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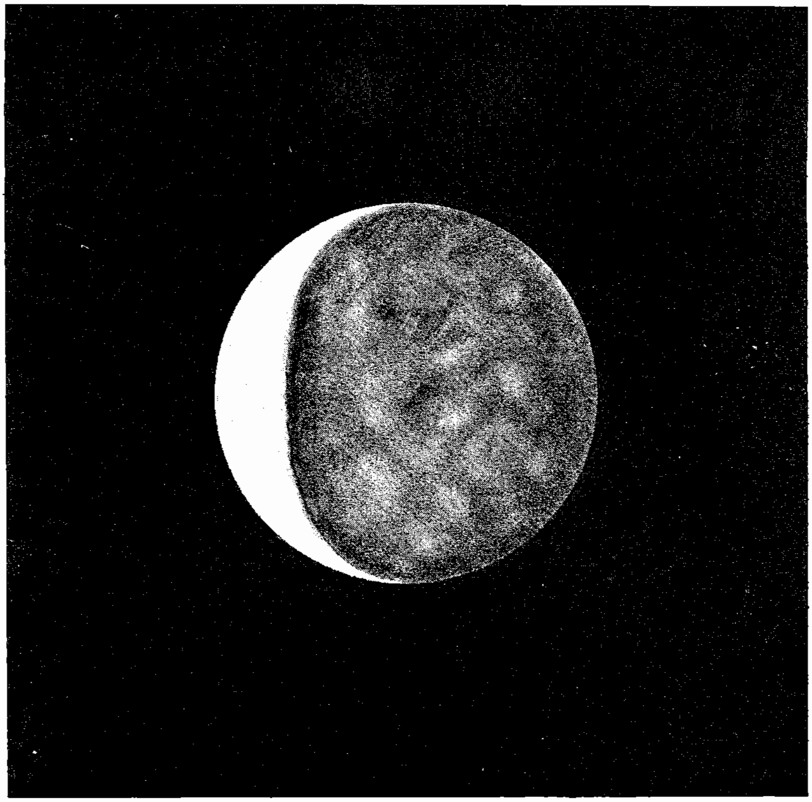

Drawing of the Ashen Light of the dark hemisphere of Venus by David L. Graham on 1988 May 16, 21h 50m U.T. Mr. Graham used a 15.2-cm. (6-in.) refractor at 222x and a Wratten 25 (red) Filter for this view. With the red filter, he noted the Ashen Light as "very strongly suspected;" it was also suspected by him with W58 (green) and W15 (orange) Filters, but not suspected with a W44A (light blue) Filter nor in integrated light. South at top; disk diameter 43.2 arc-seconds, computed phase (fraction illuminated) 0.186.

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IN THIS ISSUE

THE 1987-88 EASTERN (EVENING) APPARITION OF THE PLANET VENUS: VISUAL AND PHOTOGRAPHIC OBSERVATIONS

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

ABSTRACT

This report summarizes visual and photographic observations of the planet Venus for the 1987-88 Eastern (Evening) Apparition, based on an extensive analysis of data submitted by A.L.P.O. Venus Section observers in the United States and five other countries. Sources of data and the instruments used in acquiring information about Venus are emphasized, with a statistical analysis of the categories of features seen or suspected in the atmosphere of Venus at visual wavelengths, both in integrated light and with color filters. A similar treatment is given to the cusps, cusp-caps, and cusp-bands, together with a discussion of dark-hemisphere phenomena, including the Ashen Light; the last in conjunction with the cooperative A.L.P.O.—Pioneer Venus Orbiter Ashen Light Monitoring Program for 1988. Comparative studies deal with the observers, instruments, visual and photographic data, and simultaneous observations. Selected drawings and photographs are included in order to help the reader to appreciate the variable phenomena observed in the atmosphere of Venus in 1987-88.

INTRODUCTION

Observers submitted a very fine collection of observations of Venus for the 1987-88 Eastern (Evening) Apparition, and this report is based on their data. *Table 1*, below, summarizes the geocentric phenomena of Venus for that apparition.

Table 1. Geocentric Phenomena: 1987-88 Eastern (Evening) Apparition of Venus. [7,8]

Superior Conjunction	1987	AUG	23^d06^h
Greatest Elongation East (46°)	1988	APR	03 08
Predicted Dichotomy	1988	APR	05 05
Greatest Brilliancy (Magnitude -4.5)	1988	MAY	06 20
Stationary	1988	MAY	22 13
Inferior Conjunction	1988	JUN	13 00

Notes: All times are in Universal Time (U.T.). Venus' apparent diameter ranged from 9".65 at Superior Conjunction to 57".67 at Inferior Conjunction.

A total of 589 observations was received for the 1987-88 Apparition, both visual drawings and photographs taken at visual wavelengths. *Figure 1* (p. 146) presents a histogram that shows the distribution of observations by month. Observational coverage was very good throughout the apparition, with individuals initiating their programs early in the observing season and following through until the time when Venus was almost in inferior conjunction with the Sun. The observational period ranged from 1987 OCT 29 [elongation 17°.6] through 1988 JUN 10, [elongation 4°.8] with 90.3 percent of the observations during the months of February-May, 1988. As in previous apparitions, greatest coverage took place around the dates of greatest brilliancy and greatest elongation from the Sun.

Twenty-three individuals submitted visual observations, photographic observations, or both during the 1987-88 Eastern (Evening) Apparition; they are listed in *Table 2*, below.

Table 2. Participants in the A.L.P.O. Venus Observing Program During the 1987-88 Eastern (Evening) Apparition.

Observer & Location	No. of Obser.	Telescope Data
Aloy, J.; Barcelona, Spain	20	11.0cm (4.3in) Rr; 21.0cm (8.3in) Nt
Benton, J.L.; New Hope, PA	39	15.2cm (6.0in) Rr
Bernitz, R.; Taft, CA	1	15.2cm (6.0in) Nt
Borra, J.F.; Leawood, KS	13	8.9cm (3.5in) Mk
Bourgeois, J.; Pic-du-Midi, France	1	100cm(39.4in) Nt
Carlino, L.M.; Lockport, NY	8	20.3cm (8.0in) S-C
Gelinas, M.A.; Quebec, Canada	12	15.2cm (6.0in) Rr
Graham, D.L.; Brompton-on-Swale, U.K.	121	15.2cm (6.0in) Rr
Graham, F.; East Pittsburgh, PA	25	17.8cm (7.0in) Rr; 25.4cm (10.0in) Rr; 20.3 cm(8.0in) Rr
Haas, W.H.; Las Cruces, NM	37	20.3cm (8.0in) Nt; 31.8cm (12.5in) Nt
Heath, A.W.; Nottingham, U.K.	31	30.5cm (12.0in) Nt
Lucas, S.; Midlothian, NJ	1	33.0cm (13.0in) Nt
Lux, B.; McKeesport, PA	1	6.0cm (2.4in) Rr
Mac Dougal, C.; Tampa, FL	21	15.2cm (6.0in) Rr
Melillo, F.J.; Franklin Square, NY	4	20.3cm (8.0in) S-C
Morris, W.F.; Manahawkin, NJ	2	15.2 cm (6.0in) Nt
Neichoy, D. Göttingen, W. Germany	125	20.3cm(8.0in) S-C; 11.0cm (4.3in) Rr
Nowak, G.T.; Essex Junction, VT	5	22.9cm (9.0in) Rr
Robertson, T.; Palmdale, CA	1	15.2cm (6.0in) Nt
Robotham, R.; Willowdale, Ontario, Canada	5	15.2cm (6.0in) Nt; 11.4cm (4.5in) Nt; 8.3cm (3.3in) Rr
Schiff, M.; Fort Lauderdale, FL	29	15.2cm (6.0in) Nt
Westfall, J.; San Francisco, CA	86	25.4cm(10.0in) Cs; 50.8cm (20.0in) Rr; 15.2cm (6.0in) Rr; 10.2cm (4.0in) Rr
Williams, D.B.; Chapin, SC	1	20.3cm(8.0in) S-C

— over —

Notes: Cs = Cassegrain; Mk = Maksutov;
Nt = Newtonian; Rr = Refractor;
S-C = Schmidt-Cassegrain.

Figure 2, below, shows the distribution of the 23 observers by country. Our observing program is considered international in that about one-third of our contributors were located outside the United States. *Figure 3* (p. 147) shows the international distribution of the total of 589 observations submitted. Note that the foreign observers tended to submit more observations per person; with more than half the observations coming from abroad.

The final diagram, *Figure 4* (p. 147) shows the observations by type of instrument. In addition, 87.3 percent of the observations were made with instruments 15.2-cm. (6.0-in.) aperture or greater; 12.7 percent with smaller.

This writer here expresses his sincere gratitude to all the dedicated colleagues mentioned in this report who carried out observations for the A.L.P.O. Venus Section. Individuals everywhere are heartily invited to continue working with us in subsequent observing seasons. Efforts are now underway to encourage and coordinate intensified and more comprehensive coverage of Venus in coming apparitions. The cooperation of the A.L.P.O. Venus Section with groups such as the British Astronomical Association and the Royal Astronomical Society of Canada has begun; and we have many promising prospects of continued association with the Vereinigung der Sternfreunde in Germany and similar organizations in Belgium, France, Hungary, and Spain. We are attempting to establish and maintain an expanding international observer base in the coming years.

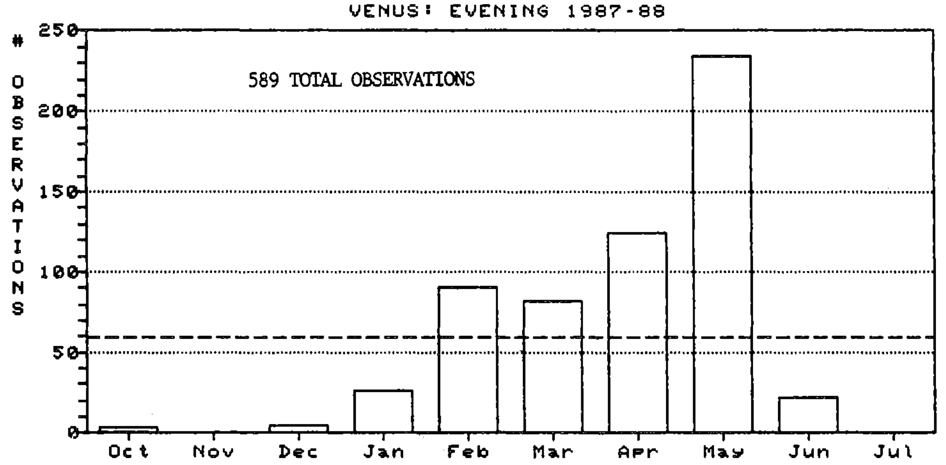

Figure 1.Distribution of observations by month; 1987-88 Eastern Apparition of Venus.

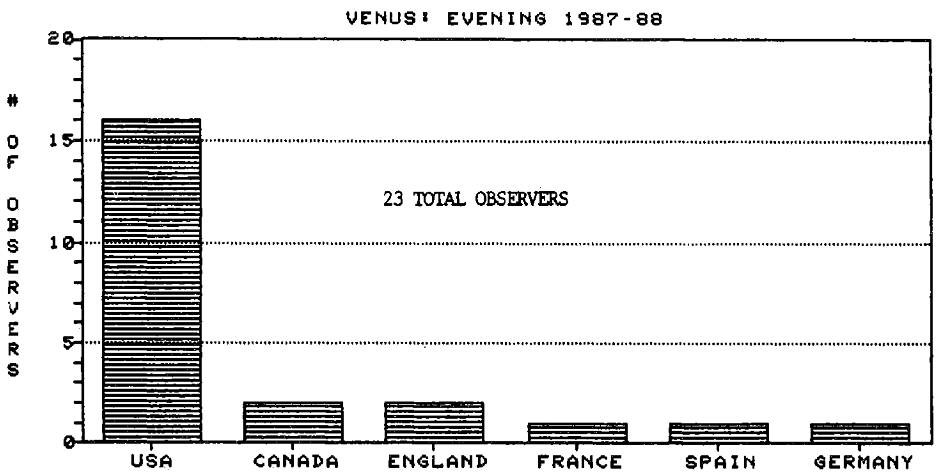

Figure 2. Distribution of observers by country, 1987-88 Eastern Apparition of Venus.

OBSERVATIONS OF VENUSIAN ATMOSPHERIC DETAILS

Conventional methods and techniques of making visual studies of the somewhat vague and elusive "markings" in the atmosphere of Venus have been outlined in the appropriate Venus Section pamphlets and booklets. [**1**, **2**, **3**] For more technical aspects of Venus observation and theory, refer to the book *Venus* by Hunten *et al.* [**4**] Careful study of these sources is strongly recommended, as well as of previous apparition reports, if one is unfamiliar with the general nomenclature used or with the basic observational methods.

This report is based upon descriptive notes, drawings that accompanied the notes, and numerous photographs; the latter chiefly taken at visible wavelengths. A few samples of these drawings and photographs appear along with this report in order to aid the reader in the interpretation of the phenomena reported or suspected on Venus in 1987-88 (*Figures 5-18*, pp. 154-156 and front cover).

The visual and photographic data for 1987-88 represented almost all of the categories of dusky and bright markings on Venus that have been described in the literature cited. A quantitative treatment of this material, similar to that done in earlier Venus apparition reports, appears in *Table 3* (p. 148), which shows the percentages of observations which fitted specific categories of features.

Despite diligent efforts to minimize the subjective aspects of the data for this apparition, these remain and must affect the quantitative data in *Table 3* and elsewhere. Nonetheless, some reasonable if tentative conclusions may be derived from the percentages in *Table 3.*

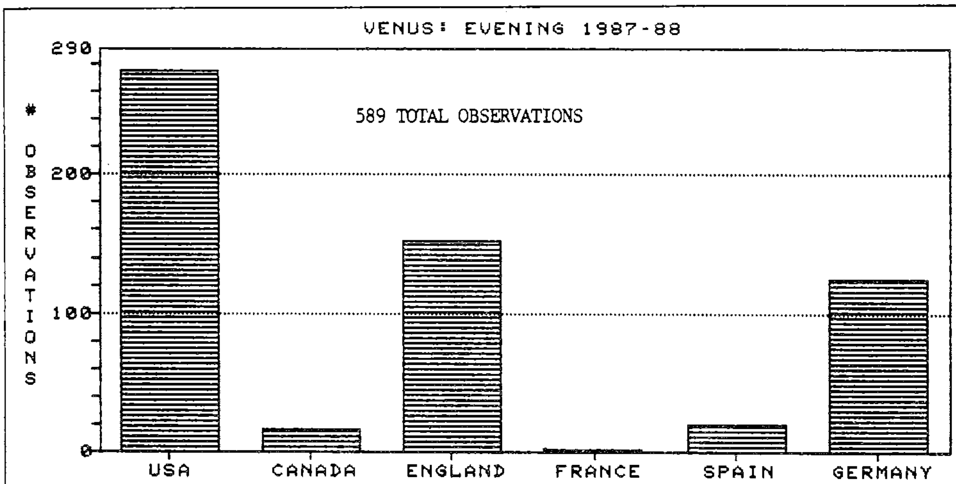

Figure 3. Distribution of observations by country, 1987-88 Eastern Apparition of Venus.

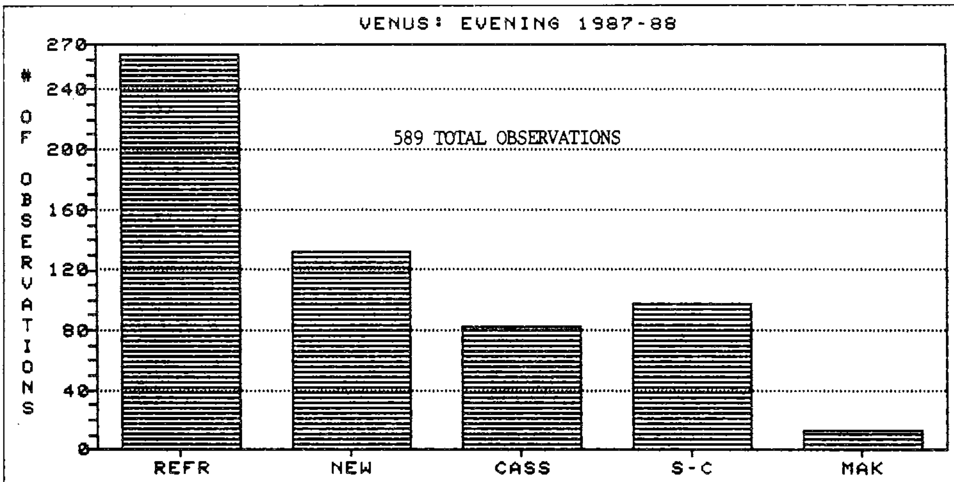

Figure 4. Distribution of observations by type of telescope, 1987-88 Eastern Apparition of Venus.

Table 3. Frequency of Occurrence of Types of Markings in the Atmosphere of Venus in the 1987-88 Eastern (Evening) Apparition.

Apparent Surface (Atmospheric) Feature Categories	Percent. of Reports Submitted
Banded Dusky Markings	26.7 %
Radial Dusky Markings	6.1
Irregular Dusky Markings	24.8
Amorphous Dusky Markings	47.7
No Markings except Terminator Shading Seen or Suspected	39.7
Terminator Shading	67.4
Bright Spots or Regions (exclusive of cusps)	8.0

Notes:

1. Desćriptions of the dusky features are: *Banded Dusky Markings*—dusky parallel streaks roughly perpendicular to the line of cusps; *Radial Dusky Markings*—a spoke pattern converging at the subsolar point; *Irregular Dusky Markings*—elongated or roughly linear dusky streaks with no clear pattern; *Amorphous Dusky Markings*—shaded features with no form, definite shape, or pattern. [3]
2. During this observing season, the phase, as measured by the proportion of the disk that was illuminated, **k**, ranged from 0.955 (1987 OCT 29) to 0.003 (1988 JUN 10).
3. Assuming that the bright illuminated hemisphere of Venus, where there were no shadings or obvious markings, was typically assigned a relative numerical intensity of 8.5 to 9.0 in 1987-88, the mean assigned intensity for the dusky markings (the first five categories in the above table) was about 7.6 to 7.9 in 1987-88. The mean intensity of the bright markings (last category) was assigned to be 9.0. These intensities are on the standard A.L.P.O. scale, where 0.0 is totally black shadow and 10.0 is the brightness of the most brilliant features ever seen.
4. The scale of conspicuousness, ranging from 0 for definitely not seen to 10 for certainly seen, was used somewhat effectively in the 1987-88 Apparition, when the conspicuousness rating was 5.0 for the first five categories in the above table as well as for the bright spots. This indicated that all features' conspicuousness lay somewhere between vague suspicions and strong indications.
5. Seeing conditions, on the standard A.L.P.O. scale from 0 (worst possible) to 10 (perfect), averaged about 4.0-4.5, or generally fair.
6. Transparency conditions, expressed as the magnitude of the faintest star detectable by the naked eye on a clear, dark night in the sky near the planet (with any reference objects usually noted), were quite difficult to evaluate because 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 +4.0.

It is well established that the dusky markings of Venus' atmosphere are quite elusive, both to the novice and to the experienced observer. It is usually felt that ultraviolet (UV) photographs of Venus are desirable in order to bring out any dusky features. Without a doubt, ultraviolet photographs (e.g., *Figure 7*, p. 155) are actively sought because many features in UV differ characteristically from those occasionally seen or suspected at visual wavelengths, particularly with respect to radial dusky patterns. It is interesting, however, that during 1987-88 three-fifths (60.3 percent) of the drawings and other visual observations of Venus reported markings of some form on the disk, in contrast to what has been the case in other recent apparitions. Nearly all the photographs of Venus that were submitted showed a completely blank disk, but observers at visual wavelengths reported banded, irregular, amorphous, and radial dusky markings more frequently than in many previous Eastern (Evening) Apparitions of Venus. These results are probably due to a more standardized, systematic use of polarizing and colored filters than in the past, rather than to any increased atmospheric activity on Venus.

Most dusky markings reported in 1987-88 were classed as "Amorphous Dusky Markings" (47.7 percent of all observations). Other dusky atmospheric features were distributed fairly evenly between the "Banded Dusky Markings" and "Irregular Dusky Markings" categories (see *Table 3*), while only a small percentage were "Radial Dusky Markings."

Excluding the cusp regions, bright areas or mottling were infrequently observed during the 1987-88 Apparition. A small number of drawings and, perhaps, one or two photographs at visual wavelengths, depicted these bright spots or regions of Venus. UV photographs, however, revealed what appeared to be both Radial Dusky Markings and Banded Dusky Markings.

As mentioned above, color-filter techniques were more effectively and systematically applied to Venus during the Eastern (Evening) Apparition of 1987-88 than in previous apparitions, with very promising results when compared with integrated-light (IL) observations. The visibility of atmospheric features on Venus was sometimes enhanced by the use of such filters as the Wratten 47 (W47; violet), W25 (red), W15 (yellow), W58 (green), W80A (light blue), or variable-density polarizing filters, and the comparative data thus generated proved most helpful.

Terminator shading was prominent during this apparition, perhaps for the same reasons that the dusky features were more apparent in 1987-88. There was the 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 of Venus. In some instances, this gradation terminated in the bright limb band. Normally, this shading extended from one cusp region to the other; and the terminator shading was reported the most often from around the time of dichotomy (1988 APR 05) and later, during the crescent phase. In terms of photographs at visual wavelengths, only a small fraction of those submitted during the apparition suggested terminator shading. All UV photographs showed terminator shading, with morphology similar to that reported visually.

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 coefficient, **k**, the fraction of the disk that is sunlit, lies between 0.8 and 0.1. These cusp-caps occasionally appear on the planet, sometimes bounded by dark, often diffuse, peripheral cusp-bands.

Table 4, below, presents selected cusp-cap and cusp-band statistics for the 1987-88 Apparition.

Table 4. Cusp-Cap and Cusp-Band Statistics: 1987-88 Eastern (Evening) Apparition of Venus.

Condition of Feature(s)	Percent. of Reports Submitted
No Cusp-Caps Visible	46.2 %
Both Cusp-Caps Visible	0.7
North Cusp-Cap Alone Visible	0.5
South Cusp-Cap Alone Visible	7.6
Either or Both Cusp-Caps Visible	8.8
North Cusp-Cap the Brighter	6.1 %
Cusp-Caps of Equal Brightness	5.1
South Cusp-Cap the Brighter	35.8
North Cusp-Cap the Larger	4.9 %
Both Cusp-Caps of Equal Size	13.9
South Cusp-Cap the Larger	39.9
No Cusp-Bands Visible	50.4 %
Both Cusp-Bands Visible	2.0
North Cusp-Band Alone Visible	1.2
South Cusp-Band Alone Visible	77.8
Either or Both Cusp-Bands Visible	81.0

Notes:

1. Assuming that the relative numerical intensity of the bright illuminated hemisphere of Venus was typically 8.5 to 9.0 in the 1987-88 observing season, the mean intensity of the cusp-caps was about 9.6, while the cusp-bands averaged about 7.7 for this apparition.
2. The seeing and transparency notes in *Table 3* (p. 148) apply here as well.
3. The sums of the percentages in the above table do 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 1987-88 Eastern (Evening) Apparition of Venus, when the southern and northern cusp-caps of Venus were recorded, they were seldom seen at the same time. In fact, the cusp-caps were infrequently detected during most of 1987-88, but at times of optimum visibility it was usually the southern cusp-cap that was seen. The southern cusp-cap was also usually the brighter and the larger of the two, and was frequently bordered by an obvious dusky cusp-band. In nearly half of the observations, neither cusp-cap was reported, and neither cusp-band was seen half of the time. There were a few instances when the north cusp-cap was the brighter and the larger of the two; but this was rare, and at such times the north cusp-cap was bordered by an inconspicuous cusp-band.

EXTENSION OF THE CUSPS

[In theory, the illuminated portion of the limb of Venus should always subtend approximately 180°; any amount significantly greater than this constitutes a *cusp extension*, and is presumed to be due to the planet's atmosphere. Ed.] Three-fourths of the observations submitted showed no cusp extensions during the 1987-88 Apparition, both in integrated light and with colored filters. However, from April through June, 1988, several observers recorded extensions of both cusps, usually ranging from 2 to 40 degrees. There were, though, several times when the reported extensions of both cusps met, forming a halo encircling the entire dark hemisphere of Venus; a truly beautiful spectacle. These cusp extensions were depicted on drawings, and were enhanced by color-filter techniques, but were wholly invisible on all photographs submitted. As expected, cusp extensions are exceedingly difficult to photograph, being considerably fainter than the sunlit portions of the disk.

