation. One case consists of those few comets with nearly circular orbits which are therefore always under observation. The present list of these includes Periodic Comets Gunn, Schwassmann-Wachmann 1, and Smirnova-Chernykh. As we refine our observing equipment and follow more comets throughout their orbits, this list will grow. The other class of comets not receiving letter designations is those found on old photographic plates or satellite images years after they were actually "observed."

A final label placed on a comet is usually given to it two or three years after initial observation. It is the year in which the comet passed perihelion (its closest point to the Sun) followed by a Roman numeral designating the order, in terms of all comets in that year, in which it reached that point.

For example, the first comet to reach its closest point to the Sun in 1985 was Comet Tsuchinshan 1, discovered in September of the previous year. It is also known as 1984p. It will now also be known as 1985 I. The comet known as 1985 II was also found in 1984. Meanwhile, Comet 1985 V was closest to the Sun in June, 1985, but was not found by Hartley until 1986 and was known as 1986c.

These designations must be given several years after initial observation because a comet often will be discovered up to a year after perihelion passage. Only when all the comets reaching perihelion during a particular year are known can they be correctly ordered with the proper Roman numeral.

Because we must have an accurate orbit to apply this last designation, no false comets in modern times carry it. On occasion, however, a comet will be discovered on several old photographic plates, from which an orbit is computed. It will then be given the next unused Roman numeral for the year in which it reached perihelion, even if it was closest to the Sun very early in that year.

Comets are also designated with proper names, usually the name of the discoverer. Here, we'll examine the normal situation as well as the exceptions to the rules.

As an example, if Joe Smith visually discovers a new comet, upon confirmation it is known as "Comet Smith." Smith often has no say in what he wants to name it; his name has to be used. This prevents the "selling" of comets by the discoverers. An exception is made if the discoverer has undergone a name change, yet had discovered comets under the previous name. Then, the discoverer chooses between his or her former or later name.

If, for example, Fred Jones discovers and promptly reports this hypothetical comet, then it is known as "Comet Smith-Jones." This is true only if Jones independently finds the comet. If Smith tells Jones where to look and Jones then observes it, this is not really an independent discovery. Otherwise, up to three names can be applied to a comet, each separated by a hyphen (-).

How close in time must the discoveries be in order for multiple names to appear on a comet? For most comets, the name is established at the time of confirmation, and for visual discoveries this is within a day of discovery. Until a few decades ago, slow communications allowed a new comet to remain unconfirmed and "co-discoverable" for several days or even weeks.

Of the 44 comets found visually since January, 1975, 35 have one name attached, three have two names, and six have three names. The number of independent discoveries of each comet provides one indication of the world-wide comet-hunting activity. Most of the multiple-name comets are found in the morning sky and are brighter than the average comet. Four of the six triple-name comets consist of three Japanese names.

When a comet is discovered by photographic means, the name is often that of the person who found it on the photograph. Usually, but not always, this is the person who exposed the photograph. If this is another person, sometimes both names are affixed to the comet. This policy is usually determined by the observatory at which the photograph was taken.

When a periodic comet, whose orbit is well-known, is recovered, the recoverer's name is not attached to the comet. On the other hand, if a previously lost periodic comet is accidentally "discovered" by someone who was unaware of its existence, their name is added to that of the old name, separated by a hyphen. In 1978, for example, Fujikawa of Japan discovered a comet. It was known as "Comet Fujikawa" until the newly computed orbital elements showed that it was Comet Denning, originally found in 1881 and lost for 11 revolutions. It is now called "Comet Denning-Fujikawa".

Here are some exceptions to the "rules" of naming comets:

If Smith discovers a comet that proves to be periodic (with an orbital period under 200 years), it is known as "Periodic Comet Smith." If he discovers another periodic comet, then his first comet becomes "Periodic Comet Smith 1" and his second comet becomes "Periodic Comet Smith 2."

If a husband-and-wife team discovers a comet, are both of their last names used? No, they are not. As an example, when Eugene and Carolyn Shoemaker find a comet, it is simply named "Comet Shoemaker," not "Comet Shoemaker-Shoemaker." (Note that two of the Shoemaker comets are credited to Carolyn alone.)

A hyphen (-) is used in a comet's name only to separate the discoverers. Thus, when sometimes the discover has a double name, the hyphen is dropped from the comet's name in order to show that there was only one discoverer. For example, in 1986 Stephen Singer-Brewster discovered a comet. It is known as "Comet Singer Brewster." Somewhat similarly, in 1926 Josep Comas Solá [*sic*] found a short-period comet, now known as "Periodic Comet Comas Solá." In 1968, John Bally-Urban and Patrick Clayton jointly found a comet. Bally-Urban dropped the last part of his name, so the comet is known as "Comet Bally-Clayton."

George van Biesbroeck's comets are each called "Comet van Biesbroeck." Similar treatment is given to comets found by Robert van Arsdale, H. van Gent, and C. van Houton. Sidney van den Bergh's comet is known as "Comet van den Bergh."

Each of D. du Toit's comets are named "Comet du Toit," with similar usage for the comets found by R. de Kock and Francesco de Vico. The famous periodic comet found by d'Arrest is called "Periodic Comet d'Arrest."

Four comets are named after persons, but not their discoverers. These are named after those who first calculated their orbits. You probably already know of two: Comet Encke and Comet Halley. Also, in 1770 Charles Messier discovered a comet whose orbit was determined by Anders Lexell; it is known as "Comet Lexell." Finally, Comet Crommelin was once known as "Comet Pons-Coggia-Winnecke-Forbes" before A. Crommelin determined its orbit.

Then there are some famous comets that are not named after people at all:

Fifteen comets are simply named as "Great Comet" [often with the year added, Ed.]. Most of these were observed between 1750 and 1850, appeared as bright naked-eye objects, and were first seen by many people at one time.

Some "Great" comets are named after months, such as "Great March Comet" (1843), "Great June Comet" (1845); and perhaps the brightest comet of all, "Great September Comet" (1882). The comet in 1910 that rivaled Halley's was the "Great January Comet."

The comet appearing in the Southern Hemisphere in 1947 is known as the "Southern Comet." Three others (1865, 1880, and 1887) are known as "Great Southern Comet." One spotted during a solar eclipse in 1948 is called the "Eclipse Comet."

Three comets are named after the Purple Mountain Observatory in Nanjing, China, where they were found; in Chinese, "Tsuchinshan."

When the SOLWIND satellite found its first comet, it was named Comet Howard-Koomen-Michels, after the man who found it on the images as well as those who designed the instrument. The comet was later unofficially named "Comet SOLWIND 1," which was followed by SOLWIND numbers 2 through 6. The IRAS comets were simply named "Comet IRAS," with co-discover names added. The Solar Maximum Mission Satellite comets are called "SMM," followed by a number (1, 2, 3, etc.).

Since we began naming comets after their discoverers 230 years ago until the most recent find (1988n), there have been 787 comets discovered, confirmed, and named. Some of these are periodic comets which have returned several times since they were discovered; considering these additional visits there have been roughly 1250 cometary apparitions since 1759.

Examining these 787 comets, how many people have had their name affixed to at least one comet? When we subtract the comets named after artificial satellites (17), mountains (3), and those comets called "Great Comet" or something similar, we find 327 individuals with a comet named after them. Only 40 percent, or 130 persons, have had their names attached to two or more comets and 85 have found at least three. A mere 60 individuals have discovered four or more comets.

Getting back to these 327 persons, do we find any two with the same name? Yes, this happens six times. These names each belonged to two different people; unrelated and usually living decades and many miles apart: Rümker, Thiele, Jones, Shajn, Wilson, and Mitchell. Amazingly, half of them, the last three, belonged to a male and a female, rare in a field in which so few women are represented.

Finally, *Table 1,* below, lists those who have had their names on at least ten comets, along with their country of residence and the years in which they discovered comets. [Note that there is some debate as to the exact number of comets that some of these persons discovered. Ed.]

Table 1. Discoverers of At Least 10 Comets.

No. of Comets	Discoverer	Country	Active Years
26	Pons, Jean	France	1801-1827
21	Brooks, William	U.S.A.	1883-1911
16	Barnard, Edward	U.S.A.	1881-1892
14	Swift, Lewis	U.S.A.	1862-1899
14	Shoemaker, C. and E.	U.S.A.	1983- ----
13	Tempel, William	France, Italy	1859-1877
13	Bradfield, William	Australia	1972- ----
12	Honda, Minoru	Japan	1940- ----
12	Mrkos, Anton	Czechoslovakia	1948- ----
12	Giacobini, M.	France	1896-1907
12	Messier, Charles	France	1759-1798
11	Borrelly, L.	France	1873-1912
10	Peltier, Leslie	U.S.A.	1925-1954
10	Winnecke, F.	Germany	1854-1877

Next in line, we have Charles Perrine (Lick Observatory, 1895-1907) with nine comets, Having found eight each are Robert Harrington, who found them on Palomar Sky Survey plates, and Malcolm Hartley, who is presently working at Siding Spring Observatory in Australia.

These counts do not include the "independent " discoveries sometimes made but not credited. This occurs when poor communication or slow comet confirmation allows many discoveries to be made by those still unaware of the new comet.

