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Lunar dome fields near the craters Hortensius (center) and Milichius (upper left). Several domes are shown below Milichius and in the lower right of the photograph. Yerkes 40-inch (102-cm.) refractor plate Y163 [Kuiper Lunar Photographic Atlas Plate E4-d (Y)]. 1959 MAY 18, 01h 44m U.T., Colong. 035.1 degrees (morning lighting). South at top, lunar west (IAU) to right. The area shown is about 330 km. north-south by 270 km. east-west. See article on pages 61-72.

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IN THIS ISSUE

THE 1983-85 APPARITION OF JUPITER: ROTATION PERIODS

By: Phillip W. Budine, A.L.P.O. Jupiter Recorder

ABSTRACT

This report summarizes the results of 1270 visual central meridian timings submitted by 23 A.L.P.O. observers for the 1983-85 Apparition of Jupiter. Tables of 30-day drift rates and of resulting rotation periods are provided for ten features and currents. This discussion includes the remnants of the South Tropical Zone Disturbance, South Equatorial Belt dark spots, blue festoons in the North Equatorial Current, and a possible new South Tropical Zone Disturbance preceding the Red Spot area.

GENERAL

The 1983-85 Apparition of Jupiter fell between the successive conjunctions with the Sun of 1983 DEC 14 and 1985 JAN 14. Some data for the date of opposition are:

Date of Opposition: 1984 JUN 29, 16^h
Geocentric Declination: -23°.1
Apparent Equatorial Diameter: 46".8
Apparent Stellar Magnitude: -2.7
Zenocentric Solar Declination: -2°.2
Zenocentric Declination of Earth: -2°.3

The highlights of this apparition were the continuing observation of the remnants of the South Tropical Zone Disturbance, of South Equatorial Belt-South dark spots moving in the Circulating Current-North of the South Tropical Zone, of blue festoons in the North Equatorial Current, and the development of a possible new South Tropical Zone Disturbance preceding the Red Spot Area.

This report is based on 1270 visual central meridian transit timings contributed by the 23 A.L.P.O. observers listed in *Table 1*, below. When plotted on graph paper, 1054 of these transits defined usable drift-lines for 63 jovian markings distributed in nine different atmospheric currents. Thirty-three selected drift-lines are graphed in *Figures 2-5* (pp. 55-58), while some of the features discussed are illustrated in *Figures 6-10* (pp. 58-60).

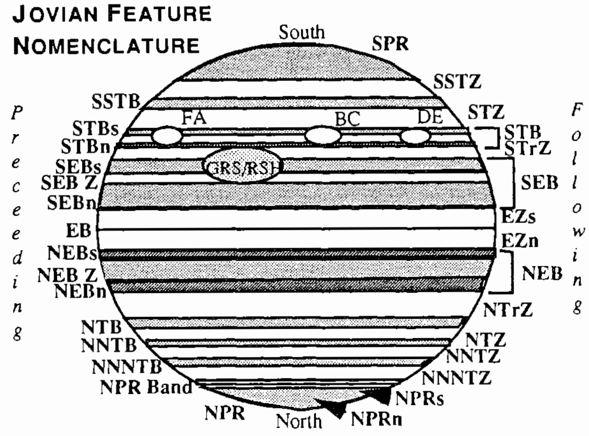
This report uses the standard jovian nomenclature, with features identified as shown in *Figure 1* (p. 50).

Table 1. Participating Observers, A.L.P.O. Jupiter Central Meridian Timings, 1983-85 Apparition.

Observer	Observing Site	Telescope *	Observation Type**
Adcock, Barry	Victoria, Australia	32-cm RL	*T, Photos.*
Barbany, Domenec	Barcelona, Spain	7.5-cm RR	*T, SS*
Benninghoven, Claus	Burlington, IA	20-cm RL	*T, SS*
Budine, Phillip W.	Walton, NY	8.3-cm M	*T, SS*
Daniels, Mark S.	Wichita, KS	20-cm RL	*T*
Dragesco, Jean	Rwanda, Africa	35-cm. RL	*Photos.*
Haas, Walter H.	Las Cruces, NM	32-cm RL	*T, SS*
Heath, Alan W.	Nottingham, England	30-cm RL	*T, SS*
Maksymowicz, S.	Moisson, France	8-cm RR, 15-cm RL	*T, SS*
McNamara, Geoff	Sydney, Australia	32-cm RL	*T*
Miyazaki, Isao	Okinawa, Japan	20-cm RL	*T, SS*
Morrow, M.J.	Ewa Beach, HI	40-cm RL	*SS*
Olivarez, José	Wichita, KS	32-cm RL	*T, SS*
Papp, Janos	Auomas, Hungary	25-cm RL	*T*
Park, Jim	Victoria, Australia	20-cm RL	*T*
Parker, Donald C.	Coral Gables, FL	32-cm RL	*Photos.*
Pedersen, Steen	Hinnerup, Denmark	10-cm RR	*T*
Robotham, Rob	Ontario, Canada	15-cm RL	*T, SS*
Ross, Terence	New Berlin, WI	32-cm RL	*T*
Scott, Pete	Indiana, PA	20-cm RL	*T*
Tatum, Randy	Richmond, VA	17-cm RR, 15-cm RL	*T, SS, Photos.*
Troiani, Daniel M.	Chicago, IL	25-cm RL	*T, SS*
Yandrick, Richard	Willow Grove, PA	20-cm RL	*SS*

* M = Maksutov Reflector; RL = Reflector (undifferentiated); RR = Refractor.
** *Photos.* = Photographs; *SS* = Strip Sketches; *T* = Transits.

JOVIAN FEATURE NOMENCLATURE



Abbreviation Key:

S, s = South	**B** = Belt
N, n = North	**Z** = Zone
E = Equatorial	**R** = Region
P = Polar	**GRS** = Great Red Spot
T = Temperate	**RSH** = Red Spot Hollow
Tr = Tropical	(**FA, BC,** and **DE** are long-term white spots)

Figure 1. Standard Jovian Nomenclature as used in this paper.

MOTIONS OF JOVIAN FEATURES

Explanation.--The longitudes, 30-day drift rates, and rotation periods that were derived from transit timings are given in *Tables 2-10* (pp. 51-55). In each table except 3, column one gives an identifying number or letter for each object. Column two indicates whether the object was dark (D) or bright (W); and whether the preceding end (p), center (c), or following end (f) was observed. The third column gives the first and last dates of transit observations; and the fourth column gives the appropriate longitudes on those dates. Column five gives the longitude at opposition (1984 JUN 29) if the feature existed at that time. The sixth column gives the number of transits observed. Column seven indicates the number of degrees in longitude that each marking drifted in 30 days, negative when the longitude decreased. The eighth and last column shows the corresponding rotation period in hours, minutes, and seconds. All longitudes are given in degrees. [They are given in "System I" or "System II" as appropriate. These two Systems are used as an approximate fit for the longitudes of most jovian atmospheric features. System I applies to the EZ, south edge of the NEB, north edge of the SEB, and the south edge of the NTB; its rotation period is 9h 50m 30.0s. System II applies to the rest of the disk (except the SEB Z, which is often intermediate between the two Systems). The rotation period of System II is 9h 55m 40.6s. In the text, which System is meant will be given following each longitude; e.g., 026°II. *Ed.*]

South Temperate Current.--The three long-enduring ovals (**FA**, **BC**, and **DE**) of the STZ Current continued to be followed by A.L.P.O. Jupiter Section observers. These features' appearances are shown in *Figure 6* (FA and BC; p. 58), *Figure 7* (FA; p. 59), *Figure 8* (FA, p. 59), *Figure 9* (DE, FA, and BC; p. 60), and *Figure 10* (DE; p. 60). The most conspicuous of the three was DE, followed by FA, while BC was the least obvious. Their mean lengths in degrees of longitude were: BC, 8°; DE, 10°; and FA, 8°. Note that Oval FA was in conjunction with the center of the Red Spot on 1984 JUN 30 at 026°II. *Table 2* (p. 51) gives rotation information for these features, along with features **2**, **3**, and **5**. Note that features **1**, **4**, and **6** simply refer to the centers of Ovals **FA**, **BC**, and **DE**, respectively.

The Red Spot.--During the 1983-85 Apparition, the Red Spot had a mean longitudinal length of 19°, with its aspect predominately that of the Red Spot Hollow (RSH). Prior to 1984 JUL 12, the Red Spot itself was seen in the following portion of the Hollow. The RSH had a very dark border during most of this apparition. By July 12, the Red Spot was seen as a dusky spot within the Red Spot Hollow interior; and by July 17, it was seen only in the extreme southern portion of the Hollow. The appearance of the Red Spot and Hollow is shown in *Figures 6-9*; its appearance on 1984 JUL 12, in particular, is shown in *Figure 7* (p. 59), a strip sketch by Daniel Troiani. From July 18 to early August, the Red Spot Hollow was extremely bright and prominent, as shown in *Figure 8* (p. 59), drawn on July 24. This was during the period when a darkening of the possible new South Tropical Zone Disturbance was developing. By mid-August, the Red Spot was becoming more prominent and dusky. This aspect is well shown in *Figure 9* (p. 60), an extended strip sketch done on 1984 AUG 15 by M. Maksymowicz.

Table 3, on p. 51, summarizes rotation data for the Great Red Spot during the 1983-85 Apparition.

Table 2. South Temperate Current (S. edge STB, STZ), System II. 1983-85 Apparition.
(Selected Features graphed in *Figure 2*, p. 55.)

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
F	Wp	MAR 07-SEP 17	078-348°	022°	22	-13°.9	09h 55m 22s
1	Wc	MAR 07-SEP 17	082-352°	026°	49	-13°.9	09 55 22
A	Wf	MAR 07-SEP 17	086-356°	030°	20	-13°.9	09 55 22
2	Wc	MAR 17-JUL 14	151-065°	075°	7	-21°.7	09h 55m 11s
3	Dc	JUN 05-JUL 19	085-041°	060°	5	-30°.0	09h 55m 00s
B	Wp	MAR 03-OCT 01	247-151°	183°	10	-13°.6	09h 55m 22s
4	Wc	MAR 03-OCT 01	251-155°	187°	29	-13°.6	09 55 22
C	Wf	MAR 03-OCT 01	255-159°	191°	12	-13°.6	09 55 22
5	Dc	AUG 11-OCT 08	220-189°	----	6	-16°.0	09h 55m 18s
D	Wp	FEB 28-OCT 13	316-221°	276°	31	-12°.5	09h 55m 24s
6	Wc	FEB 28-OCT 13	321-226°	281°	54	-12°.5	09 55 24
E	Wf	FEB 28-OCT 13	326-231°	286°	30	-12°.5	09 55 24
						Mean Rotation Period: *Excluding Features 2 and 3*	09h 55m 22s
						Features 2 and 3 only 09h	55m06s

Table 3. Great Red Spot (STrZ), System II. 1983-85 Apparition.
(Graphed in *Figure 2*, p. 55.)

Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
RSp	APR 21-NOV 23	022-010°	017°	49	-1°.7	09h 55m 38s
RSc	FEB 25-NOV 23	031-019	026°	69	-1°.3	09 55 39
RSf	APR 21-NOV 23	040-029°	036°	46	-1°.5	09 55 39
					Mean Rotation Period:	09h 55m 39s

South Tropical Zone Disturbance.--The "remnants" of the South Tropical Zone Disturbance which were observed in the 1982-83 Apparition continued to be observed in 1984. The extrapolation of the drift-line from 1982-83 for the preceding end of the South Tropical Zone Disturbance predicted it to be near 310°II in late February, 1984. Dr. Jean Dragesco observed a prominent preceding end on 1984 FEB 28 at 310°II! The preceding end was concave in shape with a preceding bright oval. In *Table 4* (p. 52), Feature **1** is the preceding bright oval and Feature **2** is the dark preceding end of the South Tropical Zone Disturbance. The following end (a remnant) was more difficult to observe, but was recovered on 1984 APR 08 near 105°II. This end was also followed by a bright oval. Feature **10** is the following end of the South Tropical Zone Disturbance, and Feature **11** is the bright oval that followed it. When we consider the expanse of longitude covered by its preceding and following ends, the length of the Disturbance when first observed in 1984 was 167°, and had increased to 225° by 1984 OCT 30, which was the latest date when both ends were observed.

Feature **3** is a bright oval and Feature **4** is a dark festoon, both of which follow the preceding remnant of the South Tropical Zone Disturbance and thus are located within the Disturbance.

On 1984 JUL 02, a very bright oval was observed by Dr. Dragesco in the STrZ near 359°II. At that time, the SEBs was very dark at that longitude. It also extended far south in latitude; and the STrZ was thus very narrow in this region. Prior to July 2, Benninghoven and Troiani had noted a dusky streak preceding the shoulder of the RSH near these longitudes, as shown in *Figure 7* (p. 59). By July 14, Domenec Barbany and Jean Dragesco had recorded a "revival" in darkness of the South Tropical Zone Disturbance! By the period of mid- to late-July, the Disturbance became more prominent; and good views were obtained by several A.L.P.O. observers, including Morrow, Dragesco, Heath, Barbany, Olivarez, and Budine. On 1984 JUL 24, the STrZ Disturbance had a well-developed concave preceding end and was 22° in length. By July 31, it was 35° long and was "fully developed," according to Olivarez. The appearance of its preceding end on July 24 is shown in *Figure 8* (p. 59).

Feature **12** is a prominent white oval in the STrZ, located between the remnants of the STrZ Disturbance.

Table 4. South Tropical Zone Disturbance (STrZ), System II. 1983-85 Apparition.
(Selected Features graphed in *Figure 3*, p. 56.)

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
1	Wc	FEB 28-OCT 30	304-202°	246°	17	-12°.5	09h 55m 24s
2	Dp	FEB 28-OCT 30	310-210°	252°	16	-12°.2	09 55 24
3	Wc	JUN 07-OCT 30	267-218°	260°	16	-10°.1	09 55 27
4	Dc	JUN 07-OCT 30	275-231°	275°	11	-9°.1	09 55 28
5	Wp	AUG 23-OCT 28	327-302°	----	9	-11°.4	09h 55m 25s
6	Wc	JUL 02-OCT 28	359-308°	----	21	-13°.0	09 55 23
7	Wf	JUL 22-OCT 28	352-314°	----	8	-11°.6	09 55 25
8	Dp	JUL 14-OCT 28	350-319°	----	15	-8°.8	09h 55m 29s
9	Df	SEP 10-NOV14	002-349°	----	11	-5°.9	09 55 33
10	Df	APR 08-OCT 29	105-075°	092°	16	-4°.4	09 55 35
11	Wc	APR 12-OCT 29	107-080°	097°	18	-4°.0	09 55 35
12	Wc	MAY 27-JUN 30	160-160°	160°	5	0°.0	09 55 41
						Mean Rotation Period:	09h 55m 29s

In the table above, Feature **6** is the center of the bright oval which became the oval preceding the preceding end of the Disturbance. Features **5** and **7** are this oval's preceding and following ends, respectively. Feature **8** is the dark preceding end of the Disturbance; and Feature **9** is the dark following end. Several of these numbered features (Features **1**, **2**, **6**, **8**, **10**, and **11**) are mapped in *Figure 9* (p. 60).

A first inspection of the data, regarding appearance, development, and periods, would lead us to consider this feature a new Disturbance. However, one important piece of evidence indicates the contrary: the absence of the Circulating Current [see Peek, 1958, Chapter 18] near this feature! No retrograding dark SEBs spots were observed within a Circulating Current-North, preceding or following the longitudes near *this feature*. However, the Circulating Current-North dark spots were active at this time, and were observed moving on the south edge of the SEB in retrograde motion up to the preceding remnant, and were moving away from the following remnant of the older South Tropical Zone Disturbance. Therefore, I believe that this new feature is actually a "revival" within the confines of the older South Tropical Zone Disturbance. The revived Disturbance was active and was seen through August and early September, 1984. It had mostly disappeared by 1984 SEP 20, although the preceding-end remnant of this feature was observed until 1984 OCT 28. The following-end remnant became more prominent in mid-September; and Walter Haas had a good series of observations of it from 1984 SEP 10 to NOV 14.

SEBs Dark Spots.--The four SEBs dark spots listed in *Table 5* below were located in the Circulating Current-Northern Branch (CCn). They were fast-moving dark spots and projections, traveling in a retrograding direction (longitude increasing with time) in the longitudes where the South Tropical Zone Disturbance was absent. Thus, they were located between the preceding and the following ends (remnants) of the Disturbance.

These dark spots were most active during three periods in 1984: early to late May; early July to late August; and late September to mid-October. It is interesting that the most SEBs dark spots were observed during the period when the STrZ Disturbance had revived; from early July to late August.

Table 5. South Edge SEBs, STrZn, CCn, System II. 1983-85 Apparition.
(Selected Features graphed in *Figure 3*, p. 56.)

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
1	Dc	MAY 07-MAY 18	235-273°	----	4	+103°.6	09h 58m 03s
2	Dc	MAY 14-MAY 21	240-264°	----	3	+102°.9	09 58 02
3	Dc	JUL 15-AUG 26	106-220°	----	9	+81°.4	09 57 32
4	Dc	SEP 30-OCT 05	134-148°	----	3	+84°.0	09 57 36
				Mean Rotation Period:		*Features 1 and 2*	09h 58m 02s
						Features 3 and 4	09h 57m 34s

Table 6. South Equatorial Belt Current (S. edge SEBn, SEB Z), System II. 1983-85 Apparition.

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
1	Df	SEP 10-OCT 28	002-000°	----	6	-1°.3	09h 55m 39s
2	Dp	SEP 11-NOV 19	030-029°	----	7	-0°.4	09 55 40
3	Wf	AUG 08-SEP 18	075-071°	----	6	-2°.9	09 55 37
4	Wc	SEP 06-OCT 01	082-082°	----	7	0°.0	09 55 41
						Mean Rotation Period:	09h 55m 39s

South Equatorial Belt Current.--The features of the South Equatorial Belt Current are listed above in *Table 6*. Note that their drift in System II longitude was very slow. Feature 1 was preceding the Red Spot Hollow, Feature **2** was near the following end of the RSH region, while Features **3** and **4** were near the longitudes of the following end (remnant) of the South Tropical Zone Disturbance.

North Equatorial Current.--Features in the North Equatorial Current are listed in *Table 7*, below. The most active features of this current were the "Olivarez Blue Features" of the NEBs-EZn latitudes. José Olivarez first drew our attention to these features in 1983, when he noted twelve of them located in this current. Seven of these 1983 features were long-lived and continued to be observed throughout the 1983-85 Apparition of Jupiter. The long-lived features first seen in 1983 are the first listed in the table below.

In addition, seven more new blue features were observed by Olivarez and other A.L.P.O. observers in 1983-85. The new "Olivarez" (OL-) blue features are listed under "1984" in *Table 7*. The mean rotation period for all 14 OL-features is 09h 50m 31s.

Table 7. North Equatorial Current (S. edge NEBs, EZn), System I. 1983-85 Apparition.

a. Olivarez Blue Features (Features graphed in *Figure 4*, p. 57).

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
1983:							
OL-1	Dc	JUN 01-NOV 23	074-066°	070°	26	-1°.4	09h 50m 28s
OL-2	Dc	MAY 17-DEC 10	096-104°	104°	26	+1°.2	09 50 32
OL-3	Dc	APR 15-OCT 28	135-162°	138°	24	+4°.1	09 50 36
OL-4	Dc	MAR 30-NOV 04	182-170°	172°	20	-1°.6	09 50 28
OL-5	Dc	APR 26-OCT 29	282-305°	290°	31	+3°.7	09 50 35
OL-6	Dc	APR 28-NOV 11	324-332°	332°	29	+1°.2	09 50 32
OL-7	Dc	FEB 26-NOV 23	039-042°	039°	33	+0°.3	09 50 30
1984:							
OL-1	Dc	JUN 12-NOV 09	188-191°	189°	14	+0°.6	09h 50m 31s
OL-2	Dc	JUN 03-OCT 01	225-229°	228°	21	+1°.0	09 50 31
OL-3	Dc	MAY 27-AUG 25	247-246°	247°	5	-0°.3	09 50 30
OL-4	Dc	JUL 28-SEP 12	256-255°	----	8	-0°.7	09 50 29
OL-5	Dc	JUL 14-NOV 09	196-191°	----	13	-1°.3	09 50 28
OL-6	Dc	AUG 26-NOV 11	357-349°	----	9	-3°.1	09 50 26
OL-7	Dc	AUG 19-NOV 23	010-014°	----	16	+1°.3	09 50 32
						Mean Rotation Period:	09h 50m 31s

b. Other Features.

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
1	Wc	OCT 18-NOV 15	053-051°	----	7	-2°.1	09h 50m 27s
2	Wc	OCT 30-NOV 10	090-092°	----	6	+5°.5	09 50 37
3	Wc	JUL 20-NOV 09	205-209°	----	15	+1°.1	09 50 31
4	Dc	OCT 21-NOV 16	269-264°	----	4	-5°.8	09 50 22
5	Wc	MAY 17-JUN 07	111-110°	----	6	-1°.4	09 50 28
						Mean Rotation Period:	09h 50m 29s

Thermal-infrared images of Jupiter taken mostly at the Anglo-Australian Observatory, and the NASA Infrared Telescope Facility on Mauna Kea, along with near-infrared photographs by Donald Parker, reveal interesting data about the NEBs-EZn latitude zone. The images at 4.8-microns wavelength show the warmth generated by Jupiter's interior, and thus the regions of the planet where we can see deepest into the atmosphere are those that appear brightest in this band. This region is mainly the Equatorial Belts. Small holes in the cloud deck at the latitude of the NEBs show us deeper. hotter regions of Jupiter whose temperatures are about 300K. These areas appear as brilliant spots in the thermal infrared and as blue spots in the Voyager images.

The Olivarez Blue Features constitute some of these blue spots; they may well represent some of the deepest and hottest areas visible on Jupiter. They may also be unique in another way! Earlier, José Olivarez (1984) suggested that these features may be isolated from the rest of the North Equatorial Current features and that one evidence of this would be "differences" between them and other features in the North Equatorial Current. He also said, "..that this may be difficult to prove because most features are blue."

In 1983, seven blue features had a mean period of 09h 50m 29s, while ten non-blue features had a mean period of 09h 50m 30s. In 1984, the mean period for all fourteen blue features listed in *Table 7* was 09h 50m 31s.

The only non-blue dark feature whose rotation rate was determined in the 1983-85 Apparition was Feature **4**, which had a mean period of 09h 50m 22s! This was indeed a "different" period--but with only one feature. The evidence is thus weak, especially because ten non-blue features in 1983 yielded a mean period of 09h 50m 30s.

One very interesting point, however, is that *only* the "Blue Features" are long-lived! More scrutiny should be given to these important features in Jupiter's North Equatorial Current.