THE BRIGHT LIMB BAND

In 1987-88, 40.9 percent of the 589 observations submitted referred to a bright limb band on the sunlit limb of Venus. This feature extended from cusp to cusp, was narrow in width along the limb, and was usually uniform in intensity throughout its extent. The mean numerical intensity assigned to the limb band was 9.6-9.8 in 1987-88. The visibility of the bright limb band was particularly enhanced using selected color- and polarizing-filter techniques.

TERMINATOR IRREGULARITIES

The terminator of Venus is the geometric curve that separates the sunlit and dark hemispheres of the planet. During the 1987-88 Apparition, 86.8 percent of the observations submitted reported obvious terminator irregularities. Amorphous and irregular dusky markings and, to a lesser extent, banded and radial dusky shadings merged with the terminator shading and with possible reported deformities along the otherwise geometrically regular terminator. As with other observations during this apparition, successful filter techniques probably increased the visibility of any suggested terminator irregularities and associated dusky atmospheric features.

THE ASHEN LIGHT AND OTHER DARK-HEMISPHERE PHENOMENA

The Ashen Light, first recorded by the Italian observer G. Riccioli in 1643, is an exceedingly elusive, faint illumination of the dark hemisphere of Venus that resembles Earthshine on the dark portion of the Moon, although the latter is of a completely different origin. It has usually been held that Venus must be viewed against a dark sky in order to have the best opportunity to see the Ashen Light, but this is at a time when Venus is low in the sky so that images suffer from the effects of poor seeing and the contrast of the bright disk of Venus with the dark sky background.

The A.L.P.O. Venus Section, in conjunction with several other astronomical associations throughout the world, actively participated in a very intensive effort to study the Ashen Light in cooperation with Pioneer Venus scientists. The Pioneer Venus Orbiter, hereinafter referred to as PVO, has been circling Venus since 1978 in a near-polar orbit. The spacecraft contains an instrument package which permits the observation of atmospheric features of Venus, monitoring interactions between the Sun and Venus, and sampling the interplanetary neighborhood of the planet. The PVO does not have, however, any equipment for directly observing the Ashen Light at visual wavelengths, and this is the reason why PVO studies must be complemented by optical (visual) work by A.L.P.O. and other Venus observers all over the globe.

The PVO data, which are now being compared with A.L.P.O. and other visual and photographic observations from Earth, are still being analyzed with the intent of correlating optical observations with spacecraft measurements. Any results that have emerged are quite tentative at this time and thus will not be addressed in this report. Pioneer scientists have, however, expressed a heartened but cautious reaction to the findings so far.

Monitoring of Venus by A.L.P.O. and other observers around the world was continued into the 1988-89 Western (Morning) Appari-tion of Venus in order to provide an uninterrupted survey of the planet, all in an effort to insure equality in sampling during eastern and western apparitions. [Past reports of the Ashen Light have been confined almost entirely to Eastern (Evening) Apparitions, but some have suggested that this is simply because most observations of Venus have been made during evening apparitions. Ed.] Observers will be fully informed about the overall results of the PVO program, when they are known to this writer, in a future issue of this Journal.

For now, it is important to consider the A.L.P.O. 1987-88 Eastern Apparition observations by themselves. *Table 5*, beginning below, lists summary data for all positive sightings of the Ashen Light for the apparition, where the phenomenon was reported from 1988 APR 02 through 1988 JUN 07. During that period there was almost daily coverage of Venus by A.L.P.O. observers, and there were obviously many more negative observations than positive ones.

Almost all the observations in *Table 5* were made during evening (dark sky) or twilight. As one might imagine, this data set was very difficult to work with, chiefly because of variations in instruments, seeing conditions, duration of observations, filters used, occulting devices employed, and of course variations in judgment by the observers themselves. Even so, one may be able to derive useful information from these data, particularly when comparing the results presented here with similar results from other groups and from the PVO observations. The abbreviations and conventions used in *Table 5* are explained in the notes at the end of the table. [*Text continued on p. 153.*]

Table 5. A.L.P.O. Venus Section Ashen Light Patrol: 1987-88 Eastern (Evening) Apparition.

U.T. Date & Time	Ob.	Instrument		Mag.	Filter	S/T	AL	Description
1988								
APR 02 00:43	RR	15.2	Nt	160	IL	7/5	S	Faint; like Earthshine.
10:42-11:42	DN	20.3	S-C	225	IL	----	S	Vague.
21:47-22:15	MG	15.2	Rr	261	W25	7/4	S	Vague.
					W47	7/4	NS	---
					IL	7/4	NS	----
03 11:30-11:42	DN	20.3	S-C	225	IL	----	S	Vague.
					Y-Gr	----	DV	Distinct!
06 19:04-20:05	DN	20.3	S-C	225	IL	----	S	Bluish; faint.
					Blue	----	S	Vague.

(continued)

Table 5. A.L.P.O. Venus Section Ashen Light Patrol: 1987-88 Eastern (Evening) Apparition--*Continued.*

U.T. Date & Time		Ob.	Instrument		Mag.	Filter	S/T	AL	Description
1988									
APR 10	02:50	JW	50.8	Rr	250	IL	4/6	S	Violet fringe encircles dark Hem.
	11:17-11:26	DN	20.3	S-C	225	IL	----	S	Vague.
						Green	----	S	Vague.
13	14:42-15:06	DN	20.3	S-C	225	W58	----	StS	Portion of dark hemisphere.
						W47	----	S	Vague.
	18:50	DG	15.2	Rr	166	W44A	----	S	Vague.
						"+OcB	----	NS	---
20	03:45-03:51	JW	25.4	Cs	233	IL	6/5	S	---
						"+OcB	6/5	NS	---
21	03:40-03:43	JW	25.4	Cs	233	IL	6/5	S	---
						"+OcB	6/5	NS	---
23	19:00	DG	15.2	Rr	166	Blue	----	S	---
						IL	----	NS	---
						Yellow	----	NS	---
						Red	----	NS	---
24	00:10	LC	20.3	S-C	153	IL	----	S	Ruddy cast.
25	01:41-03:31	WH	20.3	Nt	231	IL	3/4	S	Vague; NS with color filters.
26	04:05-04:08	JW	25.4	Cs	233	IL	5/4	S	---
						"+OcB	5/4	NS	---
27	01:15-01:30	RR	11.4	Nt	167	IL	6/5	S	Like Earthshine.
28	03:43-03:46	JW	25.4	Cs	233	IL	5/6	S	---
						"+OcB	5/6	NS	---
MAY 01	09:55-10:31	DN	20.3	S-C	225	Green	----	S	---
						Red	----	S	---
						Blue	----	S	---
						Violet	----	VStS	Faint.
02	04:06-04:10	JW	25.4	Cs	233	IL	4/6	S	---
						"+OcB	4/6	NS	---
	19:45-20:04	DN	11.0	Rr	98	Red	----	S	---
						Blue	----	S	---
03	19:45-19:59	DN	11.0	Rr	98	IL	----	VStS	---
						Blue	----	VStS	Blue-violet.
						Yellow	----	S	---
05	19:17	DN	11.0	Rr	98	IL	----	S	---
06	04:09-04:11	JW	25.4	Cs	233	IL	5/6	S	Magenta hue.
						"+OcB	5/6	NS	---
	19:55-20:07	DN	11.0	Rr	98	Red	----	VStS	---
			20.3	S-C	225	Yellow	----	S	---
			20.3	S-C	225	Blue	----	S	---
			20.3	S-C	225	IL	----	S	---
07	01:30	SL	33.0	Nt	200	IL	3/4	S	---
	10:28-11:16	DN	20.3	S-C	225	Blue	----	VStS	---
						Yellow	----	S	---
						Green	----	S	---
	23:45	GN	22.9	Rr	100	IL	5/5	S	---
08	00:42	BL	6.0	Rr	38	IL	----	S	---
09	00:00-00:20	GN	22.9	Rr	100	IL	7/6	VStS	---
[Simul.]	00:07-00:31	RR	15.2	Nt	160	IL	5/4	S	Faint; like Earthshine.
	20:23-20:39	DN	11.0	Rr	98	IL	----	VStS	Violet hue.
			20.3	S-C	225	Red	----	S	---
			20.3	S-C	225	Green	----	S	---
			20.3	S-C	225	Blue	----	S	---

Table 5. A.L.P.O. Venus Section Ashen Light Patrol: 1987-88 Eastern (Evening) Apparition--*Continued.*

U.T. Date & Time	Ob.	Instrument	Mag.	Filter	S/T	AL	Description
1988							
MAY 10 02:26-04:02	WH	31.8 Nt	202-428	W47	3/4	S	NS with other filters.
11 13:46-14:30	DN	20.3 S-C	225	Red	----	StS	---
				Violet	----	StS	---
				IL	----	S	---
12 00:52-03:20	WH	31.8 Nt	202-366	W47	2/4	S	Purplish in hue?
				W25	2/4	NS	---
				IL	2/4	NS	---
03:53-03:57	JW	25.4 Cs	233	IL	4/6	S	Magenta hue.
				"+OcB	4/6	NS	Also NS with W80A and W21
13 19:15-19:44	DN	11.0 Rr	98	Yellow	----	DV	---
				IL	----	S	---
				Red	----	S	---
				Blue	----	S	---
14 01:26-03:15	WH	31.8 Nt	202-641	W47	2/4	S	---
				W25	2/4	NS	---
				IL	2/4	NS	Also NS with W12 and W58.
03:38-04:01	JW	25.4 Cs	233	IL	4/6	S	---
				"+OcB	4/6	NS	---
15 03:53-03:57	JW	25.4 Cs	233	IL	2/6	S	---
				"+OcB	2/6	NS	---
10:54-12:15	DN	20.3 S-C	225	Yellow	----	S	---
				Magenta	----	S	---
				Violet	----	S	---
				IL	----	NS	---
				Red	----	NS	---
18:50-19:25	DG	15.2 Rr	166	W58	----	S	---
				W15	----	NS	---
				W25	----	NS	---
				W44A	----	NS	---
				IL	----	NS	---
16 18:50-21:50	DG	15.2 Rr	166	W58	----	S	---
				W15	----	S	---
				W25	----	VStS	---
				W44A	----	NS	---
				IL	----	NS	---
18 19:14-19:25	DN	11.0 Rr	98	Red	----	S	---
				Blue	----	S	---
21 19:45-20:01	DN	11.0 Rr	98	IL	----	S	---
				Yellow	----	S	---
				Red	----	S	---
				Blue	----	NS	---
22 01:50-02:20	RR	15.2 Nt	160	IL	6/4	S	---
19:31-19:51	DN	20.3 S-C	225	Yellow	----	VStS	---
				Red	----	VStS	---
				IL	----	S	---
				Blue	----	S	---
25 01:31-02:15	WH	31.8 Nt	321	W47	2/3	S	NS with IL & other color filters.
19:30-19:44	DN	11.0 Rr	98	Blue	----	S	---
				Yellow	----	S	---
				Red	----	VStS	---
				IL	----	NS	
26 19:08-19:24	DN	11.0 Rr	98	Yellow	----	S	---
				IL	----	NS	---
				Red	----	NS	---
				Blue	----	NS	---

Table 5. A.L.P.O. Venus Section Ashen Light Patrol: 1987-88 Eastern (Evening) Apparition--*Continued.*

U.T. Date & Time	Ob.	Instrument	Mag.	Filter	S/T	AL	Description
1988							
MAY 28 01:10-01:40	RR	8.3 Rr	115	IL	6/5	S	---
09:03-09:35	DN	20.3 S-C	225	IL	----	S	---
				Yellow	----	S	---
				Red	----	S	---
				Blue	----	NS	---
29 08:03-08:12	DN	20.3 S-C	225	Red	----	S	---
				Blue	----	S	---
				Violet	----	NS	---
				IL	----	NS	---
JUN 07 00:27-01:50	WH	31.8 Nt	101	W47	1/4	S	NS with other color filters.

Notes:

1. Column Headings:

"U.T. Date & Time" gives year, month, day, hour, and minute in Universal Time; "*[Simul.]*" refers to a simultaneous observation (time overlaps the time of the previous observation).
"Ob." refers to the observer as listed in *Table 2* (p. 145), indicated by the first initial followed by the last initial.
"Instrument" gives the aperture in centimeters of the instrument used, followed by its type as abbreviated in *Table 2*. This is followed by "Mag." for magnification.
"Filter" gives either: (i) the actual color of the filter; (ii) an abbreviation as follows—"IL" = Integrated Light (no filter), "Y-Gr" = Yellow-Green; (iii) the Kodak Wratten number as follows—W15 (deep yellow), W25 (red tricolor), W44A (light blue-green), W47 (blue tricolor), W58 (green tricolor); or (iv) "+OcB" indicating that an occulting bar was used in conjunction with the filter last indicated.
"S/T" is seeing and transparency as defined in the notes for *Table 3* (p. 148).
"AL" is the Ashen Light Visibility code: "NS" = nothing seen or suspected; "S" = AL suspected; "StS" = AL strongly suspected; "VStS" = AL very strongly suspected; and "DV" = AL definitely visible.
"Description" contains additional notes made by the observer.

2. There may be effects due to the use of filters for visual observations, although the evidence is ambiguous. For example, individuals reported AL with a particular filter but not in IL, while others saw AL in IL but not with various filters or when using an occulting bar (OcB). Many different filter types were used; some with unknown transmissions. The fairly dense W47 (blue tricolor; 2.6 percent visual transmission) Filter was rather frequently used. A sighting of AL which was positive without an occulting bar, but vanished when an occulting bar was used, was maintained as a positive report in order to conform with the methods used for analysis by the PVO scientists. [The editor made several of this form of sighting, and interprets them as indicating the AL report was illusory. Also, his APR 10 observation was clearly chromatic aberration. Ed.]

3. All but a few of the observations in *Table 5* were made during twilight or evening (night).

ESTIMATES OF PHASE AND DICHOTOMY

The "Schroeter Effect" on Venus, a discrepancy between the predicted and observed dates of dichotomy (half phase), was reported in 1987-88. The predicted half-phase occurs when **k** = 0.500 and **i**, the phase angle or angle between the Sun and the Earth as seen from Venus, equals 90°. The observed-minus- predicted discrepancies for Venus for 1987-88 are given in *Table 6* (p. 154).

CONCLUSIONS

Limited activity was reported in the atmosphere of Venus during the 1987-88 Eastern (Evening) Apparition. It is worthwhile to compare the 1987-88 results with those of previous evening observing seasons, as well as with morning apparitions of the planet. One important aspect of this observing season was the cooperation between the A.L.P.O., various other astronomical organizations around the world, and the Pioneer

Table 6. Observed and Predicted Dichotomy of Venus: 1987-88 Eastern (Evening) Apparition.

Predicted Dichotomy (**k** = 0.500; **i** = 90°.00) = 1988 APR $05^d.2$.

	Observer			
	A. Heath	J. Westfall	D.L. Graham	J.L. Benton
Observed Date: 1988	MAR 31.7	APR 05.1	MAR 23.8*	MAR 31.5
Observed-minus-Predicted Discrepancy:				
Days	$-4^d.5$	$-0^d.1$	$-12^d.4$	$-4^d.7$
k	-.025	-.001	-.066	-.025
i	+2°.86	+0°.08	+7°.54	+2°.89

* As observed with both W15 (medium yellow) and W25 (red tricolor) Filters.

Venus Orbiter (PVO) program for monitoring the Ashen Light. Some important tentative results appear here, but analysis of the wealth of information gathered from all sources during the 1987-88 Apparition, and the 1988-89 Western (Morning) Apparition following it, should provide interesting reading in subsequent reports in this Journal.

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 cordially invited to join us in our pursuits to gather reliable information about Venus.

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3. ________ (1987). *Visual Observations of Venus: Theory and Methods (The ALPO Venus Handbook)*. Savannah, GA: Review Publishing Co.

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5. Phillips, John (1989). "Guide to 'First Look' Figures for 1988 Ashen Light Campaign." (Unpublished private communication.)

6. Phillips, John and Russell, C.T. (1988). "The Ashen Light." (Unpublished manuscript.)

7. United States Naval Observatory (1986). *The Astronomical Almanac, 1987*. Washington: U.S. Government Printing Office.

8. ________ (1987). *The Astronomical Almanac, 1988*. Washington: U.S. Government Printing Office.

[Note that physical ephemeris information on Venus, at more frequent intervals than in the *Astronomical Almanac*, can be found in the *A.L.P.O. Solar System Ephemeris* for each year.]

SELECTED DRAWINGS AND PHOTOGRAPHS OF VENUS IN THE 1987-88 EASTERN (EVENING) APPARITION

The drawings and photographs below 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 in the vicinity of Venus. "Diam." is the disk diameter in arc-seconds, and **k** is the proportion of the disk that is sunlit. Contrasts are necessarily exaggerated in these views.

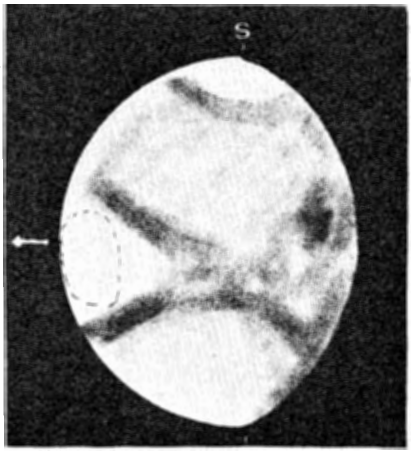

Figure 5. Drawing of Venus by Jordi Aloy on 1988 JAN 27, 16h 48m-16h 55m U.T. 21.0-cm. reflector, 172X, neutral-density filter. Seeing and transparency good. Diam. = 14".1, **k** = 0.777.

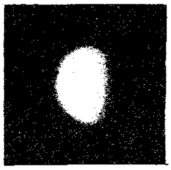

Figure 6. Photograph by Alan W. Heath on 1988 FEB 21, 18h 05m U.T. 30.0-cm. reflector with 318X eyepiece. Tri-X Film at 1/25-second exposure. Diam. = 16".4, **k** = 0.697.

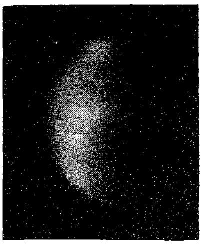

Figure 7. Photograph by Jean Bourgeois on 1988 MAR 03, 18h 00m U.T.with the Pic-du-Midi 100-cm. reflector. Exposed 0.5 seconds at f/50 on Agfaortho Film through a UG11 ultraviolet filter. Diam. = 17".7, **k** = 0.655.

Figure 8. Drawing by Jordi Aloy on 1988 MAR 03, 18h05m-18h 13m U.T.11.0-cm. refractor, green filter. Seeing very good; transparency good. Diam. = 17".7, **k** = 0.655. Note that this drawing was made only a few minutes later than the photograph above and that they show several features in common.

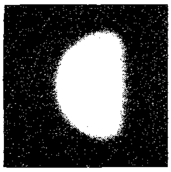

Figure 9. Photograph by Alan W. Heath on 1988 MAR 23, 18h 50m U.T. 30-cm. reflector with 318X eyepiece. Exposure 1/25 second on Tri-X Film. Diam. = 21".1, **k** = 0.566.

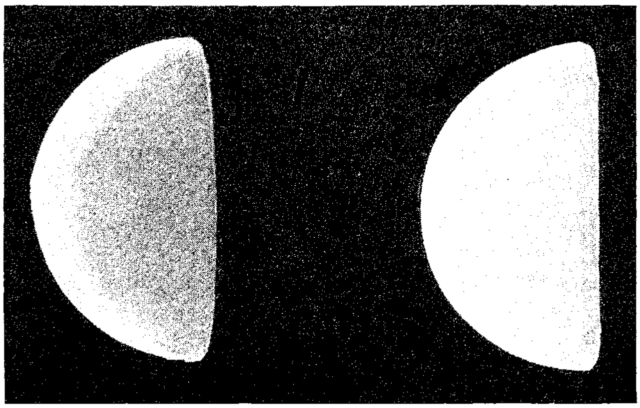

Figure 10. Paired drawings by Alan W. Heath; 1988 MAR 27, 18h 25m U.T. 30-cm. reflector, 190X. Seeing 4. The drawing on the left was made with a W47 (blue) Filter; that on the right, with a W25 (red) Filter. Diam. = 21".9, **k** = 0.546.

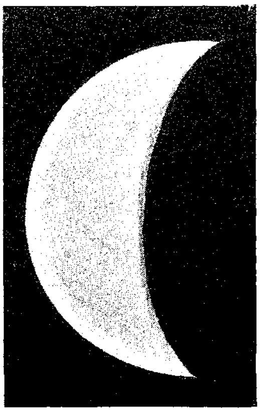

Figure 11. Drawing by Alan W. Heath on 1988 APR 20, 18h 30m U.T. 30-cm. reflector, 190X. Seeing 3. Diam. = 29".0, **k** = 0.403. Compare with *Figures 12* and *13* (p. 156) made at approximately the same time.

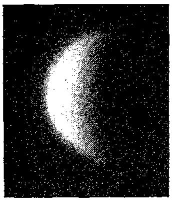

Figure 12. Photograph by Alan W. Heath on 1988 APR 20, 18h 40m U.T. 30-cm. reflector with 318X eyepiece, 1/25-second exposure. Diam. = 29".0, **k** = 0.403. Compare with *Figure 11* (p. 155) and *Figure 13* (below).

Figure 13. Drawing by Jordi Aloy on 1988 APR 20, 18h 28m-18h 38m U.T. 11.0-cm. refractor, neutral-density filter. Seeing regular, transparency good. Diam. = 29".0, **k** = 0.403. Compare with *Figure 11* (p. 155) and *figure 12* (above).

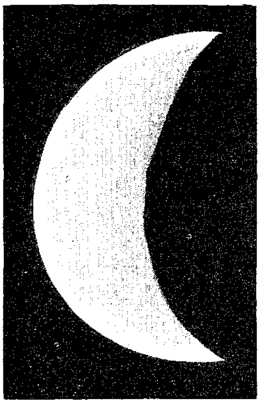

Figure 14. Drawing by Alan W. Heath on 1988 MAY 01, 18h 50m U.T. 30-cm. reflector, 190X. Seeing 4. Diam. = 34".0, **k** = 0.320.

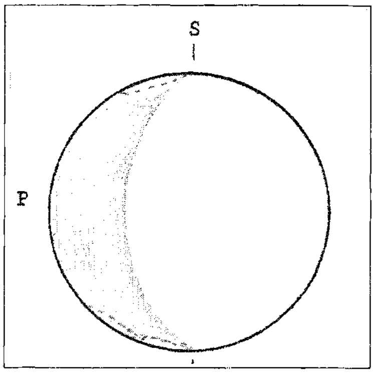

Figure 15. Drawing by Lawrence M. Carlino on 1988 MAY 09, 00h 20m U.T. 20-cm. Schmidt-Cassegrain, 153X; W25 (red) Filter and apodizing mask. Seeing 3-4, transparency fair. Diam. = 38".0, **k** = 0.259.

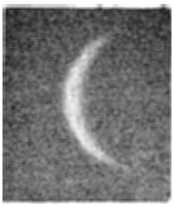

Figure 16. Photograph by Alan W. Heath on 1988 MAY 20, 19h 10m U.T. 30-cm. reflector with 190X eyepiece. 1/25-second exposure. Diam. = 45".9, **k** = 0.149.

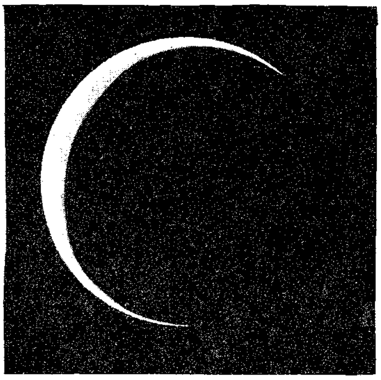

Figure 17. Drawing by David L. Graham on 1988 MAY 27, 19h 40m U.T. 15.2-cm. refractor, 166X. Diam. = 51".0, **k** = 0.084. Note cusp extension.

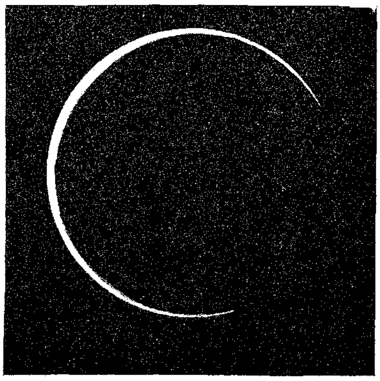

Figure 18. Drawing by David L. Graham on 1988 JUN 05, 17h 00m U.T. 15.2-cm. refractor, 166X. Diam. = 56".1, **k** = 0.020. Note cusp extension.

GALILEAN SATELLITE ECLIPSE TIMINGS: THE 1987/88 APPARITION

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

ABSTRACT

The A.L.P.O. Jupiter Section received 688 visual and 12 photoelectric timings of the eclipses of Jupiter's Galilean Satellites for the 1987/88 Apparition. For each satellite, eclipse disappearance and reappearance timings were adjusted for telescope aperture and combined for comparison with the "E-2" Ephemeris. Io's observed position fit the ephemeris quite well, but events for Europa and Ganymede tended to be significantly earlier than predicted; the discrepancy for Europa was confirmed by photoelectric timings.