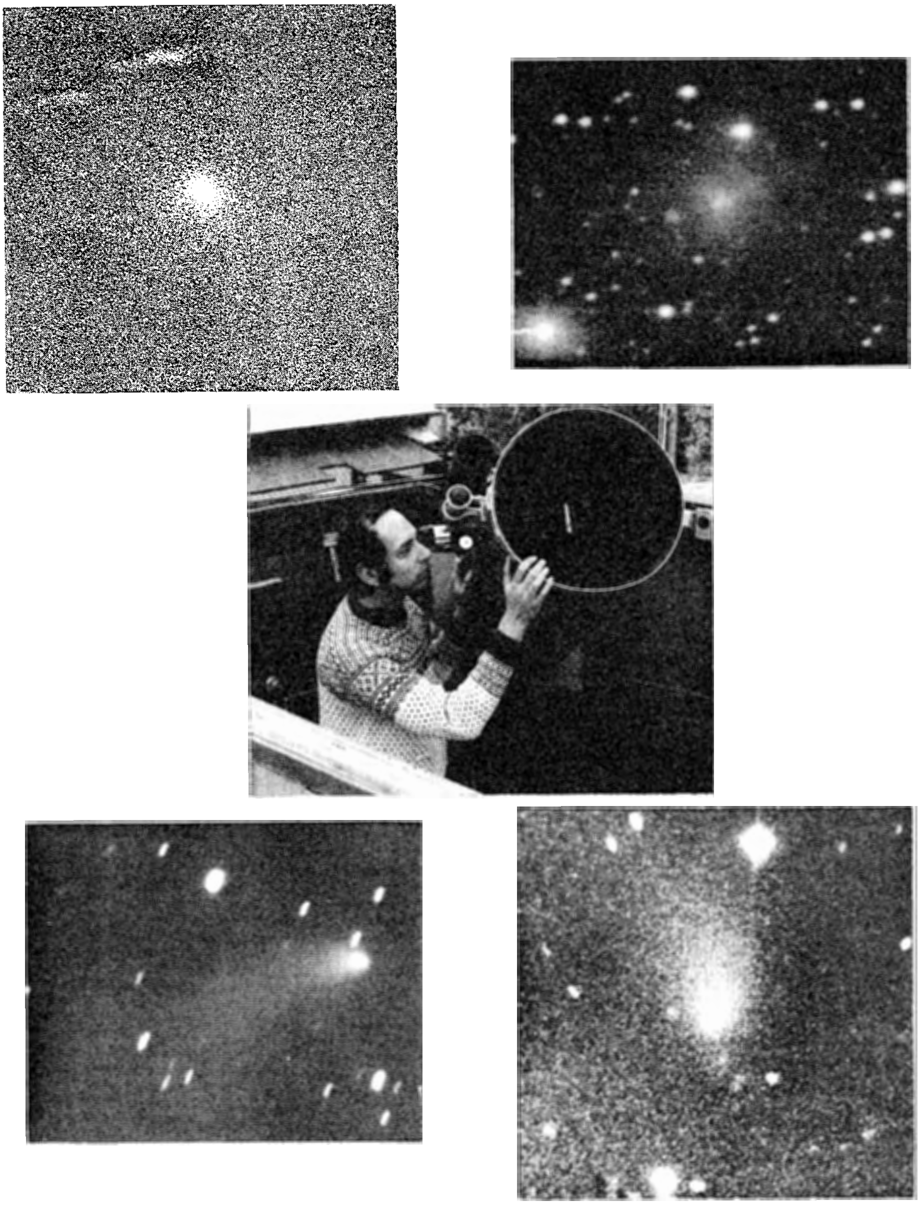


Figure 32. In the center is A.L.P.O. comets observer David H. Levy with one of his telescopes (a 16-inch Newtonian), surrounded by the four comets he has discovered to date. In clockwise order we have: *Upper Left*-- Comet Levy-Rudenko 1984t, photographed with the 1.6-meter reflector of Mount Megantic Observatory by John Glaspey and René Racine on 1984 NOV 26.99 U.T. (photograph courtesy Université de Montréal); *Upper Right*-- Comet Levy 1987a on 1987 FEB 01, 12h 39m U.T., imaged with the 0.9-meter SPACEWATCH camera of the University of Arizona by Tom Gehrels and James V. Scotti; *Lower Right*-- Comet Levy 1987y imaged on 1987 OCT 26 at 02h 01m U.T. with the Catalina Observatory (University of Arizona) 1.5-meter reflector with a red filter by Steve Larson and David Levy; *Lower Left*--Comet Levy 1988e, again taken with the Catalina Observatory 1.5-meter reflector with a red filter, on 1988 APR 12 at 11h 02m U.T., imaged by Steve Larson and David Levy. North is at the top of all views except for 1984t, where the orientation is unknown.

OBSERVING METEORS: XIV

By: David H. Levy, A.L.P.O. Assistant Meteors Recorder

With this column, having left the old obligation of A.L.P.O. Meteors Recorder, I begin my new responsibility as Assistant Recorder. It will be a lot more fun, I think, to sit back in a comfortable chair and offer all kinds of advice to the New Recorder, than it was actually to do all the work that running a Section involves!

First, I'd like to introduce John W. Griesé, III, who has agreed to take over this Section. He comes to us with a considerable amount of experience in the areas of observation, organization, and inspiration; all crucial to the successful management of an A.L.P.O. Section. He has been active as an observer and a council member of the American Association of Variable Star Observers, and has helped to operate the public program at Stamford Observatory as its Assistant Director. His professional work involves parallax measurement and photometry at Van Vleck Observatory. In 1988 his work was recognized by the Western Amateur Astronomers through its Caroline Herschel Award.

Both Jim Scotti and I will remain as Assistant Recorders for the Meteors Section. I think that this will be a much better arrangement that the one we had before; John is a far better organizer than I, and he should be able to handle the correspondence much more efficiently than did I.

I enjoyed the five years I spent as Recorder, beginning on July 26, 1983. The high points were meeting the very interesting people who observe meteors, studying their observations and editing the newsletter *Tails and Trails*, and completing with Steve Edberg the manual *Observe Meteors*. But there was a low point. Some members, apparently feeling that A.L.P.O. Recorders work for huge salaries in plush offices, expect instant responses to all inquiries. That usually isn't possible; no one on the A.L.P.O. staff gets a penny for the many hours of work that are involved. We do it because we love it, in the truest sense of amateur astronomy, and I think that we would all love it even more if observers would be a little more patient.

Of course, "Observing Meteors" will continue to appear as an occasional column in these pages. *Tails and Trails* will also continue to be published. I want to thank Jim Scotti for his help through these years, and John Westfall for the enormous amount of assistance that he has provided. And a special thanks to Walter Haas, a close friend who has encouraged me throughout my recordership. Good luck to John Griesé; I know that he will enjoy his tenure as Recorder as much as I did!

Taurid Note: I have never seen the Taurids show such dramatic activity as they did in 1988. Normally this shower peaks between November 1st and 3rd at a maximum zenithal hourly rate of 15. They are quite slow, at about 28 kilometers per second. This shower is active over a period as long as three months, sporting bright fireballs.

In 1988, the fireballs were numerous and very bright. On October 23 at 11h 28m Universal Time (U.T.), a night dominated by a bright Moon, my attention was grabbed by a lightning-like flash. I looked up to see the bright train of a bolide in Hydra. The train was straight at first, but curved in on itself within about 30 seconds. It lasted about 15 *minutes*, getting more and more diffuse during that time. This was the most remarkable of a long series of such events, another one of which, on November 4th, U.T., probably caused my neighbor's dog to go into a barking fit!

Comet Section Note: As readers of this *Journal* are already aware, I have also retired as Comets Section Recorder. I want to thank Don Machholz for agreeing to be the new Recorder. One of the world's best-known amateur observers of comets, he has so far discovered four comets. [So has David; and a montage of photographs of his four discoveries appears on p. 28. Ed.] He produces a delightful newsletter called *Comet Comets*, and is writing "Comet Corner" for this *Journal*. [See p. 25.] I am happy that the Comets Section is in such capable hands.

METEORS SECTION NEWS

By: John W. Griesé, III, Acting A.L.P.O. Meteors Recorder

I would like to thank all the observers who have recently sent in observations of the Perseids and of minor meteor showers; your observations are very much appreciated.

Meteor watching is a very special kind of observing. It is often the first observing experience that most amateurs have. I can remember as a child being awakened by my father in the middle of the night in order to observe an important meteor shower. More often than not, I tended to roll over and return to sleep, but he did try. Meteor showers even make the nightly news sometimes; and just this evening as I write this, someone called to report a fireball that he had seen two days earlier.

Observing a meteor shower pulls people like me, who observe from inside domes, outside to a deck lounger to observe a larger piece of sky. Observing meteors helps us to commune with the sky in a relaxed manner. I feel as if I am relating to the sky in a way different from my usual observing.

What other observing causes us to yell, or scream, or exclaim something as we see a meteor trail out of the corner of our eye? It is exciting, and it is something happening close to home just some tens of miles above our heads.

Meteor observing also brings us together. Most of the reports that I have received came from groups of observers and I am sure that most of us have at one time or another joined our friends and headed outside together with our loungers. Actually, watching in groups is the most efficient way to observe meteors. Having said this, I hope that all of you get out there, observe, and send in your observations. If you need help, *Observe Meteors* by David Levy and Stephen Edberg is the reference to read. [It is available for $5.75 from Astronomical League Sales, Four Klopfer St., Pittsburgh, PA 15209.]

COMING SOLAR SYSTEM EVENTS: FEBRUARY - APRIL, 1989

This column is given here in order to describe the visibility of Solar System objects and events, both for serious observation and as of general interest. For more detailed information, consult such sources as the 1989 edition of the *A.L.P.O. Solar System Ephemeris*. All dates and times below are in Universal Time (U.T.); found by adding 9 hours to Alaska Standard Time, 8 to PST, 7 to MST, 6 to CST, and 5 to EST. Directions are abbreviated.

Planetary Visibility

As has been the case for the past several months, Mars and Jupiter are the most readily observable planets, both in the evening sky. Although now drawing further away from Earth, **Mars** is still an obvious first-magnitude object, crossing from Aries to Taurus in late February. This planet will be highest during evening twilight; not a bad time to observe because the background light from the sky will reduce glare. Its disk exceeds 6 arc-seconds in diameter until March 4th, big enough for visual drawing in moderate-aperture telescopes; those with larger instruments should follow the Red Planet as long as they can. For Northern-Hemisphere observers, Mars' dwindling apparent size is compensated for by its northerly movement, climbing from 14°.9 N at the beginning of February to 24°.8 N at the end of April. The South Polar Cap will continue to be turned earthward until late April. On our February 17, Mars' Southern Hemisphere enters Autumn.

Jupiter, in Taurus, is not far from Mars in the evening sky; indeed, it passes just 2° S of Mars on March 12th. It remains a conspicuous -2 magnitude object, but fades somewhat as its apparent equatorial diameter diminishes from 42 to 33 arc-seconds. Like Mars, Jupiter is at a declination favorable for Northern-Hemisphere observers, increasing from 18°.6 to 21°.4 N during the current period.

The only other planet in the evening sky is **Mercury**, and that only in late April-early May, centered on its greatest eastern elongation on May 1st. At that time, the innermost planet will appear to be 21° from the Sun, at magnitude +0.4. Its northerly declination at that time (23°.0 N) makes this apparition favorable for our Northern Hemisphere. Mercury also reaches greatest western elongation during our period; on February 18th, when it will be 26° from the Sun at magnitude +0.1. This earlier elongation is more favorable from the Earth's Southern Hemisphere because Mercury's declination will be 19°.2 S. Also, Venus will pass 4°S of Mercury on February 1, making the latter easier to locate.

Venus is chiefly a morning object, although it closes in on the Sun as the date of its superior conjunction, April 4th, approaches. Throughout this period, Venus' disk will be at nearly full phase with a diameter of about 10 arc-seconds and at magnitude -3.9.

Saturn is now drawing away from the Sun to become observable in the morning sky. As has been the case for some time, it is well south in the constellation of Sagittarius, now at declination 22°S. Although among the Milky Way, the Ringed Planet is easy to spot at approximate magnitude +0.5. The Ring System continues to be favorably presented, with its N face tilted 25° toward Earth.

Uranus and **Neptune** are near Saturn in Sagittarius, and thus the visibility conditions of all three planets are similar. Uranus is at magnitude +6.0, with a disk diameter of 3.6 arc-seconds; corresponding values for Neptune are +7.8 magnitude and 2.2 arc-seconds. It will be easiest to spot Neptune on March 3rd, when Saturn will pass 14 arc-minutes to its S.

If you have never seen **Pluto**, start preparing for your best chance. This planet reaches opposition on May 4th, just four months before it reaches perihelion on September 5th. Thus, at magnitude +13.64, Pluto will be its brightest for the next two and one-half centuries!