Finally, in *Table 7*, Features **1**, **2**, and **3** are bright plumes in the NEBs that are associated with the blue features. Feature 1 follows OL-7 (1983); Feature **2** precedes OL-2 (1983); and Feature **3** follows OL-1 (1984).

North Equatorial Belt Current.--The one feature noted here in 1983-85 is given in *Table 8*, below. This was a "bright outbreak" (NEB Disturbance) located near 341°II when first seen on 1984 JUL 02 by Claus Benninghoven. It was well observed by Benninghoven, Robotham, Barbany, Parker, and Maksymowicz. A similar "bright outbreak" occurred in the 1982-83 Apparition, when it was first noted near 220°II by Donald Parker on 1983 JUL 01.

North Tropical Current.--This current's features are summarized in *Table 9*, below. In that table, Features **1-3** were dark features moving in the North Tropical Current A, while Features **4-7** were drifting in the North Tropical Current B.

North North Temperate Current.--The single feature in this current whose rotation period was studied is given in *Table 10* (p. 55), and was moving in the North North Temperate Current A.

Table 8. North Equatorial Belt Current (NEB Z), System II. 1983-85 Apparition.
(Feature graphed in *Figure 5*, p. 58)

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
1	Wc	JUL 02-AUG 28	341-242°	----	16	-52°.1	09h 54m 29s

Table 9. North Tropical Current (N. edge NEB, NTrZ), System II. 1983-85 Apparition.
(Selected features graphed in *Figure 5*, p. 58)

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
1	Dc	JUN 25-OCT 07	049-050°	049°	15	+0°.3	09h 55m 41s
2	Dc	MAY 17-JUN 30	092-090°	----	8	-1°.4	09 55 39
3	Dc	JUN 03-NOV 19	153-082°	140°	16	-12°.6	09 55 23
4	Wc	AUG 24-SEP 23	165-122°	----	6	-43°.0	09 54 42
5	Dp	AUG 16-SEP 09	202-173°	----	5	-36°.3	09 54 51
6	Dc	SEP 04-NOV 09	324-249°	----	9	-33°.6	09 54 55
7	Dc	SEP 17-NOV 16	332-277°	----	8	-27°.0	09 55 04
						Mean Rotation Period: *Features 1-3*	09h 55m 34s
						Features 4-6	09 54 49
						Feature 7	09 55 04

Table 10. North North Temperate Current (NNTB, NNTZ), System II. 1983-85 Apparition.

Ident.	Mark	Limiting Dates (1984)	Limiting Longitude	Opposition Longitude	No. of Transits	30-day Drift Rate	Period
1	Df	JUN 25-JUL 24	028-029°	028°	7	+1°.0	09h 55m 42s

In conclusion, I would like to thank each person who contributed to the 1983-85 Apparition of Jupiter. Every observation is greatly appreciated.

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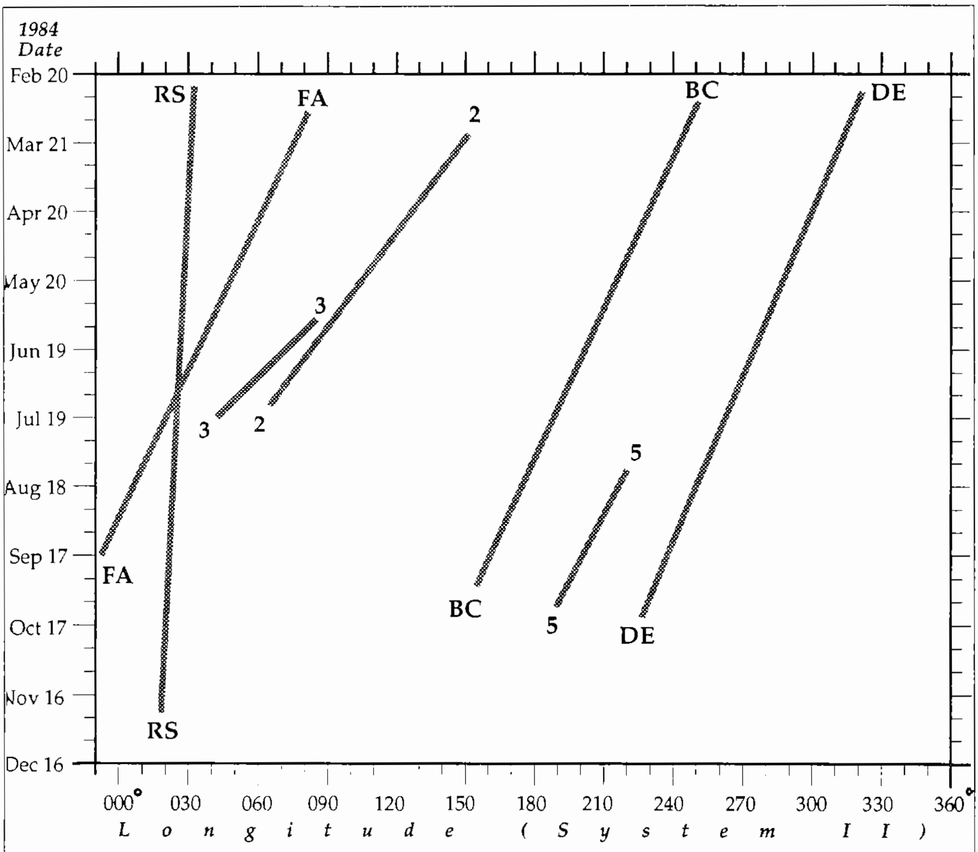

Figure 2. Drift chart, plotting System II longitude versus date, of important features on Jupiter during the 1983-85 Apparition. Actual drifts are approximated by straight lines. The lines for Ovals FA, BC, and DE represent their centers. This chart shows the Great Red Spot (RS) and features in the South Temperate Current. See also *Tables 2* and *3* in the text (p. 51).

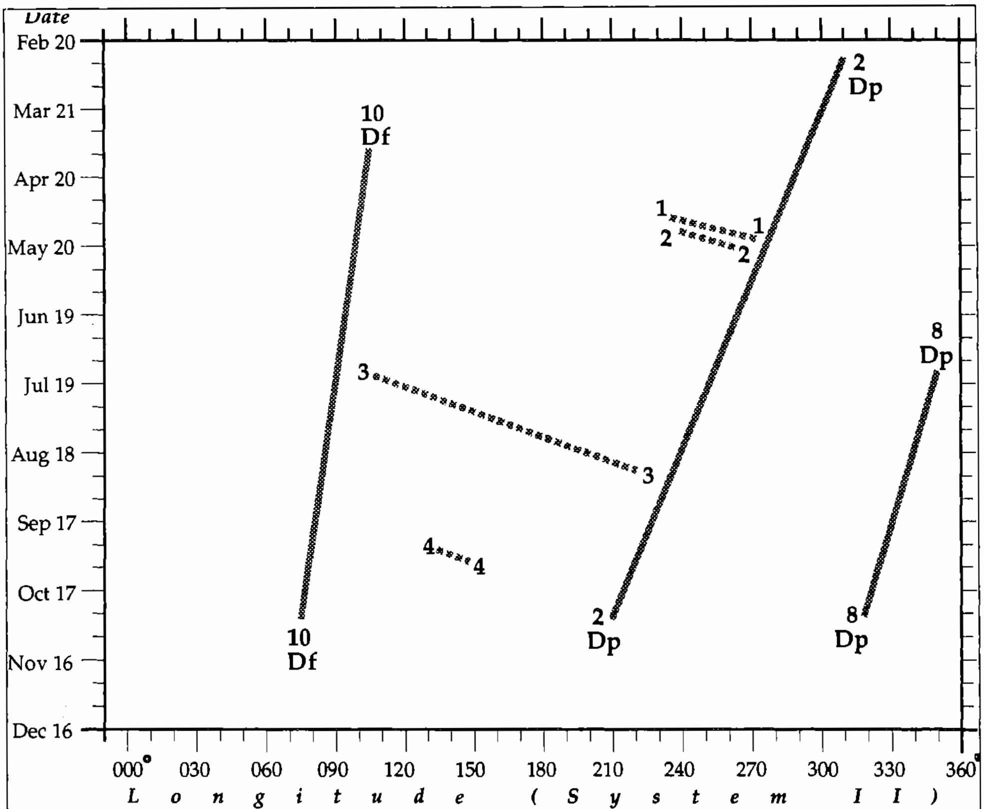

Figure 3. Drift chart, plotting System II longitude versus date, of important features on Jupiter during the 1983-85 Apparition. Actual drifts are approximated by straight lines. This chart shows features in the South Tropical Zone (STrZ) and the South Equatorial Belt-South Component (SEBs). SEBs features are shown with dashed lines. See also *Tables 4* and *5* in the text (p. 52).

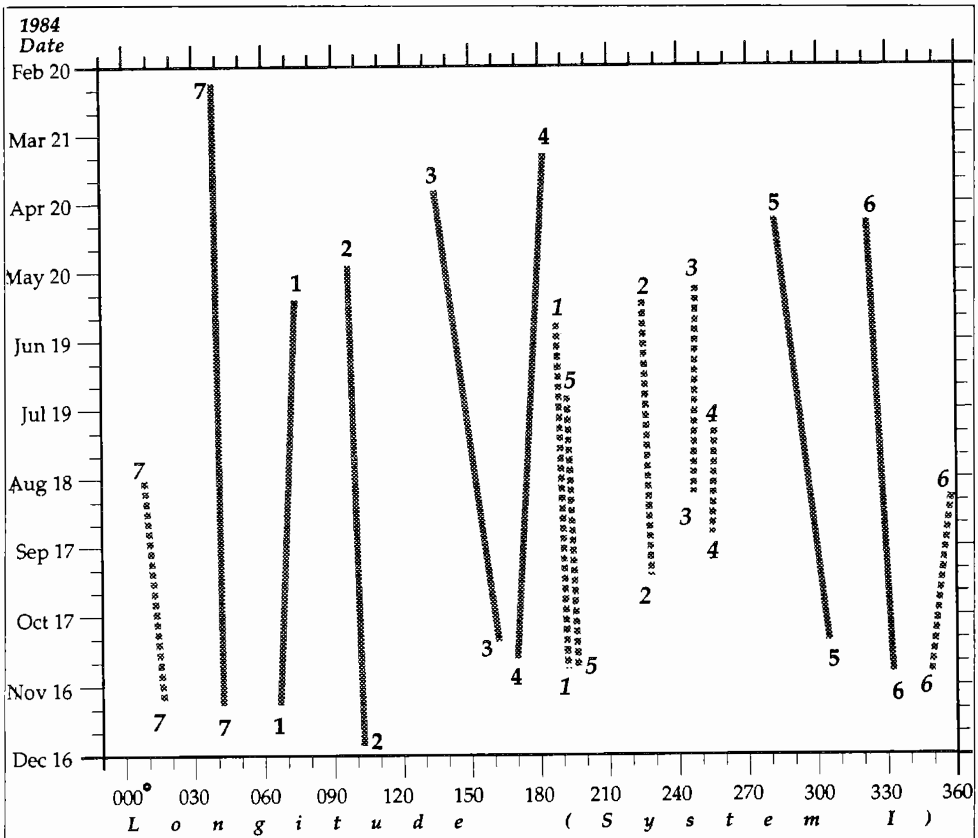

Figure 4. Drift chart, plotting System I longitude versus date, of important features on Jupiter during the 1983-85 Apparition. Actual drifts are approximated by straight lines. This chart shows "Olivarez" (OL-) blue features in the North Equatorial Current (NEBs-EZn). OL-features discovered in the 1982-83 Apparition are shown with solid lines; those discovered in the 1983-85 Apparition are shown with dashed lines. See also *Table 7* in the text (p. 53).

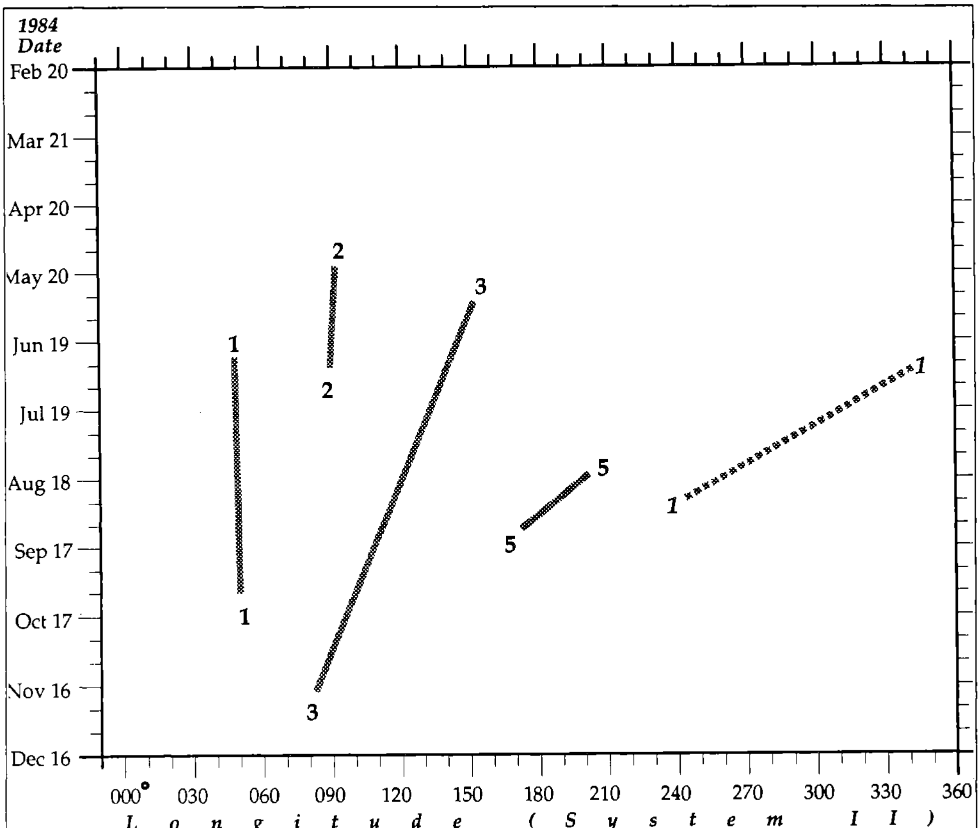

Figure 5. Drift chart, plotting System II longitude versus date, of important features on Jupiter during the 1983-85 Apparition. Actual drifts are approximated by straight lines. This chart shows a feature in the North Equatorial Belt Current (NEB Z) with a dashed line; and features in the North Tropical Current (N. edge NEB, NTrZ) with solid lines. See also *Tables 8* and *9* in the text (p. 54).

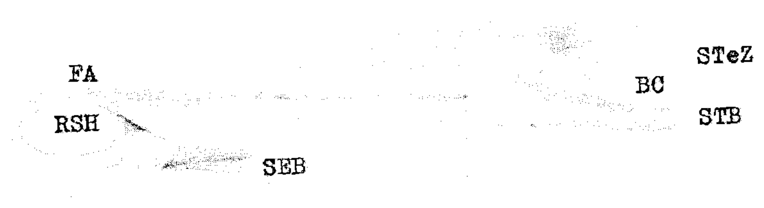

Figure 6. Strip drawing of a portion of Jupiter. Drawn by Claus Benninghoven on 1984 JUN 30 covering System II longitudes 015-250°. 20-cm reflector, 210X and 240X. Seeing 4-7, Transparency 5. (Unless otherwise stated, seeing is given on the A.L.P.O. scale, which ranges from 0 for worst to 10 for best. Transparency is on the A.L.P.O. scale, ranging from 0 for worst to 5 for best.)

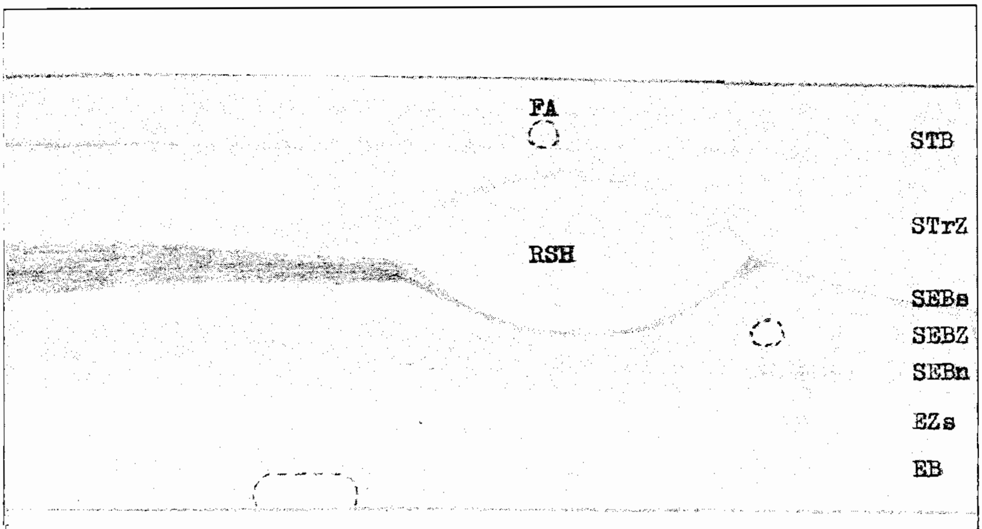

Figure 7. Strip drawing of a portion of Jupiter. Drawn by Daniel M. Troiani on 1984 JUL 12, at 03h17m-03h31m U.T. Longitude range: 136-144° I, 032-041° II. 25-cm reflector, 410X. Seeing 6, Transparency 5.

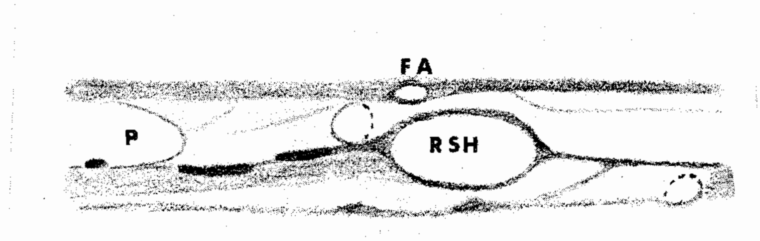

Figure 8. Sectional drawing of a portion of Jupiter. Drawn by Phillip W. Budine on 1984 JUL 24, at 02h05m-03h15m U.T. Longitude range: 353-035° II. 8.3-cm Maksutov reflector, 160X and 200X. Seeing very good, Transparency excellent. Note the STB Oval FA, the preceding end of the newer STrZ Disturbance, the bright STrZ Oval, and the bright Red Spot Hollow.

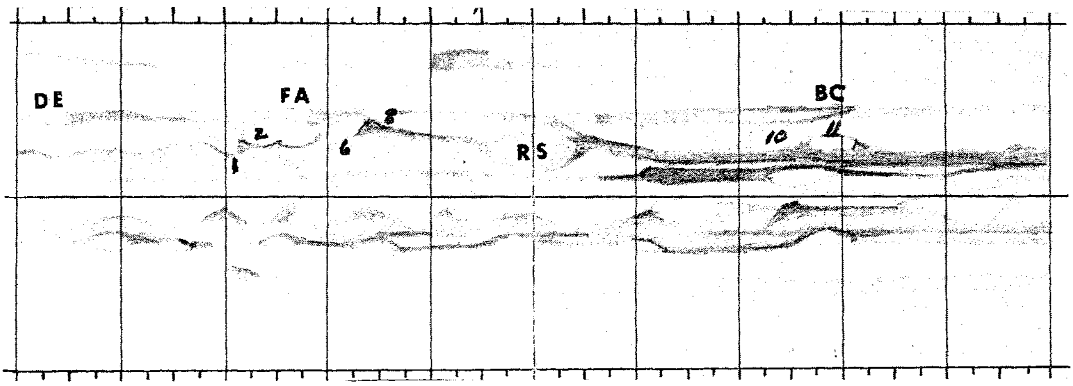

Figure 9. Extended drawing of a portion of Jupiter. Drawn by S. Maksymowicz on 1984 AUG 15, centered on 00h U.T., corresponding to longitude 346° I, 344° II. 15-cm reflector, 150X and 225X. Seeing fair-good, Transparency good-very good. Note the STB Ovals DE, FA, and BC and the Red Spot area. Numbers indicate features in the South Tropical Zone Disturbance as listed in *Table 4* (p. 52).

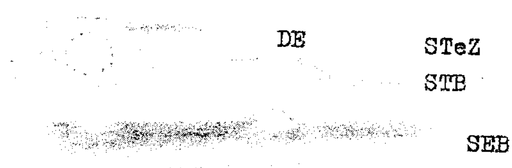

Figure 10. Strip drawing of a portion of Jupiter. Drawn by Claus Benninghoven on 1984 OCT 08 at longitudes 190-235° II. 20-cm reflector, 210X and 237X. Seeing 4-6, Transparency 5.

THE NEW LUNAR DOME SURVEY: THE HORTENSIUS-MILICHIUS-TOBIAS MAYER REGION

By: Jim Phillips, M.D., A.L.P.O. Lunar Recorder

ABSTRACT

Lunar domes are somewhat mysterious, low discrete swellings, chiefly located in the lunar *maria*. The original A.L.P.O. Lunar Dome Survey, active from 1962-70, was revived in 1986. This report presents our present knowledge of the dome concentration found near the craters Hortensius, Milichius, and Tobias Mayer in the Oceanus Procellarum. A comprehensive, annotated list of lunar domes in this region is included, along with a number of drawings and photographs of these features.

Lunar domes are curious, somewhat mysterious features. They are, as the name implies, dome-like swellings found upon the lunar surface. They appear to be located primarily, although not exclusively, within the lunar *maria*. These objects are elusive because they have very gentle slope angles, making them visible only when near the lunar terminator. In fact, domes tend to blend into their surroundings when they are more than 8-10° from the terminator. This explains why many domes are not visible on Lunar Orbiter photographs, because these photographs were taken under a moderately-high Sun. [*4, 6*]

While no single definition will ever work all the time, a working definition of lunar domes was set forth by John Westfall in 1964, when he simply stated that a lunar dome is a discrete regular swelling whose ratio of major axis:minor axis, when corrected for foreshortening, does not exceed 2:1, and whose maximum slope, not including secondary features, does not exceed 5°. A dome complex is defined as any object similar to a dome which has two or more contiguous swellings or an irregular vertical profile. [*4, 30*]

What a lunar dome really represents is not known. Goodacre classified them under "Isolated Mountains" in the introduction of his book, *The Moon* (1931, p. 22). He stated that "Another class of elevations which, though few in number are of the highest interest, exist. These are the dome or bubble-shaped hills, some of which have crater-like openings on their summits. . .The nature of these objects is at present obscure." [*10*] In 1908, W.H. Pickering suggested that the dome near Kies represented a shield volcano. [Cited in *2*, p. 392] Many domes have central crater pits, and the presence of a crater pit would be consistent with this theory. Not all domes have crater pits on their surfaces, however, and lava flows consistent with shield volcanos are not seen. Another suggestion, therefore, is that domes represent surface upheaval by underlying forces, perhaps molten magma. The surface pit is then formed by collapse or explosion. [*2*]

In 1962, the Association of Lunar and Planetary Observers (A.L.P.O.) initiated a study of lunar domes, with Harry D. Jamieson named as Recorder. The study was joined by the British Astronomical Association (B.A.A.) Lunar Section under the leadership of W.L. Rae, and a joint A.L.P.O.-B.A.A. Lunar Dome Survey was begun. The first edition of a joint A.L.P.O.-B.A.A. catalog was published in May, 1965. [*18*] Lunar dome observations continued after this, and a catalog of 134 domes was published by the A.L.P.O. in February, 1969. [*7*] In January, 1970, an additional 15 domes were added and a map was published. [*5*] After this, while observations continued, no further catalogs or maps were published, and a final catalog was never produced.