INTRODUCTION

1987/88 was the eleventh apparition of Jupiter studied by the A.L.P.O. Jupiter Section's Galilean Satellite Eclipse Timing Program. This was also our most successful apparition, with 688 visual and 12 photoelectric timings received. The satellites so timed were Io (*1*), Europa (*2*), and Ganymede (*3*); with one possible report for Callisto (4). Visual observers timed the "first speck" visible when the satellite reappeared from Jupiter's shadow (*egress*), or the "last speck" seen when the satellite disappeared into the shadow (*ingress*). Photoelectric observers timed when the satellite was at mid-ingress or mid-egress, at half its uneclipsed brightness. Reports for previous apparitions are listed under "References" (p. 161). [Westfall 1983-84, 1986a, 1986b, 1987, and 1988]

Table 1 (below) lists some significant dates for the 1987/88 Jupiter Apparition.

Table 1. 1987/88 Jupiter Apparition Chronology.

			d	*h*
Conjunction with the Sun	1987	Mar	27	01
First Eclipse Timing	1987	Jun	04	20
Closest Approach to Earth	1987	Oct	17	12
Opposition to the Sun	1987	Oct	18	15
Last Eclipse Timing	1988	Mar	22	09
Conjunction with the Sun	1988	May	02	21

The *apparition* is the period between successive conjunctions, while the *observing season* covers the period of actual observation. The observing season began 69 days after conjunction, with Jupiter 52° west of the Sun; and ended 41 days before the next conjunction, at solar elongation 31° east. During the apparition, the jovicentric declination of the Sun increased from 2°.35 to 3°.12, meaning that only Io, Europa, and Ganymede should have been eclipsed, although there was one report of a possible partial eclipse of Callisto (see p. 161).

At closest approach, Jupiter's distance from the Earth was 3.9592 A.U. (astronomical units), with an equatorial diameter of 49".72, and a visual magnitude of -2.93. Its geocentric declination at opposition was +20°.1, so this apparition favored observers in the Northern Hemisphere.

OBSERVATIONS

The timings received for 1987/88 bring our eleven-apparition total to 3535 visual and 41 photoelectric timings. Besides the timings submitted directly to the A.L.P.O. (306; 44.5 percent of the total of 688), we were fortunate to receive 216 timings (31.4 percent) by 22 New Zealand and Australian observers from the Royal Astronomical Society of New Zealand, and 166 timings (24.1 percent) by 19 Spanish observers from the Agrupacion Astronomica de Sabadell. All in all, 98 individuals or teams submitted reports. The timings themselves are listed in *Table 5* (Ap-pendix, pp. 162-166), and the observers are listed at the end of this report (pp. 166-167).

Table 2 (below and next page) gives summary statistics for the *visual* timings received.

Table 2. Summary Statistics: 1987/88 Galilean Satellite Visual Eclipse Timings.

A. By Satellite and Event Type.
(D = Disappearance; R = Reappearance; P = Partial)

1D	109 timings	3D	80 timings
1R	228	3R	64
1	337	3	144
2D	94 timings	4P	1 timing
2R	112		
2	206	*D*	283 (41.2 %)
		R	404 (58.8 %)
		P	1 (0.1 %)

B. By Month.
(with Solar Elongation Range)

1987	JUN (52-73° W)	14	Timings
	JUL (73-99° W)	39	
	AUG (99-128° W)	58	
	SEP (128-160° W)	84	
	OCT (160°W-165°E)	55	
	NOV (165-132°E)	100	
	DEC (132-100°E)	103	
1988	JAN (100-72°E)	130	
	FEB (72-48°E)	85	
	MAR (48-31°E)	20	
Before Opposition		235	(34.2 %)
After Opposition		453	(65.8 %)

(over)

(Table 2—Continued.)

C. By Telescope Aperture.
(Truncated to whole centimeters)

5 cm.	45 timings	20 cm.	164 timings
6	23	21	11
7	24	22	1
8	26	25	65
9	3	30	19
10	55	32	24
11	24	33	3
12	6	35	24
13	8	40	25
14	1	41	11
15	82	51	1
16	30	100	1
17	12		

Weighted by:	*Observations*	*Telescopes*
Mean	*18.5 cm.*	*19.1 cm.*
Median	*18.0*	*15.4*

As usual, more timings were made for Io than for Europa, and more for Europa than for Ganymede. This appears simply to be a result of their orbital periods increasing, and the frequency of their eclipses decreasing, outwards from Jupiter. On the other hand, there is a definite bias toward timing eclipse reappearances rather than disappearances. This bias was strongest for Io (a 2.1:1 ratio) and weaker for Europa (1.2:1). For Ganymede, more disappearances were timed than reappearances. The most likely reason for this pattern is that the disappearances of Io and, usually, Europa are visible only before opposition, when fewer timings are made (see below).

Likewise, the distribution of timings by month follows a familiar pattern, except for the drop for the month of opposition itself (1987 OCT), perhaps due to unfavorable weather or to the difficulty of timing eclipses when the satellites are near Jupiter. The period of most intense observing was the four months after opposition, when the planet was conveniently placed in the evening sky. We have an ongoing bias toward post-opposition timings, and we request participants to make more pre-opposition timings in the future, recognizing that this involves observing after midnight.

The most popular aperture continues to be 20 cm., with the median slightly less; 15 cm. with all telescopes weighted equally, and 18 cm. when weighted by number of observations. The range of apertures continues to be large; from 5 to 100 cm., showing that almost any telescope can be used in our program.

REDUCTION

The first step in reduction was to segregate the visual timings by satellites and by event type; disappearance versus reappearance. Observations were compared with the predictions of the "E-2" Ephemeris developed by Dr. Jay H. Lieske of the Jet Propulsion Laboratory. [Lieske, 1981] The predicted time of each event was then subtracted from the observed time; a positive residual meant that an event was "late"; a negative residual, that it was "early." These residuals are given in the right-hand column in *Table 5*. The next step was to correct for aperture with a linear regression model in which the dependent variable was the residual (**y**) and the independent variable was the reciprocal of the telescope aperture, measured in cm. (**x**). The form of the model is:

$$\mathbf{y} = \mathbf{A} + \mathbf{B}\mathbf{x},$$

where **A** and **B** are the regression coefficients. The final residual for each satellite is equal to the mean of its disappearance and reappearance regression models' predictions of the residual for an "infinite" aperture (i.e., with the reciprocal of the aperture equal to zero).

Some timings were rejected because of extreme differences (over 2 standard deviations) from the regression model. For the 1987/88 Apparition, 88 timings (12.8 percent) were so rejected, and are shown by italicized residuals in *Table 5*. This proportion of timings rejected in somewhat high and is probably due to the fact that this was the first apparition of timing for many of the observers.

As a check of the method above, the writer estimated the diameters of Io, Europa, and Callisto by taking the differences between the predicted disappearance and reappearance residuals, which should give the amount of time it took Jupiter's shadow edge to cross each satellite. Then, taking into account each satellite's velocity and average angle of entry or exit from the shadow, the diameter in kilometers was calculated.

The method of analysis is described in more detail in our 1975-82 report [Westfall, 1983-84] and the criteria for the rejection of timings are in the report for 1985/86 [Westfall, 1987].

1987/88 RESULTS

The orbital residuals for Io, Europa, Ganymede, and Callisto for all eleven apparitions from 1976/77 through 1987/88 are graphed in *Figure 19* (p. 159). In that figure, the error bars represent a ±1 standard-error range, and a significant deviation from the ephemeris would have to be at least about ±2 standard errors. Details for the 1987/88 Apparition follow on *Table 3* (p. 160). This table gives results for each of the first three satellites in a separate column. The column is divided into four parts, "Disappearance," "Reappearance," "Orbital Residual," and "Diameter." For both disappearances and reappearances, the number of timings is given first, followed in parentheses by the number actually used in the regression analysis. The next item is the coefficient of variation ("R-squared"), which is the proportion of the vari-

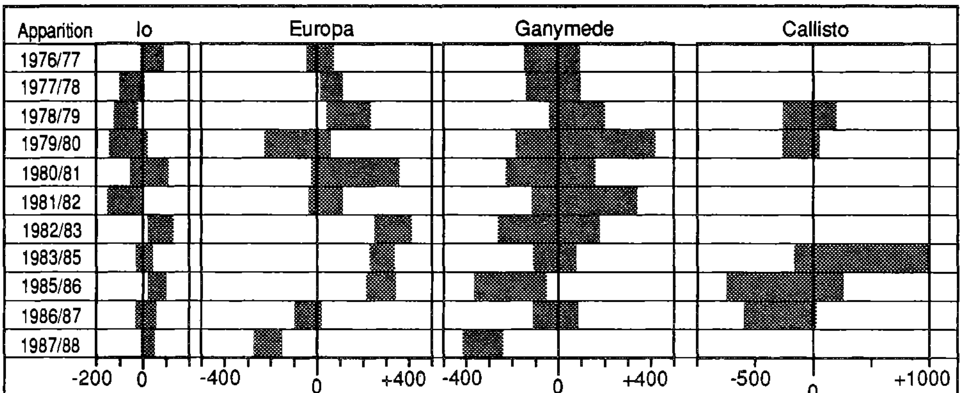

Figure 19. Graphs of deviations of the Galilean Satellites from the E-2 Ephemeris for the 1976/77 through the 1987/88 Apparitions. Units are in kilometers. The width of each bar represents ±1 standard error. Note different scale for Callisto, which was not eclipsed in every apparition.

ance among the timings that is explained by the aperture model. Third, the two regression coefficients are given with their 1-standard error uncertainty ranges; in *Table 3*, all such uncertainty ranges are preceded by the "±" symbol. Next is the standard error of estimate for the regression model. Last are the predicted residuals for three commonly used telescope apertures.

The disappearance and reappearance data are combined in order to give the orbital residuals, expressed as how far "ahead" (negative) or "behind" (positive) the satellite was in terms of the E-2 Ephemeris. This value and its 1-standard error uncertainty range are given in seconds of time, degrees of orbital arc, and kilometers.

The results of the satellite diameter check described on p. 158 are given at the bottom of each column, where the estimated satellite diameter is given in seconds of time and in kilometers. The latter value is corrected for the angle of entrance into or out of Jupiter's shadow. This quantity is then compared with the "standard" Voyager-derived satellite diameter (Io, 3640 km.; Europa, 3066 km.; and Ganymede, 5210 km.).

Table 3 also shows the statistical significance of the differences of the following values from zero; "R-squared," the orbital residual (in seconds of time only), and the difference between the estimated and the standard satellite diameters. The statistical significance is shown by "-" for not significant, "*" for significant at the 5-percent level, and "**" for significant at the 1-percent level.

There are six types of events listed in *Table 3*; eclipse disappearances and reappearances for each of the three satellites. As shown by the R-square values, in all six cases the aperture-regression model significantly reduced the variance among the timings. The average uncertainty of the timings is indicated by the standard error which was roughly the same for disappearance and reappearance timings, but increased going outward from Jupiter; about ±15-16 seconds for Io, ±31-33 seconds for Europa, and ±45-50 seconds for Ganymede. This trend is not surprising because the satellites move more slowly, and Jupiter's shadow penumbra becomes broader, as one moves away from the planet. These factors also are reflected in the increasing numerical value of the B-coefficient with distance from Jupiter; this value measures the effect of aperture variations on the reported times of events. As in previous apparitions, the B-coefficients were all greater in absolute value for reappearances than for disappearances; this difference was statistically significant only for Ganymede.

The orbital residuals, expressed in seconds of time, are the simple means of the disappearance and reappearance A-coefficients of each satellite. These values have also been expressed in units of degrees of orbital arc and in kilometers. As always, any possible deviation of Io from its predicted position was smaller than the uncertainty of our timing model.

Europa, however, was significantly out of place (1-percent confidence level); about 200 kilometers *ahead* of its predicted position. (See also the discussion on the photoelectric timings on pp. 160-161.) That satellite was near its predicted place for the 1986/87 Apparition, but was significantly *behind* the E-2 Ephemeris predictions for the three apparitions previous; 1982/83, 1983/85, and 1985/86.

For the first time in our project, the giant satellite Ganymede was also significantly different in position from the E-2 Ephemeris predictions; in this case about 300 kilometers ahead in its orbit.

The accuracy of our method of analysis is at least roughly assessed by using the A-coefficients to estimate the diameters of the satellites, and then comparing these estimates with the accurate diameters that were derived from the Voyager Missions. In all three cases there

Table 3. Galilean Satellite Timings Compared With E-2 Ephemeris, 1987/88.

Satellite:	Io	Europa	Ganymede
Disappearance			
Number of Observations	109 (99)	94 (86)	80 (70)
Coefficients:			
R-squared	.3570**	.1496**	.4332**
A (seconds)	+106.6±2.7	+109.2±6.4	+401.2±9.8
B	-221±30	-282±73	-753±104
Standard Error (seconds)	±15.7	±33.4	±45.0
Aperture Residual (seconds):			
6-cm.	+70±3	+62±8	+276±11
10-cm.	+85±2	+81±4	+326±6
20-cm.	+96±2	+95±4	+364±6
Reappearance			
Number of Observations	228 (189)	112 (98)	64 (57)
Coefficients:			
R-squared	.4411**	.2638**	.6725**
A (seconds)	-104.1±2.0	-140.4±5.9	-461.7±12.7
B	+289±24	+442±75	+1484±140
Standard Error (seconds)	±14.6	±30.7	±50.4
Aperture Residual (seconds):			
6-cm.	-56±2	-67±8	-214±14
10-cm.	-75±1	-96±4	-313±7
20-cm.	-90±1	-118±3	-387±8
Orbital Residual			
Seconds	+1.2±1.8-	-15.6±4.4**	-30.3±8.0**
Orbital Arc (degrees)	+0.0029±.0041	-0.0183±.0051	-0.0176±.0047
Kilometers	+22±30	-214±60	-329±87
Diameter			
Seconds	210.7±3.4	249.6±8.7	862.8±16.0
Kilometers	3491±56	2848±100	6422±119
Compared with Standard	-149±56** (-4.1 %)	-218±100* (- 7.1 %)	+1206±119** (+23.1 %)

were significant differences, but of different signs. Io and Europa were estimated as too small by rather small amounts, but Ganymede was estimated as much too large. Ganymede's rather oblique angle of entrance and exit into Jupiter's shadow, ranging from 39°-51°, may partly explain this large discrepancy.

PHOTOELECTRIC TIMINGS

Photoelectric timings involve recording a series of brightness measures in order to determine the moment when a satellite is at one-half its uneclipsed brightness; the assumption is that then the satellite is midway though shadow ingress or egress. This halfway point is estimated fitting a linear regression line to the brightness measurements and times near mid-event. [Westfall 1985] For the 1987/88 Apparition, two observers used photometers to time 12 events, with their results given in *Table 4* to the right. In that table, satellites are numbered; "D" stands for disappearance and "R" for reappearance. The standard errors quoted for the residuals take into account the 1-second (±0.5 sec.) precision of the E-2 Ephemeris.

Table 4. Summary of Photoelectric Eclipse Timings, 1987/88 Apparition.

Event Type	U.T. Date	Observer	Residual from E-2 Ephemeris *seconds*
1D	1987 AUG 01	Langhans	+3.2 ± 0.9**
2D	AUG 11	Langhans	-17.6 ± 0.8**
1D	AUG 17	Langhans	+1.6 ± 0.7*
2D	AUG 18	Langhans	-13.8 ± 0.7**
1D	AUG 31	Langhans	+12.6 ± 0.7**
1D	SEP 16	Langhans	-1.8 ± 0.9*
2D	SEP 19	Langhans	-21.4 ± 1.0**
2R	NOV 15	Langhans	-6.1 ± 1.7**
3R	DEC 26	Westfall	+61.7 ±14.7**
1R	1988 FEB 05	Langhans	-3.0 ± 1.6-
2R	FEB 05	Langhans	-1.1 ± 1.3-
3D	FEB 14	Langhans	-102.0 ± 4.0**

Means (seconds; third column weighted):

1D +3.9±3.1; **1R** -3.0±1.6; **1** +2.5±2.8-
2D -17.6±2.2; **2R** -3.6±2.5; **2** -12.0±3.7**
3D -102.0±4.0; **3R** +61.7±14.7; **3** -20.2±81.8-

The photoelectric results appear quite consistent for Io and Europa, in that they confirm the visual results; that Io did not differ significantly from the E-2 Ephemeris, but that Europa did. The two Ganymede timings are not consistent; their mean (-20 sec.) happens to be similar to the visual-timing deviation (-30 sec.), but the fact that only two photoelectric timings of Ganymede were made precludes any firm conclusion. It is unfortunate that the photoelectric timings for Ganymede cannot be used to confirm the unprecedented visual timing result that this satellite's E-2 Ephemeris was significantly in error.

The uncertainties quoted for the photoelectric timings are statistical errors only, and there are undoubtedly systematic errors in addition. Nonetheless, it is clear that the photoelectric timings have smaller uncertainties than the visual ones, so that the former method allows comparable results with fewer observations.

We hope that, as more observers obtain photometers, photoelectric timings become more popular. They provide an independent check on the visual timings.

ANOMALOUS PARTIAL ECLIPSE OF CALLISTO?

At the end of *Table 5* (p. 166) is an observation by Haas of a possible partial eclipse of Callisto on 1987 OCT 01. Callisto's dimming was estimated by comparison with Io and Ganymede, with the maximum dimming at about 06h 02.4m U.T. The relevant geometric values at that time were: jovicentric latitude of the Sun = +2°.86; inclination of Callisto's orbit = 0°.51; and distance of Jupiter from Sun = 4.954 A.U. These imply that the *minimum possible* distance of the edge of Jupiter's penumbra from Callisto's limb was about 1900 kilometers. If this report is correct, it is likely that either Callisto's orbital *latitude* was incorrectly predicted, obscuration existed unusually high in Jupiter's atmosphere, or both. It would have been very useful to have photoelectric confirmation of Haas' report. We recommend that those with photoelectric photometers make a series of measurements of Callisto's brightness whenever it is in conjunction with Jupiter (these events are labeled "C" in the *A.L.P.O. Solar System Ephemeris*).

IN CONCLUSION

Those who have read past reports of our program will notice that we have stopped comparing our observations with the Sampson Ephemeris, which was developed in 1910. This is because that ephemeris, although used for many years, had developed significant errors and is no longer used for predictions in the major ephemeris publications. Now, our sole basis of comparison is the E-2 Ephemeris, developed by by Dr. Jay Lieske of the Jet Propulsion Laboratory.

We encourage suitably-equipped observers to use photoelectric photometers to time the eclipses of Jupiter's four major satellites. However, it is clear that visual timings are the mainstay of our program. The more visual timings, the more accurate our results, so it is gratifying that a record number were received for 1987/88. (It already is clear that 1988/89 will also be an exceptionally well-observed apparition.) Naturally, we hope that the present observers will continue and new ones will join us. For information on this program, please write the author, whose address is given on the inside back cover. Along with instructions, he can send you a timing report form, which should be returned at the end of the current apparition (*not* the calendar year). You will also need predictions of these events, which are published each year in the *A.L.P.O. Solar System Ephemeris*; the 1990 edition is announced in this issue (p. 190).

Finally, "thanks very much" to the many observers who participated in our project for the 1987/88 Apparition of Jupiter. We hope to hear from you again!

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APPENDIX

Table 5, beginning on the next page, summarizes the visual timings received for the 1987/88 Apparition of Jupiter. The Key for this table, along with the list of observers, is given on pp. 166-167.

Table 5. Galilean Satellite Eclipse Timings, 1987-88.

U.T. Date mmdd	Geom-etry r °	Ob. No.	Con. stb	Res. sec.
----- Io Disappearances -----				
1987				
0605	0.9+15	48	100	+ 93
0616	1.0+15	51	111	+ 98
0628	1.1+15	2	100	+102
		77a	111	+110
0704	1.1+16	87	001	+ 96
0709	1.1+16	95	220	+ 52
		47a	110	+121
0714	1.2+16	45	000	+ 63
		77	111	+ 93
		48	010	+101
		94	1--	+103
0721	1.2+16	45	010	+ 43
		94	0--	+104
		77	211	+110
		47a	200	+127
0727	1.2+16	90	000	+ 73
		28	100	+ 98
		31b	000	+125
0730	1.1+16	45	000	+ 70
0801	1.1+16	95	000	+ 68
		95a	100	+ 96
0803	1.1+16	31b	000	+109
0806	1.1+16	48	200	+ 91
		46a	000	+110
		45	000	+*111*
0812	1.1+16	19	121	+ 77
0813	1.1+16	45	100	+ 63
0815	1.1+16	45	200	+ 40
		5	100	+ 83
0819	1.0+16	19	001	+ 75
		83	10-	+ 83
0822	1.0+16	46a	110	+103
		77a	111	+107
		2a	100	+113
		94	1--	+121
		45	020	+*152*
0826	1.0+16	90	---	+ *53*
		52	102	+ 87
		89	102	+ 98
		29	100	+106
		22a	102	+112
0829	0.9+16	45	000	+ 68
		48	000	+101
		46a	000	+120
0904	0.9+16	31a	000	+ 72
		14	210	+ 85
		24	---	+ 88
		29	000	+106
0905	0.8+16	45	010	+ 78
0907	0.8+16	5	000	+ 79
0911	0.8+17	90	---	+ 65
		29	101	+105
0914	0.7+17	45	000	+ 86
0912	0.7+17	80	---	+ *45*
		81	---	+ 80
		19b	101	+ 88
		18	111	+ 92
0912	0.7+17	41	111	+ 94
0916	0.7+17	48	111	+ 63
		95	100	+ 72
		95a	100	+101
0918	0.6+17	19b	001	+ 91
		22	111	+115
0919	0.6+17	54	000	+ 86
		60	000	+ 89
		19	000	+ 90
		66	000	+ 93
		25	000	+ 94
		15	000	+ 96
		16	000	+ 99
		26	000	+ 99
		22	100	+ 99
		49	011	+102
		89b	011	+106
		21	000	+107
		41	111	+109
		28	000	+113
0921	0.6+17	45	000	+ 78
		77a	111	+112
0923	0.5+17	5c	000	+ *75*
		77	111	+ 97
		55a	200	+106
0927	0.5+17	91	220	+ 59
		24	---	+ 65
0928	0.4+17	89b	011	+ 96
0930	0.4+17	48	000	+ 93
1004	0.3+17	14	000	+ 73
1005	0.3+17	22	202	+ *54*
		32	001	+ 66
		18	102	+ 85
		29	101	+ 93
		31b	101	+ 98
1009	0.2+17	13	110	+128
1011	0.2+17	95	000	+ *43*
		36	111	+ 76
		1	111	+ 78
		47a	111	+104
		95a	100	+114
1012	0.1+17	19a	201	+ *44*
		32	110	+ 57
		90	000	+ 69
		91	112	+ 75
		29	100	+ 95
1014	0.1+17	5	000	+ 45
1016	0.0+17	13	000	+ *27*
		65	000	+ 74
1018	0.0+17	95	000	+ *17*
		95a	100	+ 83
		47a	010	+ 97
------ Io Reappearances -----				
1987				
1018	-0.0+17	47a	010	-104
1020	0.0+17	51	120	- 75
1021	0.1+17	32	000	- 60
1025	0.2+17	47a	010	-118
1025	0.2+17	55a	000	-100
		46a	200	- 59
		95a	200	- *57*
		95	100	- 53
1027	0.2+17	56	001	-*146*
		51	111	-112
1028	0.2+17	51	201	- 92
		29	001	- 72
1030	0.3+17	14	210	- 52
1101	0.3+17	77a	111	-110
		46a	101	-102
		2	001	- 91
		13	000	- 90
		6	001	- 69
1103	0.3+17	47a	012	-*147*
		95a	200	- 87
		95	100	- 48
1105	0.4+17	95a	200	- 71
1106	0.4+17	89b	011	-104
		49	011	-103
		18	022	- 97
		63	012	- 81
		71	101	- 74
		30	222	- *32*
1108	0.4+17	5b	010	- 88
1110	0.5+17	47a	111	-*152*
		5a	001	- 97
1113	0.5+17	32	020	- 44
1117	0.6+17	77a	101	-114
		55a	100	-109
		2	000	- 99
		6	010	- 91
		45	000	- 56
		46a	020	-*54*
1119	0.6+17	36	11-	- 79
		95	000	- 75
1121	0.7+17	89b	100	- 98
		24	100	- 79
		7	100	- 76
		59	100	+ *94*
1122	0.7+17	3	101	- 92
		29	200	- 85
		42	---	- *28*
1124	0.7+17	78	000	- 64
1126	0.8+17	95a	200	- 87
		95	100	- 72
1128	0.8+17	1	101	-101
		31	001	- 63
1129	0.8+17	74	001	-*148*
		31b	011	-103
		19	001	- 95
		3	101	- 94
		32	000	- 87
		90	000	- 87
		29	011	- 85
		22	002	- 76
		42	001	- *4*
1203	0.9+17	77a	211	-117
		44	100	-108