Turning to the **Minor Planets**, four will reach opposition during our three-month period at brighter than 10th magnitude:

	Opposition Data		
Minor Planet	Date	Magnitude	Declination
7 Iris	FEB 07	+8.4	6°.6 N
3 Juno	FEB 21	+8.6	4°.6 N
8 Flora	MAR 04	+9.3	14°.0 N
51 Nemausa	MAR 15	+9.6	1°.8 N

We also note that four occultations of stars by minor planets are predicted:

Date	Minor Planet	Planet&Star Magnitudes	Light Loss
FEB 06.10	3 Juno	+9.5 +10.2	35 %
FEB 28.80	87 Sylvia	+12.8 +11.7	74 %
MAR 18.17	324 Bamberga	+12.5 +9.2	96 %
APR 02.22	4 Vesta	+7.0 +10.2	5 %

In chronological order, the predicted zones of visibility for the above events are: FEB 06--Mexico and the Caribbean; FEB 28--Siberia, Korea, and S Japan; MAR 18--SE to NW United States; and APR 02--Central South America.

Partial Eclipse of the Sun

Observers in northern and central North America, Hawaii, and Greenland will be treated to a partial solar eclipse on the morning of March 7th (both local time and U.T.). The portion of the Earth where this event will be visible is shown in *Figure 33*, below.

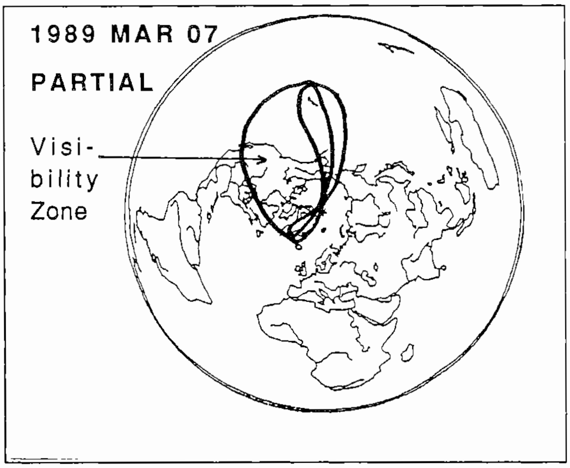


Figure 33. Area of visibility of the partial solar eclipse of 1989 MAR 07. (Reproduced from the *A.L.P.O. Solar System Ephemeris: 1989.*)

The maximum magnitude of this eclipse is 0.827 (the portion of the Sun's diameter covered by the Moon), but you would have to be in the Bering Strait at 61°.32 N/169°.84 W in order to observe this. Some data for more accessible observing sites for the time of **maximum** eclipse are:

Location	Magnitude	U.T.	Solar Altitude
Anchorage, AK	0.797	18:13.3	10°
Denver, CO	0.245	18:16.7	44°
Edmonton, Alberta	0.523	18:27.8	29°
Honolulu, HI	0.385	17:02.0	3°
Kansas City, KS	0.060	18:29.7	46°
Las Cruces, NM	0.178	18:59.8	48°
Los Angeles, CA	0.365	17:50.0	35°
Milwaukee, WI	0.020	18:44.4	41°
Nome, AK	0.822	18:14.2	2°
Omaha, NE	0.120	18:31.1	44°
Phoenix, AZ	0.265	17:56.4	45°
Portland, OR	0.550	18:05.7	31°
San Francisco, CA	0.462	17:52.1	35°
Seattle, WA	0.568	18:09.7	30°
Tucson, AZ	0.229	17:55.5	46°
Winnipeg, Manitoba	0.277	18:40.5	35°

Note that the times above are for the maximum eclipse. From first contact to last contact, the eclipse will last up to 2.1 hours, so check more detailed predictions for when the eclipse begins and ends for your locality.

Perhaps the most useful work for amateur observers for this eclipse will be photographing the Moon's profile. Make sure the accurate orientation of your photographs is indicated and send them to Eclipse Recorder Francis Graham at the address on the inside back cover.

Other Lunar Events

A **total lunar eclipse** will occur on February 20th, and is described in a separate article following this one. Also during this period, the Moon will pass near the Pleiades star cluster, and will occult the bright stars Antares and Regulus as well as the Planet Mercury.

The first **Pleiades passage** by the Moon is on 1988 FEB 13, at about 10h U.T. with a 55-percent illuminated waxing Moon; the zone of visibility is Alaska and NE-most Asia. The next passage, on MAR 12, near 10h, can be seen from Alaska and most of Asia; the Moon is a 31-percent waxing crescent. Finally, the third passage is on APR 09, near 00h, and can be seen from the N central and NE United States and central and E Canada; the Moon will be a thin 12-percent sunlit waxing crescent.

Lunar occultations of **Antares** (ca. +0.9 magnitude) occur on FEB 01 and 28, MAR 28, and APR 24. **Regulus** (magnitude +1.35) is occulted on FEB 20, MAR 19, and APR 15.

The **occultation of Mercury** happens on March 6th at about 04h U.T., when the planet is at magnitude -0.1 and 23° W of the Sun. This event will be visible from E Africa and much of Asia, as shown in *Figure 34* (upper right).

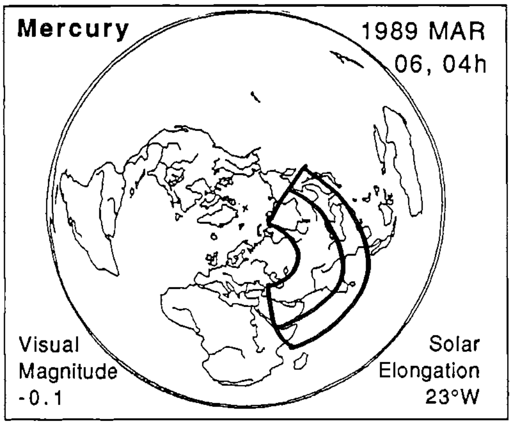


Figure 34. Area of visibility of the lunar occultation of Mercury on 1989 MAR 06. (Figure 34 is reproduced from the *A.L.P.O. Solar System Ephemeris: 1989*.)

Comets and Meteors

No bright comets are forecast for this three-month period, the two brightest (P/Gunn and Shoemaker-Holt-Rodriquez) being predicted to be about 12th magnitude.

As for the regular meteor showers, unfortunately the Moon will interfere at the time of their maxima. The Delta Leonids will peak on February 27, with a lunar age of 20 days (the shower lasts from February 6-March 19). The Sigma Leonids have their maximum on April 17 (duration March 21-May 13), with an 11-day Moon. The Sigma Leonids will thus probably be best seen shortly before dawn, when the Moon has set. Finally, the Lyrids reach maximum on April 21.8 (duration 2 days) with a 16-day Moon.

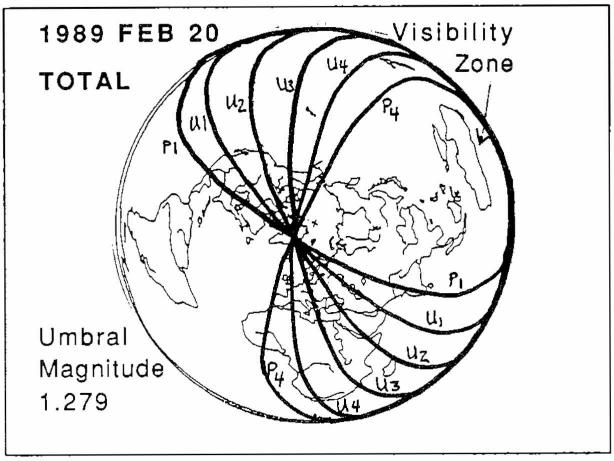
OBSERVING THE NEXT TOTAL LUNAR ECLIPSE: 1989 FEB 20

Eclipse Events

On February 20th, 1989, the Earth's first total lunar eclipse since October, 1986, will be visible from about half the Earth; the Pacific Basin; western North America, Australasia, most of Asia, and parts of Africa. The event's **umbral magnitude** is **1.279** (meaning that, at mid-eclipse, the portion of the Moon's limb outermost in the umbra is 0.279 lunar radii inside the umbral edge). This eclipse's various phases occur approximately as in the schedule on the right-hand side of *Figure 35* (p. 33). These predictions assume a 2-percent enlargement of the umbra due to the Earth's atmosphere.

Note that the times given in *Figure 35* are in Universal Time, which should be appropriately corrected if one wishes to express them in one's local time (see p. 30). This means that some areas, such as New Zealand, will see part of the eclipse on February 21st!

The two penumbral contacts are unobservable. Observers may see slight penumbral shading on the Moon's southeast (celestial directions are used throughout this paper) limb starting near 13h and on the western limb up to about 18h. The first and second umbral contacts mark the start and end, respectively, of the first partial umbral phase. Totality falls between the second umbral contact and the third umbral contact. Another partial umbral phase occurs between the third and fourth umbral contacts.



P1 = First Penumbral Contact; 12h 29.8m

U1 = First Umbral Contact; 13h 43.4m

U2 = Second Umbral Contact (begin totality); 14h 55.7m

------ Middle of the Eclipse; 15h 35.3m

U3 = Third Umbral Contact (end totality); 16h 15.0m

U4 = Fourth Umbral Contact; 17h 27.2m

P4 = Fourth Penumbral Contact; 18h 41.0m

Figure 35. Conditions of visibility of the total lunar eclipse on 1989 FEB 20.

In *Figure 35,* the region where all phases of the eclipse can be seen is labeled "Visibility Zone," and includes Australia and the eastern half of Asia. West of this area, the beginning of the eclipse will not be visible, with the labeled lines indicating where a particular phase takes place at moonrise. East of the "Visibility Zone," the end of the eclipse will not be visible, and the labeled lines indicate where eclipse phases occur at moonset. Thus, some of totality will be visible from western Asia, eastern Africa, the European Soviet Union, and northwestern North America, in addition to the "Visibility Zone."

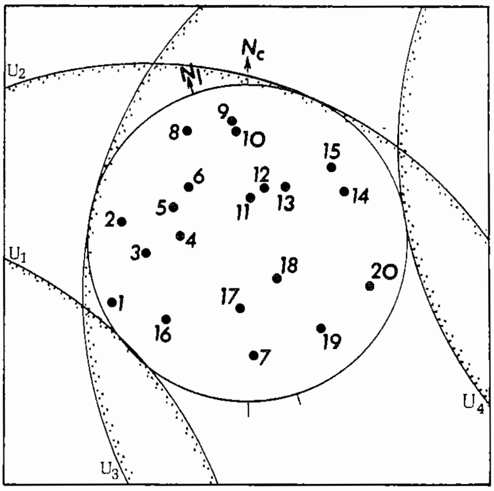


Figure 36. Edge of umbral shadow (enlarged 2 percent) at each of the four umbral contacts during the total lunar eclipse of 20 FEB 1989. Celestial and lunar north and the positions of 20 selected craters are also plotted.