In 1986, after a long lapse, I, with the help of Harry Jamieson and John Westfall, decided to reopen the lunar dome program with the primary goal of "cleaning up" the large numbers of observations and data which never had been reduced. The final goal is to publish a lunar dome catalog based on observations from the period described above, supplemented by more recent observations, and a detailed lunar map on which these domes are plotted.

To prepare for the New Lunar Dome Survey (NLDS), I obtained the files from the A.L.P.O., which contained observations of approximately 600 confirmed or suspected lunar domes. These objects were plotted on the Lunar Quadrant Maps after receiving permission for republication from the University of Arizona Press and from Sky Publishing Corporation. One symbol (⊕) was used to indicate the domes taken from the catalog of 149 domes published by the A.L.P.O., and a separate symbol (⊕) was used for unconfirmed domes. This constituted the working map for the NLDS. The project is now carried out by amateurs who are willing to observe these objects and to classify them.

Looking over the working map, it is easy to see that several areas appear cluttered. One such area is the Hortensius-Milichius-Tobias Mayer region in Oceanus Procellarum, shown in *Figure 11* (p. 62). This region has been studied by lunar observers for many years, and contains a large number of domes. An observation of the domes north of Hortensius by

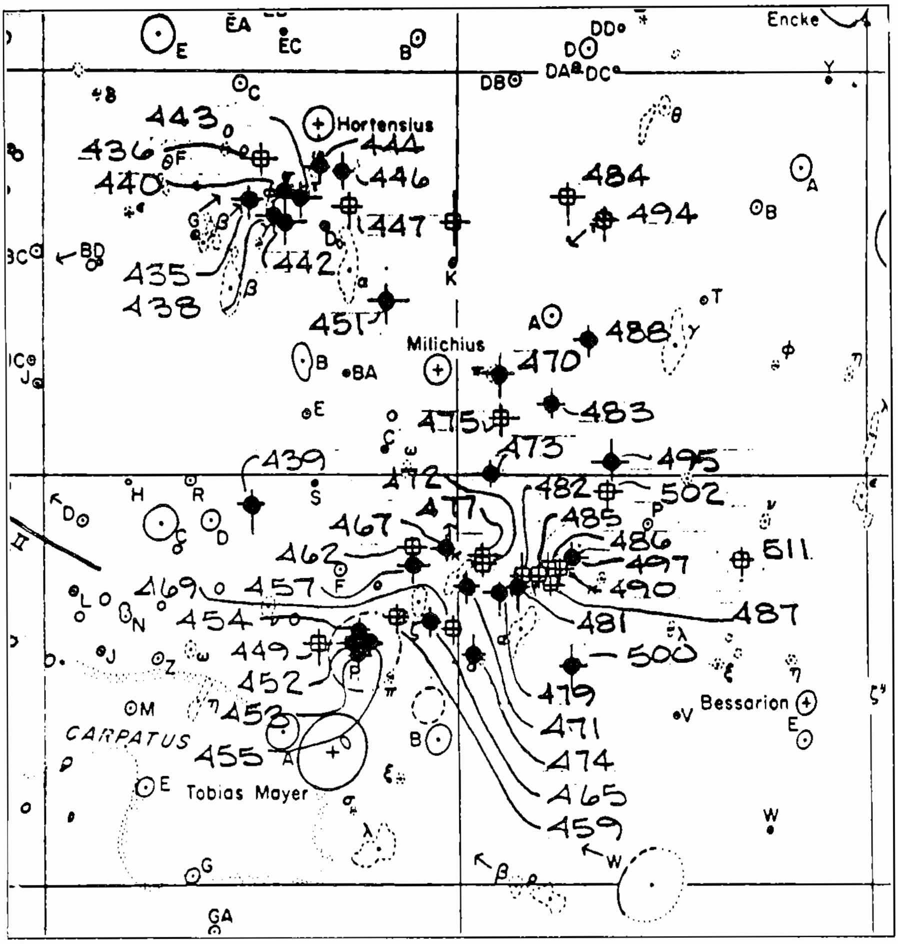

Figure 11. New Lunar Dome Survey (NLDS) working map of the Hortensius-Milichius-Tobias Mayer region in Oceanus Procellarum. Identifying numbers are those used by the NLDS. South is at the top, lunar west (i.e., the direction of Grimaldi) to the right. The square grid shown has a spacing of 0.1 lunar radii (i.e., 173.8 km.). The base map is the *Lunar Quadrant MAP II*, published by the University of Arizona Press. Symbols explained on p. 61.

Schlumberger was published in Goodacre's *The Moon* (p. 127), and is reproduced here as *Figure 12* (p. 63). S.R.B. Cooke's 1935 observations of many of these domes were published in the B.A.A. *Memoir*, Vol. 36, Part I (1947). Cooke recorded seventeen domes. K.W. Abineri made observations of this area on 1949 APR 8, recording twenty domes. Abineri confirmed the existence of Cooke's domes, although some differences were noted. [*27*] Domes in this area are also present in the first catalog of lunar domes published by Moore and Cattermole (see *Figures 15* and *16*; p. 66). [*24*]. In addition, numerous articles on this region have been published by observers both from the A.L.P.O. and the B.A.A. *Figures 13* and *14* (pp.64 and 65) show this region as charted by W.L. Rae in 1964 and S.R.B. Cooke in 1935 respectively. [*27*]

Using articles and observations from the *Journal of the Association of Lunar and Planetary Observers*, the *Journal of the British Astronomical Association*, *The Moon*, and *Sky & Telescope*, in addition to many other, unpublished observations from the A.L.P.O. files, I have tried to clarify our present knowledge of domes in this region. Besides reports by amateur observers, I have paid special attention to the *Times Atlas of the Moon*, Kopal's *New Photographic Atlas of the Moon*; the *Copernicus Quadrangle of the Moon* by H.H. Schmitt, N.U. Trask, and E.M. Shoemaker (LAC-58), the *Kepler Quadrangle of the Moon* by R.J. Hackman (LAC-57), and Gerard P. Kuiper's *Photographic Lunar Atlas.* [*3, 8-9, 12-22, 25-29*] Several of these are shown here as *Figures 17-19* (pp. 67-68 and 70) and the front cover.

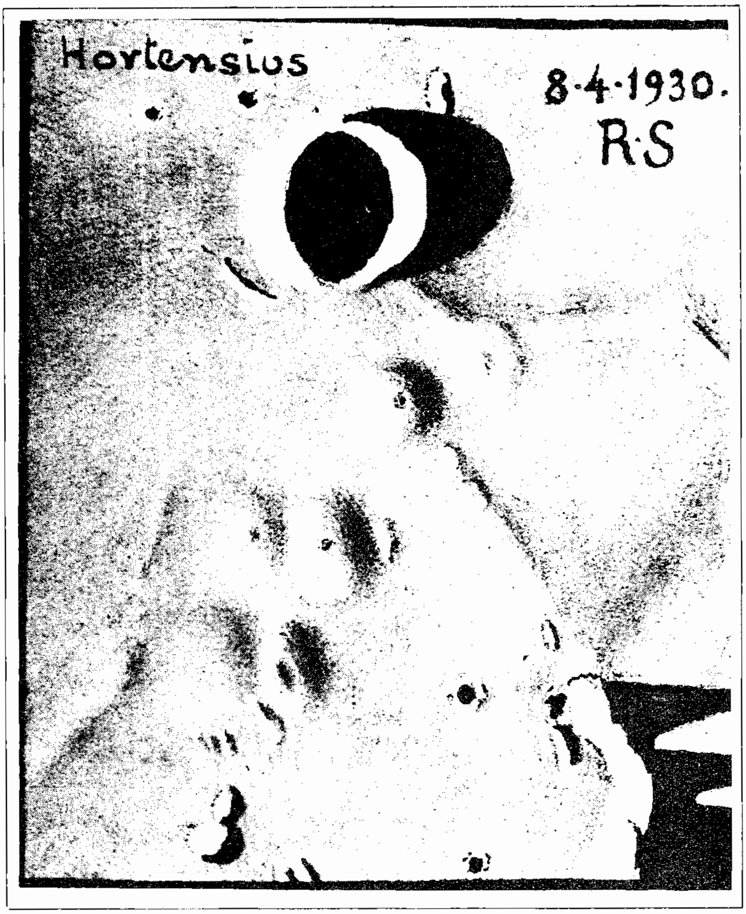

Figure 12. Drawing of domes north of Hortensius by Schlumberger on 1930 APR 08. Reproduced from *The Moon* by Walter Goodacre (1931). South at top.

I decided, if at all possible, to retain the domes from the original catalog's list of 149, published by the A.L.P.O., without making changes. These domes represent our "Messier's List;" and even if some might, under great scrutiny, not hold up as classical examples of domes, this list is of historical importance and I believe that it should remain unchanged at least for now. Each dome or suspected dome on our working map was compared to the sources described above. The results of this comparison are given in *Table 1* (pp. 69-70). The only domes that I have added to the list are those which were present on the U.S. Geological Survey charts, although not on our working map, and which have been confirmed photographically. I have also added the small group of four domes south of Hortensius. A drawing, which I believe represents the most accurate chart of lunar domes in this region to date, is given here as *Figure 21* (p. 72). This drawing is based upon chart E4-a in Kuiper's *Photographic Lunar Atlas*, and the domes have been drawn in as accurately as possible.

The domes north of Hortensius and those near Milichius are consistently shown on all photographs inspected. I have dubbed the six domes north of Hortensius the "Schlumberger Domes" because of his drawing of them. [*10*] Schlumberger discovered the summit craterlets on these domes. Dome No. 475 is suggested as a whitish patch in Kuiper's *Photographic Lunar Atlas*, but more observations are needed. Dome No. 488 is also present on photographs of the area, but there is some question about how steep its slope angle is.

One region of confusion is that south of Tobias Mayer. Here, there is a discrepancy between our observations, *The Times Atlas of the Moon*, and the U.S. Geological Survey charts. Certainly, these detailed charts are extremely accurate. Interestingly, an important aspect of this survey was to see if those charts were indeed so accurate that the New Lunar Dome Survey (NLDS) would be redundant; only re-confirming those domes already indicated on the U.S. Geological Survey charts. Clearly, while these charts are very good, they do not accurately depict all the lunar domes in this region. First, Dome No. 471 is clearly seen on our chart, and in photographs, as hugging the mountain range to its east. This dome

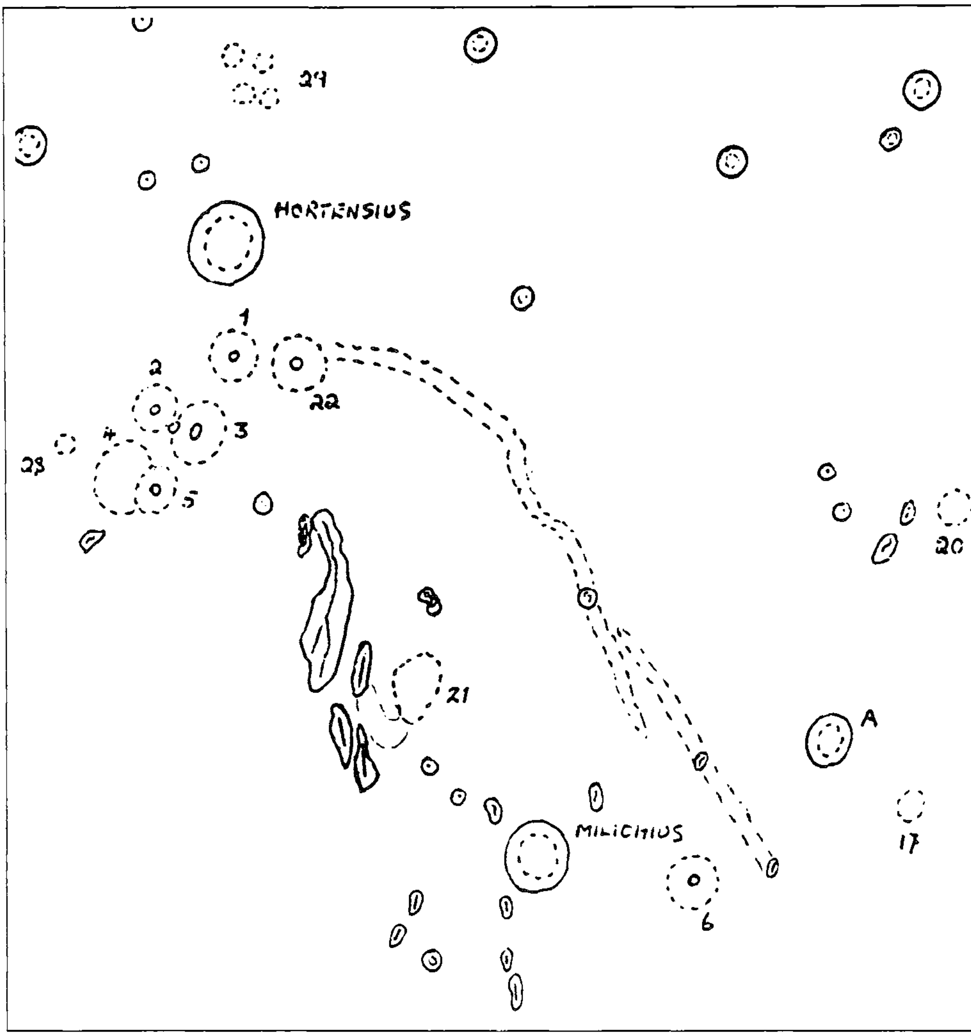

Figure 13. Domes near Hortensius and Milichius as mapped by W.L. Rae in 1964. South at top, lunar west to right.

is depicted inaccurately on the U.S. Geological Survey chart, as can be seen by comparing *Figures 18 and 19* (pp. 68 and 70) and the *front cover*. In fact, our final map contains domes not noted on the U.S. Geological Survey charts. Several domes are missing in difficult areas. The cluster of domes in Tobias Mayer P is shown as only two elongated dome-like areas, instead of being accurately depicted as was done by Cooke in 1935 (see *Figures 14, 17, and 19*; pp. 65, 67, and 70) and the *front cover*. These domes are not shown at all on the Times Atlas! The domes indicated as "A" and "B" were added to the list because of their presence on the U.S. Geological Survey charts. They are also present on plates E4-a and E4-d (Y) in Kuiper's *Photographic Lunar Atlas* (see *Figure 19*, p. 70, and the *front cover)*, and I observed "A" clearly on 1988 DEC 18, using a 6-inch (15-cm.) f/12 apochromat. This observation allowed me to correct the position of "A" as is shown with an arrow on the map (*Figure 21*, p. 72). As we have already said, the cluster of four domes (No. 29 on *Figure 13*; above) was also added.

The cluster of three small domes, Nos. 485-487, is suggested on a drawing made by Harold Hill on 1988 FEB 27, using a 10-inch (25-cm.) f/6 reflector. I observed this area on 1988 DEC 18 with a 6-inch (15-cm.) f/12 apochromat; the seeing was 6, occasionally settling down to 7-8 for a few seconds at a time [seeing is on the A.L.P.O. scale, ranging from 0 for worst to 10 for best]. The cluster of three domes was glimpsed on several occa-

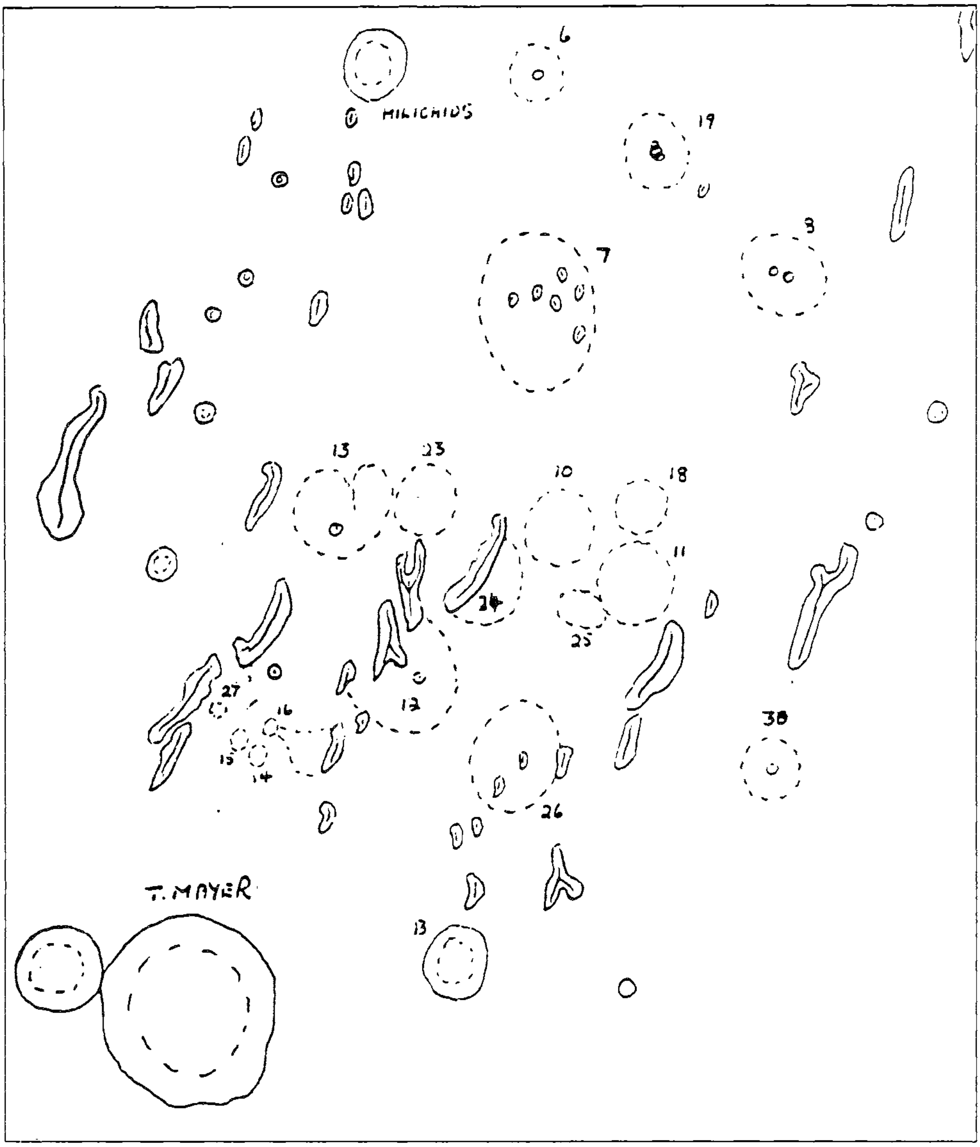

Figure 14. Domes near Milichius and Tobias Mayer as mapped by S.R.B. Cooke in 1935. South at top, lunar west to the right.

sions and was held steadily on one. The cluster is seen on Plate E4-d (Y) of Kuiper's *Photographic Lunar Atlas*, shown here on the *front cover*. Dome No. 497 is a difficult object, located in an area of hills. Additional observations of these objects are suggested.

Other domes are confirmed as indicated in *Table 1*; domes Nos. 436, 447, 459, 462, 475, 484, 490, 494, and 502 were deleted.

The Hortensius-Milichius-Tobias Mayer region of the Moon contains a vast field of lunar domes and has been mapped by many observers in the past. In the 1960's and early '70's, observations by amateur astronomers added significant numbers of potential domes to this region. These observations, however, remained unconfirmed within the A.L.P.O. files until 1986, when the New Lunar Dome Survey was begun. *Figure 21* (p. 72), a detailed chart of lunar domes within this region, is the result of a detailed investigation of these objects, using the sources already mentioned. Questions remain, additional observations are warranted; and, no doubt, domes are yet to be discovered. Even so, this chart, felt to be the most accurate of this region's domes yet published, is presented to the A.L.P.O. as a guide to this region for the active lunar observer.

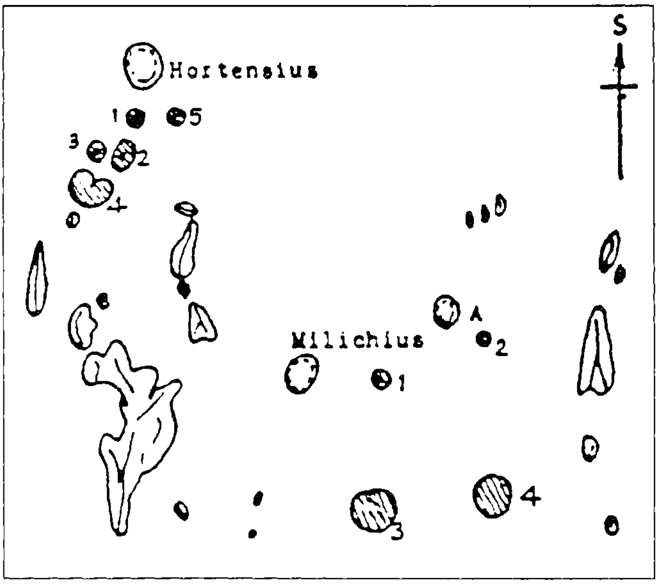

Figure 15. Domes near Hortensius drawn by Moore and Cattermole (1957). South at top, lunar west to the right.

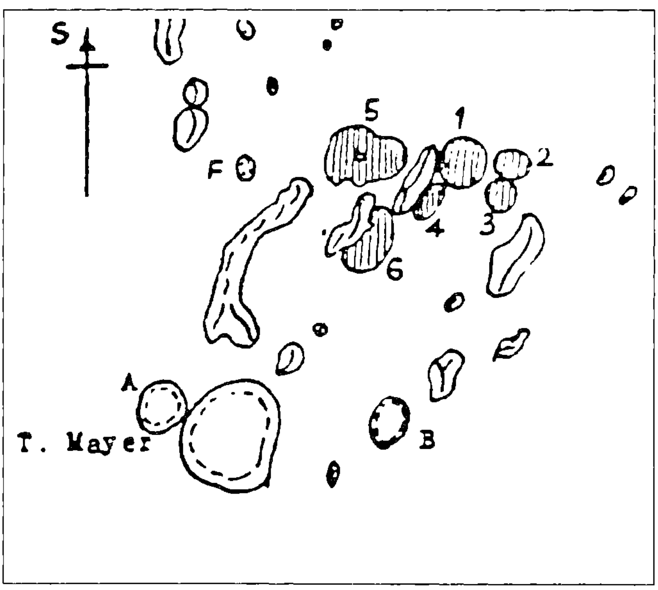

Figure 16. Domes near Tobias Mayer drawn by Moore and Cattermole (1957). South at top, lunar west to the right.