U.T. Date mmdd	Geometry r °	Ob. No.	Con. stb	Res. sec.
-Io Reappearances—Cntd.-				
1987				
1203	0.9+17	94	211	-105
		6	002	- 65
1205	0.9+17	97	011	- 72
1206	0.9+17	37	101	- 97
		22	001	- 91
		3	102	- 90
		71	101	- 53
1208	0.9+17	98	100	- 80
		87a	100	- *36*
1210	0.9+17	46a	010	-116
		55a	100	-103
		6	000	-100
		17	100	- 81
		44	000	- 76
1212	1.0+17	97	010	- 96
		95a	200	- 91
		68	200	- 90
		36a	11-	- 84
		95	100	- 80
		92	000	- *20*
1214	1.0+17	43	000	- 89
1215	1.0+17	19	001	- 97
		18	001	- 96
		90	000	- *31*
1217	1.0+18	55a	000	-114
		46a	010	-105
		44	100	-100
		6	000	- 96
1219	1.0+18	20	000	- 89
1221	1.0+18	47a	010	*-146*
		36	11-	- 95
		58	100	- 95
		95a	100	- 92
		95	000	- 70
		35	020	+ *25*
1222	1.0+18	12	00-	-118
		87a	000	-105
		29	100	- 94
		63	020	- 94
		22	110	- 91
		98	100	- 59
		91	000	- *37*
1226	1.1+18	94	011	*-167*
		48	100	-101
		44	010	- 99
		46	002	- 74
		45	000	- 48
1228	1.1+18	11a	010	-101
		38	00-	-101
		1	002	- 95
		92	222	+*227*
1229	1.1+18	19	200	- 88
		22	002	- 79
		18	001	- 67
		31	121	- 35
1988				
0102	1.1+18	77a	211	-119
0102	1.1+18	94	100	-109
		6	111	-101
		45	010	- 68
0104	1.1+18	1	101	-104
		68	202	- 75
0106	1.1+18	58	000	- 93
		53a	000	-87
		27	100	- 80
		76	111	- *38*
0107	1.1+18	29	110	-113
		3	111	- 88
		19	101	- 82
		33	-0-	- 59
		90	000	- 56
0111	1.1+18	17	001	- 53
		50	001	- *13*
0113	1.1+18	43a	000	- 98
		36	11-	- 83
		82	001	- 83
0114	1.1+18	12	10-	-102
		19	000	-100
		14	000	- *95*
		3	101	- 88
0118	1.1+18	44	110	-102
		77a	120	- 99
		17	220	- 82
		50	---	+ *74*
0120	1.1+18	56	000	- 93
		82	001	- 88
		95a	100	- 88
		95	000	- 66
0121	1.1+18	96	000	- 91
		19	211	- 72
		84	000	- 54
		90	11-	- *20*
		33	1--	+*104*
0125	1.1+18	6	111	- 77
		46a	101	- 70
		45	100	- 31
		67	000	- *28*
		5b	100	- *11*
0129	1.1+18	64	111	-114
		93	001	-103
		43a	100	- 92
		96	000	- 83
		27	001	- 70
		69	000	- 70
		84	000	- 53
		76	101	- *32*
		73	211	+ *6*
0130	1.0+18	12	02-	-105
		19	000	- 98
		88	101	- 91
		89b	101	- 87
		31	110	- 76
		3	201	- 70
		33	-0-	- 65
		90	000	- 55
0203	1.0+18	17	100	- *29*
0203	1.0+18	50	011	- *7*
0205	1.0+18	1	000	- 97
		11	000	- 91
		95a	100	- 85
		86	200	- 82
		35	000	- 76
		73	100	- 68
		84	011	- *12*
0206	1.0+18	29	110	- 87
		19	210	- 78
		49	000	- 77
		31	110	- 38
0210	1.0+18	46a	200	-104
		6	001	- 95
		2	000	- 89
		44	200	- 87
		13	101	- 83
		45	110	- 24
		23	002	+ *63*
0212	1.0+18	20	000	- 81
		95a	200	- 69
		35	100	- 57
		95	100	- 46
0213	1.0+18	73	001	- 80
		34	010	- 76
		70	010	- 36
0215	0.9+18	91	112	*-209*
		12	01-	-105
		57	1--	- 62
0221	0.9+18	53a	000	-103
		75	011	- 88
		61	000	- 73
		82	000	- 65
0222	0.9+18	33	-1-	- 35
		59	111	- *32*
0226	0.8+18	48	200	- *20*
		17	120	+ *23*
0228	0.8+18	1	101	- 88
		36a	21-	- 81
		58	210	- 62
		75	121	- 62
		61	210	- 50
0229	0.8+18	31	201	- 28
0307	0.7+18	96	001	- 82
		73	002	- 64
0315	0.7+18	51	201	- 74
0320	0.6+18	5b	201	+ *8*
0322	0.6+18	95a	220	± 94
		95	120	+ *6*
		62	200	+ *42*
-- Europa Disappearances -				
1987				
0604	1.4+27	45	120	+ 36
0608	1.5+27	51	201	+ 97
0629	1.7+28	45	000	+ 55
		77	111	+ 99
0710	1.8+29	51	001	+126
0728	1.8+29	90	000	+ 52

Table 5. Galilean Satellite Eclipse Timings, 1987-88—*Continued.*

U.T. Date	Geometry	Ob. No.	Con.	Res.
mmdd	r °		stb	sec.
--- Europa Disap.—Cntd. ---				
1987				
0728	1.8+29	79a	---	+94
		19	111	+115
		31b	000	+122
		28	100	+127
		29	100	+127
0731	1.8+29	5	000	+97
		45	000	+100
		46a	020	+104
		94	0--	+138
0807	1.7+30	48	000	+127
		94	---	+140
0822	1.6+30	29	100	+78
		24	---	+80
		14	100	+97
0825	1.5+30	5	000	+63
		45	100	+63
		46a	210	+112
		94	2--	+135
0829	1.4+31	90	---	+62
		24	---	+64
		22	110	+108
		19b	111	+121
0901	1.4+31	5	000	+77
		45	000	+84
		94	1--	+141
0905	1.3+31	29	100	+147
0908	1.2+31	77a	111	+137
0912	1.1+31	1	011	+121
0915	1.0+31	29	111	+92
		18	101	+106
		7	000	+135
		89b	000	+137
0919	0.9+31	56	000	+140
0922	0.8+32	71	001	+82
0926	0.7+32	10	000	+20
		95	101	+89
		5	000	+99
		95a	201	+111
		48	010	+124
		77a	111	+136
		47a	011	+161
0930	0.6+32	31a	000	+74
		24	---	+99
		14	000	+109
		29	000	+129
1007	0.4+32	36	111	+75
		47a	212	+128
1010	0.3+32	14	200	+7
1017	0.0+32	98	100	-*15*
		71	211	-*4*
		90	000	+37
		91	110	+52
		89b	001	+59
		18	001	+72
1213	0.0+34	91	000	+78
1220	0.1+34	3	211	+43
		19a	202	+57
1220	0.1+34	31b	100	+91
1224	0.1+35	77a	112	+120
1227	0.2+35	19	101	+29
		59	000	+42
1231	0.2+35	44	200	+82
1988				
0104	0.2+35	61	220	+33
		1	101	+105
0111	0.2+35	11	001	+73
		61	210	+95
		69b	110	+*889*
0114	0.2+35	72	20-	+49
		19	201	+55
		12	00-	+121
0121	0.2+35	33	1--	-*123*
		90	110	+*17*
		19	200	+39
0125	0.2+35	50	110	-*49*
		45	110	+13
		6	011	+35
		13	000	+41
		48	200	+48
		5b	000	+56
		67	000	+64
		2	201	+91
		46a	100	+119
0128	0.1+35	73	200	-*22*
		64	001	+118
0205	0.1+36	35	002	+54
		11	001	+63
0212	0.0+36	35	100	-*5*
0215	-0.0+36	12	21-	+96
-- Europa Reappearances --				
1987				
0629	0.1+29	2	100	-67
0710	0.2+29	47a	210	-83
0724	0.2+30	77	000	-76
0728	0.2+30	51	201	-94
		29	101	-*2*
0731	0.2+30	94	1--	-124
		46a	000	-68
0804	0.2+30	47a	210	-97
0811	0.1+31	47a	111	-146
0815	0.1+31	19	101	-*41*
0822	0.0+31	29	100	-*12*
1017	-0.0+33	89b	001	-74
		91	010	-51
		71	221	+*25*
		90	000	+*64*
1021	0.1+33	65	010	-100
		46	200	-57
1104	0.5+34	91	222	-104
1108	0.7+34	47a	011	-182
		95b	100	-162
		51	201	-137
1111	0.8+34	18	001	-142
		72	21-	-125
		24	000	-111
1111	0.8+34	90	000	-98
		31	121	-24
1115	0.9+34	48	000	-146
		77a	101	-146
		95	000	-94
		46a	021	-92
		6	111	-88
		45	000	-79
1118	1.0+34	18	001	-138
		19	101	-136
		63	000	-133
		29	000	-119
		32	000	-119
		24	110	-94
1122	1.1+34	77a	111	-156
		46a	100	-150
		6	000	-149
		45	000	-*123*
		78	010	-*41*
1126	1.1+34	95a	200	-131
		95	100	-76
1203	1.3+34	51	101	-141
		93	101	-141
		36	11-	-125
1206	1.4+35	9	10-	-187
1213	1.5+35	31b	000	-147
		59	100	+*84*
1217	1.5+35	77a	211	-154
		48	100	-153
		44	000	-119
		55a	012	-107
		6	112	-88
1220	1.6+35	31c	100	-151
		19a	200	-136
		63	020	-133
1224	1.6+35	77a	111	-157
		45	010	-80
1228	1.7+35	1	002	-134
		11a	010	-133
		68	100	-95
		92	101	-*26*
1988				
0104	1.7+35	1	101	-147
		75	111	-133
		53a	001	-129
		58	001	-114
		68	202	-47
0114	1.7+35	19	000	-142
		12	01-	-135
		3	101	-122
		14	000	-118
0118	1.7+36	44	110	-149
		17	220	+*84*
0121	1.7+36	96	000	-136
		19	211	-91
		4	001	+*156*
0125	1.7+36	46a	201	-134
		67	000	-50
0129	1.6+36	64	111	-119

Table 5. Galilean Satellite Eclipse Timings, 1987-88—*Continued.*

U.T. Date mmdd	Geometry r °	Ob. No.	Con. stb	Res. sec.
--- Europa Reap.—Cntd. ---				
1988				
0129	1.6+36	69	000	- 99
		76	101	- 88
		96	000	- 83
		43a	100	- 72
0205	1.6+36	1	110	-141
		95a	100	-107
		86	100	- 98
		95	100	- 79
		35	012	- 57
0215	1.4+36	12	20-	-121
		63	000	-112
		33	-0-	- 21
		59	010	+ *24*
0219	1.4+36	44	200	-138
		5a	000	-109
		13	100	-109
		67	000	- 99
		45	110	- 12
0222	1.3+36	73	002	- 61
0301	1.2+36	82a	001	-148
		75	011	-145
		51	101	-122
		73	101	-101
		27	000	- 98
		58	000	- 80
		70	110	+ *27*
0308	1.1+36	47	210	-123
		95a	200	- 97
		95	000	- 79
0322	0.8+36	46a	221	- *29*
-Ganymede Disappearances				
1987				
0629	2.7+40	45	010	+237
		77a	101	+371
		2	200	+388
0714	2.8+41	87	111	+308
0721	2.9+41	51	211	+390
0728	2.8+42	95	000	+327
		95a	200	+346
0804	2.8+42	45	010	+276
		94	---	+391
0818	2.5+43	79	---	+312
		85	---	+368
0826	2.4+43	19	021	+280
		52	100	+348
		89	101	+348
		39	100	+367
		31b	000	+401
		22a	100	+408
		28	010	+415
0909	1.9+44	48	211	+343
0916	1.6+44	5	000	+297
		45	000	+326
		48	200	+334
0923	1.2+45	5	000	+322
		55a	100	+395
0930	0.9+45	91	120	+344
		14	200	+358
		89b	100	+400
		31b	000	+410
		29	000	+431
1008	0.5+45	51	202	+407
1015	0.2+46	47a	010	+436
1112	0.1+47	90	000	- *52*
		32	020	+266
		89b	011	+325
		69a	000	+386
1120	0.3+47	95	000	+278
		36	11-	+339
		47a	210	+435
1127	0.6+47	95	000	+299
		95a	100	+320
		47a	010	+457
1204	0.8+48	48	020	+306
		46a	100	+423
1218	1.2+48	90	000	+*238*
		3	101	+342
		29	120	+381
		72	11-	+404
1225	1.3+49	92	222	+ *61*
		31a	000	+303
		29	100	+411
1988				
0102	1.4+49	68	101	+*159*
		53	000	+302
		61	000	+314
		58	001	+349
		51	222	+385
		75	111	+389
		11a	111	+397
0116	1.4+49	45	010	+225
		23	000	+254
		55	201	+329
		46a	100	+408
0130	1.3+50	33	-1-	+*188*
		31	110	+199
		90	000	+247
		3	201	+275
		88	101	+338
		19	000	+342
		89b	101	+379
0206	1.2+50	64	222	+*226*
		70	000	+272
		96	111	+293
0214	1.1+50	95	000	+241
		36a	21-	+*244*
		35	001	+335
		95a	100	+385
0221	0.9+51	50	110	+*179*
		17	110	+209
		8	102	+310
0313	0.4+51	59	111	- *57*
		29	210	+ *75*
-Ganymede Reappearances				
1987				
0608	0.9+39	51	201	-298
0622	1.2+40	45	120	-226
0707	1.4+40	14	001	-262
0721	1.5+41	51	101	-363
0728	1.5+42	48	100	-324
0804	1.4+42	94	---	-374
0819	1.2+43	89a	000	-380
		19	001	-352
		85a	---	-322
0826	1.0+43	29	101	- *84*
0902	0.8+44	47a	110	-408
0909	0.6+44	46a	110	-364
		48	000	-362
		5	010	-293
		45	020	- 81
0916	0.3+44	48	200	-*261*
0923	0.1+45	22	022	-*129*
		18	021	- *88*
1029	0.5+46	46a	100	-385
1105	0.9+47	72	00-	-406
		63	002	-370
		30	111	-355
		3	112	-325
		90	000	-304
		71	101	-290
1113	1.2+47	89	001	-404
		18	111	-376
1120	1.5+47	47a	110	-475
		36	11-	-378
		95	000	-300
1127	1.8+48	47	010	-454
		95a	100	-381
		95	000	-324
1204	2.1+48	55a	001	-393
		6	111	-273
1218	2.4+48	19	110	-401
		3	101	-329
1226	2.5+49	47a	111	-492
		93	000	-459
		75	121	-351
		58	121	-339
		92	000	-238
1988				
0102	2.6+49	11a	101	-410
		61	100	-220
0109	2.6+49	77a	110	-484
		13	101	-428
		40	111	-*128*
0130	2.5+50	19	100	-403
		3	211	-299
		31	110	-241
		90	000	-*231*
		33	-1-	-154
0207	2.4+50	93a	101	-464
		64	000	-432
		96	000	-432
		11	001	-391

U.T. Date mmdd	Geom-etry r °	Ob. No.	Con. stb	Res. sec.
- Ganymede Reap.—Cntd. -				
1988				
0207	2.4+50	34	000	-318
		70	000	-247
0221	2.1+51	46a	100	-466
		6	001	-399
		5b	100	-356
		67	000	-333
		45	110	-104
		23	002	+ *69*
-- Callisto Partial Eclipse ---				
1987				
1001	1.3+90	36	11-	+506

Key:

A. *U.T. Date:* the Universal Time year, month number, and day of the event.

B. *Geometry:* The apparent distance of the satellite from the nearest jovian limb in units of the jovian equatorial semidiameter, followed by the latitude in degrees of the satellite in relation to the shadow center.

C. *Ob.No.;* observer (or team) number as listed below. In the list, the first figure in parentheses represents the aperture of the telescope used in centimeters; the second (in italics) the number of timings submitted.

D. *Con.;* conditions of observation; in order, seeing, transparency, and field brightness. The numerical code is: 0 = condition not perceptible with no effect on timing; 1 = condition perceptible with possible minor effect on timing; 2 = condition serious with definite effect on the accuracy of the timing.

E. *Res.;* (residual) the time difference in seconds, found by subtracting the predicted eclipse U.T. from the observed eclipse U.T. The former, originally given in ephemeris time, was converted to U.T. using an assumed ΔT correction of +56 seconds.

Italicized residuals denote timings that were not used in the regression analysis.

Participating Observers

1 Abbott, P. (32, *11*)
2 Abrahams, W. (15; *7*)
2a " (25; *1*)
3 Arredondo, E. (10; *13*)
4 Baughman, W. (31.8; *1*)
5 Bembrick, C. (7.5; *10*)
5a " (10; *1*)
5b " (25; *5*)
5c " (30; *1*)
6 Blanksby, J. (15; *14*)
7 Blasco, J. (20; 2)
8 Blow, G. (20; *1*)
9 Bourgeois, J. (100; *1*)
10 Brickell, A. (11.4; *1*)
11 Buchheim, R. (15; *4*)
11a " (20; *4*)
12 Bulder, H. (30; *8*)
13 Buttigieg, R. (25; *7*)
14 Büttner, D. (6.3; *10*)
15 Callado, X. & Palau, X. (15; *1*)
16 Carreras, J. & Sampedro, T. (8; *1*)
17 Carstens, R. (8; *7*)
18 Casajust, J. (20.7; *11*)
19 Casas, R. (16; *24*)
19a " (20; *3*)
19b " (21; *3*)
20 Collins, M. (15; *2*)
21 Coromina, J. (15; *1*)
22 Dalmau, F. (20; *9*)
22a " (30; 2)
23 Farr, F. (11; *3*)
24 Fernandes, J. (15; *8*)
25 Ferre, R. (13; *1*)
26 Font, Je. & Font, Jo. (16; *1*)
27 Freeman, J. (7.6; *3*)
28 Gallart, C. (30; *4*)
29 Garcia, J. (40; *24*)
30 Garcia, S. (11; *2*)
31 Goncalves, R. (5; *8*)
31a " (6; *3*)
31b " (15; *1*)
31c " (40; *9*)
32 Gonzalez, O. (6; *7*)
33 Grados, J. (8; *8*)
34 Graham, J. (8; *2*)
35 Gray, H. (13; *7*)
36 Haas, W. (20; *9*)
36a " (31.8; *3*)
37 Hager, T. (32; *1*)
38 Hessom, M. (20; *1*)
39 Iparraguirre, J. (20; *1*)
40 Jackson, A. (7.6; *1*)
41 Jarboles, J. (35.5; 2)
42 Jariod, E. (16; 2)
43 Kazmierczak, M. (20; *1*)
43a " (25.4; *3*)
44 Kearney, P. (20; *10*)
45 Kerr, S. (5; *33*)
46 Kruijshoop, A. (10.5; *2*)
46a " (20; *23*)
47 Langhans, T. (20; 2)
47a " (36; *21*)
48 Loader, B. (20; *19*)
49 Lopez, M. (20; *3*)
50 Macdonald, M. (7.6; *5*)
51 MacDougal, C. (15; *16*)
52 Miralda, J. (15; *3*)
53 Mofle, S. (10.8; *1*)
53a " (33.3; *3*)
54 Muñoz, P. & Ros, J. (21; *1*)
55 Nelson, P. (15; *1*)
55a " (32; *8*)
56 Newbill, C. (15; *3*)
57 Olesen, J. (20; *1*)
58 Parmentier, R. (15; *7*)
59 Pedretti, R. (11.4; *6*)
60 Plano, J. (20; *1*)
61 Porcellino, M. (8; *6*)
62 Portoni, A. (25.4; *1*)
63 Prat, J. (12; *6*)
64 Predom, C. (25.4; *5*)
65 Priestley, J. (20; *2*)
66 Quintana, A. & Zapata, P. (20; *1*)
67 Roberts, S. (20; *5*)
68 Rose, C. (15.2; *5*)
69 Rousom, J. (8; *2*)
69a " (10.2; *1*)
69b " (14; *1*)
70 Rowley, D. (5; *4*)
71 Ruiz, B. (11.5; *6*)
72 Ruiz, J. (21; *4*)
73 Schmitt, S. (10.2; *7*)
74 Schnabel, C. (22; *1*)
75 Sheber, D. (20.5; *6*)
76 Simison, J. (20; *3*)
77 Smith, C. (7.5; *5*)
77a " (25; *17*)
78 Smith, G. (30; *2*)
79 Soldevilla, J. (6; *1*)
79a " (30; *1*)
80 Soldevilla, J. & Alvarez, - (16; *1*)
81 Soldevilla, J. & Montse,- (16; *1*)
82 Stamm, J. (9; *3*)
82a " (20; *1*)
83 Temprano, J. (21; *1*)
84 Thiers, D. (11.4; *3*)
85 Torrell, S. (15; *1*)
85a " (16; *1*)
86 Underhay, E. (6; 2)
87 Vandenbulcke, G. (21.5; 2)
87a " (25; 2)

Participating Observers—Continued		
	90 Vigil, E. (20; *20*)	95 Westfall, J. (10.2; *25*)
	91 Vingerhoets, M.(17.5; *9*)	95a " (25.4; *22*)
88 Vidal, C. (20; *2*)	92 Wahl, B. (10.2; *5*)	95b " (51; *1*)
89 Vidal, J. (20; *3*)	93 Walker, G. (17.8; *3*)	96 Wetherbec, E. (20; *7*)
89a " (30; *1*)	93a " (35; *1*)	97 Winkler, W. (25.4; *2*)
89b " (41; *11*)	94 Ward, C. (20; *13*)	98 Yvergneaux, D.(11.5; *3*)

ADDING A NEW DIMENSION TO YOUR LUNAR OBSERVATIONS: VERTICAL STUDIES

By: Harry D. Jamieson, A.L.P.O. Membership Secretary

ABSTRACT

This paper outlines a formal program of lunar elevation and vertical profile studies to be carried out by the A.L.P.O. and the B.A.A. Some reasons for such a study are discussed and some goals for the program are stated, and references are given for the detailed methods and mathematical analysis.

The most common reason that most of us have for being lunar observers is our desire to improve our knowledge of the Moon's surface features. Beginning with Galileo, we have made countless drawings of our satellite's smallest observable details and have written untold volumes of descriptive literature about them. Telescopes great and small have photographed the Moon in exhaustive detail, and orbiting spacecraft have shown us vistas that can never be visible from the Earth. Does all this mean that our knowledge of the lunar surface has become so intimate that there is no more to be done?

There is *much* more to be done, and the purpose of this paper is to propose a shift in our emphasis from the recording of ever more minute detail to the gathering of data about the heights and depths of the thousands of features that have never been so measured. This is a shift, if you will, from the horizontal to the vertical. Our knowledge of the Moon's surface can never be complete without this elevation information, and this project presents an opportunity for amateurs to continue to make a real contribution to selenography for many decades to come.

As currently planned, the *Vertical Studies Program* (VSP) will attempt to do three things:

A. Encourage observers to include shadow length measurements with their regular drawings and written notes.

B. Measure the heights of all observable positive features (ridges, hills, domes, mountains, and so forth) and the depths of all negative features (for example, craters and rilles) within certain small selected areas.

C. Obtain the vertical profiles of certain interesting areas within the selected areas mentioned above. A vertical profile is simply a graph of the rise and fall of the land along one horizontal dimension. Because the elevations we measure will be relative elevations (the differences in height between the points casting shadows and the land upon which the shadow tips fall), it can be seen that several measurements made with different solar altitudes can be plotted on a graph in order to show this type of information.

The actual observations needed by the VSP are fairly easy to make, and involve measuring shadow lengths only. Suggestions about the VSP's scope, the specific areas to be covered, or the methods used will be welcomed by the writer, whose address is given on the front cover. Those who are interested in computing actual elevations, as opposed to simply submitting shadow length measurements, may write to the writer concerning the mathematics involved, or may ask for a copy of a C64 computer program that he wrote for this purpose. Those without a computer may ask him to compute the height for them whenever they submit a shadow length.

This program is an opportunity for observers to make fresh contributions to selenography. Observational results will appear in *The New Moon* (the newsletter of the Lunar Section of the B.A.A.) and the *Journal A.L.P.O.* Our observations and results will also be offered to British and American professional astronomers.