To the lower left) is a diagram of the Moon (*Figure 36*), showing the position of the edge of the umbra at each of the four umbral contacts, labeled as in *Figure 35*. Celestial north is to the top ("Nc"), with lunar north offset to the left ("Nl"). The numbers on the Moon's face refer to craters recommended for umbral contact timings (see p. 35).

Watch for the first umbral contact with the Moon's limb near position angle 134° (celestial southeast). The fourth (last) umbral contact will be near position angle 279° (celestial west).

Eclipse Observations

It has been long enough since the last total lunar eclipse that even enthusiasts may have forgotten the many scientifically interesting types of observations that can be made on these occasions. One reason why such observations are of value is that each lunar eclipse is unique and such factors as the degree of darkening and coloration are impossible precisely to predict.

Thus, we can always use general descriptions of the appearance of the Moon throughout the eclipse, whether recorded through written comments, drawings, photographs, videotapes, or photometer readings. Some of these observations can be done easily with binoculars or even with the naked eye. This includes sketches of the pattern of light and color on the Moon's disk at various times during the eclipse. Near mid-eclipse, it is standard procedure, with binoculars or the naked eye, to estimate the **Danjon Luminosity (L)** according to the following scale:

L = 0 Very dark eclipse; Moon almost invisible, especially at mid-eclipse.

L = 1 Dark eclipse, gray or brownish coloration; details distinguishable only with difficulty.

L = 2 Deep red or rust-colored eclipse, with a very dark central umbra and the outer edge of the umbra relatively bright.
L = 3 Brick-red eclipse; usually with a bright or yellow rim to the umbra.
L = 4 Very bright copper-red or orange eclipse; with a bluish very bright shadow rim.

Experienced observers may wish to make fractional estimates, such as **L** = 2.7 or **L** = 3-1/2.

"Danjon estimates" are a form of qualitative photometry. Quantitative visual photometry of the entire disk of the eclipsed Moon can be done by comparing the Moon with a bright star. To do this, though, we need to make the Moon appear small and star-like and, except during totality with a dark eclipse, probably will have to make the Moon fainter as well.

Reversed binoculars can do both jobs. Assuming a 25-percent light loss in the instrument, the amount of apparent lunar dimming is a function only of the magnification of the binoculars (not the aperture), with the following magnitudes dimming:

6X.. 4.2 magnitudes	11X.. 5.5 magnitudes
7X.. 4.5	12X.. 5.7
8X.. 4.8	16X.. 6.3
10X.. 5.3	20X.. 6.8

The Moon's image may also be reduced and dimmed by reflection in a convex mirror, such as a Christmas-tree ball. The further the eye is from the surface, the greater the dimming, following the formula:

$$\Delta \mathbf{M} = \mathbf{K} - 5 \log \mathbf{R},$$

where: Δ**M** is the apparent dimming in stellar magnitudes, **K** is a constant to be found by observing the Full Moon (magnitude -12.7) either just before or just after the eclipse, and **R** is the distance from the eye to the reflector surface, measured in whatever units are convenient.

Those equipped with photoelectric photometers may do *spot photometry* of selected bright lunar craters at frequent intervals throughout the eclipse. Such observations allow us to map the brightness variations within the umbra. If one does multiband photometry, color variations can also be mapped. Photoelectric spot photometry of past eclipses, particularly during the penumbral phases, has provided objective evidence of **lunar transient phenomena**.

Naturally, for any quantitative photometry, one or more bright comparison stars or planets are needed. There will be no handy bright planets anywhere nearby, but it is fortunate that the eclipsed Moon will be very near the star **Regulus** (visual magnitude +1.35, spectrum B7 Vn). Actually, Regulus will be occulted by the Moon before the eclipse from

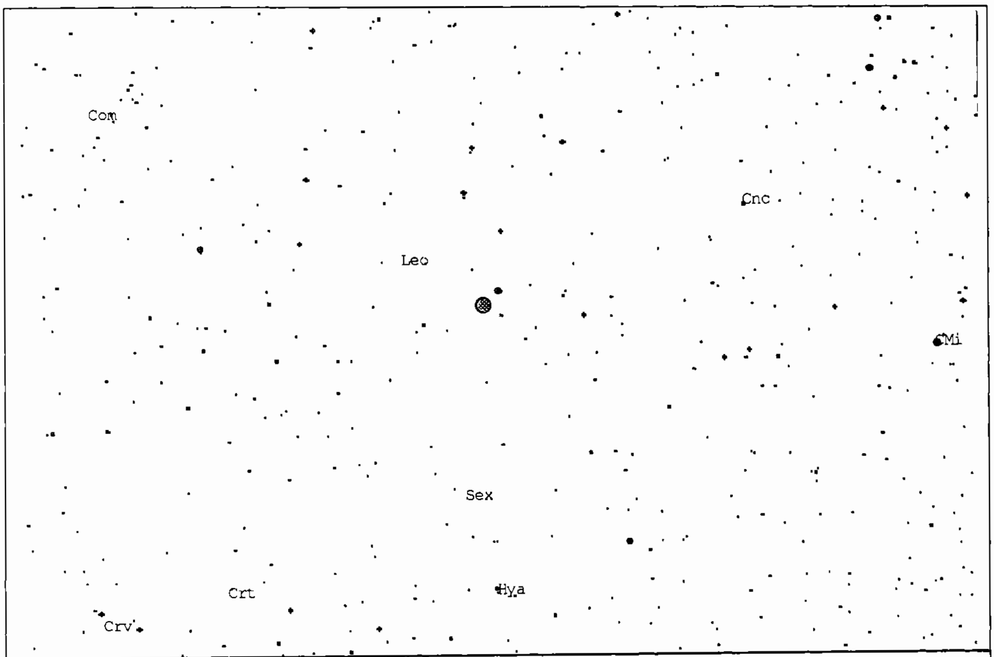


Figure 37. The sky background of the totally eclipsed Moon on 1989 FEB 20, at 15h 35m U.T. (mid-eclipse) as seen from Honolulu, Hawaii. Note the bright star Regulus to the upper right of the Moon. North at top. Field 84° in width. Plot generated by Voyager program, © Carina Software.

locations in the central or northeastern Pacific Ocean. (For example, where **D** indicates disappearance and **R** reappearance, the Universal Times of the occultation for Honolulu will be **D** 10h 47m, **R** 11h 43m; and for Kyoto will be **D** 09h 05m, **R** 09h 59m.) The position of the Moon in the sky at the time of mid-eclipse is plotted in *Figure 37* (p. 34).

Another type of relatively simple observation is **umbral contact timings**. The umbra is enlarged by an amount that is variable for each eclipse, and this value is found by such timings. Given sufficient timings, we can find, not only the degree of enlargement, but the amount of ellipticity of the umbra as well. A moderate-size telescope (10-40 cm.) at about 40-100x is quite appropriate for this. One approach is to time the four umbral contacts with the Moon's limb; the approximate times of which are given in *Figure 35* (p. 33). It is, however, probably more accurate to time when prominent craters either enter the umbra (*immersion*) or leave it (*emersion*). For large craters, it is best to time when the umbra edge first and last touches the crater and then to take the mean of these two times. The 20 recommended craters for this purpose are plotted in *Figure 36* (p. 33) Their names and immersion (**i**) and emersion (**e**) Universal Times (rounded off to the nearest 5 minutes) are as follows:

1. **Grimaldi (13h 45m i; 16h 25m e)**
2. **Aristarchus (14h 05m i; 16h 25m e)**
3. **Kepler (14h 00m i; 16h 30m e)**
4. **Copernicus (14h 10m i; 16h 40m e)**
5. **Pytheas (14h 15m i; 16h 35m e)**
6. **Timocharis (14h 20m i; 16h 40m e)**
7. **Tycho (14h 00m i; 16h 50m e)**
8. **Plato (14h 35m i; 16h 35m e)**
9. **Aristoteles (14h 40m i; 16h 45m e)**
10. **Eudoxus (14h 40m i; 16h 50m e)**
11. **Manilius (14h25m i; 16h 55m e)**
12. **Menelaus (14h30m i; 16h 55m e)**
13. **Plinius (14h 35m i; 17h 00m e)**
14. **Taruntius (14h 40m i; 17h 15m e)**
15. **Proclus (14h 45m i; 17h 10m e)**
16. **Gassendi (13h 50m i; 16h 35m e)**
17. **Birt (14h 05m i; 16h 50m e)**
18. **Abulfeda E (14h 15m i; 17h 00m e)**
19. **Nicolai A (14h 15m i; 17h 05m e)**
20. **Stevenus A (14h 30m i; 17h 20m e).**

Before the eclipse, review the Moon's appearance and be sure that you can unambiguously identify whichever of the above craters you wish to use in making umbral contact timings.

Lunar transient phenomena (LTP) may be looked for visually, photographically, or with photoelectric photometry. For example, some lunar rocks may fluoresce under short-wave solar radiation that reaches lunar areas during the penumbral phases when the reflected solar light is reduced. Also, eclipse-induced changes in light and dark tonal patches have sometimes been reported. In alphabetical order, some features where eclipse-related LTP have been reported are: Alphonsus, Aristarchus and vicinity, Atlas, Byrgius, Censorinus, Conon, Delambre, Eratosthenes, Euler, Grimaldi, Kepler, Linné, Manilius, Menelaus, Messier and Messier A, Plato, Plinius, Proclus, Pytheas, Riccioli, Römer, Schickard, Stöfler, and Tycho.

Whatever your form of observation of this fairly rare event, be sure to send your results to: Francis G. Graham, A.L.P.O. Lunar Recorder--Eclipses, P.O. Box 209, East Pittsburgh, PA 15112 U.S.A.

References

There is no room in this short announcement to go into more detail about how to observe lunar eclipses. Depending on what you are interested in doing, we recommend that you consult one or more of these references.

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Eastman Kodak Co. *Astrophotography Basics*. Kodak Publication No. P-150. Rochester, NY, 1988. See Chapter III, "Lunar Eclipse," pp. 20-21.

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JAMES I AND THE CRESCENT OF VENUS

By: Francis G. Graham and Theresa Palmer

The Scottish king, James I (1394-1437), was born to reign amidst the clan rivalries and semiautonomous nobles which characterized 15th-century Scotland. The son of Robert III and Annabella Drummond, he became heir to the throne in 1402 upon the death of his older brother, David. James' uncle, the Duke of Albany, immediately planned to kill him. To protect the heir apparent, his father sent him to France, but en route he was captured by English sailors and imprisoned in England.

Upon the death of Robert III (1406), James was still in captivity in England, and the Duke of Albany became Regent. Indeed, James remained in captivity until 1424. Then, while in the Tower of London, terms for James' release were arranged, including his marriage to Joan Beaufort. Anticipating his freedom, he wrote a long poem in the Scottish vernacular called the *Kingis Quair* . The first seven lines are of astronomical interest and refer to the planet Venus (*Citherea*):

Heigh in the hevynnis figure circulere
The rody sterres twynklyng as the fyre
And in Aquary, Citherea the clere
Rynsid hir tressis like the goldin wyre
That late to fore in fair and fresch atyre
Through Capricorn heved hir hornis bright
North northward approchit the mydnyght.