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Figure 17. Reduced section of U.S. Geological Survey *Copernicus Quadrangle* (LAC-58). Original scale 1:1,000,000. The latitude/longitude grid spacing is 2°. North at top, lunar west to the left. Features identified as domes are in dark grey, with the larger units labeled "Ipd."

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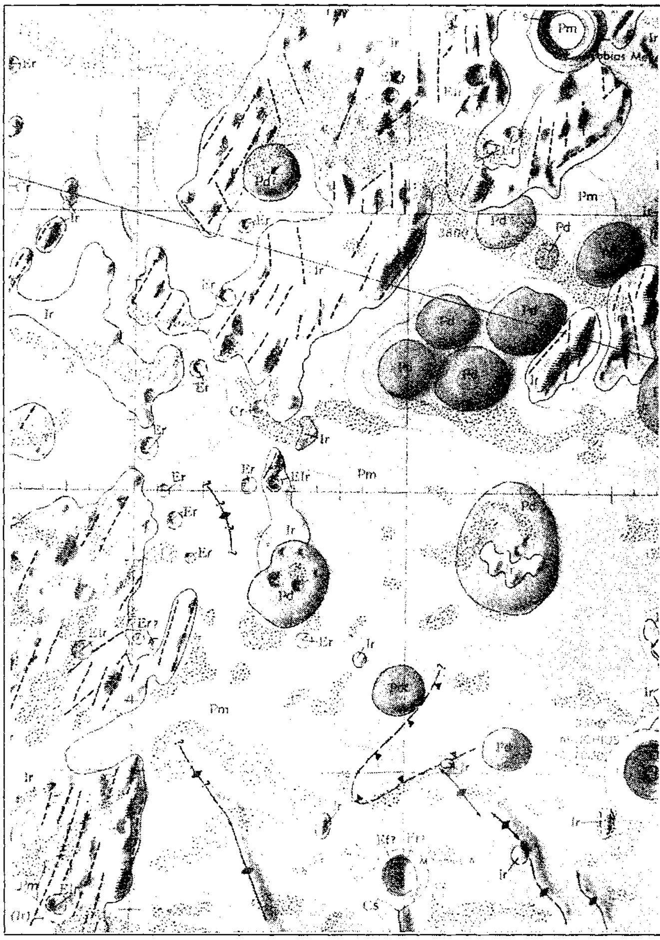

Figure 18. Reduced section of U.S. Geological Survey *Kepler Quadrangle* (LAC-57). Original scale 1:1,000,000. The latitude/longitude grid spacing is 2°. North at top, lunar west to the left. Features identified as domes are in dark grey, labeled "Pd."

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[*Table 1 begins on p. 69*]

Table 1. Domes in the Hortensius-Milichius-Tobias Mayer Region.

Dome Number	Xi, Eta* Coordinates	Source * Kuiper	Kopal	Times Atlas	Quadrangle	Comments
29	-.47 +.1	Yes	Yes	No	Yes	
435	-.449+.132	Yes	Yes	No	No (hill)	Rae: "Small, round dome W. (E.) of the Hortensius group, first suggested by Rae."
436	-.449+.132	No	No	No	No	Deleted.
438	-.452+.122	Yes	Yes	Yes	Yes	
439	-.450+.207	Yes	Yes	No	Yes	
440	-.458+.130	Yes	Yes	Yes	Yes	
442	-.458+.137	Yes	Yes	Yes	Yes	
443	-.462+.132	Yes	Yes	Yes	Yes	
444	-.466+.124	Yes	Yes	Yes	Yes	
446	-.472+.125	Yes	Yes	Yes	Yes	
447	-.473+.134	No	No	Yes	No	Deleted.
449	-.446+.242	Yes	Yes	No	No	
451	-.483+.157	Yes	Yes	N.R.	Yes	
452	-.474+.242	Yes	Yes	No	See note	452 and 453 shown as one.
453	-.475+.244	Yes	Yes	No	to right.	" " " " " "
454	-.476+.238	Yes	Yes	No	See note	454 and 455 shown as one.
455	-.478+.242	Yes	Yes	No	to right.	" " " " " "
457	-.489+.220	Yes	Yes	Yes	Yes	
459	-.485+.235	No	No	No	No	Deleted.
462	-.489+.217	No	No	No	No	Deleted.
465	-.493+.236	Yes	Yes	Yes	Yes	
467	-.497+.218	Yes	Yes	No	No	Ricker (1967). Rae (1964)
469	-.499+.238	Yes	Yes	Yes	Yes	
470	-.510+.175	Yes	Yes	Yes	Yes	
471	-.502+.227	Yes	Yes	Yes but incorrect	Yes but incorrect	
472	-.506+.221	Yes	Yes	Yes	Yes	
473	-.508+.200	Yes	Yes	Yes	Yes	
474	-.503+.245	Yes	Yes	Yes	Yes	
475	-.511+.186	(a)	No	No	No	Deleted.
477	-.506+.220	(b)	No	No	No	? Suspected on H. Hill's drawing of 1988 APR 26.
479	-.510+.229	Yes	Yes	No	No	
481	-.515+.228	Yes	Yes	Yes	Yes	
482	-.516+.225	Yes	(c)	No	No	
483	-.538+.197	Yes	Yes	N.R.	Yes	
484	-.527+.141	No	No	N.R.	No	Deleted.
485	-.520+.225	(d)	No	No	No	
486	-.522+.223	(d)	No	No	No	H.Hill 1988 FEB 27. Phillips 1988 DEC 18.
487	-.523+.227	(d)	No	No	No	
488	-.532+.166	Yes	Yes	No	No (hill)	Rae: "Small round dome NE (NW) of Milichius A...Moore [saw it as] a dome-like hill. Heath as a suspect hill."
490	-.525+.223	No	No	No	No	Deleted.
494	-.536+.136	No	No	No	No	Deleted.
495	-.538+.197	Yes	Yes	Yes	Yes	
500	-.528+.247	(e)	(f)	Yes but difficult	Yes	
502	-.537+.204	No	No	No	No	Deleted.
A	-.473+.206	Yes	No	No	Yes	Observed 1988 DEC 18 with 6-inch (15-cm.) f/12 apochromat.
B	-.428+.235	Yes	(g)	Yes	Yes	Major:minor Axis >2:1

* See notes on p. 70.

Notes:

Xi (ξ) and *Eta* (η) are rectangular coordinates, with their origin at the mean apparent center of the disk,given in units of the lunar radius. Xi is positive to the lunar east (the direction of Mare Crisium) and negative to the west; Eta is positive to the north and negative to the south.

Kuiper--Kuiper, G. *Photographic Lunar Atlas.*
Kopal--Kopal, Z. *A New Photographic Atlas of the Moon.*
Times Atlas--Lewis, H.A.G.*The Times Atlas of the Moon.*
Quadrangle--U.S. Geological Survey, *Copernicus* and *Kepler* quadrangles.

N.R.--Not recognizable as a dome.

(a) Not clear; whitish patch on Plates E4-d (Y) and E4-a.
(b) Suggestion on Plate E4-a; present on E4-d (Y).
(c) Yes; double with Dome 481.
(d) Suggested on Plates E4-b and E4-a; present on E4-d (Y).
(e) ? Whitish patch.
(f) Whitish patch.
(g) No; in shadow.

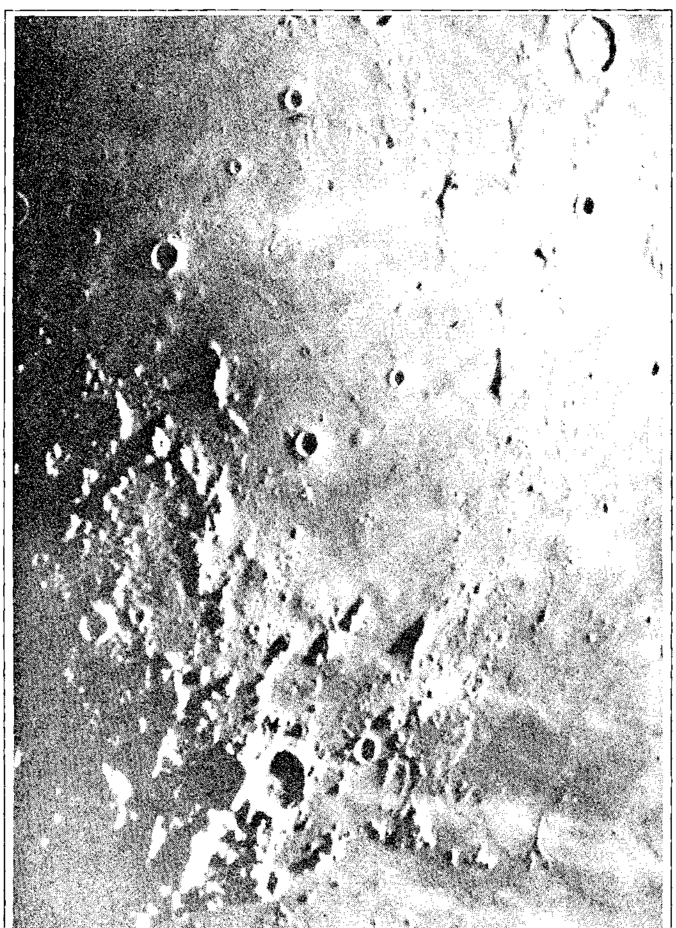

Figure 19. The dome-rich region near the craters Hortensius, Milichius, and Tobias Mayer. Hortensius is the largely-shadowed crater in the upper left; Milichius is slightly left of center; while Tobias Mayer is the large ring with a floor peak near bottom center. Afternoon lighting Reproduced from Plate 51 of Z. Kopal, *New Photographic Atlas of the Moon*, taken with the 43-inch (109-cm.) reflector of Pic du Midi Observatory on 1965 SEP 20. South at top, lunar west to the right.

Figure 20. The Hortensius-Milichius region, with the crater Hortensius near top center and Milichius to the right of center. Reproduced from Plate E4-a of: G.P. Kuiper, *Photographic Lunar Atlas*. McDonald Observatory plate M191, taken on 1956 AUG 30 at 11h 51m U.T. Afternoon lighting conditions with south at top and lunar west to the right. The colongitude (longitude of the sunrise terminator) is 201°.9.

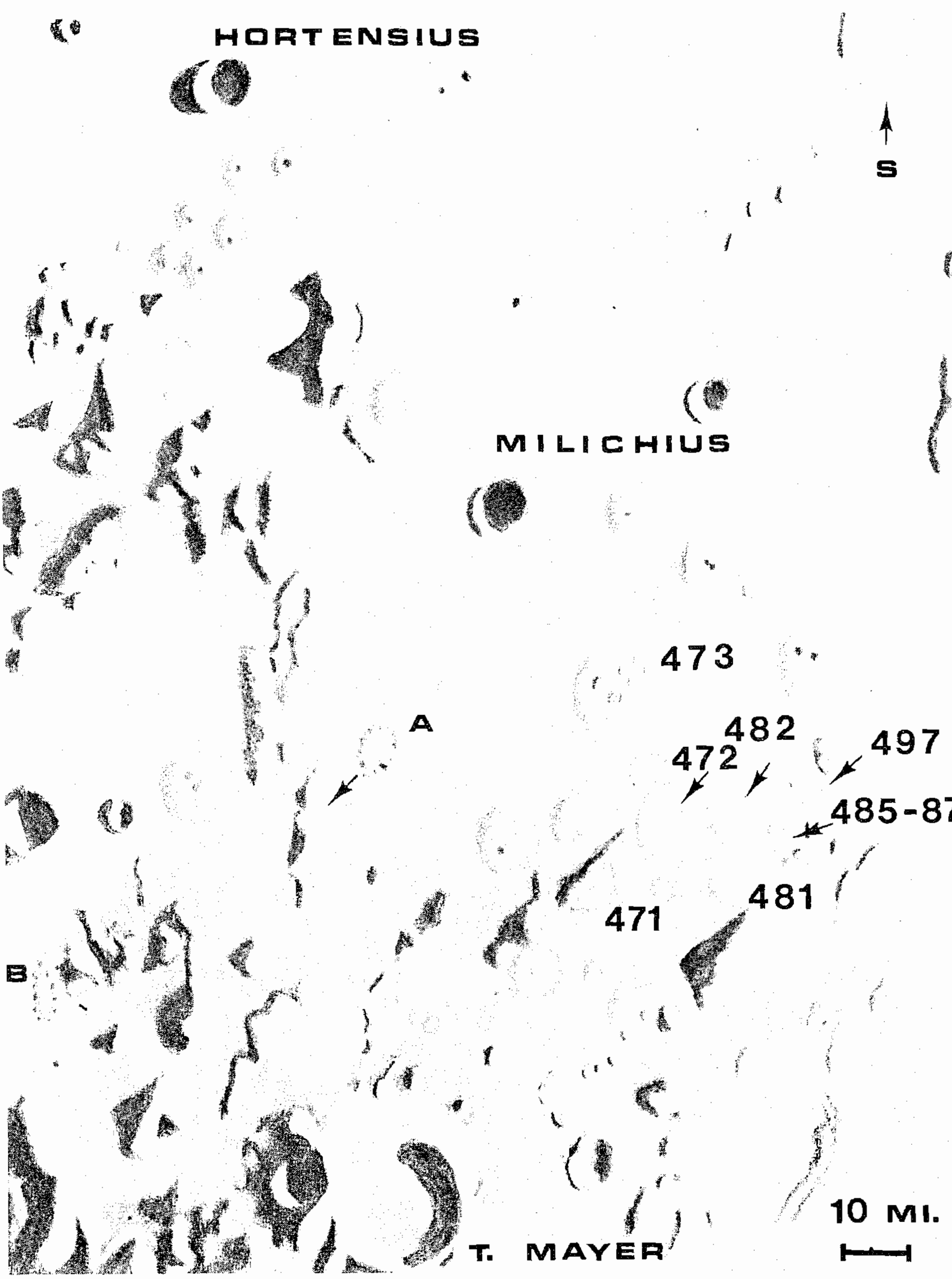

Figure 21. Map by J.H. Phillips of dome fields in the Hortensius-Milichius-Tobias Mayer region. The identifications of selected domes are as given in *Table 1* (pp. 69-70). South at top, lunar west to right. Note scale in lower right. Base map: Plate E4-a, G.P. Kuiper, *Photographic Lunar Atlas* (McDonald Observatory plate M191, 1956 AUG 30, 11h 51m U.T., colongitude 201°.9). See also text on pp. 63-65.

OBSERVATIONS OF LUNAR DOMES NORTH-NORTHWEST OF MILICHIUS: AN INTERPRETATION

By: Jim Phillips, M.D., A.L.P.O. Lunar Recorder

ABSTRACT

British amateur Harold Hill observed several domes north-northwest of the crater Milichius on two dates in 1988. Although the apparent differences between his two drawings may appear to be due to differences in familiarity and in seeing conditions, a more likely explanation is lighting differences due to changes in the selenocentric solar latitude. Mr. Hill's drawings confirm a number of elusive domes in this region.

Lunar domes are often difficult to observe because they may be impossible to see when very far from the terminator, because they blend so easily with surrounding terrain. Exceptions exist. The "Schlumberger Domes" (the six prominent domes north of Hortensius) and the dome west ["IAU" west; toward Grimaldi] of Milichius are relatively easy to spot. These domes have above-average slope angles which make them unusually prominent.

The cluster of domes north-northwest of Milichius have very gentle slope angles and are difficult to observe even when near the terminator. Trying to map this particular region has been a challenge, and this effort is reported in the previous article. [2] In particular, the reader should consult *Figure 21* (p. 72) of that article, where the domes discussed here are mapped with their identification numbers. I have used maps, photographic atlases, and catalogs, as well as observations by talented and experienced amateur astronomers. Two such observations were sent to me recently by Mr. Harold Hill, the noted British amateur, and are shown here as *Figures 22* and *23* (p. 74).

His observations are of the region north-northwest of Milichius. Interestingly, as Mr. Hill has pointed out, while the Sun's selenographical colongitudes were nearly identical on the two dates (032°.8-033°.2 on 1988 FEB 27 and 032°.9-033°.3 on 1988 APR 26), the selenographical solar latitude had changed from -0°.42 to +1°.12. This difference in solar latitude is responsible for the difference in illumination noted. For example, there is a difference in the two drawings particularly for the domes to the north of the large dome (NLDS [New Lunar Dome Survey] No. 473) in the drawings.

In one drawing, *Figure 22*, done on 1988 FEB 27, to the northwest of the large dome that contains several craterlets (NLDS No. 473), there are two ovoid domes located between two ranges of hills (numbered NLDS 472 and 482 on *Figure 21*). To the west of these is a cluster of three small domes (NLDS Nos. 485-487 on *Figure 21*). In the drawing of 1988 APR 26 (*Figure 23*), there are three ovoid domes located between the groups of hills (the additional dome is NLDS No. 481 on *Figure 21*). Hill's suggested interpretation of the differences between the drawings on the two dates is that the later drawing is probably more accurate due to superior seeing and to his increased familiarity with the region.

I disagree. I believe that *both* of Mr. Hill's drawings of this region are accurate. First, looking at his drawing of 1988 APR 26, note the following: South of the eastern range of hills is NLDS No. 472. Mr. Hill has noted a small craterlet on its surface. Just south and west of it is NLDS No. 482. To the north and slightly west of this is NLDS No. 481. This depiction matches our map (*Figure 21*) very nicely. Now, looking at the drawing of 1988 FEB 27, we note NLDS No. 471 as just visible between two shadows; it is covered by shadow in the later drawing. South of the group of hills is NLDS No. 472. Farther to the west is a cluster of three domes. They are not NLDS No. 481, which is largely covered by shadow. I believe that they are a cluster of three domes previously reported to the NLDS and numbered as NLDS Nos. 485, 486, and 487. This cluster of three domes can be seen on the *front cover*, which is Plate E4-d (Y) of G.P. Kuiper's *Photographic Lunar Atlas*. [*1*]

The effect of differential solar latitude between the two dates is as follows. Dome NLDS No. 471 is almost lost in shadow on 1988 FEB 27. NLDS No. 481 is seen on April 26 but was largely covered by shadows on February 27. The three domes, NLDS Nos. 485-487, were seen on February 27th and not on April 26th. These three domes are very elusive, only being seen under extremely low sun angles as was the case on 1988 FEB 27. Plate E4-a of the *Photographic Lunar Atlas* suggests the presence of these three domes, but they are much clearer on Plate E4-d (Y).

[For example, taking the position of Dome 487 as given in *Table 1* (pp. 69-70), we find a solar elevation of +0°.6 on 1988 FEB 27 and +0°.9 on 1988 APR 26. These values assume the middles of the time ranges indicated for the two drawings. Ed.]

It is also worthwhile to look at other features as drawn by Mr. Hill. One interesting object lies on the northwest edge of the large dome (NLDS No. 473). Mr. Hill describes this feature as a small elevation. It is also shown on *Figure 21*, where I have depicted it as a dotted area south of NLDS No. 472. I think that this may actually represent dome NLDS No. 477. The pear-shaped object seen on Mr. Hill's drawing of 1988 APR 26 (to the southwest of NLDS No. 473) appears to represent NLDS No. 495, and is shown on the *front cover*. The dome-like object to its south with the prominent crater-pit is either a previously unknown dome and/or a prominent portion of a wrinkle ridge.

Careful observation by experienced amateurs can produce spectacular results, as by Harold Hill in this case. If my interpretations are correct, his observations have helped confirm a number of elusive domes in this most interesting region of the Moon.

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1. Kuiper, G.P. *Photographic Lunar Atlas.* Chicago: University of Chicago Press, 1960.

2. Phillips, J. "The New Lunar Dome Survey: The Hortensius-Milichius-Tobias Mayer Region." *J.A.L.P.O.*, *33*, Nos. 4-6 (April, 1989), pp. 61-72.

3. ______. A.L.P.O. New Lunar Dome Survey Working Map of Lunar Domes/Suspect Domes.

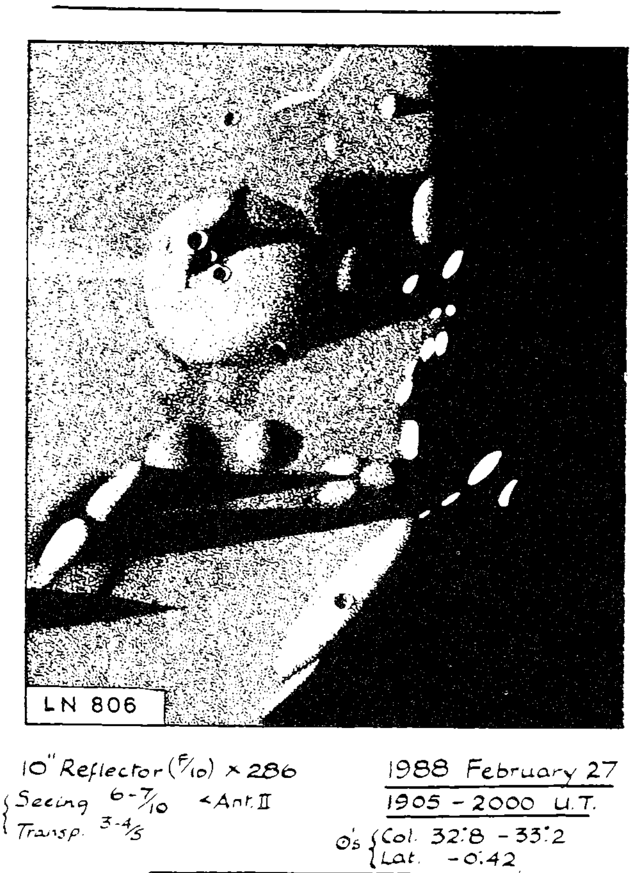

Figure 22 (top). Drawing of domes northwest of the crater Milichius by Harold Hill on 1988 FEB 27. "LN" refers to the Brown lunation number. South at top, lunar west to the right. The numerical seeing is on the A.L.P.O. Scale, which ranges for 0 for worst to 10 for best. Transparency is on a similar 0-5 scale.