[Note by Editor: We welcome this plan to make our lunar work more quantitative and three-dimensional. Perhaps this project can be coordinated with our existing Lunar Selected Areas Program and Lunar Dome Survey. Note that fairly accurate height estimates can be made without a filar micrometer. Precise measures should include the selenographic coordinates of both ends of the shadow, particularly for profiles. Mr. Jamieson has listed below a few references that will help in the measurement and mathematics of lunar heights.]

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COMET CORNER

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

PRESENT COMET ACTIVITY

With Periodic Comet Brorsen-Metcalf dimming in the morning sky, comet activity remained low until the discovery of Comet Okazaki-Levy-Rudenko (1989r) on 1989 AUG 24 (see p. 171). Besides that, comet watchers may wish to monitor Periodic Comet Schwassmann-Wachmann 1, which has a 15-year orbital period and will be closest to the Sun on Oct. 16th. Occasionally it will outburst, rising to as bright as magnitude +10 from its usual +17. Please send all positive or negative observations of this last-mentioned comet to me at the end of 1989.

COMET FINDS FOR THE FIRST HALF OF 1989

With eight comet discoveries and recoveries during the first 17 days of 1989, it appeared that we would have a busy year. However, activity then slowed down. The first six months of 1989 saw two new comets found visually by amateurs; six new comets found photographically by professionals; five returning comets recovered, all by Jim Gibson, a professional; and one comet found by a satellite; thus, fourteen comets in all. This is about an average rate for amateur finds, but we're above average for professional discoveries and recoveries. Five of the eight new comets found are periodic comets, a larger percentage than usual. Data on the 14 comets found or recovered during this period follow.

Comet Yanaka (1989a).–Tetsuo Yanaka of Japan discovered this, his second comet in four days. He found it in the morning sky on Jan. 1, sweeping with 25X150 binoculars. Over the next few weeks it dimmed as it pulled away from the Sun. This was a post-perihelion discovery as the perihelion passage had been on 1988 OCT 29, at 1.86 A.U. [1 A.U. is the mean distance from the Earth to the Sun, about 149.6 million kilometers. Ed.].

Periodic Comet Helin-Roman-Crockett (1989b).—This comet was discovered by Eleanor Helin, Ron Helin, Brian Roman, and Randy Crockett on film taken with the 0.46-meter Schmidt telescope on Palomar Mountain on Jan. 2. It was then at magnitude +15, and it was found to have an 8.2-year nearly circular orbit, varying between 3.47 and 4.04 A.U. from the Sun.

Periodic Comet Bradfield 2 (1989c).—William Bradfield of Australia discovered this, his fourteenth comet, in the evening sky on Jan. 6. It was then magnitude 12, and dimmed after discovery.The orbital period is 72 years, with a high inclination and a perihelion distance of 0.43 A.U.

Periodic Comet Russell 3 (1989d).—This returning comet was recovered by Jim Gibson at Palomar Observatory on Jan. 1. He used their 1.5-meter reflector with a CCD [charge-coupled-device electronic imager]. This object, originally discovered by Kenneth Russell in 1980, was recovered in 1989 at magnitude +20, still 17 months away from perihelion, at 2.52 A.U., when it might reach magnitude +13.

Comet Shoemaker (1989e).—Carolyn Shoemaker used the Palomar 0.46-meter Schmidt to discover this comet on Jan. 13. At that time it was in the constellation Leo and visible in large amateur instruments. It was closest to the Sun on 1989 FEB 25, at 2.64 A.U., getting no brighter than 13th magnitude.

Comet Shoemaker (1989f).—Two days before the previous find, Carolyn Shoemaker discovered this comet at magnitude +16. It reached perihelion at 2.2 A.U. in early Nov., 1988. This is her sixteenth comet discovery.

Periodic Comet Pons-Winnecke (1989-g).—Jim Gibson recovered this comet with the Palomar 1.5-meter reflector on Jan. 17. It was then at magnitude 20, eight months before perihelion; this comet may become as bright as magnitude +13. It has a 5.5-year orbital period and now has been observed on 20 returns.

Periodic Comet Clark (1989h).—Gibson also recovered this comet, on exposures taken on Jan. 2. Like 1989g, its orbital period is 5.5 years. This passage is unfavorable; the comet will get no brighter than magnitude +16.

Periodic Comet Parker-Hartley (1989i).- Quentin Parker and Malcolm Hartley of Siding Spring Observatory, Australia, discovered this comet on plates taken on March 2. When the orbit was calculated, the object was found on plates taken in October, 1986, when it had been falsely identified as a minor planet and designated **1986TF**. It had passed 16 million miles from Jupiter in 1984, changing its orbit from a nearly circular one with a perihelion distance of 4.4 A.U. to its present oval orbit with a 8.9-year period and a perihelion distance of 3.02 A.U. When recovered it was at magnitude +16 but is currently dimming.

Periodic Comet Shoemaker-Holt 2 (1989j).—Carolyn and Eugene Shoemaker and Henry E. Holt found this comet on plates exposed on March 9. At magnitude +13, it was rather bright for a photographic find, but it dimmed after discovery. We now know that it has a 7.9-year period and was closest to the Sun, at 2.69 A.U., in Sept., 1988. Dr. Brian Marsden of the Smithsonian Astrophysical Observatory suggests that this comet approached within 0.60 A.U. of Jupiter in 1984.

Periodic Comet West-Hartley (1989k).– On May 11, Richard West found a 17th-magnitude cometary object on a plate exposed two months earlier. On the plate, it was moving either northeast or southwest, the direction being impossible to determine from the streak on the photograph. An examination of a 1989 APR 28 plate appeared to eliminate a southwest long-period orbit. In late May, 1989, however, Malcolm Hartley found a comet in the southwest direction, 15° from the previous position, which now appears to be the same object that was found by West. This is Hartley's eleventh comet discovery, and is the fourth for West. Periodic Comet Hartley-West has an orbital period of 7.6 years and was at perihelion in October, 1988, at 2.13 A.U.

Periodic Comet du Toit-Neujmin-Delporte (1989L).—Jim Gibson of Palomar Observatory recovered this comet on May 22 when it was at magnitude +18. T. Seki of Japan recovered it four days later. This comet has an orbital period of 6.3 years and will be closest to the Sun, at 1.7 A.U., in October, 1989. It is not expected to get much brighter.

Comet 1989m (SMM8).—This is the eighth sungrazing comet to be found by the Solar Maximum Mission Satellite. It was observed for nearly 2 hours on June 2, when it apparently hit the Sun and disappeared. It was then at magnitude 0 and was probably part of the Kreutz Sungrazing Group.

Periodic Comet Gehrels 2 (1989n).— Jim Gibson also recovered this comet; on June 14 at magnitude +19. Comet 1989n will be closest to the Sun in November, 1989, and may reach magnitude +15.

COMET EPHEMERIDES

Tables 1 and *2* on p. 170 give ephemerides for the periodic comets Brorsen-Metcalf (1989o) and Schwassmann-Wachmann 1.

Table 1. Ephemeris of Periodic Comet Brorsen-Metcalf (1989o).

1989-1990 U.T. Date	1950.0 Position Right Ascension		1950.0 Position Declination		2000.0 Position Right Ascension		2000.0 Position Declination		Elongation from Sun	Sky*	Total Magnitude
	h	m	°	'	h	m	°	'	°		
Oct 21	12	24.7	-10	03	12	27.3	-10	19	019	M	+10.3
Oct 26	12	38.0	12	26	12	40.7	12	42	020	M	10.8
Oct 31	12	50.6	14	36	12	53.2	14	53	021	M	11.2
Nov 05	13	02.4	-16	36	13	05.1	-16	52	023	M	+11.6
Nov 10	13	13.6	18	26	13	16.3	18	42	025	M	11.9
Nov 15	13	24.2	20	08	13	27.0	20	23	027	M	12.2
Nov 20	13	34.4	21	42	13	37.0	21	57	029	M	12.5
Nov 25	13	43.8	23	10	13	46.5	23	25	032	M	12.8
Nov 30	13	52.8	24	33	13	55.6	24	47	034	M	13.0
Dec 05	14	01.3	-25	50	14	04.1	-26	04	037	M	+13.3
Dec 10	14	09.3	27	03	14	12.2	27	17	040	M	13.5
Dec 15	14	16.9	28	12	14	19.8	28	26	043	M	13.7
Dec 20	14	24.0	29	18	14	26.9	29	31	046	M	13.9
Dec 25	14	30.6	30	20	14	33.5	30	33	049	M	14.1
Dec 30	14	36.7	31	20	14	39.6	31	33	053	M	14.2
Jan 04	14	42.2	-32	17	14	45.2	-32	30	056	M	+14.4
Jan 09	14	47.3	33	12	14	50.3	33	24	060	M	14.5
Jan 14	14	51.7	34	04	14	54.8	34	17	064	M	14.7
Jan 19	14	55.6	34	55	14	58.7	35	07	068	M	14.8
Jan 24	14	58.8	35	44	15	01.9	35	56	072	M	14.9
Jan 29	15	01.4	36	31	15	04.5	36	43	076	M	15.0

Table 2. Ephemeris of Periodic Comet Schwassmann-Wachmann 1.

1989-1990 U.T. Date	1950.0 Position Right Ascension		1950.0 Position Declination		2000.0 Position Right Ascension		2000.0 Position Declination		Elongation from Sun	Sky*	Total Magnitude
	h	m	°	'	h	m	°	'	°		
Oct 21	23	32.3	+06	08	23	34.9	+06	25	148	E	+17.1
Oct 26	23	30.9	05	57	23	33.4	06	13	143	E	17.1
Oct 31	23	29.7	05	46	23	32.2	06	03	138	E	17.1
Nov 05	23	28.7	+05	36	23	31.2	+05	53	132	E	+17.1
Nov 10	23	28.0	05	28	23	30.5	05	45	127	E	17.2
Nov 15	23	27.5	05	21	23	30.1	05	38	122	E	17.2
Nov 20	23	27.4	05	15	23	29.9	05	32	117	E	17.2
Nov 25	23	27.5	05	12	23	30.0	05	28	112	E	17.2
Nov 30	23	27.9	05	09	23	30.4	05	26	107	E	17.3
Dec 05	23	28.5	+05	09	23	31.1	+05	25	102	E	+17.3
Dec 10	23	29.5	05	10	23	32.0	05	26	098	E	17.3
Dec 15	23	30.7	05	13	23	33.2	05	29	093	E	17.4
Dec 20	23	32.1	05	17	23	34.6	05	34	088	E	17.4
Dec 25	23	33.8	05	23	23	36.3	05	40	084	E	17.4
Dec 30	23	35.7	05	31	23	38.2	05	48	079	E	17.5
Jan 04	23	37.8	+05	41	23	40.3	+05	57	075	E	+17.5
Jan 09	23	40.1	05	52	23	42.6	06	08	070	E	17.5
Jan 14	23	42.6	06	04	23	45.1	06	21	066	E	17.5
Jan 19	23	45.2	06	18	23	47.8	06	34	061	E	17.6
Jan 24	23	48.1	06	33	23	50.6	06	50	057	E	17.6
Jan 29	23	51.0	06	49	23	53.6	07	06	053	E	17.6
Feb 03	23	54.1	+07	07	23	56.7	+07	24	049	E	+17.6
Feb 08	23	57.4	07	26	23	59.9	07	42	044	E	17.7
Feb 13	00	00.7	07	45	00	03.3	08	02	040	E	17.7
Feb 18	00	04.2	08	06	00	06.7	08	23	036	E	17.7
Feb 23	00	07.7	08	27	00	10.2	08	44	032	E	17.7
Feb 28	00	11.4	08	50	00	13.9	09	06	028	E	17.7

*M = Morning; E = Evening.

THE APPEARANCE OF A NEW COMET: COMET OKAZAKI-LEVY-RUDENKO (1989r)

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

Update: August 31, 1989—A new comet has been discovered. Besides being discovered by the Japanese astrophotographer Kiyomi Okazaki on 1989 AUG 24, it was also found by the former A.L.P.O. Comets Recorder David Levy on August 25th, and then by Michael Rudenko of Massachusetts on August 26th. This is Okazaki's first named comet, but is Levy's fifth and and Rudenko's third.

An early orbit indicates high inclination, with the comet always at least 39° from the Sun as seen from Earth. [The orbit is also notable for being almost precisely perpendicular to the ecliptic. Ed.] Here is an opportunity to follow a comet throughout its visit to the inner Solar System.

Comet Okazaki-Levy-Rudenko will be well-placed for northern-hemisphere observers until early December. It passes north of the Sun, from the evening sky to the morning sky, in late October. Southern-hemisphere observers (and the A.L.P.O. has a number of them) can pick it up in late November in the morning sky. The comet then rushes southward rapidly; it will be near the South Celestial Pole by Christmas. It then passes into the evening sky, but will still be circumpolar from southern temperate latitudes.

As for its brightness, this is always hard to predict, but it may be a naked-eye object during November and December. Its distance from the Sun and the Earth in Astronomical Units (A.U.; the mean distance of the Earth from the Sun, about 149,600,000 km.) varies as follows:

U.T. Date		Dist. from Sun	Dist. from Earth
1989 SEP	01	1.52 A.U.	1.57 A.U.
	16	1.29	1.55
OCT	01	1.07	1.47
	16	0.85	1.31
	31	0.69	1.05
NOV	15	0.65	0.72
	30	0.75	0.52
DEC	15	0.94	0.67
	30	1.16	0.99
1990 JAN	14	1.39	1.34
	29	1.61	1.66
FEB	13	1.83	1.96
	28	2.05	2.22

The ephemeris above and the ephemeris of positions given later are according to the orbital elements computed by Dan Green, and published in *IAU Circular 4843*, which assumes a parabolic orbit. The elements themselves are:

Time of Perihelion	1989 NOV 11.892
Distance at Perihelion	0.64156 A.U.
Argument of Perihelion	150°.626
Longitude of Ascending Node	274°.784
Inclination to Ecliptic	90°.113
Eccentricity	1.000

The position ephemeris of Comet 1989r is given in *Table 1* (below and on p. 172), which is accompanied by a plot of the comet's motion against the stars in *Figure 20* (p. 172).

Table 1. Ephemeris of Comet Okazaki-Levy-Rudenko (1989r).

1989-1990 U.T. Date		1950.0 Position Right Ascension		1950.0 Position Declination		2000.0 Position Right Ascension		2000.0 Position Declination		Elongation from Sun	Sky*	Total Magnitude
		h	m	°	'	h	m	°	'	°		
OCT	21	14	16.5	+28	21	14	18.7	+28	07	40	E	+7.4
	26	14	08.5	27	07	14	10.8	26	53	39	E	7.0
	31	13	59.2	25	15	14	01.5	25	01	39	M	6.5
NOV	05	13	48.7	+22	23	13	51.1	+22	08	40	M	+6.1
	10	13	37.2	17	57	13	39.6	17	41	40	M	5.7
	15	13	25.2	11	13	13	27.6	10	58	41	M	5.4
	20	13	13.1	+01	22	13	15.7	+01	06	42	M	5.2
	25	13	01.3	-12	15	13	04.0	-12	31	44	M	5.2
	30	12	49.7	29	00	12	52.4	29	17	48	M	5.3
DEC	05	12	37.1	-46	27	12	39.8	-46	43	55	M	+5.7
	10	12	20.8	61	41	12	23.5	61	58	61	M	6.2
	15	11	52.9	73	32	11	55.4	73	49	66	M	6.8
	20	10	42.2	82	01	10	42.1	82	16	69	M	7.5
	25	06	40.0	85	39	06	28.1	85	42	71	M	8.1
	30	03	25.3	82	49	03	21.0	82	39	72	E	8.6

- *Continued* -

Table 1. Ephemeris of Comet Okazaki-Levy-Rudenko (1989r)—*Continued.*

1989-1990 U.T. Date		1950.0 Position Right Ascension h m	Declination ° '	2000.0 Position Right Ascension h m	Declination ° '	Elongation from Sun °	Sky*	Total Magnitude
JAN	04	02 32.7	-79 01	02 31.7	-78 48	72	E	+9.1
	09	02 13.7	75 40	02 13.9	75 26	72	E	9.6
	14	02 05.9	72 47	02 06.6	72 33	72	E	10.1
	19	02 03.2	70 19	02 04.1	70 04	71	E	10.5
	24	02 03.3	68 09	02 04.4	67 55	70	E	10.8
	29	02 05.1	66 16	02 06.4	66 02	70	E	11.2
FEB	03	02 08.2	-64 36	02 09.5	-64 22	69	E	+11.5
	08	02 12.2	63 08	02 13.6	62 54	68	E	11.8
	13	02 16.9	61 49	02 18.3	61 35	68	E	12.1
	18	02 22.2	60 39	02 23.6	60 25	67	E	12.4
	23	02 27.9	59 37	02 29.3	59 23	67	E	12.6
	28	02 34.0	58 42	02 35.4	58 29	67	E	12.8

*M = Morning; E = Evening.

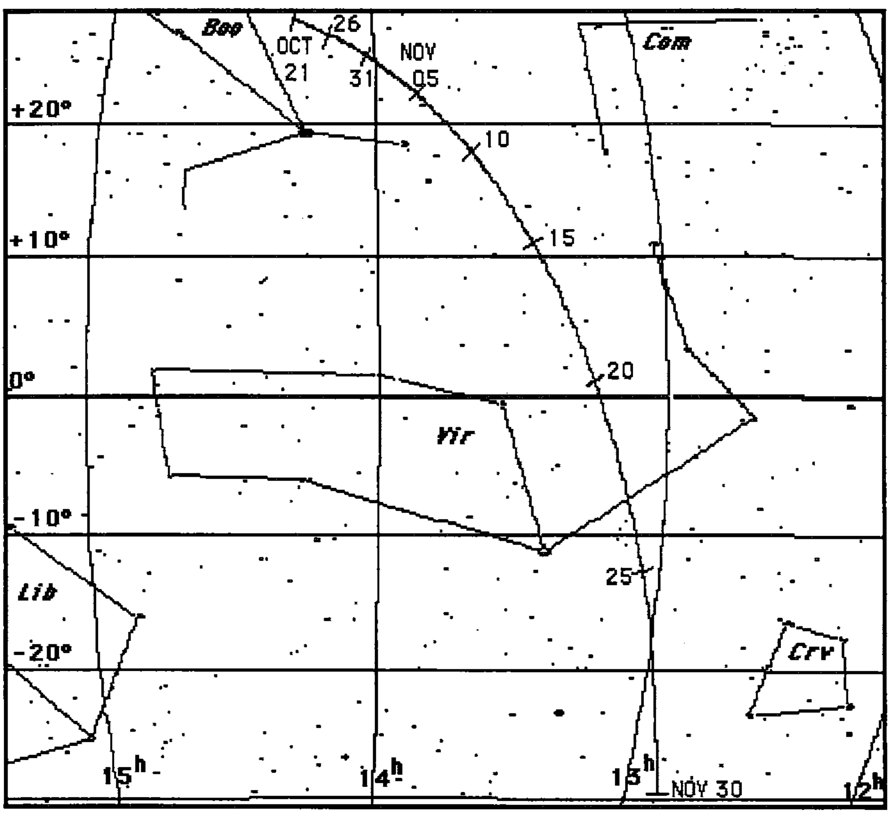

Figure 20. Predicted path of Comet Okazaki-Levy-Rudenko (1989r) through the constellations Bootes, Virgo, and Corvus from 1989 OCT 21 to NOV 30. North is at the top, and Epoch 2000.0 coordinates are shown. Limiting magnitude +6.5. The comet's predicted brightness increases from magnitude +7.4 on October 21 to +5.2 on November 20-25. See also text.

THE APPARITION OF COMET LILLER 1988a

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

ABSTRACT

We report here on the passage of Comet Liller, 1988a, covering its discovery, orbit, observing conditions, magnitude, coma size, and tail length. The majority of the data used with this report was submitted by A.L.P.O. members.

DISCOVERY

William Liller of Vina del Mar, Chile, discovered this comet on photographs taken on Sunday evening (local time), 1988 JAN 11.065 U.T. [1] He reported the comet to be at Right Ascension 23h 50.9m, Declination -28° 18' (1950.0 coordinates), which placed it in the evening sky. His early brightness estimate was that the comet was at magnitude +13, but later estimates placed it nearer magnitude +10.0. At discovery, it was about 4-5 arc-minutes in size, diffuse with a condensation. The comet was moving due north at 0°.7 per day.

Liller was participating in the PROBLICOM program organized by Ben Mayer in the late 1970's. The comet was found on two 2-minute exposures that were taken 30 minutes apart on 2415 film through a 20-cm. (8-in.) Schmidt. This was Liller's first comet discovery, but he has also discovered several novae.

This was the first comet discovery of 1988, and the third comet found by amateur-type photographic equipment in three months. During this time there were several other bright comets in the heavens, including Comets Bradfield, Furuyama, and Borrelly.

Could the comet have been found sooner? Probably not. It had been brightening at 1.0 magnitude per month and was moving north at 4° per week. For northern-hemisphere comet hunters this would be a difficult discovery—as late as one month before discovery the comet would have been very low on the southwest horizon during evening astronomical twilight. It would have been a faint magnitude +11.0. Over the next month the comet's discovery chances increased somewhat, but moonlight interfered. One night after it was discovered, I unknowingly swept over it, but it was only a few degrees above my southwestern horizon at the time.

For comet hunters in the Southern Hemisphere, astronomical twilight occurred later in the day, with the comet circumpolar until early December. Here again, the comet's faintness would have made discovery difficult.

ORBIT

In less than three days, an early orbit was issued by the Central Bureau for Astronomical Telegrams. Because it was based on semi-accurate positions, refinement was necessary as more astrometric measures became available. A final orbit, computed by Dan Green, appeared in *Minor Planet Circular 13459*, with the following elements:

Time of Perihelion	1988 MAR 31.11442 E.T.
Distance at Perihelion	0.8413332 A.U.
Argument of Perihelion	057°.38362
Longitude of Ascending Node	030°.81800
Inclination to Ecliptic	073°.31712
Eccentricity	0.9965647

[Note: E.T. stands for Ephemeris Time, then about 56 seconds ahead of Universal Time. A.U. means Astronomical Units, the Earth's mean distance from the Sun. Ed.]

Comet Liller's orbit is shown schematically in *Figure 21*, below.

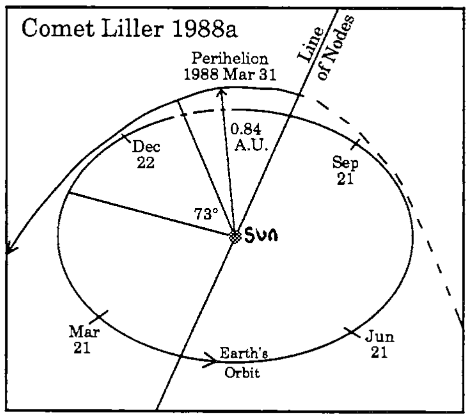

Figure 21. Sketch of orbit of Comet Liller (1988a) in relation to the Earth's orbit, with selected dates indicated.

The shape of the orbit is very close to that of a parabola, with an orbital period of 3880 years. At its most distant point [*aphelion*] it is about 250 A.U. from the Sun. However, at perihelion the comet traveled at 28 miles per second.

The comet-Earth distance at discovery was 1.88 A.U., lessening to a minimum of 1.22 A.U. in mid-May, 1988. The comet-Sun distance was 1.64 A.U. at discovery, decreasing to its perihelion distance of 0.84 A.U. on March 31. The comet, with a high inclination, crossed the ecliptic passing northward on 1988 FEB 21, when it was 1.82 A.U. from the Earth and 1.10 A.U. from the Sun. The perihelion point was well north of the ecliptic; then the comet remained above the Earth's orbital plane until 1988 DEC 01, at more than 3.6 A.U. from both the Earth and the Sun.

When Comet Liller was found, it was 60° from the Sun in the evening sky. As the comet moved north its elongation decreased, dropping to 24° by mid-March. Then, the elongation slowly increased as the comet entered the morning sky in early April, where it remained for four weeks. Due to the comet's apparent close proximity to the Sun, there was only one reported A.L.P.O. observation of it during the months of February and March, 1988.

When discovered, Comet Liller was in the constellation Sculptor, and it remained in barren sky until it entered the northern Milky Way in mid-April. On April 19, the comet passed 3° from the planetary nebula M76, and in late May it was within 5° of the galaxies M81 and M82. As it dimmed through July and August, it passed many of the galaxies in the Coma Berenices-Virgo region. A photograph of Comet Liller as it appeared in mid-May appears to the lower left as *Figure 22*.