We see that James I observed Venus pass from Aquarius to Capricorn. [1] Retrocalculating, we find that Venus spent late 1423 as an evening star, passed inferior conjunction on January 30.5, 1424 (Julian Calendar), and then rose as a morning star through Aquarius and Capricorn in February, 1424, "in fair and fresch atyre." Thus King James seems to describe what he saw during those dreadful days in the Tower.

Note also that James I saw "hir hornis bright." During Venus' sojourn in Capricorn, it was less than 10° from the Sun, having recently passed inferior conjunction. It was then very nearly one arc-minute in diameter, near the diffraction limit for the human eye. If James I had above-average eyesight, he may have been able to see the crescent horns, as some modern people have claimed to do. [2] There are other associations also in ancient literature which might also have been explained by above-average eyepower, a useful ability for a warrior-king.

What of the seventh line, "North northward approchit the mydnyght"? In Chaucher, "midnight" is poetically used to refer to the meridian. Yet we know that when Venus is usually seen in the predawn hours it can never be near the meridian. Notice, though, that James only says they *approached*. In a sense, there is a likely explanation. During a morning apparition of Venus, it is possible to follow the planet in the blue sky well after sunrise; indeed, even to the meridian, if you are careful not to remove your gaze. A prison captive might well have the idle time to do just that. Venus also was "northward" in declination at the time. [3]

In conclusion, we feel that there is no reason to doubt that James I actually observed Venus' path in the heavens and noted it in the composition of the *Kingis Quair*. To conclude our brief sketch of King James I, in April, 1424, he returned to Scotland, arrested the nobles not loyal to the crown, and generally reorganized the government. But secret animosities continued, and he was murdered on February 20-21, 1437, by a trusted nobleman jealous of his crown.

Notes by Editor:

1. In order for the dates to be at all correct, we need to assume that James I was referring to the *zodiacal signs* of Aquarius and Capricorn, rather than to the modern constellations. Were this the case, Venus passed from Aquarius to Capricorn (longitude 315°) on 1424 FEB 06 (Julian calendar). On that morning in London, Venus rose at 6:02 A.M., local mean solar time, followed by sunrise at 7:17, Venus being 13°.7 from the Sun. The view of the sky that James I would have had to the southeast at dawn on that date is depicted in *Figure 38* (p. 37). (Data here and *Figure 38* calculated by Voyager Program, © Carina Software.)

2. On 1424 FEB 06, Venus' diameter was 59".7 and her phase 3 percent illuminated. There have been a number of reports of Venus' crescent phase (or horns) being seen with the naked eye. Several cases are described in: Patrick Moore, *The Planet Venus* (New York: Macmillan, 3rd., 1960), pp. 35-36, where he cites 15 references. He also mentions that, intriguingly, the crescent symbol used for Venus predates the telescope. See also: T.W. Webb, *Celestial Objects for Common Telescopes* (ed. and rev. by Margaret W. Mayall. New York: Dover Publications, 1962), Volume I, p. 64.

3. Venus' declination was actually 8°.2 *south* that morning, although the planet was 4°.7 north of the Sun, and had a *latitude* of 8°.5 north. Note that this means that Venus' *horns*, directed away from the Sun, would have been pointing northward as well as toward the meridian.

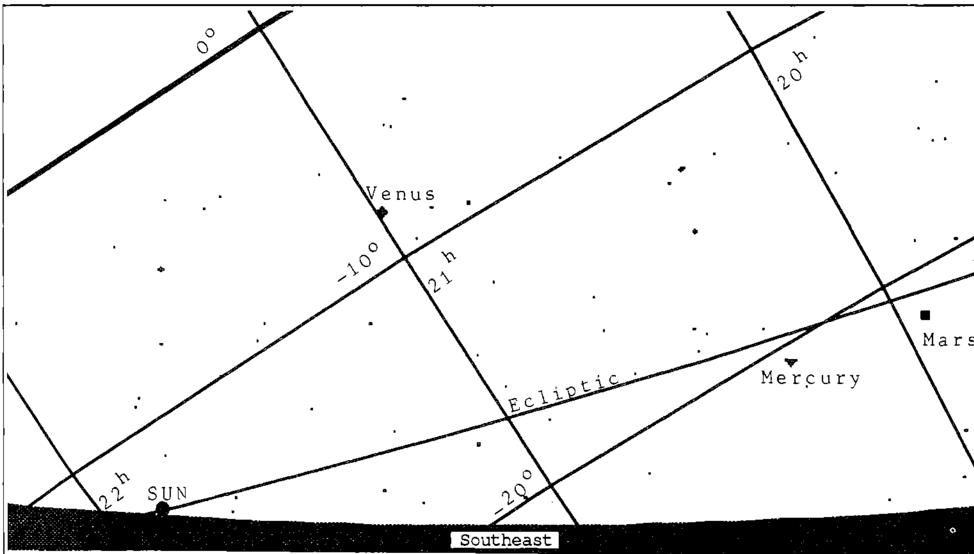


Figure 38. The southeast sky, as it might have been seen by the Scottish King James I, from the Tower of London at 7:25 A.M. on 1424 FEB 06. Venus is left of center, in the constellation of Aquarius but in the zodiacal sign of Capricorn. Venus' northern latitude would have aided its dawntime visibility. The Sun is on the horizon left of center. Also see text on p. 36. Generated by Voyager program, © Carina Software. The field of view is 40° in width.

A Martian Portfolio

The current apparition of Mars is already the most intensely observed one in history. Our Mars Section has to date received about 4000 observations from over 190 observers in 37 countries. Here are some selected photographs of Mars, all taken by Mars Recorder Donald C. Parker, M.D., with a 41-cm. f/6 Newtonian reflector at an effective focal ratio of f/165. All dates and times are in Universal Time. **Ls** is the areocentric longitude of the Sun, measured eastward from Mars' Northern Hemisphere Vernal Equinox, followed by the equivalent martian date in parentheses; **k** is the proportion of the disk that is sunlit; **CM** is the apparent central meridian of the disk; and **De** is the areocentric declination of the Earth. Seeing and transparency are on the A.L.P.O. scales, which run from 0 for worst to 10 for best for seeing and from 0 for the worst transparency to 5 for the best. The martian South Pole is at the top.

Figure 39 (*left*). 1988 AUG 21, 09h 22m. Seeing 10, Transparency 3. No filter. Kodak TP 2415 Film, 4-sec. exposure, developed in Rodinal 1:100. **Ls** = 256°.5 (DEC 09). **k** = 0.933. Diameter = 20".5. **CM** = 345°.0. **De** = -20°.1. Note Novus Mons separated from the left edge of the South Polar Cap. Meridiani Sinus is prominent below center.

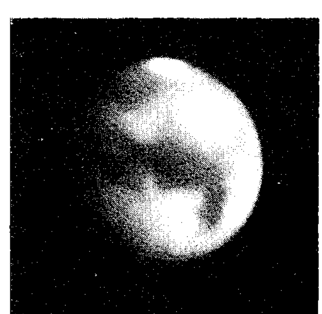


Figure 40 (*right*). 1988 AUG 25, 05h 51m. Seeing 8-9, Transparency 5. No filter. Kodak TP 2415 Film, 3-sec. exposure, developed in Rodinal 1:100. **Ls** = 259°.0 (DEC 11). **k** = 0.943. Diameter = 21".1. **CM** = 257°.0. **De** = -20°.0. Novus Mons resolved at lower right of South Polar Cap. Zea Lacus noted inside Hellas (about halfway from center to upper right limb). Cerberus III is the dark streak left of center.

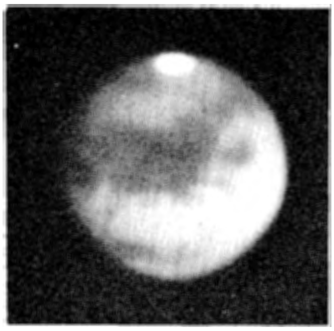


Figure 41 (*left*). 1988 SEP 18, 05h 57m. Seeing 8-9, Transparency 3. No filter. Kodak TP 2415 Film, 3-sec. exposure, developed in Rodinal 1:100. **Ls** = 274°.1 (DEC 26). **k** = 0.993. Diameter = 23".8. **CM** = 043°.4. **De** = -20°.7. Solis Lacus is prominent to the right, with Niliacus Lacus in lower left.

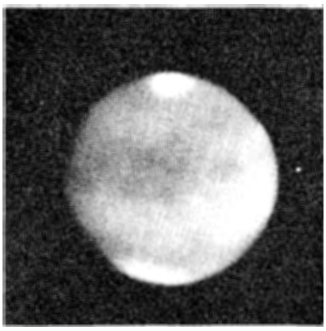


Figure 42 (*right*). 1988 SEP 18, 06h 12m. Seeing 8-10, Transparency 4. Fujichrome-100 Film, 2-sec. exposure, E-6 processing; copied through W47 (violet) Filter. Composite print. **Ls** = 274°.1 (DEC 26). **k** = 0.993. Diameter = 23".8. **CM** = 047°.1. **De** = -20°.7. Note morning haze over Solis Lacus (right of center) and bright North Polar Hood (lower left). Compare with *Figure 41* above, taken in integrated light only 15 minutes before.

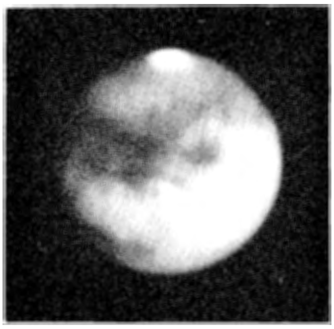


Figure 43 (*left*). 1988 SEP 18, 07h 16m. Seeing 8, Transparency 4. No filter. Kodak TP 2415 Film, 3-sec. exposure, developed in Rodinal 1:100. **Ls** = 274°.1 (DEC 26). **k** = 0.993. Diameter = 23".8. **CM** = 062°.8. **De** = -20°.7. Compare with *Figure 41* above, taken 1h 19m earlier; the 19° rotation between the two has brought Solis Lacus nearer the center of the disk and has now exposed Mare Sirenum on the right limb.

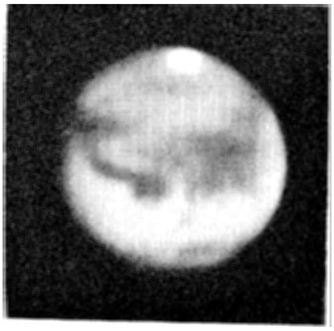


Figure 44 (*right*). 1988 SEP 21, 05h 07m. Seeing 8, Transparency 5. No filter. Kodak TP 2415 Film, 3-sec. exposure, developed in Rodinal 1:100. **Ls** = 276°.0 (DEC 28). **k** = 0.996. Diameter = 23".9. **CM** = 004°.8. **De** = -20°.9. Taken only 22 hours before Mars' closest approach to Earth. Meridiani Sinus is slightly left of center, with Mare Erythraeum to its upper right. Mare Australe (near the South Polar Cap) is dark.