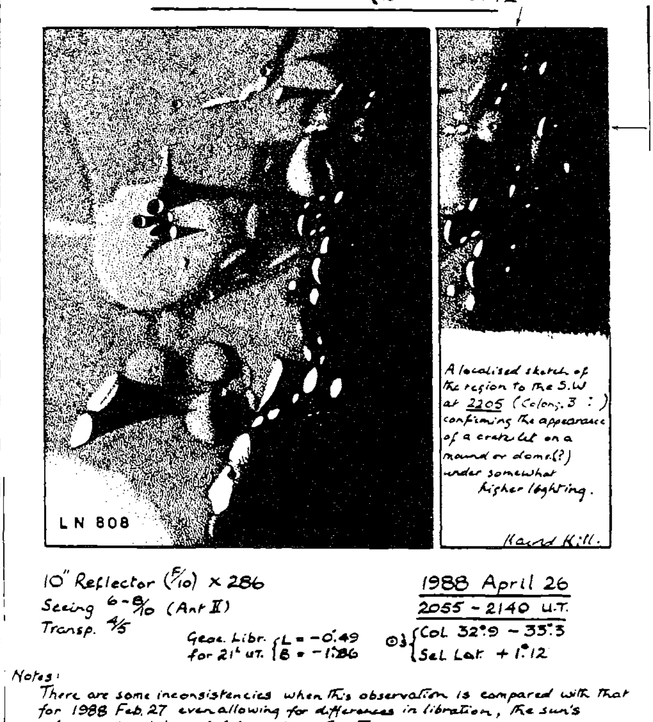

Figure 23 (bottom). Drawing of domes northwest of the crater Milichius by Harold Hill on 1988 APR 26. South at top, lunar west to the right. Seeing and transparency as given on *Figure 22*.

METEORS SECTION NEWS

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

I'd like to thank all the observers who have sent in reports since the 1988 summertime. Two observers have been continuously sending in reports: George W. Gliba of Greenbelt, Maryland, and Mark Davis of Christianburg, Virginia. We have also received a report from Mr. and Mrs. Robert Lunsford of Chula Vista, California, who sent in photographs as well. We hope to publish one of their photographs in a future issue.

The first issue of the new *Tails & Trails* newsletter has been sent out to everyone on David Levy's mailing list and also to everyone who has sent observations to me. Anyone wishing to receive *Tails & Trails* should write to me (address on inside back cover) and enclose a business-sized self-addressed stamped envelope (SASE). The newsletter will be an irregular publication.

Now, a few words about the future of the Meteors Section. I am looking for new observers and for more observations. We need year-round coverage of as many major and minor showers as possible. I encourage observers who do other kinds of observing to write to me to learn how they can broaden their programs with some meteor observing.

A number of recent articles have addressed the decline of meteor observing in the United States. I believe that this trend can be reversed and that the A.L.P.O. Meteors Section can do much toward this goal.

In the Fall of 1987, I attended a meeting in Hungary of amateur meteor and variable-star observers. Meteors and variables are the most popular types of observing for the Hungarians and are carried out in observing camps. My contacts in Hungary inform me that their meteor observers are interested in working with us. By working with our colleagues in Hungary and elsewhere in Europe, the A.L.P.O. Meteors Section can become international in scope and can play a major role in worldwide meteor observing.

Finally, I invite readers to enjoy David Levy's wisdom on meteor observing, which will appear in the next issue of the *Strolling Astronomer*. [John Griesé and David Levy plan to alternate columns on meteors in future issues. Ed.]

COMET CORNER

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

PRESENT COMET ACTIVITY

Were there no new bright comet discoveries for the remainder of the year, we would still be busy with the appearance of Periodic Comet Brorsen-Metcalf later this summer. This comet returns every 70.6 years and may reach naked-eye visibility. I'll discuss this comet in more detail in the next issue; this time I will include an ephemeris for this comet for late May-early July so that those of you with large telescopes can begin observing it. (See *Table 2*, p. 77.)

In addition, Comet Shoemaker-Holt-Rodriguez (1988h) will be well-placed, indeed circumpolar for a time, for Southern-Hemisphere observers and should reach 10th magnitude early this summer. It will remain in the morning sky through most of 1989. An ephemeris for this comet is included here in *Table 3*, p. 77. [Its perihelion passage is predicted for 1989 JUN 12. Note that this comet will pass northeast of the Small Magellanic Cloud in early June and south of the Large Magellanic Cloud in early July. Ed.]

Every 15 years one of our most unusual comets reaches its point closest to the Sun, but even then it is still outside the orbit of Jupiter. And although it is nearly always beyond the reach of your telescope (magnitude 17 and stellar), I am asking you to try to observe it as often as possible. Its name is Periodic Comet Schwassmann-Wachmann 1; and it is known for its outbursts, which can bring it up to magnitude 9. These events can happen at any time--they appear to occur once or twice a year--and most commonly the comet will reach only magnitude 12 or 13. Because this comet will be closest to the Sun this year (on 1989 OCT 16), it might be worthwhile to keep an eye on its position in order to see if it pops into view. If it does, report this event to the Central Bureau for Astronomical Telegrams, Smithsonian Astrophysical Observatory, Cambridge, MA 02138 U.S.A. Also, please report all sighting attempts to me at the end of 1989. I am also including an ephemeris for this comet (*Table 4*, p. 77). [Note that more extended ephemerides for these and other comets can also be found in the *A.L.P.O. Solar System Ephemeris: 1989*. Ordering information for this publication is given on p. 96. Ed.]

COMET FINDS FOR THE SECOND HALF OF 1988

By the middle of 1988, only Periodic Comet Tempel 2 was under widespread observation. However, comet activity picked up in the second half of 1988.

In all, 1988 saw three visual finds and one photographic discovery by amateurs. Professional astronomers found five comets, and three of these were by the Shoemakers. Three returning comets were recovered. The greatest comet discoverer of 1988, however, was the Solar Max Mission Satellite, with seven finds in all--five occurring during the calendar year. Ironically, the Solar Max Mission will not last long. It is expected to reenter the Earth's atmosphere later this year. Speaking of disintegration, 1988 saw six comets vanish due to the solar heat; five Solar Max comets and one found by an amateur.

Particular comets discovered or recovered in late 1988 were:

Periodic Comet Churyumov-Gerasimenko (1988i).—Jim Gibson of Palomar Mountain Observatory recovered this comet on 1988 JUL 06, when its nuclear magnitude was 18. It will be closest to the Sun in June and may reach magnitude 13, but will be hidden by the solar glare for most of this year.

Comet Machholz (1988j).—I discovered this comet in the morning sky on 1988 AUG 06. It was then at magnitude 8.6 and moving east at 1°.4 per day. I had searched 475 hours since my last previous find, and was using 29X120mm homemade binoculars for this discovery.

Orbital calculations indicated that this comet would pass closest to the Sun on 1988 SEP 17 at a mere 15 million miles. For roughly five weeks after discovery the comet continued to brighten as it neared the Sun, but not as rapidly as one would predict. In late September, it was expected to enter the evening sky. Many searches were made, and a few observers reported possible sightings in early October. However, thorough attempts with large instruments in middle- and late-October failed to show this comet, suggesting that it vanished due to the heat of the Sun.

Periodic Comet Kopff (1988k).—E. Alvarez, M. Belton, and K. Meech recovered this comet from Mauna Kea, Hawaii, on 1988 FEB 11. The comet appeared as a starlike object at magnitude 21. It will be closest to to Sun in 1990, but will be on the other side of the Sun and thus not easily visible.

Comet SMM 3 (1988L), Comet SMM 4 (1988m), Comet SMM 5 (1988n), Comet SMM 6 (1988p), and Comet SMM 7 (1988q).—All five of these comets were observed only from an Earth-orbiting satellite--the Solar Max Mission. They were each seen entering the solar vicinity, but were not observed leaving. Additionally, they all appear to have been in the same orbit, that of the Kreutz Sungrazing Group.

Listed below in *Table 1* is a summary of all seven SMM comets, including the first two which were announced on 1988 JUL 01, but which had hit the Sun in October, 1987.

Table 1. Solar Max Mission Comets.

Name	Designation	Perihelion Date (U.T.)	Maximum Magnitude
SMM 1	----	1987 OCT 06.1	0
SMM 2	----	1987 OCT 18.0	-2
SMM 3	1988L	1988 JUN 27.8	-1
SMM 4	1988m	1988 AUG 21.8	-3
SMM 5	1988n	1988 OCT 12.1	-4 or brighter
SMM 6	1988p	1988 NOV 18.4	+1
SMM 7	1988q	1988 OCT 24.8	-4 or brighter

Periodic Comet Ge-Wang (1988o).--Y-l Ge and Q. Wang discovered this object on plates taken in China on a 24-inch (61-cm.) Schmidt on 1988 NOV 4, when it was at magnitude 17. Prediscovery images were then found by the Shoemakers and T. Kojima. This comet orbits the Sun every 11.4 years and will not get any brighter.

Comet Yanaka (1988r).--Tetsuo Yanaka of Japan found this, his first named comet, with 25X150mm binoculars on 1988 DEC 29. It was then at magnitude 9, located 35° from the Sun in the morning sky. It had reached perihelion, 0.20 Astronomical Units from the Sun, on 1988 DEC 12, and therefore was pulling away from the Sun when it was discovered. It dimmed rapidly after discovery. Yanaka had independently discovered Comet Machholz two days after I had found it. He also went on to discover the first comet of 1989 on JAN 1.7!

Table 2. Ephemeris of Periodic Comet Brorsen-Metcalf.
(Visible in the morning sky throughout this period.)

1989 U.T.	1950.0 Position		2000.0 Position		Elongation	Stellar
Date	Right Ascension	Declination	Right Ascension	Declination	from Sun	Magnitude
MAY 27	22h41.9m	-07°21'	22h44.5m	-07°05'	86°	+15.0
JUN 01	22 48.3	-06 18	22 50.9	-06 02	89	14.7
06	22 54.7	-05 11	22 57.3	-04 55	92	14.4
11	23 01.3	-03 59	23 03.9	-03 43	95	14.0
16	23 08.1	-02 40	23 10.7	-02 24	97	13.7
21	23 15.2	-01 13	23 17.8	-00 57	100	13.3
26	23 22.6	+00 24	23 25.1	+00 40	102	12.9
JUL 01	23h30.5m	+02°13'	23h33.0m	+02°29'	104°	+12.5
06	23 39.0	+04 17	23 41.6	+04 34	106	12.1
11	23 48.4	+06 42	23 51.0	+06 59	108	11.6
16	23 59.2	+09 34	00 01.7	+09 51	109	11.1

Table 3. Ephemeris of Comet Shoemaker-Holt-Rodriquez (1988h).
(Visible in the morning sky throughout this period.)

1989 U.T.	1950.0 Position		2000.0 Position		Elongation	Stellar
Date	Right Ascension	Declination	Right Ascension	Declination	from Sun	Magnitude
MAY 02	22h37.1m	-51°26'	22h40.1m	-51°11'	84°	+10.9
07	22 50.9	-53 51	22 53.9	-53 36	87	10.8
12	23 06.3	-56 24	23 09.3	-56 08	90	10.8
17	23 23.8	-59 02	23 26.7	-58 46	93	10.7
22	23 44.0	-61 44	23 46.7	-61 27	96	10.6
27	00 07.6	-64 24	00 10.1	-64 07	98	10.6
JUN 01	00h35.6m	-66°59'	00h37.8m	-66°43'	99°	+10.5
06	01 09.2	-69 22	01 10.9	-69 06	100	10.5
11	01 49.2	-71 24	01 50.2	-71 09	101	10.5
16	02 35.8	-72 57	02 36.1	-72 44	101	10.5
21	03 27.5	-73 53	03 27.0	-73 43	100	10.5
26	04 20.8	-74 09	04 19.8	-74 02	99	10.5
JUL 01	05h11.5m	-73°47'	05h10.4m	-73°44'	98°	+10.6
06	05 56.5	-72 56	05 55.4	-72 56	96	10.6
11	06 34.6	-71 46	06 33.8	-71 48	94	10.7
16	07 06.3	-70 25	07 05.9	-70 29	92	10.7

Table 4. Ephemeris of Periodic Comet Schwassmann-Wachmann 1).
(Visible in the morning sky throughout this period.)

1989 U.T.	1950.0 Position		2000.0 Position		Elongation	Stellar
Date	Right Ascension	Declination	Right Ascension	Declination	from Sun	Magnitude
MAY 02	23h36.9m	+02°59'	23h39.5m	+03°16'	45°	+17.7
07	23 39.9	+03 24	23 42.4	+03 41	49	17.6
12	23 42.7	+03 49	23 45.3	+04 06	53	17.6
17	23 45.4	+04 13	23 48.0	+04 30	57	17.6
22	23 48.0	+04 36	23 50.5	+04 53	61	17.6
27	23 50.4	+04 59	23 52.9	+05 15	66	17.6
JUN 01	23h52.6m	+05°20'	23h55.2m	+05°37'	70°	+17.5
06	23 54.7	+05 41	23 57.2	+05 58	74	17.5
11	23 56.5	+06 01	23 59.1	+06 17	78	17.5
16	23 58.1	+06 19	00 00.7	+06 36	82	17.4
21	23 59.6	+06 37	00 02.1	+06 54	87	17.4
26	00 00.8	+06 53	00 03.3	+07 10	91	17.4
JUL 01	00h01.7m	+07°08'	00h04.3m	+07°25'	95°	+17.4
06	00 02.4	+07 22	00 05.0	+07 39	100	17.3
11	00 02.9	+07 34	00 05.5	+07 51	104	17.3
16	00 03.1	+07 45	00 05.7	+08 01	109	17.3

A.L.P.O. SOLAR SECTION OBSERVATIONS FOR ROTATIONS 1798-1802 (1988 JAN 20 TO 1988 JUN 05)

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

ABSTRACT

A.L.P.O. Solar Section observations for Rotation Numbers 1798-1802 (1988 JAN 20-JUN 05) are summarized here, particularly in terms of the morphology and development of sunspot groups. Nine observers in four nations contributed visual drawings and photographs in both integrated and Hydrogen-α light. Solar activity continued to increase during this reporting period, reaching a maximum during Rotations 1800 and 1801 (March-April, 1988).

The increase in solar activity described in the last report [*8*] continued through this reporting period. The mean International Sunspot Number (*RI*) for this period was 65.6; while that for the American Sunspot Number (*RA*) was 67.2. The highest count for one day was 148 for RI (APR 16) and for RA was 144 (APR 16 and 17). There were no days of zero counts. [*1-7*] *Figure 24* (to the right) graphs the sunspot numbers for the five rotations covered by this report.

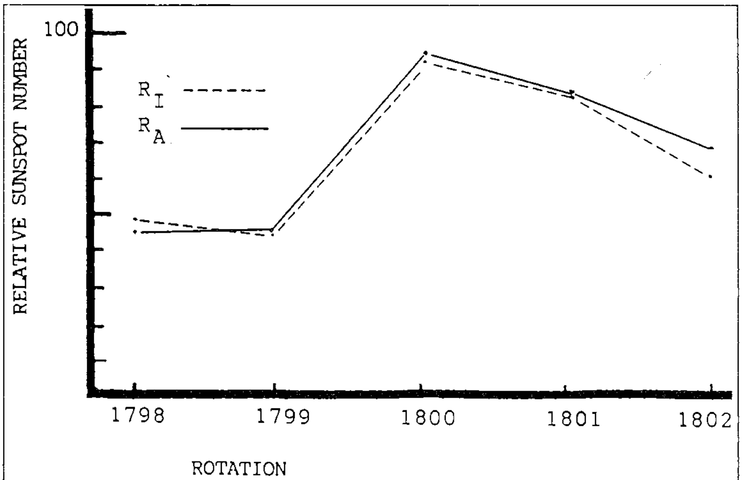

Figure 24. Graph of means of RI (International Sunspot Number) and RA (American Sunspot Number) for Solar Rotations 1798-1802.

Most of the terms and abbreviations used here are defined in either *The Handbook for the White Light Observation of Solar Phenomena*, available from this Recorder for $US 6; the *A.L.P.O.S.S. Monochromatic Handbook* by Co-Recorder Randy Tatum; or in the article "A Three-Dimensional Sunspot Classification System" in the last issue of this magazine (pp. 10-13). All times given here are in Universal Time (U.T.). Directions and angular measurements are heliographic and are abbreviated N, SE, etc. The word "group" refers to a white-light collection of sunspots, while "region" refers to the area as observed in all wavelengths. Regions are numbered by the Space Environmental Services Center of the National Oceanic and Atmospheric Administration (*SESC/NOAA*) in Boulder, Colorado. These numbers will also be used to refer to groups.

The nine observers who contributed observations for this reporting period are listed in *Table 1* to the right.

Table 1. Observers Contributing to This Report.

Observer	Telescope cm.	f/	Type	Location
Garcia, G.	20	10	S.-C.	Illinois, USA
Gelinas, M.	15	12	Refr.	Quebec, Can.
Hill, R.	6	13	Refr.	Arizona, USA
	15	10	Newt.	
Maxson, P.	15	10	Newt.	Arizona, USA
	20	8	Newt.	
Morris, R.	5	30	Refr.	Colorado, USA
Nargas B., A.G.	20	8	Newt.	Bolivia
Rousom, J.	8	5.5	Refr.	Ontario, Can.
	13	10	Newt.	
Tao, Fan-Lin	13	?	Refr.	Yuan-Shan, Taiwan
VanHoose, D.	11	8	Newt.	Virginia, USA

Notes: "cm." is the aperture of the telescope in centimeters; "f/" is its focal ratio; "Newt." is Newtonian; "Refr." is "refractor; "S.-C." is Schmidt-Cassegrain. Mr. Rousom employed a 5-cm. stop with his 13-cm. Newtonian.

Rotation 1798
(1988 JAN 20.62 to 1988 FEB 16.96)

Sunspot Number [1,2,3]	Mean	Maximum (Date)	Minimum (Date)
R_I	49.6	84 (JAN 21)	12 (FEB 12)
R_A	45.2	73 (JAN 21)	11 (FEB 12)

As this rotation began, there were three major sunspot groups on the disk. **SESC 4927** was on the central meridian (*CM* hereafter) with **SESC 4925** to the SW and **SESC 4931** (seen for the first time as "RAMEY 015" two days earlier) to the SE.

Observations by Maxson and Tao showed that after SESC 4925 came onto the disk it began to decay until by JAN 22 it was only a collection of pores and umbral spots. SESC 4927, on the other hand, was a large spot, elongated N-S and cut in half by a light bridge. This spot was followed by a few pores and umbral spots as well. The last region, SESC 4931, consisted of a main spot (about half the size of the main spot in SESC 4927) which was round and symmetrical, accompanied by a few umbral spots. The only change in these last two regions that was noted was a decrease in the number of umbral spots.

One other region, **SESC 4934**, caught the attention of our observers. It began on JAN 24 as a collection of pores, as all sunspot groups do. It developed rapidly and, as it went behind the W limb five days later, this group had become at least three major spots with penumbrae. Unfortunately, only an observer on the other side of the Solar System could enjoy the maximum development of this region!

Rotation 1799
(1988 FEB 16.96 to 1988 MAR 15.29)

Sunspot Number [2,3,4]	Mean	Maximum (Date)	Minimum (Date)
R_I	45.8	77 (MAR 04)	12 (FEB 23)
R_A	46.1	72 (MAR 04)	11 (FEB 23)

There were three major groups that were followed by the Solar Section during this rotation. Two of them can be treated together because they were on the disk at the same time.

SESC 4949 came onto the disk as a round symmetrical spot on FEB 12 (in Rotation 1798). A number of observers noted numerous bright spotted faculae around it as well as the attendant umbral spots. In the penumbra of the main spot were three to four umbrae. On FEB 18, SESC 4949 was on the CM. H-α photographs by Morris showed a strong orientation of the fibrils out to 4-5 arc-minutes (about 200,000 km.) with a large filament extending from the main spot towards the N. White-light photographs by Maxson showed a white ring just beyond the penumbra. While such rings can be photographic effects, this one persisted for the next four days, and such has never been seen on Maxson's photographs before. By FEB 20, the aforementioned filament had merged end-to-end with another to the N, and the whole feature reached from the main spot right up to the pole! There was little change as seen in white light, but the pores and umbral spots that were following had dissipated. Some others developed S of the spot on FEB 21, but no more appeared later.

SESC 4957 and **SESC 4958** can be handled together even through they were in opposite hemispheres. SESC 4957 was in the N Hemisphere and SESC 4958 was in the S. Both came onto the disk on FEB 28 as seen by Garcia; both small groups, each with one spot with penumbrae and a half-dozen or so pores and umbral spots surrounding it. On FEB 29 both groups had developed follower spots with penumbrae. The next day, MAR 01, both contained a number of spots with penumbrae. Their appearance on that day is shown in *Figure 25* below. SESC 4958 had the fewer but larger spots, including a following spot that was elongated N-S and nearly cut in half by a light bridge. Two days later, SESC 4957 was beginning to decay. Its penumbrae had become rudimentary and often fragmentary.

N of SESC 4957 a few pores had developed into umbral spots, and collectively were designated **SESC 4961**. SESC 4958 was largely unchanged; but the light bridge was gone, leaving two umbrae in one N-S elongated penumbra. On MAR 04 the light bridge once again had invaded SESC 4958's follower spot and had divided it completely. Nearly all the pores were gone. In the N, SESC 4961 had developed as a spot elongated E-W, with a penumbra followed by a number of umbral spots. By now, SESC 4957 was reduced to several spots with fragmentary penumbrae and a collection of pores. There was nothing remarkable in H-α.

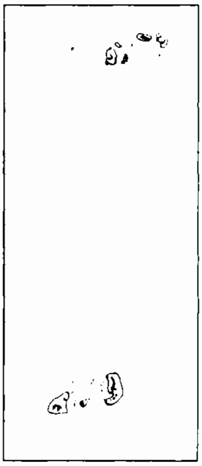

Figure 25. Drawing of SESC 4957 (top) and SESC 4958 (bottom) by John Rousom on 1988 MAR 01, 16h 50m U.T. 80-mm. refractor using projection with a 53X eyepiece. Seeing good. North at top. As with all projection drawings, the image is reversed, making celestial east on the right. The distance between the two groups is about 0.7 solar radii.

From this date on, all regions went into decline. Spots decreased in area and their penumbrae were reduced, fragmented, or disappeared completely. As these groups passed behind the limb, SESC 4961 consisted only of a few pores, while SESC 4957 and SESC 4958 each retained only one spot with a penumbra and a few pores.

Rotation 1800
(1988 MAR 15.29 to 1988 APR 11.58)

Sunspot Number [3,4,5]	Mean	Maximum (Date)	Minimum (Date)
R_I	91.9	120 (MAR 31)	63 (MAR 15)
R_A	94.3	120 (MAR 31)	58 (MAR 15)

This rotation experienced a sudden explosion of activity. Note above that this rotation's *means* are greater than the *highs* for the previous rotations. Indeed, even the lows of this rotation were greater than the means of the previous two. With such activity, it is possible here only to cite a few of the more active regions; the two largest and most active regions of this rotation were **SESC 4964/67** and **SESC 4975**.