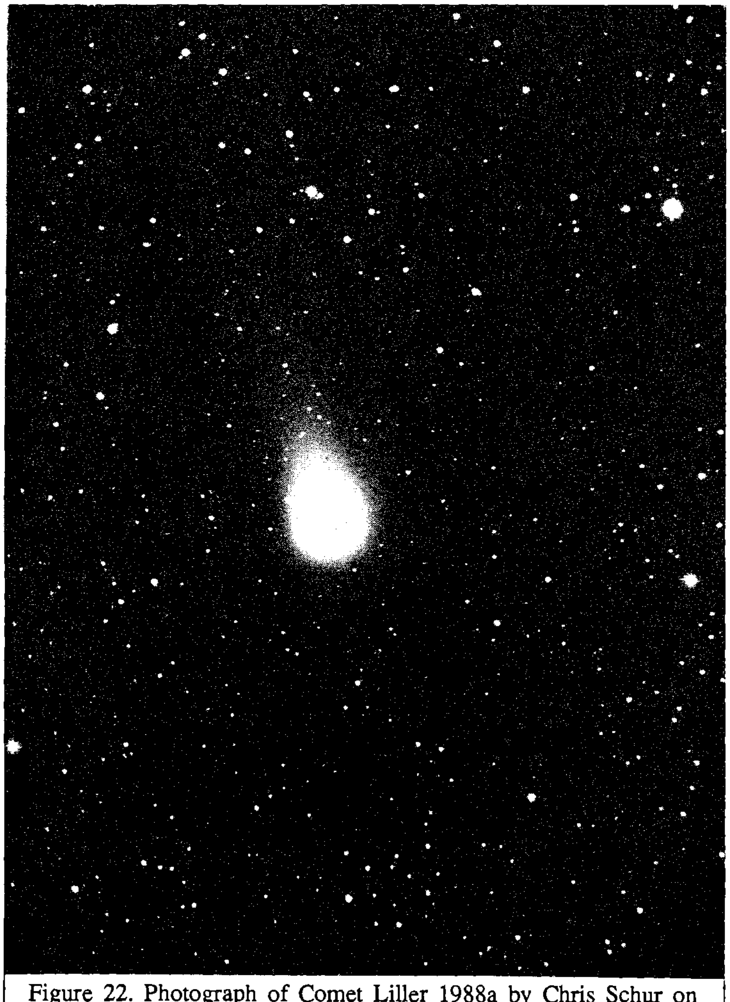

Figure 22. Photograph of Comet Liller 1988a by Chris Schur on 1988 MAY 15, 04h 45m-05h 05m U.T. 20-minute exposure on hypered Kodak TP2415 Film, with a 16-inch (41-cm.) f/4.4 reflector. North is at upper right and the field shown is about 66 arc-minutes by 41 arc-minutes .Note the faint tail extending to the upper left.

MAGNITUDE

Comet Liller was near magnitude +10.0 when it was discovered. It brightened to magnitude +5.0 in early April, and remained that bright for the next six weeks. By August it had dimmed to twelfth magnitude. This comet was not so well observed by A.L.P.O. members as were Comet Bradfield (1987s) and Periodic Comet Tempel 2. In order to compute Comet Liller's absolute magnitude, a larger pool of observations was needed. To achieve this, Gary Kronk utilized both I.A.U. (International Astronomical Union) and A.L.P.O. magnitude estimates. Two of his graphs appear as *Figures 23* and *24* on page 175. *Figure 23* shows the apparent magnitude, corrected for aperture effects, versus the date of observation. Note that the comet was brightest after perihelion (1988 MAR 31).

Figure 24 shows Comet Liller's absolute magnitude as a function of the date. The absolute magnitude of a comet is its magnitude if it were simultaneously 1.0 A.U. from both the Earth and the Sun. Because a comet is hardly ever at such a position, we use the following formula to calculate magnitude:

$$m = Ho + 5 \log D + 2.5 n \log R,$$

where: m = apparent magnitude; Ho = absolute magnitude; D = comet-Earth distance (A.U).; R = comet-Sun distance (A.U.); and n = a constant equal to the rate of brightness change as the comet-Sun distance changes.

For Comet Liller, Kronk calculated an absolute magnitude of +5.61±0.06, and an n-value of +3.7. This absolute magnitude is about one magnitude brighter than for the average comet, while the n-value is about average. Kronk also discovered that there might have been a brightening in February and March, but more observations are needed to analyze this possibility.

COMA SIZE

The next physical parameter, graphed on *Figure 25* below, is the diameter of the coma,

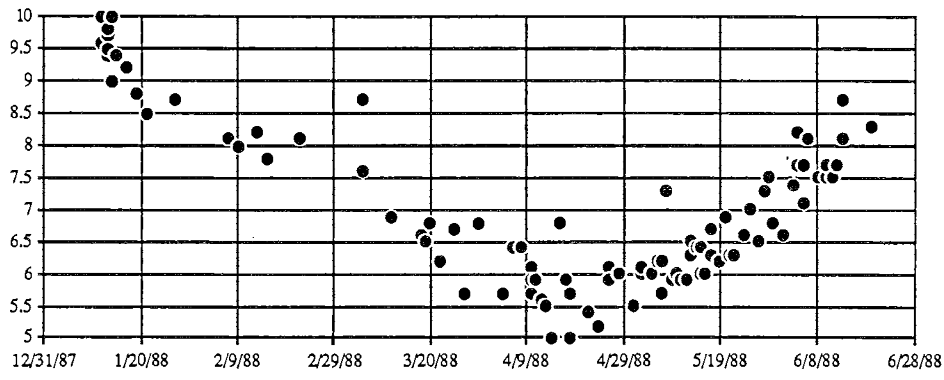

Figure 23. Apparent magnitude of Comet Liller 1988a as a function of date of observation.

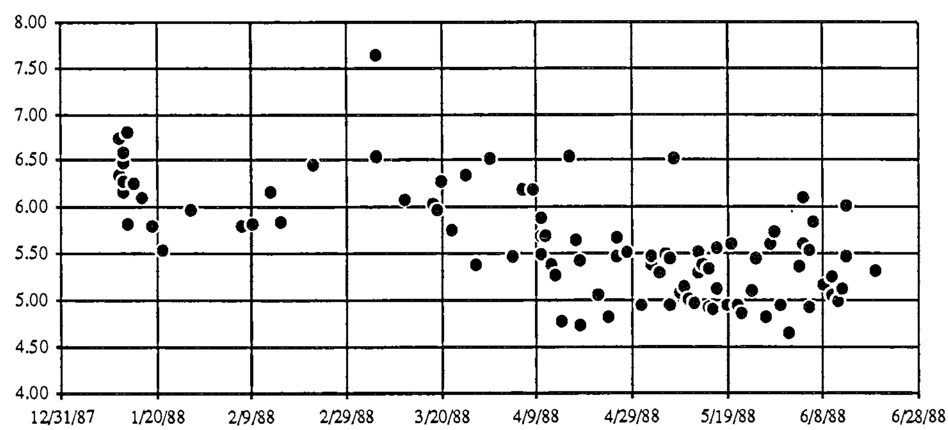

Figure 24. Absolute magnitude of Comet Liller 1988a as a function of date of observation.

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600+     +     +     +     +     +     +     +     +     +600
550+     +     +     +     +     +     +0    +     0     +550
500+     +     +     +     +     +     +  0  +     +     +500
450+     +     +     +     +     +     +     0     +     +450
400+     +     +     +     +     +     +     +     +00   +400
350+   0 +     +     +     +     +     0  0  0     0     +350
300+   000     +     +     +     +     +     00    0     +300
250+     +     +     +     +     0     +     +   00+     +250
200+     +     +     +     +     +     0  0 0+     +     +200
150+     + 0   +     +     +     +     +     +     +     +150
100+    0+     +     +     +     +     +     +     +     +100
 50+     +     +     + 0   +     +     +     +     +     + 50
  0+     +     +     +     +     +     +     +     +     +  0
 12/31 01/20 02/09 02/29 03/20 04/09 04/29 05/19 06/08 06/28
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Figure 25. Coma Diameter of Comet Liller (1988a) as a function of date of observation. The diameter, shown by the vertical scale, is in units of thousands of kilometers.

or head, of the comet. This consists of the thin atmosphere that surrounds the tiny nucleus, which for most comets is unobservable and only 5 to 15 miles across. From the Earth, observers measure the angle that the round coma subtends. This value usually ranges from 1 to 10 arc-minutes for most comets; and, besides the actual coma diameter, depends upon the comet-Earth distance and the observer's eye, sky, and instrument. On *Figure 25*, we see some scatter; but the coma size appears to have been about 300,000 km. (185,000 mi.) in diameter.

TAIL LENGTH

Few observers reported a tail on Comet Liller. [Nonetheless, one was photographed; see *Figure 22* on p. 174.] The lack of visual tail sightings was most likely due to the low elongations from the Sun that were present when the comet was brightest. The comet was then near the horizon and sometimes in a twilight sky. The few measurements that were made suggest a tail length of roughly 6 million km. (3.7 million mi.).

ACKNOWLEDGEMENTS

We thank Gary Kronk for once again determining the absolute magnitude and "n" values; he also produced *Figures 23* and *24*. Chris Shur submitted the photograph in *Figure 22*. A.L.P.O. comet observers, who submitted several dozen visual observations, are listed below with their observing sites and instruments (Bi. = binoculars; Rl. = reflector; Rr. = refractor):

Clark, M. (Armadale, W. Australia; 15-cm. Rl.)
Graham, F. (East Liverpool, OH; 24-cm. Rr.)
Kronk, G. (Troy, IL; 33-cm. Rl.; 8-cm. Bi.)
Modic, R. (Richmond Heights. OH; 20-cm. Rl., 5-cm. Bi.)
Nowak, G. (Essex Junction VT; 10-cm. Bi.)
Rhea, K. (Paragould, AR; 8-cm. Rr.; 5-cm. Bi.)
Seargent, D. (The Entrance, N.S.W., Australia; 15-cm. Rl.)

REFERENCE

1. Central Bureau for Astronomical Telegrams, *International Astronomical Union Circular No. 4527*, issued January 11, 1988, by Brian Marsden.

METEORS COLUMN

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

As the new Meteors Recorder for the A.L.P.O., I look forward to the challenge of revitalizing interest in meteor observing, especially here in America. During the last several decades, interest in meteors has been high among our counterparts in Europe, Japan, and Australia. American efforts have lagged behind; not due to a lack of interest, but rather a lack of organization. Half the Earth's surface lies between the last observing site in Europe and the first sites in Australia and Japan. The Americas, with the Hawaiian Islands, are of the utmost importance to fill this gap and thus to achieve worldwide coverage of meteor showers. Several members of the American Meteor Society (A.M.S.) and the International Meteor Organization (I.M.O.) are supportive of my revitalization project. With support from these and the many local astronomy groups we can look forward to a surge of interest across America in meteor observing.

I would prefer that all our data and articles be published in the *Journal A.L.P.O.*. I realize that sometimes space will be limited, so for such times a newsletter similar to the previous *Tails and Trails* will be issued. I look forward to working with David Levy and Jim Scotti, our Assistant Meteors Recorders, and I will rely on their expertise and experience to guide me as your Recorder. Observers new to meteor work are encouraged to purchase *Observe Meteors* by David Levy and Stephen Edberg (available for $5.75 from: Astronomical League Sales, Four Klopfer Street, Pittsburgh, PA 15209 U.S.A.).

On a personal note, I have been observing meteors since the great Leonid storm of 1966. I joined the A.M.S. in 1979 and became a founding member of I.M.O. last year. I have lived in the San Diego area for the past three decades and graduated from San Diego State University in 1980 with a B.S. in Geography. I have been married now for ten years and have two children, aged 8 and 2. My main interests in astronomy besides meteors work include visual and photographic planetary and cometary studies, and visual variable-star observing for the A.A.V.S.O. [American Association of Variable Star Observers]. I use a 15-cm. (6-in.) f/15 refractor and a 41-cm. (16-in.) f/4.5 reflector for my observations.

I look forward to hearing from meteors observers all over the world. Do not hesitate to send me your ideas or criticisms. All correspondence helps the Meteors Section to cater to everyone's needs.

SUMMARY OF 1989 A.L.P.O. PERSEID METEOR SHOWER WATCH

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

1989 U.T. Date	Observer	Location	U.T.	Number of Perseids Seen	Comments (+N = Limiting Magnitude)
JUL 29	J. Kenneth Eakins	California	08:55-09:55	2	+5.0
	"	"	09:55-10:55	2	+5.0
30	Michael Boschat	Nova Scotia	01:15-03:00	3	+5.5
	J. Kenneth Eakins	California	09:40-11:10	5	+5.5
31	J. Kenneth Eakins	California	09:15-10:15	1	+5.2
	"	"	10:15-11:15	4	+5.2
AUG 01	J. Kenneth Eakins	California	09:45-11:15	2	+5.2
02	J. Kenneth Eakins	California	09:30-11:00	5	+5.2
08	George Gliba	Maryland	06:10-07:10	8	+5.2
	Mark Davis	Virginia	07:00-07:49	2	+5.5; Partly cloudy
	George Gliba	Maryland	07:10-08:10	12	+5.3
09	William Rapacki	New York	04:45-07:14	8	Partly cloudy
	George Gliba	Maryland	05:50-06:50	9	+5.3
	Alton Smith	Tennessee	06:00-07:00	8	------
	George Gliba	Maryland	06:50-07:50	8	+5.1
	J. Kenneth Eakins	California	07:00-08:00	2	+5.1
	George Gliba	Maryland	07:50-08:50	10	+5.4
	J. Kenneth Eakins	California	08:00-09:00	4	+5.1
	J. Kenneth Eakins	California	09:00-10:00	3	+5.1
10	Michael Boschat	Nova Scotia	00:44-01:10	2	+5.0
	J. Kenneth Eakins	California	07:00-08:00	0	+5.1
	"	"	08:00-09:00	7	+5.1
	Robert Lunsford	California	08:02-09:02	5	+6.6; Partly cloudy
	J. Kenneth Eakins	California	09:00-10:00	3	+5.1
	Robert Lunsford	California	09:02-09:22	2	+6.6; Partly cloudy
	"	"	09:52-10:54	9	+6.6; Partly cloudy
11	Alton Smith	Tennessee	06:00-07:00	6	Hazy
	J. Kenneth Eakins	California	07:35-08:35	11	+5.1; Foggy
	Robert Lunsford	California	08:02-09:02	20	+6.5
	"	"	09:02-10:02	20	+6.5
	"	"	10:02-11:02	36	+6.5
	"	"	11:02-11:47	30	+6.5
12	Michael Boschat	Nova Scotia	00:45-02:30	8	40 percent cloudy
	John Wagoner	Oklahoma	03:00-04:00	1	Moon and haze
	"	"	04:00-05:00	8	Moon and haze
	"	"	05:00-06:00	11	Moon and haze
	Alton Smith	Tennessee	05:30-06:30	27	+5.5
	John Wagoner	Oklahoma	06:00-07:00	27	+6.0
	George Gliba	Ohio	06:00-07:00	40	+6.0
	A. Patrick Abbott	Alberta	06:05-07:05	21	+4.8-5.2; Aurora
	Alton Smith	Tennessee	06:30-07:30	38	+5.5
	George Gliba	Ohio	07:00-08:00	58	+6.0
	John Wagoner	Oklahoma	07:00-08:00	35	+6.0
	J. Kenneth Eakins	California	07:00-08:00	21	+5.0
	Alton Smith	Tennessee	07:45-08:45	43	+5.5
	George Gliba	Ohio	08:00-09:00	58	+6.0
	John Wagoner	Oklahoma	08:00-09:00	75	+6.0
	J. Kenneth Eakins	California	08:00-09:00	22	+5.1
	Robert Lunsford	California	08:00-09:00	43	+6.5
	Alton Smith	Tennessee	08:45-09:45	36	+5.5
	J. Kenneth Eakins	California	09:00-10:00	22	+5.1
	Robert Lunsford	California	09:00-10:00	60	+6.5
	Kermit Rhea	Arkansas	09:30-10:10	17	Partly cloudy

- Continued on next page.-

Summary of 1989 A.L.P.O. Perseid Meteor Shower Watch--*Continued.*

1989 U.T. Date	Observer	Location	U.T.	Number of Perseids Seen	Comments (+*N* = Limiting Magnitude)
AUG 12	J. Kenneth Eakins	California	10:00-11:00	29	+5.1
	Robert Lunsford	California	10:00-11:00	95	+6.5
	J. Kenneth Eakins	California	11:00-11:15	4	Foggy
	Robert Lunsford	California	11:00-12:00	82	Twilight last 15 min.
13	J. Kenneth Eakins	California	07:30-08:30	13	+5.0; Moon
	"	"	08:30-09:30	13	+5.1; Moon
	Robert Lunsford	California	09:07-10:07	32	+6.4
	J. Kenneth Eakins	California	09:30-10:30	15	------
	Robert Lunsford	California	10:07-11:07	40	+6.4
	"	"	11:07-12:07	37	Twilight last 25 min.

*Note by Editor:*The results above represent "raw data," which need to be converted to standard individual zenithal hourly rates, allowing for the observers' differing radiant elevations, durations of observing sessions, and limiting magnitudes. There was a waxing gibbous Moon (11 days age) on the night of maximum, undoubtedly reducing the counts for times before moonset. The nearly-full Moon apparently limited post-maximum observations. Nonetheless, there appears to have been a rather sharp maximum on 1989 AUG 12, U.T., confirming predictions.

Mr. Lunsford has also received recent meteors observations for non-Perseid meteors, which are listed below.

Recent A.L.P.O. Non-Perseid Meteors Observations

1989 U.T. Date	Observer	Location	U.T.	Number and type of Meteors Seen	Comments (+*N* = Limiting Magnitude)
MAY 06	Brian Simmons	Florida	08:29-09:15	3 Eta Aquarids	+5.7
	Stephen Simmons	Florida	08:30-09:08	2 Eta Aquarids	+5.7
	Wendy Simmons	Florida	08:30-09:08	1 Eta Aquarid	+5.7
	Karl Simmons	Florida	08:30-09:08	3 Eta Aquarids	+5.7
07	Stephen Simmons	Florida	08:30-09:30	10 Eta Aquarids	+5.7
	Karl Simmons	Florida	08:30-09:30	5 Eta Aquarids	+5.7
	Brian Simmons	Florida	08:30-09:30	5 Sporadic	+5.7
08	Stephen Simmons	Florida	02:04-02:34	1 Sporadic	+6.5
	Wendy Simmons	Florida	02:04-02:34	3 Sporadic	+6.5
	Karl Simmons	Florida	02:04-02:34	1 Sporadic	+6.5
	Brian Simmons	Florida	02:04-02:34	1 Sporadic	+6.5
28	Mark Davis	Virginia	03:00-04:30	2 Sporadic	------
JUL 22	J. Kenneth Eakins	California	02:30-03:30	1 Sporadic	+4.7
23	J. Kenneth Eakins	California	05:05-06:05	3 Alpha Cygnids ?	+5.0
	"	"	08:05-09:05	6 Sporadic	+4.9
27	J. Kenneth Eakins	California	07:05-08:05	5 Sporadic	+5.0
28	J. Kenneth Eakins	California	07:00-08:00	5 S. Delta Aquarids	+5.5
	"	"	08:00-09:00	4 S. Delta Aquarids	+5.5
	"	"	09:10-10:10	9 S. Delta Aquarids	+5.0
	"	"	10:10-10:40	2 S. Delta Aquarids	+5.0
AUG 03	Robert Lunsford	California	08:00-09:00	2 S. Delta Aquarids	+6.8
	"	"	09:00-10:00	10 Sporadic	+6.8
	"	"	10:00-11:00	2 S. Delta Aquarids and 1 Upsilon Pegasid	+6.8
	"	"	11:00-11:10	1 S. Delta Aquarid	Partly cloudy
04	Robert Lunsford	California	08:47-09:47	1 N. Iota Aquarid	+6.7
	"	"	09:47-10:47	1 N. Delta Aquarid and 2 S. Delta Aquarids	+6.7
	"	"	10:47-11:47	16 Sporadic	+6.5

MINUTES OF THE 1989 A.L.P.O. BUSINESS MEETING

By: Phillip W. Budine, Appointed Recording Secretary

The 1989 A.L.P.O. Business Meeting was held as part of the "W.A.A.-A.L.P.O. 1989 Convention," when we held our 39th convention meeting, with the Western Amateur Astronomers (W.A.A.) at the Pasadena Convention Center in Pasadena, California. The Business Meeting was called to order at 9:20 A.M. PDT, on August 26, 1989, by John E. Westfall, A.L.P.O. Director, with 24 other A.L.P.O. members attending. The order of business follows.

I. A.L.P.O. STATUS REPORT

A. Financial.—Director Westfall reported the following data, which are current to the dates indicated:

Heber Springs, AR, Bank Account (7/29/89)	$ 500.00
Las Cruces, NM, Bank Account (8/19/89)	1106.27
San Francisco, CA, Bank Account (8/19/89)	502.06
Subtotal	$ 2108.33
Uncashed Checks in Hand	297.00
Total Assets	$ 2405.33
Expenses owed Director (8/19/89)	$ 1482.94

Director Westfall noted that each issue of the *Journal, A.L.P.O.* costs $850-900 for printing and $550-600 for postage [i.e., slightly over $2 per member per issue; this is our largest single expense. Ed.].

B. Membership.—Director Westfall submitted the following membership data, which are current to July 31, 1989:

Issue Date	United States	Canada & Mexico	Other Countries	Total
July, 1988	539	26	137	702
Oct., 1988	555	27	136	718
Jan., 1989	552	27	127	706
Apr., 1989	546	27	133	706
July, 1989	550	28	132	710
Annual Change.....	+11 (+2%)	+2 (+8%)	-5 (-4%)	+8 (+1.1%)
Regional Percentage...	77.5%	3.9%	18.6%	---

C. Foreign Membership Fund.—Director Westfall noted the following data, which are current to August 19, 1989:

Contributed	$ 168.00
Awarded	58.00*
Remaining	110.00

*Four 1-year memberships.

II. STAFF POSITIONS

Director Westfall had appointed José Olivarez as Acting Book Review Editor. Assistant Mars Recorder Carlos Hernandez moved to accept Mr. Olivarez as Book Review Editor; seconded by Jupiter Recorder Phillip Budine, then passed unanimously.

Mars Recorder Donald Parker stated that Daniel Troiani and Harry Cralle had been appointed Acting Assistant Mars Recorders, with the approval of Director John Westfall. Recorder Parker moved to accept Mr. Troiani and Mr. Cralle as Assistant Mars Recorders. This motion was seconded by Mars Recorder Jeff Beish and then was passed unanimously.

Director Westfall stated that he had received word from John W. Griesé, III that he would be unable to continue as Acting Meteors Recorder. Director Westfall had then appointed Mr. Robert D. Lunsford as Acting Meteors Recorder. Mars Recorder Jeff Beish moved to accept Mr. Lunsford as Meteors Recorder. This motion was seconded by Jack Newton and then was passed unanimously.

It was noted by Daniel Costanzo that the work of the A.L.P.O. Meteors Section is now more significant since the American Meteor Society has become very inactive.

Director Westfall stated that the position of Secretary had been vacant for some time. However, he remarked that many of the duties and functions of the Secretary had been taken over by the Membership Secretary, Mr. Harry Jamieson. Therefore, Director Westfall suggested, the position is not needed. Assistant Mars Recorder Carlos Hernandez moved to eliminate the position of Secretary. This motion was seconded by Mike Mattei and passed with a 16 to 5 vote.

III. WALTER H. HAAS OBSERVING AWARD

Members had written to Director Westfall, suggesting changes in the methods of determining and selecting qualified persons for the award. The following changes were suggested by Director Westfall for the delegates to decide:

A. Remove A.L.P.O. Membership Requirement.—Moved by Norman Sperling; seconded by Bill Winkler; approved by a 10-7 vote.

B. Remove Current Activity Requirement.-Moved by Mars Recorder Jeff Beish; seconded by Derald Nye; approved unanimously.

C. Remove Requirement that Recipient be Alive.—Moved by Norman Sperling; seconded by Assistant Mars Recorder Carlos Hernandez; approved unanimously.

D. Require that Solar System Work be Specified.—Moved by Membership Secretary Harry Jamieson, who stated that this is the nature of A.L.P.O. work; seconded by Assistant Mars Recorder Carlos Hernandez; approved unanimously.

E. Allow a Professional to be Honored for Work Done as an Amateur.—Moved by Jack Newton; seconded by Membership Secretary Harry Jamieson; approved unanimously.

F. Include a Complimentary 1-Year A.L.P.O. Membership (New for a Non-Member; Renewal for a Member) With the Award.—Membership Secretary Harry Jamieson moved for a 2-year membership/renewal; seconded by Jack Newton; this *modified* motion was approved unanimously.