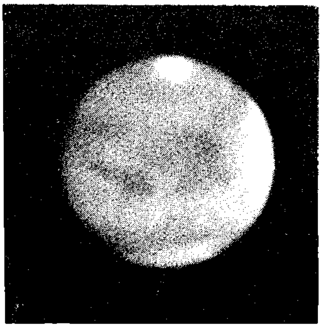


Figure 45 (*left*). 1988 SEP 21, 05h 27m. Seeing 7, Transparency 5. Fujichrome-100 Film, 2-sec. exposure, E-6 processing; copied through W47 (violet) Filter. **Ls** = 276°.0 (DEC 28). **k** = 0.996. Diameter = 23".9. **CM** = 009°.7. **De** = -20°.9. Shows bright morning limb haze and/or cloud over Solis Lacus near right limb, extending into Chryse (lower left portion of light area). An irregular North Polar Hood appears near bottom. Compare with *Figure 44* above, taken in integrated light only 20 minutes before.

Figure 46 (*left*). 1988 OCT 04, 04h 10m. Seeing 7, Transparency 4.5. No filter. Hydrogen-baked Kodak TP 2415 Film, 1-sec. exposure, developed in Rodinal 1:100. **Ls** = 284°.0 (JAN 05). **k** = 0.997. Diameter = 23".2. **CM** = 236°.4. **De** = -22°.1. Mare Cimmerium is the diagonal linear feature left of center; the fainter dark streak near its northern (lower) border developed for the first time earlier this apparition. The Ceberus III and Gomer dark streaks appear just left of center. Syrtis Major is at the extreme right.

Figure 47 (*right*). 1988 OCT 04, 04h 27m. Seeing 6, Transparency 4.5. Fujichrome-100 Film, 2-sec. exposure, E-6 processing; copied through W47 (violet) Filter. Composite print. **Ls** = 284°.0 (JAN 05). **k** = 0.997. Diameter = 23".2. **CM** = 240°.5. **De** = -22°.1. Note morning clouds over Libya, Isidis Regio, and Ausonia (all near the right limb), and weak clouds over Aethiopis and Elysium (below center). Compare with *Figure 46* above, taken in integrated light 17 minutes before.

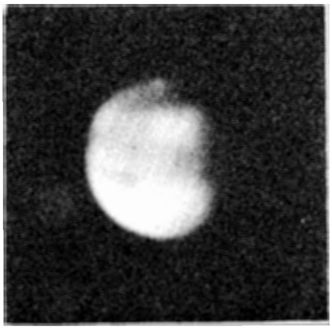


Figure 48 (*left*). 1988 NOV 28, 00h 04m. Seeing 7-8, Transparency 4. No filter. Hydrogen-baked Kodak TP 2415 Film, 1-sec. exposure, developed in Rodinal 1:100. **Ls** = 316°.7 (FEB 05). **k** = 0.904. Diameter = 13".6. **CM** = 032°.4. **De** = -25°.5. A yellow cloud extends over Argyre I, forming a terminator projection (visible on original above and right of center). Mare Australe (near top) appears very dark.

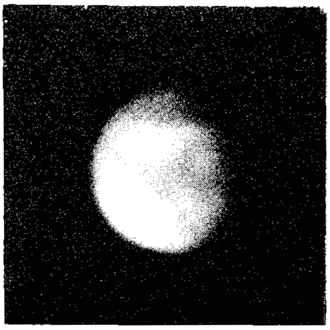


Figure 49 (*right*). 1988 NOV 28, 02h 19m. Seeing 7-8, Transparency 4. . **Ls** = 316°.8 (FEB 05). **k** = 0.904. Diameter = 13".6. **CM** = 065°.3. **De** = -25°.5. Fujichrome-100 Film, 2-sec. exposure, E-6 processing; copied without filter. A bright yellow cloud shows above center, extending over Solis Lacus across Bosporus into Ogygis Regio and Argyre I.

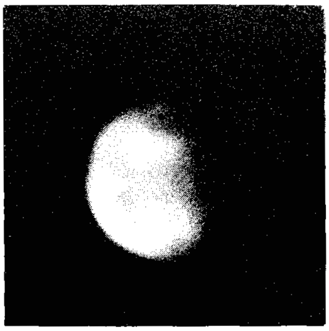


Figure 50 (*left*). 1988 DEC 01, 02h 01m. Seeing 7, Transparency 3-2. No filter. Hydrogen-baked Kodak TP 2415 Film, 2-sec. exposure, developed in Rodinal 1:100. **Ls** = 318°.5 (FEB 07). **k** = 0.900. Diameter = 13".1. **CM** = 032°.4. **De** = -25°.5. Compare with *Figure 48* above, taken 3 days earlier at the same central meridian. In the later view, the yellow cloud has moved eastwards (left) into Noachis, obscuring Mare Australe.

BOOK REVIEWS

Coordinated by J. Russell Smith

Uranus and Neptune. The Distant Giants. By Eric Burgess. Columbia University Press, 562 W. 113th St., New York, NY 10025. 1988. 188 pages, illustrations, tables, index. Price $29.95 cloth (ISBN 0-231-06492-6).

Reviewed by Richard W. Schmude, Jr.

This book presents many interesting facts about the Voyager-2 Mission and the major discoveries that it made. Although the chief emphasis is placed on Uranus and Neptune, there is also some discussion of Jupiter and Saturn. The author does a good job of comparing the four gas giants.

Chapter 1, "Aim Close to the Bull's-Eye," describes the trajectory of Voyager 2 along with the various instruments on that spacecraft. After reading this chapter, the reader should gain a solid background concerning important events such as the discovery of the uranian Rings and the Voyager flybys of Jupiter and Saturn.

The second chapter is titled "Georgium Sidus" and starts out with a description of William Herschel and the circumstances leading up to the discovery of Uranus. There are brief discussions of our understanding of Uranus in the 1960's, 1970's, and 1980's, with special emphasis placed on the atmosphere of the planet. For example, the reader finds out the expected vertical structure of the Uranian atmosphere, and also that Uranus has less cloud activity than do Jupiter and Saturn. The chapter ends with a general discussion of the uranian magnetic field and its effect on the local environment, defining such terms as *bow shock*, *magnetosphere*, and *ionosphere.*

The title of the third chapter is "Close-Up of a Distant Giant." This chapter discusses some of the discoveries about Uranus that were made by Voyager 2, such as the 17 1/4-hour rotational period of the planet, as well as the orientation of the uranian magnetic field, the magnetic environment, atmosphere, and internal heat of the planet.

Voyager 2's discoveries concerning the uranian Rings and satellites are discussed in Chapter 4, "Rings and Satellites." This chapter is well-illustrated and should enable the reader to gain an appreciation of the geology of the five largest Uranian satellites, Miranda, Ariel, Umbriel, Titania, and Oberon.

Chapter 5, "Completing the Grand Tour," begins with a description of the events leading up to the discovery of Neptune, followed by discussions of our current understanding of Neptune and its two currently known satellites, Triton and Nereid (along with a possible third, 1981N1). The author does an especially good job at painting a picture of what the meteorology and surface of Triton may be like.

The final chapter is named "Giants and Dwarfs in the Outer Darkness," and discusses Pluto along with possible bodies (planet[s] or a star) beyond Pluto. The reader also discovers that four spacecraft, Pioneers 10 and 11 and Voyagers 1 and 2, are leaving the Solar System, along with some speculation about what they may find.

Unfortunately, there are a few minor problems with this book. *Table 4.3* gives past and present computed satellite densities that are inconsistent with the quoted diameters and masses. *Table 5.1* gives the "radii" of Neptune's moons Triton, Nereid, and "1981NI" [*sic.*] as 355.00, 5.57, and 77.00 km. respectively. These actually are their *orbital* semimajor axes, expressed in units of thousands, millions, and thousands of kilometers respectively. (The same comment applies to the "miles" column.) Finally, in *Figure 5.3*, the track labeled "Voyager 2" misses Neptune by 5 astronomical units!

These are isolated problems however, and I feel that the author has done a good job in presenting this material in an accurate and interesting way.

Atlas-Guide Photographique de la Lune. By Georges Viscardy. Association Franco-Monégasque d'Astronomie, Observatoire de St Martin-de-Peille 06440 L'Escarè, France. 1985. 454 pages, 685 photographs, maps. [Also available from Masson, Paris, 1987, ISBN 2-225-81090.] Price 515 francs.

Reviewed by John E. Westfall

This large-format book is a magnificent labor of love by an "advanced amateur," Georges Viscardy. The heart of this book is the many lunar photographs taken by him, chiefly during 1982-84, at the Observatoire de St Martin-de-Peille in the Maritime Alps (730 meters above sea level) with a 52-cm. Newtonian-Cassegrain telescope and a 31-cm. Newtonian. It is worth noting that the larger instrument has a "planetary Cassegrain" configuration; operating at f/47 with only a 16-percent secondary obstruction. This fact, along with Mr. Viscardy's reliance on Kodak TP 2415 Film, his experience, and his selection of the best from 7,000 negatives, explains the exquisite clarity of almost all of the photographs.

The text is of course in French, but no knowledge of that language is needed to read the maps and the photograph captions, which form the most essential text in the book.

Persons not reading French will regret that they cannot digest the "Introduction" and "Notes Pratiques," however. The latter chapter deals primarily with photographic techniques, including film and developer recommendations. He estimates his typical resolution as 0.3-0.5 arc-seconds, reaching 0".25 in the best views. This reviewer feels that this is a realistic assessment; the last figure amounts to about 500 meters on the Moon and is comparable to the best amateur and professional earthbased coverage. For example, *Plate 379* shows six craterlets on Plato's floor.

The introductory portion of the atlas ends with photographs and descriptions of the Observatoire de Saint-Martin-de-Peille and its instruments. Besides the main instruments, we note a well-equipped darkroom, and portable telescopes and two lecture halls for public instruction. Clearly, Mr. Viscardy is an "amateur" in the sense that Percival Lowell was!

With most of the photographs being large-scale (small area) views, it is fortunate that several finding aids have been provided. First, the endpapers hold (in two sections) an attractive shaded-relief lunar map by Jacqueline Ciffreo, 50 cm. in diameter . A whole-disk photograph with latitude-longitude grid (p. 22), along with a schematic map (p. 24), shows how the photographs are grouped into 16 sections covering the entire visible face of the Moon. Individual formations are listed alphabetically, giving the plate number for each. Some of the lunar names are no longer officially recognized (e.,g., Montes Leibnitz), but were widely used on the older charts. Some photographs are repeated, so that there are 128 separate photographs reproduced on the 220 plates in the main section.

We find that the order of the plates is first from south to north, and then from east to west within each strip. This means unfortunately that each section falls within two strips a number of pages apart. Mr. Viscardy consistently uses the International Astronomical Union direction scheme (Mare Crisium is near the *east* limb) and orients his photographs with south at the top.

Each numbered "plate" usually occupies two facing pages and contains a lunar index map showing the area of coverage, an 18-by-24-cm. photograph at 1:2,100,000-scale (163 cm./lunar diameter), along with a reduced version giving feature names, and short written descriptions of the features shown. There is often a larger-scale view of a selected formation at 1:1,670,000-scale (200 cm./lunar diameter).