SESC 4964 came onto the disk as a well-developed group on MAR 12, preceded by a smattering of umbral spots and bright faculae. The two main spots of the group already had penumbrae. The next day, the main leader spot was a collection of umbrae in a single sprawling penumbra, aligned roughly N-S. The following spot was more symmetrical, with a better-formed penumbra containing a half-dozen or so umbrae. **SESC 4967** was a solitary spot W and slightly N of SESC 4964 with a rudimentary penumbra and a few pores. On MAR 14, at 23h 29m U.T., Morris caught the end of a flare in SESC 4964. (Good work, Bob!) On MAR 18, as these regions were approaching the CM, Morris recorded two huge filaments on opposite poles of the Sun. The S one ran under SESC 4964 for over 400,000 kilometers! The N filament was shorter but wider. These two filaments are shown dramatically in *Figure 26* on the next page. By this date, SESC 4967 was gone and SESC 4964 had taken on a strange appearance in white light. It appeared as if a pie-shaped wedge had been taken from the W side of the main spot, of about one-sixth the area of the spot, and displaced about two heliocentric degrees to the W! The day before, the area now removed had formed a protrusion on the SW side of the spot. On MAR 19, this displaced piece formed a penumbral attachment to the main spot that was fragmented by several light bridges. Still preceding the main spot was a group of pores, with one spot having a rudimentary penumbra. In H-α, the N filament had decreased in length, but not width, while the S one showed signs of breaking up. Both filaments continued to break up, and neither survived to pass around the limb. This was unfortunate, as either would have made a fine prominence. By MAR 20, the following spot from which the piece detached was unchanged, while the detached piece was splitting in two. Where the split was occurring, the umbra bordered directly on the photosphere. A large penumbral extension still lay between the spots. By MAR 21, SESC 4964 had greatly decreased in area and the pores were gone. The W spot had broken into four fragments, each with rudimentary penumbrae. As this group neared the limb over the next four days, all portions decayed until this group left the disk as only one small spot with a rudimentary penumbra and a few pores. Even the faculae were much reduced from those seen on the opposite limb two weeks earlier.

SESC 4975 came onto the disk on MAR 24, at the approximate position of SESC 4957 of the previous rotation. This is interesting because SESC 4957 so clearly appeared to be decaying as it left the disk. Solar Section observers noted bright faculae in abundance during SESC 4975's first day on the disk. The group was composed of a large complex spot with many umbrae in one large, sprawling penumbra, followed by two spots with rudimentary penumbrae oriented N-S. On MAR 26, Rousom and Maxson observed that the leader spot had broken into three spots with chaotic penumbrae oriented N-S with many pores in attendance. The follower spots remained much the same, with many pores and an umbral spot between them. A day later, the leader spots had only rudimentary penumbrae. There was a large detached penumbral portion to the S with a few small umbral spots inside. A few more such umbral spots were contained in yet another detached penumbra to the E. These cannot be considered as normal sunspots—umbrae surrounded by a penumbra—because the penumbra/umbra area ratio is too high. Many faculae could still be seen in and around the follower spots, which were now showing signs of decay. The N follower had by then been cut in two by a light bridge.

On MAR 28, the leader spot consisted of three collections of small umbrae; each in a separate, usually rudimentary penumbra. Several smaller spots followed, also with rudimentary penumbrae. By now, only one follower spot had even a rudimentary penumbra, and the rest consisted of a few pores and umbral spots. Any observer may well have given up on this group at this point, expecting its dissolution, but the next day saw a dramatic change. On MAR 29, two of the leader spots formed a semicircular arc to the SE, opening to the NW, and enclosing three spots with penumbrae. This arc was composed mostly of penumbral material. One more spot with a

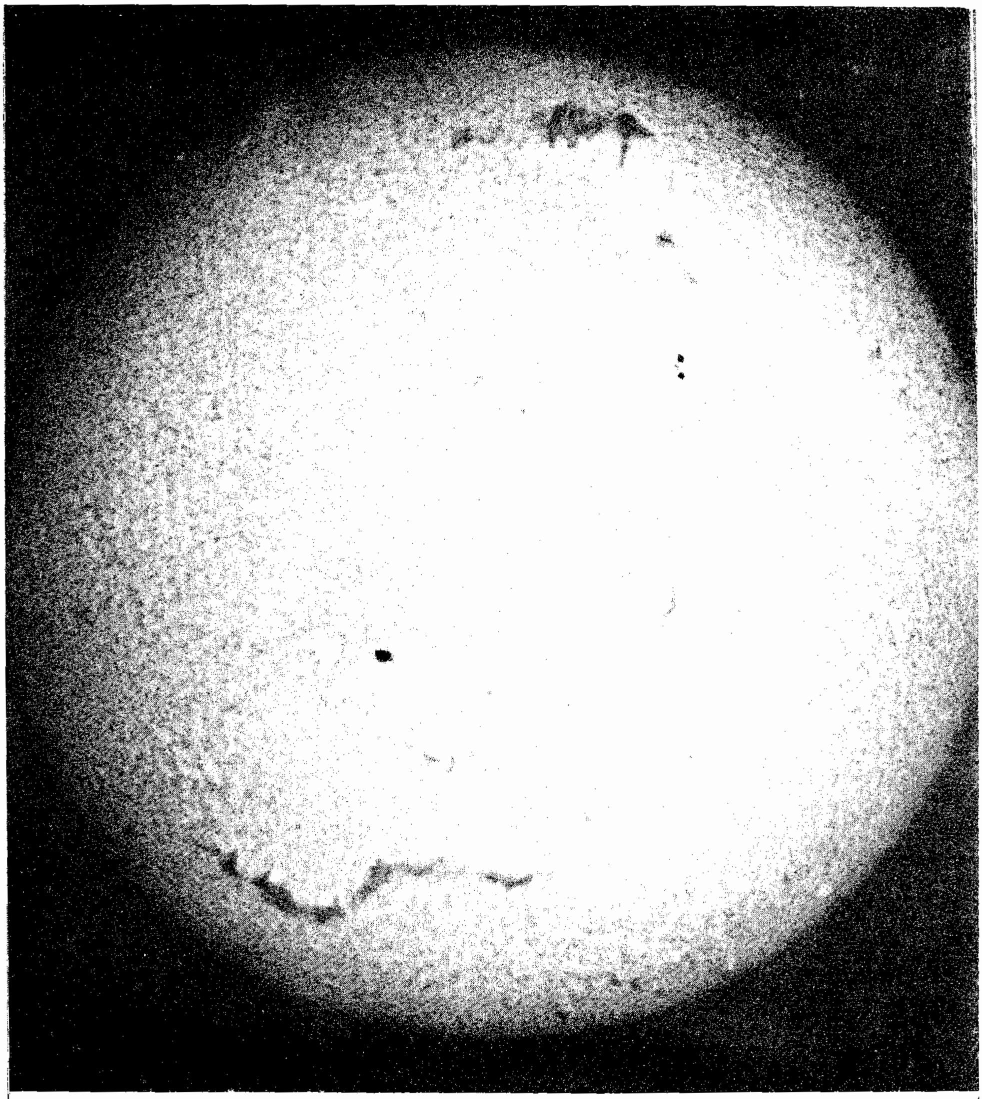

Figure 26. The Sun photographed by Robert Morris in Hydrogen-α light on 1988 MAR 18, 20h 04m U.T. Taken with a 5-cm. (2 in.) refractor at f/30. Exposure 1/250 second on Kodak TP2415 Film. North at top and celestial west (preceding) at the right. Note the two large filaments near the North and South Poles; see also text on p. 80.

penumbra lay just outside the arc to the SE. Following this were two more small spots with penumbrae and many pores and umbral spots in and around all the spots. By MAR 30, the arc had broken down into 7-9 spots with chaotic penumbrae followed by many pores.This feature was followed by one spot with a rudimentary penumbra and associated pores. This appearance remained largely unchanged over the next few days. Then, by APR 02, the leader spots had coalesced for the most part into one penumbra. About a dozen or so umbrae were contained in a single penumbra. One of the former leader spots had drifted to the E, becoming a middle spot. There were also streams of penumbral material connecting this spot to the leader with a chain of pores extending to the SE from the middle spot. The follower spot consisted of 4-6 small umbrae within a single rudimentary penumbra. As SESC 4975 neared the limb on APR 03, Maxson recorded many bright faculae around all its spots, all of which were clearly decaying.

Rotation 1801
(1988 APR 11.58 to 1988 MAY 08.83)

Sunspot Number [4,5,6]	Mean	Maximum (Dates)	Minimum (Date)
R_I	79.9	148 (APR 16)	30 (APR 24)
R_A	81.1	144 (APR 16 and 17)	38 (APR 24)

Although the mean counts were lower than in the previous rotation, activity was quite good in Rotation 1801. In fact, the highs were the highest for the entire 5-rotation reporting period. One region, **SESC 4990**, was by far the dominant one for this rotation. It attained naked-eye visibility and maximum area on APR 17, occupying over 1000 millionths of the disk. (Areas are always expressed in units of millionths of the Sun's visible disk.)

Rousom was the first to observe SESC 4990, recording it on APR 11 as two spots on the NE limb. When the entire group was in better view on the next day, observers noted many bright faculae and three or four larger spots with penumbrae attended by many pores and umbral spots. The group grew in area and complexity over the next few days until, on APR 15, the leader was composed of a number of spots with penumbrae surrounded by many pores. At that time, the follower consisted of at least two spots with penumbrae, surrounded by pores. Oddly enough, there were few pores or umbral spots between the leaders and the followers. This region reached its maximum area on APR 17 as a line of three larger spots occupying over 1000 millionths of the disk and stretching over 300,000 kilometers. In the lead was a spot composed of three umbrae arranged N-S in the same penumbra. Close behind was another large spot, here called the middle spot, that took the form of 4-6 umbrae in a single penumbra with a number of umbral spots around it. Between these two spots was a small spot with a penumbra and a few pores. About 20 heliocentric degrees following were several more umbrae in a penumbra with pores. Between the leading collection of spots and the following one there were very few pores or umbral spots. The dissolution of SESC 4990 began on APR 18, when the leading spot had broke into smaller spots and many pores and umbral spots had disappeared. The second, or middle, spot had developed an appendage that pointed toward the leader spot. There were also several detached bits with penumbrae. The following spot was becoming fairly symmetrical and round, with fewer pores. On APR 19, the leader spot collection had been reduced to one spot with a penumbra. The other spots had been replaced by, or reduced to, umbral spots. The middle spot had lost its appendage and had become smaller. There were still some detached portion with rudimentary penumbrae. The following spot was now the largest spot of the group, changing little. From this date on to passing over the limb on APR 24, SESC 4990 continued to decay; with the leader spot decaying the more rapidly than the follower.

Rotation 1802
(1988 MAY 08.83 to 1988 JUN 05.04)

Sunspot Number [5,6,7]	Mean	Maximum (Date)	Minimum (Date)
R_I	60.9	105 (JUN 04)	20 (MAY 19)
R_A	69.1	113 (JUN04)	18 (MAY 19)

This report closes with counts still at fairly high levels. In this rotation, there were four regions worth noting. They occurred in two pairs and will be so discussed.

As **SESC 5027** and **SESC 5028** came onto the disk, both Maxson and Garcia noted many extensive and bright faculae, and Garcia observed many prominences. Two days later, on MAY 23, Hill showed 5 spots with penumbrae and pores. His sequential drawings of SESC 5027 from MAY 23 through JUN 02 inclusive, are shown in *Figure 27* on the next page.The leading collection of umbral spots and pores was SESC 5028. All the spots with penumbrae belonged to SESC 5027. Morris, in H-α photographs, recorded a strong magnetic alignment of fibrils for tens of thousands of kilometers around the region. On MAY 25, he caught a subflare at 16h 05m U.T., which appeared as a bright crack extending from the leader spot down and around to the S. In white light, the main spot of SESC 5028, where the subflare originated, had an umbra that bordered directly on the photosphere on the following side. The lead spot in SESC 5027 was the largest in both groups, with 4-6 umbrae in one penumbra. Following it were two branches of umbral spots and pores. One spot in the N branch had a rudimentary penumbra. On the next day, three umbrae in one penumbra comprised the main spot in SESC 5028. This spot was partly divided by a light bridge and was surrounded by pores. In SESC 5027 the spots had chaotic penumbrae and many pores. The leader spot was the largest, with many pores in attendance. At this point, the two groups were inseparable in white light and all observers listed them as one group. The regions crossed the CM on MAY 27, with SESC 5028 again reduced to a group of pores. The lead spot in SESC 5027 comprised 3-4 umbrae in an E-W line, with "wings" of penumbral material to the N and S. One piece of penumbra was cut off to the E. The follower spots were nothing more than a few umbral spots in a rudimentary penumbra. On MAY 28, the region was much the same although spot areas were decreasing. In H-α the region was still quite complex. A day later, the leader spots, in one chaotic penumbra, extended in a line nearly 10 heliocentric degrees long. There were many pores and umbral spots surrounding the leader spots. The follower spots were unchanged, and SESC 5028 had vanished. The last active day for the remaining region, SESC 5027, was MAY 30. By then, there were four main condensations in the region. The leader spot consisted of a large umbra with a penumbra, followed by a large penumbral region containing 4 umbral spots. Next following was an elongated penumbral region containing 4-6 small umbral spots; the following spot was the largest, consisting of a large umbra and a small penumbra. The full extent of this group was about 15 heliocentric degrees. Morris photographed a subflare in progress at 15h 22m U.T., and a 1N flare at 2014 U.T. [A class-1N flare covers 100-250 millionths of the disk and is of normal brightness. Ed.] From this time on, the region decayed rapidly. As it left the disk on JUN 02, there remained only one spot with a penumbra, and a few pores and umbral spots.

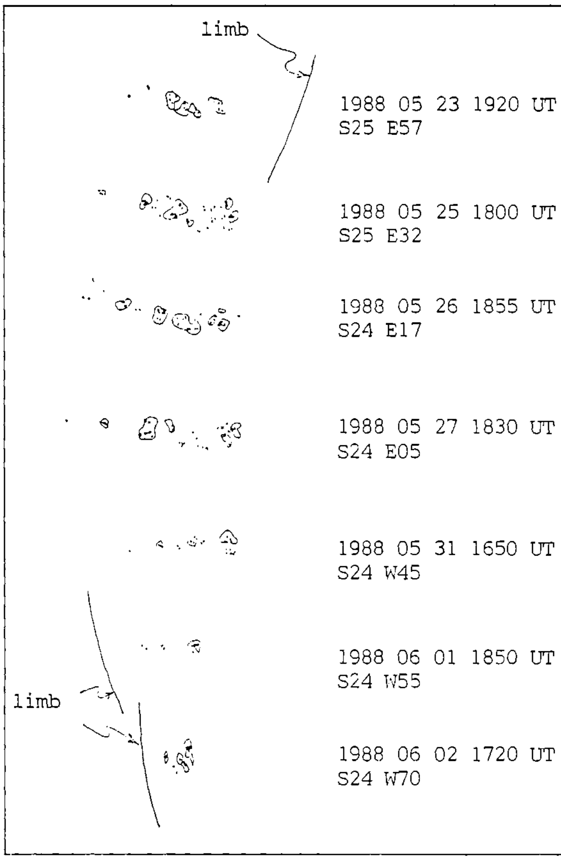

Figure 27. Development of Sunspot Region SESC 5027 as drawn by Richard Hill with a 6-cm. heliostat from 1988 MAY 23 to JUN 02. The data under each date give the heliocentric latitude, and the longitude relative to the central meridian, of the group. North at top and celestial west to the left in this reversed view.

Solar Section members observed good activity. Just as SESC 5027 was in decline, **SESC 5031** and **SESC 5032** came onto the disk on MAY 29. Garcia, Maxson, and Morris recorded these regions after 16h 00m U.T. that day, although VanHoose did not see them at 11h 30m. Though there were few faculae seen that day or the next, the few that were seen were coincident with bright areas seen in H-α. On MAY 31, SESC 5031 consisted of a large main spot that was round and symmetrical, followed by a small spot with a rudimentary penumbra and some pores. SESC 5032 contained 3-6 umbral spots with penumbrae in a triangle with many pores. SESC 5031 was N of SESC 5032, with a clear area between them. JUN 01 saw little change in SESC 5031, but SESC 5032 had developed 3 main spots with penumbrae in a right triangle, with the hypotenuse NE-SW. There were yet more pores and umbral spots. In H-α the area within the triangle was quite bright. On the next day, H-α photographs showed bright spots surrounding SESC 5031 with a dark thin filament weaving among them. This probably meant that the region was now a *gamma region* in terms of magnetism, where areas of opposite polarity are scattered throughout the region. In white light, there were no visible changes. In H-α, SESC 5032 showed a chaotic appearance. There were large fibrils strewn throughout, with no apparent uniform alignment. In white light, there were more spots with penumbrae; still in a right triangle. Fewer pores were observed by Nargas, Rousom, and Hill. On JUN 03, SESC 5031 was beginning to decay. The follower spot was reduced to a collection of pores, while the leader was quite round and symmetrical. In H-α, the bright points were nearly gone, although the feature was still fairly chaotic. In SESC 5032, the triangular configuration was breaking down as the S spot decayed. The follower spot consisted of two parallel rows of penumbrae, containing a few small umbral spots. The next day was the CM crossing of these two regions. Both were clearly decaying, with fewer and smaller spots. This decay continued until SESC 5031 left the disk as a lone spot with a penumbra, while SESC 5032 survived as only a few pores.

Conclusion

Preparing this report was very gratifying to this Recorder in that this is the first report which was a truly international effort. Nearly half the observers were *not* from the United States. We had the potential for 24-hour coverage of the Sun. Also, the quality of the observations was much improved compared with the work submitted in reports only a year or so ago. The H-α work by Morris was of exceptional quality, rivaling that done by major observatories and in some cases surpassing it. It would be yet more gratifying to see more of those persons who subscribe to Solar Section publications, and those who have copies of our *Handbook* contributing their efforts as we now approach what is almost guaranteed to be a record-setting solar maximum in 1990-92.

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COMING SOLAR SYSTEM EVENTS: MAY - JULY, 1989

This column describes the visibility of Solar System objects, and events involving them, for the next three months, both to help in planning scientific observations and as of general interest. More detailed information can be found in such sources as the *A.L.P.O. Solar System Ephemeris: 1989*. All dates and times are in Universal Time (U.T.), which is found by adding 10 hours to Hawaii Standard Time, 9 to Alaska Standard Time, 8 to PST, 7 to MST, 6 to CST, and 5 to EST. Celestial and planetary directions are abbreviated.

Four special events—Saturn's occultation of a naked-eye star on July 3rd, a total lunar eclipse on August 17th, and two asteroid "fly-bys" of the Earth—are described in separate reports following this column (pp. 87-92).

PLANETARY VISIBILITY

Both Mars and Jupiter are sinking lower in the west after sunset. **Mars'** disk shrinks to only about 4 arc-seconds in diameter as it reaches aphelion on July 22nd and approaches conjunction on September 29th. Indeed, Uranus will appear larger than Mars from July to October! By the end of July, the Red planet is only 20°E of the Sun and at magnitude +1.8. Note that Mars crosses the Beehive star cluster on June 28th.

Jupiter is difficult to observe, reaching conjunction with the Sun on June 9th. By the end of July, it will be visible as a magnitude -2.0 morning star.

Although these two planets will be unrewarding, the next four out from the Sun will be moving into place for convenient viewing.

Saturn will be preeminently visible because it reaches opposition on July 2nd, at magnitude 0.0 with its disk 18".3 in equatorial diameter and its Rings spanning 41".6 X 17".8. It will be best observed shortly after midnight in May and June and in the late evening thereafter. The northern side of Saturn and its Ring System is well-presented to us at this time, with a 25° tilt. The only bad news for northern-hemisphere observers is that Saturn will never rise high for them, being at declination 23°S in the constellation of Sagittarius. Only one day after opposition, Saturn occults the 5.4-magnitude star 28 Sgr, as described in detail in the following article (pp. 87-88).

Neptune also reaches opposition on July 2nd, so its 7.7-magnitude disk, 2".3 in diameter, will be relatively close to Saturn. Indeed, on June 24th, at 16h, Saturn passes just 18'S of Neptune; thus both planets will be visible simultaneously in a medium-power eyepiece. Note, however, that Saturn will be 1100 times brighter than Neptune; the latter planet will be only slightly brighter than Saturn's moon, Titan.

Uranus is at opposition on June 24th, just 8 days before Saturn and Neptune. Thus, Uranus is about 8°W of these planets during our period. It may be possible to spot Uranus with the unaided eye; it will be at magnitude +5.9. However, the star-rich Milky Way background will make this difficult. In the telescope, Uranus' disk will be 3".8 in diameter.

The paths of Saturn, Uranus, and Neptune (with the minor planet Vesta) are plotted for June and July in *Figure 28* (p. 85).

Finally, little **Pluto** will reach opposition on May 4th, near the Virgo-Libra border at magnitude +13.6. Because Pluto is at perihelion on September 5th, this will be the closest it approaches Earth for the next 248 years!

At the "opposite end" of the Solar System, **Mercury** undergoes two apparitions. If we define a Mercury apparition as the period when it is at least 15° from the Sun, the first lasts from April 19th to May 12th; and the second from June 4th to July 4th. The first apparition is an evening one, with a greatest eastern elongation of 20°.7 on May 1st, and is favorable for our Northern Hemisphere. The second, a morning apparition, favors the Southern Hemisphere; greatest western elongation is on June 18th, 23°.0 from the Sun.

Venus passed through superior conjunction on April 4th and thus will be rising ever higher in the evening sky after sunset; by the end of July Venus will be 31°E of the Sun and at magnitude -3.9. However, throughout these three months Venus will be on the other side of the Sun, its disk almost at full phase (99-85 percent sunlit) and only 10.-12." in diameter.

Several **planetary conjunctions** occur during this three-month period, allowing the relative colors and brightnesses of the planets to be compared, and sometimes aiding in locating the fainter planet of the two. The following passages are all closer than 1°.0:

MAY 16d 07h: **Mercury 34' N of Venus;**
11°E of the Sun; magnitudes +3.4 and -3.9.
MAY 23d 04h: **Venus 50' N of Jupiter;**
13°E of the Sun; magnitudes -3.9 and -2.0.
JUN 24d 15h: **Saturn 18' S of Neptune;**
172°W of the Sun; magnitudes +0.1 and +7.7.
JUL 02d 17h: **Mercury 35' S of Jupiter;**
17°W of the Sun; magnitudes -0.7 and -1.9.
JUL 12d 12h: **Venus 28'N of Mars;**
26°E of the Sun; magnitudes -3.9 and +1.8.