IV. A.L.P.O. ARTICLES OF INCORPORATION AND BYLAWS

Director Westfall introduced Beth Westfall, who outlined the Incorporation Articles and procedures to draft such papers. Director Westfall stated that the advantages of incorporating were: (1) advertising advantages; (2) postage reductions; (3) donations; (4) grants; and (5) expense deductions, primarily for staff. The A.L.P.O. would be incorporated as a California Nonprofit Public Benefit Corporation. Director Westfall and Emeritus Director Haas would select the Board of Directors from long-term active members who have regularly attended conventions (where the Board of Directors' meeting would be held), not necessarily staff. Mike Mattei stated that the A.L.P.O. should seek the highest level of deduction rates possible. Mars Recorder Don Parker stated that the A.L.P.O. should not become a private trust. Beth Westfall stated that the Board of Directors could meet anywhere, would give notice of its meeting places and times, and would announce any change of dates. Director Westfall added that each Board of Directors meeting would require a quorum so that only active members should belong.

V. FUTURE A.L.P.O. CONVENTION SITES AND DATES

The A.L.P.O. had received two invitations for its 1990 Convention: (1) In Boston, MA, July 14-18, 1990, with the Astronomical Society of the Pacific (A.S.P.) and the International Amateur-Professional Photoelectric Photometry organization (I.A.P.P.P.) ; or (2) in St. Louis, MO, July 31-August 4, 1990, with the Astronomical League (A.L.). The delegates had to decide on one or the other. Regarding the Boston alternative, Mike Mattei stated that the American Association of Variable Star Observers (A.A.V.S.O.) would not be attending. Bill Winkler added that it would be expensive to attend the Boston meeting. Regarding the St. Louis choice, Mars Recorder Don Parker stated that there would be more amateur activity in meeting with the A.L., there would be better arrangements; and, being held on a campus, the meeting would be less expensive to attend. It was moved by Derald Nye for the A.L.P.O. to meet with the Astronomical League in St. Louis, July 31-August 4, 1990. This was seconded by Membership Secretary Harry Jamieson and then unanimously approved.

Director Westfall then stated that we had an invitation to meet with the Astronomical Association of Northern California, the Western Amateur Astronomers, and the Astronomical League in San Jose, CA, on July 13-18, 1992. It was moved by Norman Sperling for the A.L.P.O. to accept this invitation; this was seconded by Derald Nye and then unanimously approved.

Director Westfall announced that he was a member of the organizing committee for an international amateur research symposium to be held in La Paz, Baja California Sur, Mexico on July 8-12, 1991, to tie in with the July 11, 1991, total solar eclipse. He should know by our 1990 meeting whether there will be a formal invitation for the A.L.P.O. to join this symposium for their 1991 convention.

VI. *STROLLING ASTRONOMER* ISSUE RENUMBERING

It was moved by Jack Newton that we number successive issues 1, 2, 3, and 4 for each volume, beginning with Volume 34 in 1990. This was seconded by Norman Sperling and unanimously approved.

VII. PUBLICATIONS AND ADVERTISING

A. *Solar System Ephemeris.*—Director Westfall stated that 91 copies of the 1989 edition had been sold. He would appreciate aid in producing the Ephemeris and will state the tasks to be done in the next (i.e., this) issue of the *Journal A.L.P.O.* [see p. 190].

B. Advertising.—Director Westfall stated that each issue of the *Journal* is now 48 pages. We have encouraging participation from the recipients of the Foreign Membership Fund. Mike Mattei said that we could sponsor an active foreign observer who was not able to pay the dues. He also said that advertising rates in our *Journal* are in line with other *Journals*. He said that we could increase the number of pages with more advertising revenue. Norman Sperling said that to cover the increasing costs of *Journal* printing and postage, and hopefully to enlarge future issues, we should increase the advertising rates of interior pages and of the back cover. Norman Sperling suggested an increase from $50 [the current 1-page rate] to $100. Membership Secretary Harry Jamieson suggested that we vote on increasing the 1-page rate to either (1) $75, (2) $85, (3) $95, or (4) $100. This was voted upon with the following votes in the order above: 10, 17, 9, and 2. Thus, the $85 1-page rate was accepted. [Note: In order to give current advertisers fair notice, the new rate will go into effect *after* this issue. Proportional increases in the half-page, quarter-page, and classified column-inch rates will also then go into effect. The new rate structure is given in our inside back cover.]

C. Mailing Rates.—A discussion:

(1) Norman Sperling recommended second-class mailing.

(2) General comment—Section Recorders should recoup their expenses by raising prices for forms and other materials.

(3) Paul Mackal recommended that we investigate first-class packet rates. Director Westfall will check.

VIII. MEMBERSHIP

Membership Secretary Harry Jamieson suggested ways of increasing membership:

(1) Publish Section circulars like the B.A.A.

(2) Publish Section Bulletins.

(3) Institute regional training programs headed by experienced members.

(4) Develop videotapes for training.

(5) Advertising methods; such as shirts, hats, emblems, and banners.

IX. OTHER BUSINESS

A. Suggested New Sections:

(1) Sky Phenomena, by Mars Recorder Jeff Beish.

(2) Earth Satellites, by Norman Sperling.

(3) Astro-Geology (Earth), by Assistant Jupiter Recorder Paul Mackal.

These ideas will be studied further and Director Westfall suggested that we table them officially until next year. Moved by Phillip Budine to table until next year; seconded by Carlos Hernandez; unanimously approved.

B. Children's (Youth) Section—Discussion by Mars Recorder Jeff Beish and Assistant Mars Recorder Carlos Hernandez. No action taken.

With no further business, Director Westfall asked for a motion to adjourn. This was moved by Mars Recorder Jeff Beish, seconded by Assistant Mars Recorder Carlos Hernandez and approved. The 1989 A.L.P.O. Business Meeting was adjourned at 11:32 A.M. PDT on August 26, 1989.

OBSERVATIONS AND COMMENTS

Veteran A.L.P.O. members may remember Walter Haas' column of this name which appeared intermittently a number of years ago. As space and opportunity permit, we hope to resurrect this occasional forum.

To the left are two photographs by Frank J. Mellilo of Neptune and its major satellite Triton, both of which received attention during the Voyager 2-Neptune encounter, which occurred during our 39th convention. He could not see Triton with his instrument, but clearly could photograph it. [Unlike your editor, who has seen Triton, but not photographed it!] Mr. Melillo intends to pursue photoelectric photometry of Neptune and Jupiter's moon Io; we recommend both projects to our members who have photoelectric photometers.

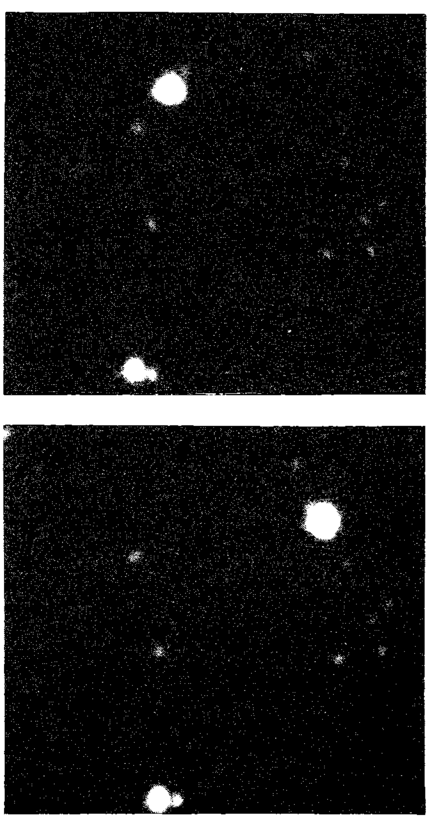

Figure 26 (to left). Photographs of Neptune and Triton by Frank J. Melillo with an 8-inch (20-cm.) Schmidt-Cassegrain reflector at f/10, using a 20-minute exposure on hypered Kodak TP2415 Film. The top view was taken 1989 JUN 30, 05h U.T.; the bottom just 24 hours later. In the upper view, Neptune (magnitude +7.7) is the bright object in the upper left; and Triton, at about magnitude +13.5, is close to its upper right, 14 arc-seconds from Neptune. In the lower frame, Neptune has moved to the right, and Triton is to its upper left, just 12 arc-seconds distant. The bright star at the bottom is SAO 187306, at visual magnitude +9.3. North at top and celestial west to right.

COMING SOLAR SYSTEM EVENTS: NOVEMBER, 1989-JANUARY, 1990

WHAT TO LOOK FOR

This column is intended to alert our readers about events happening in the Solar System during the next three months, including the visibility conditions for major and minor planets, the Moon, comets, and meteors. More detailed information can be gotten from the 1989 and 1990 editions of the *A.L.P.O. Solar System Ephemeris*. (See p. 190 of this issue to learn how to obtain the 1990 edition.) All dates and times are in Universal Time (U.T.), which is found by adding 10 hours to HST (Hawaii Standard Time), 9 hours to AST (Alaska Standard Time) or HDT, 8 hours to PST or ADT, 7 hours to MST or PDT, 6 hours to CST or MDT, 5 hours to EST or CDT, and 4 hours to EDT. Note that this may put you into the next U.T. day!

VENUS AND JUPITER— THE BEST PLANETS TO WATCH

Venus and **Jupiter** will be the most obvious planets to follow in the next three months. Catch **Venus** low in the southwest in evening twilight until mid-January, when it approaches too close to the Sun, reaching *inferior conjunction* on 1990 JAN 18. On 1989 NOV 07, with a disk diameter of 25 arc-seconds, this planet reaches theoretical half-phase (*dichotomy*), but the observed time of half-phase may be several days earlier. On the next day, Venus reaches its greatest elongation east of the Sun, 47°.2. Venus is also at its greatest southerly declination (-26°57') since 1938 and until 1997; clearly a good apparition for southern-hemisphere observers, if not for northern ones. Venus' disk now grows as its phase shrinks; when at greatest brilliancy on 1989 DEC 18, at magnitude -4.7, it is 43 arc-seconds across and 23 percent illuminated, still 38° from the Sun.

Jupiter is the second-brightest planet, but is much more conveniently observable than Venus. The giant planet is closest to the Earth on 1989 DEC 26, with an equatorial diameter of 47 arc-seconds, and in *opposition* to the Sun on DEC 27, at magnitude -2.7. This apparition is highly favorable for our Northern Hemisphere, with Jupiter at declination +23°.2 at opposition. Jupiter will be high in the sky in late evening throughout this period. As we go to press, Jupiter's **SEB** (South Equatorial Belt) and **Great Red Spot** have faded considerably in integrated light (see pp. 190-191), but are reported as still prominent in red and infrared.

Of the remaining six planets, **Mercury** perhaps is the most accessible, and it has two observing "windows." The first is centered around its greatest eastern elongation (20°.0) on 1989 DEC 23, with Mercury at least 15° from the Sun in the evening sky from 1989 DEC 08 to 1990 JAN 01. Mercury's turn in the pre-dawn sky is near its greatest western elongation; 1990 FEB 01 (25°.2); it is at least 15° from the Sun between 1990 JAN 16 to FEB 28.

Mars is not well placed, having passed conjunction with the Sun on 1989 SEP 29. It should become visible in the southeast sky in morning twilight after mid-November. However, even by 1990 JAN 31, Mars is only 40° from the Sun, 4.4 arc-seconds across, and at declination -23°.8.

The last chance to observe **Saturn** this year will be in November because it reaches solar conjunction on 1990 JAN 06. The ringed planet will be in the southwestern sky in the early evening. Its Rings remain well-presented, the north face being tilted 25°.9 towards us on 1989 NOV 01.

November is also the last month for **Uranus** and **Neptune** because they are located near Saturn. Their respective dates of conjunction with the Sun are 1989 DEC 27 and 1990 JAN 02. On 1989 NOV 01, Uranus is 54° east of the Sun at magnitude +6.0. On the same date, magnitude +7.8 Neptune lies 61° east of the Sun. A good time to look for Neptune will be on 1989 NOV 12; when, at 21h U.T., it passes 0°30' north of Saturn.

Pluto is unobservable, reaching conjunction with the Sun on 1989 NOV 07.

There are four **minor planets** that reach opposition at magnitude +10.0 or brighter during the November-January period; their 10-day ephemerides are published in the 1989 edition of the *A.L.P.O. Solar System Ephemeris*:

Minor Planet	Opposition Data 1989 Date	Magnitude	Declination
230 Athamantis	NOV 02	+10.0	20°N
115 Thyra	NOV 29	+9.7	41°N
192 Nausicaa	DEC 06	+9.3	36°N
1 Ceres	DEC 20	+6.7	26°N

THE MOON

During the current three-month period, the schedule for the Moon's **phases** is:

New Moon	First Quarter	Full Moon	Last Quarter
OCT 29.6	NOV 06.6	NOV 13.2	NOV 20.2
NOV 28.4	DEC 06.1	DEC 12.7	DEC 20.0
DEC 28.1	JAN 04.4	JAN 11.2	JAN 18.9
JAN 26.8	FEB 02.8	FEB 09.8	FEB 17.8

The 1990 FEB 09 Full Moon is notable because it marks a total lunar eclipse, described in the next article (p. 184). Likewise, the 1990 JAN 26 New Moon creates an annular solar eclipse, described later in this article (p. 183).

During this season, the Full Moon will be well-placed, and the New Moon poorly placed, for observers in the Earth's Northern Hemisphere; the opposite is true for those south of the Equator.

The other significant lunar visibility condition is the Moon's **librations**, or E-W and N-S tilts in relation to the Earth. Extreme librations occur on the following dates in November, 1989-January, 1990:

North	West	South	East
OCT 31	NOV 06	NOV 13	NOV 18
NOV 27	DEC 04	DEC 10	DEC 16
DEC 24	DEC 31	JAN 07	JAN 13
JAN 21	JAN 26	FEB 03	FEB 10

The lunar east and west directions above follow the International Astronomical Union usage, with Mare Crisium near the *east* limb. Note that lighting and libration conditions combine for a favorable view of the east limb on 1990 JAN 12-13.

SUN AND MOON ECLIPSED

Two eclipses happen in early 1990. An **annular solar eclipse** will occur in Antarctica on 1990 JAN 26, with a maximum duration of 2m 03s at 71°01'S, 22°10'W. Besides Antarctica, this eclipse's partial phases can be seen from South America (except the north-west portion of that continent) and the South Island of New Zealand.

The **total lunar eclipse** on 1990 FEB 09 will be much more widely visible. Due to its importance, it is described separately (p. 184).

OCCULTATIONS

Observers in North America have the opportunity to watch three minor planets pass in front of stars: (1) 1989 NOV 11.46; **1 Ceres** (magnitude +7.8) occults a +10.5-Mag. star, giving a 7-percent light drop for 196 seconds as seen from the western United States and Mexico. (2) 1989 DEC 02.29; **895 Helio** (Mag. +12.6) occults a +10.9-Mag. star, with a 83-percent light loss lasting 8 seconds; seen from the central United States and eastern Canada. (3) 1990 JAN 16.45; **566 Stereoskopia** (Mag. +12.9) occults a +9.4-Mag. star, resulting in a 96-percent light drop lasting 10 seconds, predicted for the southwestern United States.

We note two occultations of **Venus** by the Moon, with visibility zones shown in *Figure 27* to the right. The first occurs on 1989 NOV 02, 22h U.T., with Venus at Mag. -4.4, 47° east of the Sun. The second is one month later, on 1989 DEC 02, 07h, when Venus is 45° east of the Sun, at Mag. -4.6.

The only **bright-star occultations** by the Moon are four of **Antares** (Mag. +1.2): (1) 1989 NOV 01, 11h (31°E. of the Sun); from S. Africa and W. Australia. (2) 1989 NOV 28, 17h (6°E. of the Sun; not observable). (3) 1989 DEC 26, 00h (25°W. of the Sun); visible from Indonesia and Australasia. (4) 1990 JAN 22, 08h (53°W. of the Sun); visible from South America and S. Africa.

The series of **Pleiades passages** continues, with the Moon passing in front of this star cluster three times: (1) 1989 NOV 13, 21h (99% Moon; Europe and N. Asia); (2) 1989 DEC 11, 07h (97% Moon; Canada and the United States); (3) 1990 JAN 11, 16h (84% Moon; N. Europe, N. Asia and Alaska). The series of favorable occultations of the **Beehive** (*Praesepe*) star cluster, however, comes to an end with the event of 1989 NOV 18, 14h (66% Moon; Hawaii and W. North America).

THREE COMETS—ONE NAKED-EYE

The major comet during these three months is the "new" one; **Comet Okazaki-Levy-Rudenko (1989r)**, expected to reach naked-eye visibility. It is reported on earlier in this issue (p. 171).

Meanwhile, **Comet Brorsen-Metcalf (1989o)** continues to fade, but can be followed in larger amateur telescopes. Its current ephemeris was given earlier (p. 170).

Finally, **Periodic Comet Schwassmann-Wachmann I** can always surprise us with a flareup; for its ephemeris, see p. 170.

METEORS

(Contributed by Robert D. Lunsford, A.L.P.O. Meteors Recorder)

Both branches of the **Taurid** stream peak in early November under favorable conditions. Observe these beautiful, slow, bright meteors in the early morning hours before the 10th of the month.

The **Leonids** occur on November 16.9 with a waning gibbous Moon nearby. Observers this year will see only 2-3 bright meteors

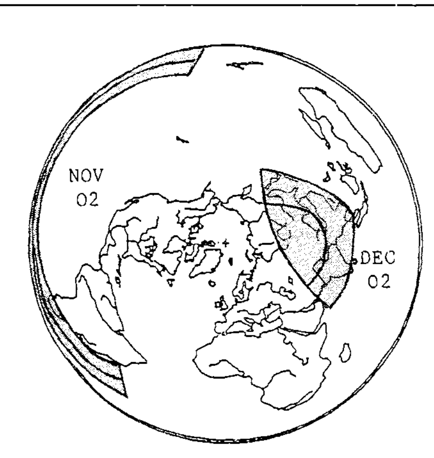

Figure 27. Areas on Earth where the 1989 NOV 02 and DEC 02 occultations of Venus by the Moon will be visible.

per hour under these conditions.

Southern-hemisphere observers should watch very early in December and also late in that month for activity from the radiants in **Phoenix** and the **Puppis-Vela** region. Rates are usually low, but shower members are often colorful and long in duration.

The **Geminids** are ruined this year by a Full Moon on December 12th; they peak on DEC 13.8. Diehard observers may still be able to count up to 20 bright meteors per hour despite the intense moonlight.

A waning crescent Moon only slightly hampers the **Ursids**, which are best seen on the morning of December 22nd. Observers with good transparency may see 5-10 Ursids per hour.

The **Quadrantids** will peak on the morning of 1990 JAN 03, under ideal conditions (a 6-day Moon). Observe during the last 3 hours of dark sky before morning twilight. If you are lucky enough to live in the right longitude, rates can surpass 100 per hour. Rates of less than 10 per hour will be seen on the 2nd and the 4th. While observing the "Quads," one may see other activity occurring from either **Cancer** or **Coma Berenices**. These two showers peak at mid-month, but are often visible during the Quadrantid maximum.

TOTAL ECLIPSE OF THE MOON: 1990 FEB 09

Observers throughout the Eastern Hemisphere will be able to see part or all of the total eclipse of the Moon on 1990 FEB 09, U.T. (Universal Time). The eclipse *magnitude* will be 1.080, meaning that, at mid-eclipse, the center of the Moon will be 1.080 lunar radii inside the edge of the *umbra* (darker part of the Earth's shadow). The entire eclipse can be seen from all Asia except the northeast and Japan, eastern Europe, and eastern Africa. The end of the event, but not the beginning, will be visible from the remainder of Europe and Africa, northeast Canada, the State of Maine, and eastern Brazil. On the other hand, the eclipse's beginning, but not its end, can be seen from Hawaii, Alaska, the Yukon, northeast Asia, Japan, and Australasia.

The *phases* of this eclipse are predicted to follow this schedule (where all times are in U.T.):

First Penumbral Contact (P1) .	16^h	19.6^m
First Umbral Contact (U1)	17	28.6
Beginning of Totality (U2) ...	18	49.2
Middle of the Eclipse	19	11.1
End of Totality (U3)	19	32.9
Last Umbral Contact (U4)	20	53.5
Last Penumbral Contact (P4) .	22	02.6

As usual, the above schedule assumes that the umbra's diameter will be 2 percent larger than simple geometry would predict. The edge of the umbra relative to the Moon is shown for each of the four umbral contacts (U1-U4), and for mid-eclipse, on *Figure 28* to the right. The figure shows that the Moon will pass to the south of the umbral center, and that the southern and southwestern (celestial directions) limbs will never be far from the edge of the umbra edge. Thus, they can be expected to remain fairly bright throughout totality. The writer believes that this eclipse will be fairly bright because there has been no recent large-scale volcanic eruption to inject light-scattering particles into our stratosphere, through which the refracted sunlight that illuminates the umbral interior must pass.

WHAT TO OBSERVE

Total lunar eclipses are beautiful to watch, and there is also a variety of scientific observations that can be made. To find out more about these, write our Lunar Eclipse Recorder, Francis Graham (address on inside back cover) to obtain a copy of the *A.L.P.O. Lunar Eclipse Handbook* ($4.00). Among the observing projects are verbal descriptions, drawings, photographs, and estimates of the *Danjon Luminosity* of the Moon at mid-eclipse.

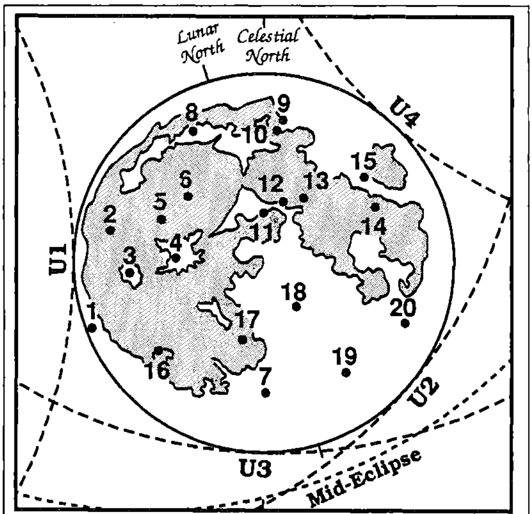

Figure 28. The edge of the umbra at mid-eclipse and at the four umbral contacts during the 1990 FEB 09 total lunar eclipse. Celestial and lunar north and the 20 timing craters on p. 185 are also plotted.

Estimating the *stellar magnitude* of the Moon, at mid-eclipse or at various times throughout the eclipse, is a useful activity. Two methods that can be used are viewing the Moon through reversed binoculars, or viewing its reflection in a convex reflector. In either case, the Moon's image is compared with a star or planet, and we are fortunate in that there are several bright comparison objects near the Moon in this eclipse.

Figure 29, below, shows the celestial hemisphere centered on the Moon at mid-eclipse. (This will be the view from Nyatami, Karnataka State, southern India, where the Moon will be overhead at mid-eclipse!) The visual magnitudes of the objects named on the diagram are: Jupiter, -2.54; Sirius, -1.46; Arcturus, -0.04; Procyon, +0.38; and Regulus, +1.35. Lunar magnitudes found from such comparisons should be corrected for *differential atmospheric extinction* if the comparison object's altitude is much different from that of the Moon. This is less of a problem with Regulus, which lies only 9° from the Moon.

The angular size of the umbra varies unpredictably from eclipse to eclipse. It can be found accurately by timing the four umbral contacts with the limb, and especially by timing when the umbral edge crosses the 20 selected craters that are listed below and are plotted on the Moon's disk in *Figure 28* (p. 184). If possible, time both umbral *immersion* and *emersion*. For large craters, take the mean of the times when the umbral edge crosses opposite crater walls. The timing should be precise to 0.1 minute. To help you to be prepared, the *approximate* predicted U.T.'s for immersion and emersion for the selected craters are:

Number	Name	Immersion	Emersion
1	Grimaldi	17^h35^m	19^h50^m
2	Aristarchus	17 35	20 05
3	Kepler	17 40	20 00
4	Copernicus	17 50	20 10
5	Pytheas	17 45	20 15
6	Timocharis	17 50	20 20
7	Tycho	18 05	20 00
8	Plato	17 50	20 30
9	Aristoteles	18 00	20 35
10	Eudoxus	18 00	20 35
11	Manilius	18 00	20 25
12	Menelaus	18 05	20 30
13	Plinius	18 10	20 35
14	Taruntius	18 25	20 40
15	Proclus	18 20	20 45
16	Gassendi	17 45	19 50
17	Birt	18 05	20 00
18	Abulfeda E	18 15	20 10
19	Nicolai A	18 30	20 00
20	Stevinus A	18 40	20 15

Whatever the form of observations that you make, be sure to send them to our Lunar Eclipse Recorder. For crater and limb timings, send a duplicate copy to *Sky & Telescope*, P.O. Box 9111, Belmont, MA 02178-9111.