The main section is followed by "Quelques Formations Remarquables," which consists of 30 highly-enlarged views of "showpiece" formations. The scales are 1:1,370,000 (250 cm./lunar diameter) or even 1:920,000 (365 cm./lunar diameter). The features included here might well be called "the Messier objects of the Moon," and include Hyginus, Clavius, Plato, Posidonius, the "Straight Wall," Fracastorius, Linné, Copernicus, and fifteen others.

The last photographic section is called "Recherches Sélénographiques. L'Étude de la Lune et sa Surveillance." This begins with a short discussion of lunar volcanism, transient phenomena, meteoritic impacts, and amateur groups that study the Moon (including the A.L.P.O.). This is followed by groups of photographs that illustrate relief features, rays, domes, the O'Neill "Lunar Bridge," the radial bands of Aristarchus, and several other types of features. Gratifyingly, a five-page section is devoted to the A.L.P.O.'s "Luna Incognita" project. Finally, we have a list of 55 features recommended for surveillance due to suspected changes or transient phenomena. "LTP" are unconfirmed in some of these areas, but have been repeatedly reported in others.

The last section of the book gives some autobiographical information about the author and his love of astronomy and the Moon, as well as some history about the observatory he uses.

It is difficult to find problems with this book. Sometimes it is difficult to find a particular area, and an index map with frame outlines would help the search. One gets the impression that the author followed the logical strategy of taking large numbers of photographs in short intervals when seeing was ideal. Because there are considerably more afternoon-illumination views than ones under a morning Sun, one further supposes that this procedure was usually in the pre-dawn hours. As is unfortunately the case with most lunar photographic atlases, there are very few high-Sun views. The quality of the paper and printing is high, but some detail is seen to be lost when one can compare the printed version of a photograph with an actual enlargement. In a few cases, terminator areas were over-dodged.

The photographs are all unrectified, in the near-Orthographic projection one sees from Earth. Universal Time dates and times are given for each photograph so that essential data can be computed. However, it would have been a great convenience to have the solar colongitude and latitude and topocentric librations listed for each frame. Exposure and seeing and transparency descriptions would also be very desirable because, of course, these cannot be computed later.

With so few professional astronomers studying the Moon these days, we can be thankful that such excellent work as Mr. Viscardy's is being carried on by so-called amateurs. A large book like this, with hundreds of plates, is well worth the price. If you are a student of the Moon, you will need this atlas, whether or not you know the French language. I can only hope that this atlas inspires other selenophotographers!

NEW BOOKS RECEIVED

Notes by J. Russell Smith

James Lick's Monument. The Saga of Captain Richard Floyd and the Building of the Lick Observatory. By Helen Wright. Cambridge University Press, 32 East 57th St., New York, NY 10022. 1987. 231 pages, notes, index. Price $32.50 cloth (ISBN 0-521-32105-0).

This book's chapters are: "The Story of James Lick," "Captain Floyd and the Lick Trust," "European Journey," "Transition to the Skies Over Mount Hamilton," "Dear Captain," "Ladder to the Sky," "Success and Conflict," "Engineering Feat of Mount Hamilton," "James Lick's Last Journey," "Final Stages," "To the Stars," and "Epilogue." As a former teacher of astronomy, I recommend this book.

The Omni Space Almanac. By Neil McAleer. Pharos Books, 200 Park Ave., New York, NY 10166. 1987. 382 pages, illustrations, index. Price $24.95 cloth (ISBN 0-345-34395-6).

After an Introduction, the chapters are: "A Space History: The Golden Years," "The Shuttle Ships," "Space Station and Beyond," "Daily Life in Space," "Space Disasters and Close Calls," "Space International," "Rockets and Space Ships," "Robots from Earth," "Commerce and Science in Orbit," "Space Weapons and Wars," "Settlement and Colonization of Space," and "Extraterrestrials and Star Trips." If you are interested in this subject, you will certainly want a copy of this book.

The Human Quest in Space. Edited by Gerald L. Burdett and Gerald A. Soffen. Published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, CA 92128. 1987. 295 pages, illustrations, appendix, index. Price $55.00 cloth (ISBN 0-87703-262-9), $45.00 paper (ISBN 0-87703-263-7).

This book is about the 24th Goddard Memorial Symposium, held in March, 1986, at the Goddard Space Flight Center. After the Introduction, the principal sections are: "What Happens After Space Station," "Visionary Technologies," "The Human Role in the Quest of Space," and "Conclusion."

Flyby: The Interplanetary Odyssey of Voyager 2. By Joel Davis. Atheneum Publishers, 115 Fifth Avenue, New York, NY 10003. 1987. 256 pages, illustrations. Price $19.95 cloth (ISBN 0-689-11657-8).

This book's chapters are as follows: "Before Voyager," "The Perils of Voyager 2," "New Worlds," "The Quiet Cruise," "The Perils of Mark IV-A," "Closing In," "Far Encounters," "Flyby," and "Endings and Returns." I recommend this book if you are interested in this subject.

Fifty Year Canon of Solar Eclipses: 1986-2035. (NASA Reference Publication 1178 Revised). By Fred Espenak. National Aeronautics and Space Administration, Code NTT-4, Washington, DC 20546-0001. 1987. 278 pages, illustrations, appendices. Available for $19.95, cloth, from Sky Publishing Corp., P.O. Box 9111, Belmont, MA 02178-9111.

The contents of this book are as follows: Section 1, "Solar Eclipse Catalog: 1901-2100;" Section 2, "World Maps of Eclipse Paths: 1901-2100;" Section 3, "Central Path Catalog: 1986-2035;" Section 4, "Global Maps of Solar Eclipses: 1986-2035;" Appendix A, "Solar Eclipses;" and Appendix B, "Program SUNECL," a computer program. If you are interested in this subject, I recommend this book.

Darkness at Night: A Riddle of the Universe. By Edward Harrison. Harvard University Press, 79 Garden St., Cambridge, MA 02138. 1987. 264 pages, illustrations, bibliography, appendix, notes, and index. Price $25.00 cloth (ISBN 0-674-19270-2).

This book's contents are: "Why is the Sky Dark at Night?," "The Riddle Begins" (three chapters), "The Riddle Develops" (six chapters), and "The Riddle Continues" (eight chapters). If you are interested in this subject, you will want this book on your shelf.

Meteor Showers: A Descriptive Catalog. By Gary W. Kronk. Enslow Publishers, Bloy Street and Ramsey Avenue, P.O. Box 777, Hillside, NJ 07205. 1987. 256 pages, illustrations, appendices, index. Price $24.50 paper (ISBN 0-89490-072-2).

This catalog arranges meteor showers by month. It is recommended for meteor observers.

Space: The Next Twenty-five Years. By Thomas R. McDonough. John Wiley and Sons, 605 Third Avenue, New York, NY 10158. 1987. 237 pages, illustrations, references, index. Price $17.95 cloth (ISBN 0-471-85671-1).

The contents of this book are: "Space, The Final Frontier," "From Fire Arrows to Neil Armstrong," "Orbital Truck," "A Nice Place to Visit," "Star Wars," "Captain Kirk--

Here We Come," "A Room With a View," "The Man and Woman in the Moon," "Who Stole the Canals?," "Dinosaur Killers," "Near Neighbors," "Giant Worlds," "Glimpsing Infinity," "How to Build a Starship," "In Search of Extraterrestrial Intelligence," and "Footsteps into the Universe." I believe that you would like this book on your shelf.

Meteorite Craters. By Kathleen Mark. University of Arizona Press, 1230 N. Park, No. 102, Tucson, AZ 85719. 1987. 288 pages, illustrations, references, index. Price $29.95 cloth (ISBN 0-8165-09020-6).

After a Preface and an Introduction, the contents are: "The Recognition of Meteorites," "Curious Landforms of the Colorado Plateau," "Meteor Crater, Arizona," "More Meteorite Craters," "Explosive Impact," "Cryptovolcanic Structures," "The Work of Harvey Harlow Nininger," "Meteorite Craters Known at Mid-Century," "The Craters of the Moon," "Coesite and Shatter Cones," Meteorite Craters in Canada and Crater Forms," "More Controversy, More Craters," "Impact Metamorphism," "The Bushveld Igneous Complex and the Vredefort Ring," "Sudbury: A Geologic Puzzle," and "The Origin of Tektites and the Significance of Cratering." If you are interested in meteorites, you will want this book.

The International Encyclopedia of Astronomy. Edited by Patrick Moore. Orion Books, 225 Park Avenue South, New York, NY 10003. 1987. 448 pages, color illustrations, tables (no index). Price $40.00 cloth (ISBN 0-517-56179-4).

The major sections of this book are: "A Family Named Universe," "Big Bang," "Exploring Space," "Interstellar Matter," "Moons," "Pulsars," and "Superclusters." This is an outstanding book and, as a retired teacher of astronomy, I recommend it for the advanced student.

Universe '87. Proceedings of a Meeting at Pomona College, Claremont, California on June 11-16, 1987. Edited by John Sanford. Orange County Astronomers, 2215 Martha Avenue, Orange, CA 92667. 114 pages, illustrations. Soft cover. Price $12.00 in the United States and Canada, $14.00 surface or $17.00 air for other countries.

The contents consist of: "In the Shadow of Kitt Peak: The Special Joy of Amateur Astronomy," "Searching for Supernovae," "The A.L.P.O. Lunar Selected Areas Program," "Galilean Peregrinations," "What to Report With Each Observation," "The Basics of Comet Hunting," "Exhibitors at the Meeting," "The Grasslands Observatory," "An Addiction to Astrophotography," "Variable Star Photometry in a Small Undergraduate Physics Department," "The Politics of Light Pollution," "A.S.P. and W.A.A. Award Summaries," "Light Pollution: An Amateur's Viewpoint," "Video Graze Occultations," "Eclipse Solar Diameter Measurements," "The 1983 Pallas Occultation: The Best Yet," "Observatories Versus Astronomical Seeing," and "Supernova Triggered Comet Showers." There is a Table of Contents, but no index. This book is an outstanding value.

Riverside Telescope Makers Conference 1987. Edited by John Sanford. OCA Publications, 2215 Martha Avenue, Orange, CA 92667. 1987. 65 pages, illustrations. Soft cover. Price $10.00 in the United States; elsewhere $12.50 surface or $14.00 air.

This is a collection of papers given at the RTMC in May, 1987, including the following: "Fremont Peak Observatory," "On the Construction of a 10.5-inch Telescope," "What! Another Newtonian Design," "Konica 1600--Facts and Fantasy," "Grinding and Polishing Hints for Larger Optics at Short Focal Ratios," "A Drive Corrector With a Hand Warmer," "A Telescope Maker's Wish List," "Merit Award List," "Photographs," "Dewing--What It Is and What to Do About It," "A Simple Star Tracker for Astrophotos," "Binoculars--There's More Than Meets the Eye," "The Orange County Astronomers Low Light Video System," "The Solano Telescope," "A New Unobstructed Reflector," and "In Search of the Clown--NGC 2392." There is a good Table of Contents, but no index.I believe that you will be glad that you purchased this book after you see it.