Although just after the period we are discussing, to be certain to inform our overseas readers in time we mention the **very close passage** of Mercury just 47 arc-seconds N of Mars on August 5th at 21.9h. The respective magnitudes will be -0.4 and +1.8, with the two planets 18°E of the Sun.

Besides the occultation of 28 Sgr by Saturn on July 3rd, two other stellar occultations by major planets will occur. On JUN 16.18, Mars (magnitude +1.8) occults SAO 79984 (magnitude +9.3) as seen from the NW United States and Tahiti, when Mars is 35°E of the Sun. Then on JUL 05.08, Venus (magnitude -3.9) passes in front of SAO 80331 (magnitude +9.0), 24°E of the Sun, visible from the E United States and central Mexico.

Four **minor planets** will be brighter than 10th magnitude in the May-July period:

	Opposition Data		
Minor Planet	1989 Date	Magnitude	Declination
29 Amphitrite	MAY 03	+9.6	22°S
20 Massalia	MAY 10	+9.8	17°S
10 Hygiea	JUN 06	+9.0	25°S
4 Vesta	JUN 26	+5.3	21°S

This apparition of **Vesta** is noteworthy because it was at perihelion on April 25th and thus is unusually close to us and unusually bright. In order to aid those who wish to try to spot this object visually, the path of Vesta is plotted for the months of June and July in *Figure 28* below. That chart also plots the paths of Saturn, Uranus, and Neptune; note that Vesta will be slightly brighter than Uranus. The open star cluster M21 is shown on the chart because Vesta actually passes in front of the cluster on July 12th.

During this period, two "Earthgrazing" minor planets, **1580 Betulia** and **1917 Cuyo**, will pass near us. Their ephemerides are given later in a separate report (pp. 91-92).

THE MOON

Besides eclipsing and being eclipsed, and occulting objects, the **Moon** of course goes through its normal sequence of **phases**; in the following pattern during our period:

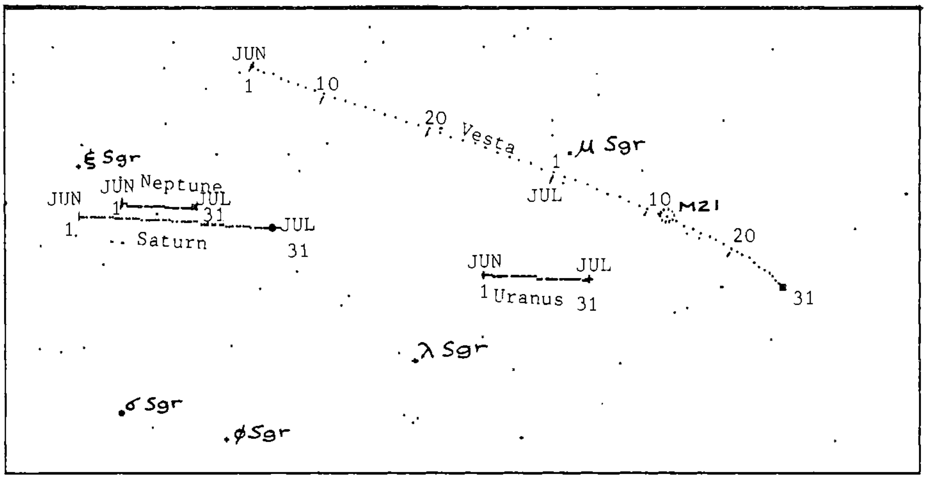


Figure 28. Paths of the minor planet Vesta and the planets Saturn, Uranus, and Neptune during June and July, 1989. North at top; this diagram covers 21°east-west. Plotted with the *Voyager* program, © Carina Software.

New Moon	First Quarter	Full Moon	Last Quarter
MAY 05.5	MAY 12.6	MAY 20.8	MAY 28.2
JUN 03.8	JUN 11.3	JUN 19.3	JUN 26.4
JUL 03.2	JUL 11.0	JUL 18.7	JUL 25.6

Another important factor in lunar observing is the Moon's **librations**, or E-W and N-S tilts in relation to the Earth. Extreme librations happen as follows in May-July, 1989:

South	East	North	West
MAY 07	MAY 10	MAY 21	MAY 25
JUN 03	JUN 07	JUN 17	JUN 20
JUN 30	JUL 04	JUL 14	JUL 17
JUL 27	JUL 31	AUG 10	AUG 14

The lunar E and W directions used above are in the International Astronomical Union usage, with Mare Crisium near the *east* limb. Note particularly favorable libration combinations on the following dates: *Southeast limb*, May 7-12, June 5-8, and July 5; *Northwest limb*, May 20-21, June 18-19, and July 18-19.

ECLIPSES

Two eclipses occur in August, just after the period discussed here. We mention them now for the sake of overseas readers. The first is a **total eclipse of the Moon** on August 17th; this event is described in some detail in a separate article in this issue (pp.89-90).

On August 31st, between 03h 34m and 07h 28m occurs a **partial eclipse of the Sun**. This event can be seen, at least in part, in S Africa, Madagascar, the SW Indian Ocean, and Antarctica. The maximum magnitude (relative coverage of the Sun by the Moon) is 0.635; in the southernmost Indian Ocean.

LUNAR OCCULTATIONS

The Moon occults two bright planets; both on July 5th. First, it covers **Venus** at about 04h, at magnitude -3.9 and 24°E of the Sun. This event is visible from E Asia and the W and central Pacific Ocean. Then there is an occultation of **Mars** at about 12h; at magnitude +1.8, 28°E of the Sun. The latter event can be seen from Spain, Italy, N Africa, and the Arabian Peninsula. Both occultation tracks are shown to the upper right in *Figure 29.*

The **Pleiades passages** of the Moon continue, with our satellite passing in front of that star cluster on June 30th, 05h, as seen from Newfoundland and Iceland. At that time the Moon will be 11 percent sunlit. The second passage is on July 27th, 11h, with a 29-percent illuminated Moon occulting the Pleiades (M45) from NW North America.

The Moon also twice moves in front of the **Beehive star cluster** (M44). The first time is on May 11th, 10h, with a 38-percent phase; the event is visible from Hokkaido and Alaska. The second M44 passage is with an 18-percent sunlit Moon on June 7th, 19h, and will be visible from the Mediterranean area.

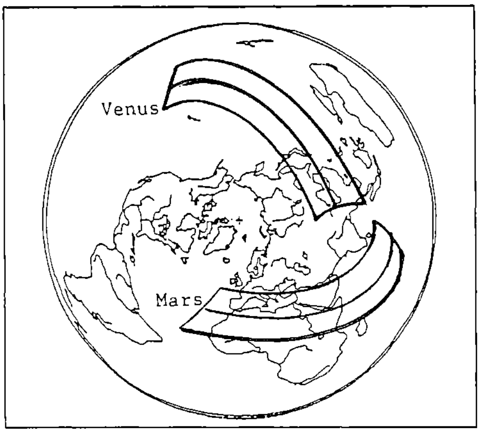


Figure 29. Areas on the Earth from which the lunar occultations of Venus and Mars will be visible on 1989 JUL 05.

The remaining noteworthy occultations by the Moon involve the bright stars **Antares** (magnitude +0.9) and **Regulus** (magnitude +1.35), as follows):

Regulus--
May 13 06h New Guinea, S Pacific.
June 09 14h S Africa, Madagascar, Antarctica.
July 06 23h S Pacific, N New Zealand, Antarctica.

Antares--
May 21 13h Indonesia, Australia-New Zealand, S Pacific.
June 17 21h E S. America, S Atlantic, S Africa, Antarctica, SW Australia.
July 15 05h E Australia, New Zealand, Antarctica, S S. America.

COMETS AND METEORS

Three **comets** that will be visible during May-July 1989, Periodic Comet Brorsen-Metcalf, Comet Shoemaker-Holt-Rodriquez, and Comet Schwassmann-Wachmann 1 have been described in "Comet Corner" (pp. 75-77). Refer to the *A.L.P.O. Solar System Ephemeris: 1989* (pp. N-2 and N-11) for ephemerides for Periodic Comet Gunn (about +12 magnitude) and Periodic Comet Pons-Winnecke (magnitude +14 to +12).

Two major **meteor showers** will take place. The Eta Aquarids peak on MAY 02.8 (reaching a zenithal hourly rate of 20) with a 27-day Moon. Then, on JUL 28, the South Delta Aquarids peak (with a similar rate) at the time of a 25-day Moon. The usual durations of these two showers are 3 and 7 days respectively. Note that moonlight will interfere with observing only the latter shower, and then just before dawn.

Two minor showers, the Tau Herculids (JUN 03; 28-day Moon) and Alpha Capricornids (JUL 29, 5 per hour, 26-day Moon), also can be observed under good conditions during this three-month period.

SATURN OCCULTS A BRIGHT STAR: 1989 JUL 03

On July 3, 1989, a *very* unusual event occurs as Saturn occults a naked-eye star. At least some of this event will be visible from all the Americas south of Alaska; and from New Zealand, southeast Australia, Antarctica, and points in the Pacific Ocean between the above. The occultation takes place less than one day after Saturn's opposition, making Saturn visible almost the entire night.

The star is 28 Sagittarii, visual magnitude +5.4, of spectral class K4, at 1950.0 coordinates α 18h 43m 19.8s, δ -22°26' 47". The star's apparent angular diameter is 0".0014, or about 9 km. at Saturn's distance. Because Saturn is moving about 11".08 per hour with respect to the star, it covers this distance in about 0.45 seconds, so occultation events should be timed to at least this accuracy. Note also that there is a 13th-magnitude companion star, 12" to the southwest of 28 Sgr.

The apparent movement of 28 Sgr in relation to Saturn is shown below in *Figure 30.* Note that the Ring System, as well as the Ball, will occult the star. An approximate schedule of occultation events is given in *Table 1* to the right. The times given in this table are *geocentric*, and may differ by up to 5 minutes for the observer's actual location. Unobservable events have their times given in italics; however, northern-hemisphere observers may see the Ring C event near 06h 54m.

Table 1. Geocentric Event Schedule for the Saturn-28 Sgr Occultation, 1989 JUL 03 U.T.

Immersion:	Ring G	$05^h54.5^m$
	Ring F	06 03.4
	Ring A, outer edge	06 05.6
	inner edge	06 18.3
	Ring B, outer edge	06 20.4
	inner edge	06 41.2
	Ring C, inner edge	*06 53.6*
	Ring D, inner edge	*07 00.5*
	Ball	06 53.3
Closest Approach (1".61 South)		*07 40.5*
Emersion:	Ball	08 30.3
	Ring D, inner edge	08 35.6
	Ring C, inner edge	08 42.4
	Ring B, inner edge	08 54.9
	outer edge	09 15.6
	Ring A, inner edge	09 17.8
	outer edge	09 30.4
	Ring F	09 32.7
	Ring G	09 54.5

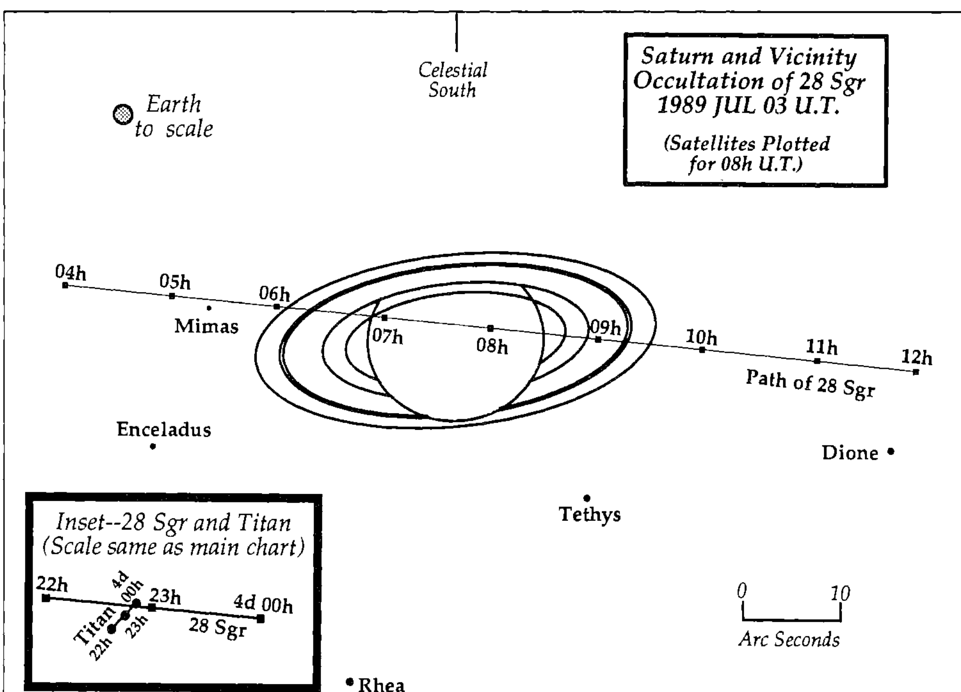


Figure 30. Geocentric path of 28 Sagittarii relative to Saturn between 04h and 12h U.T. on 1989 JUL 03. The satellites Mimas through Rhea are shown for 08h. Note the inset showing 28 Sgr and Titan between JUL 03d 22h - 04d 00h. Saturn's A, B, and C Rings are shown.

The positions of the satellites Mimas through Rhea are shown in *Figure 30* for 08h U.T., and in the inset for Titan from 3d 22h to 4d 00h. The star 28 Sgr passes 3".6 from Dione at 12h 38m and 1".2 from Titan at 22h 42m. With the latter event, we note that all positions in *Figure 30* are geocentric, and Saturn's System may be shifted in relation to the observer by as much as 0".97 (i.e., Saturn's parallax). Then, taking account of Titan's semidiameter of 0".39 and positional uncertainties for both Titan and 28 Sgr, it is very possible that Titan will occult 28 Sgr for observers in South America, Africa, the Mediterranean, and Europe.

Observing the Occultation

This occultation will be a spectacular event to watch even in a small telescope. The light from this bright star should fluctuate noticeably as it passes through Saturn's Rings, its upper atmosphere; and, possibly, Titan's atmosphere.

Another interesting observation will be to photograph 28 Sgr and Saturn together, possibly with the star shining through the Rings. We suggest at least an 8-inch (20-cm.) telescope for such a project, using a relatively long focal ratio. Then, any exposure time that gives a reasonable film image of Saturn will probably also record the star if it is visible at that time.

In terms of adding to our scientific knowledge, 28 Sgr will not be so sensitive a probe as was δ Scorpii when Voyager 2 used it to scan the Rings when that spacecraft flew by Saturn. However, Voyager 2 profiled only a single line through the Ring System, while observers of 28 Sgr can profile many lines, giving a 2-dimensional model of the Ring System. Atmospheric information about Saturn and perhaps Titan can also be obtained.

The easiest means of recording useful information for this occultation will be to visually monitor the star for brightness and color changes. For this, you need a telescope at least 4 inches (10 cm.) in aperture, a shortwave radio, and an audio tape recorder. Simply record WWV time signals and your voice comments together on the tape. Use brief monosyllables to indicate rapid brightness changes (e.g., "in" and "out").

Videotaping is a more demanding method of recording this event. A fairly large telescope, perhaps at least 14 inches (36 cm.) aperture, may be necessary, depending on the sensitivity of the camera. Those having image intensifiers may wish to use them in addition to their video cameras. To reduce background light from the Rings and the Ball, employ a long focal ratio. Using a shortwave receiver, record WWV time signals on the audio track of the tape.We strongly suggest that you experiment with your planned equipment beforehand; both on Saturn and on a star of magnitude 6-7 (i.e., allowing for some light loss for 28 Sgr).

Advanced observers may wish to use photometers or charge-coupled devices (CCD's). If so, it is best to observe at infrared wavelengths, so as to dim Saturn in relation to the star. Photometry will be difficult, but may be the only way to record the G and F rings.

Naturally, your observations need to be submitted for analysis and potential publication if they are to be of scientific use. We will be happy to receive reports of this event for possible publication in the *Journal, A.L.P.O.* Photographs, timings, graphs, and *copies* of any electronic media should be forwarded to IOTA: International Occultation Timing Association, 7006 Megan Lane, Greenbelt, MD 20770 U.S.A.

This will probably be the last issue of the *Journal, A.L.P.O.* prior to this extraordinary event. However, this occultation is already generating considerable interest and detailed forecasts should appear in *Sky & Telescope* (June, 1989, issue), *Astronomy*, and undoubtedly other magazines. IOTA members in the zone of visibility should receive detailed predictions for their own observing sites. Some references available at the time of writing are given below.

References

Dunham, David W. "Occultation of 28 Sagittarii by Saturn in July." *Occultation Newsletter, 4,* No. 11 (March, 1989), 268-269; tabular data are given on pp. 274-275, while maps of the visibility zone are given on pp. 281-283. This forecast describes 28 Sgr as visual magnitude +5.4 and spectral class K4, based on the *Yale Bright Star Catalog*. Some other forecasts cite magnitude +5.8 and spectral class K2.

International Astronomical Union Circular, 24 March 1989. "Possible Occultation by Titan." (L.H. Wasserman)

Millis, Robert L. "Planetary Appulses and Occultations." Royal Astronomical Society of Canada, *Observer's Handbook--1989.* Toronto: Royal Astronomical Society of Canada, 1988. pp. 154-156.

________. Personal Communication, August 17, 1988 and April 2, 1989.

Mink, Douglas J. "Occultations by Planets, 1988-1999." Poster displayed at the 19th Annual Meeting of the Division for Planetary Sciences, 10-13 November 1987, Pasadena, California.

"Occultations by Planets." *The Handbook of the British Astronomical Association, 1989.* London: British Astronomical Association, 1988. p.27. The event times listed there are incorrect.

The second total lunar eclipse of 1989 takes place on August 17th, U.T. (Universal Time). *Figure 31*, below, shows the portions of the Earth that can see this event along with the Universal Times of its several phases. South and Central America, eastern North America, and westernmost Europe and Africa will see the entire event. Most of the remainder of Europe and Africa, and central North America will see all of totality. Only the final portions of the eclipse will be visible from western North America. Likewise, only the beginning phases can be seen from the Middle East and South and Central Asia. Note that the times given in *Figure 31* are in U.T. and, for North America, most or all of the eclipse will take place on the evening of August 16th local time.

As always, the penumbral contacts (P1 and P4) will be unobservable. Observers should begin to see darkening on the Moon's east limb (celestial directions) by about 01h, and the last apparent shading should depart from the west limb by perhaps about 05h 20m. Partial umbral phases fall between the first and second (U1 and U2) and the third and fourth (U3 and U4) umbral contacts. The total phase, falling between umbral contacts U2 and U3, will be unusually deep. "Umbral magnitude 1.604" means that, at mid-eclipse, the part of the lunar limb outermost in the umbra will be 0.604 lunar radii inside the umbra. Describing the situation another way, the center of the Moon will pass only 10 arc-minutes south of the center of the umbra. Nonetheless, this may be a bright eclipse because of the lack of recent large-scale volcanic eruptions to darken the Earth's upper atmosphere.

The outlines of the umbra (enlarged 2 percent due to the effects of the Earth's atmosphere) at each of the four umbral contacts are shown in *Figure 32*, below. This figure also shows the positions of the 20 craters recommended later for crater contact timings. In *Figure 32*, celestial north (**N**c) is at the top, with lunar north (**N**l) tilted 17°.8 clockwise. The first umbral contact will be at celestial position angle 057° and the fourth will be at 253°. (Position angle is measured 0-360°, counterclockwise starting at the north.)

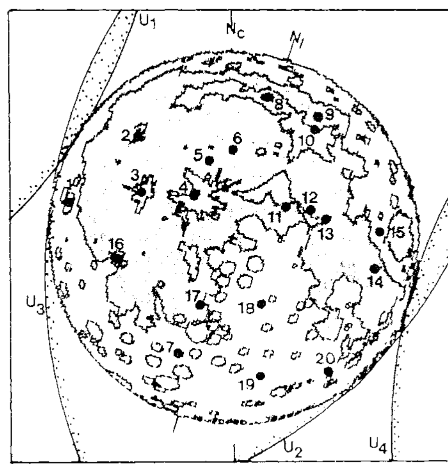
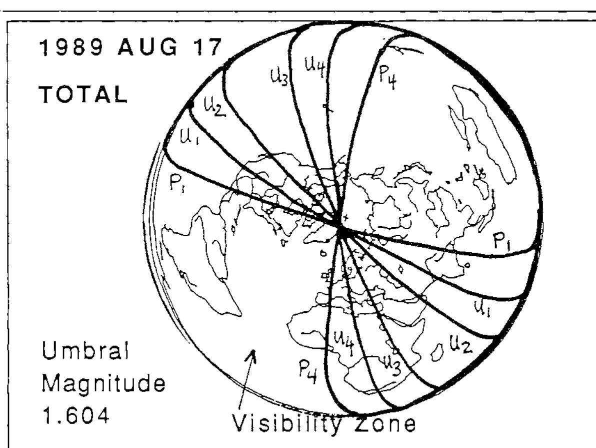


Figure 32. Edge of the umbral shadow (enlarged 2 percent) at each of the four umbra-limb contacts during the total lunar eclipse of 1989 AUG 17. Celestial and lunar north and the positions of the 20 craters listed on p. 90 are also plotted.



P1 = First Penumbral Contact; 00h 22.8m

U1 = First Umbral Contact; 01h 20.7m

U2 = Second Umbral Contact (begin totality); 02h 19.9m

------ Middle of the Eclipse; 03h 08.2m

U3 = Third Umbral Contact (end totality); 03h 56.4m

U4 = Fourth Umbral Contact; 04h 55.7m

P4 = Fourth Penumbral Contact; 05h 53.4m

Figure 31. Zones of visibility of the phases of the total lunar eclipse of 1989 AUG 17. All times are in Universal Time (U.T.).

A variety of scientifically useful observations can be done at any total lunar eclipse. Such studies were described in the forecast of the 1989 FEB 20 eclipse in the previous issue (*J.A.L.P.O., 33,* Nos. 1-3 [January, 1989], pp. 32-35): (1) making verbal descriptions, drawings, and/or photographs throughout the eclipse (this might include videotaping); (2) determining the *Danjon Luminosity*; (3) visual whole-disk photometry; (4) photoelectric whole-disk or spot photometry; (5) searches for *Lunar Transient Phenomena*; ; (6) timing stellar occultations, particularly of faint stars; (7) umbra-limb contact timings and (8) umbra-crater contact timings.