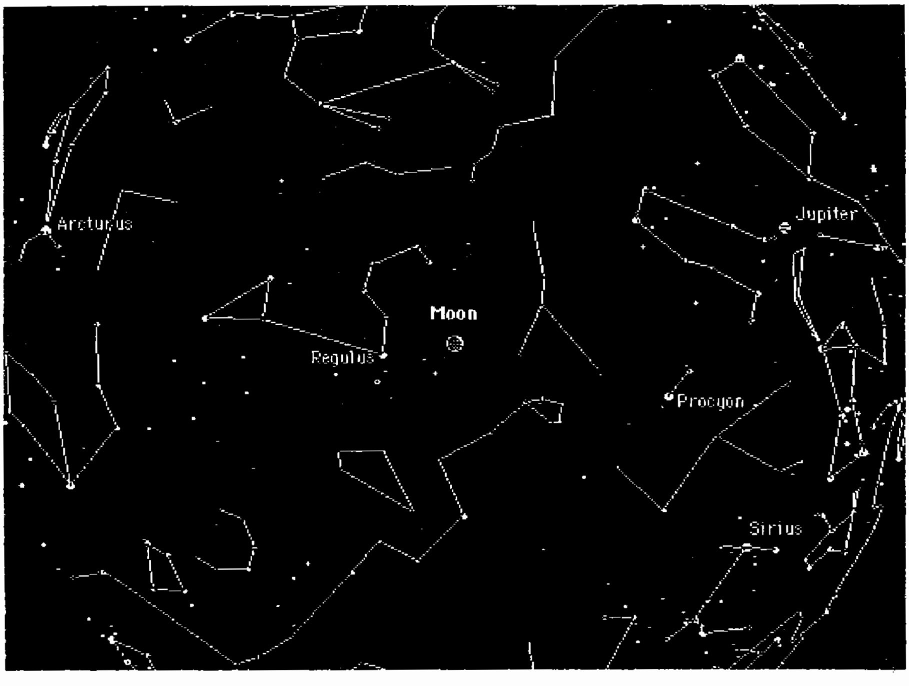

Figure 29. The celestial hemisphere centered on the Moon at mid-eclipse, 1990 FEB 09, 19h 11.1m U.T. See text for magnitudes of named objects. North at top. Plotted by *Voyager* program, © Carina Software.

BOOK REVIEWS

Edited by José Olivarez

Planets Beyond: Discovering the Outer Solar System, By Mark Littmann. John Wiley and Sons, Inc., 605 Third Ave., New York, NY 10158. 1988. 286 pages, color illustrations, tables, appendices, index, glossary. Price $22.95 cloth (ISBN 0-471-61128-X).

Reviewed by Richard W. Schmude, Jr.

The contents of this book can be broken down into two parts. The first part deals with history, and the second with the three (or four?) planets in the outer Solar System; Uranus, Neptune, Pluto, and Planet X, along with the Voyager-2 spacecraft. The book ends with a glossary, index, bibliography, and three Appendices.

The history section contains six chapters, with the titles: "The Discovery of Uranus," "The Fervor for New Planets," "Trouble with Uranus," "Neptune: the Planet Found on a Sheet of Paper," "Percival Lowell and Planet X," and "The Discovery of Pluto." Overall, the historical accounts are both accurate and interesting. The author also gives some insight into the nature of the people involved in the discoveries of Uranus, Neptune, and Pluto. Littmann also explains in simple language how Neptune was creating problems with Uranus' orbit during the early-to-mid nineteenth century.

The modern investigation of the outer Solar System is covered in Chapters 7-14. The seventh chapter, "Toward Uranus," discusses some of the recent developments relating to Uranus before the Voyager-2 fly-by. These include the discovery of Uranus' Rings and the fortunate coincidence that the four giant planets (Jupiter, Saturn, Uranus, and Neptune) were arranged in such a manner that a single spacecraft could visit all four within a 15-year period. "The Grand Tour of Voyager 2" (Chapter 8) discusses several of the problems and limitations that Voyager 2 had as it approached Uranus, and the ways in which these difficulties were overcome. As the title of Chapter 9, "Triumph at Uranus," suggests, it describes the main discoveries of the Voyager-2 flyby of Uranus. The reader discovers that Uranus has aurorae, 15 known satellites, 12 known Rings, and a cold atmosphere that is largely made up of hydrogen and helium. Some insights into the natures of the interiors of Uranus and its moons are also given. This chapter is well illustrated and contains Voyager-2 images of Uranus, its Rings, and several of its satellites. Curiously, the author does not discuss the nature of the Rings that Voyager 2 discovered.

The tenth chapter, "Appointment with Neptune," describes the improvements that have been made in the programming of Voyager 2 since 1986 and what scientists may find on that distant world. A timetable of the Voyager-2 flyby of Neptune and its moons is given, along with a summary of our pre-Voyager knowledge of the Neptune System. The next chapter in this section, "Voyagers to the Stars," describes where each of the two Voyager spacecraft is heading. Our understanding of Pluto and its moon is given in Chapter 12, "The Smallest Planet," where the author presents a good picture of what an astronaut may find on Pluto. The thirteenth chapter, "Is there a Tenth Planet?" discusses the evidence for a tenth planet (or a second star), along with several of the current theories of its effect on the Earth. The main portion of the book ends with "Cosmic Archives: What the Outer Solar System Can Tell Us." This fourteenth chapter contains a sneak preview of the future space probes; Galileo, CRAF (Comet Rendezvous-Asteroid Flyby), and Cassini. A brief discussion of the creation of the Solar System is also given.

This book contains three appendices. Appendix A contains detailed chronologies of the discoveries of Uranus, Neptune, and Pluto, with other significant solar-system discoveries made since 1948. Appendix B presents data on the Voyager-2 spacecraft, while Appendix C gives the physical and orbital characteristics of all the planets and of the satellites known in 1988. The reader also should find the 112-term glossary useful. There is a good index.

Overall, this book is well-illustrated and is written at about the college freshman level, being thus well-suited for the general audience. I highly recommend *Planets Beyond: Discovering the Outer Solar System* to anyone who has a limited knowledge of the outer Solar System and who wants to learn more about this region.

The Supernova Story. By Laurence A. Marschall. Plenum Press, Plenum Publishing Corp., 233 Spring St., New York, NY 10013. 1988. 295 pages, illustrations, index. Price $22.95 cloth (ISBN 0-306-429-551).

Reviewed by Rodger W. Gordon

From its title, one might suppose that this book gives the story of Supernova 1987A and indeed it does, but not until page 235 do we get the inside information on the discovery and its ramifications. Instead, through most of the book we are given a very "meaty" background about supernovae and their importance in astrophysical theory. The author also covers the history of all the known and suspected supernovae from ancient times to the present.

The book is divided into 12 chapters, and Marschall carefully blends each chapter into each successive chapter with a skill and deftness rarely found in popular science writing. The personal stories of astronomers such as Kepler and Tycho are woven into the book as integral parts. We see them as human beings, and not just great names. Personal glimpses of today's astronomers are also given, and we come away with an appreciation of the spirit and dedication of modern astronomers as well.

This book is intended for the scientific layperson, but can be recommended to anyone who wishes to know why there is all the fuss over supernovae and why astronomers refer to them as "laboratories in the sky."

The author gives a list of suggested readings, together with a small but informational glossary of terms. Those not familiar with astronomical jargon might wish to refer to the glossary before starting the text. The book is well-illustrated with photographs, several of which show noted astronomers, both present and past,.in relaxed moments.

The Supernova Story is a highly readable work that I recommend to anyone. At $22.95, the price is in general keeping with most hardcover scientific books.

Do-It-Yourself Astronomy. By Sydney G. Brewer. Edinburgh University Press, 22 George Square, Edinburgh, U.K. Distributed by Columbia University Press, 562 West 113th St., New York, NY 10025. 1988. 135 pages, illustrations, appendices, index. Price $15.00 paper (ISBN 0-85224-573-4).

Reviewed by Matthew Will

Do-It-Yourself Astronomy invites the reader to rediscover our Solar System in a manner not unlike the way Kepler, Newton, and others discovered it long ago; through innovative experiments that one can understand and duplicate. The author performs a variety of naked-eye observations of the stars and planets, using instruments of home-made or improvised design. He then applies mathematical equations to his observational results in order to demonstrate the existence of some physical property of the Solar System. In other words, Brewer shows how, from simple observation, one can develop a tangible, three-dimensional model of the Solar System and its surroundings through the language of mathematics.

In the first two chapters of the book, the author acquaints the reader with techniques for determining the length of the sidereal day, measuring angular distances in the sky, and finding the latitude at a given location.

Kepler's three laws of planetary motion are the subjects of the next three chapters. In Chapter 3, Brewer elucidates the first two laws through his study of the Sun's day-to-day motions in the sky. Chapters 4 and 5 focus on Kepler's Third Law. The author applies this law to his observed measurements of the motions of Venus, Mars, Jupiter, and Saturn in order to determine their distances from the Sun.

Although the distances of the planets were determined in integer astronomical units in the previous chapters, Chapters 6 and 7 examine the problems in estimating such distances in miles or kilometers. Brewer derives an equation to find the radius of any planet, based primarily on magnitude comparisons of different planets that he observed. He then applies these values to finding the true length of the astronomical unit.

In Chapter 8, "The Radius of the Earth," Brewer develops a methodology for discovering the Earth's radius by means of measuring the Sun's passage of a particular point in the sky from two locations. In Chapter 9, "The Moon," the author solves for the distance of the Moon from the Earth. In Chapter 10, "The Nearer Stars," he impresses upon us the vastness of interstellar space by attempting to determine the distance from the star Capella to the Sun. Finally, Brewer's final chapter is "The Remote Background," which explains the mysterious motions of the Foucault pendulum.

The mathematics in this book is not too difficult to follow if one has the proper background in algebra, trigonometry, and geometry in order to understand how the mathematical equations are derived and applied. In an effort not to bog down the text with endless mathematical details, the author has wisely included, in the back of each chapter, notes expanding on the development of the equations. Also, two appendices are devoted to further mathematical explanations.

Although some material could have been more clearly presented, the author explains scientific concepts better than I have seen in most mathematics or physics textbooks. Some concepts would have been made clearer by the use of more diagrams. Almost every chapter involves measurements taken using Brewer's instruments. The conceptual design of these hand-built instruments is easy to follow. However, little is written about the actual construction of the more complicated ones.

The author's style of writing is personable. His personal anecdotes, and experiences with his handcrafted instruments, along with his historical references, made for interesting reading.

I find it hard to give *Do-It-Yourself Astronomy* an unqualified recommendation because of the mathematics that is used. Be that as it may, I found this book to be a welcome addition to astronomical literature because of its unique approach to a side of astronomy which is not often written about at the popular level.

NEW BOOKS RECEIVED

Coordinated by José Olivarez; Notes by J. Russell Smith

Practical Astronomy With Your Calculator. By Peter Duffett-Smith. Cambridge University Press, 32 East 57th St., New York, NY 10022. Third Edition, 1988. 198 pages, index. Price $19.95 spiral-bound (ISBN 0-521-35699-7).

The Sections of this book consist of: "Time," "Coordinate Systems," "The Sun, "The Planets, Comets and Binary Stars," "The Moon and Eclipses," "Glossary of Terms," and "Symbols and Abbreviations." If you are interested in this subject, I heartily recommend this book.

The Moon Observer's Handbook. By Fred W. Price. Cambridge University Press, 32 East 57th St., New York, NY 10022. 1988. 320 pages, illustrations; indices of subjects, authors, names, and named formations. Price $34.50 cloth (ISBN 0-521-33500-0).

The contents are as follows: "Introduction," "Why Observe the Moon?," "Our Moon," "The Moon's Motions and Consequent Phenomena," "The Moon Observer's Telescope," "The Moon from New to Full," "Observing and Recording," "Mysterious Happenings on the Moon," "Suggestions for Research," and eight appendices.

I recommend this book to anyone interested in the Moon.

Astronomical Centers of the World. By Kevin Krisciunas. Cambridge Uni-versity Press, 32 East 57th St., New York, NY 10022. 1988. 350 pages, illustrations, index. Price $24.95 cloth (ISBN 0-521-30278-1).

The principal contents are as follows: "The Alexandrian Museum," "Astronomical Capitals of the Moslem World," "Tycho Brahe's Observatory at Hven," "Paris and Greenwich," "Pulkova Observatory," "Harvard, Lick and Yerkes and the Rise of Astrophysics," "Mt. Wilson and Palomar," "The Present," and "The Future," followed by an Appendix. This is an excellent book.

Meteorites and the Early Solar System. Edited by John F. Kerridge and Mildred Shapley Matthews. The University of Arizona Press, 1230 N. Park, No. 102, Tucson, AZ 85719. 1988. 1269 pages, illustrations, glossary, index. Price $55.00 cloth (ISBN 0-8165-1063-6).

This book's Parts are: 1, "Introduction;" 2, "Source Regions;" 3, "Secondary Processing;" 4, "Irradiation Effects;" 5, "Solar-System Chronology;" 6, "The Early Solar System;" 7, "Chemistry of Chondrites and the Early Solar System;" 8, "Magnetic Fields in the Early Solar System;" 9, "Chondrules;", 10, "Primitive Material Surviving in Chondrites;" 11, "Micrometeorites;" 12, "Inhomogeneity of the Nebula;" 13, "Survival of Presolar Material in Meteorites;" 14, "Nucleosynthesis;" 15, "Extinct Radionucleides;" and 16, "Boundary Conditions for the Origin of the Solar System." These are followed by "Future Directions in Meteorite Research," appendices, glossary, acknowledgements, and index.

If you are fairly advanced in astronomy, you will like to have this book on your shelf.

HELP WANTED!

The A.L.P.O.'s work is done entirely by a volunteer staff, but we need more volunteers! Here are two specific jobs that need to be done.

You may have noticed that this magazine is not indexed. It used to be; Volumes 1-8 (1947-1954) and 16-27 (1962-1979) were indexed. It should be indexed again. This could involve a little indexing, or a lot, with the following priorities:

1. Index the current volume (Vol. 33).
2. Continue with Volumes 34 and on.
3. Index recent unindexed volumes (i.e., starting with Vol. 28 in 1979).
4. Index Vols. 9-15 (1955-1963), using loaned or copied issues if necessary.
5. And this is a major task—Prepare a comprehensive multivolume index.

Our indexing could be done at your own pace, as slow as one volume per year!

The second task, involving a more regular work pattern, is that of editing, producing, and distributing our *Solar System Ephemeris* each year. This work does not include the actual computation (unless you like that sort of thing) because the computer programs that do this already exist. Instead, you would need to solicit materials from the staff each year, update general data tables, assemble the pages, have them reproduced, and sell copies of the final volume. The Editor/Director is presently doing all this; but it is beginning to delay his other duties, including the editing of this magazine. Help with at least some of the above processes is thus urgently needed.

In other words, here are a couple interesting spare-time jobs that would definitely help the A.L.P.O. If you would like to assist with either of these, the Director would be very happy to tell you more.

ANNOUNCEMENTS

A.L.P.O. BUSINESS

To find out a lot about your Association's business, be sure to read the Minutes of our 1989 Business Meeting that appear on pp. 179-181. Some of the more significant decisions are also described in the first three items below.

1990 A.L.P.O. Convention.—Our fortieth Convention will be held with the Astronomical League (A.L.) in St. Louis, Missouri, July 31-August 4, 1990. Few details are yet known, except that it is planned to meet on a college campus. Also, the A.L.P.O. plans to host a **Solar System Drawing Exhibit and Contest**. Details are being worked out; exhibit entries can be any form of representation of what a person saw–drawing, painting, or even computer art. It will be possible to display material without taking part in the contest, but all contest entries must be on display.

Staff Changes.—We are happy to report that the following persons have been promoted from acting positions to permanent positions. Their addresses are on the inside back cover; their names and new positions are: **José Olivarez**, Book Review Editor; **Daniel Troiani**, Assistant Mars Recorder; **Harry Cralle**, Assistant Mars Recorder; and **Robert D. Lunsford**, Meteors Recorder. Congratulations to all four!

New Advertising Rates.—Beginning with the **next issue**, our advertising rates will be:

Full-Page Display Ad.	$ 85.00
Half-Page Display Ad.	50.00
Quarter-Page Display Ad. ...	35.00
Classified Ad.;	
per column-inch	10.00

The above rates are *per issue*; the 10-percent discount for 3-time insertion still applies. These new rates are also listed on our inside back cover.

1990 Solar System Ephemeris.—We are now accepting advance orders for the *A.L.P.O. Solar System Ephemeris: 1990*. Delivery should be in November or early December. The format will be similar to that of the 1989 edition, with about 100 pages of data on the visibility in the coming year of the major and minor planets, major satellites, the Sun, the Moon, comets, and meteors. Payment should be in U.S. funds; $6.00 for the United States, Canada, and Mexico; and $8.50 for other countries (includes air mail delivery). Send a check or money order, made out to "A.L.P.O." to our San Francisco address.

Address Change for Jean Dragesco.—Our Assistant Jupiter Recorder for Photography , Jean Dragesco, an expert lunar and planetary photographer, has moved to: 394, Bd. du Grand Devois. 34980, St. Clement-la-Riviere, France.

A.L.P.O. on CompuServe.–Members having computers with modems may now communicate with the Director/Editor over the CompuServe computer network. His User ID Number is **73737,1102**.

Releasing Membership Addresses.—From time to time, we receive requests for a list of A.L.P.O. members in the requester's vicinity. If the requester is an individual A.L.P.O. member, we provide such lists; *we do not provide this information to businesses or public agencies*. We feel that giving members such information helps the activities of the A.L.P.O.; however: If you do not want your name and address given out, even to fellow members, please inform Membership Secretary Jamieson by January 1, 1990.

A Major Change on Jupiter.—Jupiter Recorder Phillip Budine has supplied the following announcement, dated August 1, 1989.

Some early morning observers of the planet Jupiter were startled in July to see that the planet presented only one dark equatorial belt when, as recently as last April and for over a decade before, there were *two* prominent equatorial belts on the planet! These two belts were the North Equatorial Belt (NEB) and the South Equatorial Belt (SEB). According to José Olivarez and Phillip W. Budine, A.L.P.O. Jupiter Recorders, the SEB began fading in May after more than a decade of prominence. The belt's fading continued during Jupiter's conjunction with the Sun and was quickly reported by early morning observers as a "pale ghost" of its former self when Jupiter emerged from the morning twilight. Indeed, at first glance, Jupiter did appear to have only one dark equatorial belt, the NEB, but closer scrutiny revealed the pale SEB!

At least two other events may be related to the current major change in the SEB. One of these is the astonishingly rapid retrograde motion of the Great Red Spot (GRS) that was observed from November, 1988, through July, 1989. The Red Spot's retrograde motion began with a sudden jump in the direction of increasing longitude in late November and the feature was still retrograding by the end of July. Additionally, when the GRS began retrograding, the white-spot activity in the SEBZ (South Equatorial Belt Zone) adjacent to the Red Spot Region suddenly became inactive. The SEBZ white-spot activity has been continually observed for about a decade.

What will happen next? Jupiter merits watching for the rest of 1989 and all of 1990. It is possible that the next events in Jupiter's

Southern Hemisphere will be the further darkening of the GRS and the return of the SEB to prominence through the explosive "South Equatorial Belt Disturbance" phenomenon, which was last seen to occur in 1975.

Observers are urged to observe Jupiter frequently, and its South Equatorial Belt in particular, looking for any more changes or signs of the reappearance of dark matter in the belt. Jupiter Recorder Olivarez will be glad to receive reports of SEB activity at his address, listed on the inside back cover.

Erratum.—We apologize to Mr. Donald H. De Karske for misspelling his name on page 103 of the last issue (July, 1989).

NON-A.L.P.O. BUSINESS

Amateur Events in 1990.—There are two other major amateur meetings in 1990; fortunately neither of them conflicts with the A.L.P.O.-A.L. meeting described on p. 190.

First, the **Astronomical Society of the Pacific** will have its first meeting away from the Pacific Basin; in Boston, Massachusetts, July 13-18, 1990. This is their 102nd meeting, which will be held with the International Amateur-Professional Photoelectric Photometry group (I.A.P.P.P.). Among other activities, there will be a teaching workshop, "The Universe in the Classroom" (July 14-15); and, on July 13-15, the "Symposium on Automated Telescopes and Global Networking." For more information, write to: Meeting Info., A.S.P., 390 Ashton Avenue, San Francisco, CA 94112.

Second, the **Western Amateur Astronomers** will meet with the **Riverside Telescope Makers Conference** at Camp Oakes (near Big Bear, southern California) on Memorial Day Weekend, May 25-27, 1990. There will be more information in notices in mid-winter in *Sky & Telescope* and *Astronomy* magazines.

Another form of 1990 event will be **Astronomy Day**, on April 28th. The A.L.P.O. will be a participant. If other groups also wish to take part, they should obtain the 120-page ($7.00 in the U.S.; check made out to "Astronomical League") *Handbook* for the event from: Gary E. Tomlinson, Astronomy Day Coordinator, Astronomical League, c/o Chaffee Planetarium, 54 Jefferson, S.E., Grand Rapids, MI 49503.

Optics for Africa.—Tanzania, East Africa, contains enthusiastic amateurs, with excellent observing conditions, who need binoculars or telescopes. If you are interested in donating your unused optics, write for more information to: Central Eye Health Foundation, c/o Dr. B.B.O. Mmbaga, P.O. Box 192, Kenga (via Dodoma), Tanzania, East Africa.

PUBLICATIONS OF THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

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Available from: A.L.P.O. Membership Secretary, P.O. Box 143, Heber Springs, AR 72543, U.S.A.—*The A.L.P.O.'s Observing Sections--1988/89.* *Free*; just send a stamped, self-addressed envelope. A 12-page description of each Observing Section's personnel, projects, and publications.

♦♦

Available from: Walter H. Haas, 2225 Thomas Drive, Las Cruces, NM 88001, U.S.A.— Back issues of ***The Strolling Astronomer (J.A.L.P.O.).*** The following are still in stock but may not long remain so. In this list, volume numbers are in ***italics***, issue numbers are not, years are given in parentheses, and prices are $1.50 per issue unless otherwise stated. Discounts can be arranged for purchases over $20. Make payment to "Walter H. Haas."

1 (1947); 4 and 6. ***8*** (1954); 7-8. ***11*** (1957); 11-12. ***15*** (1961); 11-12. ***18*** (1964); 11-12.
19 (1965-66); 5-6 and 7-8. ***20*** (1967-68); 7-8 and 9-10. ***21*** (1968-69); 3-4 and 7-8.
22 (1970-71); 7-8. ***23*** (1971-72); 3-4, 7-8, 9-10, and 11-12.
25 (1974-76); 1-2, 3-4, 7-8, 9-10, and 11-12.
26 (1976-77); 1-2, 3-4, 5-6, 9-10, and 11-12. [each $1.75]
27 (1977-79); 3-4, 5-6, 7-8, 9-10, and 11-12. [each $1.75]
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32 (1987-88); 1-2, 5-6, and 11-12. [each $2.50] ***33*** (1989); 1-3, 4-6, and 7-9. [each $2.50]
Current Issue [*33*, 10-12]—$3.00.

KEEPING YOUR MEMBERSHIP CURRENT—Because all A.L.P.O. memberships include a subscription to the *Strolling Astronomer (J.A.L.P.O.),* the top line of your mailing label gives the volume and issue number for which your membership will expire (e.g., "33.10" means Volume 33, Numbers 10-12). We also include a *First Renewal Notice* in that issue and, if necessary, a ***Final** Renewal Notice* with the following issue.
Please also let the Membership Secretary know if your address changes.

CONTRIBUTING TO *THE STROLLING ASTRONOMER (J.A.L.P.O.)*—We welcome reports and observations from our readers and our staff. Please submit typewritten, doubled-spaced copy. For articles more than two pages in length, begin with a 75-150 word abstract (our magazine is abstracted). Cite pertinent references in full, including page numbers. Fully document observations with the name and address of the observer; the observing site if different from the observer's address; the date and time in Universal Time; the telescope type, aperture (cm. preferred), and magnification; filters used if any; atmospheric conditions (seeing on the 0-10 A.L.P.O. scale; transparency as the limiting stellar magnitude in the vicinity of the object); and other data as pertinent to the object observed. Illustrations are welcome, although we cannot publish color. For low-contrast objects, contrasts should be exaggerated on drawings and photographs. Also, be sure to indicate celestial north or south, as well as celestial east or west if the image is laterally reversed.

With all communications with A.L.P.O. staff, please furnish a stamped, self-addressed envelope.

THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

Founded in 1947, the A.L.P.O. now numbers over 700 members. Our dues include a subscription to this quarterly Journal, The Strolling Astronomer, and are $14.00 for one year ($24.00 for two years) for the United States, Canada, and Mexico; and $16.00 for one year ($29.00 for two years) for other countries. One-year Sustaining Memberships are $20.00; Sponsorships are $40.00.

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