ANNOUNCEMENTS

Hubble Space Telescope (HST)--The scheduled shuttle launch date for the HST has been moved up to December, 1989. We are still accepting Phase II amateur observing proposals for the HST, but the postmark deadline for them is the next shuttle launch, now scheduled for February 18, 1989. If you have submitted a Preliminary Proposal (Phase I) that has been approved for Phase II, you should send your Phase II proposal **soon** to: Walter H. Haas, 2225 Thomas Drive, Las Cruces, NM 88001.

New J.A.L.P.O. Format.--We trust that by now everyone has noticed that our magazine's format has been changed; for example, in terms of type styles and number of columns. Now both the inside back cover and the page facing it are devoted to information about the A.L.P.O. For the technically minded, our pages are now composed using FullWrite Professional on a Macintosh II and a LaserWriter IINT. This gives us more flexibility than our previous system and probably there will be some changes in style as we learn the new system. We always welcome suggestions from our readers. Although we state this goal with trepidation, we hope to maintain a regular quarterly publication schedule, with each volume representing one calendar year, and with issues appearing in January, April, July, and October. [Wish us luck.]

Strolling Astronomer Return Policy.--We have learned that some issues of the previous *Strolling Astronomer* had pages missing or duplicated. If this ever happens to you, please let the Director/Editor know and we will be happy to replace your imperfect copy.

Foreign Subscribers' Surprise.--Due to a mistake by our mailing service, our overseas subscribers received their last issue (October, 1988) via **air mail**. Fortunately for us, the additional cost was absorbed by the mailing service. We regret that we cannot afford this when *we* have to pay for it, so we hope that no one's expectations have been unduly raised!

Five 1989 Meetings.--A.L.P.O. members will be interested in one or more of these five meetings scheduled in 1989:

1. The A.L.P.O. Convention. We continue with our plans to meet with the Western Amateur Astronomers in Pasadena, California for the Voyager-2 Neptune flyby, on August 24, 1989. Our meeting will probably be held on the days immediately following the flyby, although we cannot give further details now because we go to press before the W.A.A. Board Meeting on January 14.

2. Centennial Meeting of the Astronomical Society of the Pacific. Details of this special meeting were given in the previous issue (p. 280). It will be held in Berkeley, California on June 21-25, 1989. It now appears likely that there will be an amateur astronomy seminar on the weekend of June 24-25. For more information, write to: Berkeley Meeting Information, A.S.P., 390 Ashton Avenue, San Francisco, CA 94112.

3. Division of Planetary Sciences. The Division of Planetary Sciences (DPS) of the American Astronomical Society has about 550 members and is probably the most important group of planetary scientists. Their annual meetings are open to non-DPS members, and the next one will be held in Providence, Rhode Island at the Omni Biltmore Hotel, October 31-November 3, 1989.

4. Astrophoto VIII. This will be an all-day astrophotography seminar/photographic exposition at California State University-Fullerton on Saturday, February 25, 1989. The cost of admission is $20, which includes two coffee breaks and a copy of the *Proceedings*. For information, contact: ASTROPHOTO VIII, 2215 Martha Avenue, Orange, CA 92667. (Telephone 714-639-8446)

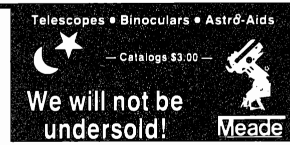
5. Remote-Access Automatic Telescopes. This will be the 10th Annual Fairborn/I.A.P.P.P./Smithsonian Symposium, on March 15-18, 1989, in Tucson, Arizona. The contacts are: *Program Chairman*--David L. Crawford, KPNO, P.O. Box 26712, Tucson, AZ 85726 (telephone 602-325-9346); *Local Host*--Raymond E. White, University of Arizona, Steward Observatory, Tucson, AZ 85721 (telephone 602-621-6528); and *Accommodations*--Hotel Park Houston, 5151 E. Grant Road, Tucson, AZ 85712 (telephone 602-323-6262).

Astronomical Society of the Pacific Publications.-- The A.S.P. has two publications of interest to us. One is their 4-page *The Solar System: An Introductory Bibliography* (which also lists seven Solar System slide sets available from them). For the bibliography, send two 25-cent stamps to: A.S.P., 390 Ashton Avenue, San Francisco, CA 94112. The other is a *Moon Kit* , with 18 slides and a 24-page booklet, for $24.45 (including postage and handling; California residents add sales tax; foreign purchasers add $3.00 additional).

Two Worthwhile Organizations,--There are two new astronomical groups whose existence should be of interest. The first is the **International Dark-Sky Association**, 3545 N. Stewart Avenue, Tucson, AZ 85716. This organization is concerned with preserving our deteriorating skies; individual memberships are $20.00, which includes a quarterly newsletter. The second group, of more regional appeal, is **Friends of the Observatory**, which helps support the activities of Griffith Observatory in Los Angeles. Memberships begin at $30.00 and include a subscription to the well-known monthly, *The Griffith Observer*. Write to: Friends of the Observatory, P.O. Box 886, Pacific Palisades, Ca 90272-9900.

Astronomy Day, 1989.--Astronomy Day is now a tradition, and will be held on Saturday, May 13, 1989. We can promote our specialty via speaking programs and public viewing sessions. Jupiter will be briefly visible in the west after sunset, while Mars will not set until mid-evening, about when Saturn rises. The 8-day Moon will be well-placed to show spectacular features like the Apennines and the Straight Wall. Check with local astronomy institutions about plans for your area.

Deluxe Latitude Adj. $26
Field Tripod/Equatorial Wedge (for Models 2045, 2045/LX3) $224
Alt./az. Adapter for Field Tripod (for Meade 8" & 10" Schmidt-Cass) $26
Center Table Tripod Leg for High Lat.(47°-69°) (for 2045, 2045/LX3) $35
Access. Shelf for Field Tripod (for Meade 4", 8", & 10" Schmidt-Cass) $26
Carrying Bag for Equatorial Wedge and Field Tripod $79
Bracket for 5x24mm Finder $12
Eyepiece Holder (.965") $24
Eyepiece Holder (1¼") $24
Rotary Eyepiece Holder (1¼") $105
#AD-1 Eyepiece Adapter (.965") $12
#AD-2 Eyepiece Adapter (1¼") $18
#924 Erecting Prism System (1¼") $39
#928 45° Erect-Image Roof Prism (1¼") $43
#671 Wide-Field Adapter System, (WFAS), complete (1¼") $105
#64 T-Adapter only, for WFAS $27
#919 Diagonal Prism w/Threaded Ring (1¼") for WFAS $32
Telecompressor System, complete with Extender Tube $59
Telecompressor Lens only $40
Eyepiece Extender Tube only $16
#929 2" Diagonal Mirror
Includes eyepiece adapters for both 1¼" and 2" $152
Series 2 Orthoscopic Eyepiece (1¼"):
4, 6, 9, 12.5, 18, 25mm $49
Super Plossl
6.4, 9.7, 12.4, 15, 20, 26 . . . . . $64
32, 40mm $83
56mm (2") $143
Ultra Wide 4.7mm $118
6.7mm $144
8.8mm (1¼-2") $178
14mm (1¼-2") $194
Super Wide Angle
13.8mm $99
18mm $108
24.5mm $122
32mm (2") $171
40mm (2") $218
#106C Off-Axis Guider Assembly, complete w/Illum. Reticle Eyepiece $129
Off-Axis Guider, Body only $59
#419 Illuminated Reticle Eyepiece only (1¼") $79
#126 2X Telenegative Amplifier (2045, 2045/LX3) $39
#122 2X Telenegative Amplifier (for all 8" & 10" Schmidt-Cassegrains) $42
#127 2X-3X Variable Teleneg. Amp. (for all 8" & 10" Schmidt-Cass) $59
#140 2X Telenegative Amplifier (for all 8" & 10" Schmidt-Cassegrains) $59
Photo-Visual Color Filter (1¼") thread-in: #8 Light Yellow, #11 Yellow-Green, #12 Yellow, #21 Orange, #23A Light Red, #25A Red, #47 Violet, #58 Green, #80A Blue; each $12
Color Filter Polarizer (30% transmission) (1¼") thread-in $12
Set of 6 Photo-Visual Color Filters (1¼"):
(#8, #23A, #58, #80A, 2 polarizers) $72
#905 Variable Polarizing Eyepiece System (1¼") $39
Series VI Drop-in Filter Set (#1A Skylight, #8 Light Yellow, #11 Yellow-Green, #25 Red, #80A Blue, Neutral Density ND4) $49
#1A Skylight Filter/Dust Seal $42
#908 Nebular Filter (1¼"), thread-in $60
#910 Nebular Filter (2") $99
#911 Nebular Filter (rear cell thread-on) $110
#582 Dew Shield (4") (2045, 2045/LX3) $46
#712 Dew Shield (8") (for Meade 8" Schmidt-Cassegrains) $56



#710 Dew Shield (10") (for Meade 10" Schmidt-Cassegrains) . . . $89
#62 T-Adapter (basic camera adapter) $28
T-to-C 16mm Movie/Video Camera Adapter $28
Tele-extender $25
Piggyback Bracket (2045, 2045/LX3) $21
Piggyback Bracket (for Meade 8" Schmidt-Cassegrains) $30
Piggyback Bracket (for Meade 10" Schmidt-Cassegrains) $30
Piggyback Bracket (for Meade 10" Schmidt-Cassegrains) $29
#2047 4" Mirror-Lens Cassegrain Photo-Guide Telescope, with Bracket
(for Meade 8" Schmidt-Cassegrains) $699
Mounting Bracket only for Model 2047 . . . . . $169
#2048 4" Mirror-Lens Cassegrain Photo-Guide Telescope, with Bracket
(for Meade 10" Schmidt-Cassegrains) $724
Mounting Bracket only for Model 2048 . . . . . $169
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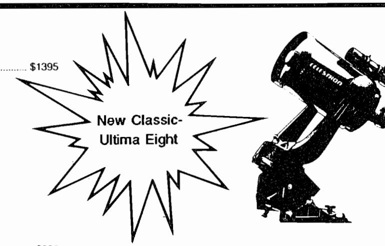

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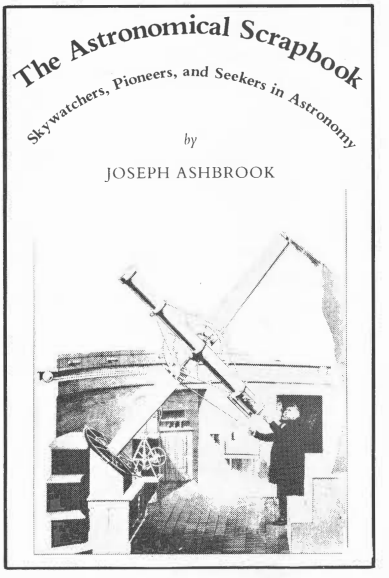

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