Projects (3), (4), (6), and (8) above require information specific to this eclipse. First, photometry of the eclipsed Moon requires fairly bright comparison objects. *Figure 33* below shows the position of the Moon in the sky at mid-eclipse. Saturn (lower right), at magnitude +0.3, is the only bright planet at all near the Moon. Fomalhaut (magnitude +1.16) is southeast of the Moon, while Altair (magnitude +0.77) is to its northwest.

Site-specific predictions of occultations may be obtained from the International Occultation Timing Association (*IOTA*; address given in previous article; p. 88). Some European observers can see occultations of the stars 44 and 45 Capricorni, magnitudes +5.99 and +5.90 respectively, during totality.

In timing the umbral entrances (*immersions*) and exits (*emersions*) of craters, observers can plan using the following times, rounded to the nearest five minutes to preclude bias (times are: immersion; emersion)

1. **Grimaldi (01h 25m; 04h 00m)**
2. **Aristarchus (01h 30m; 04h 10m)**
3. **Kepler (01h 35m; 04h 10m)**
4. **Copernicus (01h 40m; 04h 20m)**
5. **Pytheas (01h 40m; 04h 20m)**
6. **Timocharis (01h 40m; 04h 25m)**
7. **Tycho (01h 55m; 04h 20m)**
8. **Plato (01h 45m; 04h 25m)**
9. **Aristoteles (01h 50m; 04h 30m)**
10. **Eudoxus (01h 55m; 04h 35m)**
11. **Manilius (01h 55m; 04h 35m)**
12. **Menelaus (01h 55m; 04h 35m)**
13. **Plinius (02h 00m; 04h 40m)**
14. **Taruntius (02h 10m; 04h 50m)**
15. **Proclus (02h 10m; 04h 50m)**
16. **Gassendi (01h 40m; 04h 10m)**
17. **Birt (01h 50m; 04h 25m)**
18. **Abulfeda E (02h 00m; 04h 30m)**
19. **Nicolai A (02h 10m; 04h 35m)**
20. **Stevinus A (02h 15m; 04h 45m).**

Whatever amount and type of eclipse observations that you make, they will be useful to others only if you send them to our Lunar Eclipse Recorder, Francis G. Graham (address on inside back cover). We wish you clear skies!

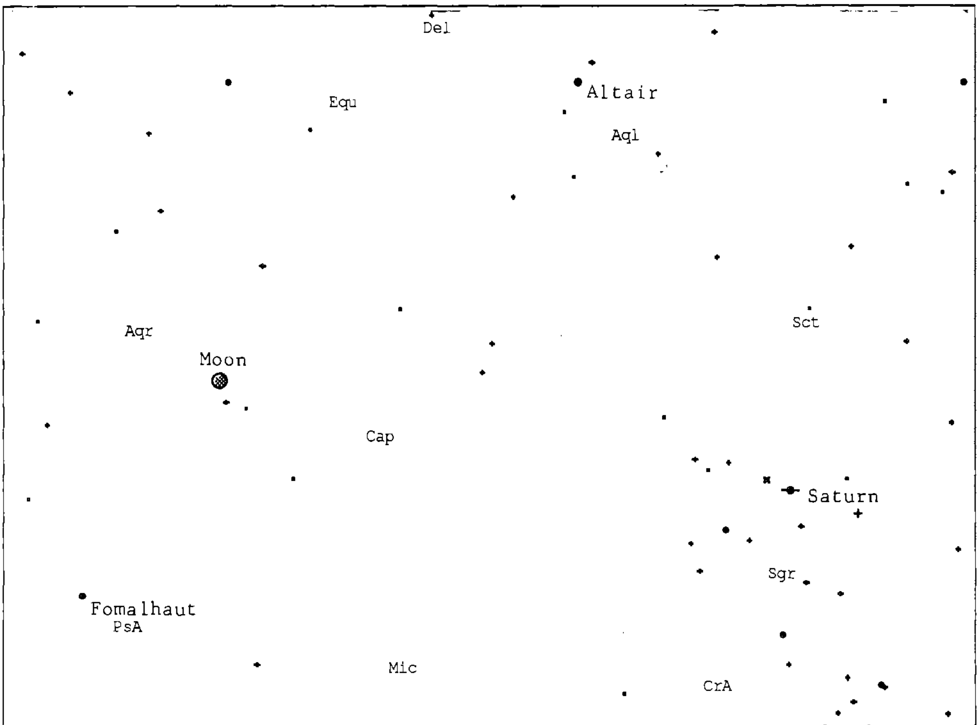


Figure 33. The totally eclipsed Moon in the sky at mid-eclipse, 1989 AUG 17, 03h 08m U.T. as seen from New York City. North at top; field 84° wide and 59° high. Plot generated by *Voyager* program © Carina Software.

Dr. Richard Binzel of the Department of Earth, Atmospheric, and Planetary Sciences of the Massachusetts Institute of Technology has kindly forwarded ephemerides for two minor planets that will approach Earth closely in the next few months. This is a unique chance for astrometry and photometry of the two bodies.

The first object, Minor Planet **1580 Betulia**, an object of high inclination and eccentricity, will pass 0.185 astronomical units from the Earth (28 million km.) on 1989 MAY 27, at which time it will be moving 5°.2 per day to the south-southwest. Its 0h U.T. ephemeris for the period that it is at least as bright as magnitude +15.5 is given below.

1580 Betulia

1989 U.T.Date	1950.0 Coordinates α h	m	δ °	'	Magnitude V	Solar Elong.
MAY 04	17	39.39	+62	23.5	+15.5	95°W
06	17	23.53	61	50.6	15.4	96°W
08	17	05.82	61	02.2	15.2	98°W
10	16	46.28	59	52.8	15.0	100°W
12	16	25.04	58	15.6	14.8	102°W
14	16	02.40	+56	02.0	+14.6	105°W
15	15	50.70	54	38.4	14.5	106°W
16	15	38.81	53	01.7	14.4	108°W
17	15	26.83	51	10.5	14.2	110°E
18	15	14.83	49	03.2	14.1	111°E
19	15	02.89	46	38.4	14.0	113°E
20	14	51.08	43	54.8	13.8	115°E
21	14	39.48	40	51.7	13.7	117°E
22	14	28.14	37	28.5	13.6	119°E
23	14	17.13	33	45.7	13.5	121°E
24	14	06.50	29	44.6	13.4	123°E
25	13	56.27	25	27.4	13.3	124°E
26	13	46.47	20	57.6	13.2	126°E
27	13	37.13	16	19.5	13.2	127°E
28	13	28.26	11	38.2	13.2	127°E
29	13	19.84	6	58.7	13.2	127°E
30	13	11.89	+ 2	25.8	13.3	127°E
31	13	04.39	- 1	56.4	13.3	126°E
JUN 01	12	57.34	6	04.8	13.4	126°E
02	12	50.71	9	57.5	13.5	125°E
03	12	44.49	13	33.5	13.6	123°E
05	12	33.20	-19	55.0	+13.9	121°E
07	12	23.33	25	13.9	14.1	118°E
09	12	14.71	29	39.2	14.4	115°E
11	12	07.22	33	20.4	14.6	113°E
13	12	00.70	-36	26.0	+14.8	111°E
14	11	57.78	37	47.8	14.9	110°E
15	11	55.07	39	03.3	15.0	109°E
16	11	52.54	40	13.1	15.1	108°E
17	11	50.20	41	17.9	15.2	107°E
18	11	48.03	42	18.2	15.3	106°E
19	11	46.02	43	14.4	15.4	106°E
20	11	44.17	-44	07.0	+15.5	105°E

The second such object is Minor Planet **1917 Cuyo**, also with an eccentric orbit although with a smaller inclination. It approaches to 0.143 astronomical units (21 million km.) of Earth on 1989 OCT 10, then moving about 3°.4 per day south-southeast. The 0h U.T. ephemeris for the period that it is magnitude +15.5 or brighter follows.

1917 Cuyo

1989 U.T.Date	1950.0 Coordinates α h	m	δ °	'	Magnitude V	Solar Elong.
AUG 17	19	52.16	+40	56.5	15.5	120°E
22	19	48.45	40	22.4	15.3	119°E
27	19	45.60	39	19.3	15.1	119°E
SEP 01	19	43.98	37	42.0	14.9	118°E
06	19	44.01	35	23.5	14.7	118°E
11	19	46.11	+32	13.6	+14.4	118°E
13	19	47.63	30	39.9	14.3	118°E
15	19	49.59	28	54.2	14.2	118°E
17	19	52.01	26	54.8	14.1	118°E
19	19	54.95	24	40.0	13.9	119°E
21	19	58.44	22	07.5	13.8	119°E
23	20	02.53	19	15.1	13.7	119°E
25	20	07.30	16	00.3	13.5	119°E
27	20	12.81	12	20.7	13.4	120°E
29	20	19.13	8	14.3	13.3	120°E
OCT 01	20	26.35	+ 3	39.9	13.2	120°E
03	20	34.57	- 1	22.0	13.1	120°E
05	20	43.88	6	48.9	13.0	120°E
07	20	54.39	12	35.4	12.9	119°E
09	21	06.21	18	33.2	12.9	118°E
11	21	19.41	24	31.7	13.0	117°E
12	21	26.57	-27	27.6	13.0	117°E
13	21	34.09	30	19.5	13.0	116°E
14	21	42.00	33	05.9	13.1	115°E
15	21	50.28	35	45.7	13.1	114°E
16	21	58.94	38	18.0	13.1	114°E
17	22	07.96	40	42.0	13.2	113°E
18	22	17.34	42	57.1	13.3	112°E
19	22	27.04	45	02.8	13.3	111°E
20	22	37.05	46	58.9	13.4	110°E
21	22	47.34	48	45.5	13.5	110°E
23	23	08.57	-51	50.3	+13.6	108°E
25	23	30.37	54	19.0	13.7	107°E
27	23	52.30	56	14.9	13.9	106°E
29	00	13.93	57	41.7	14.0	105°E
31	00	34.85	-58	43.5	+14.1	104°E
NOV 01	00	44.93	59	06.2	14.2	104°E
02	00	54.73	59	24.2	14.3	104°E
03	01	04.20	59	37.8	14.3	104°E
04	01	13.34	59	47.5	14.4	103°E
05	01	22.14	59	53.7	14.4	103°E
06	01	30.57	59	56.7	14.5	103°E
07	01	38.64	59	56.8	14.5	103°E
08	01	46.36	59	54.4	14.6	103°E
09	01	53.72	59	49.7	14.6	103°E

-- *Continued* --

1917 Cuyo--*Continued.*

1989 U.T.Date	1950.0 Coordinates α h m	δ ° '	Mag-nitude V	Solar Elong.
NOV 10	02 00.73	-59 43.0	+14.7	102°E
12	02 13.76	59 24.4	14.8	102°E
14	02 25.53	58 59.8	14.9	102°E
16	02 36.15	58 30.6	15.0	102°E
18	02 45.74	57 57.5	15.0	102°E
20	02 54.40	57 21.2	15.1	103°E
22	03 02.24	56 42.1	15.2	103°E
24	03 09.35	56 00.7	15.3	103°E
26	03 15.82	55 17.2	15.3	103°E
28	03 21.74	54 31.8	15.4	104°E
30	03 27.17	53 44.7	15.5	104°E
DEC 02	03 32.17	-52 56.1	+15.5	104°E

The above data originally appeared in the 1989 edition of the *Ephemerides of Minor Planets,*, prepared by the Institute of Theoretical Astronomy of the U.S.S.R. (Note that ephemerides of the brighter minor planets can be found in the *A.L.P.O. Solar System Ephemeris: 1989.*)

At least medium-size telescopes will be needed to observe these objects; and periods of bright moonlight should be avoided (see p. 86). Also, note that the asteroids will at times have high northerly or southerly declinations.

Photographic, photometric, and other observations of these two asteroids should be sent to the Minor Planets Recorder, Frederick Pilcher, at the address given on the inside back cover.

BRIEF REPORT ON THE 1987-89 PERIHELIC APPARITION OF MARS

By: Jeff D. Beish, A.L.P.O. Mars Recorder

The A.L.P.O. Mars Section's meteorological survey and computer analysis is an ongoing process. To date, we have evaluated almost *18,000* observations of Mars in the A.L.P.O. Mars Observational Report Archives (*MORA*). During the last four apparitions alone, the International Mars Patrol (*IMP*) contributed more than 12,000 observations. We also have available the Charles F. Capen Memorial Library and Historical Archives with thousands of books and papers on, and nearly 30,000 photographs of, Mars taken with some of the world's largest planetary telescopes.

In this apparition, over 900 letters were received from interested amateur and professional astronomers in 38 countries and United States territories. However, persons in only 20 of these areas contributed observations.

The 1987-89 perihelic observing season for Mars began with Don Parker's observation on 1987 NOV 09 . Reports continued to be received by the Mars Recorders as of 1989 FEB 17. Mars reached opposition on 1988 SEP 28 and was closest to the Earth . on 1988 SEP 22, at a distance of 0.39314 astronomical units (58,813,000 km. or 36,545,000 mi.) with an apparent disk diameter of 23.85 arc-seconds.

So far this apparition, 300 telescopes have been used by IMP observers, with a mean aperture of 12.7 in. (32 cm.). Although most of the telescopes used ranged from 3 to 16 inches (7.6-41 cm.), several astronomers used reflectors of 20-90 inches (51-229 cm.) and refractors of 6-33 inches (15-84 cm.) aperture.

By 1989 MAR 28, 268 observers had contributed 5,768 Mars observations (4121 drawings, 1440 photographs, 12 charge-coupled device images, 191 micrometer measurements, and 4 videotapes with several hours of images), indicating high interest in the scientific study of the planet. A very successful observing program indeed!

A.L.P.O. Mars Recorders Jeff Beish and Don Parker represented amateur astronomy at the *Fourth International Conference on Mars* at Tucson, Arizona, on January 10-15, 1989. "Telescopic Observations of Mars in 1988," by L.J. Martin, P.B. James, D.C. Parker, and J.D. Beish, was the lead-off paper at this meeting. A poster of photographs of Mars by A.L.P.O./IMP astronomers also was presented and was very well-received.

After a thorough search and computer analysis of yellow clouds and dust storms on Mars over the past 100 years, Mars Recorder Beish predicted that a dust storm would occur in the first week of June, 1988. A major dust storm did occur, on 1988 JUN 03, and persisted for two weeks; a report on it was published in the March, 1988, issue of *Astronomy*. Further predictions were published later in the IMP *Martian Chronicles*. Articles in *Astronomy* and *Sky & Telescope* predicted that dust storms were probable on August 10 and in the last weeks of November, 1988. No dust storm was reported in August. However, what began as a quiet Thanksgiving ended with the second major dust storm for 1988 and began a most successful amateur-professional cooperative observing experiment. A telephone call was made to NASA-Ames scientist Terry Z. Martin to alert him that a dust storm had occurred on or about 1988 NOV 25 and was expanding quite rapidly. Subsequently, he flew to Hawaii and observed with Mauna Kea's 120-inch (305-cm.) telescope in the infrared, when he observed higher-than-normal background dust in the martian atmosphere.

Naturally, detailed reports on the 1987-89 martian apparition will appear in later issues of the *Journal, A.L.P.O.*

A.L.P.O./W.A.A. Convention.—Since our last issue, some more aspects of our 1989 convention have been decided. The A.L.P.O. will meet with the W.A.A. in Pasadena, California, as follows: Tue. AUG 22, Palomar Mountain tour; Wed. AUG 23, Griffith Park Planetarium–North American Rockwell International tour; Thu. AUG 24, paper sessions followed by all-night Planetfest Neptune Voyager 2 flyby; Fri. AUG 25, paper sessions with W.A.A./A.L.P.O. Banquet in evening; Sat. AUG 26, A.L.P.O. Business Meeting and Workshop and Phobos Probe presentation.

What's left to decide are charges and lodging. To keep updated on such, write the W.A.A. Secretary, Margaret Matlack, 13617 E. Bailey, Whittier, CA 90601.

This meeting will overlap the Planetary Society's 5-day *Planetfest '89*, which includes *Voyager Watch*, with the option of day-by-day registration. Information on this meeting can be had from: Susan Lendroth, The Planetary Society, 65 North Catalina Ave., Pasadena, CA 91106. We recommend that A.L.P.O. members also register for Planetfest '89 and arrange their lodging through them.

A.L.P.O. members are invited to give papers, limited to 15-20 minutes. Please send your abstract and list of audio-visual needs to the A.L.P.O. Director/Editor, John Westfall, *by July 15, 1989*. Bring a camera-ready copy of your paper, along with *prints* of any photographic illustrations, with you to the convention for inclusion in the *Proceedings*. Display material should be sent to Dr. Westfall *to arrive by August 10, 1989*. See you there!

Other Meetings.—We remind readers of two meetings announced in our last issue: the Centennial Meeting of the Astronomical Society of the Pacific (June 21-25); and the Division of Planetary Sciences (Oct. 31-Nov. 3). We can now add three others to the list:

—The famous **Riverside Telescope Maker's Conference**, May 26-29, 1989 (Memorial Day weekend), at Camp Oakes at 7,300 feet elevation in the San Bernardino Mountains. To find out more, write: RTMC, 8642 Wells Ave., Riverside, CA 92503.

—The next stop is the **Texas Star Party**, held May 29-June 3, 1989, (*near New Moon*) at the dark-sky Prude Ranch in the Davis Mountains of West Texas. Obtain information from: Bobby R. Braley, Jr., T.S.P. Registrar, P.O. Box 386, Wylie, TX 75098.

—Then there is the meeting of the **American Astronomical Society** in Ann Arbor, Michigan, on June 11-15, 1989. To obtain a meeting brochure, write: American Astronomical Society, 2000 Florida Ave., N.W., Suite 300, Washington, DC 20009.

A.L.P.O. Supporters.—It is a pleasant task now and then to list those who choose to contribute more than the minimum dues to the A.L.P.O. In recent months, our *Sponsors*, who now contribute $40 per year, are: **Darryl J. Davis, Philip R. Glaser, José Olivarez, Dr. A.K. Parizek, Dr. Howard W. Williams, Phillip D. Wyman**, and the **Ventura County Astronomical Society**. Those who are *Sustaining Members*, which is now $20 per year, are: **Reginald F. Buller, Harry D. Jamieson, Daniel Louderback, David McDavid, W.R. Pettyjohn, Timothy J. Robertson, Richard Stanton, Harold J. Stelzer, Michael E. Sweetman, Ken Thomson, Joseph P. Vitous, Matthew Will,** and the **Kansas Astronomical Observers**. (If you should be on one of these lists and are not, contact Membership Secretary Harry D. Jamieson [address on inside back cover].) Our thanks to the people above!

A.L.P.O. Foreign Membership Fund.—This fund exists to pay the dues of deserving amateurs who live in areas where dollars are even harder to come by than here. Our current balance in this fund is $46; after granting memberships to: Evan M. Mbozi (Zambia, central Africa), Yuan Qian (People's Republic of China), and Janos Papp (Hungary). We welcome donations of any amount to this fund (sent to the A.L.P.O. Director Westfall) in order that persons of such caliber can belong to our organization.

Optics for Central Africa.—Mr. Mbozi (see above) writes that at his school not even binoculars are available. If you have a little-used small telescope, consider donating it to this institution. We understand that if a Certificate of Donation is enclosed, no duty will be charged. If you would like to help astronomy in Zambia, write Mr. Evan M. Mbozi, Matero Girls Secondary School, P.O. Box 33094, Matero, Lusaka, Zambia.

Some More Jupiter Handbooks.—Jupiter Recorder Dr. P. Karl Mackal has put together about a dozen of the previously out-of-print *Jupiter Handbooks*, and is making them available for $4 per copy, sent to his address on the inside back cover.

Astronomy Day, 1989.—In 1989, this event falls on May 13th, civil time, when A.L.P.O. members, working with their local groups or institutions, can help promote astronomy. We suggest evening public observing sessions viewing the 9-day Moon, Mars, Jupiter, and Saturn; check "Coming Solar System Events " (pp. 84-86) for ideas. Talks to the public and to schools are also encouraged.

New Astronomy Computing Journal.— We've now received the first two quarterly issues of *Celestial Computing,* which is devoted to computer applications in astronomy, astrometry, and spaceflight. For example, the second issue's feature article was "A Computer Program for Predicting Lunar Eclipses." An IBM-compatible program disk subscription is also available. *Until December 31, 1989, A.L.P.O. members receive a discount 1-year subscription;* $19.95 for the journal and $11.95 for the disk. The address is: Science Software, 7370 South Jay Street, Littleton, CO 80123-4661.

New Planetary Observing Group.—A French-language group has recently started up; the **G.I.O.S.P.**, or *Groupement International d'Observateurs des Surfaces Planetaires*, who publish the journal *Pulsar.* Its Honorary President is our Mars Recorder Donald C. Parker, and the President is Jupiter Recorder Jean Dragesco. Write either person for information on how to join (their addresses are on the inside back cover).

LARGE Amateur Telescope Planned.— A San Francisco Bay Area-based amateur non-profit organization has purchased a 72-inch (1.8-meter) mirror blank and plans to build a computer-controlled telescope around it. The instrument would be available for both amateur and professional astronomical research, including A.L.P.O. projects. To find out how you can help this project, write: Group 70, c/o Epoch Instruments, 2331 American Avenue, Hayward, CA 94545.

Uranus on Video—The Astronomical Society of the Pacific now offers a 30-minute VHS-format videotape of the Voyager-Uranus encounter, including a booklet. The cost is $34.95 (California residents, add sales tax; foreign orders, add $5.00), and the tape can be ordered from: A.S.P., Uranus Tape Orders, 390 Ashton Ave., San Francisco, CA 94112.

Ninth Planet News.—Not all readers may realize that occultations and eclipses in the Pluto/Charon system can be observed with larger amateur instruments. *Ninth Planet News* is a newsletter for observers of these phenomena, and can be obtained from Edward F. Tedesco, IPAC/CalTech, MS 100-22, Pasadena, CA 91125.

Congratulations, José Olivarez.— Lunar and Planetary Training Program Director, José Olivarez, celebrated his 20th anniversary as Director of the Wichita, Kansas, Omnisphere and Science Center, with a southern star-gazing trip to Chile. If you are interested in joining him in a return visit early in 1990, write him at his address on the inside back cover.

PUBLICATIONS OF THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

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

① ***The A.L.P.O. Solar System Ephemeris: 1989.*** $6.00 in the United States, Canada, and Mexico; $8.50 elsewhere (airmail included). 100 pages of tables, graphs, and maps describing the positions and appearances of the Sun, Moon, each major planet, the readily observable planetary satellites, Minor Planets, meteors, and comets. Make payment to "A.L.P.O."

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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]
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32 (1987-88); 1-2, 5-6, and 11-12. [each $2.50] ***33*** (1989); 1-3. [each $2.50]
Current Issue [***33***, 4-6]—$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 dues will expire (e.g., "33.06" means Volume 33, Numbers 4-6). 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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